Subsurface Investigation Report

6301 Campeau Dr., Ottawa, ON, K2K 3E9

Abstract

This report presents the findings of a Subsurface Investigation completed at the 6301 Campeau Dr. parcel, in the City of Ottawa, ON, K2K 3E9, and issue recommendations for a proposed Townhouses and 6 Storey Appartment Buildings development. It provides technical information about the subsurface conditions at 15 borehole locations compiled from field sampling and testing and a subsequent laboratory testing program of soils. The majority of the site was found to be of shallow bedrock conditions. The far west of the property was found to have the greatest depth to bedrock at 7.14 m overlain by very stiff clay. The borehole locations are shown in figure 2 in page 10. The information reviewed also includes readily available geologic information from the Geological Survey of Canada (GSC) and local climate data from Environment Canada.

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[1] For the account of Bayview Hospitality Holdings Limited (BHHL) as per proposal in email dated March 10, 2020 and subject to the user agreement in page 26 .

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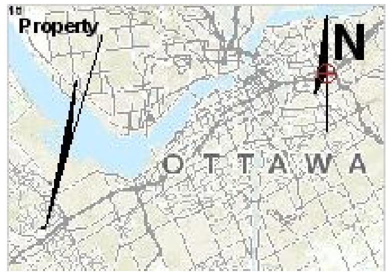


Figure 1: Key Plan

1 Introduction

This document reports the findings of a subsurface investigation completed at 6301 Campeau Dr., in the City of Ottawa, ON, K2K 3E9, located to the west of Ottawa, ON as shown in the key plan in fig.1 in page 7 and having extents and geometry shown in figure 2 in page 10. The geotechnical materials in Ottawa and the surrounding areas are largely influenced by a history of glaciation, glacio-fluvial activity and the Champlain Sea. Common overburden materials include clay, very sensitive silty clay, till, boulder till, clean sand and silty sand overlying sedimentary rocks. Igneous and metamorphic rocks are also present. Organic materials have also influenced numerous soil deposits.

This property was subject to a preliminary subsurface investigation under report 44-BHH-R0 dated November 23, 2019. The investigation was carried out by advancing 15 boreholes through overburden soils and bedrock and other available exploration techniques for characterization of bedrock outcrops for engineering purposes. The information compiled from the exploration and sampling and testing completed in the boreholes and a subsequent laboratory testing program of soils and rock is to assist in the design and construction of a proposed Townhouses and 6 Storey Appartment Buildings development. The information reviewed also includes readily available geologic information from the Geological Survey of Canada (GSC), and local climate data from Environment Canada.

2 Report Organization

The body of this report and its appendices constitute the entire report. The discussion presented under sections in the body may refer to further information and/or background and/or details in the appendices. The reader is responsible of reviewing the information in the appendices. Other references may be presented as footnotes.

Part I
Investigation

3 Sampling and Testing

The field and laboratory program set out in our proposal dated March 10, 2020, is guided by the following standards and documents:

- 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,
- ASTM D1586 - 11 based Dynamic Cone Penetration Test (DCPT),
- ASTM D2113 - 14 Standard Practice for Rock Core Drilling and Sampling of Rock for Site Exploration;
- United States. Soil Conservation Service., United States. Department of Agriculture. (1985). Chapter 4: Engineering Classification of Rock Materials. In National engineering handbook. Washington, D.C.: U.S. Dept. of Agriculture, Soil Conservation Service .
- Method C of ASTM D7012-14 Standard Test Methods for Compressive Strength and Elastic Moduli of Intact Rock Core Specimens under Varying States of Stress and Temperatures.
- Caterpillar Inc. (2000). Handbook of Ripping. Twelfth Edition. Caterpillar Inc., Peoria, IL, 33 p.

The ASTM D1586 tests were completed using an “auto safety” hammer rated at 60% energy.

The program also included proving of bedrock depth, a site recognizance to identify some bedrock outcrops and engineering assessments of the bedrock using a hammer with pick end, a pocket knife, a tape measure, a compass and a digital inclinometer.

The program included in addition a laboratory review of samples recovered from the field and two samples 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 2 in page 10 and fig. 3 in page 11. 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.

3.1 The Probe for Bedrock Depth

The depth to bedrock is often an important consideration in design and construction. The probe for bedrock depth (BD) is not straight forward and it is an issue that still challenge geotechnical engineers using standard drilling equipment. The probe for BD may well be considered a field test. The presence of boulders is often the culprit of the failure of all methods used to prove bedrock depth. Any method considered as acceptable practice to determine BD can fail, however they can fall into confidence levels. It appears fit to rate confidence levels of the probe of BD as low, medium and high. The methods used ordered in low to high order are: shallow manual provehole refusals, sampler and DCPT refusals, auger refusals, rock cores and standard 1.52 m rock cores.

There is general agreement that from a practical stand point 1.52 m rock cores should be considered proof of bedrock depth for shallow to deep deposits for most developments. As such, they represent the high confidence level. For deep deposits auger refusals and shorter rock cores could be rated at medium confidence level and sampler and DCPT refusals at low confidence level. Proveholes are only feasible at shallow depth for which they could be assign a low confidence level. A probe for BD by any of the methods are reasonably justified for many engineering purposes such as site class assignments, pile lengths for smaller projects, etc..

In this report, based on site conditions and experience, 1.52 m rock cores, 0.3 m or greater rock cores at 1.2 m or less depth where one or more instances of bedrock outcrops are visible within a few meters and proveholes at 0.3 m or less are assigned a high confidence level. Shorter than 1.52 m rock cores deeper than 1.2 m are assigned the medium confidence level and all other refusals are assigned a low confidence level.

Part II
Findings

4 Physical Settings, Strata and Topography

The site is densely treed as seen in current available satellite images at the time of writing. Figure 2 in page 10 depicts the topography, the hole locations, the footprint of the proposed buildings and a schematic subdivision in three main areas. Area A, area B and area C which are described in fig. 3 in page 11. The level contours are indicated at each 0.5 m in available plans.

Area A is a flatter portion and sits at 8 m lower than the highest point of the site. Area A forms a ± 2 m depth basin with respect to the elevation of the sidewalk at Campeau Drive. Area A is bound to the north and west by the edge of fill of large rocks as seen in the figure, much like the sides of a dike possibly placed as part of the construction of Campeau Dr. and the existing developed land adjacent on the west side. To the south and east area A is

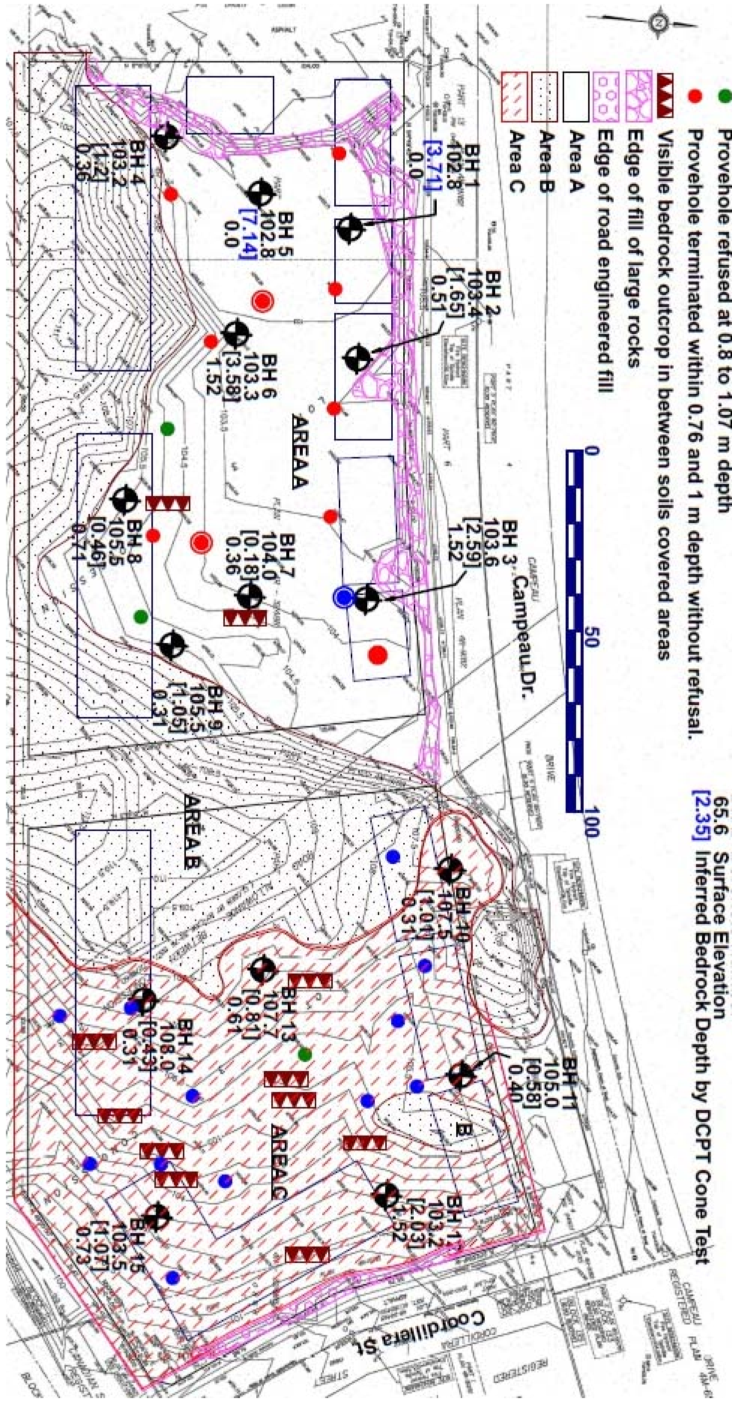


Figure 2: Test hole Locations Plan

DEFINITIONS AND NOTES FOR THE BOREHOLE LOCATIONS PLAN

1. Area A: soils covered area. A few outcrops shown are visible on the surface.
2. Area B: Gneiss Bedrock Outcrop. The bedrock near the high portions are largely exposed and/or trees are more scarcely present at lower elevations with multiple bedrock outcrops visible.
3. Area C: Area covered with soils with multiple bedrock outcrops distributed throughout. The visible outcrops shown were the outcrops mapped. Multiple instances were not mapped.
4. The symbol for visible bedrock outcrop denotes a particular location in which the rock is visible to an extend greater than 3 m and have features indicativeof a massive outcrop unit.
5. Proveholes are holes that are advanced with blows of a hand held sledge hammer to a steel rod.
6. A provehole refusal is a provehole that cannot be advanced with numerous blows on a hard surface.
7. A provehole terminated is a provehole that is terminated because the steel rod cannot be physically pulled out by hand if further advanced.
8. Locations and elevations are approximate.
9. The areas boundaries are rough schematic boundary lines of limited precision.

Figure 3: Definitions and Notes for the Test hole Locations Plan

bound by bedrock outcrops. The differences in elevations can readily be noted by the level contours. From the stand point of ground conditions area A is fairly distinct from areas B and C.

