

**Foundation Investigation and  
Design Report  
Two Overhead Sign Supports**

Highway 417 near Harmer  
Avenue, City of Ottawa

City Contract # ISD16-7043

MTO Reference: W.O. 2017-11022

GEOCRES No. 31G5-283



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Project No. 163601070

December 2017

# FOUNDATION INVESTIGATION AND DESIGN REPORT

## TWO OVERHEAD SIGN SUPPORTS

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December 2017

FOUNDATION INVESTIGATION REPORT  
For Two Overhead Sign Supports  
City of Ottawa (Reference #ISD16-7043)

Harmer Avenue Pedestrian Bridge Replacement Project,  
Highway 417  
Ottawa, Ontario

## 1.0 INTRODUCTION

Stantec Consulting Ltd. (Stantec) was retained by the City of Ottawa (City) to complete a foundation investigation for the replacement of the Harmer Avenue Pedestrian Bridge that crosses over Highway 417 between the Parkdale Avenue and Island Park Drive interchanges. As part of this project, two Ministry of Transportation Ontario (MTO) signs currently attached to the existing pedestrian bridge are proposed to be replaced with new Tri-Chord Cantilever signs.

One of the new signs, referred to herein as the Westbound Overhead Sign, is planned to be located in close proximity to the north end of the new pedestrian bridge. The other sign, referred to herein as the Eastbound Overhead Sign, is to be located on the south side of Highway 417 near Ruskin Street approximately 300 m southwest of the existing bridge. The proposed locations of the new signs are displayed on the Key Plan inset on Drawing No. 1, provided in Appendix A.

This Foundation Investigation Report has been prepared specifically and solely for the proposed replacement of the two MTO signs being completed as part of the Harmer Avenue Pedestrian Bridge replacement project.

City Reference Number: ISD16-7043

Project (Sign) Locations: Harmer Avenue and Ruskin Avenue at Highway 417, Ottawa, ON

MTO has assigned reference number WO 2017-11022 to this project and GEOCREs No. 31G5-283 to this report.

## **2.0 SITE DESCRIPTION AND GEOLOGY**

### **2.1 SITE LOCATION AND DESCRIPTION**

The existing Harmer Avenue Pedestrian Bridge crosses over Highway 417 about midway between the Parkdale Avenue and the Island Park Drive Interchanges. The Westbound Overhead Sign is planned to be located in close proximity to the north end of the new pedestrian bridge. The Eastbound Overhead Sign is to be located on the south side of Highway 417 near Ruskin Street approximately 300 m southwest of the existing bridge. The sign locations are shown on Drawing No. 1, provided in Appendix A.

The proposed signs are planned to be located outside of the existing concrete highway barrier walls in grass-surfaced areas. The Eastbound Overhead Sign is also located south of the existing highway noise barrier wall.

A 1.2 m diameter watermain runs parallel to the south side of Highway 417 and is located immediately south of the proposed Eastbound Overhead Sign. The watermain was located/exposed in the immediate vicinity of the proposed sign using hydro-vacuum excavation methods. The location of this watermain is displayed on Drawing No. 1. The watermain has an approximate obvert elevation of 70 m at this site corresponding to an invert elevation of about 68.5 m.

### **2.2 SITE GEOLOGY**

#### Physiographic Description

Soil and bedrock mapping published by the Ontario Geological Survey suggests that the subsurface conditions at the site consist of sandy silt to silty sand-textured till on Paleozoic terrain underlain by limestone bedrock of the Ottawa Formation.

## **3.0 INVESTIGATION PROCEDURES**

### **3.1 FIELD INVESTIGATION**

The foundation investigation for the sign supports consisted of advancing one borehole at each sign location. Borehole BH17-1 was located near to the proposed Westbound Overhead Sign location. This borehole was offset a few meters from the proposed sign location due to obstructions to drilling equipment access and set-up posed by the presence of existing structures (i.e. the pedestrian bridge approach ramp and highway noise barrier wall). Borehole BH17-7 was drilled at the location of the proposed Eastbound Overhead Sign. The borehole locations are shown on Drawing No.1 in Appendix A.

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Prior to carrying out the investigation, USL-1 Underground Service Locators Inc. of Ottawa, Ontario, was retained to carry out the public and private utility locates for the proposed borehole locations.

The field drilling programs were carried out on September 19<sup>th</sup> and October 27<sup>th</sup>, 2017. Due to access constraints associated with the existing Harmer Avenue pedestrian bridge, Borehole BH17-1 was advanced using portable tripod drilling equipment, supplied and operated by Ohlmann Geotechnical Services (OGS) Inc. of Almonte, Ontario. Due to the presence of nearby overhead power-lines, Borehole BH17-7 was advanced using a low-clearance drill rig, owned and operated by George Downing Estate Drilling Ltd. of Hawkesbury, Ontario. Both the portable drilling equipment and the low-clearance drill rig were equipped for soil and rock sampling.

The subsurface stratigraphy encountered in the boreholes were recorded in the field by experienced Stantec personnel. Split spoon samples were collected at regular depth intervals within overburden materials as part of Standard Penetration Testing (ASTM D1586). Bedrock coring was carried out in both boreholes using NQ-sized coring equipment.

All soil samples recovered were stored in moisture-proof containers and were returned to our Ottawa laboratory for detailed classification and testing. Rock core samples were logged in the laboratory and Total Core Recovery and Rock Quality Designation (RQD) values were determined for the recovered bedrock core.

## 3.2 LOCATION AND ELEVATION SURVEY

The borehole locations and respective ground surface elevations were surveyed in the field by Stantec personnel. Table 3.1 below summarizes the borehole survey information and provides the borehole depths, termination elevations and number of samples collected.

**Table 3.1: Borehole Information Summary**

|                              | Boreholes |         |
|------------------------------|-----------|---------|
|                              | 17-1      | 17-7    |
| MTM Zone 10 Coordinates      |           |         |
| Northing                     | 5028529   | 5028233 |
| Easting                      | 365010    | 364898  |
| Ground Surface Elevation, m  | 71.7      | 73.6    |
| Total Depth Drilled, m       | 8.2       | 6.8     |
| End of Borehole Elevation, m | 63.5      | 66.8    |
| Number of Soil Samples       | 7         | 5       |

## 3.3 LABORATORY TESTING

All samples were brought to Stantec's Ottawa laboratory where a detailed visual examination of the samples was completed by a Geotechnical Engineer. The geotechnical laboratory testing program completed on the borehole samples is summarized in Table 3.2.

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**Table 3.2: Geotechnical Laboratory Testing Program**

| Laboratory Testing | Total Number of Soil Samples | Moisture Contents | Gradation Analyses | Unconfined Compressive Strength Tests (Bedrock) |
|--------------------|------------------------------|-------------------|--------------------|---|
| Number of Tests    | 12                           | 16                | 3                  | 4   |

One soil sample from each site was also submitted to Paracel Laboratories in Ottawa, Ontario, for determination of pH, soluble sulphate content, chloride content, and resistivity.

Samples remaining after testing will be placed in storage for a period of one year after issuance of this report. After the storage period, the samples will be discarded unless directed otherwise by the City of Ottawa.

## 4.0 SUBSURFACE CONDITIONS

### 4.1 OVERVIEW

The subsurface conditions observed and the results of in situ and laboratory testing are presented in detail on the Borehole Records provided in Appendix B. An explanation of the symbols and terms used to describe the Borehole Records is also provided in Appendix B. The results of geotechnical laboratory testing are also presented on Figures C-1 to C-3 contained in Appendix C. A borehole location plan is provided on Drawing No. 1 in Appendix A.

The stratigraphic boundaries on the borehole records and strata plot are inferred from non-continuous sampling and, therefore, represent transitions between soil types rather than exact boundaries between geological units. The subsoil conditions will vary between and beyond the borehole locations.

In general, the subsurface conditions at each sign site consisted of near-surface topsoil and fill overlying predominantly granular overburden soils (silty sand till, cobbles and boulders, or gravelly sand) over bedrock. The bedrock at both sign locations consists of limestone with laminations to thin beds of shale.

### 4.2 STRATIGRAPHY

#### 4.2.1 Topsoil

A layer of silty sand to sand and gravel topsoil was encountered at ground surface in both boreholes. The topsoil layers in boreholes BH17-1 and BH17-7 were 610 mm and 860 mm thick, respectively. Standard Penetration Test (SPT) 'N' values of 8 and 9 blows per 0.3 m of penetration were measured within the topsoil indicating the topsoil is in a loose state.

As noted in the following section, buried topsoil layers were also encountered at elevations of about 71.9m and 71.1m within the fill materials present in borehole BH17-7.

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### 4.2.2 Fill

The topsoil was underlain by fill materials at both sign locations.

The fill materials encountered at borehole BH17-1 (Westbound Sign location) consisted of silty sand containing gravel, cobbles and boulders that extended to a depth of approximately 1.7 m below ground surface corresponding to an elevation of about 70 m. SPT 'N' values of 39 blows per 0.3 m of penetration and 50 blows per 0.15 m (split spoon refusal on inferred boulder) of penetration were recorded within these fill materials indicating this fill is in a dense to very dense state.

The fill materials encountered at borehole BH17-7 (Eastbound Sign location) consisted of a mixture of sandy silt and sandy silty clay and contained silty sand seams/zones as well as frequent cobbles and boulders. The following photographs, taken during the hydro-vacuuming operations to expose the watermain, display cobbles and boulders retrieved from within the fill during the hydro-vac activities (Photograph 1) and a larger boulder within the hydro-vac excavation (Photograph 2).



**Photograph 1 – Cobbles and Boulders Excavated During Hydro-Vac Activities**



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**Photograph 2 – Boulders Within Hydro-Vac Excavation**

100 mm to 125 mm thick layers of buried topsoil were encountered at elevations of approximately 72.1 m and 71.3 m within the fill materials at borehole BH17-7.

SPT 'N' values of between 6 and 15 blows per 0.3 m of penetration were recorded within the fill materials at BH17-7 indicating this fill is in a loose to compact state.

Moisture contents of the fill materials varied from about 4 to 9 % for samples from borehole BH17-1 and between about 9 and 21 percent for samples from borehole BH17-7.

