Subsurface Investigation Report

1546 Scott St., Ottawa, ON, K1Y 4S8

Abstract

This report presents the findings of a Subsurface Investigation completed at the 1546 Scott St. parcel, in the City of Ottawa, ON, K1Y 4S8, and issue recommendations for a proposed Highrise Building with 3 to 4 Levels of Underground Parking development. It provides technical information about the subsurface conditions at 14 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. Moderately hard to hard limestone bedrock was cored to a 13.4 m depth at 2 borehole locations. The borehole locations are shown in figure 2 in page 11. 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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Report 47-CEI-R1
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Contents

1 Executive Summary

Yuri Mendez Engineering was retained by COLESTAR Environmental Inc. acting on behalf of Starbank Developments 2000 Corp. to conduct a geotechnical site investigation of the site located at 1546 Scott Street in Ottawa, Ontario. The geotechnical site investigation was carried out to establish geotechnical related design parameters for the construction of a high rise building (25 to 30 stories) complete with a three to four level underground parking garage.

The investigation found that the three to four levels of underground parking will be advanced through 1.1 to 2.9 m of overburden soils and limestone bedrock to the approximate founding depth. The bedrock was found to be moderately hard to hard, slowly permeable and of fair to excellent quality. Water level measurements also completed as part of the investigation suggest that the permanent water table is at approximately 8.7 m depth.

The investigation findings are indicative that the proposed high rise building can be founded on spread and/or strip footings placed on undisturbed bedrock, that water proofing will be required and that rock excavations could be advanced through nearly vertical rock cuts using heavy ripping equipment or blasting.

2 Introduction

This document reports the findings of a subsurface investigation completed at 1546 Scott St., in the City of Ottawa, ON, K1Y 4S8, located just west from downtown Ottawa, ON as shown in the key plan in fig.1 in page 8 and having extents and geometry shown in figure 2 in page 11. 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.

The investigation was carried out by advancing 12 boreholes through overburden soils and bedrock and using other exploration techniques for characterization of bedrock 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 Highrise Building with 3 to 4 Levels of Underground Parking development. The information reviewed also includes readily available geologic information from the Geological Survey of Canada (GSC), and local climate data from Environment Canada.

3 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

Figure 1: Key Plan

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.

Future revisions to this report will be referred to as "47-CEI-R#", where # is the consecutive number of the revision. Additions and/or alterations and/or inclusions to the information provided in this report at the request of any institution and/or body with authority to request the additions and/or alterations and/or inclusion will be provided in a separate "Response to " (RT) section at the end of the report, before the appendices. The RT section shall state the section that is added and/or altered, the name of the person making the request and the reason. The section altered and or portions added will be provided in full as a subsection of the RT section. Any subsection added under the RT section will be considered a replacement to the original section.

Part I

Investigation

4 Sampling and Testing

The field and laboratory program set out in our proposal dated August 11, 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 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.

The investigation was carried out by advancing 12 testholes on July, 02, 03 and 09. Two holes were existing for a total of 14 holes. The test hole locations are shown in the test-hole location plan in figure 2 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.

Twelve of the 14 holes at this site, namely, Monitoring Wells 1 to 6 (MWs 1 to 6), MWs 9 to 11 and Boreholes 12 to 14 (BHs 12 to 14) were completed in coordination with Colestar Environmental Inc. to meet geotechnical and environmental purposes. It is understood that O-MW-8 and O-MW-9 were completed previously at the site for environmental purposes. Water level measurements in O-MW-8 and O-MW-9 are used in this report for groundwater assessments.

For bedrock properties and for proving bedrock depth, 2 of the 12 holes, namely, MW-3 and 9 were cored to a 13.4 m depth, 7 of the 12 holes, namely MWs 1, 2, 4, 5, 6, 10 and 11 were advanced to auger refusal and further advanced using a truck mounted compressed air percussion hammer for installation of monitoring wells which were checked for hammer resistance and speed of advance to confirm bedrock. Bedrock depth proving at BHs 12 to 14 is by auger refusals. Other engineering assessments for rock were performed on hand samples using a hammer with pick end and a pocket knife.

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

The program also included an elevation survey referenced to an elevation of 100 m assigned arbitrarily to the catch basin located on the east side of the existing building (TBM) shown in the Test Hole Locations Plan in fig. 2 in page 11.

The program included in addition a laboratory review of samples recovered from the field and one sample submitted to a local laboratory to investigate soluble ions concentration, PH and resistivity.

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

Part II
Findings

5 Physical Settings, Strata and Topography

The site is to the west of downtown Ottawa, ON as shown in Fig.1 in page 8. As can be seen in fig. 2 in page 11 the site is presently occupied by a one storey building of slab on grade construction and its parking areas. The site and its surrounding areas are relatively flat. A one storey portion and one level of underground parking of the building to the west abut the west boundary line. Rough field measurements suggest an approximately 2.2 m founding depth for this underground parking as measured from the top of the sidewalks on the perimeter of the existing Beer Store building. The reminder boundaries are surrounded by parking areas and access lanes.

The geology data base by Belanger J. R. 1998 suggests 2 to 5 m of overburden soils underlain by Limestone bedrock at this site.

6 Surface and Subsurface Materials

The site is underlain by shallow bedrock at depths ranging from 1.1 to 2.9 m depth. Approximately 10 cms of asphalt cover overburden materials consisting on the pavement base of granular materials and fill. The fill mostly consists of *dense* mixed sand, silty sand and gravel overlying rock or glacial till. *Dense* glacial till consisting of silty sand with gravel was encountered in 3 boreholes ranging in thickness of 0.5 to 1 m between overburden fill and shallow bedrock.

6.1 Bedrock

6.1.1 Rock Material Properties

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

6.1.1.1 Rock Type

The field program confirmed the sedimentary Limestone bedrock reported by the geology data base.

6.1.1.2 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 UCS of rock often exhibit significant scatter. Averaging schemes at comparable depths appear best suited in many instances, as similar

Figure 2: Test hole Locations Plan

depths may represent similarity in terms of weathering processes such as exposure to oxygen and the chemistry of water, overburden pressure, etc. In other instances assessments under discontinuities in section 6.1.2 may also influence the averaging scheme. The averaging scheme per depth below along with other assessments appear feasible for the conditions of the bedrock encountered.

