



FINAL REPORT

Foundation Investigation and Design Highway 417 Overpass Structures at Rochester Street Rapid Bridge Replacement

Site Nos. 3-56/1 & 3-56/2

Ottawa, Ontario

G.W.P. 4173-15-00

W.P. 4071-13-01 & 4072-13-01

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PART A

Foundation Investigation
Highway 417 Overpass Structures at Rochester Street
Rapid Bridge Replacement
Site Nos. 3-56/1 & 3-56/2

1.0 INTRODUCTION

Golder Associates Ltd. (Golder) has been retained by WSP Canada Group Limited (WSP) on behalf of the Ministry of Transportation, Ontario (MTO) to carry out foundation investigations associated with the detailed design of numerous bridge replacements, overhead signs, noise barrier walls, temporary roadway protection systems, replacement of storm sewers (including trenchless crossings) and a high fill embankment on Highway 417 between Island Park Drive and Kent Street in Ottawa, Ontario (Assignment number 4016-E-0001).

This report presents the results of the foundation investigation carried out for the rapid bridge replacement (RBR) and widening of the Highway 417 eastbound (Site 3-56/1) and westbound (Site 3-56/2) overpass structures at Rochester Street (G.W.P. 4173-15-00 and W.P. 4071-13-01 and W.P. 4072-13-01). The replacement of the structures is to be carried out in accordance with the current version of the Canadian Highway Bridge Design Code, S6-14 (CHBDC).

The terms of reference and scope of work for the foundation investigation are outlined in the MTO's Request for Proposal, dated April 2016, and subsequent addenda. Golder's scope of work for foundation engineering services associated with the Highway 417 Overpasses at Rochester Street is contained in Table 17.8.3 of WSP's Technical Proposal for this assignment dated June 28, 2016.

Additional foundation investigation and engineering services associated with the replacement of the Highway 417 Overpasses at Rochester Street were also outlined in Golder's Change Order #2 Technical Memorandum dated July 27, 2019. The additional investigation program was identified as necessary by the designers to provide additional information for the design of the bridge retaining walls and for design of temporary protection systems.

The work has been carried out in accordance with Golder's Quality Control Plan for foundation engineering services for the project dated August 29, 2016.

2.0 SITE DESCRIPTION AND GEOLOGY

2.1 Site Description

Sites 3-56/1 and 3-56/2 are located at Station 27+245, approximately 350 m east of the O-Train Trillium Line, within the City of Ottawa. The location of the overpass structures is shown on the Key Plan on Drawings 1 through 5. Site photographs showing the general conditions at the site are presented in Appendix F.

At this location, Highway 417 is a divided highway with four travel lanes in each direction separated by a concrete barrier wall. A concrete barrier wall is present along the south sides of the highway and combination concrete barrier and noise barrier wall along the north side.

Each of the existing structures is a single-span concrete rigid frame bridge that is supported on shallow foundations founded directly on bedrock. Information provided in the RFP indicates that the structures were built in 1962. The structures have a clear span of 18.3 m measured perpendicular to the abutments and are separated from each other by a longitudinal joint. The average overall deck width of each structure, measured perpendicular to the centerline of the highway, is approximately 19.1 m. Each abutment has two retaining walls located along the north and south sides of the highway embankment for retaining the embankment fill. Noise barriers are present along the north side of Highway 417 and carried through the entire length of the structures.

There is a 1.2 m diameter watermain located just south of the eastbound structure which runs parallel to the highway.

The existing approach embankments are about 5.5 m to 6.5 m high relative to the elevation of Rochester Street, with side slopes oriented at approximately 2 horizontal to 1 vertical (2H:1V). Based on a visual observation at the time of the site investigation, no signs of foundation settlement were observed, and the existing embankment slopes appear to be performing satisfactorily.

2.2 Regional Geology

As delineated in *The Physiography of Southern Ontario*¹, this section of Highway 417 lies within the minor physiographic region known as the Ottawa Valley Clay Plain, which is within the major physiographic region of the Ottawa-St. Lawrence Lowland.

The Ottawa Valley Clay Plain region is characterized by relatively thick deposits of sensitive marine clay, silt and silty clay that were deposited within the former Champlain Sea basin. These deposits, known as the Champlain Sea clay or Leda clay, overlie relatively thin, commonly reworked glacial till and glaciofluvial deposits, that in turn overlie bedrock².

This region is underlain by a series of sedimentary rocks, consisting of sandstones, dolostones, limestones and shales that are, in turn, underlain at depth by igneous and metamorphic bedrock of the Precambrian Shield. Regional bedrock mapping indicates that the bedrock at this site is primarily limestone of the Verulam Formation.³ The limestone is described as interbedded bioclastic, sublithographic to fine crystalline with very thin to medium bedded shale interbeds up to 8 cm thick. Bedrock outcrops are mapped north and south of the Highway 417 / Bronson Avenue Interchange.

The site lies between two faults striking southeast to northeast. The more prominent fault, the Gloucester fault, crosses Highway 417 at the approximate location of Preston Street.⁴ The second fault crosses Highway 417 some 300 metres east. Bedding which is normally sub-horizontal often dips steeply adjacent to and within fault zones.

The site falls within the Western Québec (WQ) seismic zone according to the Geological Survey of Canada. The WQ zone constitutes a large area which encompasses the urban areas of Montreal, Ottawa-Hull and Cornwall. Within the WQ zone recent seismic activity has been concentrated in two subzones; one along the Ottawa River and another more active subzone along the Montreal-Maniwaki axis. The two major earthquakes that have recently occurred in the WQ zone are the 1935 Témiscaming event, which had a magnitude (i.e., a measure of the intensity of the earthquake) of 6.2, and the 1944 Cornwall-Massena event, which had a magnitude of 5.6.

3.0 INVESTIGATION PROCEDURES

3.1 Current Investigations

The field work for the 2016/2017 investigation was carried out at the existing abutments along Rochester Street between December 14 and 23, 2016 and April 5 and April 7, 2017, and included advancing a total of 24 coreholes, designated 17-A01 to 17-A24, and four boreholes designated 17-111 to 17-114, respectively.

¹ Chapman, L. J. and Putnam, D. F., 1984. *The Physiography of Southern Ontario*, Ontario Geological Survey. Special Volume 2, Third Edition. Accompanied by Map P.2715, Scale 1:600,000. Ontario Ministry of Natural Resources.

² Belanger, J.R. "Urban Geology of Canada's National Capital Area", in *Urban Geology of Canadian Cities*, Geological Association of Canada Special Paper 42, Ed. P.F. Karrow and O.L. White, 1998.

³ Williams, D.A. Rae, A.M., and Wolf, R.R. 1984: Paleozoic Geology of the Ottawa Area, Southern Ontario, Ontario Geological Survey, Map P.2716. Geological Series-Preliminary Map, scale 1:50,000. Geology 1982.

⁴ MacDonald, G. and Harrison, J.E. 1976: Generalized Bedrock Geology, Ottawa-Hull, Ontario and Quebec, Geological Survey of Canada, Map 1508A, scale 1:125,000. Geology 1967.

A supplemental investigation was carried out between October 4 and 12, 2018, that included advancing four boreholes located along the highway approach embankments behind the existing abutments, designated as 18-1109 to 18-1112. A further eight boreholes, numbered 18-1101 to 18-1108, were advanced within the highway embankments between November 26 and 29, 2018 and between April 16 to 22, 2019, that included coring of the existing concrete footings.

Five additional boreholes were also advanced as part of the investigation for the proposed staging areas for this project. These included boreholes (numbered 18-1212 and 18-1213) which were advanced on November 19, 2018 and Boreholes 18-1209 to 18-1211 advanced on January 27, 2019.

Tables 1 and 2 further outline the location of the testholes with respect to the existing structures and staging areas.

The 24 coreholes (12 per abutment) were drilled at approximately 3 m spacing along Rochester Street through the existing sidewalks using portable drilling equipment and were then subsequently hydro-excavated to expose the top of the existing footings. Eight of the coreholes (four per abutment) were further advanced into the underlying bedrock to form Drillholes 17-A01D, 17-A04D, 17-A08D, 17-A12D, 17-A13D, 17-A16D, 17-A20D, and 17-A24D. Following vertical hydro-excavation, Drillholes 17-A01D and 17-A04D were drilled on an incline due to the proximity of the corehole location to the adjacent abutment and existing utilities. The angle of inclination is indicated on the Record of Drillholes and is relative to the horizontal, with an azimuth perpendicular to the abutments.

Boreholes 18-1101, 18-1102, 18-1105 and 18-1106 were advanced using portable rotary drilling equipment employing a third weight hammer lifted manually and dropped from the SPT height. Where a third weight hammer was used, the N values presented on the Record of Boreholes are “uncorrected” and should be interpreted in consideration of their reduced penetration energy. This drilling equipment was supplied and operated by CCC Geotechnical & Environmental Drilling Ltd. (CCC) of Ottawa, Ontario.

Boreholes 18-1103, 18-1104, 18-1107 and 18-1108 were advanced with portable rotary drilling equipment using NW and HW sized casing due to the proximity of the borehole locations to the adjacent abutment retaining walls and embankment slopes. The drilling equipment used a full weight hammer, but was dropped from a reduced height of 0.61 m. Where the reduced drop height was used, the N values presented on the Record of Boreholes are “uncorrected” and should be interpreted in consideration of their reduced penetration energy.

The boreholes advanced with the staging area were advanced with a truck mounted drill rig. The drilling equipment was supplied and operated by CCC.

The highway approach embankments were advanced using a truck mounted drill rig supplied and operated by George Downing Estate Drilling Limited of Hawkesbury, Ontario.

Traffic control required to close either the driving lanes of Highway 417 or Rochester Street while carrying out field operations was provided by Beacon Lite Ltd. of Ottawa, Ontario.

Grab samples of the overburden were recovered from within the hydro-excavations carried out at the coreholes and Boreholes 17-113 and 17-114. Soil samples in Boreholes 17-111, 17-112 and 18-1101 to 1106 were obtained at vertical sampling intervals of about 0.6 m, using a 50 mm outer diameter split-spoon sampler in general accordance with the Standard Penetration Test (SPT) procedure (ASTM D1586). Soil samples from boreholes

advanced with either the truck or truck-mounted drilling equipment (Boreholes 18-1107 to 18-1115) were obtained at vertical intervals of about 0.76 m also in accordance with ASTM D1586.

Concrete and bedrock core samples were obtained in the drillholes and in Boreholes 18-1103, 18-1104, 18-1107 and 18-1108 using BQ sized equipment. Concrete and bedrock core samples were obtained in Boreholes 18-1103, 18-1104, 18-1107 and 18-1108 and Boreholes 17-111 to 17-114 using a combination of NQ and HQ sized equipment.

Monitoring wells were installed in Boreholes 17-111, 17-114, and 18-1112, to observe the stabilised groundwater level across the site. The monitoring wells consist of 32 mm outside diameter PVC tubing with a 1.5 m long slotted tip. The final groundwater levels were measured in the wells on April 26, 2016 (Boreholes 17-111 and 17-114) and December 6, 2018 (Borehole 18-1112) and then the wells were decommissioned according to Ontario MOE Regulation 903 (O.Reg 903) by a licenced well technician.

Where cored, the holes advanced through the existing footings and bedrock were grouted following completion of the work. The coreholes/drillholes were then backfilled with granular material above the existing footing level to the underside of the existing sidewalk, then capped with concrete. The boreholes were backfilled with bentonite within the bedrock, and bentonite mixed with soil cuttings within the overburden. The boreholes were then capped with either concrete sidewalk patch or asphaltic concrete cold patch, depending on the surrounding surface cover. The boreholes were backfilled in general accordance with the intent of O.Reg 903, as amended. The site conditions were restored following completion of the field work.

The field work was supervised on a full-time basis by members of Golder's staff who located the testholes in the field, directed the drilling, sampling, and in-situ testing operations, logged the testholes and examined and cared for the samples. The soil and bedrock samples were identified in the field, placed in labelled containers, and transported to Golder's laboratory in Ottawa for further examination and testing. Index and classification tests consisting of water content determinations, grain size distribution analyses and organic content were carried out on selected soil samples at Golder's Ottawa laboratory. Unconfined compressive strength testing was carried out on select samples of the bedrock at Golder's Mississauga laboratory. The laboratory tests were carried out to MTO and/or ASTM Standards, as appropriate.

Three soil samples were submitted to Eurofins Environmental Testing for chemical analysis related to potential corrosion of exposed buried steel and potential sulphate attack on buried concrete elements (corrosion and sulphate attack).

In addition to the borehole investigations shear wave velocity profiling was also completed at this site. The shear wave velocity profiling was carried out in the grassy area next to the eastbound E-N/S off-ramp of the Highway 417 / Rochester Street Interchange, just west of Rochester Street, using the Multichannel Analysis of Surface Waves (MASW) technique. The MASW profiling was carried out on October 18, 2017, by personnel from Golder's Mississauga and Ottawa offices. A series of low frequency (4.5 Hz) geophones were laid out at 2 m intervals. A 9.9 kg sledgehammer and 34 kg drop weight were used as the seismic source. The source locations were offset at various distances beyond the end and collinear with the geophone array.

The testhole locations and elevations were surveyed by Golder using a Trimble R8 GPS unit referenced to the NAD83 CSRS CBNv6-2010.0 MTM Zone 9 geodetic datum. The testhole locations, including northing and easting coordinates, ground surface and top of existing abutment footing elevations, and drilled/cored depths are summarized in Tables 1 and 2.

Table 1: Summary of Corehole/Drillhole Locations

Corehole/ Drillhole ¹	Location	NAD83 CSRS CBNv6 2010.0 MTM Zone 9		Ground Surface Elevation (m)	Testhole Inclination ² (°)	Top of Existing Footing Elevation ³ (m)	Footing Thickness (m)	Corehole/ Drillhole Depth ⁴ (m)
		Northing (m)	Easting (m)					
17-A01/D	Sidewalk on Rochester Street at east abutment	5029594.8	366756.1	63.8	65	63.1	0.9	2.3
17-A02		5029592.0	366757.4	63.7	Vertical	63.1	-	0.6
17-A03		5029589.3	366758.6	63.7	Vertical	63.1	-	0.6
17-A04/D		5029586.5	366759.8	63.7	81	63.1	0.9	1.6
17-A05		5029583.6	366761.1	63.7	Vertical	63.1	-	0.6
17-A06		5029581.0	366762.2	63.7	Vertical	63.1	-	0.6
17-A07		5029578.6	366763.3	63.7	Vertical	63.1	-	0.6
17-A08/D		5029576.2	366764.4	63.7	Vertical	63.1	0.8	1.8
17-A09		5029573.5	366765.6	63.7	Vertical	63.0	-	0.7
17-A10		5029570.6	366766.8	63.8	Vertical	63.1	-	0.7
17-A11		5029567.8	366768.0	63.8	Vertical	63.1	-	0.7
17-A12/D		5029565.2	366769.4	63.8	Vertical	63.1	0.9	2.4
17-A13/D	Sidewalk on Rochester Street at west abutment	5029556.5	366754.1	63.9	Vertical	63.2	1.1	2.4
17-A14		5029559.2	366752.8	63.8	Vertical	63.2	-	0.6
17-A15		5029561.9	366751.7	63.8	Vertical	63.2	-	0.6
17-A16/D		5029564.6	366750.5	63.7	Vertical	63.2	1.0	2.1
17-A17		5029567.5	366749.2	63.7	Vertical	63.2	-	0.5
17-A18		5029570.2	366748.0	63.7	Vertical	63.2	-	0.5
17-A19		5029572.9	366746.8	63.7	Vertical	63.2	-	0.5
17-A20/D		5029575.7	366745.6	63.7	Vertical	63.2	1.1	2.5
17-A21		5029578.4	366744.3	63.7	Vertical	63.2	-	0.5
17-A22		5029581.2	366743.2	63.7	Vertical	63.2	-	0.5
17-A23		5029583.9	366742.0	63.7	Vertical	63.2	-	0.5
17-A24/D		5029586.5	366740.6	63.7	Vertical	63.2	1.1	2.5

Notes:¹ A = Corehole only; A/D = Combination Corehole and Drillhole² Testhole inclination is measured counter-clockwise from the vertical³ Top of footing elevation shown is measured vertically from the ground surface⁴ Depth indicated is measured along the drill path

Table 2: Summary of Borehole Location

Borehole ¹	Location	NAD83 CSRS CBNv6-2010.0 MTM Zone 9		Ground Surface Elevation (m)	Top of Existing Footing Elevation (m)	Footing Thickness (m)	Drilled Length (m)
		Northing (m)	Easting (m)				
17-111	Rochester Street West Sidewalk South of west abutment	5029553.0	366756.5	64.0	N/A	N/A	4.7
17-112	Rochester Street East Sidewalk South of east abutment	5029558.6	366771.2	64.0			4.4
17-113	Rochester Street West Sidewalk North of west abutment	5029593.8	366738.7	63.8			4.9
17-114	Rochester Street East Sidewalk North of east abutment	5029598.8	366753.0	63.8			4.8
18-1101	Highway 417 Embankment Northwest of west abutment	5029589.8	366734.2	65.2	63.7	1.2	4.6
18-1102	Highway 417 Embankment Southwest of west abutment	5029553.8	366749.9	65.4	63.1	0.9	5.1
18-1103	Highway 417 Embankment Northeast of east abutment	5029598.0	366763.5	66.3	64.5	1.5	4.9
18-1104	Highway 417 Embankment Southeast of east abutment	5029561.2	366775.7	65.3	63.9	1.1	4.8
18-1105	Highway 417 Embankment Northwest of west abutment	5029588.6	366729.2	67.3	64.1	1.0	5.8
18-1106	Highway 417 Embankment Southwest of west abutment	5029552.5	366745.0	67.1	63.6	0.9	6.2
18-1107	Highway 417 Embankment Northeast of east abutment	5029599.8	366768.6	68.9	64.6	1.0	6.9
18-1108	Highway 417 Embankment Southeast of east abutment	5029563.3	366782.6	68.7	64.6	1.6	7.2
18-1109	Highway 417 Westbound West of west abutment	5029583.4	366730.9	69.3	N/A	N/A	5.6
18-1110	Highway 417 Eastbound West of west abutment	5029566.6	366733.4	69.2			4.7
18-1111	Highway 417 Westbound East of east abutment	5029583.0	366771.4	70.3			6.4
18-1112	Highway 417 Eastbound East of east abutment	5029567.3	366779.6	70.5			7.4
18-1209	Staging Area 1 Southwest of eastbound structure South of Orangeville Street	5029514.3	366806.2	65.3	N/A	N/A	1.0
18-1210	Staging Area 1 Southwest of eastbound structure South of Orangeville Street	5029529.9	366838.3	66.0			1.0
18-1211	Staging Area 1 Southwest of eastbound structure South of Orangeville Street	5029545.2	366884.1	66.8			1.6

Borehole ¹	Location	NAD83 CSRS CBNv6-2010.0 MTM Zone 9		Ground Surface Elevation (m)	Top of Existing Footing Elevation (m)	Footing Thickness (m)	Drilled Length (m)
		Northing (m)	Easting (m)				
18-1212	Staging Area 2 Southeast of eastbound structure South of Orangeville Street	5029556.0	366916.4	67.2	N/A	N/A	1.6
18-1213	Staging Area 2 Southeast of eastbound structure South of Orangeville Street	5029572.0	366933.6	67.8			1.4

Note: ¹ All boreholes were drilled vertically with an inclination of 90°

3.2 Previous Investigation (1959)

A previous investigation was carried out for the design of the existing structures in 1959. The subsurface information and results of the original investigation are contained in the report titled:

- Report prepared by John D. Paterson Consulting Engineer and Geologist titled “*Report of Soil Investigation Site of Bridge No. 16, at Rochester Street, the Queensway, For De Leuw, Cather & Company of Canada, Limited, Consulting Engineers, Report No. S-109-59, W.P. 940-59*”, dated October 5, 1959 (Geocres No. 31G05-029).

As part of the current assignment, previously collected subsurface information pertinent to the site was reviewed and compiled.

A total of six boreholes were advanced at the site as part of the original investigation along the then proposed bridge alignment over Rochester Street. The Soil Profile and Laboratory Test Sheets from the previous investigation are provided for reference in Appendix C. The approximate borehole locations and ground surface elevations are shown on Drawings 1 and 2.

The locations of the previous boreholes should be considered approximate since the locations were referenced to an imperial borehole location plan rather than metric MTM coordinates. Further, the boreholes from the previous investigation were advanced prior to construction of the bridge and the ground surface conditions shown may not be representative of the post-construction subsurface conditions, particularly with respect to the composition and thickness of overburden and fill. It is also unknown if the surface of the bedrock as encountered in the 1959 investigation was altered during construction of the overpass structure. Therefore, the stratigraphy encountered in the 1959 boreholes was not included in the stratigraphic profiles shown on Drawings 1 and 2.

4.0 DESCRIPTION OF SUBSURFACE CONDITIONS

4.1 General

The subsurface soil, bedrock and groundwater conditions encountered in the testholes and the results of in situ testing from the current investigation are given on the Record of Borehole, Corehole, and Drillhole sheets presented in Appendix A. The results of the laboratory testing carried out during the current investigation are presented on the Record of Borehole sheets as well as on Figures B1 to B7 in Appendix B. . The borehole locations and the interpreted stratigraphic profile projected along each abutment and staging areas are provided on Drawings 1 to 5.

Photographs of the core recovered from the concrete footings and underlying bedrock are shown on Figures A1 to A40 provided in Appendix A. An assessment of the condition of the Portland Cement Concrete (PCC) footing cores is provided in Table A1 of Appendix A. The results of basic chemical analysis completed on select soil samples are provided in Appendix D.

The MASW test results and report from are presented in Appendix E and include the calculated shear wave velocity profile measured from the field testing and a graphical representation of the shear wave velocity profile with depth.

The stratigraphic boundaries shown on the testhole sheets and on the interpreted stratigraphic sections from Drawings 1 to 5, are inferred from observations of drilling progress and noncontinuous sampling and therefore, represent transitions between soil types rather than exact planes of geological change. The subsoil conditions will vary between and beyond the borehole locations.

4.2 Site Stratigraphy Overview

In general, the subsurface conditions at the testhole locations advanced along Rochester Street consist of PCC sidewalk at surface, overlying granular fill overlying PCC footings and/or limestone bedrock.

At the approach boreholes the subsurface conditions consist of asphaltic concrete/Portland cement concrete surface cover, overlying fill materials, overlying native glacial till all underlain by limestone bedrock. Due to the age of the structures, it is possible that remnants of temporary works abandoned after construction of the existing structure may be buried in the fill.

At the embankment boreholes, the subsurface conditions consist of topsoil surface cover, overlying fill materials, overlying granular fill overlying PCC footing, all underlain by limestone bedrock.

At the staging area boreholes, the subsurface conditions consist of asphaltic concrete surface cover, overlying fill materials, overlying native glacial till, all underlain by limestone bedrock.

The groundwater levels measured at the site range from 1.8 to 7.4 m in depth, corresponding to Elevations 61.2 to 63.8 m.

A more detailed description of the overburden soil deposits, concrete footings, bedrock geology and groundwater conditions encountered during the field investigation is provided in the following sections.

4.3 Highway 417 Approach Embankments

4.3.1 Surface Cover / Surficial Materials

Boreholes 18-1109 to 18-1112 were advanced through the Highway 417 pavement structure. The thickness of the asphaltic concrete at the borehole locations ranges from 130 to 300 mm.

PCC was encountered below the asphaltic concrete in Boreholes 18-1112 and 18-1109 is about 200 and 230 mm in thickness, respectively.

4.3.2 Pavement Structure and Embankment Fills

Pavement structure fill consisting predominantly of sand and gravel was encountered below the asphaltic concrete in Boreholes 18-1110 and 18-1111 and below the PCC at Boreholes 18-1109 and 18-1112. The top of this layer was encountered at elevations ranging from 68.9 to 70.1 m. The thickness of the fill ranges from 300 to 600 mm.

Fill consisting predominantly of sand with varying amounts of silt and gravel was encountered at the ground surface at embankment Boreholes 18-1101 to 18-1108 and below the pavement structure at approach Boreholes 18-1109 to 18-1112. The top of this layer was encountered at elevations ranging from 65.1 to 69.7 m. The thickness of the fill ranges from 1.2 to 6.8 m. The SPT N values ranged from 2 to 85, indicating a loose to very dense state of packing, but more typically dense to very dense. The measured moisture content of the samples tested ranged from 2 to 16 percent. The results of grain size analysis testing carried out on ten samples of the fill are provided on Figures B1 and B2 in Appendix B.

A gravelly sand to gravel and sand fill was encountered in Boreholes 18-1101, 18-1103, 18-1105 and 18-1107 and 18-1111 at elevations of 63.9 to 65.1 m. This fill contains debris including concrete, asphalt debris as well as organic matter and cobbles. The thickness of the fill at these locations ranged from 0.2 to 1.1 m. The measured moisture content of two samples tested was 8 percent. The results of grain size analysis testing carried out on a single sample of this material are provided on Figure B3 in Appendix B.

4.3.3 Glacial Till

Glacial till was encountered below the fill in Boreholes 18-1109, 18-1110 and 18-1112. The glacial till generally consists of a heterogeneous mixture of cobbles within a soil matrix of gravel and sand. The till is classified as a sandy silty clayey gravel. The top of till layer was encountered at elevations ranging from 63.3 to 65.4 m. The thickness of the till ranges from 0.2 to 1.3 m. One SPT N value of 54 was recorded in the till, indicating a very dense state of packing; the remaining recorded blow counts exceeded 100 blows per 0.3 m of penetration, indicating indicated sampler refusal. The higher blow count (i.e., greater than 100 for 300 mm) noted on the Record of Boreholes may have been influenced by the underlying bedrock surface or the presence of cobbles or boulders within the till, rather than the state of packing of the soil matrix.

The measured moisture content of a single sample of the glacial till was 9 percent. The results of grain size distribution testing carried out on a single sample of the glacial till are provided on Figure B4 in Appendix B.