The results of grain size distribution testing carried out on a sample of the fill from borehole BH17-7 is displayed on Figure C-1. An Atterberg Limit test conducted on this sample determined the material was non-plastic.

### **4.2.3 Till**

A deposit of grey silty sand till containing varying amounts of gravel and clay was encountered in borehole BH17-1 from a depth of about 1.7 m to 4.7 m (elevation of about 70.0 m to 67.0 m).

The glacial till of the Ottawa area is usually crowded with cobbles and boulders set in a matrix of finer-grained soil (gravel, sand, silt and clay); larger boulders with dimensions greater than 1 m are common. The till is unsorted and without stratification, but in places contains discontinuous layers or irregularly shaped masses of sand and/or silt. Due to the unsorted and unstratified nature of the glacial till, it is possible to only to encounter matrix materials; however, where glacial till deposits are identified, cobbles and boulders will be present and water-bearing permeable layers of sand and silt may randomly be present.

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Cobbles and boulders were encountered frequently within the till in borehole BH17-1. Cobbles and boulders were also encountered throughout the till deposits at the Harmer Avenue pedestrian bridge site and portions of the till were comprised predominantly of cobbles and boulders. Coring was required to advance the borehole through a cobble or boulder between about 1.7 to 2.0 m depth. Drilling through the till at other borehole locations at the bridge replacement site also required either coring or several attempts as the drill casing was damaged (i.e. bent or broken) due to the presence of boulders. The till deposits encountered during previous investigations at the site were described as a boulder till and coring was needed to advance some boreholes through the till. Based on the above, the till is considered to consist of cobbles and boulders in a matrix of silty sand.

SPT 'N' values measured within the till ranged from 8 to 21 indicating the till is in a loose to compact state.

The moisture content of samples of the till deposit were measured to range from approximately 9% to 11%. The results of grain size distribution testing carried out on a sample of the till from borehole BH17-1 is displayed on Figure C-2.

#### 4.2.4 Cobbles and Boulders

A layer of limestone cobbles and boulders were encountered above the bedrock layer in borehole BH17-1 from a depth of about 4.7 m to 5 m (~elevation 67.0 m to 66.7 m).

#### 4.2.5 Gravelly Sand

A 0.8 m thick deposit of light grey, gravelly sand containing some silt (possible fill) was encountered beneath the fill and above the bedrock in borehole BH17-7. This layer was encountered between depths of about 2.7 m and 3.6 m corresponding to elevations of 70.9 m to 70.0 m.

A SPT 'N' value of 146 blows per 0.3 m of penetration was measured in the gravelly sand indicating the material is very dense.

The moisture content of this material was determined to be approximately 3%. The results of grain size distribution testing carried out on a sample of the gravelly sand is displayed on Figure C-3 in Appendix C.

#### 4.2.6 Bedrock

Limestone with laminations to thin beds of shale bedrock was encountered at elevations 66.7 and 70.0 m in borehole BH17-01 and BH17-07, respectively. A detailed description of the rock core is provided in the Field Bedrock Core Logs in Appendix B. Rock core photographs are also provided in Appendix B.

The Rock Quality Designation (RQD) of the rock ranged from 27% to 87% at BH17-1 and from 0% to 97% at BH17-7 indicating very poor to excellent quality. The bedrock above an elevation of

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about 68 m in borehole BH17-7 was highly fractured with RQD values of between 0% and 11%. This is near to the elevation as the invert of the adjacent watermain (~68.5 m) and it is possible that this rock was damaged/fractured (e.g. by blasting) during installation of the watermain.

Four (4) unconfined compressive strength tests were conducted on samples of the bedrock ranged from 92.7 MPa to 170.1 MPa indicating the rock is strong to very strong.

Both boreholes were terminated within the bedrock at elevations of between 63.5 m and 66.8 m.

## 4.3 GROUNDWATER

The boreholes were open and dry prior to initiation of coring.

The water levels in monitoring wells installed to the north of Highway 417 on Helena Street and Harmer Avenue North during the subsurface investigation for replacement of the pedestrian bridge were measured to vary from approximately 68.5 m to 69 m and a similar water level is expected at the Westbound Sign Site. The water level at the Eastbound Sign site is inferred to be at an elevation of about 70 m.

Fluctuations in the groundwater level due to seasonal variations or in response to a particular precipitation event should be anticipated.

## 4.4 CHEMICAL ANALYSIS

Representative samples retrieved from BH17-1 and BH17-7 were tested for resistivity, pH, and water soluble sulphates and chloride concentrations. The results of this chemical analysis are provided in Table 4.3.

**Table 4.1: Results of Chemical Analysis**

| Borehole No. | Sample No. | Depth (m)    | pH  | Chloride (µg/g) | Sulphate (µg/g) | Resistivity (Ohm-m) |
|--------------|------------|--------------|-----|-----------------|-----------------|---------------------|
| BH17-1       | SS5        | 2.4 to 3.1   | 7.8 | 83              | 119             | 30                  |
| BH17-7       | SS4        | 3.81 to 4.42 | 7.9 | 14              | 30              | 55                  |

## 5.0 MISCELLANEOUS

The field work was carried out under the supervision of Shanti Ratmono, E.I.T., and Jason Hopwood-Jones, geotechnical technician, under the direction of Kevin Nelson, P.Eng.

USL-1 Underground Service Locators Inc. of Ottawa, Ontario, carried out the public and private utility locates for the boreholes.

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The CME drill rig was supplied and operated by George Downing Estate Drilling Ltd. of Hawkesbury, Ontario. The portable drilling equipment was supplied and operated by Ohlmann Geotechnical Services (OGS) Inc. of Almonte, Ontario.

The elevation and location survey of the borehole locations was carried out by Stantec personnel.

Geotechnical laboratory testing was carried out at Stantec's Ottawa laboratory. Chemical testing for pH, soluble sulphate, and chloride content, and resistivity was carried out by Paracel Laboratories of Ottawa.

This report was prepared by Shanti Ratmono, E.I.T., and reviewed by Kevin Nelson, P.Eng. and Raymond Haché, P.Eng, Designated Principal MTO Foundation Contact.

## 6.0 CLOSURE

A subsurface investigation is a limited sampling of a site. The subsurface conditions given herein are based on information gathered at the specific borehole locations. Should any conditions at the site be encountered which differ from those at the borehole locations, we request that we be notified immediately in order to assess the additional information.

Respectfully Submitted;

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For Two Overhead Sign Supports  
City of Ottawa (Reference #ISD16-7043)

Harmer Avenue Pedestrian Bridge Replacement Project,  
Highway 417  
Ottawa, Ontario

## **7.0 DISCUSSIONS AND RECOMMENDATIONS**

### **7.1 GENERAL**

This section of the report provides foundation design recommendations for the foundation design of two Cantilever Tri-Chord overhead signs that are to be constructed as part of the Harmer Avenue Pedestrian Bridge replacement project.

The engineering input provided herein has been based on interpretation of the factual data obtained from the boreholes advanced during the subsurface investigation at the site. The discussion and recommendations presented herein are intended to provide the designers with sufficient information to assess feasible foundation alternatives and to carry out the design of the foundations for the replacement structure. Where comments are related to construction aspects of the project, they are provided only to highlight items that could affect the design of the project. Those requiring information on aspects of construction should make their own interpretation of the factual information provided as such interpretation may affect equipment selection, proposed construction methods, scheduling and the like.

### **7.2 PROJECT DESCRIPTION AND BACKGROUND**

#### Project Description

The overall project involves the reconstruction of the existing pedestrian bridge providing access across Highway 417 (the Queensway) between Harmer Avenue South, on the south side of the highway, and Harmer Avenue North and Helena Street on the north side of the highway. As part of this project, two Ministry of Transportation Ontario (MTO) signs currently attached to the existing pedestrian bridge are proposed to be replaced with new Tri-Chord Cantilever signs.

One of the new signs, referred to herein as the Westbound Overhead Sign, is planned to be located in close proximity to the north end of the new pedestrian bridge. The other sign, referred to herein as the Eastbound Overhead Sign, is to be located on the south side of Highway 417 near Ruskin Street approximately 300 m southwest of the existing bridge. The proposed locations of the new signs are displayed on the Key Plan inset on Drawing No. 1, provided in Appendix A.

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Both of the overhead signs consist of Class 1 signs that are planned to be supported using ground-mounted, Cantilever Tri-Chord sign supports.

The analysis and design approach for this report are based on the requirements outlined in MTO's Sign Support Manual (MTO, 2015).

### 7.2.1 Caisson Foundations for Overhead Signs

The Sign Support Manual (SSM) includes standard foundation designs for ground-mounted (single or tri-chord) cantilever overhead signs which are described in Section 4 of the SSM and Standard Drawing SS118-3 (Jan. 2015). The standard foundation design for each sign support consists of a single, reinforced concrete caisson.

Based on Drawing SS118-3, the standard foundation for a Class 1 Cantilever Tri-Chord sign consists of a 6.5 m long, 1.35 m diameter concrete caisson. The caisson depth/length (L) of 6.5 m is measured from the bottom of the frost penetration depth which is 1.8 m for the Ottawa area resulting in a total embedment depth of 8.3 m.

The standard foundation designs provided in the SSM do not apply to sites where bedrock is at or near the surface, the footings will be located in rock fill or exceptionally soft or loose soils are present within the foundation zone. The standard sign foundations presented in the SSM for the ground-mounted, cantilever overhead sign supports have been developed for sites where the following minimum soil conditions are present within the foundation zone.

- Case 1 (Cohesionless Soils): Competent soils of uniform composition with a minimum internal friction angle of 28 degrees within the upper 2/3 of the caisson below the frost zone and 30 degrees within the lower third of the caisson below the frost zone.
- Case 2 (Cohesive Soils): Clay soil with a minimum undrained shear strength of 25 kPa within the upper 2/3 of the caisson below the frost zone and a minimum undrained shear strength of 50 kPa within the lower third of the caisson below the frost zone

The Notes to Designer section of Drawing SS118-3 further indicates that "if sound rock is encountered at a depth of 'Y' < L from the bottom of the frost layer, this dimension can be reduced to  $Y + (L - Y)/2$ " upon the Ministry's approval.

A site-specific footing design is required for sites where soil conditions not meeting the minimum requirements outlined above are present.