1. At approximately 2 m depth at MW3, 39 MPa UCS was measured. A suitable UCS sample at similar depth could not be obtained at MW-9. The bedrock is thus of the *"moderately hard"* hardness class. Refer to subsection 6.1.2 "Jointing" for further comments.

2. At depth ± 6.5 m UCS values were 19.9, 44.0, 101.0 at MW-3 RC4 and MW-9 RC4 and RC5 respectively for an average of 55 MPa. The bedrock is thus of the *"hard"* hardness class. Refer to subsection 6.1.2 "Jointing" for further comments.

3. At depth ± 13.1 m UCS values were 51.7 and 91.2 at MW-3 RC8 and MW-9 RC8 respectively for an average of 71 MPa. The bedrock is thus of the *" hard"* hardness class. Refer to subsection 6.1.2 "Jointing" for further comments.

From the results, the general hardness class range is *"moderately hard to hard"* and it appears to be increasing with depth.

6.1.1.3 Density

Density of $2,870 kg/m^3$ was determined within the framework of UCS tests.

6.1.1.4 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. Within the highly jointed and fractured top 0.25 m of the first core run the rock is *moderately weathered* in both holes cored. The bedrock is otherwise jointed and fresh beneath this depth. The UCS at 39 MPa at MW3 located at approximately 0.6 m below the top of the bedrock confirm jointed unweathered rock at that depth.

6.1.1.5 Color

The bedrock is dark gray in color as seen in fresh breaks. The rock has light gray to gray appearance when exposed due to the action of the drill.

6.1.2 Rock Mass Structural Discontinuities (Jointing and Fractures)

Jointing visible in rock cores would be those that could intercept the vertical shaft formed by the cores. Near vertical joints will not be properly detected by the cores. The dip orientation on a horizontal plane. cannot be determined on rock cores, however, they can provide a rough idea of their inclination.

6.1.2.1 Jointing, Joint Orientation and Joint Density

Systematic near horizontal bedding plane partings type of joints were found through the rock cores. Their joint spacing category varies from *close* within 0.3 m of the top of the cores to *wide* near the bottom of the cores. Joint spacing beneath the 0.3 m weathered portion increase rapidly as reveled by Rock Quality Designations (RQDs) within the 50 to 75 *fair* rock quality found on the first 2 core runs (RC1 and RC2) in both holes cored. Generally, Joint spacing between 50 to 80 mm could be found within 2.5 m of the top of the bedrock but it is in general at 100 to 600 mm spacing within that 2.5 m portion and wider at greater depths. The rock quality thus varies between *fair to excellent* from the top to the bottom of the coring depth under the RQD scheme.

Aperture Width: The aperture width less than 2 mm in width found is of the *extremely narrow* aperture category class for the majority of the profile.

Infilling: Infilling in the form of clay or other materials does not appear present from the rock cores.

6.1.2.2 Comments on Structural Discontinuities

Limestone bedrock in Ottawa often exhibit a tendency to break in nearly horizontal planes. These planes are not visible. The near horizontal jointing that is also found in limestone in Ottawa and at this site as well is thought to be related to the presence of these nearly horizontal weak planes. Applied blows with the pick end of a hammer produced near horizontal fractures on hand samples which confirms this tendency for the bedrock at this site.

6.1.3 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.

6.1.3.1 Seismic Velocity

The shear wave velocity is estimated to be within the range of 2,000 to 2,300 m/sec as judged from seismic refraction tests completed in rocks of similar properties 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.

6.1.3.2 Joint Face Weathering

Joint faces are fresh, unweathered.

6.1.4 Comments on Bedrock Properties

Rock materials are suitable for a multitude of engineering purposes, including bearing to support structures. 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.

6.2 Groundwater and Moisture

The water level was measured on July 09 and 20, 2020 in wells installed in all of the holes at depths ranging from 4.05 and 11.3 m and shown in the borehole logs. Ground water measurements in well installations often require numerous assessments in combination with borehole data.

In the borehole logs, a 91.44 m elevation of the water table is presented as interpreted from measurements. This value is an overall estimation of the elevation for the relatively flat site and lead to an average depth of 8.76 m measured from the holes surface. For its estimation, the depths measured at MWs 4 and 6 were filtered out and is more influence by the measurements of July 20, 2020.

The overburden soils are relatively dry. Perched water in overburden soils does not appear present at the site.

6.3 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 native 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 limestone 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 4 and from geotechnical engineering evaluation and assessments.

It is understood that the proposed development will consist of a Highrise Building with 3 to 4 Levels of Underground Parking.

7 Foundations General

This investigation findings indicate that the underground parking of the proposed Highrise Building with 3 to 4 Levels of Underground Parking will be advanced through bedrock. The proposed OBC part 4 building can thus be founded on spread footings placed on the bedrock encountered at the proposed founding depth.

7.1 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).

7.2 Bearing Capacity of Strip and/or Pad Footings

For the properties and assessments of bedrock cores set forth under section 6.1.1, RQDs and UCS shown in the borehole logs, the service limit (SLS) bearing capacity below represent a fraction of 0.14 of the allowable bearing capacity suggested by Peck[2] et al. (1974) which can be used for design of the proposed spread footings placed on the bedrock encountered at the proposed founding depth. An average load factor of 1.5 is assumed for the bearing capacity for factored loads (ULS).

- 4.4 MPa at service limit (SLS).
- 6.6 MPa for factored loads (ULS).

For canopies or other structures which may be required on the perimeter of the building, pad footings up to 2 m wide or strip footings up to 0.9 m wide placed on an undisturbed near surface jointed un-weathered bedrock surface the bearing capacities below can be considered.

- 200 KPa at service limit (SLS).
- 300 kPa for factored loads (ULS).

[2]Peck, Ralph B. & Hanson, Walter Edmund. & Thornburn, Thomas Hampton. (1974). Foundation engineering. New York : Wiley

For canopies or other structures which may be required on the perimeter of the building, pad footings up to 2 m or strip footings up to 0.9 m wide placed on an undisturbed glacial till surface the bearing capacities below can be considered.

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

7.3 Settlements

For the bearing capacities provided above settlement of foundations on bedrock will be 1.5 to 2.5 mm.

7.4 Frost Protection for Foundations

Shallow foundations on frost susceptible which may be required on the perimeter of the building for canopies or other structures 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.