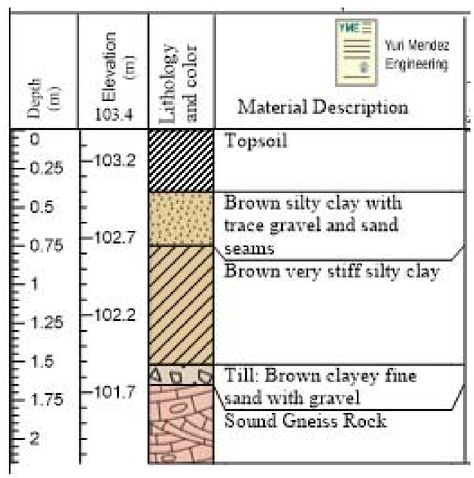
The schematic rough outline representing area B denotes a zone of higher elevations in which a massive un-jointed very lightly weathered *gneiss* bedrock outcrop can be seen on the surface. Large trees are not present in this higher zone and the outcrop is easily seen between some scarce shrubs and grass. At lower elevations area B is somewhat similar to area C with the outcrop more visible on the surface, particularly along the steeper portions.

Jointed gneiss bedrock outcrops were noted to be scattered throughout the sloping ground sloping downward to the east in area C. These outcrops are between soil covered areas. Smaller portions were seen to be massive and the joints were seen to be of random orientation and dip forming blocks roughly 0.3 to 0.9 m in size. Some boulder size rock blocks are also seen on the surface. Some hand dug pits were at some locations advanced to bedrock or exposed a narrow portion of a rock surface in the extend of the pit. Sampler or probe tool refusals indicate an object preventing further advance of the hole which could be bedrock or boulders. The outcrops shown in area C are just a sample of the population of outcrops that is greater through area C.

The geology data base by Belanger J. R. 1998 suggests 0 to 1 m of overburden soils underlain by Paragneiss bedrock at this site.

5 Surface and Subsurface Materials

The site surface at areas A and C shown in fig. 2 in page 2 are covered with near surface organic topsoil materials. At the higher portions of area B the massive



a)

Figure 4: Soil encountered in area A (a) and area C (b)

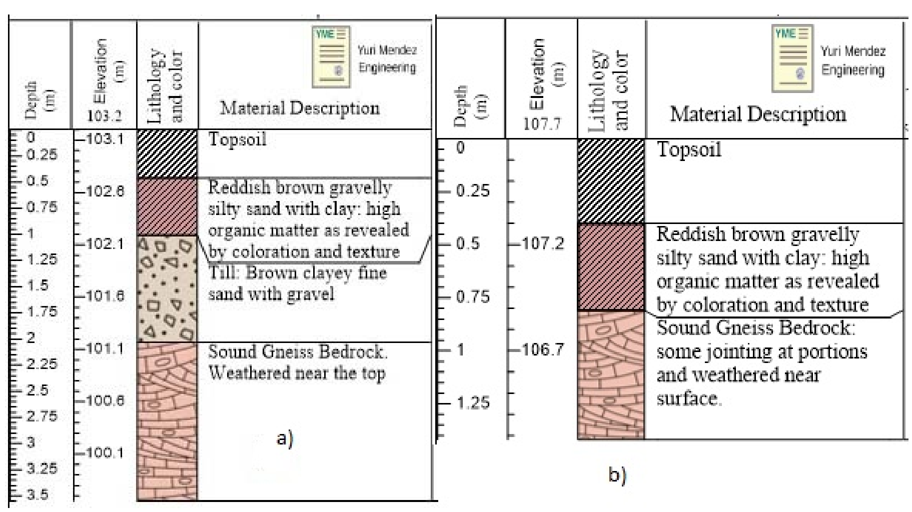


Figure 5: Most typical soils in area A (a) and area C (b)

gneiss bedrock outcrop is exposed. At lower portions of area B, organic soils are scattered between portions of the outcrop which turns more visible along the steeper parts of area B. The arrangement of strata found in our investigation is shown in the borehole logs in appendix A. Figure 4 in page 12 shows borehole 2 (BH2) listing in depth order the geotechnical materials found in area A and represents average conditions of BHs deeper than about 1.6 m to bedrock in area A. Figure 5 A in page 12 shows BH12 listing in depth order the geotechnical materials found in area C. Figure 5B in page 12 shows BH13 depicting the average representative profile of the conditions found in area C.

It can be seen fig. 2 in page 2 that area A is underlain by bedrock at depths ranging between 0.18 and 7.14. The deepest portion of the site as found in the BHs is towards the north west one half of area A in which the depths encountered were 3.71, 1.85, 2.59 and 3.58 in Bhs 1, 2, 3, 5, and 6 respectively. Figure 4 in page 12 depict the materials generally found above the gneiss bedrock. Variations encountered in shallower than about 1.6 m holes in area A can be found in the borehole logs. Shallow bedrock conditions (0.3 to 1.07 m) were found in area C as depicted in fig. 5(b) in page 12. The exception in area C is BH12 shown in fig. 5(a) in page 12which was advanced through glacial till to gneiss bedrock to a 2.03 m depth.

5.1 Very Stiff Silty Clay

Brown very stiff silty clay of estimated *medium plasticity* and shear strength greater than 100 kPa was found in BHs 1, 2, 3, 5 and 6 which are located at the northwest of area A. Shear strength estimated from SPT blow counts on the weakest portions at depth in BH5 are indicative of high overconsolidation. The unit weight of very stiff clay is in the order of 1,850 kg/m^3.

5.2 Brown Clay with Trace Gravel and Sand Seams

Brown very stiff silty clay of estimated *medium plasticity* and shear strength greater than 100 kPa was found in BHs 1, 2, 5 and 6 which are located at the northwest of area A. Shear strength estimated from SPT blow counts is indicative of high overconsolidation. Its unit weight can be considered in the order of 1,850 kg/m^3.

5.3 Glacial Till

Glacial till encountered in BHs 3, 9 and 12 consist of a mix of clayey and silty sand with gravel and cobbles. A near bedrock depth thin stratum of till was also found in BHs 1, 2, 5 and 6. The till encountered is generally *dense* and can be considered to have a unit weight of 1,900 kg/m^3 and friction of 34 degrees based on our findings.

5.4 Redish Silty Sand with Gravel

Near surface redish silty sand with gravel beneath the surficial topsoil was found near the south east of area A in BHs 8 and 9 and throughout area C. Experience in Ottawa with the coloration and texture exhibited by this material is indicative of organic content. Its overall average thickness revealed by this field program is approximately 0.48 m.

5.5 Organic Topsoil

Organic topsoil is present throughout the surface of the site including portions of area B. Its overall average thickness measured was 0.23 m. This field program required preparation of the areas for drilling which may have reduced the topsoil measured by about 7 cms.

5.6 Comments on Soil Materials

Undisturbed very stiff silty clay, brown clay with trace sand and glacial till are geotechnical materials that are suitable for many engineering purposes. Undisturbed means that they are preserved in the condition they have in their natural deposits and this includes moisture content. Upon exposure, the combination of changes in exposure to the environment, including rain and lost of water by wind or direct sunlight and the direct effect of mechanical action by equipment or people working often disturb the near surface portion of areas exposed.

Soils containing organic matter are not suitable for construction purposes other than landscaping.

5.7 Bedrock

5.7.1 Rock Material Properties

The following properties are confirmed within the framework of the referenced chapter 4 from the field program.

5.7.1.1 Rock Type

The field program confirmed the metamorphic Paragneiss bedrock reported by the geology data base.

5.7.1.2 Hardness

The Unconfined Compressive Strength (UCS) represents the hardness range which may assist assessments for design and construction. The details of six UCS tests completed in samples extracted during the field program are shown in appendix C.1. The values of UCS found are: 9.3, 51.6, 24.4, 80.3, 29.7 and 95.3 Mpa. Assessments resulting from discussion under subsection 5.7.2 have led to averaging the 3 higher values of the results leading to the 76 Mpa (775 kg/cm^2 or 11,000 $lbs/(inch)^2$) average strength for intact rock. The bedrock is thus *"hard"*.

5.7.1.3 Density

Density of $2,740kg/m^3$ was determined within the framework of UCS tests.

5.7.1.4 Weathering

In this terminology moderately weathered is rock recognizable as such through the mass but with portions that have lost the original mechanical properties. Weathering is thus in connection with jointing only in the sense that jointing may have favor more exposure to weathering processes but jointed bedrock is not necessarily highly weathered. The rock cores from BHs 9, 10, 14 and 15 indicate that some near surface portions may be moderately weathered, however, hand and outcrop specimens assessed using the hammer with pick end and the pocket knife indicated slightly weathered rock near the surface at area C. Where the outcrop was seen massive without jointing the bedrock appeared fresh.

5.7.1.5 Color

The bedrock is banded but in majority of a redish brown color. The bands are of white, gray, yellowish, brown, gray and orange colors.

5.7.2 Rock Mass Structural Discontinuities (Jointing and Fractures)

Recognizable patterns of jointing could not be determined. Jointing is mostly present in area C and it is random. In the near surface of outcrops inspected in area C randomly oriented joints form blocks of near right angles ranging in mean size roughly between 0.3 m to 0.9 m suggesting *moderately wide spacing joint category* of joints over the top of more massive rock. Some shallow rock cores with Rock Quality Designation RQDs 50% or less in area B suggest *close spacing category of joints*. Similar *moderately wide spacing joint category* conditions are present along the lower portions of area B. The portions near the top of area B are massive un-jointed. Other attributes of joints such as aperture width, infilling, linear persistence, etc. could not be seen to follow any reportable pattern.

A discontinuity of particular interest was noted in hand samples and rock cores that are otherwise intact and unjointed. These discontinuities can only be noted in rock cores and freshly broken rocks and not where the massive rock is visible on the surface because it is hairline like and it is “erased” quickly on the surface. The discontinuities follow an irregular path in a nearly vertical direction. It forms a preferred path for breaks which occurred with pick end blows in hand samples and the action of the core drill. The hairline discontinuity exhibit a faintly visible white mist of silt size powder. Their spacing could not be determined, however, their presence in many of the rock cores indicates that they are widely spread even where the rock is massive in appearance. Weaker planes induced by these discontinuities are inferred to have influence the UCS tests inducing the high scatter in the results.

5.7.3 Non-Structural Discontinuities

Foliation refers to the layered appearance of metamorphic rocks. Foliation can be noted in the form of white, gray, yellowish, brown, gray and orange bands in the otherwise redish brown rock. There is no physical separation between the bands, neither there are noticeable differences in their mechanical properties.

5.7.4 Additional Rock Properties

Additional rock properties include seismic velocity, joint face weathering and primary or secondary cavities. Cavities were not present in the hand or core samples and comments in the structural discontinuities section regarding jointing appear sufficient for joint face weathering.

5.7.4.1 Seismic Velocity

The shear wave velocity is estimated to be within the range of 2,200 to 2,400 m/sec as judged from seismic refraction tests completed in rocks of similar strength in Ottawa. The seismic velocity of the bedrock is correlated to the excavatability of bedrock and has a direct impact in earthquake design accelerations when measured directly with seismic tests.