4.4 Rochester Street

Boreholes 17-111 to 17-114 and the coreholes/drillholes 17-A01 to 17-A24 were advanced within the Rochester Street right-of-way along the existing abutments.

4.4.1 Surface Cover

A PCC sidewalk was encountered at the ground surface at Boreholes 17-111 to 17-114 and the coreholes/drillholes advanced along Rochester Street. The thickness of the concrete ranges from 100 to 200 mm at the testhole locations.

4.4.2 Sand, Gravelly Sand, and Sand and Gravel Fill

A fill consisting predominantly of sand with varying amounts of silt and gravel was encountered below the PCC sidewalk at all testhole locations. The top of this layer was encountered at elevations ranging from 63.6 to 63.8 m. The thickness of the layer ranges from 0.4 to 1.1 m. The SPT N values ranged from 9 to 11, indicating a loose to compact state of packing.

The moisture content of the samples tested ranged from 5 to 6 percent. The results of grain size analysis tests carried out on six samples of this material are provided on Figure 5 in Appendix B.

4.5 Staging Areas

Boreholes 18-1209 to 18-1211 were advanced within Staging Area 1 and Boreholes 18-1212 and 18-1213 were advanced within Staging Area 2. The locations of the staging areas are shown on the plan view on Drawing 5.

4.5.1 Surface Cover

Asphaltic concrete was encountered at the ground surface of all boreholes advanced within the staging areas.

The thickness of the asphaltic concrete at the borehole locations in Staging Area 1 ranges from 40 to 50 mm, while in Staging Area 2 the thickness ranges from 70 to 80 mm.

4.5.2 Fill

A fill consisting predominantly of sand and gravel with varying amounts of silt was encountered below the asphaltic concrete at all boreholes advanced in the staging areas. The top of this layer was encountered at elevations ranging from 65.2 to 67.7 m. The thickness of the layer ranges from 0.95 to 1.6 m. The measured SPT N values ranged from 31 to 36, indicating a dense state of packing.

The measured moisture content of the five samples tested ranged from 3 to 8 percent. The results of a grain size analysis test carried out on a single sample of this material are provided on Figure B6 in Appendix B.

4.6 Concrete Footings

An assessment of the condition of the PCC cores from both the abutment and retaining wall footings is provided in Table A1 of Appendix A.

4.6.1 Abutment Footings

The PCC footings for the existing abutments were encountered in coreholes/drillholes 17-A01 to 17-A24. The top of the concrete footing was encountered at elevations ranging from 63.0 to 63.2 m. The thickness of the footings ranges from 0.8 to 1.1 m, as indicated by coring through the existing footing to the underlying bedrock. Table 1 in Section 3.1 provides the top of footing elevation and footing thickness at each of the drillhole locations.

4.6.2 Retaining Wall Footings

The PCC concrete footings for the existing retaining walls were encountered in Boreholes 18-1101 to 18-1108. The top of the concrete footing was encountered at elevations ranging from 63.1 to 64.6 m. The thickness of the footings ranges from 0.9 to 1.6 m, as indicated by coring through the existing footing to the underlying bedrock. Table 2 in Section 3.1 provides the top of footing elevation and footing thickness at each of the borehole locations.

4.7 Bedrock

The overburden materials and concrete footings are underlain by limestone bedrock with shale partings and interbeds. It is slightly weathered to fresh and thinly to medium bedded. Regional bedrock mapping indicates that the bedrock at this site is primarily limestone of the Verulam Formation.

Bedrock was proven by coring in the drillholes and in Boreholes 18-1103, 18-1104, 18-1107 and 18-1108 using BQ sized equipment. A combination of NQ and HQ sized equipment was used to prove bedrock in Boreholes 17-111 to 17-114, 18-1101, 18-1102, 18-1105 and 18-1106. Photographs of the bedrock core from the current investigation are provided in Appendix A. Bedrock was also proven by coring using BX sized coring equipment in Boreholes 1 to 6 during the 1959 investigation.

Table 3 summarizes the depths and the elevations of the bedrock surface as encountered at the testhole locations from the current and previous investigations.

Table 3: Summary of Bedrock Surface Depths and Elevations

Drillhole / Borehole	Drillhole / Borehole Location	Existing Ground Surface Elevation (m)	Testhole Inclination ¹ (°)	Depth to Bedrock Surface ² (m)	Bedrock Surface Elevation ³ (m)
17-A01D	Sidewalk along Rochester Street at east abutment	63.8	65	1.6	62.3
17-A04D		63.7	81	1.5	62.2
17-A08D		63.7	Vertical	1.4	62.3
17-A12D		63.8	Vertical	1.6	62.2
17-A13D	Sidewalk along Rochester Street at west abutment	63.9	Vertical	1.8	62.1
17-A16D		63.7	Vertical	1.5	62.2
17-A20D		63.7	Vertical	1.6	62.1
17-A24D		63.7	Vertical	1.6	62.1
17-111	Rochester Street Southwest of west abutment	64.0	Vertical	1.4	62.5
17-112	Rochester Street Southeast of east abutment	64.0	Vertical	1.1	62.9
17-113	Rochester Street Northwest of west abutment	63.8	Vertical	1.2	62.7
17-114	Rochester Street Northeast of east abutment	63.8	Vertical	1.1	62.7
18-1101	Highway 417 Embankment Northwest of west abutment	65.2	Vertical	2.8	62.4
18-1102	Highway 417 Embankment Southwest of west abutment	65.4	Vertical	3.2	62.2
18-1103	Highway 417 Embankment Southeast of east abutment	66.3	Vertical	3.3	63.0
18-1104	Highway 417 Embankment Northeast of east abutment	65.3	Vertical	2.5	62.8
18-1105	Highway 417 Embankment Northwest of west abutment	67.3	Vertical	4.1	63.2
18-1106	Highway 417 Embankment Southwest of west abutment	67.1	Vertical	4.4	62.9
18-1107	Highway 417 Embankment Northeast of east abutment	68.9	Vertical	5.3	64.6
18-1108	Highway 417 Embankment Southeast of east abutment	68.7	Vertical	5.6	63.1
1	West abutment	65.1	Vertical	64.6	0.5
2	West abutment	65.1	Vertical	0.2	64.9
3	East abutment	65.4	Vertical	0.2	65.2
4	East abutment	65.3	Vertical	0.8	64.5
5	West abutment	65.2	Vertical	0.6	64.6
6	East abutment	64.9	Vertical	0.8	64.1

Notes:

¹ Testhole inclination is measured counter clockwise from the vertical

² Depth indicated is measured along the drill path

³ Top of bedrock surface elevation shown is measured vertically from the ground surface

Rock Quality Designation (RQD) values measured on recovered bedrock core samples ranged from about 0 to 89 percent. Fractured bedrock of typically very poor to poor quality, as indicated by the measured RQD values of between 0 and 49 percent, was generally encountered above approximately Elevation 61.8 m. Below this elevation, RQD values were higher and can be classified as fair to good with RQD values between 50 and 89 percent.

Results of unconfined compressive strength (UCS) testing carried out on four bedrock core samples are presented on Figure B7. The samples tested had UCS values of about 59 and 78 MPa, indicating a strong bedrock.

The results of UCS testing of six samples tested for Geocres Report No. 31G05-029 varied between 28 and 81 MPa indicating a medium strong to strong bedrock.

4.8 Groundwater Conditions

Monitoring wells were installed in Boreholes 17-111, 17-114, and 18-1112 to allow for measurement of the groundwater levels across the site.

Table 4 summarizes the depths and the elevations of the groundwater levels measured in the monitoring wells installed at the site.

Table 4 Summary of Groundwater Conditions

Borehole	Borehole Location	Screened Interval	Depth (m)	Elevation (m)	Date
17-111	West abutment	Bedrock	2.8	61.2	April 26, 2017
17-114	East abutment	Bedrock	1.8	62.0	April 26, 2017
18-1112	East abutment	Embankment fill Glacial till	7.4	63.1	December 6, 2018

Geocres Report No. 31G05-029 reported that “the ground water table is located at surface of the bedrock. There is very little, if any, water circulating within the bedrock” at the time of that investigation. It should be noted that groundwater observations were not recorded on the 1959 borehole records.

It is expected that the groundwater levels will be subject to fluctuations both seasonally and as a result of precipitation events.

4.9 Steel Corrosion and Sulphate Attack, Chemical Analysis

Three soil samples were submitted to Eurofins Environmental Testing for chemical analysis related to potential corrosion of exposed buried steel and potential sulphate attack on buried concrete elements (corrosion and sulphate attack). The test results are provided in Appendix D and are summarized in Table 5.

Table 5: Steel Corrosion and Sulphate Attack, Chemical Analysis

Borehole	Sample	Sample Depth (m)	Sample Type	Chloride (%)	Sulphate (%)	Electrical Conductivity (mS/cm)	pH	Resistivity (ohm-cm)
17-113	SS1	0.7 – 0.9	Fill	0.018	<0.01	0.38	8.5	2630
18-1106	SS5	2.4 – 3.1	Fill	0.003	0.04	0.05	9.0	20,000
18-1105	SS6	3.1 – 3.2	Fill	0.093	0.10	1.02	10.0	980

5.0 CLOSURE

This report was prepared by Mr. Kenton Power, P.Eng. It was reviewed by Mr. Bill Cavers, P.Eng., a Senior Geotechnical Engineer and Associate of Golder. Mr. Fintan Heffernan, P.Eng. a Senior Consultant with Golder and the Designated MTO Foundations Contact for this project, carried out an independent quality control review of this report.

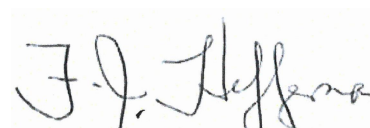
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PART B

Foundation Design
Highway 417 Overpass Structures at Rochester Street
Rapid Bridge Replacement
Site Nos. 3-56/1 and 3-56/2

6.0 FOUNDATION ENGINEERING RECOMMENDATIONS

6.1 General

This section of the report provides geotechnical input for the rapid bridge replacement (RBR) and widening of the Highway 417 eastbound (Site 3-56/1) and westbound (Site 3-56/2) overpass structures at Rochester Street, (G.W.P. 4173-15-00, W.P. 4071-13-01 & 4072-13-01). The input provided herein is based on interpretation of the factual data obtained from the testholes advanced during the current subsurface investigation as well as the available GEOCRESS information for the site and in accordance with the current Canadian Highway Bridge Design Code CAN/CSA-S6-14 (CHBDC).

The foundation investigation report, discussion, and recommendations are intended for the use of the Ministry of Transportation, Ontario (MTO) and shall not be used or relied upon for any other purpose or by any other parties, including the construction contractor. The contractor must make their own interpretation based on the factual data in Part A (Foundation Investigation) of the report. Where comments are made on construction, they are provided to highlight those aspects that could affect the design of the project. Those requiring information on aspects of construction must make their own interpretation of the factual information provided as such interpretation may affect equipment selection, proposed construction methods, scheduling and the like.

6.2 Existing Conditions

Each of the existing structures is a single-span concrete rigid frame bridge that is supported on shallow foundations founded directly on bedrock. Information provided in the RFP indicates that the structures were built in 1962. The structures have a clear span of 18.3 m measured perpendicular to the abutments and are separated from each other by a longitudinal joint. The average overall deck width of each structure, measured perpendicular to the centerline of the highway, is approximately 19.1 m. Each abutment has two retaining walls located along the north and south sides of the highway embankment for retaining the embankment fill. Noise barriers are present along the north side of Highway 417 and carried through the entire length of the structures.

At this location, Highway 417 is a divided highway with four travel lanes in each direction separated by a concrete barrier wall.

Based on the base plan mapping provided for this project and the ground surface elevations at the borehole locations surveyed during the field investigation, the top of pavement elevation of Highway 417 ranges from 69.3 to 69.2 m at the west abutment, and from 70.3 to 70.5 m at the east abutment in the westbound and eastbound directions respectively. The top of sidewalk elevations of Rochester Street ranges from about Elevation 63.8 to 64.0 m.

The existing approach embankments are about 5.5 m to 6.5 m high relative to the elevation of Rochester Street with side slopes oriented at approximately 2H:1V. Based on a visual observation at the time of the site investigation, no signs of foundation settlement were observed and the existing embankment slopes appear to be performing satisfactorily.

The original 1962 General Arrangement (GA) Drawing D-4709-2 indicates that the footings for the abutments and retaining walls were to bear directly on the bedrock, with top of footing elevation ranging from about 63.1 m at the abutments to 64.0 m and the ends of the retaining walls. The 1962 Foundation Drawing D4709-4, indicates that the founding elevation of the abutment footings was about 62.2 m and ranged between elevation 62.2 and 63.3 m for the associated retaining walls. Drawing D4709-4 also indicates that the abutments were to be supported on

1.5 m wide, 0.9 m thick spread footings and the associated retaining walls were to be supported on 3.4 to 4.1 m wide, by 0.8 to 1.0 m thick spread footings stepped into the bedrock.

6.3 Proposed Structures

Based on the April 2019 Preliminary GA Drawing provided by WSP, Highway 417 will be widened approximately 3.5 m to the north and south at this location for the addition of a new speed change lane in each direction. It is understood that the preferred replacement alternative involves the use of RBR techniques. The existing bridge structures will be demolished in place with the removal of the superstructure down to the existing footing level. The new structures will be pre-assembled in the staging area and transported using specialized heavy-lift equipment to their final locations. Consideration is also being given to incorporating the existing spread footings into the new overpass structures.

6.4 Seismic Design

6.4.1 Seismic Hazard and Importance Category

The CHBDC states that the seismic hazard values associated with the design earthquakes should be those established for the National Building Code of Canada (NBCC) by the Geological Survey of Canada (GSC). The current seismic hazard maps (referred to as the 5th generation seismic hazard maps) were developed by the GSC and were made available for public use in December 2015.

In accordance with Section 4.4.2 of the CHBDC, and as specified in the RFP by the MTO, the bridge structures have been given an importance category of “Major Route” bridge.

6.4.2 Seismic Site Classification

In addition to the borehole investigations, shear wave velocity profiling was also completed at this site. The shear wave velocity profiling was carried out in the grassy area next to the eastbound E-N/S off-ramp of the Highway 417 / Rochester Street Interchange, just west of Rochester Street, using the Multichannel Analysis of Surface Waves (MASW) technique. Profiling was carried out on October 18, 2017, by personnel from the Golder’s Mississauga and Ottawa offices.

The shear wave velocities measured at this site are presented in the technical memorandum in Appendix E and indicate that the average shear wave velocity in the upper 30 m of the subsurface soil and bedrock stratigraphy is 734 m/s.

However, drillholes advanced through the existing abutment footings into the underlying bedrock as part of the current foundation investigation confirms that the abutment footings are founded directly on the limestone bedrock at this site. Therefore, an average shear wave velocity of 1,530 m/s was calculated for 30 m of bedrock underlying the footings, corresponding to a seismic Site Class A in accordance with Table 4.1 of the CHBDC. It should be noted that, as indicated in the notes for Table 4.1 of the CHBDC, a Site Class A is only assigned for structures founded directly on bedrock.

6.4.3 Spectral Response Values and Seismic Performance Category

In accordance with Section 4.4.3.1 of the CHBDC and based on the location of the bridge (latitude 45.40 N longitude 75.71 W), the values provided in Table 6 are the reference seismic Site Class C (reference) peak seismic hazard values based on the data obtained from Earthquakes Canada (www.earthquakescanada.nrcan.gc.ca).

Table 6: Site Class C Spectral Values for Subject Site

Parameter	2% Probability of Exceedance in 50 Years (2,475-year) (g)
PGA	0.280
$T \leq 0.2$ s	0.438
$T = 0.5$ s	0.237
$T = 1.0$ s	0.118
$T = 2.0$ s	0.056
$T = 5.0$ s	0.015
$T \Rightarrow 10.0$ s	0.005

The values given above are for the reference ground condition Site Class C and must be modified to the site-specific seismic site classification given in Section 6.4.2 (Site Class A) in accordance with Section 4.4.3 of the CHBDC. As indicated in Section 4.4.3.3 of the CHBDC, the value of PGA_{ref} for use with Tables 4.2 to 4.9 shall be taken as 80 percent of the PGA for Site Class C where $Sa(0.2)/PGA$ is less than 2.0. Based on this requirement a PGA_{ref} value of 0.224 was used for the 2,475-year return period. The corresponding site-specific Site Class A seismic hazard values given in Table 7 can be used for design.

Table 7: Site Class A Spectral Values for Subject Site

Parameter	2% Probability of Exceedance in 50 Years (2,475-year) (g)
PGA	0.252
$T \leq 0.2$ s	0.302
$T = 0.5$ s	0.135
$T = 1.0$ s	0.067
$T = 2.0$ s	0.032
$T = 5.0$ s	0.009
$T \Rightarrow 10.0$ s	0.003

The fundamental period of the replacement structures has yet to be confirmed and may depend on the final design of the superstructure. In consideration of the structure's "Major Route" importance category and the site specific seismic hazard values given in Table 7, the bridges would fall in Seismic Performance Category 1, if the fundamental period of the structure is greater than or equal to 0.5 s, or Seismic Performance Category 2, if the fundamental period of the structure is less than 0.5 s, in accordance with Table 4.10 of the CHBDC.

Based on the regular geometry of the bridge (since its skew angle is less than 20°), it is understood that the structure will be designed using a "force-based approach" as defined in the CHBDC, depending on the Seismic Performance Category.

6.5 Foundation Options

6.5.1 Consequence and Site Understanding Classification

In accordance with Section 6.5 of the CHBDC and its Commentary, the existing overpass structures and foundation systems may be classified as having large traffic volumes and its performance as having potential impacts on other transportation corridors, hence having a “typical” consequence level associated with exceeding limits states design. Given the level of foundation investigation completed to date as presented in Sections 3.0 and 4.0, in comparison to the degree of site understanding in Section 6.5 of CHBDC, the level of confidence for design is considered to be a “typical degree of site and prediction model understanding” for these sites. Accordingly, the appropriate corresponding ULS and SLS consequence factor, ψ of 1.0, and geotechnical resistance factors from Tables 6.1 and 6.2 of the CHBDC have been used for design, as indicated in the following sections.

For seismic design, the consequence factor, Ψ , and resistance factor, ϕ_{gu} , should be taken as unity, as per Section 4.6.3 of the CHBDC.

6.5.2 Existing Conditions

The original 1962 GA Drawing D-4709-2 indicates that the footings for the abutments and retaining walls were to bear directly on the bedrock, with a design top of footing elevations of about 63.1 m at the abutments to 64.0 m at the ends of the retaining walls. The coreholes/drillholes advanced through the existing abutment footings into the underlying bedrock as part of the current foundation investigation confirms that the abutment footings and associated retaining wall are founded directly on the limestone bedrock.

6.5.3 Foundation Design Alternatives

Based on the results of the current investigation, shallow foundations are considered the preferred alternative from a foundations perspective for the replacement of the overpass structures and the associated retaining walls. Shallow foundations are more cost-effective than deep foundations (see Table 14 following the text of the report) for both conventional and rapid bridge replacement of the structure, whether by incorporating the existing foundations, or removing the existing foundations and constructing new footings directly on the bedrock. For the RBR option, the re-use of the existing foundations is considered a significant advantage.

Deep foundations, including steel H-piles, steel tube piles or caissons, are not considered warranted or practical at this site in comparison to shallow foundations, since the bedrock surface is located at shallow depth (i.e., less than 1.8 m) below the top of pavement elevation of Rochester Street.

The South Elevation on the April 2019 GA Drawings indicates that “200 diameter micropiles” are required to support the western end of the proposed southwest abutment retaining wall. Based on the results of the boreholes advanced along the existing abutments (i.e. Boreholes 18-1106 and 18-1102) the elevation of the bedrock surface ranges from 62.9 to 63.0 m at or about the proposed top of footing elevation. As such it is likely that spread footing foundations would be a more viable option than piles for this foundation element.

A comparison of foundation alternatives, including advantages, disadvantages, risks and relative costs is provided in Table 14 following the text of this report.

6.6 Shallow Foundations

6.6.1 Founding Level

Table 8 provides the founding elevations recommended for the design of new abutment footings founded directly on the bedrock surface. The founding elevations were selected based on the bedrock quality as well as to match the founding elevations of the existing structures.

Table 8: Design Footing Founding Elevations

Foundation Element	Footing Founding Elevations (m)
West Abutment	62.1 to 62.2
West Retaining Walls	62.2 to 63.3
East Abutment	62.2 to 62.3
East Retaining Walls	62.2 to 63.9

Subexcavation may be required to remove any weathered, loose, or fractured bedrock before construction of the abutment and retaining wall footings. For the shallow excavation depths expected (i.e., of less than about 2 m) the bedrock can likely be removed using mechanical methods such as hoe ramming.

Alternatively, the existing foundations may be left in place and new cast-in-place footings constructed or precast footings may be placed on top of the existing concrete footings. Table 9 outlines the elevation of the top surface of the existing west and east abutment footings.

Table 9: Summary of Top of Footing Elevations

Footing Location	Corehole	Elevation of Top of Footing (m)
West Abutment	17-A13 to 17-A24	63.0 to 63.1
East Abutment	17-A01 to 17-A12	63.2

6.6.2 Geotechnical Resistance

6.6.2.1 New Footings Supported on Bedrock Surface

The overpass replacement structures can be supported on cast-in-place strip or spread footings founded at or below the elevations provided in Section 6.6.1. The design should be based on a factored geotechnical resistance of 2 MPa at Ultimate Limit States (ULS). For footings founded on/in the bedrock, settlement is considered to be negligible under the anticipated loadings and therefore the SLS condition will not govern the design.

The factored geotechnical resistances provided above are given for loads that will be applied perpendicular to the surface of the footings. Where the load is not applied perpendicular to the footing, inclination of the load should be taken into account in accordance with Sections 6.10.3 and 6.10.4 of the CHBDC.

6.6.2.2 *New Footings Supported on Existing Footings*

If the existing footings are left in place and new footings (cast-in-place or precast) are constructed on top, the geotechnical resistances provided above are also applicable. Table A1 provided in Appendix A summarizes the condition of the cores taken from the existing footings at the site.

6.6.3 *Resistance to Lateral Forces/Sliding Resistance*

6.6.3.1 *Footings on Bedrock*

Resistance to lateral forces/sliding resistance between new or existing cast-in-place concrete footings and the bedrock surface should be calculated in accordance with Section 6.10.5 of the CHBDC.

An unfactored coefficient of friction, $\tan \phi' = 0.70$ can be used for the interface between the cast-in-place concrete footing and bedrock. For the assessment of sliding resistance between precast concrete footings placed on bedrock it is recommended that a coefficient of friction of 0.6 be used.

If necessary, sliding resistance can be supplemented by doweling the footings into the bedrock. The horizontal resistance of the dowels will be dependent on the strength of the bedrock, grout and steel. For this site, where the rock mass is essentially as strong as or is stronger than concrete, the design of the dowels in the rock may be handled in the same way as the dowel embedment into the concrete. The dowels should have a minimum embedded length within sound bedrock of 1 m, and the structural strength of the dowel and compressive strength of the grout should not be exceeded.

For uplift of the dowels, a factored value of 1 MPa may be assumed for the grout-to-rock bond stress for ULS design. The actual bond stress along the rock-grout interface may vary from the design value given and it should therefore be verified in the field by pull-out testing. In this case, a Special Provision will have to be included in the Contract Documents to cover this testing.

Alternatively, additional resistance to sliding can be provided by 'keying' the footing into the bedrock. The bedrock at the footing interface is considered to be poor quality and, based on the rock quality, the additional resistance provided by a shear key embedded at least 0.5 m below the surface of the rock (i.e., to about the underside of the existing footings) may be taken as 150 kN per metre of footing length. This represents an unfactored value; in accordance with the CHBDC, a resistance factor of 0.4 (based on a low degree understanding) is to be applied in calculating the horizontal passive resistance. The geotechnical resistance should be reduced if the surrounding rock is unavoidably disturbed or excavation is planned in rock adjacent to the footing. Excavation for the shear key should be carried out using mechanical excavation methods which should include closely spaced line drilling along the perimeter of the shear key prior to excavation of the key, such that a uniform vertical face will be created.

Dowelling is typically more labour intensive in comparison to the relatively limited rock excavation required for a shear key. However, dowels may be placed immediately adjacent to the existing footing without risk of disturbing the rock underlying the existing footing. If the shear key resistance provided above is not sufficient then consideration could be given to combining the shear key with dowels.

6.6.3.2 *New Footings Supported on Existing Footings*

Cast-in-place or precast footings could be constructed on top of the existing footings for a rapid bridge replacement. It is recommended that consideration be given to roughening the surface of the existing footings prior to constructing cast-in-place footings. In the case of new precast footings, it is anticipated that it would be

necessary to place a concrete levelling pad on top of the existing foundations, to ensure a level and even surface on which to place the new footings.

For the assessment of sliding resistance between precast (formed) concrete footings on screened concrete, and assuming the use of post-grouting, it is recommended that a coefficient of friction of 0.6 be used.

To supplement the sliding resistance and provide additional resistance to lateral forces, mechanical attachments such as dowels may be used to secure the new footings to the existing footings; the dowels should be designed by the structural engineer. Lightweight fill could also be used behind the abutment walls to reduce the active thrust on the walls.

6.6.4 Foundation Compliance Springs

Once the preferred foundation design alternative has been confirmed and the footing configurations and dimensions are known, foundation compliance springs for dynamic analysis for the bridge abutments can be provided.

6.6.5 Frost Protection

For spread footings placed on fresh limestone bedrock, existing footings or mass concrete, frost protection cover is not required.

6.7 Lateral Earth Pressures for Design

The lateral earth pressures acting on the abutment walls and any associated wing walls will depend on the type and method of placement of the backfill materials, the nature of the soils behind the backfill, the magnitude of surcharge including construction loadings, the freedom of lateral movement of the structure, and the drainage conditions behind the walls. Seismic (earthquake) loading must also be taken into account in the design.