7.5 Foundation Insulation

To meet the required frost protection in section 7.4 for foundations for canopies or other structures in the perimeter of the building and in unheated areas in otherwise heated buildings 50 mm of extruded polystyrene insulation (XPS) type V, VI or VII meet foundation insulation requirements for the freezing index in the Ottawa area.

7.6 Basement Waterproofing

For the subsurface conditions encountered hydrostatic pressure will build up along the perimeter of the underground parking of the building. Waterproofing is thus required.

The waterproofing system should be such to seal the building envelope by:

- grouting bedrock joints along the perimeter of the building to a height 2 m above the ground water table;
- providing a blind side waterproofing (or tanking) system such as Preprufe Plus® or similar as specified by the manufacturer;
- providing waterproof concrete;
- providing one or more sealed sumps and pumps inside the building and drainage to catch any water which may breach the waterproofing system.

8 Site Class for Seismic Design

The Shear Wave Velocity ($Vs_{(30)}$) 30 m beneath the proposed founding depth will exceed 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 the rock encountered, 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 highly recommended before structural design.

It is hence recommended to refer to the following information in appendix B.1:

1. The 2010 National Building Code Seismic Hazard Calculation for the *reference site* in page 42.

2. Figure 3 in page 41 showing the design spectral accelerations.

9 Bedrock

Assessment of the properties outlined in section 6.1.1 under the framework of chapter 4 referenced in section 4 lead to the following recommendations.

9.1 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 *" 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. Rock excavation based solely in hoe rammers are not generally an option for large quantities of rock.

The presence of jointing and weaker bedding plane partings of nearly horizontal orientation noted under section 6.1.2 will be a consideration for excabatability. 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 in section 16 for other recommendations for rock excavations.

9.2 Rock Mass Stability

For the strength, hardness, jointing and RQD the bedrock is of the *"stable"* class. Nearly vertical cuts are thus technically feasible.

9.3 Permeability of Rock

For the *extremely narrow* rock mass discontinuities and *wide* joint spacing class below the estimated water table elevation the rock is of the *"slowly permeable"* class. The permeability is thus estimated in the proximity of $5x10^{-}8m/s$

9.4 Construction Quality of Rock

For the 19.9 and 101 MPa UCS range *"moderately hard to hard"* hardness class and 2,870 kg/m^3 unit weight the rock is of the *"medium to high grade"* construction quality class. "Rock material is suitable for high-stress aggregate, filter and drain material, riprap, and other applications."

10 Roadbed Soils and Pavement Structure

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

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

Additional information regarding pavements will be provided as part of this report if required.

11 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.

11.1 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.*

11.2 Construction and Excavation Along Adjacent Structures and Property Boundaries

Significant concerns regarding safety and property damage result from excavations along adjacent structures. O. Reg. 213/91 under "*Protection of Adjacent Structures*" establishes the following for excavations near adjacent structures:

- 229. (1) If an excavation may affect the stability of an adjacent building or structure, the constructor shall take precautions to prevent damage to the adjacent building or structure. O. Reg. 213/91, s. 229 (1).
- 229. (2) A professional engineer shall specify in writing the precautions required under subsection (1). O. Reg. 213/91, s. 229 (2).
- 229 (3) Such precautions as the professional engineer specifies shall be taken. O. Reg. 213/91, s. 229 (3).
- any comment and/or precaution and/o recommendation in this report is followed.

This section establishes the precautions required under O. Reg. 213/91 section 229 (2) above.

Excavation depths below the founding depth of adjacent structures will not take place, unless:

- Lateral support is provided to soils by cutting the slope to 1 horizontal to 1 vertical or
- lateral support is provided by shoring.
- any comment and/or precaution and/o recommendation in this report is followed.

It is also recommended that the edge of the 1 horizontal to 1 vertical slope providing lateral support be offset 0.3 m away from the edge of the foundation.

11.3 Comments on Excavations and Protection of Adjacent Structures

It is to be noted that since excavations and safety are controlled by the contractor, the design of shoring and structures to protect neighboring buildings are done by the contractors. This report is to provide recommendations for the excavations and information which will assist in the design of those structures.

The investigation findings suggests that there will be 0.8 to 2.9 m of overburden soils which will need to be cut to acceptable slopes or shored up. The bedrock could be cut vertical according to the findings in the boreholes.

Abutting the west boundary line, there is one level of underground parking and one storey above which appears to extend along the entire length of that boundary line according to rough measurements completed inside the said underground parking. The following scenarios could be considered for the conditions along the west boundary line subject to confirmations which will be completed at a later time:

1. that the building is founded on the bedrock;

2. that the building is founded on soils.

For scenario 1, the uncertainty remains about the capacity of the bedrock to bear the loads along the edge of the potential rock cut to be completed. To overcome this uncertainty, the installation of rock dowels prior to rock excavations or any other type of reinforcement can be considered to ensure safety for this structure. Dowels should be such to intercept any potential failure planes. Dowels that are inclined downward to the west at 25 degrees and that extend 4.5 m in length are thought to be capable of intercepting failure planes from what is found in this investigation. Assumptions for the design of dowels could be such to consider conservatively *smooth* failure planes. The properties reported here, along with the assumption of smooth planes appear to meet the requirements of the relationship in Spang and Egger (1990)[3] for rock dowels design.

For scenario 2, the soils will need to shored up and the bedrock will have to be provided with similar reinforcement.

12 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 6 and 6.2 and information seen in the borehole logs, water inflow is expected to be low and controllable by pumping from open sumps.

12.1 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 6 and 6.2 pumping from

[3]Spang, K. and Egger, P. (1990) Action of fully-grouted bolts in joined rock for fractured ground. J. Rock Mech. Rock Engng., 23, 21099.

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.

13 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 corrosive. Resistivity, PH and soluble ions testing was completed in a representative sample at 1.8 m depth in MW9. After Romanoff (1957)[4], 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.

14 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.

15 Special Issues or Concerns

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

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

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

Appendix D 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.