5.7.5 Comments on Bedrock Properties

Rock materials are suitable for a multitude of engineering purposes. The physical and mechanical properties of bedrock and other properties of bedrock described in this section are intended to serve the purposes of engineering and construction. Of particular interest for design and construction are: the excavatability, the rock mass stability, the permeability and its construction quality for different applications such as rockfill, aggregates, etc.

5.8 Groundwater and Moisture

The water level was measured on July 08, 2020 in stand pipes installed in BH3 and BH6 at 1.7 and 1.4 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.

Field observations of soils as extracted in the field in the sampler, coloration and stiffness suggest that the permanent water may be at approximately 3.3 m depth in BHs 5 and 6 or approximately at 100.15 m elevation. The water level measurements obtained on July 08, 2020 are thus assessed as influenced by other factors such as the extensive use of water for core drilling.

Moisture contents vary above the ground water table.

5.9 Freezing Index, Frost Depth and Frost Susceptibility

It is generally assumed that the frost depth for the 1,000 degree Celsius-days freezing index applicable to Ottawa will reach no deeper than 1.8 m on bare ground (snow free) or pavement. It is also assumed that frost depth will reach no deeper than 1.5 m on snow covered ground.

The soil materials encountered at this site are frost susceptible and thus will heave upon exposure to freezing temperatures. Heaving destroys the mechanical properties of soils so that any soil which has been frozen is considered disturbed.

The gneiss bedrock encountered at this site is not frost susceptible. It will not loose its properties upon exposure to freezing temperatures.

Part III
Recommendations

The following set of the recommendations result from sampling and testing outlined in section 3 and from geotechnical engineering evaluation and assessments.

It is understood that the proposed development will consist of Townhouses and 6 Storey Appartment Buildings with one level of underground parking.

6 Foundations General

Generally speaking, code compliant Part 9 and Part 4 residential buildings founded on shallow spread footings can be considered for the proposed Townhouses and 6 Storey Appartment Buildings.

6.1 Load and Resistance Factors

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

- A resistance factor is applied to the computed or estimated (nominal) bearing resistance from field or lab tests to obtain the strength limit for factored loads (ULS). The value of the resistance factor is stated for each option.
- An average load factor of 1.5 is assumed to compute the service limit (SLS).

6.2 Bearing Capacity of Strip and/or Pad Footings

The (ULS) bearing capacity below represents a resistance factor of 0.55 of the ultimate bearing capacity estimated for very stiff silty clay or on brown clay with trace sand. This bearing capacity can be used for design of *large pad footings* up to 4 m or strip footings up to 2.5 m wide placed on undisturbed very stiff clay or glacial till or bedrock or compacted granular B type 2 placed on glacial till or very stiff clay.

- 300 KPa at service limit (SLS).

- 450 kPa for factored loads (ULS).

For residential town homes considered at this site, pad footings up to 2 m or strip footings 0.5 to 0.9 m wide placed on undisturbed very stiff clay or brown clay with trace sand or glacial till or compacted granular B type 2 placed on glacial till or on a jointed un-weathered bedrock surface the bearing capacities below can be considered.

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

The (ULS) bearing capacity below represents a resistance factor of 0.27 of the ultimate bearing capacity estimated for rock from the lowest UCS test value.

- 1.6 MPa at service limit (SLS).
- 2.4 MPa for factored loads (ULS).

Footings can be placed on a *jointed un-weathered* rock surface using this bearing capacity.

6.3 Friction δ

Friction will be a consideration for retaining walls. Most native soils in Ottawa have a significant amount of plastic fines which reduce the friction substantially. Construction practices are such that there is always a degree of near surface disturbance that reduces friction further. Retaining wall foundations placed on 150 mm or more of compacted granular B type 2 underlain by native undisturbed soils at this site can be design using a friction factor of 0.6. Where footings are placed directly on native soils, friction of 0.4 could be used. Friction of 0.7 could be used for footings on rock at this site.

6.4 Settlements

For the footing loads provided in section 6.2 building settlements for foundations on undisturbed very stiff silty clay or glacial till soils are not to exceed service limit values (SLS) of 25 mm and 20 mm total and differential settlements respectively at this site.

For the bearing capacities provided above settlement of foundations on bedrock will be negligible.

6.5 Other Foundation Alternatives

Where building loads can not be accommodated with the bearing capacity described in section 6.2 deep foundations, such as driven or bored piles need to be considered.

Piles are generally driven to refusal and/or drilled to bedrock and proof tested. The sound bedrock encountered in the boreholes will be competent to support pile foundations.

For pile foundations analysis involving piles embedded into the rock, the near average UCSs value of 50 MPa is acceptable. 55 GPa Modulus of elasticity and high RDDs are also acceptable for analysis. Where the friction angle of the bedrock is required, use 30 degrees.

Specific geotechnical resistance for specific pile systems and locations will be provided if requested as part of this report.

6.6 Frost Protection for Foundations

Shallow foundations in section 6.2 on frost susceptible soils 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.

6.7 Foundation Insulation

For foundation placement not having the minimum soil cover protection indicated in section 6.6 and in unheated areas in otherwise heated buildings foundation insulation is required.

Generally speaking, 50 mm of extruded polystyrene insulation (XPS) type V, VI or VII meet foundation insulation requirements for the freezing index in the Ottawa area.

6.8 Foundation Wall Dampproofing and Drainage

Appendix E.1 presents page 2 of NRC Construction Evaluation Reports CCMC 12658-R showing dampproofing and foundation wall drainage system details satisfying the provisions under OBC 2012 and suitable for the conditions found at this site. Other available similar systems having the components shown in CCMC 12658-R may be used.

Foundation drainage must be provided to daylight or a positive outlet, or sump.

7 Site Class for Seismic Design

At this site, the geotechnical testing completed are indicative of a Vs(30) exceeding 360 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.

Site classes A or B will be applicable for buildings founded on rock, however OBC 2012 requires confirmation of the seismic velocity via a seismic test for assignment of classes A or B. The site class along with the natural period of buildings will define the magnitude of the sideways acceleration induced by earthquakes and it varies substantially in different regions of Canada. This confirmation is recommended.

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 48.

2. Figure 6 in page 47 showing the design spectral accelerations.

8 Bedrock

Assessment of the properties outlined in section 5.7.1 under the framework of chapter 4 referenced in section 3 lead to the following recommendations.

8.1 Excavatability of Rock

As stated in the referenced guide the *excavatability class* is based on rock properties and the 12^{th} edition of Caterpillar's handbook of ripping (CH). The equipment flywheel horse power FWHP considered under the guide is often less than the equipment FWHP rating in the CH cited in the guide which appear related to the fact that the guide indicates the minimum FWHP, however, it is noted here that there is a portion below the point in which the material is non rippaable for the equipment in which performance is only marginal. The selection here is thus to minimize the marginal portion for the equipment selected and not the minimum non-rippable-marginally rippable.

By hardness, seismic velocity and strength the bedrock is of the *"very hard ripping to blasting"* class. Excavation can thus be completed via adequate equipment an/or line drilling and blasting.

Adequate equipment is defined as heavy ripping equipment with a rear-mounted, heavy duty, single-tooth, ripping attachment mounted on a track type tractor having a power rating of at least 400 FWHP.

The use of hoe rammers is also feasible depending on the scale and quantities of rock excavation. Hoe ramming may be required where the ability of ripping equipment to rip rock is hindered by very steep slopes.

It is to be noted that the bedrock at this site differ from many sedimentary rocks found in Ottawa in that the presence of weaker bedding plane partings of nearly horizontal orientation is not present. The equipment mentioned will not offer much control of neither the vertical or the horizontal location of the breaks which will render rock cuts very irregular. In rock with nearly horizontal bedding, the bedding planes will favor break along those planes, however, ripping equipment will offer no control of the location of breaks along vertical planes. In tight urban environments, control of the location of the vertical planes of breakage will need to be implemented by other means if ripping equipment is considered.

Refer to the construction recommendations for other recommendations for rock excavations.

8.2 Rock Mass Stability

For the strength, hardness, jointing and RQD The bedrock is of the *"stable"* class. A "preferred" orientation of weak planes was not identified. Nearly vertical cuts are thus technically feasible. Vertical cuts by direct mechanical action of equipment will be irregular.

8.3 Permeability of Rock

For the *extremely narrow* rock mass discontinuities, non plastic very fine silt size particles *infilling* the rock is of the *"slowly permeable"* class. The permeability is thus estimated in the proximity of $1x10^{-}6m/s$

8.4 Construction Quality of Rock

For the 75 MPa strength assigned under assessments and UCS tests, the *"hard"* hardness and 2,740 kg/m^3 unit weight the rock is of the *"high grade"* construction quality class. "Rock material is suitable for high-stress aggregate, filter and drain material, riprap, and other construction applications requiring high durability."

9 Roadbed Soils and Pavement Structure

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). ESALs are a measure of mix traffic loads including vehicle loads and truck loads. The number of ESALs applications depend on traffic class and use.

Roadbed denotes the materials beneath pavement structures. The term pavement is used to denote the layered structure that forms a road carriageway or vehicle parking. *The general quality of the near surface undisturbed soil to serve as foundation for pavement structure (Roadbed soil) at this site are assumed to be fair* as defined in the AASHTO guide. It is hence recommended to refer to the following information in appendix D:

- *Yuri Mendez Engineering's pavement catalog in appendix D.1 to select pavement structures* for traffic classes on the fair roadbed soils encountered at this site.

- Appendix D.2 for guidelines regarding frost heave.

- Appendix D.3 for frost protection recommendations for manholes and catch basin construction.

Note that if pavement elevation is such that it can be placed on a subgrade surface consisting of rock, the construction could be such to have the asphalt thicknesses specified in appendix D for each traffic class overlying granular A that is at least 75 mm thick placed on undisturbed jointed un-weathered bedrock.

10 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 all excavations to the depth of the top of the bedrock, soils can be considered type II under O. Reg. 213/91 and type 1 for excavations through the bedrock. As such, the following key aspects of O. Reg. 213/91 are applicable to this site:

1. For excavations up to depth of the top of the bedrock (soil types II):
   - 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.
2. For excavations through the bedrock (soil types I):
   - Safe open cut is vertical.
3. Where the safe open cut in item 1 is not provided, either the shoring systems described in O. Reg. 213/91 or engineered shoring systems need be used.

Information regarding physical and mechanical properties of subsurface materials which will be required for shoring design are provided in this report.

10.0.1 Conditions Requiring Engineered Shoring

O. Reg. 213/91 describe the conditions in which engineered shoring systems are required. Some key aspects of O.Reg. 213/91 regarding the conditions in which an engineered shoring system is required are:

- Where soils are type I to III and the prescribed safe open cuts are not provided and
  - The excavation is not a trench or
  - The excavation is a trench either deeper than 6 m or wider than 3.6 m or both
- For trench excavations or open cut, where soils are type IV and the safe open cuts are not provided.

Note that along with the descriptions in O. Reg. 213/91 for soils type IV, any difficult soil having significant seepage and/or strength loss upon excavation such as caving soils can be rendered as type IV.