The following recommendations are made concerning the design of the walls:

- Select, free draining granular fill meeting the specifications of OPSS.PROV 1010 (Aggregates) Granular A or Granular B Type II, should be used as backfill behind the walls. Alternatively, 19 mm clear crushed stone can be used as a backfill material provided a Class II nonwoven geotextile having a Filtration Opening Size (FOS) not exceeding 100 microns in accordance with OPSS 1860 is placed over the existing embankment fill and native soil, with overlaps of at least 0.5 m between rolls, prior to placement of the clear stone. If clear stone backfill is used it should only be placed once the wing walls are in place, otherwise some type of restraint (e.g., gabion baskets) would need to be provided perpendicular to the abutments (i.e., at the end of the excavation) prior to placement of the clear stone. Longitudinal drains or weep holes should be installed to provide positive drainage of the granular backfill. Compaction (including type of equipment, target densities, etc.) should be carried out in accordance with OPSS.PROV 501 (Compacting). Other aspects of the granular backfill requirements with respect to sub drains and frost taper should be in accordance with OPSD 3101.150 (Walls, Abutment, Backfill, Minimum Granular Requirement), OPSD 3121.150 (Walls, Retaining, Backfill, Minimum Granular Requirement), and 3190.100 (Walls, Retaining and Abutment, Wall Drain).
- A minimum compaction surcharge of 12 kPa should be included in the lateral earth pressures for the structural design of the walls, in accordance with CHBDC Section 6.12.3 and Figure 6.6. Care must be taken during the compaction operation not to overstress the wall. Heavy construction equipment should be maintained at a distance of at least 1 m away from the walls while the backfill soils are being placed. Hand

operated compaction equipment should be used to compact the backfill soils within a 1 m wide zone adjacent to the walls. Other surcharge loadings should be accounted for in the design, as required.

- For restrained walls, granular fill should be placed in a zone with the width equal to at least 1.8 m behind the back of the wall (Case (a) on Figure C6.20 of the Commentary to the CHBDC). For unrestrained walls, fill should be placed within the wedge-shaped zone defined by a line drawn at 1.5 horizontal to 1 vertical (1.5H:1V) extending up and back from the rear face of the footing (Case (b) on Figure C6.20 of the Commentary to the CHBDC).

6.7.1 Static Lateral Earth Pressures for Design

The following guidelines and recommendations are provided regarding the lateral earth pressures for static (i.e., not earthquake) loading conditions. These lateral earth pressures assume that the ground above the wall will be flat, not sloping. If the inclination of the slope above the wall changes then new lateral earth pressures will need to be calculated.

- For Case (a), the pressures are based on the proposed embankment fill and the following unfactored parameters in Table 10 may be used assuming the use of earth fill or Select Subgrade Material (SSM):

Table 10: Static Lateral Earth Pressure Coefficients, Earth Fill or SSM

Soil Type	Internal Angle of Friction (ϕ°)	Soil Unit Weight (γ , kN/m ³)	Coefficients of Earth Pressure		
			Active, K_a	At-Rest, K_o	Passive, K_p
Earth Fill or SSM	30	20	0.33	0.50	3.0

- For Case (b), the pressures are based on using engineered granular fill or clear stone and the following unfactored parameters in Table 11 may be used:

Table 11: Static Lateral Earth Pressure Coefficients, Earth Granular A, B Type II and Clear Stone

Soil Type	Internal Angle of Friction (ϕ°)	Soil Unit Weight (γ , kN/m ³)	Coefficients of Earth Pressure		
			Active, K_a	At-Rest, K_o	Passive, K_p
Granular A	35	22	0.27	0.43	3.7
Granular B Type II	35	21	0.27	0.43	3.7
Clear Stone	28	17	0.36	0.53	2.8

Where the wall support does not allow lateral yielding (i.e., restrained structure where the rotational or horizontal movement is not sufficient to mobilize an active earth pressure condition), at rest earth pressures (plus any compaction surcharge) should be assumed for geotechnical design.

Where the wall support and superstructure allow lateral yielding, active earth pressures may be used in the geotechnical design of the structure. The movement to allow active pressures to develop within the backfill, and thereby assume an unrestrained structure for design, should be calculated in accordance with Section C6.12.1 and Table C6.6 of the Commentary to the CHBDC.

6.7.2 Seismic Lateral Earth Pressures for Design

Seismic (earthquake) loading must be taken into account in the design in accordance with Section 4.6 of the CHBDC. In this regard, the following should be included in the assessment of lateral earth pressures.

Seismic loading will result in increased lateral earth pressures acting on the wall. The wall should be designed to withstand the combined lateral loading for the appropriate static pressure conditions given in Section 6.7.1 above, plus the earthquake-induced dynamic earth pressure.

In accordance with Sections 4.6.5 and C.4.6.5 of the 2014 CHBDC and its Commentary, for structures which do not allow lateral yielding, the horizontal seismic coefficient (k_h) used in the calculation of the seismic active pressure coefficient is taken as equal to the site adjusted PGA estimated at the ground surface (i.e. 0.25g for Site Class A for this site; see Section 6.4.3). For structures which allow lateral yielding, k_h is taken as 0.5 times the site adjusted PGA estimated at the ground surface (i.e. 0.13g for Site Class A).

The seismic active pressure coefficients (K_{AE}) provided in Table 12 for the two backfill cases (Case (a) and Case (b)) may be used in design. It should be noted that these seismic earth pressure coefficients assume that the back of the wall is vertical and the ground surface behind the wall is flat. Where sloping backfill is present above the top of the wall, the lateral earth pressures under seismic loading conditions should be calculated by treating the weight of the backfill located above the top of the wall as a surcharge.

In accordance with Section C4.6.5 of the Commentary to the CHBDC the K_{AE} value for a yielding wall is applicable provided that the wall can move up to $250k_h$ mm, where k_h is the site-specific PGA as given in Table 12. This corresponds to displacements of about 60 mm for the 2,475-year design earthquake at this site.

Table 12: Seismic Active Pressure Coefficients, K_{AE} for Various Materials

Structure Type	Design Earthquake	Site Specific PGA (g)	Granular A	Granular B Type II	Clear Stone	SSM
Yielding Wall	2,475-year	0.252	0.44	0.44	0.52	0.56
Non-Yielding Wall			0.34	0.34	0.42	0.45

The earthquake-induced dynamic pressure distribution, which is to be added to the static earth pressure distribution, is a linear distribution with maximum pressure at the top of the wall and minimum pressure at its toe (i.e. an inverted triangular pressure distribution).

The total pressure distribution (static plus seismic) may be determined as follows:

$$\sigma_h(d) = K_a \gamma d + (K_{AE} - K_a) \gamma (H-d), \text{ yielding walls}$$

$$\sigma_h(d) = K_o \gamma d + (K_{AE} - K_a) \gamma (H-d), \text{ non-yielding walls}$$

- Where:
- $\sigma_h(d)$ is the (static plus seismic) lateral earth pressure at depth, d , (kPa);
 - K_a is the static active earth pressure coefficient;
 - K_o is the static at-rest earth pressure coefficient;
 - K_{AE} is the seismic active earth pressure coefficient;
 - γ is the unit weight of the backfill soil (kN/m^3), as given previously;
 - d is the depth below the top of the wall (m); and,
 - H is the total height of the wall (m).

6.8 Embankment Design and Construction

Based on the April 2019 GA Drawing provided by WSP, Highway 417 will be widened approximately 3.5 m to the north and south at this location for the addition of a new speed change lane in each direction using conventional 2H:1V side slopes.

6.8.1 Subgrade Preparation

Any surficial topsoil, organic matter, and softened/loosened soils or fill containing deleterious material should be stripped from within the limits of the footprint of the new embankment, including from the any existing embankment side slopes. All subgrade soils should be proof rolled prior to fill placement.

Any new embankment fills for the approach embankments should be placed and compacted in accordance with OPSS.PROV 206 (Grading) and OPSS.PROV 501 (Compacting). Benching of the existing embankment side slopes should be carried out to “key in” the new fill materials in areas where the embankment is widened, in accordance with OPSD 208.010 (Benching of Earth Slopes).

To reduce erosion of the embankment side slopes due to surface water runoff, placement of topsoil and seeding or pegged sod is recommended as soon as practicable after construction of the embankments. The erosion protection should be in accordance with OPSS.PROV 804 (Seed and Cover).

6.8.2 Assessment of Global Stability

The global stability for the proposed widening constructed using conventional granular fill with 2H:1V side slopes as outlined in WPS’s April 2019 GA, was evaluated using GeoStudio 2018 Slope/W software for limit equilibrium analysis. Input parameters for the analysis provided in Table 13 are based on the in-situ SPT N values and the results of laboratory testing. It has been assumed the site preparation activities as outlined above will occur prior to construction of the embankment.

The following additional parameters were used in the analysis.

- The embankment is to be constructed with a horizontal backslope.
- A seismic horizontal loading of 0.126g, equal to ½ of the site adjusted PGA value (0.252g) was used for seismic analysis, (see Section 6.4.3).
- Groundwater level of 63.1 m (Borehole 18-1112).

Table 13: Geotechnical Design Parameters for Stability Analysis

Material	Bulk Unit Weight (kN/m ³)	Internal Angle of Friction (ϕ°)
New Earth or Granular Embankment Fill	20	33
Existing Embankment Fill	20	33
Existing Grade Fill	19	30

With appropriate subgrade preparation and proper placement of earth or granular soils, the 6 to 7 m high embankment, with a 2H:1V side slope, will have a factor of safety greater than 1.54 against deep seated slope instability and a factor of safety greater than 1.1 for seismic. The results do however indicate that some shallow

sloughing (with factors of safety less than 1.1) could occur of the embankment side slopes during seismic loading. That sloughing would not however impair the embankment in the short-term and is mainly a maintenance/repair issue. The potential for sloughing could be reduced by providing well vegetated side slopes, as mentioned above in Section 6.8.1. The results of the slope stability analysis are provided in Figures G1 and G2 in Appendix G.

6.8.3 Settlement

Based on the subsurface conditions encountered at the site (and in the absence of any compressible soil layers), only minimal settlement (i.e., less than 25 mm) is anticipated due to the compression of the existing embankment fill, which is expected to take place during the construction of the widening. The magnitude of settlement of the new embankment fill will depend on the type of fill placed and, on the method, and sequence of placement and compaction, but is expected to range from about 0.5 to 1.0 percent of the thickness of the embankment fill.

6.9 Construction Considerations

6.9.1 Open-Cut Excavations

Excavations should be carried out in accordance with the guidelines outlined in the latest edition of the Occupational Health and Safety Act (OHSA) for Construction Activities.

Excavations to depths of up to about 6 to 7 m below the existing Highway 417 grade through the existing fill are anticipated. The groundwater levels at the abutments are indicated to be at about Elevation 65.7 m within the overburden, just above the bedrock surface (i.e., at or just above the founding level of the existing foundations).

The soils at this site would be generally classified as Type 3 soils (compact to loose fill material above groundwater level) in accordance with the OHSA. Accordingly, excavations should be made with side slopes no steeper than 1H:1V. Any fill which extends below the water table would be classified as Type 4 soil and excavations in these materials should be sloped no steeper than 3H:1V. As indicated in OHSA, if an excavation contains more than one type of soil, the soil type for the excavation shall be classified as the type with the highest number among the soil types present within the excavation.

6.9.2 Temporary Protection Systems

If the required safe side slopes for the open cut excavations cannot be accommodated, then temporary roadway protection (i.e., excavation shoring) will be required to facilitate excavation to the foundation level for the RBR. Temporary excavation support may also be required along Rochester Street for construction of the abutment footings due to space restrictions and existing utilities.

The design of the shoring will be entirely the responsibility of the contractor. Where required, temporary protection systems should be designed and constructed in accordance with OPSS.PROV 539 (Temporary Protection Systems), and the lateral movement should meet Performance Level 2 provided that any existing adjacent utilities can tolerate this magnitude of deformation. Traffic loading should be included as a surcharge. Traffic loading above the shoring and does not account for construction equipment loadings which may be higher; the contractor's shoring designer should confirm those load requirements.

6.9.3 Groundwater and Surface Water Control

The groundwater level at the site is typically near or below the bedrock surface. Excavations to expose the bedrock surface for founding of spread footings will likely involve minimal groundwater and surface water control. It should be possible to handle ground and surface water inflows by pumping from well filtered sumps established in the floor of the excavations.

6.10 Corrosion and Cement Type

Three soil samples were submitted to Eurofins Environment Testing for chemical analysis related to potential corrosion of exposed buried steel and potential sulphate attack on buried concrete elements (corrosion and sulphate attack). The test results are provided in Appendix D.

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 sulphate results in Table 5 were compared with Table 3 of Canadian Standards Association Standards A23.1-14 (CSA A23.1) and generally indicate a low degree of sulphate attack potential on concrete structures at this site. It should be noted that one sample did indicate a moderate degree of sulphate attack potential. Accordingly, the structural designer should consider the results provided in Table 5 to determine the cement type to be specified for concrete in below grade applications.

The pH, resistivity and chloride concentration provide an indication of the degree of corrosiveness of the sub-surface environment. Generally, the test results provided in Table 5 indicate a very high potential for corrosion of exposed ferrous metal at the site which should be considered in the design.

7.0 CLOSURE

This report was prepared by Mr. Kenton Power, P.Eng. It was reviewed by Mr. Bill Cavers, P.Eng., a Senior Geotechnical Engineer and Associate of Golder. Mr. Fintan Heffernan, P.Eng. a Senior Consultant with Golder and the Designated MTO Foundations Contact for this project, carried out an independent quality control review of this report.

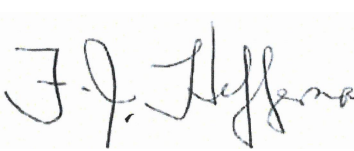
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Kenton Power, P.Eng., MASc
Geotechnical Engineer



William Cavers, P.Eng
Associate, Senior Geotechnical Engineer



Fintan J. Heffernan, P.Eng.
Designated MTO Foundations Contact

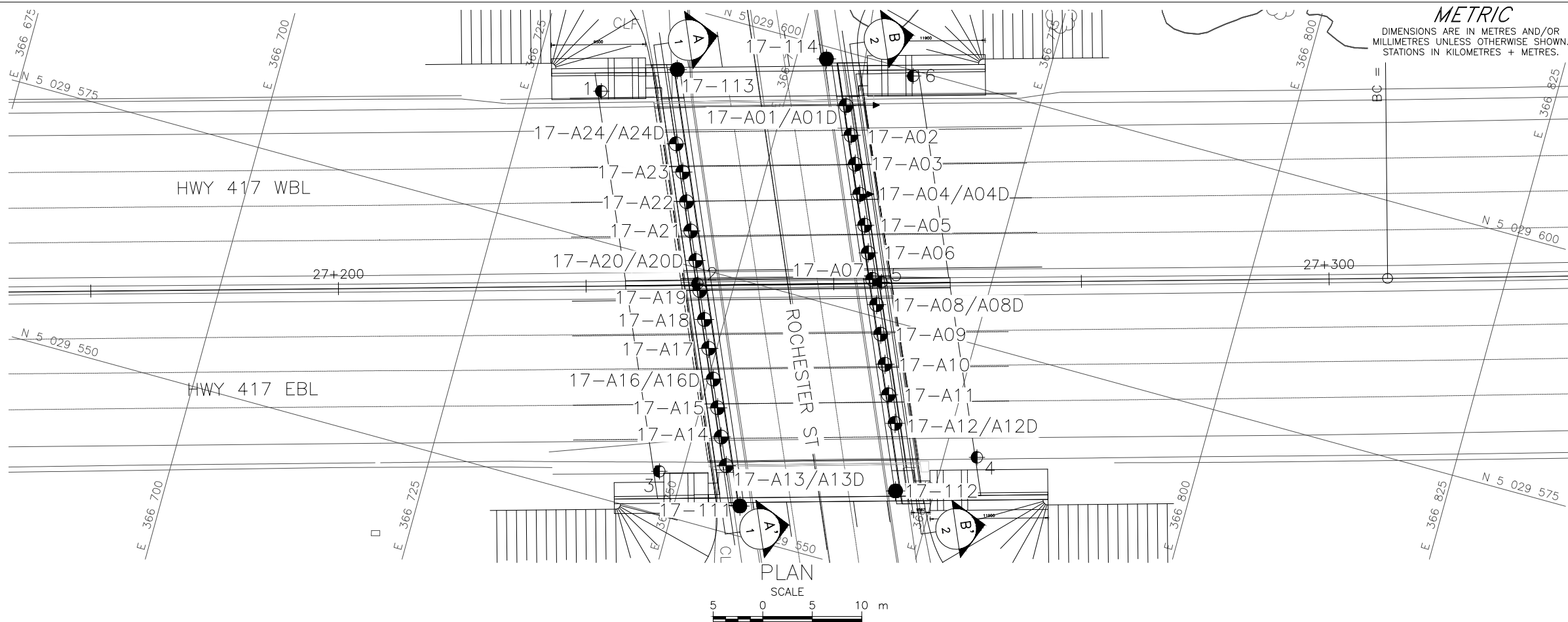
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Table 14 – Comparison of Foundation Alternatives

Foundation Option	Feasibility	Advantages	Disadvantages	Relative Costs	Constructability/Risks
New cast-in-place or precast spread footings supported on existing spread footings	- Feasible for support of the bridge replacement and rapid bridge replacement (RBR) technique - Preferred option from a foundation perspective	- Avoids demolition and removal of existing foundations allowing reduced excavation support - Compatible with rapid bridge replacement (RBR) techniques - Facilitates shorter construction time compared to casting new footings	- Structural design must counteract sliding of new footings on existing foundations - A levelling layer of grout will likely be required between the new and existing footings if precast footings are used	- Low cost - Less expensive than deep foundations	- Low risk of settlement; existing overpass structures have performed satisfactorily - Low to moderate risk of variation in elevation of top surface of existing footings and can be addressed through the use of a concrete levelling layer on top of footing
New cast-in-place or precast spread footings supported on bedrock	Feasible for support of the of the bridge replacement and rapid bridge replacement (RBR) technique	- Conventional excavation and construction - Also compatible with RBR techniques.	- Would require demolition and removal of existing footings, unless new footings are located behind existing with a longer bridge span length (which would increase structure costs) and would increase construction time - Deeper temporary protection required - Results in increased time for construction compared to incorporating existing foundations due to excavation, demolition/ removal, forming, reinforcing and casting stages	- Moderate cost - Less expensive than deep foundations	Low risk of settlement; existing overpass structures have performed satisfactorily
Deep foundations	Feasible but not required or practical	- High bearing resistance - Negligible settlement	Shallow bedrock depth would result lengths of less than 2 m which would likely require socketing into the strong limestone bedrock for a stable pile/caisson configuration	High cost, compared to other viable alternatives	Rock socketing would be required

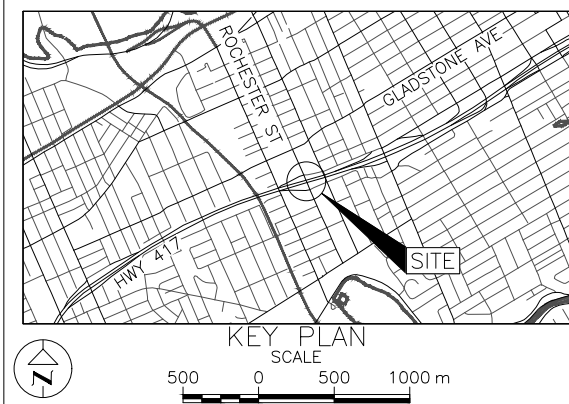


METRIC
DIMENSIONS ARE IN METRES AND/OR
MILLIMETRES UNLESS OTHERWISE SHOWN.
STATIONS IN KILOMETRES + METRES.

CONT No.
GWP No. 4173-15-00

HIGHWAY 417 OVERPASS
STRUCTURES AT ROCHESTER STREET
BOREHOLE LOCATIONS AND SOIL STRATA
LAT. 45.403381 LONG. -75.708617

SHEET



LEGEND

Borehole - Current Investigation

Corehole - Current Investigation

Borehole - Previous Investigation
(Geocres No. 31G05-029)

Inclined Borehole Orientation

Seal

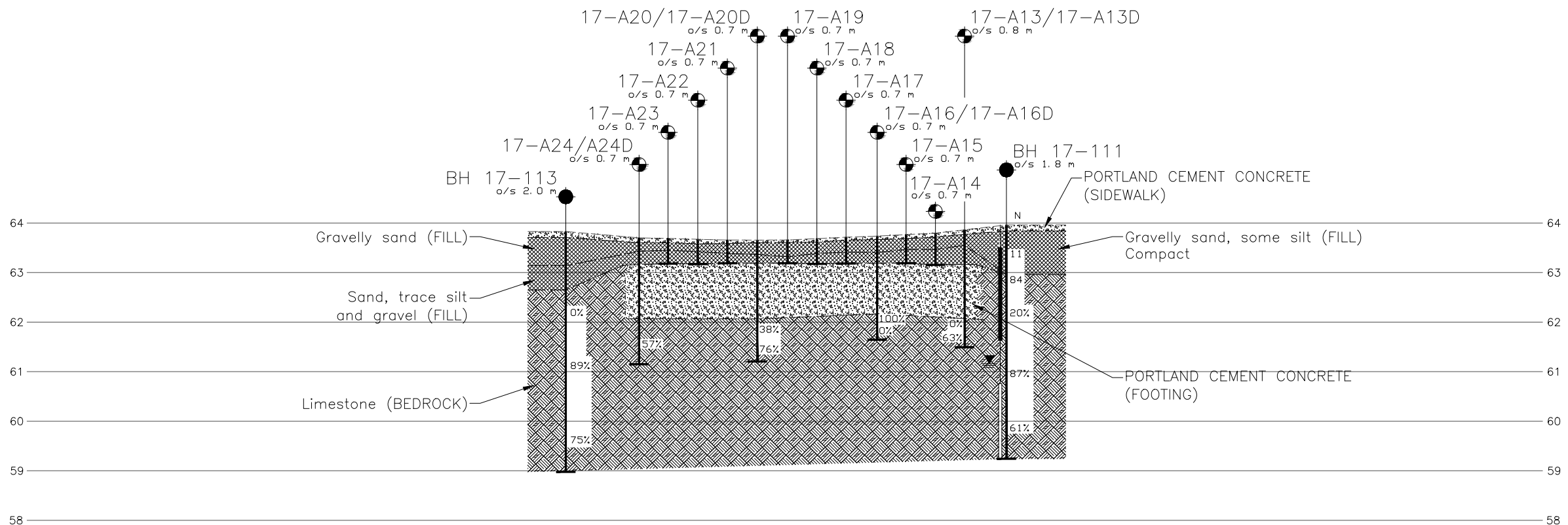
Piezometer

Standard Penetration Test Value

Blows/0.3m unless otherwise stated
(Std. Pen. Test, 475 j/blow)

100% Rock Quality Designation (RQD)

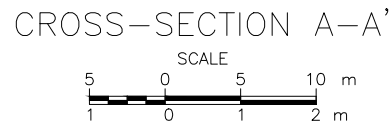
WL in piezometer, measured on APRIL 26, 2017



NOTES

This drawing is for subsurface information only. The proposed structure details/works are shown for illustration purposes only and may not be consistent with the final design configuration as shown elsewhere in the Contracts Documents.

The boundaries between soil strata have been established only at borehole locations. Between boreholes the boundaries are assumed from geological evidence.



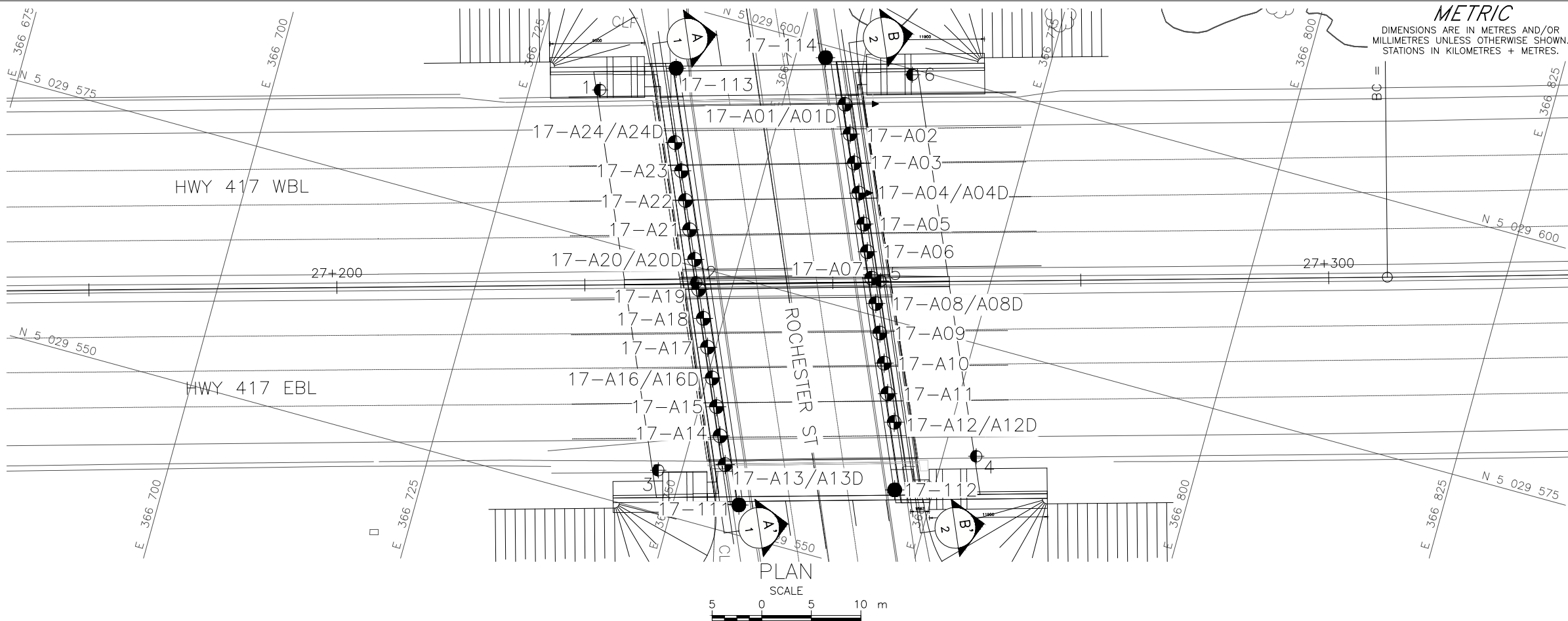
REFERENCE

Base plans provided in digital format by WSP Canada Group Limited, drawing file no. S3416024-308-001GA.dwg, received MAY 7, 2019.