17 Additional Geotechnical Services

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

User Agreement

Acknowledgment of Duties

In this 47-CEI-R1 report, Yuri Mendez Engineering (YME) has pursued to fulfill every aspect of the obligations of professional engineers. As a part of those duties, from field work, operations, testing, analyses, application of knowledge and report, YME has ensured that it meats a high standard of Geotechnical engineering practice and care in the province of Ontario. Obligations under R.R.O. 1990, Reg. 941: Professional Engineers Act, R.S.O. 1990, c. P.28, further referred to as Reg. 941 which are of immediate interest to this service are:

"77. 7. A practitioner shall,

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

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

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

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

Communications

47-CEI-R1 is to be used solely in connection with the Highrise Building with 3 to 4 Levels of Underground Parking by Starbank Developments 2000 Corp. (SD) and thus subject of communications amongst other professionals (OP), government bodies and authorities, and SD 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 SD 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 SD in this report will be forwarded to YME.

Reasonable Completeness

OP and Starbank Developments 2000 Corp. 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 SD 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 47-CEI-R1 report by adding R# to each revision where # is the number of the revision. OP covenant to conduct all communications in connection with these reviews following great care to preclude the suggestion of a breach to the reasonable completeness acknowledged herein. Written communications which may trigger reviews under this agreement will be acknowledged as requests for "review under the 47-CEI-R1 report user agreement". This reasonable completeness is also relative to the scope of services generally accepted in geotechnical engineering work in Ontario

Errors

Where errors are found during reviews under the 47-CEI-R1 report user agreement, OP covenant great care in communications to preclude the suggestion of a breach to the duties acknowledge herein which could induce damages to YME. Communications triggered by errors or any such communication which would render the person doing the request in a position of technical authority above the author implies an unauthorized review and constitute a serious breach of the code of ethics under Reg. 941 and damages to YME and so subject to disciplinary measures and/or liability for damages to YME. SD 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 SD in this report occur, SD covenants to inform YME. SD 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

SD 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. SD 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.

Part IV
Appendices

A Borehole Logs

Report 47-CEI-R1
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Project: **Proposed Highrise Building with 3 to 4 levels of Underground Parking**		YME Yuri Mendez Engineering.
Location: **1546 Scott St.**	Client: **Starbank Developments 2000**	**Test Hole No.: MW1 of 14**
Job No.: **47-CEI-1546Scott**	Test Hole Type: **7" OD Auger.**	Date: **July 02, 03 and 09, 2020**
Casing and 61 mm diameter cores	SPT Hammer Type: **Auto Safety**	Logged By: **Yuri Mendez**

YME Yuri Mendez Engineering

Depth (m)	Elevation (m) 100.02	Lithology and color	Material Description	Samples or Blows/Ft	Water	Elevation (m) 100.02	Depth (m)	Shear Strength (kPa)	Laboratory Tests: Moisture Content (%)	Rock Quality RQD %	Other Lab Tests
0 – 0.25	100		Asphalt			100	0 – 0.25				
0.25 – 0.75	99.5		Granular fill: Sand and gravel, brown and dry	73		99.5	0.25 – 0.75				
0.75 – 2.1	99 – 98		Fill: Medium sand, trace silt and weathered bedrock, Brown and dry.	48		99 – 98	0.75 – 2.1				
2.1 – 11.5	98 – 88.5		Bedrock by Percussion Hammer		▼ (at 91.5 / 8.5 m)	98 – 88.5	2.1 – 11.5				

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, 4.5, 4.75, 5, 5.25, 5.5, 5.75, 6, 6.25, 6.5, 6.75, 7, 7.25, 7.5, 7.75, 8, 8.25, 8.5, 8.75, 9, 9.25, 9.5, 9.75, 10, 10.25, 10.5, 10.75, 11, 11.25, 11.5

Elevation scale (m): 100, 99.5, 99, 98.5, 98, 97.5, 97, 96.5, 96, 95.5, 95, 94.5, 94, 93.5, 93, 92.5, 92, 91.5, 91, 90.5, 90, 89.5, 89, 88.5

Water Level: Meassured on July 09 and 20, 2020 at 11.18 and 9.75 m depth respectively.

S = Sample for lab review and moisture content

▼ Interpreted water level

Project: **Proposed Highrise Building with 3 to 4 levels of Underground Parking**		YME Yuri Mendez Engineering.
Location: **1546 Scott St.**	Client: **Starbank Developments 2000**	**Test Hole No.: MW2 of 14**
Job No.: **47-CEI-1546Scott**	Test Hole Type: **7" OD Auger.**	Date: **July 02, 03 and 09, 2020**
Casing and 61 mm diameter cores	SPT Hammer Type: **Auto Safety**	Logged By: **Yuri Mendez**

Yuri Mendez Engineering

Depth (m)	Elevation (m) 100.31	Lithology and color	Material Description	Samples or Blows/Ft	Water	Elevation (m) 100.31	Depth (m)	Shear Strength (kPa)	Moisture Content (%)	Rock Quality RQD %	Other Lab Tests
0 – 0.25	100		Asphalt	28		100	0 – 0.25				
0.25 – 0.75	99.5		Granular fill: sand and gravel. Brown and dry			99.5	0.25 – 0.75				
0.75 – 1.5	99		Fill: silty sand, trace gravel and weathered bedrock. Brown and dry.			99	0.75 – 1.5				
1.5 – 10	98.5 – 90.5		Bedrock by Percussion Hammer			98.5 – 90.5	1.5 – 10				
8.2	92		Water Level: Meassured on July 09 and 20, 2020 at 8.2 and 8.05 m depth respectively.		▼	92	8.2				

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, 4.5, 4.75, 5, 5.25, 5.5, 5.75, 6, 6.25, 6.5, 6.75, 7, 7.25, 7.5, 7.75, 8, 8.25, 8.5, 8.75, 9, 9.25, 9.5, 9.75, 10

Elevation scale (m): 100, 99.5, 99, 98.5, 98, 97.5, 97, 96.5, 96, 95.5, 95, 94.5, 94, 93.5, 93, 92.5, 92, 91.5, 91, 90.5

S = Sample for lab review and moisture content

▼ Interpreted water level

Project: **Proposed Highrise Building with 3 to 4 levels of Underground Parking**	YME Yuri Mendez Engineering.
Location: **1546 Scott St.** / Client: **Starbank Developments 2000**	**Test Hole No.: MW3 of 14**
Job No.: **47-CEI-1546Scott** / Test Hole Type: **7" OD Auger.**	Date: **July 02, 03 and 09, 2020**
Casing and 61 mm diameter cores / SPT Hammer Type: **Auto Safety**	Logged By: **Yuri Mendez**