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

11 Reinstatement of Excavated Soils

As stated in appendix F the suitability of material for specific purposes is determined by the geotechnical engineer. To the extent they are needed, suitable material from the excavations can be used in the construction of required permanent earthfill or rockfill.

12 Tree Planting

Tree planting can be liable of damages to buildings and infrastructure. Sites where clay deposits are encountered are particularly more prompt to such potential damage. This is due to shrinkage of clays and silty clays induced by reduction of water content. Trees having greater water requirements should be avoided. As general guidelines tree planting should be reduced to species having low water requirements and heights at mature age. Hence, the following can be considered:

- Plant species having 10 m or less of mature height
- Use species having low water requirements
- Offset trees from buildings a distance equal to the mature height
- Space trees a distance equal to the mature height

The following can be considered as reference species acceptable at 6 to 8 m spacing as accepted at some locations where silty clays are encountered:

- Amur Maple
- Serviceberry
- Japanese Lilac
- Flowering Crab

Avoid the following species:

- Poplar
- Willow
- Eastern Cottonwood

Note that conifers have low water requirements

13 Water Inflow Within Excavations and Water Takings

Water inflow within excavations in soils is influenced by the depth of excavations relative to the water table and flow behavior of water in soils as controlled by the permeability of soils. Because of the assessments under sections 5 and 5.8 and information seen in the borehole logs, water inflow is expected to be low and controllable by pumping from open sumps.

13.0.1 Water Takings and Permits

Water takings from the environment, including groundwater in excavations, are regulated under Ontario Water Resources Act, R.S.O. 1990, c. O.40. (OWRA). The OWRA is enforced by the Ministry of Environment (MOE). Under the OWRA. a Permit to Take Water (PTTW) is required for pumping from excavations exceeding 400 cubic meters per day. Along with the consideration of ground water from excavations, PTTW applications require in addition the consideration of precipitation. The excavations at this site are subject to OWRA and this section is intended to provide criteria indicative of whether a PTTW may be required or not.

Given the size (area) of the proposed excavations, precipitation data in Ottawa and the soil conditions assessed under sections 5 and 5.8 pumping from excavations is not expected to exceed the threshold of 400 cubic meters per day so that *the requirement of a PTTW may not apply to the proposed development.*

Metered outlets must be maintained and recorded as proof for confirmation in case that OWRA requires it. Note that PTTWs are issued after months of the first filing of documents.

14 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 non corrosive. Resistivity, PH and soluble ions testing was completed in a representative sample at 0.9 m depth in BHs 5 and 9. After Romanoff (1957)[2], the following corrosion rates can be used:

1. For carbon steel:
   - 11 μm/year for the first 2 years,
   - 8 μm/year, thereafter.
2. For galvanized metal:
   - 3.6 μm/year for the first 2 years,
   - 2.25 μm/year until depletion of zinc,
   - 8 μm/year for carbon steel.

15 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.

16 Special Issues or Concerns

Our investigation did not reveal special concerns for the proposed development, such as slope stability, liquefaction, organic materials, etc. Near surface organic materials found are shown in the borehole logs.

17 Stripping, Excavation to Undisturbed Soils and rock, Earth and Rock Fill Placement. Asphalt Placement and Compaction

Appendix F presents recommended geotechnical specifications and guidelines for stripping, earth and rock excavation to undisturbed surfaces, earth and rock fill placement, asphalt 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

18 Additional Geotechnical Services

The geotechnical services outlined in appendix G may be required during design and construction.

User Agreement

Acknowledgment of Duties

In this 46-BHH-R0 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

46-BHH-R0 is to be used solely in connection with the Townhouses and 6 Storey Appartment Buildings by Bayview Hospitality Holdings Limited (BHHL) and thus subject of communications amongst other professionals (OP), government bodies and authorities, and BHHL 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 BHHL 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 BHHL in this report will be forwarded to YME.

Reasonable Completeness

OP and Bayview Hospitality Holdings Limited 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 BHHL 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 46-BHH-R0 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 46-BHH-R0 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 46-BHH-R0 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. BHHL 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 BHHL in this report occur, BHHL covenants to inform YME. BHHL 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

BHHL 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. BHHL 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.

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Part IV
Appendices

A Borehole Logs

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Project: Proposed Townhouses and 6 Storey Appartment Buildings		YME Yuri Mendez Engineering.
Location: 6301 Campeau Dr.	Client: Bayview Hospitality Holdings	Test Hole No.: BH1 of 15
Job No.: 46-BHH-R0	Test Hole Type: 7" OD Auger.	Date: July 22, 23 and 24, 2020
Casing and 56 mm diameter cores	SPT Hammer Type: Auto Safety	Logged By: Yuri Mendez

Yuri Mendez Engineering

Depth (m)	Elevation (m) 102.8	Lithology and color	Material Description	Samples or Blows/Ft	Water	Shear Strength (kPa)	Laboratory Tests: Moisture Content (%)	Rock Quality RQD %	Other Lab Tests
0 – 0.2	102.8 – 102.6		Topsoil						
0.2 – 0.6	102.6 – 102.2		Brown silty clay with trace gravel and sand seams	16					
0.6 – 3.6	102.2 – 99.2		Brown very stiff silty clay. Shear strength greater than 100 kPa.	14, 27, 13, 14, 9					
3.6 – 4.32	99.2 – 98.48		Till: Brown clayey fine sand with gravel. Friction angle of 35 degrees estimated.	11, >100					

Depth scale (m): 0, 0.25, 0.5, 0.75, 1, 1.25, 1.5, 1.75, 2, 2.25, 2.5, 2.75, 3, 3.25, 3.5, 3.75, 4, 4.25

Elevation scale (m): 102.4, 101.9, 101.4, 100.9, 100.4, 99.9, 99.4, 98.9

SPT Sampler Refusal at 4.32 m.

S = Sample for lab review and moisture content

▼ Interpreted water level

Project: **Proposed Townhouses and 6 Storey Appartment Buildings**		YME Yuri Mendez Engineering.
Location: **6301 Campeau Dr.**	Client: **Bayview Hospitality Holdings**	**Test Hole No.: BH2 of 15**
Job No.: **46-BHH-R0**	Test Hole Type: **7" OD Auger.**	Date: **July 22, 23 and 24, 2020**
Casing and 56 mm diameter cores	SPT Hammer Type: **Auto Safety**	Logged By: **Yuri Mendez**

Yuri Mendez Engineering

Depth (m)	Elevation (m) 103.4	Lithology and color	Material Description	Samples or Blows/Ft	Water	Elevation (m) 103.4	Depth (m)	Shear Strength (kPa)	Laboratory Tests: Moisture Content (%)	Laboratory Tests: Rock Quality RQD %	Laboratory Tests: Other Lab Tests
0			Topsoil				0				
0.25	103.2		Brown silty clay with trace gravel and sand seams	**30**		103.2	0.25				
0.5							0.5				
0.75	102.7		Brown very stiff silty clay. Shear strength greater than 100 kPa.	**27**		102.7	0.75				
1							1				
1.25	102.2					102.2	1.25				
1.5			Till: Brown clayey fine sand with gravel. Friction angle of 35 degrees estimated	**35**			1.5				
1.75	101.7		Sound Gneiss Rock			101.7	1.75			100	
2							2				

S = Sample for lab review and moisture content

▼ Interpreted water level

Project: **Proposed Townhouses and 6 Storey Appartment Buildings**		YME Yuri Mendez Engineering.
Location: **6301 Campeau Dr.**	Client: **Bayview Hospitality Holdings**	**Test Hole No.: BH3 of 15**
Job No.: **46-BHH-R0**	Test Hole Type: **7" OD Auger.**	Date: **July 22, 23 and 24, 2020**
Casing and 56 mm diameter cores	SPT Hammer Type: **Auto Safety**	Logged By: **Yuri Mendez**

YME Yuri Mendez Engineering

Depth (m)	Elevation (m) 103.6	Lithology and color	Material Description	Samples or Blows/Ft	Water	Elevation (m) 103.6	Depth (m)	Shear Strength (kPa)	Laboratory Tests: Moisture Content (%)	Laboratory Tests: Rock Quality RQD %	Laboratory Tests: Other Lab Tests
0			Topsoil				0				
0.25	103.4		Brown very stiff silty clay. Shear strength greater than 100 kPa.. Water level measured at a 1.4 m depth on July 08, 2020.	21		103.4	0.25				
0.5							0.5				
0.75	102.9					102.9	0.75				
1				13			1				
1.25	102.4					102.4	1.25				
1.5				20			1.5				
1.75	101.9		Till: Brown clayey fine sand with gravel. Friction angle of 35 degrees estimated.			101.9	1.75				
2							2				
2.25	101.4			19		101.4	2.25				
2.5							2.5				
2.75	100.9		Sound Gneiss Bedrock. UCS test = 9.3 MPa			100.9	2.75				
3							3				
3.25	100.4					100.4	3.25			100	
3.5							3.5				
3.75	99.9					99.9	3.75				
4							4				

S = Sample for lab review and moisture content

Interpreted water level

Project: **Proposed Townhouses and 6 Storey Appartment Buildings**		YME Yuri Mendez Engineering.
Location: **6301 Campeau Dr.**	Client: **Bayview Hospitality Holdings**	**Test Hole No.: BH4 of 15**
Job No.: **46-BHH-R0**	Test Hole Type: **7" OD Auger.**	Date: **July 22, 23 and 24, 2020**
Casing and 56 mm diameter cores	SPT Hammer Type: **Auto Safety**	Logged By: **Yuri Mendez**

YME Yuri Mendez Engineering

Depth (m)	Elevation (m) 103.2	Lithology and color	Material Description	Samples or Blows/Ft	Water	Elevation (m) 103.2	Depth (m)	Shear Strength (kPa)	Laboratory Tests: Moisture Content (%)	Laboratory Tests: Rock Quality RQD %	Laboratory Tests: Other Lab Tests
0	103.1		Topsoil			103.1	0				
0.25			Brown very stiff silty clay. Shear strength greater than 100 kPa.	21			0.25				
0.5	102.6					102.6	0.5				
0.75				39			0.75				
1	102.1					102.1	1				
1.25			Sound Gneiss Bedrock.				1.25				
1.5							1.5				

S = Sample for lab review and moisture content

▼ Interpreted water level

Project: **Proposed Townhouses and 6 Storey Appartment Buildings**		YME Yuri Mendez Engineering.
Location: **6301 Campeau Dr.**	Client: **Bayview Hospitality Holdings**	**Test Hole No.: BH5 of 15**
Job No.: **46-BHH-R0**	Test Hole Type: **7" OD Auger.**	Date: **July 22, 23 and 24, 2020**
Casing and 56 mm diameter cores	SPT Hammer Type: **Auto Safety**	Logged By: **Yuri Mendez**

Yuri Mendez Engineering

Depth (m)	Elevation (m) 102.8	Lithology and color	Material Description	Samples or Blows/Ft	Water	Elevation (m) 102.8	Depth (m)	Shear Strength (kPa)	Laboratory Tests: Moisture Content (%)	Laboratory Tests: Rock Quality RQD %	Laboratory Tests: Other Lab Tests
0			Topsoil				0				
0.25	102.6		Brown silty clay with trace gravel and sand seams	22		102.6	0.25				
0.5							0.5				
0.75	102.1		Brown very stiff silty clay. Shear strength greater than 100 kPa.			102.1	0.75				
1				20			1				
1.25	101.6					101.6	1.25				
1.5				37			1.5				
1.75	101.1					101.1	1.75				
2							2				
2.25	100.6			17		100.6	2.25				
2.5							2.5				
2.75	100.1			21		100.1	2.75				
3							3				
3.25	99.6					99.6	3.25				
3.5				17	▼		3.5				
3.75	99.1					99.1	3.75				
4				19			4				
4.25	98.6		Strata tested using Dynamic Cone Penetration Test (DCPT)			98.6	4.25				
4.5				5			4.5				
4.75	98.1			8		98.1	4.75				
5				8			5				
5.25	97.6			8		97.6	5.25				
5.5							5.5				
5.75	97.1			5		97.1	5.75				
6				5			6				
6.25	96.6			7		96.6	6.25				
6.5				11			6.5				
6.75	96.1			29		96.1	6.75				
7				>100			7				

Dynamic Cone Penetration Refusal at 7.14 m.