BOREHOLE CO-ORDINATES NAD 83 (CSRS)/MTM ZONE 9			
No.	ELEVATION	NORTHING	EASTING
17-111	64.0	5029553.0	366756.5
17-112	64.0	5029558.6	366771.2
17-113	63.8	5029593.8	366738.7
17-114	63.8	5029598.8	366753.0
17-A01/A01D	63.8	5029594.8	366756.1
17-A02	63.7	5029592.0	366757.4
17-A03	63.7	5029589.3	366758.6
17-A04/A04D	63.7	5029586.5	366759.8
17-A05	63.7	5029583.6	366761.1
17-A06	63.7	5029581.0	366762.2
17-A07	63.7	5029578.6	366763.3
17-A08/A08D	63.7	5029576.2	366764.4
17-A09	63.7	5029573.5	366765.6
17-A10	63.8	5029570.6	366766.8
17-A11	63.8	5029567.8	366768.0
17-A12/A12D	63.8	5029565.2	366769.4
17-A13/A13D	63.9	5029556.5	366754.1
17-A14	63.8	5029559.2	366752.8
17-A15	63.8	5029561.9	366751.7
17-A16/A16D	63.7	5029564.6	366750.5
17-A17	63.7	5029567.5	366749.2
17-A18	63.7	5029570.2	366748.0
17-A19	63.7	5029572.9	366746.8
17-A20/A20D	63.7	5029575.7	366745.6
17-A21	63.7	5029578.4	366744.3
17-A22	63.7	5029581.2	366743.2
17-A23	63.7	5029583.9	366742.0
17-A24/A24D	63.7	5029586.5	366740.6
1	65.1	5029589.6	366731.9
2	65.1	5029573.4	366746.4
3	65.4	5029554.2	366747.7
4	65.3	5029564.0	366778.2
5	65.2	5029578.5	366764.2
6	64.9	5029599.4	367528.9

NO.	DATE	BY	REVISION
1	01/08/2019	JM	1
Geocres No. 31G-295			
HWY. 417		PROJECT NO. 1655214-1110	
SUBM'D. KP		DATE: 01/08/2019	
DRAWN: JM		SITE: 3-56.1 & 3-56.2	
CHKD. FJH		APPD. FJH	
		DWG. 1	



METRIC
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STATIONS IN KILOMETRES + METRES.

CONT No.
GWP No. 4173-15-00



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STRUCTURES AT ROCHESTER STREET
BOREHOLE LOCATIONS AND SOIL STRATA
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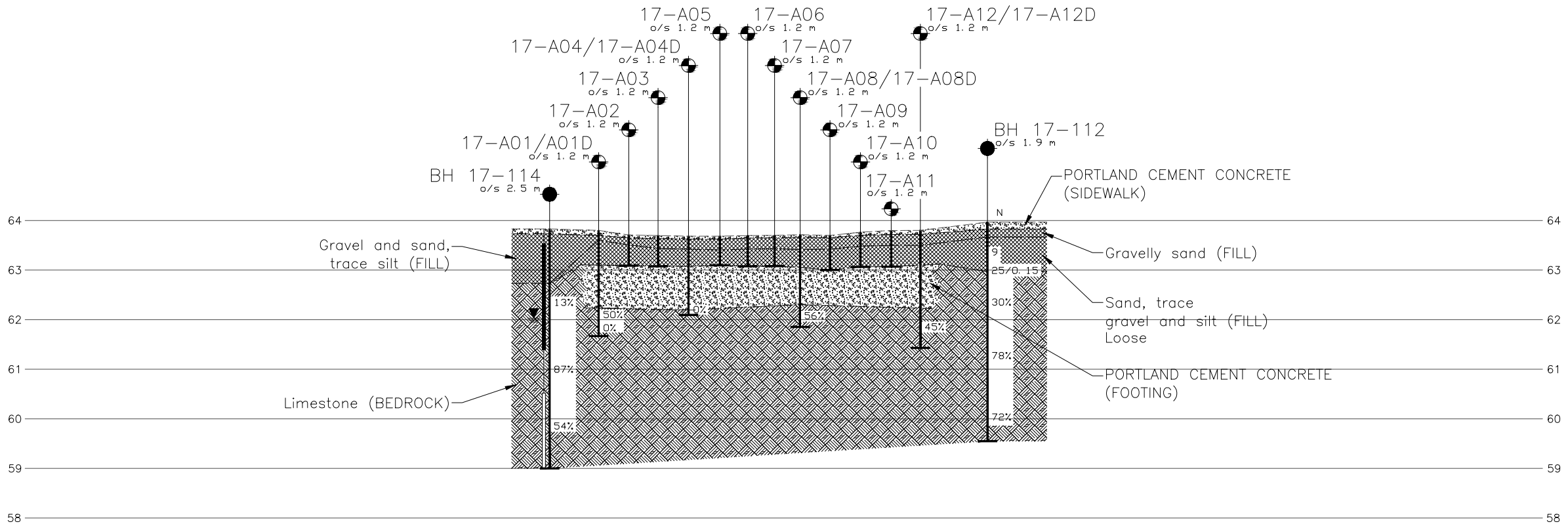


LEGEND

- Borehole - Current Investigation
- ◐ Corehole - Current Investigation
- ◑ Borehole - Previous Investigation (Geocres No. 31G05-029)
- Inclined Borehole Orientation
- ⊥ Seal
- ⊥ Piezometer
- N Standard Penetration Test Value
- 16 Blows/0.3m unless otherwise stated (Std. Pen. Test, 475 j/blow)
- 100% Rock Quality Designation (RQD)
- ≡ WL in piezometer, measured on APRIL 26, 2017

BOREHOLE CO-ORDINATES NAD 83 (CSRS)/MTM ZONE 9

No.	ELEVATION	NORTHING	EASTING
17-111	64.0	5029553.0	366756.5
17-112	64.0	5029558.6	366771.2
17-113	63.8	5029593.8	366738.7
17-114	63.8	5029598.8	366753.0
17-A01/A01D	63.8	5029594.8	366756.1
17-A02	63.7	5029592.0	366757.4
17-A03	63.7	5029589.3	366758.6
17-A04/A04D	63.7	5029586.5	366759.8
17-A05	63.7	5029583.6	366761.1
17-A06	63.7	5029581.0	366762.2
17-A07	63.7	5029578.6	366763.3
17-A08/A08D	63.7	5029576.2	366764.4
17-A09	63.7	5029573.5	366765.6
17-A10	63.8	5029570.6	366766.8
17-A11	63.8	5029567.8	366768.0
17-A12/A12D	63.8	5029565.2	366769.4
17-A13/A13D	63.9	5029556.5	366754.1
17-A14	63.8	5029559.2	366752.8
17-A15	63.8	5029561.9	366751.7
17-A16/A16D	63.7	5029564.6	366750.5
17-A17	63.7	5029567.5	366749.2
17-A18	63.7	5029570.2	366748.0
17-A19	63.7	5029572.9	366746.8
17-A20/A20D	63.7	5029575.7	366745.6
17-A21	63.7	5029578.4	366744.3
17-A22	63.7	5029581.2	366743.2
17-A23	63.7	5029583.9	366742.0
17-A24/A24D	63.7	5029586.5	366740.6
1	65.1	5029589.6	366731.9
2	65.1	5029573.4	366746.4
3	65.4	5029554.2	366747.7
4	65.3	5029564.0	366778.2
5	65.2	5029578.5	366764.2
6	64.9	5029599.4	367528.9

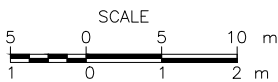


NOTES

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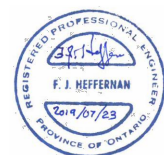
The boundaries between soil strata have been established only at borehole locations. Between boreholes the boundaries are assumed from geological evidence.

CROSS-SECTION B-B'



REFERENCE

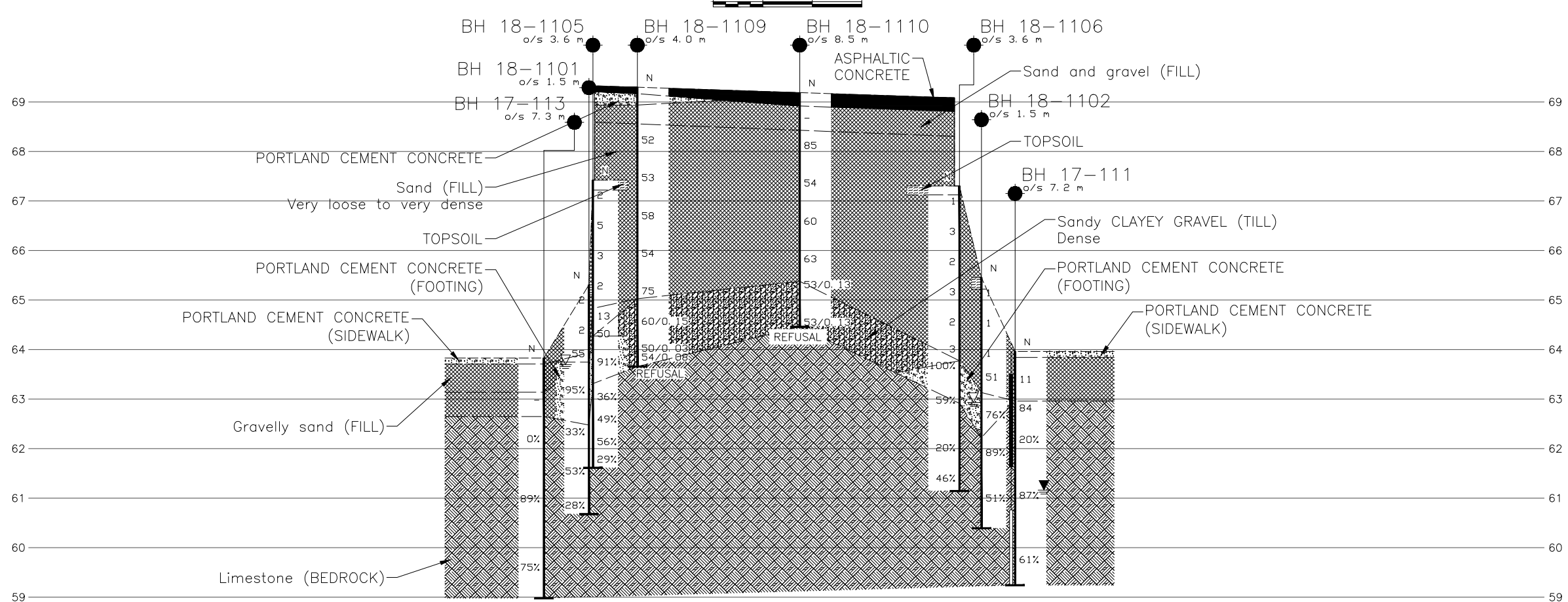
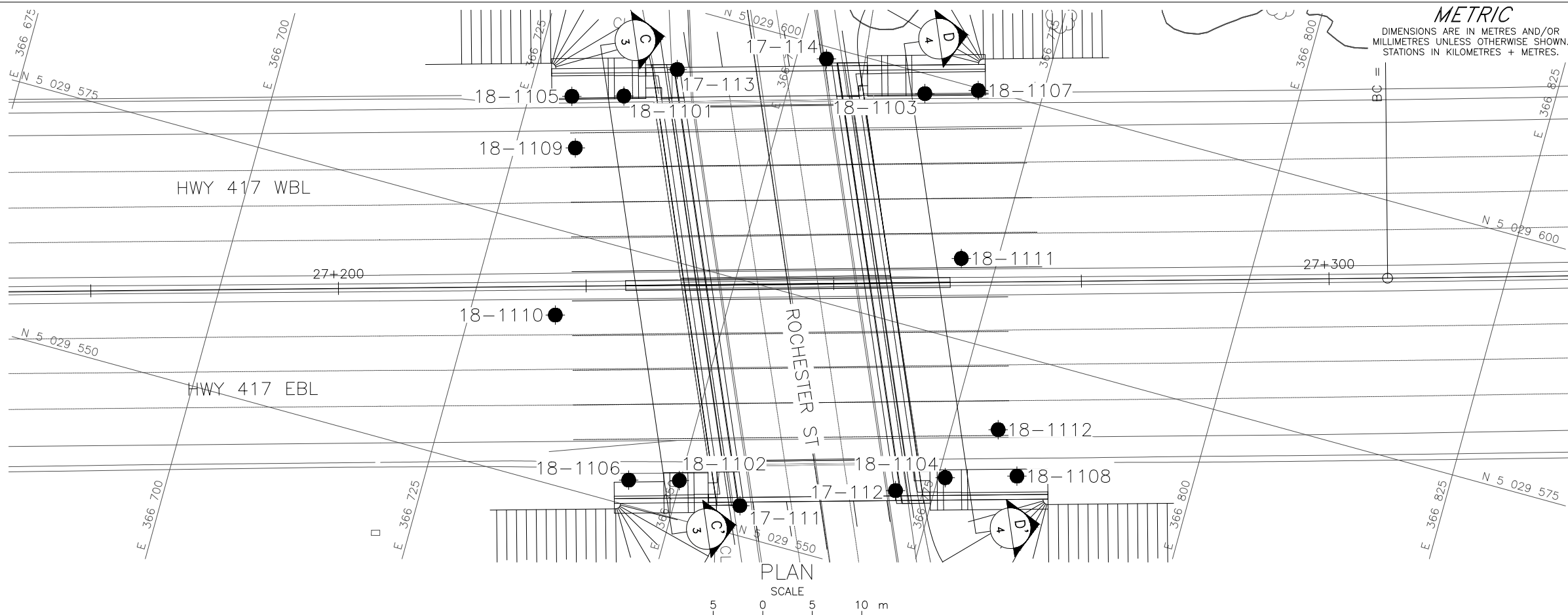
Base plans provided in digital format by WSP Canada Group Limited, drawing file no. S3416024-308-001GA.dwg, received MAY 7, 2019.



NO.	DATE	BY	REVISION
1	01/08/2019	JM	1
2	01/08/2019	FJH	2

Geocres No. 31G-295

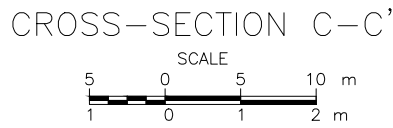
HWY. 417	PROJECT NO. 1655214-1110	DIST. EASTERN
SUBM'D. KP	CHKD. KP	DATE: 01/08/2019
DRAWN: JM	CHKD. FJH	APPD. FJH
		DWG. 2



NOTES

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REFERENCE

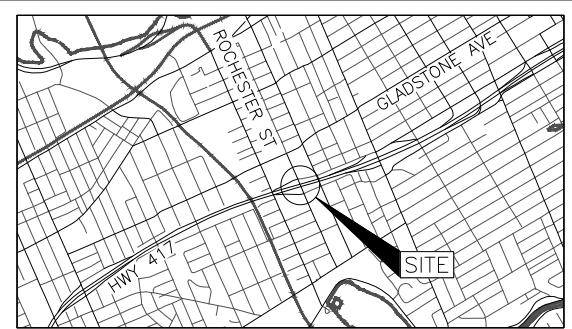
Base plans provided in digital format by WSP Canada Group Limited, drawing file no. S3416024-308-001GA.dwg, received MAY 7, 2019.



CONT No.
GWP No. 4173-15-00

HIGHWAY 417 OVERPASS
STRUCTURES AT ROCHESTER STREET
BOREHOLE LOCATIONS AND SOIL STRATA
LAT. 45.403381 LONG. -75.708617

SHEET

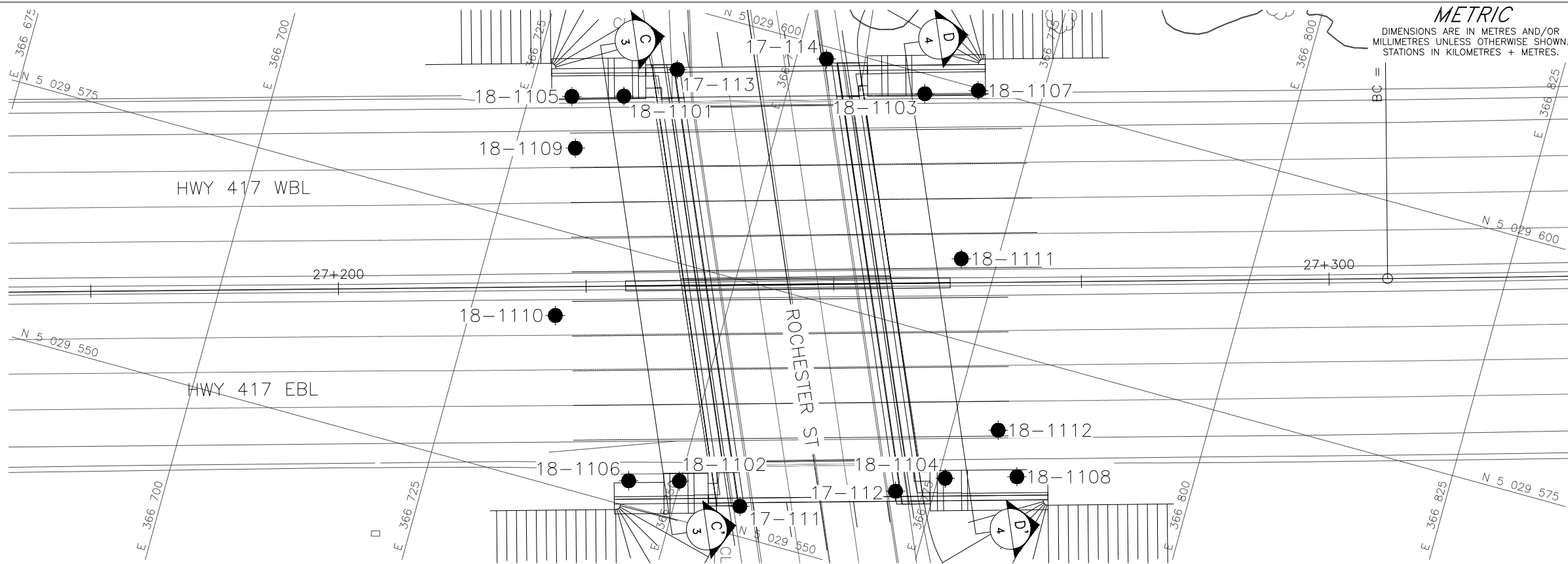


LEGEND

- Borehole - Current Investigation
- ⊥ Seal
- ⊥ Piezometer
- N Standard Penetration Test Value
- 16 Blows/0.3m unless otherwise stated (Std. Pen. Test, 475 j/blow)
- 100% Rock Quality Designation (RQD)
- ≡ WL in piezometer, measured on APRIL 26, 2017
- ≡ WL upon completion of drilling

BOREHOLE CO-ORDINATES NAD 83 (CSRS)/MTM ZONE 9			
No.	ELEVATION	NORTHING	EASTING
17-111	64.0	5029553.0	366756.5
17-112	64.0	5029558.6	366771.2
17-113	63.8	5029593.8	366738.7
17-114	63.8	5029598.8	366753.0
18-1101	65.2	5029589.8	366734.2
18-1102	65.4	5029553.8	366749.9
18-1103	66.3	5029598.0	366763.5
18-1104	65.3	5029561.2	366775.7
18-1105	67.3	5029588.3	366729.2
18-1106	67.1	5029552.5	366745.0
18-1107	68.9	5029599.8	366768.6
18-1108	68.7	5029563.3	366782.6
18-1109	69.3	5029583.4	366730.9
18-1110	69.2	5029566.6	366733.4
18-1111	70.3	5029583.0	366771.4
18-1112	70.5	5029567.3	366779.6

NO.	DATE	BY	REVISION
1	01/08/2019	JM	1
Geocres No. 31G-295			
HWY. 417		PROJECT NO. 1655214-1110	
SUBM'D. KP		DATE: 01/08/2019	
DRAWN: JM		SITE: 3-56.1 & 3-56.2	
CHKD: FJH		APPD: FJH	
DWG. 3		DIST. EASTERN	



METRIC
DIMENSIONS ARE IN METRES AND/OR
MILLIMETRES UNLESS OTHERWISE SHOWN.
STATIONS IN KILOMETRES + METRES.

CONT No.
GWP No. 4173-15-00

HIGHWAY 417 OVERPASS
STRUCTURES AT ROCHESTER STREET
BOREHOLE LOCATIONS AND SOIL STRATA
LAT. 45.403381 LONG. -75.708617

SHEET



KEY PLAN
SCALE
500 0 500 1000 m

LEGEND

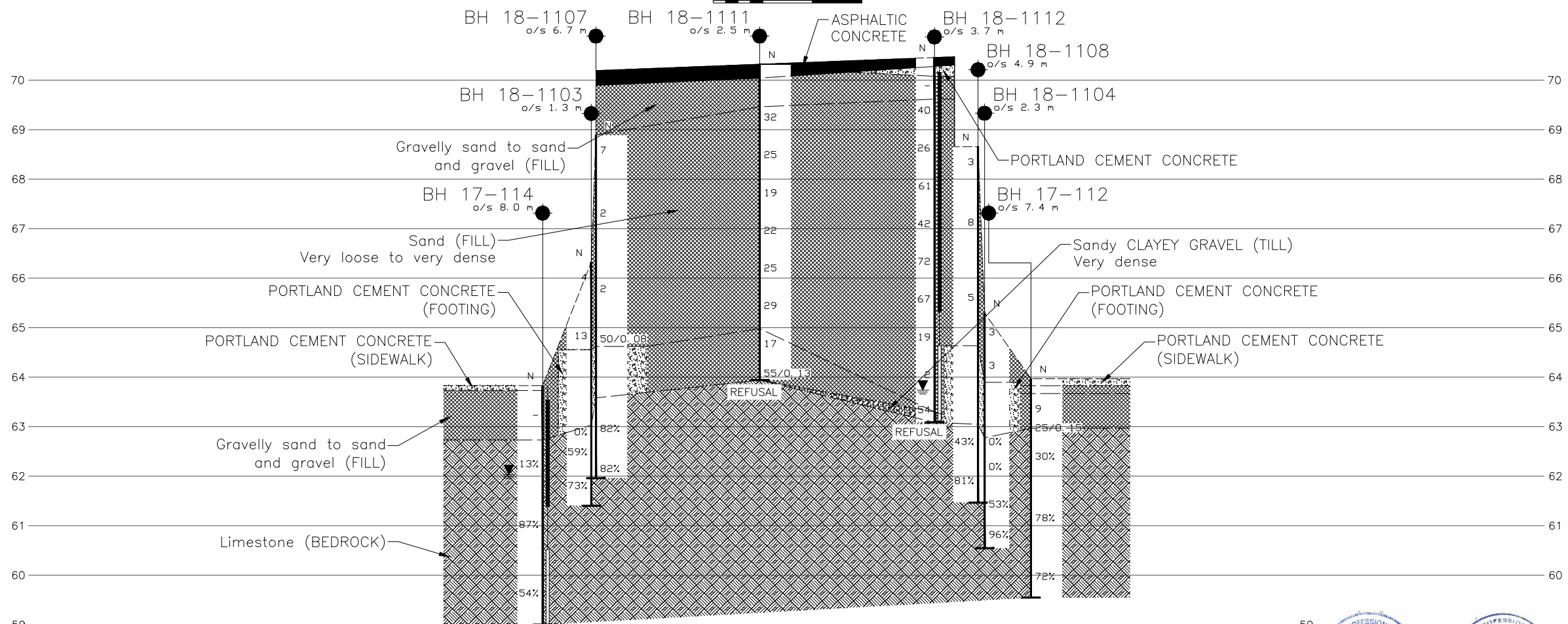
- Borehole - Current Investigation
- ⊢ Seal
- ⊢ Piezometer
- N Standard Penetration Test Value
- 16 Blows/0.3m unless otherwise stated
(Std. Pen. Test, 475 j/blow)
- 100% Rock Quality Designation (RQD)
- ⊢ WL in piezometer, measured on APRIL 26, 2017 and
DEC. 6, 2018
- ⊢ WL upon completion of drilling

BOREHOLE CO-ORDINATES NAD 83 (CSRS)/MTM ZONE 9			
No.	ELEVATION	NORTHING	EASTING
17-111	64.0	5029553.0	366756.5
17-112	64.0	5029558.6	366771.2
17-113	63.8	5029593.8	366738.7
17-114	63.8	5029598.8	366753.0
18-1101	65.2	5029589.8	366734.2
18-1102	65.4	5029553.8	366749.9
18-1103	66.3	5029598.0	366763.5
18-1104	65.3	5029561.2	366775.7
18-1105	67.3	5029588.3	366729.2
18-1106	67.1	5029552.5	366745.0
18-1107	68.9	5029599.8	366768.6
18-1108	68.7	5029563.3	366782.6
18-1109	69.3	5029583.4	366730.9
18-1110	69.2	5029566.6	366733.4
18-1111	70.3	5029583.0	366771.4
18-1112	70.5	5029567.3	366779.6

NOTES

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CROSS-SECTION D-D'

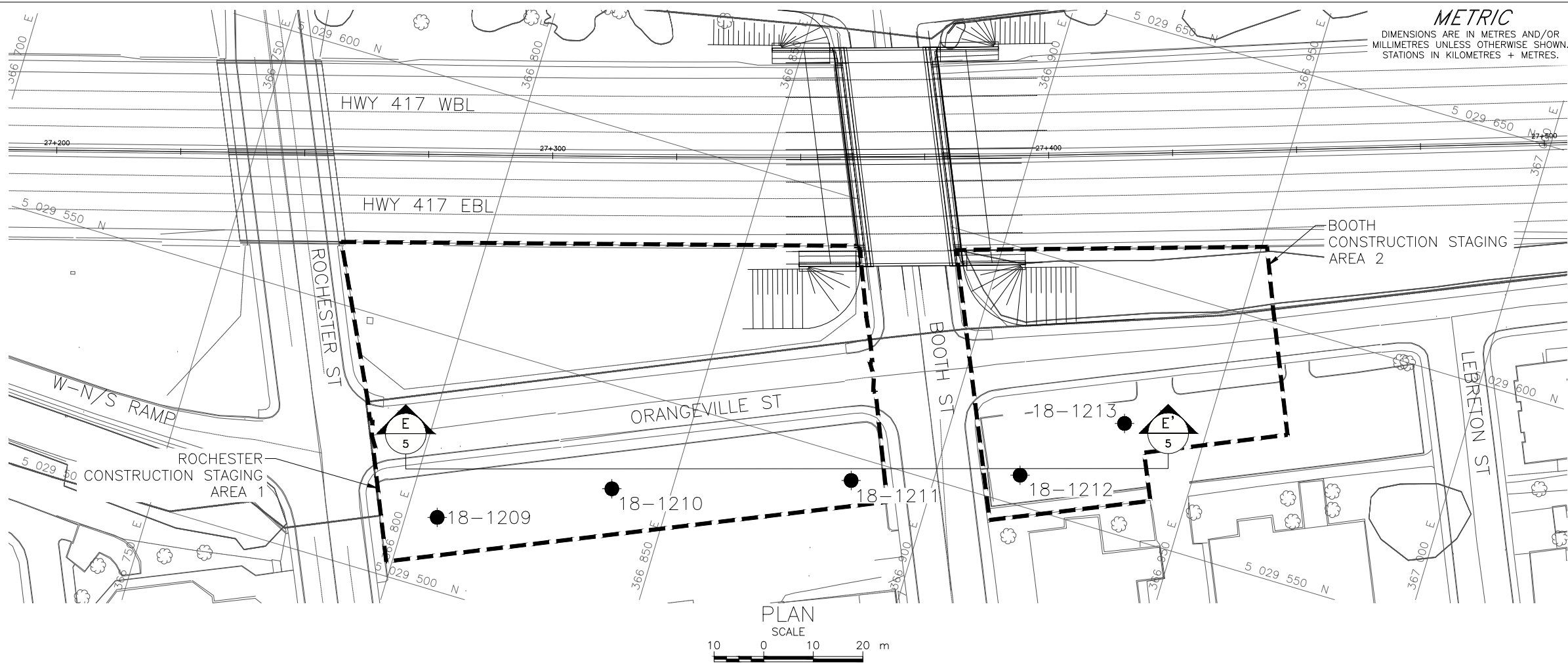
SCALE
5 0 5 10 m
1 0 1 2 m

REFERENCE

Base plans provided in digital format by WSP Canada Group Limited,
drawing file no. S3416024-308-001GA.dwg, received MAY 7, 2019.