Depth (m) | Elevation (m) 99.37 | Lithology and color | Yuri Mendez Engineering — Material Description | Samples or Blows/Ft | Water | Elevation (m) 99.37 | Depth (m) | Shear Strength (kPa) | Laboratory Tests: Moisture Content (%) | Rock Quality RQD % | Other Lab Tests

Material Description:

- Asphalt
- Granular fill
- Fill: fine sand
- Weathered Limestone
- Limestone Bedrock: unweathered with near horizontal moderately wide jointing (20 to 50 cms spacing) at 3.0 m depth. UCS @ 2 and 6 m depth of 39.0 and 19.9 MPa respectively.
- Water Level: Meassured on July 09 and 20, 2020 at 7.24 and 7.08 m depth respectively. UCS @ 13 m depth of 55.7 MPa.
- Limestone Bedrock: As above with wide jointing (Greater than 60 cms pacing).

Samples or Blows/Ft: 26, 56

Rock Quality RQD %: 69, 74, 91, 100, 100, 97, 94, 98

S = Sample for lab review and moisture content

Interpreted water level

Project: **Proposed Highrise Building with 3 to 4 levels of Underground Parking**		YME Yuri Mendez Engineering.
Location: **1546 Scott St.**	Client: **Starbank Developments 2000**	**Test Hole No.: MW4 of 14**
Job No.: **47-CEI-1546Scott**	Test Hole Type: **7" OD Auger.**	Date: **July 02, 03 and 09, 2020**
Casing and 61 mm diameter cores	SPT Hammer Type: **Auto Safety**	Logged By: **Yuri Mendez**

YME Yuri Mendez Engineering

Depth (m)	Elevation (m) 100.36	Lithology and color	Material Description	Samples or Blows/Ft	Water	Elevation (m) 100.36	Depth (m)	Shear Strength (kPa)	Moisture Content (%)	Rock Quality RQD %	Other Lab Tests
0–0.1			Asphalt								
0.1–1.25			Fill: Sand and gravel. Brown and dry.	22							
1.25–3.9			Bedrock by Percussion Hammer	>100							
			Water Level: Meassured on July 09 and 20, 2020 at 4.32 and 4.05 m depth respectively.		▼ (approx. 91.5)						

Depth scale: 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, 4.5, 4.75, 5, 5.25, 5.5, 5.75, 6, 6.25, 6.5, 6.75, 7, 7.25, 7.5, 7.75, 8, 8.25, 8.5, 8.75, 9, 9.25, 9.5

Elevation scale: 100, 99.5, 99, 98.5, 98, 97.5, 97, 96.5, 96, 95.5, 95, 94.5, 94, 93.5, 93, 92.5, 92, 91.5, 91

Laboratory Tests

S = Sample for lab review and moisture content

▼ Interpreted water level

Project: **Proposed Highrise Building with 3 to 4 levels of Underground Parking**		YME Yuri Mendez Engineering.
Location: **1546 Scott St.**	Client: **Starbank Developments 2000**	**Test Hole No.: MW5 of 14**
Job No.: **47-CEI-1546Scott**	Test Hole Type: **7" OD Auger.**	Date: **July 02, 03 and 09, 2020**
Casing and 61 mm diameter cores	SPT Hammer Type: **Auto Safety**	Logged By: **Yuri Mendez**

Yuri Mendez Engineering

Depth (m)	Elevation (m) 100.23	Material Description	Samples or Blows/Ft	Water
0–0.1	100.23	Asphalt	**34**	
0.1–0.5		Granular fill		
0.5–1.3		Fill: sand and gravel	**>100**	
1.3–11.25		Bedrock by Percussion Hammer		
		Water Level: Meassured on July 09 and 20, 2020 at 8.11 and 8.0 m depth respectively.		▼ (approx. 8.8 m / 91.4)

Columns: Lithology and color; Shear Strength (kPa); Laboratory Tests: Moisture Content (%), Rock Quality RQD %, Other Lab Tests.

Depth scale: 0 to 11.25 m; Elevation scale: 100 to 89.

S = Sample for lab review and moisture content

▼ Interpreted water level

Project: **Proposed Highrise Building with 3 to 4 levels of Underground Parking**		YME Yuri Mendez Engineering.
Location: **1546 Scott St.**	Client: **Starbank Developments 2000**	**Test Hole No.: MW6 of 14**
Job No.: **47-CEI-1546Scott**	Test Hole Type: **7" OD Auger.**	Date: **July 02, 03 and 09, 2020**
Casing and 61 mm diameter cores	SPT Hammer Type: **Auto Safety**	Logged By: **Yuri Mendez**

Yuri Mendez Engineering

Depth (m)	Elevation (m) 100.15	Lithology and color	Material Description	Samples or Blows/Ft	Water	Elevation (m) 100.15	Depth (m)	Shear Strength (kPa)	Laboratory Tests: Moisture Content (%)	Rock Quality RQD %	Other Lab Tests
0 – 0.25	100		Asphalt			100	0 – 0.25				
0.25 – 1.35	100 – 98.8		Fill: sand and gravel. Brown and dry.	28, 78							
1.35 – 11.5	98.8 – 88.65		Bedrock by Percussion Hammer		▼ at 8.75 (91.5)						
			Water Level: Meassured on July 09 and 20, 2020 at 10.08 and 4.40 m depth respectively.								