Based on the results of the current investigation, the overburden soils within the anticipated founding depths of the two overhead sign supports (OHSS) consist predominantly of loose to compact fill (Eastbound Overhead Sign) and dense to very dense fill followed by loose to compact silty sand fill containing frequent cobbles and boulders (Westbound Overhead Sign). These soils are underlain by limestone bedrock at depths of 3.6 m at the Eastbound Overhead sign and 5.0 m at the Westbound overhead sign. The overburden soils are considered to have friction angles greater than the minimum requirements outlined for Case 1 above and, as such, the standard OHSS foundation designs are applicable to this project



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The upper portion of the bedrock is highly fractured and sound rock is considered to have been encountered at about 5.8 m depth at both borehole locations corresponding to elevations of 66 m at BH17-1 (Westbound Overhead Sign) and 67.8 m at BH17-7 (Eastbound Overhead Sign). These levels correspond to a depth 'Y' of 4 m below the frost layer. This value can be used in determining the potential reductions in the lengths of the caissons due to the presence of sound rock, subject to MTO approval as outlined above.

### 7.2.2 Installation Considerations

Construction of the sign support foundations should be in accordance with OPSS PROV.915 (Construction Specification for Sign Support Structures).

The elevation of the bedrock determined from the subsurface investigations at the site ranged from about 66.7 m (Westbound Sign Site) to about 70 m (south side of highway). The overburden above the bedrock consists of fill materials, granular till containing zones comprised predominantly of cobbles and/or boulders as well as layers of granular soils (e.g. silty sand, gravelly sand etc.). The water levels measured in monitoring wells installed in boreholes from boreholes from previous investigations advanced near the pedestrian bridge site varied from 68.5 m to 69 m which is in the range of about 1.5 m to 2.5 m above the bedrock surface.

Cobbles and boulders were frequently encountered within the fill and till during the current investigation and a layer of cobbles and boulders were present between the till and bedrock at BH17-1. In addition, it is noted that coring was required to advance BH17-1 as well as several other boreholes advanced in the area of the Harmer Avenue pedestrian bridge through cobbles and/or boulders present within the till. The presence of cobbles and boulders could obstruct and add significant difficulty during drilling of the caisson shafts. The upper portion of the bedrock encountered at Borehole 17-7 was noted to be heavily fractured with low RQD values. Similar installation difficulties could be encountered advancing drilled piers within this material.

Specialized installation equipment and methods may be required to advance the drilled shafts through the above noted materials. The construction methods undertaken for the drilling of the caisson shafts should consider the difficulties associated with encountering cobbles, boulders and highly fractured bedrock and it is recommended that a Non-Standard Special Provision (NSSP) be included with the contract documents that notifies the contractor of the presence of these obstructions. A sample NSSP has been included in Appendix D.

Sloughing of the sidewalls of the drilled shafts, and significant groundwater inflows and loss of ground would be expected to occur in unsupported caisson excavations/drilled shafts developed within the granular overburden soils below the water table. Provision should be included for the use of temporary liners/casings, installed through the overburden materials and seated at the surface of the bedrock, to reduce the potential for the sloughing/loss of ground into the drilled shafts and the amount of groundwater inflow in the drilled piers. However, the advancement of liners/casings would also be hindered by the presence of the cobbles and



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boulders in the overburden. If liners are not able to be advanced to the bedrock surface, the use of drilling muds could be considered to maintain the stability of the drilled shafts.

The drilled shafts for the sign support foundation will extend below the water table in coarse glacial till and fractured bedrock materials and it is anticipated that caisson shafts will not be able to be maintained in a dry condition. Concrete placement should be carried out using tremie techniques for such conditions and/or if the use of drilling muds are required as part of the installation process.

The installation of the caissons must be inspected by a QVE qualified in geotechnical engineering.

### **7.3 CEMENT TYPE AND CORROSION POTENTIAL**

One sample of the overburden soils from each sign site were submitted to Paracel Laboratories in Ottawa, Ontario for analysis of pH, water soluble sulphate and chloride concentrations, and resistivity. The testing was completed to determine the potential for degradation of the concrete in the presence of soluble sulphates and the potential for corrosion of exposed steel used in foundations and buried infrastructure. The analysis results are summarized in Table 4.3.

The concentration of soluble sulphate provides an indication of the degree of sulphate attack that is expected for concrete in contact with soil and groundwater at the site. The soluble sulphate concentrations for the samples ranged from 30 µg/g to 119 µg/g. Soluble sulphate concentrations less than 1000 µg/g generally indicate that a low degree of sulphate attack is expected for concrete in contact with soil and groundwater. Type GU (General Use) Portland Cement should therefore be suitable for use in concrete in contact with the native soils at this site.

The pH, resistivity and chloride concentration provide an indication of the degree of corrosiveness of the sub-surface environment. The soil pH values ranged from 7.8 to 7.9 which is within what is considered the normal range for soil pH of 5.5 to 9.0. The pH level of the tested soil does not indicate a highly corrosive environment. The resistivity results ranged from 30 Ohm-m to 55 Ohm-m suggestive of a moderate degree of corrosiveness for steel. The test results provided in Table 4.3 may be used to aid in the selection of coatings and corrosion protection systems for buried steel objects.

## 8.0 CLOSURE

Use of this report is subject to the Statement of General Conditions provided in Appendix A. It is the responsibility the City of Ottawa who is identified as "the Client" within the Statement of General Conditions, and its agents to review the conditions and to notify Stantec Consulting Ltd. should any of these not be satisfied. The Statement of General Conditions addresses the following:

- Use of the report
- Basis of the report
- Standard of care
- Interpretation of site conditions
- Varying or unexpected site conditions
- Planning, design or construction

Respectively Submitted,

**STANTEC CONSULTING LTD.**

Shanti Ratmono, M.Eng., E.I.T.  
Geotechnical Engineer-in-Training

Kevin Nelson, P.Eng.  
Senior Geotechnical Engineer



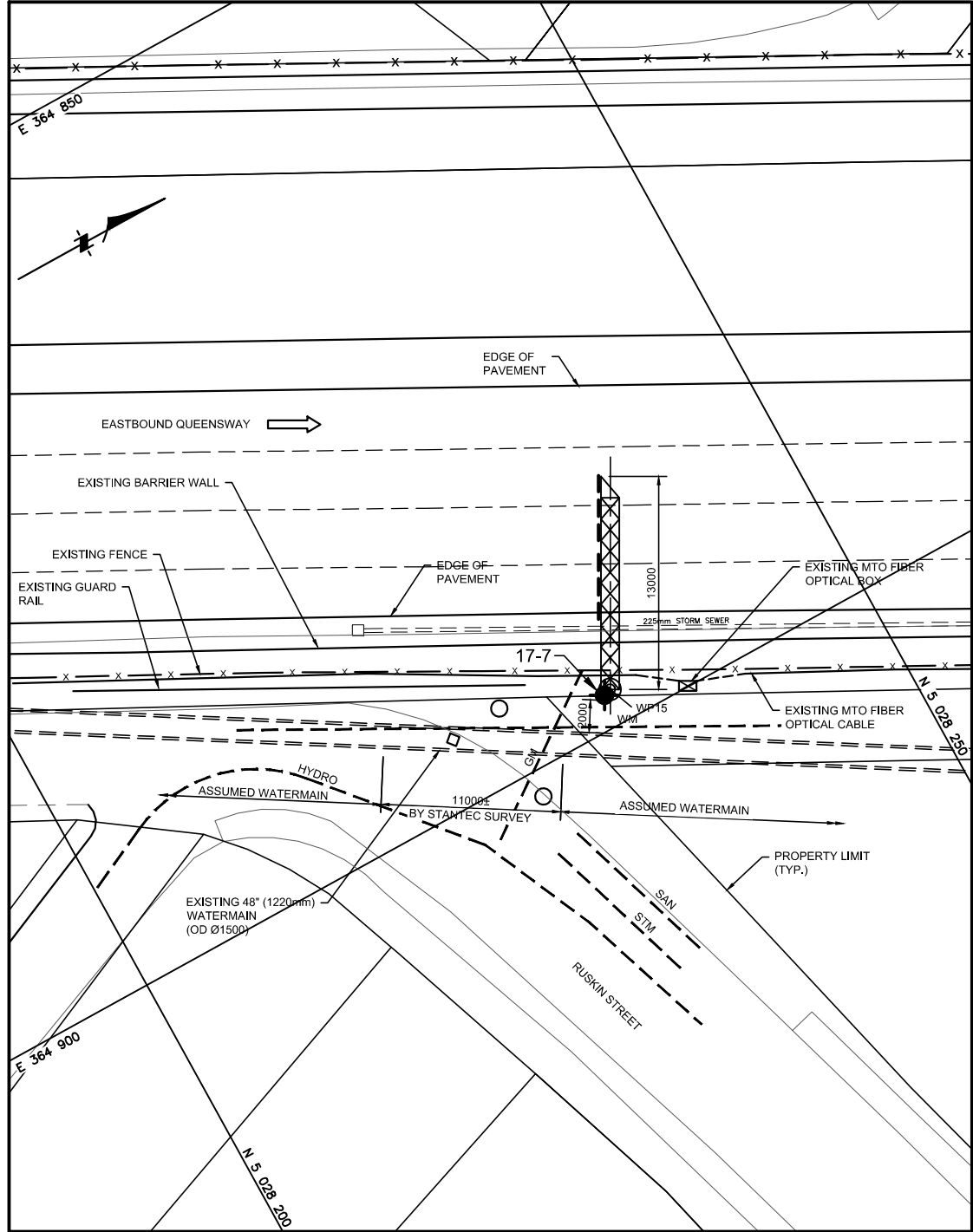
Raymond Haché, M.Sc., P.Eng.  
Designated Principal MTO Foundation Contact