Geocres No. 31G-295			
HWY. 417	PROJECT NO. 1655214-1110		DIST. EASTERN
SUBM'D. KP	CHKD. KP	DATE: 01/08/2019	SITE: 3-56.1 & 3-56.2
DRAWN: JM	CHKD. FJH	APPD. FJH	DWG. 4



CONT No.
GWP No. 4173-15-00



HIGHWAY 417 OVERPASS
STRUCTURES AT ROCHESTER STREET

STAGING AREA
BOREHOLE LOCATIONS AND SOIL STRATA
LAT. 45.403170 LONG. -75.706753

SHEET



KEY PLAN
SCALE

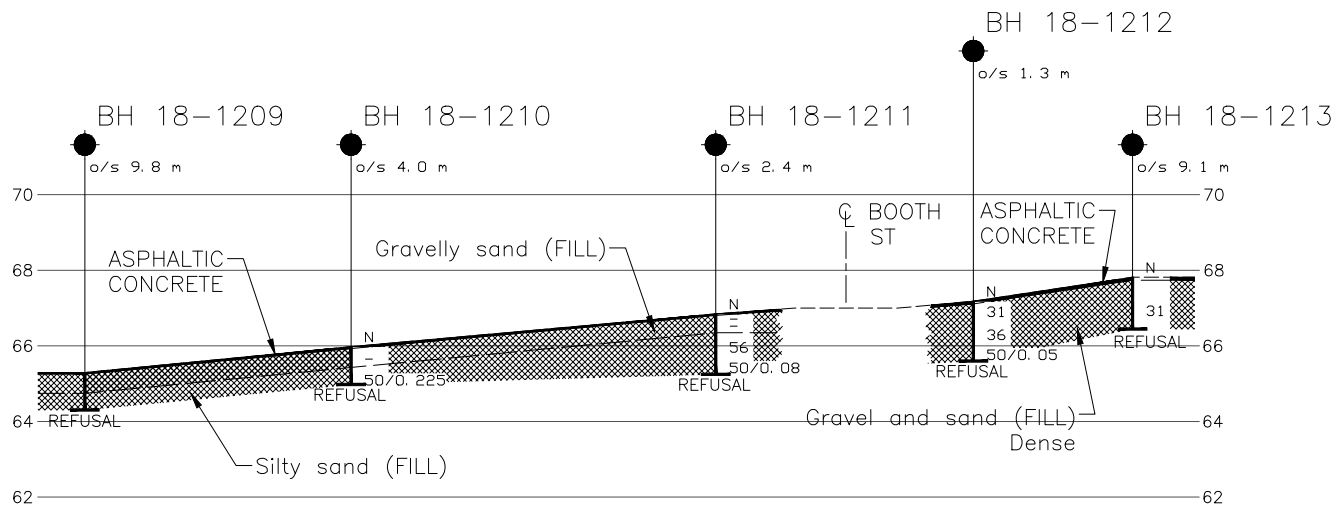
10 0 10 20 m

LEGEND

- Borehole - Current Investigation
- N Standard Penetration Test Value
- 16 Blows/0.3m unless otherwise stated (Std. Pen. Test, 475 j/blow)

BOREHOLE CO-ORDINATES NAD 83 (CSRS)/MTM ZONE 9

No.	ELEVATION	NORTHING	EASTING
18-1209	65.3	5029514.3	366806.2
18-1210	66.0	5029529.9	366838.3
18-1211	66.8	5029545.2	366884.1
18-1212	67.2	5029556.0	366916.4
18-1213	67.8	5029572.0	366933.6



CROSS-SECTION E-E'

SCALE

10 0 10 20 m
2 0 2 4 m

REFERENCE

Base plans provided in digital format by WSP Canada Limited, drawing file no. 3416024-XSTAGING AREA.dwg, received MARCH 22, 2019.

NOTES

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NO.	DATE	BY	REVISION
1	01/08/2019	JM	1
Geocres No. 31G-295			
HWY. 417	PROJECT NO. 1655214-1110		DIST. EASTERN
SUBM'D. KP	CHKD. KP	DATE: 01/08/2019	SITE: 3-56.1 & 3-56.2
DRAWN: JM	CHKD. FJH	APPD. FJH	DWG. 5



APPENDIX A

Record of Boreholes, Current Investigation

Lists of Abbreviations and Symbols

Lithological and Geotechnical Rock Description Terminology

Record of Coreholes/Drillholes 17-A01 to 17-A24

Record of Boreholes 17-111 to 17-114

Record of Boreholes 18-1101 to 18-1112

Record of Boreholes 18-1209 to 18-1213

Bedrock Core Photographs, Figures A1 to A40

Table A1 - Concrete Core Condition Assessment

LIST OF SYMBOLS

Unless otherwise stated, the symbols employed in the report are as follows:

I. GENERAL

π	3.1416
$\ln x$,	natural logarithm of x
$\log_{10}$	x or log x, logarithm of x to base 10
g	acceleration due to gravity
t	time
FoS	factor of safety

II. STRESS AND STRAIN

γ	shear strain
Δ	change in, e.g. in stress: $\Delta \sigma$
ε	linear strain
ε_v	volumetric strain
η	coefficient of viscosity
ν	Poisson's ratio
σ	total stress
σ'	effective stress ($\sigma' = \sigma - u$)
σ'_{vo}	initial effective overburden stress
$\sigma_1, \sigma_2, \sigma_3$	principal stress (major, minor)
σ_{oct}	mean stress or octahedral stress $= (\sigma_1 + \sigma_2 + \sigma_3)/3$
τ	shear stress
u	porewater pressure
E	modulus of deformation
G	shear modulus of deformation
K	bulk modulus of compressibility

III. SOIL PROPERTIES

(a)	Index Properties
$\rho(\gamma)$	bulk density (bulk unit weight)*
$\rho_d(\gamma_d)$	dry density (dry unit weight)
$\rho_w(\gamma_w)$	density (unit weight) of water
$\rho_s(\gamma_s)$	density (unit weight) of solid particles
γ'	unit weight of submerged soil ($\gamma' = \gamma - \gamma_w$)
D_R	relative density (specific gravity) of solid particles ($D_R = \rho_s / \rho_w$) (formerly G_s)
e	void ratio
n	porosity
S	degree of saturation

(a) Index Properties (continued)

w	water content
w_l or LL	liquid limit
w_p or PL	plastic limit
I_p or PI	plasticity index = $(w_l - w_p)$
w_s	shrinkage limit
I_L	liquidity index = $(w - w_p) / I_p$
I_c	consistency index = $(w_l - w) / I_p$
e_{max}	void ratio in loosest state
e_{min}	void ratio in densest state
I_D	density index = $(e_{max} - e) / (e_{max} - e_{min})$ (formerly relative density)

(b) Hydraulic Properties

h	hydraulic head or potential
q	rate of flow
v	velocity of flow
i	hydraulic gradient
k	hydraulic conductivity (coefficient of permeability)
j	seepage force per unit volume

(c) Consolidation (one-dimensional)

C	compression index (normally consolidated range)
C_r	recompression index (over-consolidated range)
C_s	swelling index
C_{α}	secondary compression index
m_v	coefficient of volume change
C_v	coefficient of consolidation (vertical direction)
C_h	coefficient of consolidation (horizontal direction)
T_v	time factor (vertical direction)
U	degree of consolidation
σ'_p	pre-consolidation stress
OCR	over-consolidation ratio = σ'_p / σ'_{vo}

(d) Shear Strength

τ_p, τ_r	peak and residual shear strength
ϕ'	effective angle of internal friction
δ	angle of interface friction
μ	coefficient of friction = $\tan \delta$
c'	effective cohesion
c_u, s_u	undrained shear strength ($\phi = 0$ analysis)
p	mean total stress $(\sigma_1 + \sigma_3)/2$
p'	mean effective stress $(\sigma'_1 + \sigma'_3)/2$
q	$(\sigma_1 - \sigma_3)/2$ or $(\sigma'_1 - \sigma'_3)/2$
q_u	compressive strength $(\sigma_1 - \sigma_3)$
S_t	sensitivity

* Density symbol is ρ . Unit weight symbol is γ where $\gamma = \rho g$ (i.e. mass density multiplied by acceleration due to gravity)

Notes: 1
2

$\tau = c' + \sigma' \tan \phi'$
shear strength = (compressive strength)/2

LIST OF ABBREVIATIONS

The abbreviations commonly employed on Records of Boreholes, on figures and in the text of the report are as follows:

I. SAMPLE TYPE

AS	Auger sample
BS	Block sample
CS	Chunk sample
DS	Denison type sample
FS	Foil sample
RC	Rock core
SC	Soil core
SS	Split-spoon
ST	Slotted tube
TO	Thin-walled, open
TP	Thin-walled, piston
WS	Wash sample

II. PENETRATION RESISTANCE

Standard Penetration Resistance (SPT), N:

The number of blows by a 63.5 kg. (140 lb.) hammer dropped 760 mm (30 in.) required to drive a 50 mm (2 in.) drive open sampler for a distance of 300 mm (12 in.)

Dynamic Cone Penetration Resistance; N_d :

The number of blows by a 63.5 kg (140 lb.) hammer dropped 760 mm (30 in.) to drive uncased a 50 mm (2 in.) diameter, 60° cone attached to "A" size drill rods for a distance of 300 mm (12 in.).

PH: Sampler advanced by hydraulic pressure

PM: Sampler advanced by manual pressure

WH: Sampler advanced by static weight of hammer

WR: Sampler advanced by weight of sampler and rod

Piezo-Cone Penetration Test (CPT)

A electronic cone penetrometer with a 60° conical tip and a project end area of 10 cm² pushed through ground at a penetration rate of 2 cm/s. Measurements of tip resistance (Q_t), porewater pressure (PWP) and friction along a sleeve are recorded electronically at 25 mm penetration intervals.

III. SOIL DESCRIPTION

(a) Non-Cohesive (Cohesionless) Soils

Condition	N Blows/300 mm or Blows/ft
Very loose	0 to 4
Loose	4 to 10
Compact	10 to 30
Dense	30 to 50
Very dense	over 50

(b) Cohesive Soils

Consistency	kPa	psf
Very soft	0 to 12	0 to 250
Soft	12 to 25	250 to 500
Firm	25 to 50	500 to 1,000
Stiff	100 to 200	1,000 to 2,000
Very stiff	over 200	over 4,000

IV. SOIL TESTS

w	water content
w _p	plastic limit
w _l	liquid limit
C	consolidation (oedometer) test
CHEM	chemical analysis (refer to text)
CID	consolidated isotropically drained triaxial test ¹
CIU	consolidated isotropically undrained triaxial test with porewater pressure measurement ¹
D _R	relative density (specific gravity, G_s)
DS	direct shear test
M	sieve analysis for particle size
MH	combined sieve and hydrometer (H) analysis
MPC	Modified Proctor compaction test
SPC	Standard Proctor compaction test
OC	organic content test
SO ₄	concentration of water-soluble sulphates
UC	unconfined compression test
UU	unconsolidated undrained triaxial test
V	field vane (LV-laboratory vane test)
γ	unit weight

Note: 1 Tests which are anisotropically consolidated prior to shear are shown as CAD, CAU.

V. MINOR SOIL CONSTITUENTS

Per cent by Weight	Modifier	Example
0 to 10	Trace	Trace sand
10 to 20	Some	Some sand
20 to 35	(ey) or (y)	Sandy
over 35	And	Sand and Gravel

LITHOLOGICAL AND GEOTECHNICAL ROCK DESCRIPTION TERMINOLOGY

WEATHERINGS STATE

Fresh: no visible sign of weathering

Faintly weathered: weathering limited to the surface of major discontinuities.

Slightly weathered: penetrative weathering developed on open discontinuity surfaces but only slight weathering of rock material.

Moderately weathered: weathering extends throughout the rock mass but the rock material is not friable.

Highly weathered: weathering extends throughout rock mass and the rock material is partly friable.

Completely weathered: rock is wholly decomposed and in a friable condition but the rock and structure are preserved.

BEDDING THICKNESS

<u>Description</u>	<u>Bedding Plane Spacing</u>
Very thickly bedded	Greater than 2 m
Thickly bedded	0.6 m to 2 m
Medium bedded	0.2 m to 0.6 m
Thinly bedded	60 mm to 0.2 m
Very thinly bedded	20 mm to 60 mm
Laminated	6 mm to 20 mm
Thinly laminated	Less than 6 mm

JOINT OR FOLIATION SPACING

<u>Description</u>	<u>Spacing</u>
Very wide	Greater than 3 m
Wide	1 m to 3 m
Moderately close	0.3 m to 1 m
Close	50 mm to 300 mm
Very close	Less than 50 mm

GRAIN SIZE

<u>Term</u>	<u>Size*</u>
Very Coarse Grained	Greater than 60 mm
Coarse Grained	2 mm to 60 mm
Medium Grained	60 microns to 2 mm
Fine Grained	2 microns to 60 microns
Very Fine Grained	Less than 2 microns

Note: * Grains greater than 60 microns diameter are visible to the naked eye.

CORE CONDITION

Total Core Recovery (TCR)

The percentage of solid drill core recovered regardless of quality or length, measured relative to the length of the total core run.

Solid Core Recovery (SCR)

The percentage of solid drill core, regardless of length, recovered at full diameter, measured relative to the length of the total core run.

Rock Quality Designation (RQD)

The percentage of solid drill core, greater than 100 mm length, as measured along the centerline axis of the core, relative to the length of the total core run. RQD varies from 0% for completely broken core to 100% for core in solid segments.

DISCONTINUITY DATA

Fracture Index

A count of the number of discontinuities (physical separations) in the rock core, including both naturally occurring fractures and mechanically induced breaks caused by drilling.

Dip with Respect to Core Axis

The angle of the discontinuity relative to the axis (length) of the core. In a vertical borehole a discontinuity with a 90° angle is horizontal.

Description and Notes

An abbreviation description of the discontinuities, whether naturally occurring separations such as fractures, bedding planes and foliation planes or mechanically induced features caused by drilling such as ground or shattered core and mechanically separated bedding or foliation surfaces. Additional information concerning the nature of fracture surfaces and infillings are also noted.

Abbreviations

JN Joint	PL Planar
FLT Fault	CU Curved
SH Shear	UN Undulating
VN Vein	IR Irregular
FR Fracture	K Slickensided
SY Stylolite	PO Polished
BD Bedding	SM Smooth
FO Foliation	SR Slightly Rough
CO Contact	RO Rough
AXJ Axial Joint	VR Very Rough
KV Karstic Void	
MB Mechanical Break	

PROJECT 1655214-1110		RECORD OF BOREHOLE No 17-111				SHEET 1 OF 2		METRIC			
G.W.P. 4173-15-00		LOCATION N 5029553.0; E 366756.5 NAD 83 MTM ZONE 9 (LAT. 45.403182; LONG. -75.708571)				ORIGINATED BY DWM					
DIST Eastern HWY 417		BOREHOLE TYPE Power Auger, 200 mm Diam. (Hollow Stem)/NQ Core				COMPILED BY ZS					
DATUM Geodetic		DATE April 5, 2017				CHECKED BY KCP					
SOIL PROFILE			SAMPLES			DYNAMIC CONE PENETRATION RESISTANCE PLOT		PLASTIC LIMIT NATURAL MOISTURE CONTENT LIQUID LIMIT		UNIT WEIGHT γ kN/m ³	REMARKS & GRAIN SIZE DISTRIBUTION (%)
ELEV DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE	"N" VALUES	GROUND WATER CONDITIONS	ELEVATION SCALE	20 40 60 80 100	W _p W W _L		
64.0	GROUND SURFACE										
0.0	PORTLAND CEMENT CONCRETE (SIDEWALK)										
63.9											
0.1	(SP) Gravelly sand (FILL) Grey										
63.7											
0.3	(SP) Gravelly sand, trace silt (FILL) Compact Brown Dry		1	SS	11						
63.0											
1.0	Highly weathered (BEDROCK)		2	SS	84						
62.6											
1.4	Limestone (BEDROCK) Bedrock cored from depths 1.4 m to 4.7 m For bedrock coring details refer to Record of Drillhole 17-111		C1	RC	REC 86%						
			C2	RC	REC 100%						
			C3	RC	REC 100%						
59.3											
4.7											

Continued Next Page

+ 3, X 3: Numbers refer to Sensitivity ○ 3% STRAIN AT FAILURE

GTA-MTO 001 \GOLDER.GDS\GALOTTAWA\ACTIVE\SPATIAL_IMMITO\HWY417\REHAB&WIDENING\02_DATA\GINT\1655214.GPJ GAL-GTA.GDT 19-8-1 JM

PROJECT		1655214-1110				RECORD OF BOREHOLE No 17-111				SHEET 2 OF 2				METRIC					
G.W.P.		4173-15-00		LOCATION		N 5029553.0; E 366756.5 NAD 83 MTM ZONE 9 (LAT. 45.403182; LONG. -75.708571)				ORIGINATED BY				DWM					
DIST		Eastern		HWY		417		BOREHOLE TYPE		Power Auger, 200 mm Diam. (Hollow Stem)/NQ Core				COMPILED BY		ZS			
DATUM		Geodetic		DATE		April 5, 2017				CHECKED BY		KCP							
SOIL PROFILE		SAMPLES				GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT					PLASTIC LIMIT NATURAL MOISTURE CONTENT LIQUID LIMIT			UNIT WEIGHT γ	REMARKS & GRAIN SIZE DISTRIBUTION (%)		
ELEV. DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE	"N" VALUES			20	40	60	80	100	W _p	W	W _L				
	--- CONTINUED FROM PREVIOUS PAGE --- END OF BOREHOLE NOTES: 1. Water level in well screen at a depth of 2.8 m below ground surface (Elev. 61.2 m), measured on April 26, 2017.																		

GTA-MTO 001 \GOLDER.GDS\GALOTTAWA\ACTIVE\SPATIAL_IMMITO\HWY417\REHAB&WIDENING\02_DATA\GINT1655214.GPJ GAL-GTA.GDT 19-8-1 JM

SHEET 2 OF 2

DATUM: Geodetic

DRILLING CONTRACTOR: CCC

[illegible]

CHECKED: KCP

PROJECT		1655214-1110		RECORD OF BOREHOLE No 17-112		SHEET 1 OF 2		METRIC									
G.W.P.		4173-15-00		LOCATION		N 5029558.6; E 366771.2 NAD 83 MTM ZONE 9 (LAT. 45.403231; LONG. -75.708382)		ORIGINATED BY									
DIST		Eastern HWY 417		BOREHOLE TYPE		Power Auger, 200 mm Diam. (Hollow Stem)/NQ Core		COMPILED BY									
DATUM		Geodetic		DATE		April 5, 2017		CHECKED BY									
KCP																	
SOIL PROFILE		SAMPLES			GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT					PLASTIC LIMIT W _p	NATURAL MOISTURE CONTENT W	LIQUID LIMIT W _L	UNIT WEIGHT γ	REMARKS & GRAIN SIZE DISTRIBUTION (%)	
ELEV DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE			"N" VALUES	SHEAR STRENGTH kPa									WATER CONTENT (%)
64.0	GROUND SURFACE																
0.0	PORTLAND CEMENT CONCRETE (SIDEWALK)																
63.9	(SP) Gravelly sand (FILL) Grey																
0.1																	
63.7																	
0.3	(SP) Sand, trace silt and gravel (FILL) Loose Brown Moist		1	SS	9												
63.0																	
	Highly weathered (BEDROCK)		2	SS	25/0.15												
1.1	Limestone (BEDROCK)																
	Bedrock cored from depths 1.1 m to 4.4 m																
	For bedrock coring details refer to Record of Drillhole 17-112																
			C1	RC	REC 76%												RQD = 30%
			C2	RC	REC 98%												RQD = 78%
			C3	RC	REC 100%												RQD = 72%
59.6	END OF BOREHOLE																
4.4																	

GTA-MTO 001 \GOLDER.GDS\GALOTTAWA\ACTIVE\SPATIAL_IMMITO\HWY417\REHAB&WIDENING\02_DATA\GINT\1655214.GPJ GAL-GTA.GDT 19-8-1 JM

PROJECT: 1655214-1110

RECORD OF DRILLHOLE: 17-112

SHEET 2 OF 2

LOCATION: N 5029558.6 ;E 366771.2

DRILLING DATE: April 5, 2017

DATUM: Geodetic

INCLINATION: -90° AZIMUTH: ---

DRILL RIG: CME 45

DRILLING CONTRACTOR: CCC

DEPTH SCALE METRES	DRILLING RECORD	DESCRIPTION	SYMBOLIC LOG	ELEV. DEPTH (m)	RUN No.	NOTE: For abbreviations, symbols and descriptions refer to LITHOLOGICAL AND GEOTECHNICAL ROCK DESCRIPTION TERMINOLOGY												FEATURES																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																											
						RECOVERY		R.Q.D. %	FRACT. INDEX PER	DIP w.r.t CORE AXIS °	DISCONTINUITY DATA		HYDRAULIC CONDUCTIVITY K, cm/sec	WEATH- ERING INDEX																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																															
						TOTAL CORE %	SOLID CORE %				TYPE AND SURFACE DESCRIPTION	Jr		Ja	W1	W2	W3		W4	W5	W6																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																								
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DEPTH SCALE

1 : 25



LOGGED: DWM

CHECKED: KCP

GTA-RCK 031 \\GOLDER\GDS\GAL\OTTA\ACTIVE\SPATIAL _IMMTOHWY417\REHAB&WIDENING\02_DATA\GINT\1655214.GPJ_GAL-MISS.GDT_19-8-1_JM

PROJECT		1655214-1110		RECORD OF BOREHOLE No 17-113		SHEET 1 OF 2		METRIC								
G.W.P.		4173-15-00		LOCATION		N 5029593.8; E 366738.7 NAD 83 MTM ZONE 9 (LAT. 45.403550; LONG. -75.708792)		ORIGINATED BY								
DIST		Eastern HWY 417		BOREHOLE TYPE		Hydro-excavation/NQ Core		COMPILED BY								
DATUM		Geodetic		DATE		April 6/7, 2017		CHECKED BY								
								KCP								
SOIL PROFILE			SAMPLES			GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT				PLASTIC LIMIT W _p	NATURAL MOISTURE CONTENT W	LIQUID LIMIT W _L	UNIT WEIGHT γ	REMARKS & GRAIN SIZE DISTRIBUTION (%)
ELEV DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE	"N" VALUES			SHEAR STRENGTH kPa								
63.8	GROUND SURFACE															
0.0	PORTLAND CEMENT CONCRETE (SIDEWALK)															
63.7	(SP) Gravelly sand (FILL) Grey															
0.1																
63.1	(SP) Sand, trace silt (FILL) Brown Moist		1	GRAB	-											
0.7																
62.6	Limestone (BEDROCK)															
1.2	Bedrock cored from depths 1.2 m to 4.9 m For bedrock coring details refer to Record of Drillhole 17-113		C1	RC	REC 66%											RQD = 0%
			C2	RC	REC 100%											RQD = 89%
			C3	RC	REC 100%											RQD = 75%
59.0	END OF BOREHOLE															
4.9																