Depth scale: 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, 4.5, 4.75, 5, 5.25, 5.5, 5.75, 6, 6.25, 6.5, 6.75, 7, 7.25, 7.5, 7.75, 8, 8.25, 8.5, 8.75, 9, 9.25, 9.5, 9.75, 10, 10.25, 10.5, 10.75, 11, 11.25, 11.5

Elevation scale: 100, 99.5, 99, 98.5, 98, 97.5, 97, 96.5, 96, 95.5, 95, 94.5, 94, 93.5, 93, 92.5, 92, 91.5, 91, 90.5, 90, 89.5, 89

S = Sample for lab review and moisture content

▼ Interpreted water level

Project: **Proposed Highrise Building with 3 to 4 levels of Underground Parking**		YME Yuri Mendez Engineering.
Location: **1546 Scott St.**	Client: **Starbank Developments 2000**	**Test Hole No.: O-MW7 of 14**
Job No.: **47-CEI-1546Scott**	Test Hole Type: **7" OD Auger.**	Date: **July 02, 03 and 09, 2020**
Casing and 61 mm diameter cores	SPT Hammer Type: **Auto Safety**	Logged By: **Yuri Mendez**

Yuri Mendez Engineering

Depth (m)	Elevation (m) 100.18	Lithology and color	Material Description	Samples or Blows/Ft	Water	Elevation (m) 100.18	Depth (m)	Shear Strength (kPa)	Laboratory Tests: Moisture Content (%)	Laboratory Tests: Rock Quality RQD %	Laboratory Tests: Other Lab Tests
0 – 8.49	100 – 91.69		Overburden not loged during previous drilling: profile inferred similar to MW5 and MW6			100 – 91.69	0 – 8.49				
8.49 – 9	91.69 – 91.18		Water Level: Meassured on July 09 and 20, 2020 at 8.49 and 8.35 m depth respectively.		▼	91.5	8.75				

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, 4.5, 4.75, 5, 5.25, 5.5, 5.75, 6, 6.25, 6.5, 6.75, 7, 7.25, 7.5, 7.75, 8, 8.25, 8.5, 8.75, 9

Elevation scale (m): 100, 99.5, 99, 98.5, 98, 97.5, 97, 96.5, 96, 95.5, 95, 94.5, 94, 93.5, 93, 92.5, 92, 91.5

S = Sample for lab review and moisture content

▼ Interpreted water level

Project: **Proposed Highrise Building with 3 to 4 levels of Underground Parking**		YME Yuri Mendez Engineering.
Location: **1546 Scott St.**	Client: **Starbank Developments 2000**	**Test Hole No.: O-MW8 of 14**
Job No.: **47-CEI-1546Scott**	Test Hole Type: **7" OD Auger.**	Date: **July 02, 03 and 09, 2020**
Casing and 61 mm diameter cores	SPT Hammer Type: **Auto Safety**	Logged By: **Yuri Mendez**

YME Yuri Mendez Engineering

Depth (m)	Elevation (m) 100.29	Lithology and color	Material Description	Samples or Blows/Ft	Water	Elevation (m) 100.29	Depth (m)	Shear Strength (kPa)	Laboratory Tests: Moisture Content (%)	Rock Quality RQD %	Other Lab Tests
0 – 8.97	100.29 – 91.32		Overburden not loged during previous drilling: profile inferred similar to MW9								
8.97 – 12	91.32 – 88.29		Water Level: Meassured on July 09 and 20, 2020 at 8.97 and 8.9 m depth respectively.		▼						

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, 4.5, 4.75, 5, 5.25, 5.5, 5.75, 6, 6.25, 6.5, 6.75, 7, 7.25, 7.5, 7.75, 8, 8.25, 8.5, 8.75, 9, 9.25, 9.5, 9.75, 10, 10.25, 10.5, 10.75, 11, 11.25, 11.5, 11.75, 12

Elevation scale (m): 100, 99.5, 99, 98.5, 98, 97.5, 97, 96.5, 96, 95.5, 95, 94.5, 94, 93.5, 93, 92.5, 92, 91.5, 91, 90.5, 90, 89.5, 89, 88.5

S = Sample for lab review and moisture content

▼ Interpreted water level

Project: **Proposed Highrise Building with 3 to 4 levels of Underground Parking**		YME Yuri Mendez Engineering.
Location: **1546 Scott St.**	Client: **Starbank Developments 2000**	**Test Hole No.: MW9 of 14**
Job No.: **47-CEI-1546Scott**	Test Hole Type: **7" OD Auger.**	Date: **July 02, 03 and 09, 2020**
Casing and 61 mm diameter cores	SPT Hammer Type: **Auto Safety**	Logged By: **Yuri Mendez**

YME Yuri Mendez Engineering

Depth (m)	Elevation (m) 100.32	Lithology and color	Material Description	Samples or Blows/Ft	Water	Elevation (m) 100.32	Depth (m)	Shear Strength (kPa)	Laboratory Tests: Moisture Content (%)	Laboratory Tests: Rock Quality RQD %	Laboratory Tests: Other Lab Tests
			Asphalt	34							
			Granular fill								
			Fill: fine sand	18							
				>100							
			Till: Brownish silty sand and gravel. Trace clay. Moist							75	
			Weathered Limestone								
			Limestone Bedrock with White Vertical Narrow Portions: unweathered with near horizontal moderately wide jointing (20 to 60 cms spacing) at 3.5 m depth.							67	
										84	
			Limestone Bedrock: unweathered with moderately wide near horizontal jointing (20 to 60 cms spacing). Two UCS @ 6.7 m depth of 44.0 and 101.0 MPa.							100	
			Water Level: Meassured on July 09 and 20, 2020 at 8.2 and 8.08 m depth respectively. UCS @ 13 m depth of 91.2 MPa.							95	
										100	
										89	
										95	

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, 4.5, 4.75, 5, 5.25, 5.5, 5.75, 6, 6.25, 6.5, 6.75, 7, 7.25, 7.5, 7.75, 8, 8.25, 8.5, 8.75, 9, 9.25, 9.5, 9.75, 10, 10.25, 10.5, 10.75, 11, 11.25, 11.5, 11.75, 12, 12.25, 12.5, 12.75, 13

Elevation scale (m): 100, 99.5, 99, 98.5, 98, 97.5, 97, 96.5, 96, 95.5, 95, 94.5, 94, 93.5, 93, 92.5, 92, 91.5, 91, 90.5, 90, 89.5, 89, 88.5, 88, 87.5

S = Sample for lab review and moisture content

▼ Interpreted water level

Project: **Proposed Highrise Building with 3 to 4 levels of Underground Parking**		YME Yuri Mendez Engineering.
Location: **1546 Scott St.**	Client: **Starbank Developments 2000**	**Test Hole No.: MW10 of 14**
Job No.: **47-CEI-1546Scott**	Test Hole Type: **7" OD Auger.**	Date: **July 02, 03 and 09, 2020**
Casing and 61 mm diameter cores	SPT Hammer Type: **Auto Safety**	Logged By: **Yuri Mendez**