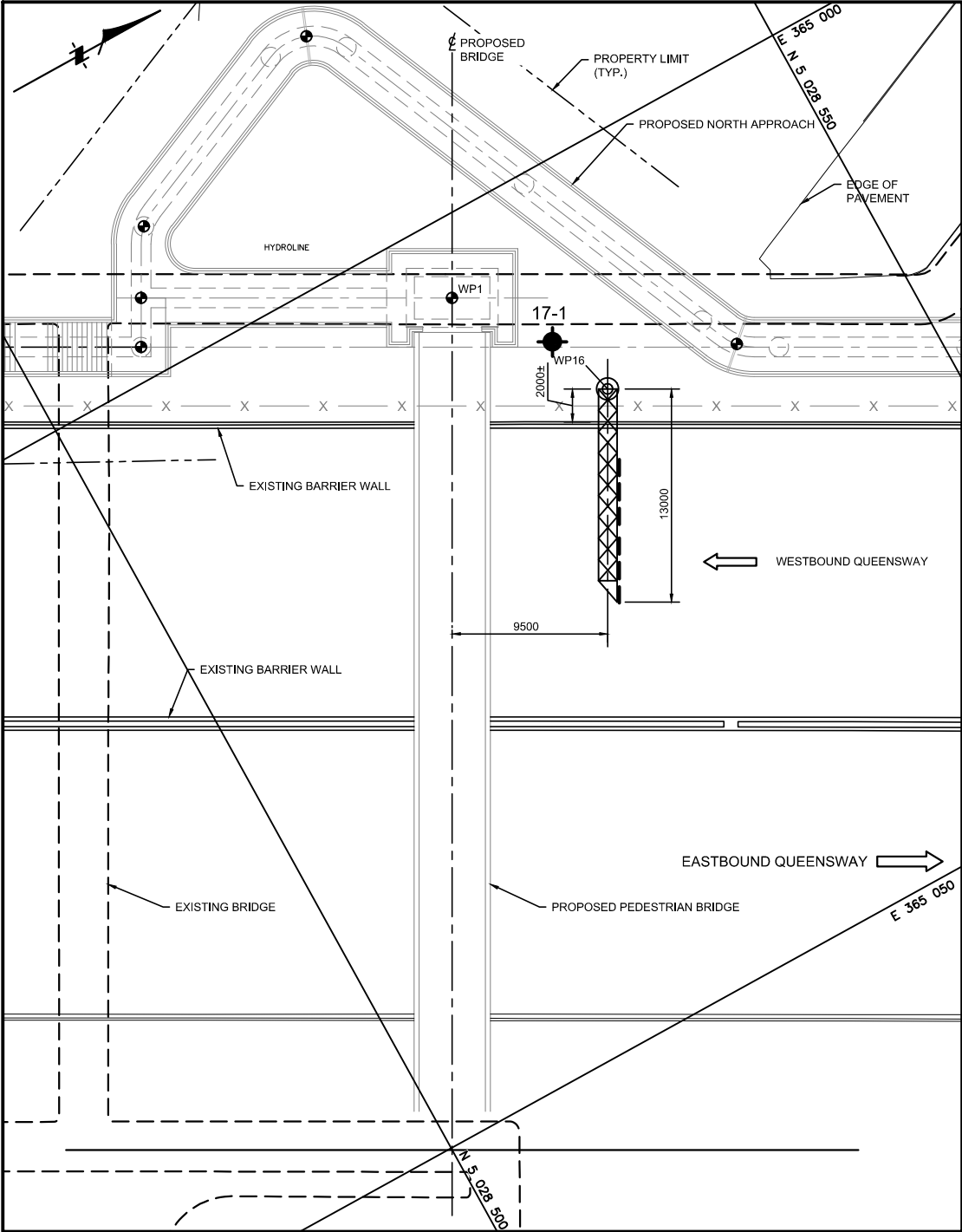
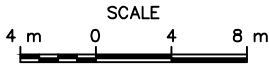
v:\01216\active\other\_pc\_projects\163601070\05\_report\_deliv\deliverables\overhead sign  
report\163601070\_fidr\_harmer\_signs\_rpt\_final\_20171220.docx

## **APPENDIX A**

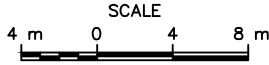
Drawing No. 1 – Borehole Location Plan



EASTBOUND OVERHEAD SIGN SUPPORT PLAN



WESTBOUND OVERHEAD SIGN SUPPORT PLAN



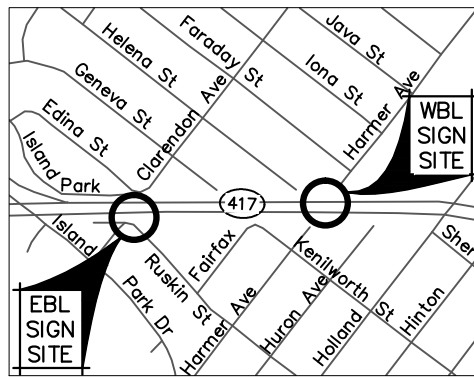
METRIC  
DIMENSIONS ARE IN METRES  
AND/OR MILLIMETRES  
UNLESS OTHERWISE SHOWN

PLATE No  
CONT ISD16-7043  
WP 2017-11022

HARMER AVENUE  
OVERHEAD SIGN STRUCTURE  
BOREHOLE LOCATION PLAN



SHEET



LEGEND

● Borehole (2017 Investigation)

| No   | ELEVATION | MTM ZONE 9 NORTH | COORDINATES EAST |
|------|-----------|------------------|------------------|
| 17-1 | 71.7      | 5 028 529.2      | 365 009.9        |
| 17-7 | 73.6      | 5 028 233.0      | 364 898.0        |

NOTES

Borehole locations from previous investigation were based on previous drawings and are approximate only.

NOTE: The complete foundation investigation and design report for this project and other related documents may be examined at the Engineering Materials Office, Downsview. Information contained in this report and related documents is specifically excluded in accordance with the conditions of Section 102-2 of Form 100.

| REVISIONS | DATE | BY | DESCRIPTION |
|-----------|------|----|-------------|
|           |      |    |             |
|           |      |    |             |

GEOCREs No 3165-283

|            |         |                 |       |
|------------|---------|-----------------|-------|
| HWY No 417 | CHECKED | DATE 2017-12-22 | DIST  |
| SUBM'D ZP  | CHECKED | APPROVED        | SITE  |
| DRAWN GBB  | CHECKED | APPROVED        | DWG 1 |

## **APPENDIX B**

Symbols and Terms Used on Borehole Records

Borehole Records

Rock core Logs

Rock core Photographs

## SYMBOLS AND TERMS USED ON BOREHOLE AND TEST PIT RECORDS

### SOIL DESCRIPTION

#### Terminology describing common soil genesis:

|                |   |
|----------------|---|
| <i>Topsoil</i> | - mixture of soil and humus capable of supporting vegetative growth                     |
| <i>Peat</i>    | - mixture of visible and invisible fragments of decayed organic matter                  |
| <i>Till</i>    | - unstratified glacial deposit which may range from clay to boulders                    |
| <i>Fill</i>    | - material below the surface identified as placed by humans (excluding buried services) |

#### Terminology describing soil structure:

|                   |  |
|-------------------|--|
| <i>Desiccated</i> | - having visible signs of weathering by oxidization of clay minerals, shrinkage cracks, etc. |
| <i>Fissured</i>   | - having cracks, and hence a blocky structure  |
| <i>Varved</i>     | - composed of regular alternating layers of silt and clay                                    |
| <i>Stratified</i> | - composed of alternating successions of different soil types, e.g. silt and sand            |
| <i>Layer</i>      | - > 75 mm in thickness   |
| <i>Seam</i>       | - 2 mm to 75 mm in thickness   |
| <i>Parting</i>    | - < 2 mm in thickness  |

#### Terminology describing soil types:

The classification of soil types are made on the basis of grain size and plasticity in accordance with the Unified Soil Classification System (USCS) (ASTM D 2487 or D 2488). The classification excludes particles larger than 76 mm (3 inches). The USCS provides a group symbol (e.g. SM) and group name (e.g. silty sand) for identification.

#### Terminology describing cobbles, boulders, and non-matrix materials (organic matter or debris):

Terminology describing materials outside the USCS, (e.g. particles larger than 76 mm, visible organic matter, construction debris) is based upon the proportion of these materials present:

|                             |               |
|-----------------------------|---------------|
| <i>Trace, or occasional</i> | Less than 10% |
| <i>Some</i>                 | 10-20%        |
| <i>Frequent</i>             | > 20%         |

#### Terminology describing compactness of cohesionless soils:

The standard terminology to describe cohesionless soils includes compactness (formerly "relative density"), as determined by the Standard Penetration Test N-Value (also known as N-Index). A relationship between compactness condition and N-Value is shown in the following table.

| Compactness Condition | SPT N-Value |
|-----------------------|-------------|
| <i>Very Loose</i>     | <4          |
| <i>Loose</i>          | 4-10        |
| <i>Compact</i>        | 10-30       |
| <i>Dense</i>          | 30-50       |
| <i>Very Dense</i>     | >50         |

#### Terminology describing consistency of cohesive soils:

The standard terminology to describe cohesive soils includes the consistency, which is based on undrained shear strength as measured by *in situ* vane tests, penetrometer tests, or unconfined compression tests.

| Consistency       | Undrained Shear Strength |           |
|-------------------|--------------------------|-----------|
|                   | kips/sq.ft.              | kPa       |
| <i>Very Soft</i>  | <0.25                    | <12.5     |
| <i>Soft</i>       | 0.25 - 0.5               | 12.5 - 25 |
| <i>Firm</i>       | 0.5 - 1.0                | 25 - 50   |
| <i>Stiff</i>      | 1.0 - 2.0                | 50 - 100  |
| <i>Very Stiff</i> | 2.0 - 4.0                | 100 - 200 |
| <i>Hard</i>       | >4.0                     | >200      |

## ROCK DESCRIPTION

### Terminology describing rock quality:

| RQD    | Rock Mass Quality |
|--------|-------------------|
| 0-25   | <i>Very Poor</i>  |
| 25-50  | <i>Poor</i>       |
| 50-75  | <i>Fair</i>       |
| 75-90  | <i>Good</i>       |
| 90-100 | <i>Excellent</i>  |

Rock quality classification is based on a modified core recovery percentage (RQD) in which all pieces of sound core over 100 mm long are counted as recovery. The smaller pieces are considered to be due to close shearing, jointing, faulting, or weathering in the rock mass and are not counted. RQD was originally intended to be done on NW core; however, it can be used on different core sizes if the bulk of the fractures caused by drilling stresses are easily distinguishable from *in situ* fractures. The terminology describing rock mass quality based on RQD is subjective and is underlain by the presumption that sound strong rock is of higher engineering value than fractured weak rock.