GTA-MTO 001 \GOLDER.GDS\GALOTTAWA\ACTIVE\SPATIAL_IMMITO\HWY417\REHAB&WIDENING\02_DATA\GINT1655214.GPJ GAL-GTA.GDT 19-8-1 JM

PROJECT: 1655214-1110

RECORD OF DRILLHOLE: 17-113

SHEET 2 OF 2

LOCATION: N 5029593.8 ;E 366738.7

DRILLING DATE: April 6/7, 2017

DATUM: Geodetic

INCLINATION: -90° AZIMUTH: ---

DRILL RIG: CME 45

DRILLING CONTRACTOR: CCC

DEPTH SCALE METRES	DRILLING RECORD	DESCRIPTION	SYMBOLIC LOG	NOTE: For abbreviations, symbols and descriptions refer to LITHOLOGICAL AND GEOTECHNICAL ROCK DESCRIPTION TERMINOLOGY																FEATURES																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																						
				ELEV. DEPTH (m)	RUN No.	FLUSH RETURN	RECOVERY		R.Q.D. %	FRACT. INDEX PER	DIP w.r.t CORE AXIS °	DISCONTINUITY DATA		HYDRAULIC CONDUCTIVITY K, cm/sec		WEATH- ERING INDEX																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																										
							TOTAL CORE %	SOLID CORE %				TYPE AND SURFACE DESCRIPTION	Jr	Ja	10 ⁻⁶	10 ⁻⁵	10 ⁻⁴	10 ⁻³	W1		W2	W3	W4	W5	W6																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																	
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DEPTH SCALE

1 : 25



LOGGED: DWM

CHECKED: KCP

GTA-RCK 031 \\GOLDER\GDS\GAL\OTTA\ACTIVE\SPATIAL _IMMTO\HWY417\REHAB&WIDENING\02_DATA\GINT\1655214.GPJ_GAL-MISS.GDT_19-8-1_JM

PROJECT		1655214-1110		RECORD OF BOREHOLE No 17-114		SHEET 1 OF 2		METRIC														
G.W.P.		4173-15-00		LOCATION		N 5029598.8; E 366753.0 NAD 83 MTM ZONE 9 (LAT. 45.403594; LONG. -75.708610)		ORIGINATED BY														
DIST		Eastern HWY 417		BOREHOLE TYPE		Hydro-excavation/NQ Core		COMPILED BY														
DATUM		Geodetic		DATE		April 6/7, 2017		CHECKED BY														
								KCP														
SOIL PROFILE			SAMPLES			DYNAMIC CONE PENETRATION RESISTANCE PLOT			PLASTIC LIMIT NATURAL MOISTURE CONTENT LIQUID LIMIT			UNIT WEIGHT			REMARKS & GRAIN SIZE DISTRIBUTION (%)							
ELEV	DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE	"N" VALUES	GROUND WATER CONDITIONS	ELEVATION SCALE	SHEAR STRENGTH kPa					WATER CONTENT (%)			γ			GR SA SI CL		
63.8	0.0	GROUND SURFACE							20 40 60 80 100 ○ UNCONFINED + FIELD VANE ● QUICK TRIAXIAL × REMOULDED					W _p — W — W _L 25 50 75			kN/m ³					
63.7	0.1	PORTLAND CEMENT CONCRETE (SIDEWALK)																				
		(GP/SP) Gravel and sand, trace silt (FILL) Grey Moist		1	GRAB	-														53 42 4 1		
62.7	1.1	Limestone (BEDROCK)																				
		Bedrock cored from depths 1.1 m to 4.8 m For bedrock coring details refer to Record of Drillhole 17-114		C1	RC	REC 56%														UCS = 60 MPa RQD = 13%		
				C2	RC	REC 100%														RQD = 87%		
				C3	RC	REC 91%														RQD = 54%		
59.0	4.8																					

Continued Next Page

+ 3, × 3: Numbers refer to Sensitivity ○ 3% STRAIN AT FAILURE

GTA-MTO 001 \GOLDER.GDS\GALOTTAWA\ACTIVE\SPATIAL_IMMITO\HWY417\REHAB&WIDENING\02_DATA\GINT1655214.GPJ GAL-GTA.GDT 19-8-1 JM

PROJECT		1655214-1110				RECORD OF BOREHOLE No 17-114				SHEET 2 OF 2				METRIC					
G.W.P.		4173-15-00		LOCATION		N 5029598.8; E 366753.0 NAD 83 MTM ZONE 9 (LAT. 45.403594; LONG. -75.708610)				ORIGINATED BY				DWM					
DIST		Eastern		HWY		417		BOREHOLE TYPE		Hydro-excavation/NQ Core				COMPILED BY		ZS			
DATUM		Geodetic		DATE		April 6/7, 2017				CHECKED BY		KCP							
SOIL PROFILE		SAMPLES				GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT					PLASTIC LIMIT NATURAL MOISTURE CONTENT LIQUID LIMIT			UNIT WEIGHT	REMARKS & GRAIN SIZE DISTRIBUTION (%)		
ELEV DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE	"N" VALUES			20	40	60	80	100	W _p	W	W _L			γ	
	--- CONTINUED FROM PREVIOUS PAGE --- END OF BOREHOLE NOTES: 1. Water level in well screen at a depth of 1.8 m below ground surface (Elev. 62.0 m), measured on April 26, 2017.																		

GTA-MTO 001 \GOLDER\GDS\GALOTTAWA\ACTIVE\SPATIAL_IMMITO\HWY417\REHAB&WIDENING\02_DATA\GINT\1655214.GPJ GAL-GTA.GDT 19-8-1 JM

PROJECT		1655214-1110		RECORD OF BOREHOLE No 17-A01		SHEET 1 OF 1		METRIC						
G.W.P.		4173-15-00		LOCATION		N 5029594.8; E 366756.1 NAD 83 MTM ZONE 9 (LAT. 45.403558; LONG. -75.708570)		ORIGINATED BY PAH						
DIST		Eastern HWY 417		BOREHOLE TYPE		Portable Drill/Hydro-excavation		COMPILED BY JM						
DATUM		Geodetic		DATE		December 14, 2016		CHECKED BY KCP						
SOIL PROFILE			SAMPLES			GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT		PLASTIC LIMIT W _p	NATURAL MOISTURE CONTENT W	LIQUID LIMIT W _L	UNIT WEIGHT γ	REMARKS & GRAIN SIZE DISTRIBUTION (%)
ELEV DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE	"N" VALUES			SHEAR STRENGTH kPa						
63.8	GROUND SURFACE							20 40 60 80 100	20 40 60 80 100	25 50 75				
0.0	PORTLAND CEMENT CONCRETE (SIDEWALK)													
63.7	(SP) Gravelly sand (FILL) Grey		1	GRAB	-									
63.6	(SP) Sand, trace gravel (FILL) Brown		2	GRAB	-									
0.2														
63.2	END OF COREHOLE AT TOP OF FOOTING													
0.6	NOTES: 1. Corehole continued on Record of Drillhole 17-A01D.													

GTA-MTO 001 \GOLDER\GDS\GAL\OTTA\ACTIVE\SPATIAL_IMMITO\HWY417\REHAB&WIDENING\02_DATA\GINT\1655214.GPJ GAL-GTA.GDT 19-8-1 JM

PROJECT: 1655214-1110

RECORD OF DRILLHOLE: 17-A01D

SHEET 1 OF 1

LOCATION: N 5029594.8 ;E 366756.1

DRILLING DATE: December 20, 2016

DATUM: Geodetic

INCLINATION: -65° AZIMUTH:

DRILL RIG: Portable Drill/56 mm Diam. Core

DRILLING CONTRACTOR: CCC

DEPTH SCALE METRES	DRILLING RECORD	DESCRIPTION	SYMBOLIC LOG	ELEV. DEPTH (m)	RUN No.	NOTE: For abbreviations, symbols and descriptions refer to LITHOLOGICAL AND GEOTECHNICAL ROCK DESCRIPTION TERMINOLOGY														FEATURES																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																				
						FLUSH RETURN	RECOVERY		R.Q.D. %	FRACT. INDEX PER	DIP w.r.t CORE AXIS °	DISCONTINUITY DATA		HYDRAULIC CONDUCTIVITY K, cm/sec		WEATH- ERING INDEX																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																								
							TOTAL CORE %	SOLID CORE %				TYPE AND SURFACE DESCRIPTION	Jr	Ja	10 ⁻⁹	10 ⁻⁸	10 ⁻⁷	10 ⁻⁶	W1		W2	W3	W5	W6																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																
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DEPTH SCALE

1 : 25

**GOLDER**

LOGGED: PAH

CHECKED: KCP

GTA-RCK 031 \\GOLDER.GDS\GALOTTAWA\ACTIVE\SPATIAL _IMMTOHWY417\REHAB&WIDENING\02_DATA\GINT\1655214.GPJ GAL-MISS.GDT 19-8-1 JM

PROJECT <u>1655214-1110</u>		RECORD OF BOREHOLE No 17-A02		SHEET 1 OF 1		METRIC	
G.W.P. <u>4173-15-00</u>		LOCATION <u>N 5029592.0; E 366757.4 NAD 83 MTM ZONE 9 (LAT. 45.403533; LONG. -75.708554)</u>		ORIGINATED BY <u>PAH</u>			
DIST <u>Eastern</u> HWY <u>417</u>		BOREHOLE TYPE <u>Portable Drill/Hydro-excavation</u>		COMPILED BY <u>JM</u>			
DATUM <u>Geodetic</u>		DATE <u>December 14, 2016</u>		CHECKED BY <u>KCP</u>			

SOIL PROFILE			SAMPLES			GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT					PLASTIC LIMIT NATURAL MOISTURE LIQUID CONTENT LIMIT			UNIT WEIGHT γ kN/m³	REMARKS & GRAIN SIZE DISTRIBUTION (%)			
ELEV DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE	"N" VALUES			SHEAR STRENGTH kPa					W _p	W	W _L		GR	SA	SI	CL
								○ UNCONFINED	+	FIELD VANE	● QUICK TRIAXIAL	×	REMOULDED	WATER CONTENT (%)						
63.7	GROUND SURFACE						20	40	60	80	100		25	50	75					
0.0	PORTLAND CEMENT CONCRETE (SIDEWALK)																			
0.1	(SP) Gravelly sand (FILL)																			
63.5	Grey																			
0.2	(SP) Sand, trace gravel (FILL) Brown																			
63.1																				
0.6	END OF COREHOLE AT TOP OF FOOTING																			

GTA-MTO 001 \GOLDER.GDS\GALOTTAWA\ACTIVE\SPATIAL_IMMITO\HWY417\REHAB&WIDENING\02_DATA\GINT1655214.GPJ GAL-GTA.GDT 19-8-1 JM

PROJECT <u>1655214-1110</u>		RECORD OF BOREHOLE No 17-A03				SHEET 1 OF 1		METRIC	
G.W.P. <u>4173-15-00</u>		LOCATION <u>N 5029589.3; E 366758.6 NAD 83 MTM ZONE 9 (LAT. 45.403508; LONG. -75.708539)</u>				ORIGINATED BY <u>PAH</u>			
DIST <u>Eastern</u> HWY <u>417</u>		BOREHOLE TYPE <u>Portable Drill/Hydro-excavation</u>				COMPILED BY <u>JM</u>			
DATUM <u>Geodetic</u>		DATE <u>December 14, 2016</u>				CHECKED BY <u>KCP</u>			

SOIL PROFILE			SAMPLES			GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT					PLASTIC LIMIT NATURAL MOISTURE CONTENT LIQUID LIMIT			UNIT WEIGHT γ	REMARKS & GRAIN SIZE DISTRIBUTION (%)
ELEV DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE	"N" VALUES			20	40	60	80	100	W _p	W	W _L		
63.7	GROUND SURFACE																
0.0	PORTLAND CEMENT CONCRETE (SIDEWALK)																
0.1	(SP) Gravelly sand (FILL) Grey																
63.4																	
0.3	(SP) Sand, trace gravel (FILL) Brown																
63.1																	
0.6	END OF COREHOLE AT TOP OF FOOTING																

GTA-MTO 001 \GOLDER.GDS\GALOTTAWA\ACTIVE\SPATIAL_IMMITO\HWY417\REHAB&WIDENING\02_DATA\GINT1655214.GPJ GAL-GTA.GDT 19-8-1 JM

PROJECT		RECORD OF BOREHOLE No 17-A04				SHEET 1 OF 1		METRIC						
G.W.P. 1655214-1110		LOCATION N 5029586.5; E 366759.8 NAD 83 MTM ZONE 9 (LAT. 45.403483; LONG. -75.708524)				ORIGINATED BY PAH								
DIST Eastern HWY 417		BOREHOLE TYPE Portable Drill/Hydro-excavation				COMPILED BY JM								
DATUM Geodetic		DATE December 14, 2016				CHECKED BY KCP								
SOIL PROFILE			SAMPLES			GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT		PLASTIC LIMIT W _p	NATURAL MOISTURE CONTENT W	LIQUID LIMIT W _L	UNIT WEIGHT γ	REMARKS & GRAIN SIZE DISTRIBUTION (%)
ELEV DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE	"N" VALUES			SHEAR STRENGTH kPa						
63.7	GROUND SURFACE							20 40 60 80 100	20 40 60 80 100	25 50 75				
0.0	PORTLAND CEMENT CONCRETE (SIDEWALK)													
0.1	(SP/GP) Sand and Gravel, some silt (FILL)		1	GRAB	-									35 54 (11)
63.4	Brown													
0.3	(SP) Sand, some gravel (FILL)		2	GRAB	-									
63.1	Grey													
0.6	END OF COREHOLE AT TOP OF FOOTING													
NOTES: 1. Corehole continued on Record of Drillhole 17-A04D.														

GTA-MTO 001 \GOLDER.GDS\GALOTTAWA\ACTIVE\SPATIAL_IMMITO\HWY417\REHAB&WIDENING\02_DATA\GINT1655214.GPJ GAL-GTA.GDT 19-8-1 JM

PROJECT: 1655214-1110

RECORD OF DRILLHOLE: 17-A04D

SHEET 1 OF 1

LOCATION: N 5029586.5 ;E 366759.8

DRILLING DATE: December 15 and 19, 2016

DATUM: Geodetic

INCLINATION: -81° AZIMUTH:

DRILL RIG: Portable Drill/56 mm Diam. Core

DRILLING CONTRACTOR: CCC

DEPTH SCALE METRES	DRILLING RECORD	DESCRIPTION	SYMBOLIC LOG	ELEV.		RUN No.	FLUSH RETURN	NOTE: For abbreviations, symbols and descriptions refer to LITHOLOGICAL AND GEOTECHNICAL ROCK DESCRIPTION TERMINOLOGY														FEATURES																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																
				DEPTH (m)	ELEV.			RECOVERY		R.Q.D. %	FRACT. INDEX PER	DISCONTINUITY DATA				HYDRAULIC CONDUCTIVITY K, cm/sec		WEATH- ERING INDEX																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																				
								TOTAL CORE %	SOLID CORE %			DIP w.r.t CORE AXIS	TYPE AND SURFACE DESCRIPTION	Jr	Js	10 ⁻⁵	10 ⁻⁴	10 ⁻³	10 ⁻²	W1	W2		W3	W4	W5	W6																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																												
1	Rotary Drill 56 mm Diam.	TOP OF FOOTING PORTLAND CEMENT CONCRETE (FOOTING)		63.11 0.58		C1																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																

DEPTH SCALE

1 : 25



LOGGED: PAH

CHECKED: KCP

PROJECT <u>1655214-1110</u>		RECORD OF BOREHOLE No 17-A05		SHEET 1 OF 1		METRIC	
G.W.P. <u>4173-15-00</u>		LOCATION <u>N 5029583.6; E 366761.1 NAD 83 MTM ZONE 9 (LAT. 45.403457; LONG. -75.708508)</u>		ORIGINATED BY <u>PAH</u>			
DIST <u>Eastern</u> HWY <u>417</u>		BOREHOLE TYPE <u>Portable Drill/Hydro-excavation</u>		COMPILED BY <u>JM</u>			
DATUM <u>Geodetic</u>		DATE <u>December 14, 2016</u>		CHECKED BY <u>KCP</u>			

SOIL PROFILE			SAMPLES			GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT					PLASTIC LIMIT NATURAL MOISTURE CONTENT LIQUID LIMIT			UNIT WEIGHT γ kN/m³	REMARKS & GRAIN SIZE DISTRIBUTION (%)				
ELEV DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE	"N" VALUES			SHEAR STRENGTH kPa					W _p	W	W _L		GR	SA	SI	CL	
								○ UNCONFINED	+	FIELD VANE	● QUICK TRIAXIAL	×	REMOULDED	WATER CONTENT (%)							
63.7	GROUND SURFACE						20	40	60	80	100		25	50	75						
0.0	PORTLAND CEMENT CONCRETE (SIDEWALK)																				
0.1	(SP) Gravelly sand (FILL) Grey																				
63.4																					
0.3	(SP) Sand, trace gravel (FILL) Brown																				
63.1																					
0.6	END OF COREHOLE AT TOP OF FOOTING																				

GTA-MTO 001 \GOLDER.GDS\GALOTTAWA\ACTIVE\SPATIAL_IMMITO\HWY417\REHAB&WIDENING\02_DATA\GINT1655214.GPJ GAL-GTA.GDT 19-8-1 JM

PROJECT <u>1655214-1110</u>		RECORD OF BOREHOLE No 17-A06		SHEET 1 OF 1		METRIC	
G.W.P. <u>4173-15-00</u>		LOCATION <u>N 5029581.0; E 366762.2 NAD 83 MTM ZONE 9 (LAT. 45.403434; LONG. -75.708494)</u>		ORIGINATED BY <u>PAH</u>			
DIST <u>Eastern</u> HWY <u>417</u>		BOREHOLE TYPE <u>Portable Drill/Hydro-excavation</u>		COMPILED BY <u>JM</u>			
DATUM <u>Geodetic</u>		DATE <u>December 14, 2016</u>		CHECKED BY <u>KCP</u>			

SOIL PROFILE			SAMPLES			GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT					PLASTIC LIMIT NATURAL MOISTURE LIQUID CONTENT LIMIT			UNIT WEIGHT γ kN/m³	REMARKS & GRAIN SIZE DISTRIBUTION (%)			
ELEV DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE	"N" VALUES			SHEAR STRENGTH kPa					W _p	W	W _L		GR	SA	SI	CL
								○ UNCONFINED	+	FIELD VANE	● QUICK TRIAXIAL	×	REMOULDED	WATER CONTENT (%)						
63.7	GROUND SURFACE						20	40	60	80	100		25	50	75					
0.0	PORTLAND CEMENT CONCRETE (SIDEWALK)																			
0.1	(SP) Gravelly sand (FILL) Grey																			
63.4																				
0.3	(SP) Sand, trace gravel (FILL) Brown																			
63.1																				
0.6	END OF COREHOLE AT TOP OF FOOTING																			

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PROJECT <u>1655214-1110</u>		RECORD OF BOREHOLE No 17-A07		SHEET 1 OF 1		METRIC	
G.W.P. <u>4173-15-00</u>		LOCATION <u>N 5029578.6; E 366763.3 NAD 83 MTM ZONE 9 (LAT. 45.403411; LONG. -75.708480)</u>		ORIGINATED BY <u>PAH</u>			
DIST <u>Eastern</u> HWY <u>417</u>		BOREHOLE TYPE <u>Portable Drill/Hydro-excavation</u>		COMPILED BY <u>JM</u>			
DATUM <u>Geodetic</u>		DATE <u>December 14, 2016</u>		CHECKED BY <u>KCP</u>			

SOIL PROFILE			SAMPLES			GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT		PLASTIC LIMIT NATURAL MOISTURE CONTENT LIQUID LIMIT			UNIT WEIGHT γ	REMARKS & GRAIN SIZE DISTRIBUTION (%)							
ELEV DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE	"N" VALUES			SHEAR STRENGTH kPa		W _P W W _L											
								○ UNCONFINED + FIELD VANE	● QUICK TRIAXIAL × REMOULDED	WATER CONTENT (%)											
63.7	GROUND SURFACE							20	40	60	80	100		25	50	75	kN/m ³	GR	SA	SI	CL
0.0	PORTLAND CEMENT CONCRETE (SIDEWALK)																				
0.1	(SP) Gravelly sand (FILL) Grey																				
63.4																					
0.3	(SP) Sand, trace gravel (FILL) Brown																				
63.1																					
0.6	END OF COREHOLE AT TOP OF FOOTING																				

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PROJECT <u>1655214-1110</u>		RECORD OF BOREHOLE No 17-A08			SHEET 1 OF 1		METRIC	
G.W.P. <u>4173-15-00</u>		LOCATION <u>N 5029576.2; E 366764.4 NAD 83 MTM ZONE 9 (LAT. 45.403390; LONG. -75.708467)</u>		ORIGINATED BY <u>PAH</u>				
DIST <u>Eastern</u> HWY <u>417</u>		BOREHOLE TYPE <u>Portable Drill/Hydro-excavation</u>		COMPILED BY <u>JM</u>				
DATUM <u>Geodetic</u>		DATE <u>December 14, 2016</u>		CHECKED BY <u>KCP</u>				

SOIL PROFILE			SAMPLES			GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT					PLASTIC LIMIT NATURAL MOISTURE CONTENT LIQUID LIMIT			UNIT WEIGHT γ	REMARKS & GRAIN SIZE DISTRIBUTION (%)	
ELEV DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE	"N" VALUES			SHEAR STRENGTH kPa					W _p	W	W _L			
63.7	GROUND SURFACE							20	40	60	80	100						
0.0	PORTLAND CEMENT CONCRETE (SIDEWALK)																	
0.1	(SP) Gravelly sand (FILL) Grey		1	GRAB	-													
63.4	(SP) Sand, trace gravel (FILL) Brown																	
0.3			2	GRAB	-													
63.0	END OF COREHOLE AT TOP OF FOOTING																	
0.7	NOTES: 1. Corehole continued on Record of Drillhole 17-A08D.																	