S = Sample for lab review and moisture content

▼ Interpreted water level

Project: Proposed Townhouses and 6 Storey Appartment Buildings		YME Yuri Mendez Engineering.
Location: 6301 Campeau Dr.	Client: Bayview Hospitality Holdings	Test Hole No.: BH6 of 15
Job No.: 46-BHH-R0	Test Hole Type: 7" OD Auger.	Date: July 22, 23 and 24, 2020
Casing and 56 mm diameter cores	SPT Hammer Type: Auto Safety	Logged By: Yuri Mendez

Yuri Mendez Engineering

Depth (m)	Elevation (m) 103.3	Lithology and color	Material Description	Samples or Blows/Ft	Water	Shear Strength (kPa)	Moisture Content (%)	Rock Quality RQD %	Other Lab Tests
0 – 0.15			Topsoil						
0.15 – 0.6			Brown silty clay with trace gravel and sand seams	21					
0.6 – 3.3			Brown very stiff silty clay. Shear strength greater than 100 kPa. Water level measured on July 08, 2020 at 1.4 m depth.	26, 45, 15, 13	▼ (approx. 3.1 m)				
3.3 – 3.75			Till: Brown clayey fine sand with gravel. Friction angle of 35 degrees estimated	6					
3.75 – 5.1			Sound Gneiss Bedrock. UCS test = 51.6 MPa					95	

S = Sample for lab review and moisture content

▼ Interpreted water level

Project: **Proposed Townhouses and 6 Storey Appartment Buildings**		YME Yuri Mendez Engineering.
Location: **6301 Campeau Dr.**	Client: **Bayview Hospitality Holdings**	**Test Hole No.: BH7 of 15**
Job No.: **46-BHH-R0**	Test Hole Type: **7" OD Auger.**	Date: **July 22, 23 and 24, 2020**
Casing and 56 mm diameter cores	SPT Hammer Type: **Auto Safety**	Logged By: **Yuri Mendez**

Depth (m)	Elevation (m) 104	Lithology and color	Yuri Mendez Engineering Material Description	Samples or Blows/Ft	Water	Elevation (m) 104	Depth (m)	Shear Strength (kPa)	Laboratory Tests: Moisture Content (%)	Laboratory Tests: Rock Quality RQD %	Laboratory Tests: Other Lab Tests
0	103.94		Topsoil			103.94	0				
0.25			Sound Gneiss Bedrock. UCS test = 95.3 MPa				0.25			100	
0.5							0.5				

S = Sample for lab review and moisture content

▼ Interpreted water level

Project: **Proposed Townhouses and 6 Storey Appartment Buildings**	YME Yuri Mendez Engineering.
Location: **6301 Campeau Dr.** / Client: **Bayview Hospitality Holdings**	**Test Hole No.: BH8 of 15**
Job No.: **46-BHH-R0** / Test Hole Type: **7" OD Auger.**	Date: **July 22, 23 and 24, 2020**
Casing and 56 mm diameter cores / SPT Hammer Type: **Auto Safety**	Logged By: **Yuri Mendez**

Yuri Mendez Engineering

Depth (m)	Elevation (m) 105.5	Lithology and color	Material Description	Samples or Blows/Ft	Water	Elevation (m) 105.5	Depth (m)	Shear Strength (kPa)	Laboratory Tests: Moisture Content (%)	Laboratory Tests: Rock Quality RQD %	Laboratory Tests: Other Lab Tests
0			Topsoil				0				
0.25	105.3		Reddish brown gravelly silty sand with clay: high organic matter as revealed by coloration and texture	**48**		105.3	0.25				
0.5 – 1	104.8		Sound Gneiss Bedrock: top 200 mm is fractured (jointed) rock. UCS test = 29.7 MPa			104.8	0.5 – 1			71	

S = Sample for lab review and moisture content

▼ Interpreted water level

Project: **Proposed Townhouses and 6 Storey Appartment Buildings**		YME Yuri Mendez Engineering.
Location: **6301 Campeau Dr.**	Client: **Bayview Hospitality Holdings**	**Test Hole No.: BH9 of 15**
Job No.: **46-BHH-R0**	Test Hole Type: **7" OD Auger.**	Date: **July 22, 23 and 24, 2020**
Casing and 56 mm diameter cores	SPT Hammer Type: **Auto Safety**	Logged By: **Yuri Mendez**

Yuri Mendez Engineering

Depth (m)	Elevation (m) 105.5	Lithology and color	Material Description	Samples or Blows/Ft	Water	Elevation (m) 105.5	Depth (m)	Shear Strength (kPa)	Laboratory Tests: Moisture Content (%)	Laboratory Tests: Rock Quality RQD %	Laboratory Tests: Other Lab Tests
0			Topsoil				0				
0.25			Reddish brown gravelly silty sand with clay: high organic matter as revealed by coloration and texture	10			0.25				
	105.1		Till: Brown clayey fine sand with gravel			105.1					
0.5							0.5				
0.75							0.75				
	104.6			11		104.6					
1			Sound Gneiss Bedrock: top 150 mm is weathered and fractured (jointed) rock				1				
1.25							1.25			50	

S = Sample for lab review and moisture content

Interpreted water level

Project: **Proposed Townhouses and 6 Storey Appartment Buildings**		YME Yuri Mendez Engineering.
Location: **6301 Campeau Dr.**	Client: **Bayview Hospitality Holdings**	**Test Hole No.: BH10 of 15**
Job No.: **46-BHH-R0**	Test Hole Type: **7" OD Auger.**	Date: **July 22, 23 and 24, 2020**
Casing and 56 mm diameter cores	SPT Hammer Type: **Auto Safety**	Logged By: **Yuri Mendez**

Yuri Mendez Engineering

Depth (m)	Elevation (m) 107.5	Lithology and color	Material Description	Samples or Blows/Ft	Water	Elevation (m) 107.5	Depth (m)	Shear Strength (kPa)	Laboratory Tests: Moisture Content (%)	Laboratory Tests: Rock Quality RQD %	Laboratory Tests: Other Lab Tests
0			Topsoil				0				
0.25				**27**			0.25				
	107.1		Reddish brown gravelly silty sand with clay: high organic matter as revealed by coloration and texture			107.1					
0.5							0.5				
0.75							0.75				
	106.6					106.6					
1			Gneiss Bedrock: weathered and fractured (jointed) through the length of the rock core				1			0	
1.25							1.25				

S = Sample for lab review and moisture content

▼ Interpreted water level

Project: **Proposed Townhouses and 6 Storey Appartment Buildings**		YME Yuri Mendez Engineering.
Location: **6301 Campeau Dr.**	Client: **Bayview Hospitality Holdings**	**Test Hole No.: BH11 of 15**
Job No.: **46-BHH-R0**	Test Hole Type: **7" OD Auger.**	Date: **July 22, 23 and 24, 2020**
Casing and 56 mm diameter cores	SPT Hammer Type: **Auto Safety**	Logged By: **Yuri Mendez**

YME Yuri Mendez Engineering

Depth (m)	Elevation (m) 105	Lithology and color	Material Description	Samples or Blows/Ft	Water	Elevation (m) 105	Depth (m)	Shear Strength (kPa)	Laboratory Tests: Moisture Content (%)	Laboratory Tests: Rock Quality RQD %	Laboratory Tests: Other Lab Tests
0			Topsoil				0				
0.25				**31**			0.25				
0.5	104.5		Reddish brown gravelly silty sand with clay: high organic matter as revealed by coloration and texture			104.5	0.5				
			Sound Gneiss Bedrock: some jointing at portions.								
0.75							0.75			54	

S = Sample for lab review and moisture content

▼ Interpreted water level

Project: **Proposed Townhouses and 6 Storey Appartment Buildings**		YME Yuri Mendez Engineering.
Location: **6301 Campeau Dr.**	Client: **Bayview Hospitality Holdings**	**Test Hole No.: BH12 of 15**
Job No.: **46-BHH-R0**	Test Hole Type: **7" OD Auger.**	Date: **July 22, 23 and 24, 2020**
Casing and 56 mm diameter cores	SPT Hammer Type: **Auto Safety**	Logged By: **Yuri Mendez**

Yuri Mendez Engineering

Depth (m)	Elevation (m) 103.2	Lithology and color	Material Description	Samples or Blows/Ft	Water	Elevation (m) 103.2	Depth (m)	Shear Strength (kPa)	Laboratory Tests: Moisture Content (%)	Laboratory Tests: Rock Quality RQD %	Laboratory Tests: Other Lab Tests
0 – 0.46	103.1		Topsoil	**13**		103.1	0 – 0.46				
0.46 – 1.01	102.6		Reddish brown gravelly silty sand with clay: high organic matter as revealed by coloration and texture			102.6	0.46 – 1.01				
1.01 – 2.03	102.1, 101.6		Till: Brown clayey fine sand with gravel	**18**, **51**		102.1, 101.6	1.01 – 2.03				
2.03 – 3.55	101.1, 100.6, 100.1		Sound Gneiss Bedrock. Jointed and fractured near the top. UCS test = 24.4 MPa			101.1, 100.6, 100.1	2.03 – 3.55			77	

S = Sample for lab review and moisture content	▼ Interpreted water level

Project: Proposed Townhouses and 6 Storey Appartment Buildings		YME Yuri Mendez Engineering.
Location: **6301 Campeau Dr.**	Client: **Bayview Hospitality Holdings**	**Test Hole No.: BH13 of 15**
Job No.: **46-BHH-R0**	Test Hole Type: **7" OD Auger.**	Date: **July 22, 23 and 24, 2020**
Casing and 56 mm diameter cores	SPT Hammer Type: **Auto Safety**	Logged By: **Yuri Mendez**