### Terminology describing rock mass:

| Spacing (mm) | Joint Classification   | Bedding, Laminations, Bands |
|--------------|------------------------|-----------------------------|
| > 6000       | <i>Extremely Wide</i>  | -                           |
| 2000-6000    | <i>Very Wide</i>       | <i>Very Thick</i>           |
| 600-2000     | <i>Wide</i>            | <i>Thick</i>                |
| 200-600      | <i>Moderate</i>        | <i>Medium</i>               |
| 60-200       | <i>Close</i>           | <i>Thin</i>                 |
| 20-60        | <i>Very Close</i>      | <i>Very Thin</i>            |
| <20          | <i>Extremely Close</i> | <i>Laminated</i>            |
| <6           | -                      | <i>Thinly Laminated</i>     |

### Terminology describing rock strength:

| Strength Classification | Unconfined Compressive Strength (MPa) |
|-------------------------|---------------------------------------|
| <i>Extremely Weak</i>   | < 1                                   |
| <i>Very Weak</i>        | 1 – 5                                 |
| <i>Weak</i>             | 5 – 25                                |
| <i>Medium Strong</i>    | 25 – 50                               |
| <i>Strong</i>           | 50 – 100                              |
| <i>Very Strong</i>      | 100 – 250                             |
| <i>Extremely Strong</i> | > 250                                 |

### Terminology describing rock weathering:

| Term                        | Description  |
|-----------------------------|--|
| <i>Fresh</i>                | No visible signs of rock weathering. Slight discolouration along major discontinuities                                   |
| <i>Slightly Weathered</i>   | Discolouration indicates weathering of rock on discontinuity surfaces. All the rock material may be discoloured.         |
| <i>Moderately Weathered</i> | Less than half the rock is decomposed and/or disintegrated into soil.  |
| <i>Highly Weathered</i>     | More than half the rock is decomposed and/or disintegrated into soil.  |
| <i>Completely Weathered</i> | All the rock material is decomposed and/or disintegrated into soil. The original mass structure is still largely intact. |

## STRATA PLOT

Strata plots symbolize the soil or bedrock description. They are combinations of the following basic symbols. The dimensions within the strata symbols are not indicative of the particle size, layer thickness, etc.



Boulders  
Cobbles  
Gravel



Sand



Silt



Clay



Organics



Asphalt



Concrete



Fill



Bedrock

## SAMPLE TYPE

|                  |   |
|------------------|---|
| SS               | Split spoon sample (obtained by performing the Standard Penetration Test)     |
| ST               | Shelby tube or thin wall tube   |
| DP               | Direct-Push sample (small diameter tube sampler hydraulically advanced)       |
| PS               | Piston sample   |
| BS               | Bulk sample   |
| WS               | Wash sample   |
| HQ, NQ, BQ, etc. | Rock core samples obtained with the use of standard size diamond coring bits. |

## WATER LEVEL MEASUREMENT



measured in standpipe,  
piezometer, or well



inferred

## RECOVERY

For soil samples, the recovery is recorded as the length of the soil sample recovered. For rock core, recovery is defined as the total cumulative length of all core recovered in the core barrel divided by the length drilled and is recorded as a percentage on a per run basis.

## N-VALUE

Numbers in this column are the field results of the Standard Penetration Test: the number of blows of a 140 pound (64 kg) hammer falling 30 inches (760 mm), required to drive a 2 inch (50.8 mm) O.D. split spoon sampler one foot (305 mm) into the soil. For split spoon samples where insufficient penetration was achieved and N-values cannot be presented, the number of blows are reported over sampler penetration in millimetres (e.g. 50/75). Some design methods make use of N value corrected for various factors such as overburden pressure, energy ratio, borehole diameter, etc. No corrections have been applied to the N-values presented on the log.

## DYNAMIC CONE PENETRATION TEST (DCPT)

Dynamic cone penetration tests are performed using a standard 60 degree apex cone connected to A size drill rods with the same standard fall height and weight as the Standard Penetration Test. The DCPT value is the number of blows of the hammer required to drive the cone one foot (305 mm) into the soil. The DCPT is used as a probe to assess soil variability.

## OTHER TESTS

|          |  |
|----------|--|
| S        | Sieve analysis   |
| H        | Hydrometer analysis  |
| k        | Laboratory permeability  |
| $\gamma$ | Unit weight  |
| $G_s$    | Specific gravity of soil particles   |
| CD       | Consolidated drained triaxial  |
| CU       | Consolidated undrained triaxial with pore pressure measurements  |
| UU       | Unconsolidated undrained triaxial  |
| DS       | Direct Shear   |
| C        | Consolidation  |
| $Q_u$    | Unconfined compression   |
| $I_p$    | Point Load Index ( $I_p$ on Borehole Record equals $I_p(50)$ in which the index is corrected to a reference diameter of 50 mm) |

|  |   |
|--|---|
|  | Single packer permeability test; test interval from depth shown to bottom of borehole |
|  | Double packer permeability test; test interval as indicated                           |
|  | Falling head permeability test using casing   |
|  | Falling head permeability test using well point or piezometer                         |





# RECORD OF BOREHOLE No BH17-1

1 OF 1

METRIC

W.P. W.O. 2017-11022 LOCATION Harmer Ave Pedestrian Bridge - Westbound Sign N: 5 028 529 E: 365 010 ORIGINATED BY JHJ  
 DIST East HWY 417 BOREHOLE TYPE Portable Drilling, Split Spoon COMPILED BY SR  
 DATUM Geodetic DATE 2017 09 19 CHECKED BY KN

| SOIL PROFILE  |   |            | SAMPLES |      |              | GROUND WATER<br>CONDITIONS | ELEVATION SCALE | DYNAMIC CONE PENETRATION<br>RESISTANCE PLOT                      |    |    |     |  | PLASTIC<br>LIMIT<br>W <sub>P</sub> | NATURAL<br>MOISTURE<br>CONTENT<br>W | LIQUID<br>LIMIT<br>W <sub>L</sub> | UNIT<br>WEIGHT<br>γ | REMARKS<br>&<br>GRAIN SIZE<br>DISTRIBUTION<br>(%) |                   |  |  |
|---------------|---|------------|---------|------|--------------|----------------------------|-----------------|--|----|----|-----|--|------------------------------------|-------------------------------------|-----------------------------------|---------------------|---|-------------------|--|--|
| ELEV<br>DEPTH | DESCRIPTION   | STRAT PLOT | NUMBER  | TYPE | "N" VALUES   |                            |                 | SHEAR STRENGTH kPa   |    |    |     |  |                                    |                                     |                                   |                     |   | WATER CONTENT (%) |  |  |
|               |   |            |         |      |              |                            |                 | ○ UNCONFINED      ✕ FIELD VANE<br>● QUICK TRIAXIAL    ✕ LAB VANE |    |    |     |  |                                    |                                     |                                   |                     |   |                   |  |  |
| 71.7          | Grass   |            |         |      |              |                            | 20              | 40   | 60 | 80 | 100 |  |                                    |                                     |                                   |                     |   |                   |  |  |
| 0.0           | 610 mm TOPSOIL: sand and gravel<br>containing organic material  |            | 1       | SS   | 9            |                            |                 |  |    |    |     |  |                                    |                                     |                                   |                     |   |                   |  |  |
| 71.1          | Silty sand, some gravel (FILL)<br>Contains cobbles and boulders   |            | 2       | SS   | 39           |                            |                 |  |    |    |     |  |                                    |                                     |                                   |                     |   |                   |  |  |
| 0.6           | Dense to very dense<br>Brown to grey<br>Moist   |            | 3       | SS   | 50/<br>152mm |                            |                 |  |    |    |     |  |                                    |                                     |                                   |                     |   |                   |  |  |
| 70.0          | - Tip of SS2 contains sand<br>- Spilt spoon refusal on boulder  |            |         |      |              |                            |                 |  |    |    |     |  |                                    |                                     |                                   |                     |   |                   |  |  |
| 1.7           | SILTY SAND (SM), some gravel, trace<br>clay (TILL)<br>Contains frequent cobbles and boulders            |            | 4       | SS   | 11           |                            |                 |  |    |    |     |  |                                    |                                     |                                   |                     |   |                   |  |  |
|               | Loose to compact<br>Grey<br>Moist to wet  |            | 5       | SS   | 21           |                            |                 |  |    |    |     |  |                                    |                                     |                                   |                     |   |                   |  |  |
|               | - Cored through cobble or boulder<br>between 1.7 and 2.0m depth<br>- SS5 contains coarse granular seams |            | 6       | SS   | 7            |                            |                 |  |    |    |     |  |                                    |                                     |                                   |                     |   |                   |  |  |
|               | Difficulty encountered advancing casing<br>below 3m due to cobbles and boulders                         |            | 7       | SS   | 8            |                            |                 |  |    |    |     |  |                                    |                                     |                                   |                     |   |                   |  |  |
| 67.0          | Limestone cobbles and boulders  |            |         |      |              |                            |                 |  |    |    |     |  |                                    |                                     |                                   |                     |   |                   |  |  |
| 4.7           | Dark grey   |            |         |      |              |                            |                 |  |    |    |     |  |                                    |                                     |                                   |                     |   |                   |  |  |
| 66.7          | LIMESTONE with laminations to thin<br>beds of shale   |            | 8       | NQ   | RQD<br>27%   |                            |                 |  |    |    |     |  |                                    |                                     |                                   |                     |   |                   |  |  |
| 5.0           | Fresh to slightly weathered<br>Light grey<br>Strong to very strong                                      |            |         |      |              |                            |                 |  |    |    |     |  |                                    |                                     |                                   |                     |   |                   |  |  |
|               | Refer to bedrock core logs for additional<br>details  |            | 9       | NQ   | RQD<br>77%   |                            |                 |  |    |    |     |  |                                    |                                     |                                   |                     |   |                   |  |  |
|               |   |            | 10      | NQ   | RQD<br>87%   |                            |                 |  |    |    |     |  |                                    |                                     |                                   |                     |   |                   |  |  |
| 63.5          | End of Borehole   |            |         |      |              |                            |                 |  |    |    |     |  |                                    |                                     |                                   |                     |   |                   |  |  |
| 8.2           |   |            |         |      |              |                            |                 |  |    |    |     |  |                                    |                                     |                                   |                     |   |                   |  |  |