Depth (m)	Elevation (m) 100.55	Lithology and color	Material Description	Samples or Blows/Ft	Water	Elevation (m) 100.55	Depth (m)	Shear Strength (kPa)	Moisture Content (%)	Rock Quality RQD %	Other Lab Tests
0–0.3	100.55–100.25		Asphalt								
0.3–0.75	100.25–99.8		Granular fill	46							
0.75–1.5	99.8–99.05		Fill: silty sand, trace gravel, trace rock fragments. Brown and dry.	55							
1.5–11.5	99.05–89		Bedrock by Percussion Hammer								
			Water Level: Meassured on July 09 and 20, 2020 at 9.7 and 9.50 m depth respectively.		▼ (91.5)						

S = Sample for lab review and moisture content

▼ Interpreted water level

Project: **Proposed Highrise Building with 3 to 4 levels of Underground Parking**		YME Yuri Mendez Engineering.
Location: **1546 Scott St.**	Client: **Starbank Developments 2000**	**Test Hole No.: MW11 of 14**
Job No.: **47-CEI-1546Scott**	Test Hole Type: **7" OD Auger.**	Date: **July 02, 03 and 09, 2020**
Casing and 61 mm diameter cores	SPT Hammer Type: **Auto Safety**	Logged By: **Yuri Mendez**

Depth (m)	Elevation (m) 100.5	Lithology and color	Material Description	Samples or Blows/Ft	Water	Elevation (m) 100.5	Depth (m)	Shear Strength (kPa)	Laboratory Tests: Moisture Content (%)	Rock Quality RQD %	Other Lab Tests
0 – 0.25	100.5		Interlock Pavers			100.5	0 – 0.25				
0.25 – 0.5	100		Granular fill	7		100	0.5				
0.5 – 1.5	99.5 – 99		Fill: silty sand, trace gravel. Brown and moist to wet.	18		99.5 – 99	1 – 1.5				
1.5 – 11.5	99 – 89		Bedrock by Percussion Hammer		▼ at 9 m (91.5)	99 – 89	1.5 – 11.5				

Water Level: Meassured on July 09 and 20, 2020 at 11.3 and 11.1 m depth respectively.

S = Sample for lab review and moisture content

▼ Interpreted water level

Project: **Proposed Highrise Building with 3 to 4 levels of Underground Parking**		YME Yuri Mendez Engineering.
Location: **1546 Scott St.**	Client: **Starbank Developments 2000**	**Test Hole No.: BH12 of 14**
Job No.: **47-CEI-1546Scott**	Test Hole Type: **7" OD Auger.**	Date: **July 02, 03 and 09, 2020**
Casing and 61 mm diameter cores	SPT Hammer Type: **Auto Safety**	Logged By: **Yuri Mendez**

Yuri Mendez Engineering

Depth (m)	Elevation (m) 99.74	Lithology and color	Material Description	Samples or Blows/Ft	Water	Elevation (m) 99.74	Depth (m)	Shear Strength (kPa)	Laboratory Tests: Moisture Content (%)	Laboratory Tests: Rock Quality RQD %	Laboratory Tests: Other Lab Tests
0			Asphalt				0				
0.25	99.5		Granular fill	23		99.5	0.25				
0.5							0.5				
0.75	99		Till: Brownish silty sand and gravel. Trace clay. Moist			99	0.75				
1				>100			1				
			Auger Refusal								

S = Sample for lab review and moisture content

Interpreted water level

Project: **Proposed Highrise Building with 3 to 4 levels of Underground Parking**		YME Yuri Mendez Engineering.
Location: **1546 Scott St.**	Client: **Starbank Developments 2000**	**Test Hole No.: BH13 of 14**
Job No.: **47-CEI-1546Scott**	Test Hole Type: **7" OD Auger.**	Date: **July 02, 03 and 09, 2020**
Casing and 61 mm diameter cores	SPT Hammer Type: **Auto Safety**	Logged By: **Yuri Mendez**

Yuri Mendez Engineering

Depth (m)	Elevation (m) 100.27	Lithology and color	Material Description	Samples or Blows/Ft	Water	Elevation (m) 100.27	Depth (m)	Shear Strength (kPa)	Laboratory Tests: Moisture Content (%)	Laboratory Tests: Rock Quality RQD %	Laboratory Tests: Other Lab Tests
0			Asphalt				0				
0.25	100.1		Granular fill	**47**		100.1	0.25				
0.5							0.5				
0.75	99.6		Till: Brownish silty sand and gravel. Trace clay. Moist			99.6	0.75				
1				**>100**			1				
1.25	99.1					99.1	1.25				
1.5							1.5				
			Auger Refusal								

S = Sample for lab review and moisture content

Interpreted water level

Project: **Proposed Highrise Building with 3 to 4 levels of Underground Parking**		YME Yuri Mendez Engineering.
Location: **1546 Scott St.**	Client: **Starbank Developments 2000**	**Test Hole No.: BH14 of 14**
Job No.: **47-CEI-1546Scott**	Test Hole Type: **7" OD Auger.**	Date: **July 02, 03 and 09, 2020**
Casing and 61 mm diameter cores	SPT Hammer Type: **Auto Safety**	Logged By: **Yuri Mendez**

Yuri Mendez Engineering

Depth (m)	Elevation (m) 100.39	Lithology and color	Material Description	Samples or Blows/Ft	Water	Elevation (m) 100.39	Depth (m)	Shear Strength (kPa)	Laboratory Tests: Moisture Content (%)	Rock Quality RQD %	Other Lab Tests
0			Asphalt				0				
0.25			Granular fill				0.25				
0.5	99.9					99.9	0.5				
0.75							0.75				
1	99.4		Fill: Medium sand with trace gravel. Brown and dry.	**23**		99.4	1				
1.25							1.25				
1.5	98.9					98.9	1.5				
1.75				**17**			1.75				
2	98.4					98.4	2				
2.25			Till: Brownish silty sand and gravel. Trace clay. Moist				2.25				
2.5	97.9			**8**		97.9	2.5				
2.75							2.75				
			Auger Refusal								