Depth (m)	Elevation (m) 107.7	Lithology and color	Material Description	Samples or Blows/Ft	Water	Elevation (m) 107.7	Depth (m)	Shear Strength (kPa)	Laboratory Tests: Moisture Content (%)	Laboratory Tests: Rock Quality RQD %	Laboratory Tests: Other Lab Tests
0			Topsoil				0				
0.25				**22**			0.25				
0.5	107.2		Reddish brown gravelly silty sand with clay: high organic matter as revealed by coloration and texture			107.2	0.5				
0.75							0.75				
1	106.7		Sound Gneiss Bedrock: some jointing at portions and weathered near surface. UCS test = 80.3 MPa			106.7	1			75	
1.25							1.25				

S = Sample for lab review and moisture content

▼ Interpreted water level

Project: **Proposed Townhouses and 6 Storey Appartment Buildings**		YME Yuri Mendez Engineering.
Location: **6301 Campeau Dr.**	Client: **Bayview Hospitality Holdings**	**Test Hole No.: BH14 of 15**
Job No.: **46-BHH-R0**	Test Hole Type: **7" OD Auger.**	Date: **July 22, 23 and 24, 2020**
Casing and 56 mm diameter cores	SPT Hammer Type: **Auto Safety**	Logged By: **Yuri Mendez**

Depth (m)	Elevation (m) 108	Lithology and color	Material Description	Samples or Blows/Ft	Water	Elevation (m) 108	Depth (m)	Shear Strength (kPa)	Laboratory Tests: Moisture Content (%)	Laboratory Tests: Rock Quality RQD %	Laboratory Tests: Other Lab Tests
0			Topsoil				0				
0.25	107.74		Reddish brown gravelly silty sand with clay: high organic matter as revealed by coloration and texture	**32**		107.74	0.25				
0.5			Gneiss Bedrock: weathered and fractured (jointed) through the length of the rock core				0.5			42	

S = Sample for lab review and moisture content

▼ Interpreted water level

Project: **Proposed Townhouses and 6 Storey Appartment Buildings**		YME Yuri Mendez Engineering.
Location: **6301 Campeau Dr.**	Client: **Bayview Hospitality Holdings**	**Test Hole No.: BH15 of 15**
Job No.: **46-BHH-R0**	Test Hole Type: **7" OD Auger.**	Date: **July 22, 23 and 24, 2020**
Casing and 56 mm diameter cores	SPT Hammer Type: **Auto Safety**	Logged By: **Yuri Mendez**

Yuri Mendez Engineering

Depth (m)	Elevation (m) 103.5	Lithology and color	Material Description	Samples or Blows/Ft	Water	Elevation (m) 103.5	Depth (m)	Shear Strength (kPa)	Laboratory Tests: Moisture Content (%)	Laboratory Tests: Rock Quality RQD %	Laboratory Tests: Other Lab Tests
0 – 0.35	103.5 – 103.2		Topsoil	**21**		103.5 – 103.2	0 – 0.35				
0.35 – 1.07	103.2 – 102.4		Reddish brown gravelly silty sand with clay: high organic matter as revealed by coloration and texture	**95**							
1.07 – 1.70			Gneiss Bedrock: weathered fractured (jointed) through the length of the rock core							0	

Depth scale (m): 0, 0.25, 0.5, 0.75, 1, 1.25, 1.5, 1.75

Elevation scale (m): 103.2, 102.7, 102.2, 101.7

S = Sample for lab review and moisture content

Interpreted water level

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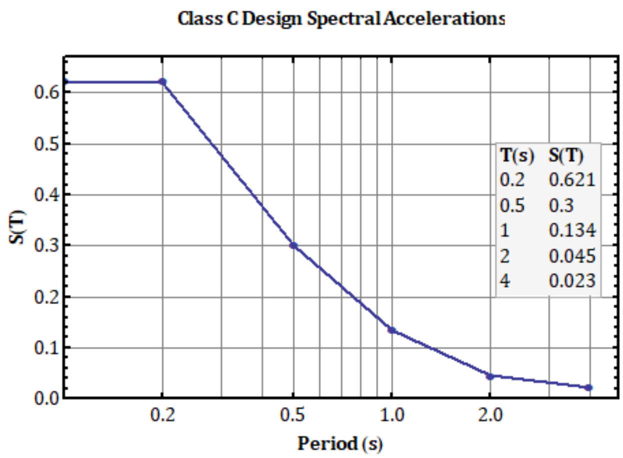

Figure 6:

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 48 of this appendix. Figure 6 in page 47 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

Site: 45.315N 75.907W **User File Reference:** 6301 Campeau Dr., Ottawa, ON 2020-07-12 02:43 UT

Requested by: Yuri Mendez

Probability of exceedance per annum	0.000404	0.001	0.0021	0.01
Probability of exceedance in 50 years	2 %	5 %	10 %	40 %
Sa (0.2)	0.621	0.377	0.241	0.085
Sa (0.5)	0.300	0.181	0.119	0.042
Sa (1.0)	0.134	0.085	0.054	0.017
Sa (2.0)	0.045	0.027	0.017	0.006
PGA (g)	0.317	0.195	0.119	0.036

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

Appendix

C Resistivity, PH and Soluble Salts Test & Unconfined Compressive Strength (UCS) Tests

Certificate of Analysis

Client: **Geoseismic**

Client PO:

Report Date: 07-Jul-2020

Order Date: 30-Jun-2020

Project Description: 6301 Campeau Drive

	Client ID:	BH5 ~~BH7-SS2~~	BH9 ~~BH3-SS3~~	-	-
	Sample Date:	24-Jun-20 09:00	23-Jun-20 09:00	-	-
	Sample ID:	2027174-01	2027174-02	-	-
	MDL/Units	Soil	Soil	-	-
Physical Characteristics					
% Solids	0.1 % by Wt.	74.3	89.0	-	-
General Inorganics					
pH	0.05 pH Units	7.35	7.65	-	-
Resistivity	0.10 Ohm.m	117	107	-	-
Anions					
Chloride	5 ug/g dry	22	13	-	-
Sulphate	5 ug/g dry	22	<5	-	-

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ROCK CORE COMPRESSIVE STRENGTH ASTM D7012-14 METHOD C

CLIENT:	**Yuri Mendez Engineering**	FILE No.:	**PM7869**
PROJECT:	Lab Testing	REPORT No.:	1
STRUCTURE TYPE & LOCATION:	**6301 Campeau Drive**	DATE REPT'D:	6-Jul-20

SAMPLE INFORAMTION			
LAB NO.:	**17477**	**17477**	**17477**
SAMPLE NO.:	BH3 ~~BH1~~	BH6 ~~BH5~~	BH12
LOCATION:	8'8" - 9'4"	11'9" - 12'.1"	7'4" - 7'8"
SAMPLE DATES			
DATE CAST	-	-	-
DATE CORED	-	-	-
DATE RECEIVED	30-Jun-20	30-Jun-20	30-Jun-20
DATE TESTED	5-Jul-20	5-Jul-20	5-Jul-20
SAMPLE DIMENSIONS			
(D) AVERAGE DIAMETER (mm)	55.90	55.90	55.90
(H) HEIGHT (mm)	99.10	104.10	104.10
(W) WEIGHT (g)	700	700	680
(A) AREA = πD2 / 4 (mm^2)	2454	2454	2454
(V) VOLUME = A X H ÷ 1000 (cm^3)	243	255	255
UNIT WEIGHT = W / V X 1000 (kg/m^3)	**2878**	**2740**	**2662**
TEST RESULTS			
H / D RATIO	1.77	1.86	1.86
CORRECTION FACTOR	0.982	0.988	0.988
LOAD (lbs)	5200	28800	13600
GROSS Mpa = L X 4.448222 / A	9.4	52.2	24.6
MPa CORRECTED	**9.3**	**51.6**	**24.4**
FORM OF BREAK	**-**	**-**	**-**
DIRECTION OF LOADING	Parallel	Parallel	Parallel
CURING CONDITIONS	SITE→→→→→→→→→→→→→→→→→→→→→→→→→→→→→→		

COMMENTS:

Rock Cores Vairous Depths and Locations

TECHNICIAN:	**OM**	APPROVED BY:	C. Beadow

patersongroup
consulting engineers

ROCK CORE COMPRESSIVE STRENGTH ASTM D7012-14 METHOD C

CLIENT:	**Yuri Mendez Engineering**	FILE No.:	**PM7869**
PROJECT:	Lab Testing	REPORT No.:	3
STRUCTURE TYPE & LOCATION:	**6301 Campeau Drive**	DATE REPT'D:	6-Jul-20

SAMPLE INFORAMTION			
LAB NO.:	**17477**	**17477**	**17477**
SAMPLE NO.:	BH13	BH8 ~~BH4~~	BH7 ~~BH2~~
LOCATION:	3'2" - 4'6"	11'9" - 12'.1"	7'4" - 7'8"
SAMPLE DATES			
DATE CAST	-	-	
DATE CORED	-	-	-
DATE RECEIVED	30-Jun-20	30-Jun-20	30-Jun-20
DATE TESTED	6-Jul-20	6-Jul-20	6-Jul-20
SAMPLE DIMENSIONS			
(D) AVERAGE DIAMETER (mm)	55.90	55.90	55.90
(H) HEIGHT (mm)	111.80	111.80	111.80
(W) WEIGHT (g)	780	760	700
(A) AREA = πD2 / 4 (mm^2)	2454	2454	2454
(V) VOLUME = A X H ÷ 1000 (cm^3)	274	274	274
UNIT WEIGHT = W / V X 1000 (kg/m^3)	**2843**	**2770**	**2551**
TEST RESULTS			
H / D RATIO	2.00	2.00	2.00
CORRECTION FACTOR	1.000	1.000	1.000
LOAD (lbs)	44300	16400	52600
GROSS Mpa = L X 4.448222 / A	80.3	29.7	95.3
MPa CORRECTED	**80.3**	**29.7**	**95.3**
FORM OF BREAK	**-**	**-**	**-**
DIRECTION OF LOADING	Parallel	Parallel	Parallel
CURING CONDITIONS	SITE→→→→→→→→→→→→→→→→→→→→→→→→→→→→→→→→		

COMMENTS:

Rock Cores Vairous Depths and Locations

TECHNICIAN:	**OM**	APPROVED BY:	C. Beadow

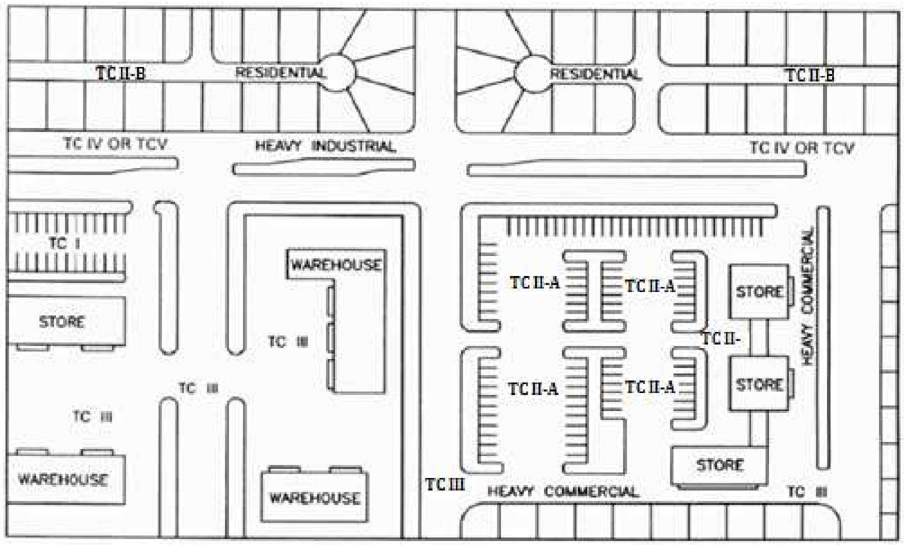

Figure 7: Traffic Classes

Appendix

D Pavement

D.1 Traffic Classes and Pavement Catalog

Figure 7 in page 53 presents a schematic site plan differentiating example uses for five traffic classes developed by the Wisconsin Asphalt Pavement Association and presented in their Design Guide May, 2001.