×<sup>3</sup>, ×<sup>3</sup>: Numbers refer to Sensitivity ○ 3% STRAIN AT FAILURE

STN13-ONTARIO MTO STANTEC 163601070 HARMER AVE PEDESTRIAN BRIDGE - MOST RECENT GP J. ONTARIO MOT. GDT 12/8/17



## RECORD OF BOREHOLE No BH17-7

1 OF 1

METRIC

W.P. W.O. 2017-11022 LOCATION Harmer Ave Pedestrian Bridge - Eastbound Sign N: 5 028 233 E: 364 898 ORIGINATED BY SR  
DIST East HWY 417 BOREHOLE TYPE Hollow Stem Augers, Split Spoon Sampler COMPILED BY SR  
DATUM Geodetic DATE 2017 10 27 CHECKED BY KN

| SOIL PROFILE  |   |            | SAMPLES |      |            | GROUND WATER<br>CONDITIONS | ELEVATION SCALE | DYNAMIC CONE PENETRATION<br>RESISTANCE PLOT |    |    |    |     | PLASTIC<br>LIMIT<br>W <sub>P</sub> | NATURAL<br>MOISTURE<br>CONTENT<br>W | LIQUID<br>LIMIT<br>W <sub>L</sub> | UNIT<br>WEIGHT<br><br>γ | REMARKS<br>&<br>GRAIN SIZE<br>DISTRIBUTION<br>(%) |                   |    |    |
|---------------|---|------------|---------|------|------------|----------------------------|-----------------|---|----|----|----|-----|------------------------------------|-------------------------------------|-----------------------------------|-------------------------|---|-------------------|----|----|
| ELEV<br>DEPTH | DESCRIPTION   | STRAT PLOT | NUMBER  | TYPE | "N" VALUES |                            |                 | SHEAR STRENGTH kPa                          |    |    |    |     |                                    |                                     |                                   |                         |   | WATER CONTENT (%) |    |    |
|               |   |            |         |      |            |                            |                 | 20  | 40 | 60 | 80 | 100 |                                    |                                     |                                   |                         |   | 20                | 40 | 60 |
| 73.6          | Grass   |            |         |      |            |                            |                 |   |    |    |    |     |                                    |                                     |                                   |                         |   |                   |    |    |
| 0.0           | TOPSOIL: silty sand, some gravel,<br>contains organic material and rootlets<br>Loose<br>Dark brown<br>Moist   |            | 1       | SS   | 8          |                            |                 |   |    |    |    |     |                                    |                                     |                                   |                         |   |                   |    |    |
| 72.7          |   |            |         |      |            |                            |                 |   |    |    |    |     |                                    |                                     |                                   |                         |   |                   |    |    |
| 0.9           | SANDY SILT (SM), some clay, trace<br>gravel to SANDY SILTY CLAY (CI) (FILL)<br>Contains silty sand seams (up to 0.3m<br>thick) and frequent cobbles and<br>boulders.<br>Buried topsoil layers encountered at<br>elev. 72.1m (~100mm thick) and 71.3m<br>(~125mm thick)<br>Loose to compact<br>Brown to dark brown<br>Moist to wet |            | 2       | SS   | 6          |                            |                 |   |    |    |    |     |                                    |                                     |                                   |                         |   |                   |    |    |
|               |   |            |         |      |            |                            |                 |   |    |    |    |     |                                    |                                     |                                   |                         |   |                   |    |    |
|               |   |            | 3       | SS   | 5          |                            |                 |   |    |    |    |     |                                    |                                     |                                   |                         |   |                   |    |    |
|               |   |            |         |      |            |                            |                 |   |    |    |    |     |                                    |                                     |                                   |                         |   |                   |    |    |
| 70.9          |   |            | 4       | SS   | 15         |                            |                 |   |    |    |    |     |                                    |                                     |                                   |                         |   |                   |    |    |
| 2.7           | GRAVELLY SAND (SW), some silt<br>(Possible FILL)<br><br>Very dense<br>Light grey  |            |         |      |            |                            |                 |   |    |    |    |     |                                    |                                     |                                   |                         |   |                   |    |    |
|               |   |            | 5       | SS   | 146        |                            |                 |   |    |    |    |     |                                    |                                     |                                   |                         |   |                   |    |    |
| 70.0          |   |            |         |      |            |                            |                 |   |    |    |    |     |                                    |                                     |                                   |                         |   |                   |    |    |
| 3.6           | LIMESTONE with shale laminations<br>Heavily fractured above elevation ~68m<br>Slightly weathered<br>Light grey<br>Strong<br><br>Refer to bedrock core logs for additional<br>details  |            | 6       | NQ   | RQD<br>0%  |                            |                 |   |    |    |    |     |                                    |                                     |                                   |                         |   |                   |    |    |
|               |   |            |         |      |            |                            |                 |   |    |    |    |     |                                    |                                     |                                   |                         |   |                   |    |    |
|               |   |            | 7       | NQ   | RQD<br>11% |                            |                 |   |    |    |    |     |                                    |                                     |                                   |                         |   |                   |    |    |
|               |   |            |         |      |            |                            |                 |   |    |    |    |     |                                    |                                     |                                   |                         |   |                   |    |    |
|               |   |            | 8       | NQ   | RQD<br>0%  |                            |                 |   |    |    |    |     |                                    |                                     |                                   |                         |   |                   |    |    |
|               |   |            |         |      |            |                            |                 |   |    |    |    |     |                                    |                                     |                                   |                         |   |                   |    |    |
|               |   |            | 9       | NQ   | RQD<br>19% |                            |                 |   |    |    |    |     |                                    |                                     |                                   |                         |   |                   |    |    |
|               |   |            |         |      |            |                            |                 |   |    |    |    |     |                                    |                                     |                                   |                         |   |                   |    |    |
|               |   |            | 10      | NQ   | RQD<br>97% |                            |                 |   |    |    |    |     |                                    |                                     |                                   |                         |   |                   |    |    |
| 66.8          |   |            |         |      |            |                            |                 |   |    |    |    |     |                                    |                                     |                                   |                         |   |                   |    |    |
| 6.8           | End of Borehole   |            |         |      |            |                            |                 |   |    |    |    |     |                                    |                                     |                                   |                         |   |                   |    |    |

$\times^3, \times^3$ : Numbers refer to Sensitivity  $\circ$  3% STRAIN AT FAILURE

STN13-ONTARIO MTO STANTEC 163601070 HARMER AVE PEDESTRIAN BRIDGE - MOST RECENT GPJ ONTARIO MOT. GDT 12/8/17

**Client:** City of Ottawa  
**Project:** Harmer Pedestrian Bridge  
**Contractor:** OGS

**Project No.:** 163601070  
**Date:** 19-Sep-17  
**Borehole No.:** BH 17-01  
**Logger:** SR

| DEPTH FROM (m) | RUN NO. | % CORE RECOVERY | % RQD | DEPTH TO (m) | GENERAL DESCRIPTION                              | STRENGTH | WEATHERING | DISCONTINUITIES |        |             |         |           |          |         | OCCASIONAL FEATURES | DRILLING OBSERVATIONS                          |
|----------------|---------|-----------------|-------|--------------|--|----------|------------|-----------------|--------|-------------|---------|-----------|----------|---------|---------------------|--|
|                |         |                 |       |              |  |          |            | NO. OF SETS     | TYPE/S | ORIENTATION | SPACING | ROUGHNESS | APERTURE | FILLING |                     |  |
| 4.7            |         |                 |       | 5.0          | LIMESTONE cobbles and boulders                   |          |            |                 |        |             |         |           |          |         |                     | Sample from casing advanced through overburden |
| 5.0            | NQ 08   | 100%            | 27%   | 6.5          | LIMESTONE with laminations to thin beds of shale | R5       | W2         | 1               | BD     | F           | C       | RP        | MW       | N/A     |                     |  |
| 6.5            | NQ 09   | 100%            | 77%   | 7.6          | LIMESTONE with laminations to thin beds of shale | R5       | W2         | 2               | BD     | F           | C       | RP        | O        | N/A     |                     |  |
|                |         |                 |       |              |  |          |            |                 | JN     | F           | M       | RP        | MW       | N/A     |                     |  |
| 7.6            | NQ 10   | 100%            | 87%   | 8.2          | LIMESTONE with laminations to thin beds of shale | R4       | W1         | 2               | BD     | F           | M       | RP        | MW       | N/A     |                     |  |
|                |         |                 |       |              |  |          |            |                 | JN     | F           | M       | RP        | MW       | N/A     |                     |  |

#### STRENGTH (MPa)

| Grade/Classification | Est. Strength (MPa) |
|----------------------|---------------------|
| R0 Extremely Weak    | 0.25 - 1.0          |
| R1 Very Weak         | 1.0 - 5.0           |
| R2 Weak              | 5.0 - 25.0          |
| R3 Medium Strong     | 25.0 - 50.0         |
| R4 Strong            | 50.0 - 100.0        |
| R5 Very Strong       | 100.0 - 250.0       |
| R6 Extremely Strong  | >250.0              |

#### JOINT TYPE

BD = Bedding  
 JN = Joint  
 FOL = Foliation  
 CON = Contact  
 FLT = Fault  
 VN = Vein

#### ORIENTATION

F = Flat = 0-20°  
 D = Dipping = 20-50°  
 V = n-Vertical = >50°

#### FILLING

T = Tight, Hard  
 O = Oxidized  
 SA = Slightly Altered, Clay Free  
 S = Sandy, Clay Free  
 Si = Sandy, Silty, Minor Clay  
 NC = Non-softening Clay  
 SC = Swelling, Soft Clay

#### APERTURE

VT = Very Tight (<0.1mm)  
 T = Tight (0.1 - 0.25mm)  
 PO = Partly Open (0.25 - 0.5mm)  
 O = Open (0.5 - 2.5mm)  
 MW = Moderately Wide (2.5 - 10mm)  
 W = Wide (>10mm)  
 VW = Very Wide (1 - 10cm)  
 EW = Extremely Wide (10 - 100cm)  
 C = Cavernous (> 1m)