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PROJECT: 1655214-1110

RECORD OF DRILLHOLE: 17-A08D

SHEET 1 OF 1

LOCATION: N 5029576.2 ;E 366764.4

DRILLING DATE: December 14, 2016

DATUM: Geodetic

INCLINATION: -90° AZIMUTH: ---

DRILL RIG: Portable Drill/56 mm Diam. Core

DRILLING CONTRACTOR: CCC

DEPTH SCALE METRES	DRILLING RECORD	DESCRIPTION	SYMBOLIC LOG	ELEV. DEPTH (m)	RUN No.	NOTE: For abbreviations, symbols and descriptions refer to LITHOLOGICAL AND GEOTECHNICAL ROCK DESCRIPTION TERMINOLOGY														FEATURES																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																									
						RECOVERY		R.Q.D. %	FRACT. INDEX PER	DIP w.r.t CORE AXIS	DISCONTINUITY DATA		HYDRAULIC CONDUCTIVITY K, cm/sec	WEATH- ERING INDEX																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																															
						TOTAL CORE %	SOLID CORE %				TYPE AND SURFACE DESCRIPTION	Jr		Js	10 ⁻⁵	10 ⁻⁴	10 ⁻³	10 ⁻²	W1		W2	W3	W4	W5	W6																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																				
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1	Rotary Drill 56 mm Diam.	TOP OF FOOTING		63.06																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																									</

DEPTH SCALE

1 : 25



LOGGED: PAH

CHECKED: KCP

PROJECT <u>1655214-1110</u>		RECORD OF BOREHOLE No 17-A09				SHEET 1 OF 1		METRIC	
G.W.P. <u>4173-15-00</u>		LOCATION <u>N 5029573.5; E 366765.6 NAD 83 MTM ZONE 9 (LAT. 45.403365; LONG. -75.708452)</u>				ORIGINATED BY <u>PAH</u>			
DIST <u>Eastern</u> HWY <u>417</u>		BOREHOLE TYPE <u>Portable Drill/Hydro-excavation</u>				COMPILED BY <u>JM</u>			
DATUM <u>Geodetic</u>		DATE <u>December 14, 2016</u>				CHECKED BY <u>KCP</u>			

SOIL PROFILE			SAMPLES			GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT					PLASTIC LIMIT W _p	NATURAL MOISTURE CONTENT W	LIQUID LIMIT W _L	UNIT WEIGHT γ	REMARKS & GRAIN SIZE DISTRIBUTION (%)
ELEV DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE	"N" VALUES			SHEAR STRENGTH kPa									
63.7	GROUND SURFACE							20	40	60	80	100					
0.0	PORTLAND CEMENT CONCRETE (SIDEWALK)																
0.1	(SP) Gravelly sand (FILL) Grey																
63.4	(SP) Sand, trace gravel (FILL) Brown																
0.3																	
63.0																	
0.7	END OF COREHOLE AT TOP OF FOOTING						63										

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PROJECT <u>1655214-1110</u>		RECORD OF BOREHOLE No 17-A10		SHEET 1 OF 1		METRIC	
G.W.P. <u>4173-15-00</u>		LOCATION <u>N 5029570.6; E 366766.8 NAD 83 MTM ZONE 9 (LAT. 45.403340; LONG. -75.708437)</u>		ORIGINATED BY <u>PAH</u>			
DIST <u>Eastern</u> HWY <u>417</u>		BOREHOLE TYPE <u>Portable Drill/Hydro-excavation</u>		COMPILED BY <u>JM</u>			
DATUM <u>Geodetic</u>		DATE <u>December 14, 2016</u>		CHECKED BY <u>KCP</u>			

SOIL PROFILE			SAMPLES			GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT					PLASTIC LIMIT NATURAL MOISTURE CONTENT LIQUID LIMIT			UNIT WEIGHT γ kN/m³	REMARKS & GRAIN SIZE DISTRIBUTION (%)			
ELEV DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE	"N" VALUES			SHEAR STRENGTH kPa					W _p	W	W _L		GR	SA	SI	CL
								○ UNCONFINED	● QUICK TRIAXIAL	+	×	FIELD VANE	REMOULDED	WATER CONTENT (%)						
63.8	GROUND SURFACE						20	40	60	80	100		25	50	75					
0.0	PORTLAND CEMENT CONCRETE (SIDEWALK)																			
0.1	(SP) Gravelly sand (FILL) Grey																			
63.5																				
0.3	(SP) Sand, trace gravel (FILL) Brown																			
63.1																				
0.7	END OF COREHOLE AT TOP OF FOOTING																			

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PROJECT <u>1655214-1110</u>		RECORD OF BOREHOLE No 17-A11		SHEET 1 OF 1		METRIC	
G.W.P. <u>4173-15-00</u>		LOCATION <u>N 5029567.8; E 366768.0 NAD 83 MTM ZONE 9 (LAT. 45.403314; LONG. -75.708422)</u>		ORIGINATED BY <u>PAH</u>			
DIST <u>Eastern</u> HWY <u>417</u>		BOREHOLE TYPE <u>Portable Drill/Hydro-excavation</u>		COMPILED BY <u>JM</u>			
DATUM <u>Geodetic</u>		DATE <u>December 14, 2016</u>		CHECKED BY <u>KCP</u>			

SOIL PROFILE			SAMPLES			GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT					PLASTIC LIMIT NATURAL MOISTURE LIQUID CONTENT			UNIT WEIGHT γ kN/m³	REMARKS & GRAIN SIZE DISTRIBUTION (%)			
ELEV DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE	"N" VALUES			SHEAR STRENGTH kPa					WATER CONTENT (%)				GR	SA	SI	CL
								20	40	60	80	100	W _p	W	W _L					
63.8	GROUND SURFACE																			
0.0	PORTLAND CEMENT CONCRETE (SIDEWALK)																			
0.1	(SP) Gravelly sand (FILL) Grey		1	GRAB	-															
63.5																				
0.3	(SP) Sand, trace silt (FILL) Brown		2	GRAB	-													2 92 (6)		
63.1																				
0.7	END OF COREHOLE AT TOP OF FOOTING																			

GTA-MTO 001 \GOLDER.GDS\GALOTTAWA\ACTIVE\SPATIAL_IMMITO\HWY417\REHAB&WIDENING\02_DATA\GINT1655214.GPJ GAL-GTA.GDT 19-8-1 JM

PROJECT		1655214-1110		RECORD OF BOREHOLE No 17-A12		SHEET 1 OF 1		METRIC									
G.W.P.		4173-15-00		LOCATION		N 5029565.2; E 366769.4 NAD 83 MTM ZONE 9 (LAT. 45.403290; LONG. -75.708405)		ORIGINATED BY PAH									
DIST		Eastern HWY 417		BOREHOLE TYPE		Portable Drill/Hydro-excavation		COMPILED BY JM									
DATUM		Geodetic		DATE		December 14, 2016		CHECKED BY KCP									
SOIL PROFILE			SAMPLES			GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT					PLASTIC LIMIT W _p	NATURAL MOISTURE CONTENT W	LIQUID LIMIT W _L	UNIT WEIGHT γ	REMARKS & GRAIN SIZE DISTRIBUTION (%)
ELEV DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE	"N" VALUES			SHEAR STRENGTH kPa									
63.8	GROUND SURFACE																
0.0	PORTLAND CEMENT CONCRETE (SIDEWALK)																
0.1	(SP) Gravelly sand (FILL) Grey		1	GRAB	-												
63.5																	
0.3	(SP) Sand, trace gravel (FILL) Brown		2	GRAB	-												
63.1																	
0.7	END OF COREHOLE AT TOP OF FOOTING																
NOTES:																	
1. Corehole continued on Record of Drillhole 17-A12D.																	

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PROJECT: 1655214-1110

RECORD OF DRILLHOLE: 17-A12D

SHEET 1 OF 1

LOCATION: N 5029565.2 ; E 366769.4

DRILLING DATE: December 14, 2016

DATUM: Geodetic

INCLINATION: -90° AZIMUTH: ---

DRILL RIG: Portable Drill/56 mm Diam. Core

DRILLING CONTRACTOR: CCC

DEPTH SCALE METRES	DRILLING RECORD	DESCRIPTION	SYMBOLIC LOG	ELEV. DEPTH (m)	RUN No.	FLUSH RETURN	NOTE: For abbreviations, symbols and descriptions refer to LITHOLOGICAL AND GEOTECHNICAL ROCK DESCRIPTION TERMINOLOGY														FEATURES					
							RECOVERY		R.Q.D. %	FRACT. INDEX PER	DIP w.r.t CORE AXIS °	DISCONTINUITY DATA		HYDRAULIC CONDUCTIVITY K, cm/sec	WEATH- ERING INDEX											
							TOTAL CORE %	SOLID CORE %				TYPE AND SURFACE DESCRIPTION	Jr		Ja	10 ⁻⁶	10 ⁻⁵	10 ⁻⁴	10 ⁻³	W1		W2	W3	W4	W5	W6
							88 8																			

DEPTH SCALE

1 : 25



LOGGED: PAH

CHECKED: KCP

GTA-RCK 031 \\GOLDER.GDS\GALOTTAWA\ACTIVE\SPATIAL_IMMTOHWY417\REHAB&WIDENING\02_DATA\GINT\1655214.GPJ GAL-MISS.GDT 19-8-1 JM

PROJECT 1655214-1110			RECORD OF BOREHOLE No 17-A13			SHEET 1 OF 1			METRIC								
G.W.P. 4173-15-00			LOCATION N 5029556.5; E 366754.1 NAD 83 MTM ZONE 9 (LAT. 45.403214; LONG. -75.708601)			ORIGINATED BY PAH											
DIST Eastern HWY 417			BOREHOLE TYPE Portable Drill/Hydro-excavation			COMPILED BY JM											
DATUM Geodetic			DATE December 21, 2016			CHECKED BY KCP											
SOIL PROFILE			SAMPLES			GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT					PLASTIC LIMIT W _p	NATURAL MOISTURE CONTENT W	LIQUID LIMIT W _L	UNIT WEIGHT γ	REMARKS & GRAIN SIZE DISTRIBUTION (%)
ELEV DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE	"N" VALUES			SHEAR STRENGTH kPa									
63.9	GROUND SURFACE																
63.8	PORTLAND CEMENT CONCRETE (SIDEWALK)																
0.1	(SM) Gravelly sand, some silt (FILL) Grey		1	GRAB	-												28 60 (12)
63.6	(SP-SM) Sand, some gravel and silt (FILL) Brown		2	GRAB	-												
0.3																	
63.2	END OF COREHOLE AT TOP OF FOOTING																
0.7	NOTES: 1. Corehole continued on Record of Drillhole 17-A13D.																

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PROJECT: 1655214-1110

RECORD OF DRILLHOLE: 17-A13D

SHEET 1 OF 1

LOCATION: N 5029556.5 ;E 366754.1

DRILLING DATE: December 23, 2016

DATUM: Geodetic

INCLINATION: -90° AZIMUTH: ---

DRILL RIG: Portable Drill/56 mm Diam. Core

DRILLING CONTRACTOR: CCC

DEPTH SCALE METRES	DRILLING RECORD	DESCRIPTION	SYMBOLIC LOG	ELEV. DEPTH (m)	RUN No.	FLUSH RETURN	NOTE: For abbreviations, symbols and descriptions refer to LITHOLOGICAL AND GEOTECHNICAL ROCK DESCRIPTION TERMINOLOGY														FEATURES				
							RECOVERY		R.Q.D. %	FRACT. INDEX PER	DIP w.r.t CORE AXIS °	DISCONTINUITY DATA		HYDRAULIC CONDUCTIVITY K, cm/sec		WEATH- ERING INDEX									
							TOTAL CORE %	SOLID CORE %				TYPE AND SURFACE DESCRIPTION	Jr	Ja	10 ⁻⁵	10 ⁻³	10 ⁻¹	10 ¹	W1	W2		W3	W4	W5	W6
							80 60 40 20 0	80 60 40 20 0																	
1	Rotary Drill 56 mm Diam.	TOP OF FOOTING		63.17																					
		PORTLAND CEMENT CONCRETE (FOOTING)		0.73	C1																				
					C2																				
2		Limestone (BEDROCK), with black shale partings Fresh Thinly to medium bedded Grey Fine grained Porous Strong		62.08 1.82	C3																				
					C4	50																			
		END OF DRILLHOLE		61.50 2.40																					
3																									
4																									
5																									

DEPTH SCALE

1 : 25



LOGGED: PAH

CHECKED: KCP

GTA-RCK 031 \\GOLDER\GDS\GALOTTAWA\ACTIVE\SPATIAL _IMMTOHWY417\REHAB&WIDENING\02_DATA\GINT\1655214.GPJ GAL-MISS.GDT 19-8-1 JM

PROJECT <u>1655214-1110</u>		RECORD OF BOREHOLE No 17-A14		SHEET 1 OF 1		METRIC	
G.W.P. <u>4173-15-00</u>		LOCATION <u>N 5029559.2; E 366752.8 NAD 83 MTM ZONE 9 (LAT. 45.403238; LONG. -75.708617)</u>		ORIGINATED BY <u>PAH</u>			
DIST <u>Eastern</u> HWY <u>417</u>		BOREHOLE TYPE <u>Portable Drill/Hydro-excavation</u>		COMPILED BY <u>JM</u>			
DATUM <u>Geodetic</u>		DATE <u>December 21, 2016</u>		CHECKED BY <u>KCP</u>			

SOIL PROFILE			SAMPLES			GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT					PLASTIC LIMIT NATURAL MOISTURE CONTENT LIQUID LIMIT			UNIT WEIGHT γ kN/m³	REMARKS & GRAIN SIZE DISTRIBUTION (%)				
ELEV DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE	"N" VALUES			SHEAR STRENGTH kPa					W _p	W	W _L		GR	SA	SI	CL	
					○ UNCONFINED + FIELD VANE ● QUICK TRIAXIAL × REMOULDED					WATER CONTENT (%)											
63.8	GROUND SURFACE							20	40	60	80	100	25	50	75						
0.0	PORTLAND CEMENT CONCRETE (SIDEWALK)																				
0.1	(SP) Gravelly sand (FILL) Grey																				
63.5																					
0.3	(SP) Sand, trace gravel (FILL) Brown																				
63.2																					
0.6	END OF COREHOLE AT TOP OF FOOTING																				

GTA-MTO 001 \GOLDER.GDS\GALOTTAWA\ACTIVE\SPATIAL_IMMITO\HWY417\REHAB&WIDENING\02_DATA\GINT1655214.GPJ GAL-GTA.GDT 19-8-1 JM

PROJECT		RECORD OF BOREHOLE No 17-A15				SHEET 1 OF 1		METRIC											
G.W.P. 1655214-1110		LOCATION N 5029561.9; E 366751.7 NAD 83 MTM ZONE 9 (LAT. 45.403263; LONG. -75.708631)				ORIGINATED BY PAH													
DIST Eastern HWY 417		BOREHOLE TYPE Portable Drill/Hydro-excavation				COMPILED BY JM													
DATUM Geodetic		DATE December 21, 2016				CHECKED BY KCP													
SOIL PROFILE			SAMPLES			DYNAMIC CONE PENETRATION RESISTANCE PLOT			PLASTIC LIMIT NATURAL MOISTURE CONTENT LIQUID LIMIT			UNIT WEIGHT			REMARKS & GRAIN SIZE DISTRIBUTION (%)				
ELEV DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE	"N" VALUES	GROUND WATER CONDITIONS	ELEVATION SCALE	SHEAR STRENGTH kPa			WATER CONTENT (%)			γ					
63.8	GROUND SURFACE							20 40 60 80 100	○ UNCONFINED	+	FIELD VANE	25 50 75							
0.0	PORTLAND CEMENT CONCRETE (SIDEWALK)								● QUICK TRIAXIAL	×	REMOULDED								
0.1	(SP) Gravelly sand (FILL) Grey																		
63.5																			
0.3	(SP) Sand, trace gravel (FILL) Brown																		
63.2																			
0.6	END OF COREHOLE AT TOP OF FOOTING																		

GTA-MTO 001 \GOLDER.GDS\GALOTTAWA\ACTIVE\SPATIAL_IMMITO\HWY417\REHAB&WIDENING\02_DATA\GINT1655214.GPJ GAL-GTA.GDT 19-8-1 JM

PROJECT		1655214-1110		RECORD OF BOREHOLE No 17-A16		SHEET 1 OF 1		METRIC									
G.W.P.		4173-15-00		LOCATION		N 5029564.6; E 366750.5 NAD 83 MTM ZONE 9 (LAT. 45.403287; LONG. -75.708646)		ORIGINATED BY PAH									
DIST		Eastern HWY 417		BOREHOLE TYPE		Portable Drill/Hydro-excavation		COMPILED BY JM									
DATUM		Geodetic		DATE		December 21, 2016		CHECKED BY KCP									
SOIL PROFILE			SAMPLES			GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT					PLASTIC LIMIT W _p	NATURAL MOISTURE CONTENT W	LIQUID LIMIT W _L	UNIT WEIGHT γ	REMARKS & GRAIN SIZE DISTRIBUTION (%)
ELEV DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE	"N" VALUES			SHEAR STRENGTH kPa									
63.7	GROUND SURFACE																
0.0	PORTLAND CEMENT CONCRETE (SIDEWALK)																
0.1	(SP) Gravelly sand (FILL) Grey		1	GRAB	-												
63.4																	
0.3	(SP) Sand, trace gravel (FILL) Brown		2	GRAB	-												
63.2																	
0.5	END OF COREHOLE AT TOP OF FOOTING																
NOTES: 1. Corehole continued on Record of Drillhole 17-A16D.																	

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PROJECT: 1655214-1110

RECORD OF DRILLHOLE: 17-A16D

SHEET 1 OF 1

LOCATION: N 5029564.6 ;E 366750.5

DRILLING DATE: December 23, 2016

DATUM: Geodetic

INCLINATION: -90° AZIMUTH: ---

DRILL RIG: Portable Drill/56 mm Diam. Core

DRILLING CONTRACTOR: CCC

DEPTH SCALE METRES	DRILLING RECORD	DESCRIPTION	SYMBOLIC LOG	ELEV. DEPTH (m)	RUN No.	FLUSH RETURN	NOTE: For abbreviations, symbols and descriptions refer to LITHOLOGICAL AND GEOTECHNICAL ROCK DESCRIPTION TERMINOLOGY														FEATURES																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																															
							RECOVERY		R.Q.D. %	FRACT. INDEX PER	DIP w.r.t CORE AXIS °	DISCONTINUITY DATA		HYDRAULIC CONDUCTIVITY K, cm/sec	WEATH- ERING INDEX																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																					
							TOTAL CORE %	SOLID CORE %				TYPE AND SURFACE DESCRIPTION	Jr		Js	10 ⁻⁵	10 ⁻⁴	10 ⁻³	10 ⁻²	W1		W2	W3	W4	W5	W6																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																										
		TOP OF FOOTING		63.18																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																

DEPTH SCALE

1 : 25

**GOLDER**

LOGGED: PAH

CHECKED: KCP

GTA-RCK 031 \\GOLDER\GDS\GALOTTAWA\ACTIVE\SPATIAL_IMMTOHWY417\REHAB&WIDENING\02_DATA\GINT\1655214.GPJ GAL-MISS.GDT 19-8-1 JM

PROJECT <u>1655214-1110</u>		RECORD OF BOREHOLE No 17-A17		SHEET 1 OF 1		METRIC	
G.W.P. <u>4173-15-00</u>		LOCATION <u>N 5029567.5; E 366749.2 NAD 83 MTM ZONE 9 (LAT. 45.403313; LONG. -75.708662)</u>		ORIGINATED BY <u>PAH</u>			
DIST <u>Eastern</u> HWY <u>417</u>		BOREHOLE TYPE <u>Portable Drill/Hydro-excavation</u>		COMPILED BY <u>JM</u>			
DATUM <u>Geodetic</u>		DATE <u>December 21, 2016</u>		CHECKED BY <u>KCP</u>			

SOIL PROFILE			SAMPLES			GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT					PLASTIC LIMIT NATURAL MOISTURE CONTENT LIQUID LIMIT			UNIT WEIGHT γ kN/m³	REMARKS & GRAIN SIZE DISTRIBUTION (%)			
ELEV DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE	"N" VALUES			SHEAR STRENGTH kPa					W _p	W	W _L		GR	SA	SI	CL
								○ UNCONFINED	● QUICK TRIAXIAL	+	×	FIELD VANE	REMOULDED	WATER CONTENT (%)						
63.7	GROUND SURFACE																			
0.0	PORTLAND CEMENT CONCRETE (SIDEWALK)																			
0.1	(SP) Gravelly sand (FILL) Grey																			
63.4																				
0.3	(SP) Sand, trace gravel (FILL) Brown																			
63.2																				
0.5	END OF COREHOLE AT TOP OF FOOTING																			

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PROJECT <u>1655214-1110</u>		RECORD OF BOREHOLE No 17-A18		SHEET 1 OF 1		METRIC	
G.W.P. <u>4173-15-00</u>		LOCATION <u>N 5029570.2; E 366748.0 NAD 83 MTM ZONE 9 (LAT. 45.403337; LONG. -75.708676)</u>		ORIGINATED BY <u>PAH</u>			
DIST <u>Eastern</u> HWY <u>417</u>		BOREHOLE TYPE <u>Portable Drill/Hydro-excavation</u>		COMPILED BY <u>JM</u>			
DATUM <u>Geodetic</u>		DATE <u>December 21, 2016</u>		CHECKED BY <u>KCP</u>			

SOIL PROFILE			SAMPLES			GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT					PLASTIC LIMIT NATURAL MOISTURE CONTENT LIQUID LIMIT			UNIT WEIGHT γ kN/m³	REMARKS & GRAIN SIZE DISTRIBUTION (%)				
ELEV DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE	"N" VALUES			SHEAR STRENGTH kPa					W _p	W	W _L		GR	SA	SI	CL	
								○ UNCONFINED	● QUICK TRIAXIAL	+	×	FIELD VANE	REMOULDED	WATER CONTENT (%)							
63.7	GROUND SURFACE																				
0.0	PORTLAND CEMENT CONCRETE (SIDEWALK)																				
0.1	(SP) Gravelly sand (FILL) Grey																				
63.4																					
0.3	(SP) Sand, trace gravel (FILL) Brown																				
63.2																					
0.5	END OF COREHOLE AT TOP OF FOOTING																				

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PROJECT <u>1655214-1110</u>		RECORD OF BOREHOLE No 17-A19				SHEET 1 OF 1		METRIC	
G.W.P. <u>4173-15-00</u>		LOCATION <u>N 5029572.9; E 366746.8 NAD 83 MTM ZONE 9 (LAT. 45.403361; LONG. -75.708692)</u>				ORIGINATED BY <u>PAH</u>			
DIST <u>Eastern</u> HWY <u>417</u>		BOREHOLE TYPE <u>Portable Drill/Hydro-excavation</u>				COMPILED BY <u>JM</u>			
DATUM <u>Geodetic</u>		DATE <u>December 21, 2016</u>				CHECKED BY <u>KCP</u>			

SOIL PROFILE			SAMPLES			GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT					PLASTIC LIMIT NATURAL MOISTURE CONTENT LIQUID LIMIT			UNIT WEIGHT γ	REMARKS & GRAIN SIZE DISTRIBUTION (%)
ELEV DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE	"N" VALUES			20	40	60	80	100	W _p	W	W _L		
63.7	GROUND SURFACE																
0.0	PORTLAND CEMENT CONCRETE (SIDEWALK)																
0.1	(SP) Gravelly sand (FILL) Grey																
63.4	(SP) Sand, trace gravel (FILL) Brown																
63.2	END OF COREHOLE AT TOP OF FOOTING																
0.5																	

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PROJECT		1655214-1110		RECORD OF BOREHOLE No 17-A20		SHEET 1 OF 1		METRIC						
G.W.P.		4173-15-00		LOCATION		N 5029575.7; E 366745.6 NAD 83 MTM ZONE 9 (LAT. 45.403387; LONG. -75.708707)		ORIGINATED BY PAH						
DIST		Eastern HWY 417		BOREHOLE TYPE		Portable Drill/Hydro-excavation		COMPILED BY JM						
DATUM		Geodetic		DATE		December 21, 2016		CHECKED BY KCP						
SOIL PROFILE			SAMPLES			GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT		PLASTIC LIMIT W _p	NATURAL MOISTURE CONTENT W	LIQUID LIMIT W _L	UNIT WEIGHT γ	REMARKS & GRAIN SIZE DISTRIBUTION (%)
ELEV DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE	"N" VALUES			SHEAR STRENGTH kPa						
63.7	GROUND SURFACE							20 40 60 80 100		25 50 75				
0.0	PORTLAND CEMENT CONCRETE (SIDEWALK)													
0.1	(SP) Gravelly sand (FILL) Grey		1	GRAB	-									
63.4														
0.3	(SP) Sand, trace silt and gravel (FILL) Brown		2	GRAB	-									
63.2														
0.5	END OF COREHOLE AT TOP OF FOOTING													
NOTES: 1. Corehole continued on Record of Drillhole 17-A20D.														

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SHEET 1 OF 1

DATUM: Geodetic

DRILLING CONTRACTOR: CCC

GTA-RCK 031 \\GOLDER.GDS\GAL\OTTAWA\ACTIVE\SPATIAL IM\IMTO\HWY417\REHAB&WIDENING\02 DATA\GINT\1655214.GPJ GAL-MISS.GDT 19-8-1 JM

CHECKED: KCP

PROJECT <u>1655214-1110</u>		RECORD OF BOREHOLE No 17-A21		SHEET 1 OF 1		METRIC	
G.W.P. <u>4173-15-00</u>		LOCATION <u>N 5029578.4; E 366744.3 NAD 83 MTM ZONE 9 (LAT. 45.403412; LONG. -75.708723)</u>		ORIGINATED BY <u>PAH</u>			
DIST <u>Eastern</u> HWY <u>417</u>		BOREHOLE TYPE <u>Portable Drill/Hydro-excavation</u>		COMPILED BY <u>JM</u>			
DATUM <u>Geodetic</u>		DATE <u>December 21, 2016</u>		CHECKED BY <u>KCP</u>			

SOIL PROFILE			SAMPLES			GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT 	PLASTIC LIMIT NATURAL MOISTURE CONTENT LIQUID LIMIT 	UNIT WEIGHT kN/m ³	REMARKS & GRAIN SIZE DISTRIBUTION (%)
ELEV DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE	"N" VALUES						
63.7	GROUND SURFACE										
0.0	PORTLAND CEMENT CONCRETE (SIDEWALK)										
0.1	(SP) Gravelly sand (FILL) Grey										
63.4											
0.3	(SP) Sand, trace gravel (FILL) Brown										
63.2											
0.5	END OF COREHOLE AT TOP OF FOOTING										

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PROJECT <u>1655214-1110</u>		RECORD OF BOREHOLE No 17-A22		SHEET 1 OF 1		METRIC	
G.W.P. <u>4173-15-00</u>		LOCATION <u>N 5029581.2; E 366743.2 NAD 83 MTM ZONE 9 (LAT. 45.403436; LONG. -75.708737)</u>		ORIGINATED BY <u>PAH</u>			
DIST <u>Eastern</u> HWY <u>417</u>		BOREHOLE TYPE <u>Portable Drill/Hydro-excavation</u>		COMPILED BY <u>JM</u>			
DATUM <u>Geodetic</u>		DATE <u>December 21, 2016</u>		CHECKED BY <u>KCP</u>			

SOIL PROFILE			SAMPLES			GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT					PLASTIC LIMIT NATURAL MOISTURE LIQUID CONTENT LIMIT			UNIT WEIGHT γ kN/m³	REMARKS & GRAIN SIZE DISTRIBUTION (%)			
ELEV DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE	"N" VALUES			SHEAR STRENGTH kPa					W _p	W	W _L		GR	SA	SI	CL
								○ UNCONFINED	+	FIELD VANE	● QUICK TRIAXIAL	×	REMOULDED	WATER CONTENT (%)						
63.7	GROUND SURFACE						20	40	60	80	100		25	50	75					
63.6	PORTLAND CEMENT CONCRETE (SIDEWALK)																			
0.1	(SP) Gravelly sand (FILL) Grey																			
63.5	(SP) Sand, trace gravel (FILL) Brown																			
0.3																				
63.2	END OF COREHOLE AT TOP OF FOOTING																			
0.5																				

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PROJECT <u>1655214-1110</u>		RECORD OF BOREHOLE No 17-A23		SHEET 1 OF 1		METRIC	
G.W.P. <u>4173-15-00</u>		LOCATION <u>N 5029583.9; E 366742.0 NAD 83 MTM ZONE 9 (LAT. 45.403461; LONG. -75.708752)</u>		ORIGINATED BY <u>PAH</u>			
DIST <u>Eastern</u> HWY <u>417</u>		BOREHOLE TYPE <u>Portable Drill/Hydro-excavation</u>		COMPILED BY <u>JM</u>			
DATUM <u>Geodetic</u>		DATE <u>December 21, 2016</u>		CHECKED BY <u>KCP</u>			

SOIL PROFILE			SAMPLES			GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT		PLASTIC LIMIT NATURAL MOISTURE CONTENT LIQUID LIMIT			UNIT WEIGHT γ kN/m ³	REMARKS & GRAIN SIZE DISTRIBUTION (%) GR SA SI CL
ELEV DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE	"N" VALUES			SHEAR STRENGTH kPa		WATER CONTENT (%)				
								20 40 60 80 100		W _p W W _L				
								○ UNCONFINED + FIELD VANE						
								● QUICK TRIAXIAL × REMOULDED						
63.7	GROUND SURFACE							20 40 60 80 100		25 50 75				
63.6	PORTLAND CEMENT CONCRETE (SIDEWALK)													
0.1	(SP) Gravelly sand (FILL) Grey													
63.5														
0.2	(SP) Sand, trace gravel (FILL) Brown													
63.2														
0.5	END OF COREHOLE AT TOP OF FOOTING													

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PROJECT		1655214-1110		RECORD OF BOREHOLE No 17-A24		SHEET 1 OF 1		METRIC					
G.W.P.		4173-15-00		LOCATION		N 5029586.5; E 366740.6 NAD 83 MTM ZONE 9 (LAT. 45.403485; LONG. -75.708769)		ORIGINATED BY PAH					
DIST		Eastern HWY 417		BOREHOLE TYPE		Portable Drill/Hydro-excavation		COMPILED BY JM					
DATUM		Geodetic		DATE		December 21, 2016		CHECKED BY KCP					
SOIL PROFILE			SAMPLES			GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT		PLASTIC LIMIT NATURAL MOISTURE CONTENT LIQUID LIMIT		UNIT WEIGHT γ	REMARKS & GRAIN SIZE DISTRIBUTION (%)
ELEV DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE	"N" VALUES			SHEAR STRENGTH kPa		WATER CONTENT (%)			
63.7	GROUND SURFACE							20 40 60 80 100					
63.6	PORTLAND CEMENT CONCRETE (SIDEWALK)												
0.1	(SW) Gravelly sand (FILL) Grey		1	GRAB	-								
63.4	(SP) Sand, trace gravel (FILL) Brown												
0.3			2	GRAB	-								
63.2	END OF COREHOLE AT TOP OF FOOTING												
0.5	NOTES: 1. Corehole continued on Record of Drillhole 17-A24D.												