1. Refer to figure 7 in page 53 to differentiate pavement classes for the proposed Townhouses and 6 Storey Appartment Buildings.

2. Refer to table 1 in page 54 for additional information and design ESALs.

3. Refer to Tables 2, 3 and 4 in page 54 to select pavement structures for each traffic class on fair soils encountered at this site.

Consult Yuri Mendez Engineering for pavement structures on roadbed consisting of newly placed engineered fill, underground parking or as required, where the roadbed is not the near surface fair soil encountered at this site.

Ontario Category	Classes	ESALs	Uses
A	I	50,000	Residential dead end and parking lots 50 stalls or less.
A	II-A	100,000	Parking lots 51 to 500 stalls.
A	II-B	200,000	Residential streets, parking lots more than 500 stalls.
B	III	600,000	Minor colectors, local streets and light industrial lots.
B	IV	900,000	Collector Streets and heavy industrial parking lots.
B	V	2,200,000	Minor Arterial.

Table 1: Design ESALs (20 years) and uses for traffic classes

		Thicknesses			
Material	Specification	Class I		Class II-A	
Class		mm	in	mm	in
Surface course	OPSS 1151 Superpave 9.5	50.8	2	50.8	2
Surface course	OPSS 1151 Superpave 12.5				
Binder course	OPSS 1151 Superpave 19.0				
Base	OPSS 1010 Granular A	152.4	6	152.4	6
Subbase	OPSS 1010 Granular B Type II	127.0	5	203.2	8
Subgrade	Undisturbed In situ Soil				

Table 2: Flexible Pavement Structure Classes I and II-A

		Thicknesses			
Material	Specification	Class II-B		Class III	
Class		mm	in	mm	in
Surface course	OPSS 1151 Superpave 9.5				
Surface course	OPSS 1151 Superpave 12.5	63.5	2.5	76.2	3
Binder course	OPSS 1151 Superpave 19.0				
Base	OPSS 1010 Granular A	152.4	6	152.4	6
Subbase	OPSS 1010 Granular B Type II	228.6	9	304.8	12
Subgrade	Undisturbed In situ Soil				

Table 3: Flexible Pavement Structure Classes II-B and III

		Thicknesses			
Material	Specification	Class IV		Class V	
Class		mm	in	mm	in
Surface course	OPSS 1151 Superpave 9.5	31.8	1.25		
Surface course	OPSS 1151 Superpave 12.5				
Binder course	OPSS 1151 Superpave 19.0	57.2	2.25		
Base	OPSS 1010 Granular A	152.4	6		
Subbase	OPSS 1010 Granular B Type II	330.2	13		
Subgrade	Undisturbed In situ Soil				

Table 4: Flexible Pavement Structure Classes IV and V

D.2 Frost Heave in Pavements

Frost heave of founding materials for pavement induces reduction (serviceability losses) of the performance period (along with traffic ESALs) for which the structure was designed. Generally speaking, AASHTO 1993 does not provide for an increase in thicknesses (structural number) for reduction of losses, as such increase has very small influence in the detrimental effects of frost heave. Frost heave affects pavements by roughness induced by differential frost heave, i.e., if the longitudinal vertical alignment is all equally frost susceptible, there is negligible detrimental effect. This is difficult to achieve in urban developments in which services trenches are backfilled with non frost susceptible materials. For long lasting pavements on frost susceptible soils, the general guideline is, where possible; ensure that all soils serving as pavement foundation are equally frost susceptible. This could be achieved by providing frost susceptible backfill within 1.4 m of the pavement foundation in service trenches. Where measures to mitigate the effect of frost heave are not undertaken, decrease of the performance period is accepted to occur.

D.3 Frost Protection for Manholes, Catch Basins and Others

Manholes and catch basin type structures provide a cold bridge to a deeper portion of the soil profile and create localized areas prompt to pavement failure by excessive frost heave roughness in frost susceptible soils. This can be prevented by providing insulation extending downward around the structure and horizontally outward to create a transition from the varying pavement elevation to the more stable catch basin elevation. On the alternative, non frost susceptible backfill can be provided tapered outward from the structure to the surrounding pavement.

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Appendix

E Foundation Drainage

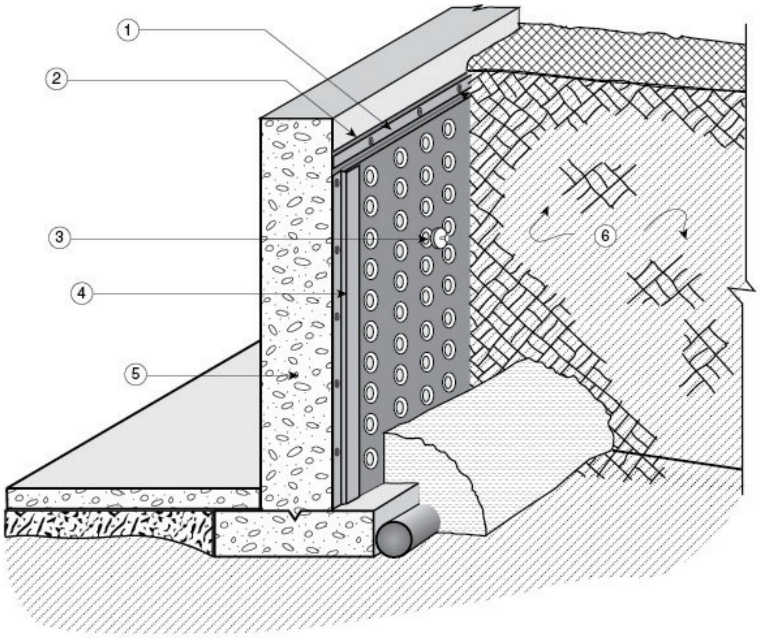

Figure 1. "Cosella-Dörken DELTA®-MS and DELTA®-MS CLEAR Dampproofing Membranes" – face in contact with the soil

1. **termination bar**
2. **caulking (behind membrane)**
3. **fastener**
4. **mould strip**
5. **concrete foundation**
6. **backfill**

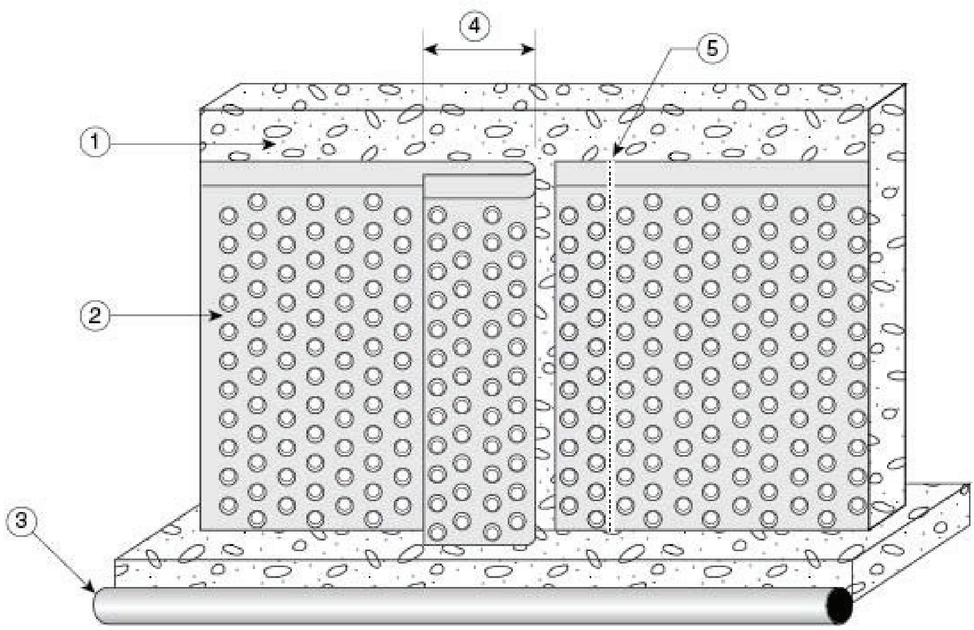

Figure 2. "Cosella-Dörken DELTA®-MS and DELTA®-MS CLEAR Dampproofing Membranes" – face in contact with the wall

1. **concrete foundation**
2. **membrane**
3. **drainage tile**
4. **minimum 6" overlap**
5. **caulking**

Appendix

F Construction Recommendations for Stripping, Earth and Rock Excavation to Undisturbed Soils, Earth and Rock Fill Placement, Asphalt 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 manufacturer's specifications take precedence.

The contractor shall be prepared to proceed as directed by the geotechnical consultant within the framework of these recommendations. Construction methods will abide to these recommendations and/or be discussed and agreed upon with the consultant on site in real time or as expressed in writing.

F.1 Removal of Water

Removal and diversion of surface water and ground water will be planed prior to all earthwork within the scope of these recommendations. All surfaces in which to commence construction will be maintained dry and free of muddy conditions.

F.2 Earth Excavation

Earth excavations are subject to the provisions in O. Reg. 213/91: Construction Projects under Occupational Health and Safety Act. Refer to section 10 for key aspect of O. Reg. 213/91 applicable to the findings in testholes at this site.

For the purpose of these recommendations earth materials will be refer to as one or more of the general material classes: topsoil and organic soils, non engineered fill, granular fill, native soils and rock. Topsoil and organic soils and non engineered fill are the subject of striping in subsection F.2.3.

F.2.1 Suitability of Earth Materials

The suitability of material for specific purposes is determined by the geotechnical engineer. To the extent they are needed, suitable material from the excavations can be used in the construction of required permanent earthfill or rockfill.

F.2.2 Stockpiling and Sorting

Stockpiling is not an acceptable mean to build up the subgrade beneath the perimeter of structures of any kind. For stock piling, with the exception of native soils, material will be sorted in piles belonging exclusively to each material class. For native soils, sorting will be as determined by the geotechnical engineer. Mixed materials will be rendered unusable for uses other than the buildup of the subgrade in landscaped areas.

F.2.3 Striping

Topsoil and/or organic soils and/or 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.