#### WEATHERING

| Grade/Classification | Description  |
|----------------------|--|
| W1 Fresh             | No Visible Signs of Weathering                             |
| W2 Slightly          | Discoloration, Weathering on Discontinuities               |
| W3 Moderately        | <50% of Rock Material is Decomposed, Fresh Core Stones     |
| W4 Highly            | >50% Decomposed to soil: Fresh Core Stones                 |
| W5 Completely        | 100% Decomposed to Soil: Original Structure Intact         |
| W6 Residual Soil     | All Rock Converted to Soil, Structure and Fabric Destroyed |

#### DISCONTINUITY SPACING

| Spacing (mm)     |                 |
|------------------|-----------------|
| EW = >6000       | Extremely Wide  |
| VW = 2000 - 6000 | Very Wide       |
| W = 600 - 2000   | Wide            |
| M = 200 - 600    | Moderate        |
| C = 60 - 200     | Close           |
| VC = 20 - 60     | Very Close      |
| EC = <20         | Extremely Close |

#### JOINT ROUGHNESS

| Jr  | Description                       |
|-----|-----------------------------------|
| 4   | DJ = Discontinuous Joints         |
| 3   | RU = Rough, Irregular, Undulating |
| 1.5 | SU = Smooth, Undulating           |
| 1.5 | LU = Slickensided, Undulating     |
| 1.0 | RP = Rough or Irregular, Planar   |
| 0.5 | SP = Smooth, Planar               |
| 2   | LP = Slickensided, Planar         |

**Client:** City of Ottawa  
**Project:** Harmer Pedestrian Bridge  
**Contractor:** George Downing Estate Drilling Limited

**Project No.:** 163601070  
**Date:** 27-Oct-17  
**Borehole No.:** BH17-07  
**Logger:** SR

| DEPTH FROM (m) | RUN NO. | % CORE RECOVERY | % RQD | DEPTH TO (m) | GENERAL DESCRIPTION                        | STRENGTH | WEATHERING | DISCONTINUITIES |        |             |         |           |          | OCCASIONAL FEATURES | DRILLING OBSERVATIONS |         |
|----------------|---------|-----------------|-------|--------------|--|----------|------------|-----------------|--------|-------------|---------|-----------|----------|---------------------|-----------------------|---------|
|                |         |                 |       |              |  |          |            | NO. OF SETS     | TYPE/S | ORIENTATION | SPACING | ROUGHNESS | APERTURE |                     |                       | FILLING |
| 3.6            | NQ 06   | 73%             | 0%    | 4.6          | Dark grey LIMESTONE with shale laminations |          | W2         | 1               | JN     | D-V         | VC      | RU-RP     | N/A      | Si                  |                       |         |
|                |         |                 |       |              |  |          |            |                 |        |             |         |           |          |                     |                       |         |
|                |         |                 |       |              |  |          |            |                 |        |             |         |           |          |                     |                       |         |
| 4.6            | NQ 07   | 51%             | 11%   | 5.5          | Dark grey LIMESTONE with shale laminations |          | W2         | 1               | JN     | D-V         | VC-C    | RU-RP     | O-VW     | Si                  |                       |         |
|                |         |                 |       |              |  |          |            |                 |        |             |         |           |          |                     |                       |         |
|                |         |                 |       |              |  |          |            |                 |        |             |         |           |          |                     |                       |         |
| 5.5            | NQ 08   | 100%            | 0%    | 5.6          | Dark grey LIMESTONE with shale laminations |          | W2         | 1               | JN     | D           | VC      | RU-RP     | N/A      | Si-NC               |                       |         |
|                |         |                 |       |              |  |          |            |                 |        |             |         |           |          |                     |                       |         |
|                |         |                 |       |              |  |          |            |                 |        |             |         |           |          |                     |                       |         |
| 5.6            | NQ 09   | 40%             | 19%   | 6.2          | Dark grey LIMESTONE with shale laminations |          | W2         |                 | BD     | F           | C       | RU-RP     | O        | N/A                 |                       |         |
|                |         |                 |       |              |  |          |            |                 |        |             |         |           |          |                     |                       |         |
|                |         |                 |       |              |  |          |            |                 |        |             |         |           |          |                     |                       |         |

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 C = Cavernous (> 1m)

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| Grade/Classification | Description  |
|----------------------|--|
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**Date:** 27-Oct-17  
**Borehole No.:** BH17-07  
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| DEPTH FROM (m) | RUN NO. | % CORE RECOVERY | % RQD | DEPTH TO (m) | GENERAL DESCRIPTION                        | STRENGTH | WEATHERING | DISCONTINUITIES |        |             |         |           |          |         | OCCASIONAL FEATURES | DRILLING OBSERVATIONS |
|----------------|---------|-----------------|-------|--------------|--|----------|------------|-----------------|--------|-------------|---------|-----------|----------|---------|---------------------|-----------------------|
|                |         |                 |       |              |  |          |            | NO. OF SETS     | TYPE/S | ORIENTATION | SPACING | ROUGHNESS | APERTURE | FILLING |                     |                       |
| 6.2            | NQ 10   | 97%             | 97%   | 6.8          | Dark grey LIMESTONE with shale laminations |          | W1         | 2               | JN     | F           | M       | RU/RP     | O        | N/A     |                     |                       |
|                |         |                 |       |              |  |          |            |                 | BD     | F           | M       | RU/RP     | O        | N/A     |                     |                       |
|                |         |                 |       |              |  |          |            |                 |        |             |         |           |          |         |                     |                       |
|                |         |                 |       |              |  |          |            |                 |        |             |         |           |          |         |                     |                       |
|                |         |                 |       |              |  |          |            |                 |        |             |         |           |          |         |                     |                       |
|                |         |                 |       |              |  |          |            |                 |        |             |         |           |          |         |                     |                       |
|                |         |                 |       |              |  |          |            |                 |        |             |         |           |          |         |                     |                       |
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#### JOINT ROUGHNESS

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Rock Core Photo No.: 1 Borehole: BH 17-1 (NQ 8 to NQ 10) Depth: 4.7 m to 8.2 m



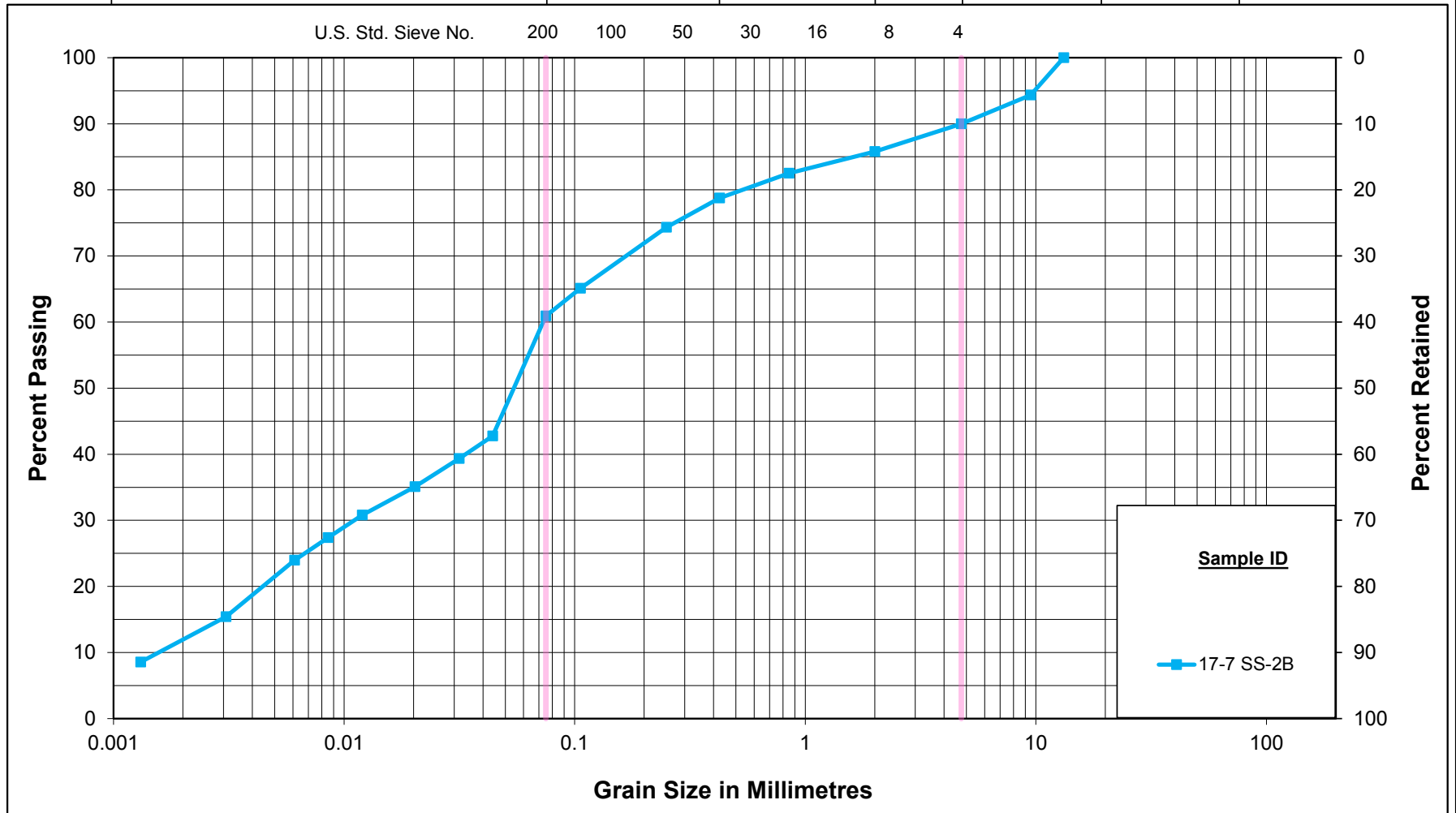
Rock Core Photo No.: 2 Borehole: BH 17-07 (NQ 6 to NQ 10) Depth: 3.5 m to 6.8 m

## **APPENDIX C**

### Laboratory Test Results

# Unified Soil Classification System

|             |  |  | SAND |        |        | Gravel |        |
|-------------|--|--|------|--------|--------|--------|--------|
| CLAY & SILT |  |  | Fine | Medium | Coarse | Fine   | Coarse |