S = Sample for lab review and moisture content

Interpreted water level

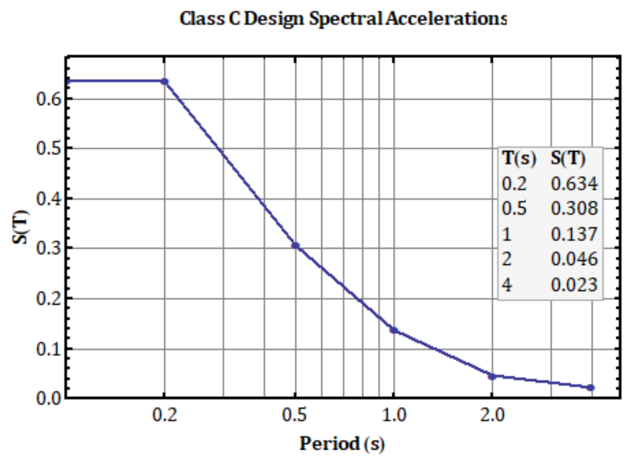

Figure 3:

Appendix

B Geotechnical Site Class Assignment

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

B.1 Reference Site and Design Spectral Accelerations

Details of the *reference site* spectral and peak seismic hazard values applicable to this site are presented in the 2010 National Building Code Seismic Hazard Calculation in page 42 of this appendix. Figure 3 in page 41 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: 45.404N 75.733W **User File Reference:** 1546 Scott St. 2020-07-28 01:31 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)	0.634	0.385	0.248	0.089
Sa (0.5)	0.308	0.186	0.122	0.043
Sa (1.0)	0.137	0.087	0.056	0.017
Sa (2.0)	0.046	0.028	0.018	0.006
PGA (g)	0.323	0.201	0.122	0.038

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 and Unconfined Compressive Strength Tests

Certificate of Analysis

Client: **Geoseismic**

Client PO:

Report Date: 13-Jul-2020

Order Date: 8-Jul-2020

Project Description: 1546 Scott St.

	Client ID:	MW9 SS3	-	-	-
	Sample Date:	03-Jul-20 09:00	-	-	-
	Sample ID:	2028266-01	-	-	-
	MDL/Units	Soil	-	-	-
Physical Characteristics					
% Solids	0.1 % by Wt.	91.0	-	-	-
General Inorganics					
pH	0.05 pH Units	7.68	-	-	-
Resistivity	0.10 Ohm.m	10.7	-	-	-
Anions					
Chloride	5 ug/g dry	509	-	-	-
Sulphate	5 ug/g dry	239	-	-	-

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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.:	4
STRUCTURE TYPE & LOCATION:	**1546 Scott Street**	DATE REPT'D:	6-Jul-20

SAMPLE INFORAMTION			
LAB NO.:	**17478**	**17478**	**17478**
SAMPLE NO.:	RC5 - MW9	RC8 - MW9	RC1 - MW3
LOCATION:	24'3" - 24'8"	42'7" - 43'.0"	6'4" - 6'9"
SAMPLE DATES			
DATE CAST	-	-	-
DATE CORED	-	-	-
DATE RECEIVED	3-Jul-20	3-Jul-20	3-Jul-20
DATE TESTED	6-Jul-20	6-Jul-20	6-Jul-20
SAMPLE DIMENSIONS			
(D) AVERAGE DIAMETER (mm)	61.00	61.00	61.00
(H) HEIGHT (mm)	122.00	122.00	122.00
(W) WEIGHT (g)	1020	1000	1040
(A) AREA = $\pi D2 / 4$ (mm^2)	2922	2922	2922
(V) VOLUME = A X H ÷ 1000 (cm^3)	357	357	357
UNIT WEIGHT = W / V X 1000 (kg/m^3)	**2861**	**2805**	**2917**
TEST RESULTS			
H / D RATIO	2.00	2.00	2.00
CORRECTION FACTOR	1.000	1.000	1.000
LOAD (lbs)	66400	59900	25600
GROSS Mpa = L X 4.448222 / A	101.1	91.2	39.0
MPa CORRECTED	**101.1**	**91.2**	**39.0**
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.:	2
STRUCTURE TYPE & LOCATION:	**1546 Scott Street**		DATE REPT'D:	6-Jul-20

SAMPLE INFORAMTION			
LAB NO.:	**17478**	**17478**	**17478**
SAMPLE NO.:	RC4 - MW3	RC8 - MW3	RC4 - MW9
LOCATION:	19'9" - 20'1"	42'.0" - 42'.5"	21'0" - 21'5"
SAMPLE DATES			
DATE CAST	-	-	-
DATE CORED	-	-	-
DATE RECEIVED	3-Jul-20	3-Jul-20	3-Jul-20
DATE TESTED	6-Jul-20	6-Jul-20	6-Jul-20
SAMPLE DIMENSIONS			
(D) AVERAGE DIAMETER (mm)	61.00	61.00	61.00
(H) HEIGHT (mm)	122.00	122.00	119.40
(W) WEIGHT (g)	1020	1040	1000
(A) AREA = πD2 / 4 (mm^2)	2922	2922	2922
(V) VOLUME = A X H ÷ 1000 (cm^3)	357	357	349
UNIT WEIGHT = W / V X 1000 (kg/m^3)	**2861**	**2917**	**2866**
TEST RESULTS			
H / D RATIO	2.00	2.00	1.96
CORRECTION FACTOR	1.000	1.000	0.996
LOAD (lbs)	13100	36600	29100
GROSS Mpa = L X 4.448222 / A	19.9	55.7	44.3
MPa CORRECTED	**19.9**	**55.7**	**44.1**
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

Appendix

D 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.

D.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.

D.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 11 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 D.2.3.

D.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.

D.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.

D.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.

D.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 1.

Except as otherwise indicated for select earthfill materials (subsection D.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 1.

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

D.3 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.

D.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.

D.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).

D.6 Rock Excavation

For the *"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 400 flywheel horsepower.

D.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.

D.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.

D.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.

D.8.1 Granular Earthfill Placement

D.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.

D.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 1 in page 53.

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

D.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.

D.8.2.1 Moisture for Select Earthfill

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

D.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 1 in page 53.

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

D.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.

D.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.

D.9 Rockfill

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

D.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.

D.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.

D.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 1 in page 53 presents Proctor Standard (PS) compaction requirements for specified placement and materials.

D.11 Compaction Specific

D.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.

D.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.

D.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.

D.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.

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

D.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.

D.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.

D.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

E 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.

E.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.

E.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)

E.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.