F.2.4 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)). Native soil surfaces exposed to the weather for a period exceeding 72 hours are considered disturbed. Where rainy weather and/or equipment operation and/or labor make impractical or difficult the preservation of USS a working-leveling granular pad may be used. Use the compaction requirements and materials in Table 5.

Except as otherwise indicated for select earthfill materials (subsection F.8) at this site, reinstatement of excavated soil is not allowed. When excavation exceeds the depth of the proposed USS, a granular pad using the compaction requirements and materials in Table 5.

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.

F.3 Foundations Placement

Native soil surfaces exposed to the weather for a period exceeding 72 hours are considered disturbed. Place foundations on a OPSS.MUNI 1010 granular B type 2 granular pad that is at least 150 mm thick placed on undisturbed soils.

F.4 Retaining Wall Foundations

Retaining wall foundations are to be placed on a OPSS.MUNI 1010 granular B type 2 granular pad that is at least 150 mm thick.

F.5 Imported Materials

Materials to be imported are subject to prior approval by the geotechnical engineer. The exceptions are granular materials having 12 % or less fines including clean sands. Fines are materials passing the # 200 sieve (70 μm).

F.6 Rock Excavation

For the *"very hard ripping to blasting"* rock excavatability class at this site, adequate equipment is defined as heavy ripping equipment with a rear-mounted, heavy duty, single-tooth, ripping attachment mounted on a track type tractor having a power rating of at least 350 flywheel horsepower.

F.6.1 Bedrock Preparation

Footings will be placed on a clean sound bedrock surface. Final cleaning of bedrock surfaces for footings placement with compressed air is required.

F.7 Overexcavation

Excavation in rock beyond the specified lines and grades shall be corrected by filling the resulting voids with portland cement concrete which will be cured by spraying water twice a day for 7 days. Excavation in earth beyond the specified lines and grades shall be corrected by filling the resulting voids with approved, compacted earthfill.

F.8 Earthfill

The type of Earthfill materials will be as indicated in plans and specifications. Suitability of materials for uses not explicitly specified in plans will be determined by the geotechnical engineer.

Earthfill materials shall contain no frozen soil, sod, brush, roots, or other perishable material. Rock particles larger than 2/3 of the maximum approved lift thickness shall be removed prior to compaction of the fill.

For the purpose of this subsection all suitable materials will belong to one of the following two classes: *granular earthfill* and *select earthfill*. Granular eathfill will be any natural or crushed earth materials containing 12% or less passing the #200 sieve (70 μm). Select earthfill will be materials for which more than 12% passes the #200 sieve *and* have water content close to the optimum *and* have been rendered as suitable by the geotechnical engineer.

F.8.1 Granular Earthfill Placement

F.8.1.1 Moisture for Granular Earthfill

For granular earthfill it is to be assumed that moisture will be added for placement. Compaction in wet of optimum condition is preferred for granulars.

F.8.1.2 Compacted Lifts Thicknesses Equipment and Passes for Granular Eathfill

Compacted lifts will not exceed 250 mm. 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.

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 will not exceed 250 mm.

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 5 in page 65.

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.

F.8.2 Select Earthfill Placement

It is to be assumed that suitable select fill will be materials that will be excavated from the bank to be put directly on hauling equipment transported and dumped directly for spreading in lifts by push tractors, be added water and compacted. Stockpiling at the source or on site is not acceptable.

F.8.2.1 Moisture for Select Earthfill

It is to be assumed that moisture will be added for placement.

F.8.2.2 Compacted Lifts Thicknesses Equipment and Passes for Select Earthfill

Compacted lifts will not exceed 200 mm for heavy sheep foot rollers. Suitability of smooth vibratory rollers for the materials will be determined by the geotechnical engineer.

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 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 will not exceed 200 mm.

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 5 in page 65.

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.

F.8.2.3 Re-working and/or Re-stripping for Select Earthfill

Re-stripping of 75 mm for select fill surfaces expose to rain or the environment for more than 24 hours is required. Areas of water ponding shall be stripped-off and backfilled.

F.8.3 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 4, 5 or 6 passes for 95, 98 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 select earthfill materials loose lifts may be approximately 125 and 190 mm for compacted lift thicknesses 100 and 150 mm respectively.

F.9 Rockfill

Rockfill material shall be excavated, selected, processed, and handled as necessary to conform to the specified gradation (grain size) requirements.

F.9.1 Rockfill Placement

For rockfill it is to be assumed that moisture will be added for placement.

For rockfill, use the number of passes of equipment as for granular earthfill.

F.9.1.1 Compacted Lifts Thicknesses Equipment and Passes for Rockfill

Compacted lifts will not exceed 400 mm. Subject to test trials a maximum compacted lift of 550 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.

F.10 Compaction General

It is to be assumed that water will be added for compaction and that the required maximum grain size shall be 3/4 of the compacted lift thickness.

Obtain the approximate loose lift thickness by dividing the compacted lift by 0.88. Compacted lifts are approximately 12% less than the loose lift thickness.

Each lift shall be compacted by the specified number of passes of the approved type and weight of roller or other equipment.

Table 5 in page 65 presents Proctor Standard (PS) compaction requirements for specified placement and materials.

F.11 Compaction Specific

F.11.1 Compaction Along Basement Walls, Retaining Walls and Structures

No heavy compaction equipment is to be operated within 0.9 m of any structure. 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 or any structure. Only light to very light compaction is to be applied along the consolidation zone with no more than 2 passes of light vibratory equipment.

F.11.2 Self Compacting Materials

There are no self compacting materials. Total fill thickness of 200 mm of granular materials consisting of more than 90% of one nominal size referred to as crushed stone are acceptable without compaction under concrete slabs.

F.11.3 Settlement Allowance and Overfill

The settlement (consolidation) of lightly compacted earthfill can be excessive. Overfill to compensate for settlement allowance will be discussed with the geotechnical engineer.

F.11.4 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 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. Density probes will only measure the density within 0.12 m depth at the point of the measurement.

F.12 Asphalt Pavement

Place asphalt mix only when base course, or previous course is dry and air temperature is 7 degrees C and increasing.

Asphalt pavement mix temperatures at the time of placement will be within the range of 120 to 160 degrees C.

Do not place asphalt on a surface which is wet or covered by snow or ice or if the ground is frozen.

Material Placement	Material Description	% PS
Base	OPSS.MUNI 1010 Granular A	100
Subbase	OPSS.MUNI 1010 Granular B Type II	100
Subgrade	Granular earthfill (with 12 % or less fines) and 100% passing 106 mm sieve	95
	Select earthfill	95
Backfill for trenches under pavement	Granular earthfill (with 12 % or less fines) and 100% passing 106 mm sieve.	95
	Select earthfill	95
Under sidewalks top 200 mm	Any OPSS.MUNI 1010 Granular specification for which 100% passes the 26.5 mm sieve	95
Under foundations	OPSS.MUNI 1010 Granular B type 2 with 12% or less fines and for which 100% passes the 106 mm sieve	98
Backfill under slabs on grade	Cohesionless (with 12 % or less fines) and 100% passing 106 mm sieve.	100
	Select earthfill	100
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.MUNI 1010 Granular specification for which 100% passes the 26.5 mm sieve	95
Trench foundation (stabilization minimum 200 mm)	Any OPSS 1010.MUNI 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	Granular (with 12 % or less fines) and 100% passing 106 mm sieve	90
	Select earthfill	90
Placement not specified above	Granular (with 12% or less fines) and 100% passing 106 mm sieve	95
	Select earthfill	95

Table 5: Proctor Standard (PS) compaction requirements for specified placement and materials.

F.12.1 Surface Preparation for Asphalt Pavement

It is to be assumed that rough grading and fine grading shall take place before asphalt placement. Rough grading will be completed to within ± 25 mm of the underside of asphalt and tested to meet the specified density. Fine grading and rolling will completed by the paving contractor. The granular material for fine grading will meet OPSS.MUNI 1010 Granular M.

F.12.2 Proof Rolling Prior to Asphalt Pavement

Conduct proof rolling using a single pass of a tandem-axle dump truck or a tri-axle dump truck with the third axle raised loaded to a minimum gross vehicle weight of 26 metric tons at walking speed. Rutting in excess of 25 mm is considered failure. Where proof rolling reveals areas of defective subgrade, Remove base, Sub-base and subgrade material to depth and extent and width that will allow reconstruction using the available equipment or as directed by the Consultant.

F.12.3 Asphalt compaction

The compacted lifts are accepted to be 80% of the loose lift thickness (the loose lift reduces thickness by 20% when compacted). Divide the compacted lift thickness by 0.8 to obtain the thickness of the loose lift.

Compaction will consist on at least three passes at approximately walking speed (5.4 km/hr) as follows: *break down rolling* using a vibratory steel drum roller, *intermediate rolling* with a static (non-vibrating) roller or a pneumatic roller and *finish rolling* with a smooth static roller.

Appendix

G Recommended Geotechnical Services During Design and Construction

It is recommended that geotechnical services be retained in order to insure that the recommendations in this report are implemented in the final design and construction.

G.1 Design Phase Supplemental Geotechnical Services for the Proposed Development

Geotechnical services are expected to consist in additional design and plan reviews once draft plans defining details concerning grading, services, pavements and foundation dimensions, elevations, depth and loads become available. The design services may be requested in advance by other designers and depend on design decisions and/or plans differing from the assumptions in this report. The geotechnical designer is to produce at this stage technical letters and/or drawings supporting analyses and final design decisions.

G.2 Construction Phase Supplemental Geotechnical Consultant Services for the Proposed Development

The geotechnical consultant services for construction will consist on inspections and testing for quality control. The inspections may be visual examination only or in conjunction with testing. Inspection and quality control testing programs are tailored to include but not limited to:

- Confirmation of findings of the geotechnical investigation.
- Monitor the performance of temporary geotechnical structures in time.
- Satisfy the consultant that the physical and mechanical properties of existing and newly placed geotechnical materials meet the requirements in this report.
- Inspect temporary soil cut for signs of distress.
- Satisfy the consultant that manufacturer specifications involving systems and materials interacting with ground conditions and ground water are being met
- Satisfy the consultant that performance measures and tolerances of geotechnical structures are being met (piles, anchors, etc.)

Supplemental geotechnical services in this stage may include shop drawings review for contractor designed geotechnical structures (typically shoring, temporary soil cut and anchors)

G.3 Contractor Designed Temporary Geotechnical Structures

Since excavations are recognized as a hazardous construction operation and contractors have control of the construction operations and safety, temporary slope cut stability and temporary shoring design are typically done by the contractor. The anchoring systems to shoring, dewatering systems and other applications are also done by the contractor except specified otherwise. In particularly sensitive ground water conditions dewatering systems may need to be designed by the geotechnical consultant.

Temporary soil cut and shoring must be designed to meet O. Reg. 213/91. The general design requirement is that the risks to workers and the public be kept to acceptable levels and that adjacent properties and existing structures are not damaged.

The consultant role is to conduct reviews of shop drawings defining details of temporary geotechnical structure designed by the contractor. It is expected that this investigation report be sufficient to supply the data required for temporary slope cut and shoring design.