**FILL: SANDY SILT some clay**  
 Harmer Ave. Pedestrian Bridge  
 City of Ottawa

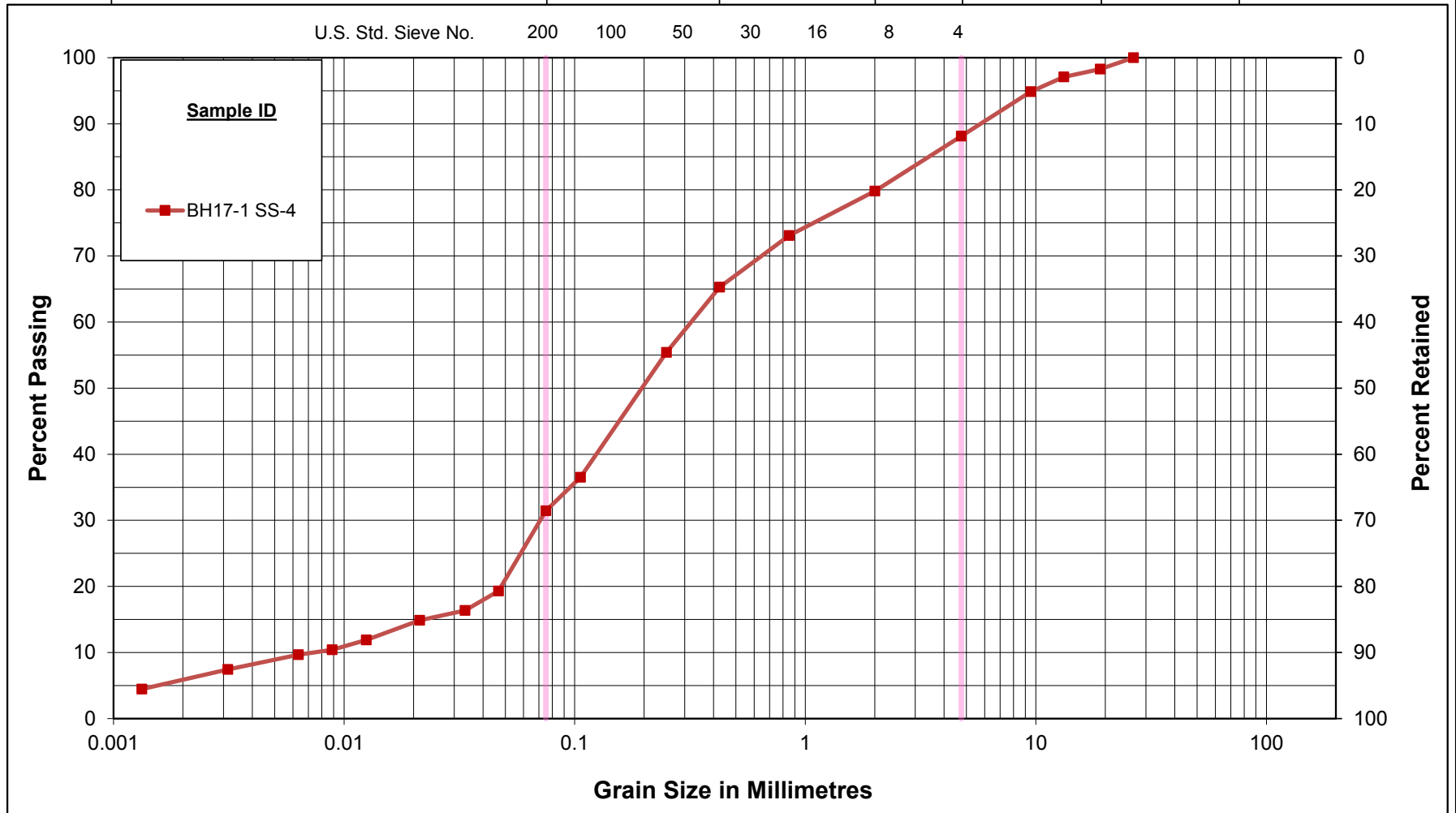
Figure No. C-1

Project No. 163601070



# Unified Soil Classification System

|             |  |  | SAND |        |        | Gravel |        |
|-------------|--|--|------|--------|--------|--------|--------|
| CLAY & SILT |  |  | Fine | Medium | Coarse | Fine   | Coarse |



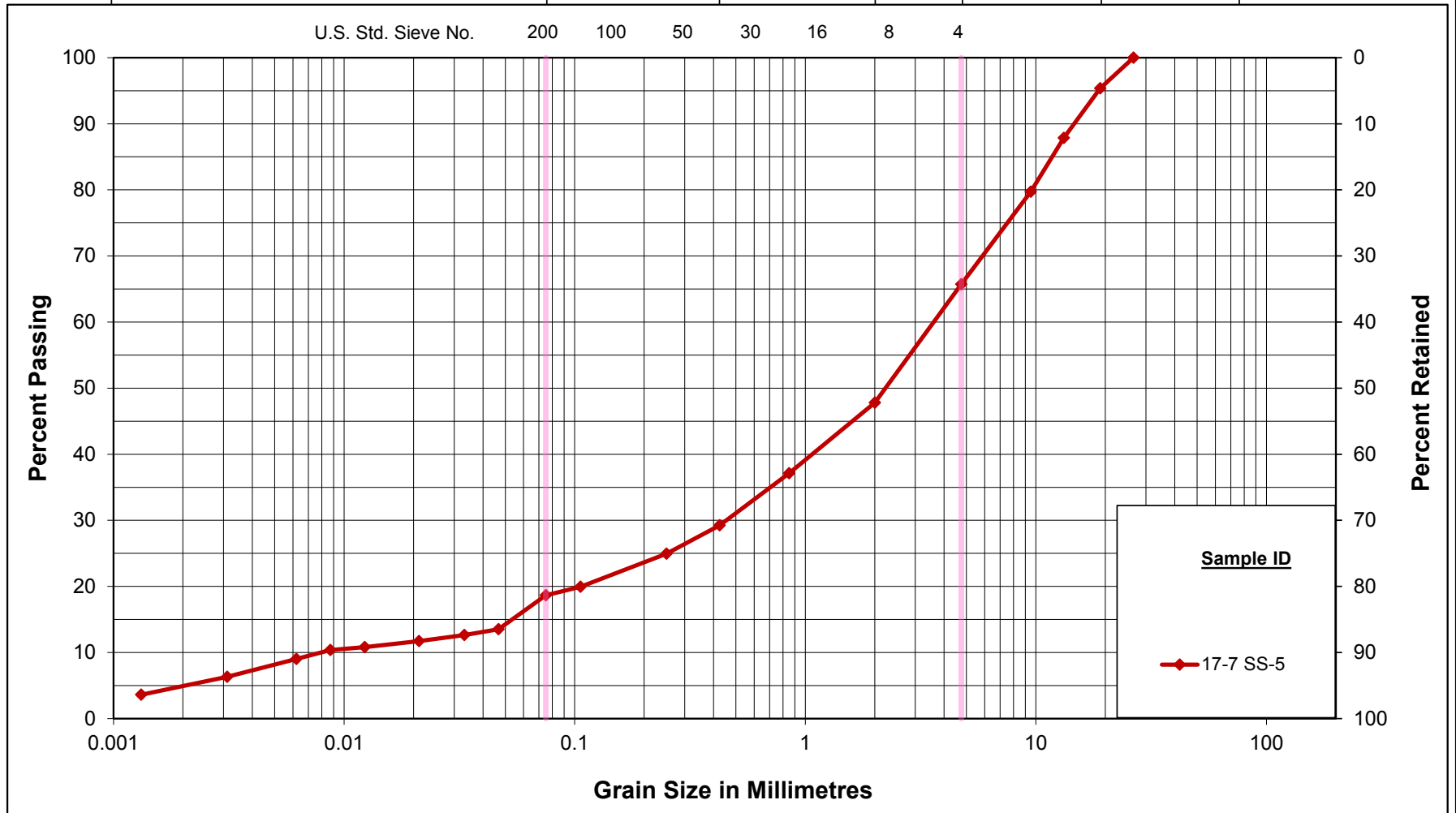
**Till: SILTY SAND some gravel**  
Harmer Ave. Pedestrian Bridge  
City of Ottawa

Figure No. C-2

Project No. 163601070

# Unified Soil Classification System

|             |  |  | SAND |        |        | Gravel |        |
|-------------|--|--|------|--------|--------|--------|--------|
| CLAY & SILT |  |  | Fine | Medium | Coarse | Fine   | Coarse |



**Gravelly SAND (SW) - Possible FILL**

Harmer Ave. Pedestrian Bridge  
City of Ottawa

Figure No. C-3

Project No. 163601070

## **APPENDIX D**

Sample NSSP – Obstructions

## **Obstructions —Item No.**

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### Special Provision

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#### **1.0 SCOPE**

The work required for the installation of caisson/drilled pier foundations shall include consideration for encountering cobbles and/or boulders.

#### **2.0 CONSTRUCTION**

Cobbles and boulders may obstruct excavation activities and the installation of drilled piers/caissons. Impacts associated with these obstructions could include, but are not limited to, the following:

- Additional effort will be required to excavate fill and glacial till materials containing cobbles and boulders.
- The development of the drilled shafts for caisson foundations, and the associated installation of liners/casings for the drilled shafts, could be obstructed by cobbles and boulders within the overburden soils prior to the drilled piers reaching the bedrock surface. The contractor will require appropriate equipment and construction methods to penetrate or remove cobbles and boulders.
- The contractor will also need to establish suitable groundwater control measures to permit construction of the drilled shafts without ingress of groundwater and soil into the shafts if liners/casings are not installed throughout the length of the shaft within the overburden.
- The removal of cobbles and boulders from excavations may lead to undermining of materials in the sidewalls of excavations. The contractor would need to implement measures to prevent instability of the undermined materials.

#### **3.0 BASIS OF PAYMENT**

Payment at the Contract price for the appropriate tender items associated with excavations, caisson/drilled pier excavation and construction, and temporary roadway protection systems shall include full compensation for all labour, Equipment and Material to do the work.