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SHEET 1 OF 1

DATUM: Geodetic

DRILLING CONTRACTOR: CCC

[illegible]

DEPTH SCALE

1 : 25



GOLDER

LOGGED: PAH

CHECKED: KCP

PROJECT		1655214-1110		RECORD OF BOREHOLE No 18-1101		SHEET 1 OF 2		METRIC										
G.W.P.		4173-15-00		LOCATION		N 5029589.8; E 366734.2 NAD 83 MTM ZONE 9 (LAT. 45.403510; LONG. -75.708850)		ORIGINATED BY										
DIST		Eastern HWY 417		BOREHOLE TYPE		Rotary Drill, BW Casing/AW Core		COMPILED BY										
DATUM		Geodetic		DATE		November 26, 2018		CHECKED BY										
								KCP										
SOIL PROFILE			SAMPLES			GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT					PLASTIC LIMIT W _p	NATURAL MOISTURE CONTENT W	LIQUID LIMIT W _L	UNIT WEIGHT γ	REMARKS & GRAIN SIZE DISTRIBUTION (%)	
ELEV DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE	"N" VALUES			SHEAR STRENGTH kPa										WATER CONTENT (%)
65.2	GROUND SURFACE							20	40	60	80	100						
0.0	(SM) Silty SAND, contains organic matter (rootlets) (TOPSOIL)		1	SS	8													
0.2	Dark brown Moist																	
	(SP/SM) Sand to silty sand, trace gravel, contains silt seams (FILL)		2	SS	8													
	Brown Moist																	
63.8			3	SS	165/0.15													
63.6	(SM) Gravelly silty sand, contains mortar, asphalt and organic matter (rootlets) (FILL)																	
1.6	Dark brown to black Moist		1	RC	-													
	PORTLAND CEMENT CONCRETE (FOOTING)																	
62.4			2A	RC	-													
2.8	Limestone (BEDROCK)		2B	RC	REC 100%													RQD = 0%
	Bedrock cored from depths 2.8 m to 4.6 m																	
	For bedrock coring details refer to Record of Drillhole 18-1101		3	RC	REC 91%													RQD = 53%
			4	RC	REC 100%													RQD = 28%
60.6	END OF BOREHOLE																	
4.6	NOTES:																	
	1. Manual third weight hammer used for all split spoon samples. "N" values are not representative of ASTM D1586 SPT N values and should be interpreted in consideration of their reduced energy.																	

SHEET 2 OF 2

DATUM: Geodetic

DRILLING CONTRACTOR: CCC

G:\TA-RCK 031 \GOLDER.GDS\GAL\OTTAWA\ACTIVE\SPATIAL IM\IMTO\HWY417\REHAB&WIDENING\02 DATA\GINT\1655214.GPJ GAL-MISS.GDT 19-8-1 JM

LOGGED: RI
CHECKED: KCP

PROJECT		1655214-1110		RECORD OF BOREHOLE No 18-1102		SHEET 1 OF 2		METRIC									
G.W.P.		4173-15-00		LOCATION		N 5029553.8; E 366749.9 NAD 83 MTM ZONE 9 (LAT. 45.403180; LONG. -75.708650)		ORIGINATED BY									
DIST		Eastern HWY 417		BOREHOLE TYPE		Rotary Drill, BW Casing/AW Core		COMPILED BY									
DATUM		Geodetic		DATE		November 26-29, 2018		CHECKED BY									
								KCP									
SOIL PROFILE			SAMPLES			GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT					PLASTIC LIMIT W _p	NATURAL MOISTURE CONTENT W	LIQUID LIMIT W _L	UNIT WEIGHT γ	REMARKS & GRAIN SIZE DISTRIBUTION (%)
ELEV DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE	"N" VALUES			SHEAR STRENGTH kPa									
65.4	GROUND SURFACE																
0.0	(SM) Silty sand, contains organic matter (rootlets) (TOPSOIL)																
65.2	Dark brown		1	SS	1												
0.2	Moist																
	(SP) Sand, trace gravel (FILL)		2	SS	1												
	Brown																
	Moist																
			3	SS	1												
			4	SS	51												
63.1	PORTLAND CEMENT CONCRETE (FOOTING)		1	RC	-												
2.3			2A	RC	-												
62.2	Limestone (BEDROCK)		2B	RC	REC 100%												
3.2	Bedrock cored from depths 3.2 m to 5.1 m																
	For bedrock coring details refer to Record of Drillhole 18-1102		3	RC	REC 97%												
60.3	END OF BOREHOLE																
5.1	NOTES:																
	1. Manual third weight hammer used for all split spoon samples. "N" values are not representative of ASTM D1586 SPT N values and should be interpreted in consideration of their reduced energy.																

PROJECT: 1655214-1110

RECORD OF DRILLHOLE: 18-1102

SHEET 2 OF 2

LOCATION: N 5029553.8 ;E 366749.9

DRILLING DATE: November 26-29, 2018

DATUM: Geodetic

INCLINATION: -90° AZIMUTH: ---

DRILL RIG: Portable Drill

DRILLING CONTRACTOR: CCC

DEPTH SCALE METRES	DRILLING RECORD	DESCRIPTION	SYMBOLIC LOG	ELEV. DEPTH (m)	RUN No.	FLUSH RETURN	NOTE: For abbreviations, symbols and descriptions refer to LITHOLOGICAL AND GEOTECHNICAL ROCK DESCRIPTION TERMINOLOGY														FEATURES																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																							
							RECOVERY		R.Q.D. %	FRACT. INDEX PER	DIP w.r.t. CORE AXIS °	DISCONTINUITY DATA		HYDRAULIC CONDUCTIVITY K, cm/sec	WEATH- ERING INDEX																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																													
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DEPTH SCALE

1 : 50



LOGGED: RI

CHECKED: KCP

GTA-RCK 031 \\GOLDER\GDS\GALOTTAWA\ACTIVE\SPATIAL_IMMTO\HWY417\REHAB&WIDENING\02_DATA\GINT\1655214.GPJ_GAL-MISS.GDT_19-8-1_JM

PROJECT		1655214-1110		RECORD OF BOREHOLE No 18-1103		SHEET 1 OF 2		METRIC										
G.W.P.		4173-15-00		LOCATION		N 5029598.0; E 366763.5 NAD 83 MTM ZONE 9 (LAT. 45.403580; LONG. -75.708470)		ORIGINATED BY		RI								
DIST		Eastern HWY 417		BOREHOLE TYPE		Rotary Drill, HW Casing/HQ Core		COMPILED BY		ZS								
DATUM		Geodetic		DATE		April 16, 2019		CHECKED BY		KCP								
SOIL PROFILE			SAMPLES			GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT					PLASTIC LIMIT W _p	NATURAL MOISTURE CONTENT W	LIQUID LIMIT W _L	UNIT WEIGHT γ	REMARKS & GRAIN SIZE DISTRIBUTION (%)	
ELEV DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE	"N" VALUES			SHEAR STRENGTH kPa										WATER CONTENT (%)
66.3	GROUND SURFACE							20	40	60	80	100						
0.0	(SW) Sand (FILL) Brown Moist		1	SS	4													
65.1																		
1.2	(SM) Gravelly silty sand, contains brick (FILL) Brown Moist to wet		2	SS	13													
64.5																		
1.8	PORTLAND CEMENT CONCRETE (FOOTING)		1	RC	-													
			2	RC	-													
			3A	RC	-													
63.0																		
3.3	Limestone (BEDROCK)		3B	RC	REC 96%													RQD = 0%
	Bedrock cored from depths 3.3 m to 4.9 m		4	RC	REC 96%													RQD = 59%
	For bedrock coring details refer to Record of Drillhole 18-1102		5	RC	REC 98%													RQD = 73%
61.4																		
4.9	END OF BOREHOLE																	
	NOTES: 1. A reduced hammer drop of 0.61 m was used for all split spoon samples. "N" values are not representative of ASTM D1586 SPT N values and should be interpreted in consideration of this reduced energy.																	

GTA-MTO 001 \GOLDER\GDS\GALOTTAWA\ACTIVE\SPATIAL_IMMITO\HWY417\REHAB&WIDENING\02_DATA\GINT\1655214.GPJ GAL-GTA.GDT 19-8-1 JM

PROJECT: 1655214-1110

RECORD OF DRILLHOLE: 18-1103

SHEET 2 OF 2

LOCATION: N 5029598.0 ;E 366763.5

DRILLING DATE: April 16, 2019

DATUM: Geodetic

INCLINATION: -90° AZIMUTH: ---

DRILL RIG: EXPLO 220

DRILLING CONTRACTOR: Marathon Drilling

DEPTH SCALE METRES	DRILLING RECORD	DESCRIPTION	SYMBOLIC LOG	ELEV. DEPTH (m)	RUN No.	NOTE: For abbreviations, symbols and descriptions refer to LITHOLOGICAL AND GEOTECHNICAL ROCK DESCRIPTION TERMINOLOGY														FEATURES																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																	
						RECOVERY		R.Q.D. %	FRACT. INDEX PER	DIP w.r.t CORE AXIS °	DISCONTINUITY DATA		HYDRAULIC CONDUCTIVITY K, cm/sec	WEATH- ERING INDEX																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																							
						TOTAL CORE %	SOLID CORE %				TYPE AND SURFACE DESCRIPTION	Jr		Js	10 ⁻⁵	10 ⁻⁴	10 ⁻³	W1	W2		W3	W4	W5	W6																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																													
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DEPTH SCALE

1 : 50

**GOLDER**

LOGGED: RI

CHECKED: KCP

GTA-RCK 031 \\GOLDER\GDS\GAL\Ottawa\ACTIVE\SPATIAL_IM\IMTO\HWY417\REHAB&WIDENING\02_DATA\GINT\1655214.GPJ_GAL-MISS.GDT_19-8-1_JM

PROJECT		RECORD OF BOREHOLE No 18-1104				SHEET 1 OF 2		METRIC										
G.W.P. 1655214-1110		LOCATION N 5029561.2; E 366775.7 NAD 83 MTM ZONE 9 (LAT. 45.403240; LONG. -75.708320)		ORIGINATED BY RI														
DIST Eastern HWY 417		BOREHOLE TYPE Rotary Drill, HW Casing/HQ Core		COMPILED BY ZS														
DATUM Geodetic		DATE April 18, 2019		CHECKED BY KCP														
SOIL PROFILE			SAMPLES			GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT					PLASTIC LIMIT W _p	NATURAL MOISTURE CONTENT W	LIQUID LIMIT W _L	UNIT WEIGHT γ	REMARKS & GRAIN SIZE DISTRIBUTION (%)	
ELEV DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE	"N" VALUES			SHEAR STRENGTH kPa										WATER CONTENT (%)
65.3 0.0	GROUND SURFACE (SW) Sand, trace gravel (FILL) Brown Moist		1	SS	3		65											
			2	SS	3													
63.9 1.4	PORTLAND CEMENT CONCRETE (FOOTING)		1	RC	-		64											
			2A	RC	-													
62.8 2.5	Limestone (BEDROCK) Bedrock cored from depths 2.5 m to 4.8 m For bedrock coring details refer to Record of Drillhole 18-1102		2B	RC	REC 100%		63											RQD = 0%
			3	RC	REC 77%													RQD = 0%
			4	RC	REC 88%													RQD = 53%
			5	RC	REC 98%													RQD = 96%
60.6 4.8	END OF BOREHOLE NOTES: 1. A reduced hammer drop of 0.61 m was used for all split spoon samples. "N" values are not representative of ASTM D1586 SPT N values and should be interpreted in consideration of this reduced energy.						61											

PROJECT: 1655214-1110

RECORD OF DRILLHOLE: 18-1104

SHEET 2 OF 2

LOCATION: N 5029561.2 ; E 366775.7

DRILLING DATE: April 18, 2019

DATUM: Geodetic

INCLINATION: -90° AZIMUTH: ---

DRILL RIG: EXPLO 220

DRILLING CONTRACTOR: Marathon Drilling

DEPTH SCALE METRES	DRILLING RECORD	DESCRIPTION	SYMBOLIC LOG	ELEV. DEPTH (m)	RUN No.	FLUSH RETURN	NOTE: For abbreviations, symbols and descriptions refer to LITHOLOGICAL AND GEOTECHNICAL ROCK DESCRIPTION TERMINOLOGY														FEATURES			
							RECOVERY		R.Q.D. %	FRACT. INDEX PER	DIP w.r.t. CORE AXIS	DISCONTINUITY DATA		HYDRAULIC CONDUCTIVITY K, cm/sec	WEATH- ERING INDEX									
							TOTAL CORE %	SOLID CORE %				TYPE AND SURFACE DESCRIPTION	Jr		Ja	W1	W2	W3	W4	W5		W6		
							000000 000000 000000 000000 000000	000000 000000 000000 000000 000000															000000 000000 000000 000000 000000	000000 000000 000000 000000 000000
		Continued from Record of Borehole 18-1104		63.90																				
2	Rotary Drill HQ Core	PORTLAND CEMENT CONCRETE (FOOTING)		1.40	1																			
					2A																			
				62.78	2B	100																		
				2.52	3	100																		
					4	100																		
4		Limestone (BEDROCK), with black shale partings Fresh to slightly weathered Thinly to medium bedded Grey to brown Fine to medium grained non-porous Medium strong			5	100																		
5		END OF DRILLHOLE		60.55 4.75																				
5																								
6																								
7																								
8																								
9																								
10																								
11																								

DEPTH SCALE

1 : 50



LOGGED: RI

CHECKED: KCP

GTA-RCK 031 \\GOLDER\GDS\GALOTTAWA\ACTIVE\SPATIAL_IMMTOHWY417\REHAB&WIDENING\02_DATA\GINT\1655214.GPJ_GAL-MISS.GDT_19-8-1_JM

PROJECT		RECORD OF BOREHOLE No 18-1105				SHEET 1 OF 2		METRIC									
G.W.P. 1655214-1110		LOCATION N 5029588.3; E 366729.2 NAD 83 MTM ZONE 9 (LAT. 45.403490; LONG. -75.708910)		ORIGINATED BY RI													
DIST Eastern HWY 417		BOREHOLE TYPE Rotary Drill, BW Casing/AW Core		COMPILED BY ZS													
DATUM Geodetic		DATE November 26-28, 2018		CHECKED BY KCP													
SOIL PROFILE			SAMPLES			GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT					PLASTIC LIMIT W _p	NATURAL MOISTURE CONTENT W	LIQUID LIMIT W _L	UNIT WEIGHT γ	REMARKS & GRAIN SIZE DISTRIBUTION (%)
ELEV DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE	"N" VALUES			SHEAR STRENGTH kPa									
67.3	GROUND SURFACE																
0.0	(SM) Silty sand, contains organic matter (rootlets) (TOPSOIL)																
0.2	Dark brown Moist		1	SS	7												
	(SP) SAND (FILL)																
	Brown Moist		2	SS	15												
			3	SS	9												
			4	SS	6												
64.7	(SP/GP) Gravel and sand, contains asphalt, mortar, concrete and organic matter (rootlets) (FILL)		5	SS	39												
64.2	Dark brown to black Moist		6	SS	150/0.08												
64.2	PORTLAND CEMENT CONCRETE (FOOTING)		1	RC	-												
63.2	Limestone (BEDROCK)		2	RC	REC 94%												
4.1	Bedrock cored from depths 4.1 m to 5.1 m		3	RC	REC 91%												
	For bedrock coring details refer to Record of Drillhole 18-1105		4	RC	REC 92%												
			5	RC	REC 100%												
61.5	END OF BOREHOLE																
5.8	NOTES:																
	1. Manual third weight hammer used for all split spoon samples. "N" values are not representative of ASTM D1586 SPT N values and should be interpreted in consideration of their reduced energy.																

PROJECT: 1655214-1110

RECORD OF DRILLHOLE: 18-1105

SHEET 2 OF 2

LOCATION: N 5029588.3 ;E 366729.2

DRILLING DATE: November 26-28, 2018

DATUM: Geodetic

INCLINATION: -90° AZIMUTH: ---

DRILL RIG: Portable Drill

DRILLING CONTRACTOR: CCC

DEPTH SCALE METRES	DRILLING RECORD	DESCRIPTION	SYMBOLIC LOG	ELEV. DEPTH (m)	RUN No.	FLUSH RETURN	NOTE: For abbreviations, symbols and descriptions refer to LITHOLOGICAL AND GEOTECHNICAL ROCK DESCRIPTION TERMINOLOGY														FEATURES				
							RECOVERY		R.Q.D. %	FRACT. INDEX PER	DIP w.r.t CORE AXIS °	DISCONTINUITY DATA		HYDRAULIC CONDUCTIVITY K, cm/sec	WEATH- ERING INDEX										
							TOTAL CORE %	SOLID CORE %				Jr	Js		W1	W2	W3	W4	W5	W6					
																						TYPE AND SURFACE DESCRIPTION	10°	10°	10°
		Continued from Record of Borehole 18-1105		64.16																					
	Rotary Drill AW Core	PORTLAND CEMENT CONCRETE (FOOTING)		3.15																					
4				1																					
		Limestone (BEDROCK), with black shale partings Fresh Thinly to medium bedded Grey to brown Fine to medium grained Non-porous Medium strong		63.20 4.11																					
				2	0																				
5				3	0																				
				4	0																				
			5	0																					
6		END OF DRILLHOLE		61.50 5.81																					
7																									
8																									
9																									
10																									
11																									
12																									
13																									

DEPTH SCALE

1 : 50

**GOLDER**

LOGGED: RI

CHECKED: KCP

GTA-RCK 031 \\GOLDER\GDS\GAL\OITAWA\ACTIVE\SPATIAL_IMMTO\HWY417\REHAB&WIDENING\02_DATA\GINT\1655214.GPJ_GAL-MISS.GDT_19-8-1_JM

PROJECT		RECORD OF BOREHOLE				No 18-1106		SHEET 1 OF 2		METRIC							
G.W.P. 4173-15-00		LOCATION		N 5029552.5; E 366745.0 NAD 83 MTM ZONE 9 (LAT. 45.403170; LONG. -75.708720)				ORIGINATED BY RI									
DIST Eastern HWY 417		BOREHOLE TYPE		Rotary Drill, BW Casing/AW Core				COMPILED BY ZS									
DATUM Geodetic		DATE		November 26-29, 2018				CHECKED BY KCP									
SOIL PROFILE			SAMPLES			GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT					PLASTIC LIMIT W _p	NATURAL MOISTURE CONTENT W	LIQUID LIMIT W _L	UNIT WEIGHT γ	REMARKS & GRAIN SIZE DISTRIBUTION (%)
ELEV DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE	"N" VALUES			SHEAR STRENGTH kPa									
67.1	GROUND SURFACE							20	40	60	80	100					
66.9	(SM) Silty sand, contains organic matter (rootlets)		1	SS	5												
0.2	Dark brown Moist																
	(SP) Sand, trace gravel and silt (FILL)		2	SS	11												
	Brown to red-brown Moist																
			3	SS	6												
			4	SS	9												
			5	SS	8												
			6	SS	11												
63.6	PORTLAND CEMENT CONCRETE (FOOTING)		1	RC	-												
			2A	RC	-												
62.7	Limestone (BEDROCK)																
4.4	Bedrock cored from depths 4.4 m to 6.2 m		3	RC	REC 100%												RQD = 19%
	For bedrock coring details refer to Record of Drillhole 18-1106		4	RC	REC 85%												RQD = 20%
			5	RC	REC 100%												RQD = 46%
60.9	END OF BOREHOLE																
6.2	NOTES:																
	1. Manual third weight hammer used for all split spoon samples. "N" values are not representative of ASTM D1586 SPT N values and should be interpreted in consideration of their reduced energy.																

PROJECT: 1655214-1110

RECORD OF DRILLHOLE: 18-1106

SHEET 2 OF 2

LOCATION: N 5029552.5 ;E 366745.0

DRILLING DATE: November 26-29, 2018

DATUM: Geodetic

INCLINATION: -90° AZIMUTH: ---

DRILL RIG: Portable Drill

DRILLING CONTRACTOR: CCC

DEPTH SCALE METRES	DRILLING RECORD	DESCRIPTION	SYMBOLIC LOG	ELEV. DEPTH (m)	RUN No.	NOTE: For abbreviations, symbols and descriptions refer to LITHOLOGICAL AND GEOTECHNICAL ROCK DESCRIPTION TERMINOLOGY														FEATURES																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																						
						RECOVERY		R.Q.D. %	FRACT. INDEX PER	DIP w.r.t. CORE AXIS °	DISCONTINUITY DATA		HYDRAULIC CONDUCTIVITY K, cm/sec	WEATH- ERING INDEX																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																												
						TOTAL CORE %	SOLID CORE %				TYPE AND SURFACE DESCRIPTION	Jr		Js	10 ⁻⁵	10 ⁻⁴	10 ⁻³	W1	W2		W3	W4	W5	W6																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																		
		Continued from Record of Borehole 18-1106		63.61																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																						</

DEPTH SCALE

1 : 50

**GOLDER**

LOGGED: RI

CHECKED: KCP

GTA-RCK 031 \\GOLDER\GDS\GAL\OITAWA\ACTIVE\SPATIAL_IMMTOHWY417\REHAB&WIDENING\02_DATA\GINT\1655214.GPJ_GAL-MISS.GDT_19-8-1_JM

PROJECT		RECORD OF BOREHOLE No 18-1107				SHEET 1 OF 2		METRIC									
G.W.P. 1655214-1110		LOCATION N 5029599.8; E 366768.6 NAD 83 MTM ZONE 9 (LAT. 45.403590; LONG. -75.708410)		ORIGINATED BY RI													
DIST Eastern HWY 417		BOREHOLE TYPE Rotary Drill, HW Casing/HQ Core		COMPILED BY ZS													
DATUM Geodetic		DATE April 17, 2019		CHECKED BY KCP													
SOIL PROFILE			SAMPLES			GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT					PLASTIC LIMIT W _p	NATURAL MOISTURE CONTENT W	LIQUID LIMIT W _L	UNIT WEIGHT γ	REMARKS & GRAIN SIZE DISTRIBUTION (%)
ELEV DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE	"N" VALUES			SHEAR STRENGTH kPa									
68.9 0.0	GROUND SURFACE (SW) Sand, some silt, trace gravel (FILL) Dark brown to brown moist to wet		1	SS	7												4 84 (12)
			2	SS	2												
64.9 4.3	(SW) Sand, some gravel, contains cobbles and wood (FILL) Brown Moist to wet PORTLAND CEMENT CONCRETE (FOOTING)		4	SS	50/0.08												
			1	RC	-												
			2A	RC	-												
63.6 5.3	Limestone (BEDROCK) Bedrock cored from depths 5.3 m to 6.9 m For bedrock coring details refer to Record of Drillhole 18-1107																RQD = 82%
			2B	RC	REC 100%												
			3	RC	REC 97%												
62.0 6.9	END OF BOREHOLE NOTES: 1. A reduced hammer drop of 0.61 m was used for all split spoon samples. "N" values are not representative of ASTM D1586 SPT N values and should be interpreted in consideration of this reduced energy.																

SHEET 2 OF 2

DATUM: Geodetic

DRILLING CONTRACTOR: Marathon Drilling

[illegible]

DEPTH SCALE

1 : 50



GOLDER

LOGGED: RI

CHECKED: KCP

GTA-RCK 031 \\GOLDER.GDS\GAL\OTTAWA\ACTIVE\SPATIAL IM\MTOWH\WY417\REHAB&WIDENING\02 DATA\GINT\1655214.GPJ GAL-MISS.GDT 19-8-1 JM

PROJECT		RECORD OF BOREHOLE No 18-1108				SHEET 1 OF 2		METRIC									
G.W.P. 1655214-1110		LOCATION N 5029563.3; E 366782.6 NAD 83 MTM ZONE 9 (LAT. 45.403260; LONG. -75.708230)		ORIGINATED BY RI													
DIST Eastern HWY 417		BOREHOLE TYPE Rotary Drill, HW Casing/HQ Core		COMPILED BY ZS													
DATUM Geodetic		DATE April 22, 2019		CHECKED BY KCP													
SOIL PROFILE			SAMPLES			GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT					PLASTIC LIMIT W _p	NATURAL MOISTURE CONTENT W	LIQUID LIMIT W _L	UNIT WEIGHT γ	REMARKS & GRAIN SIZE DISTRIBUTION (%)
ELEV DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE	"N" VALUES			SHEAR STRENGTH kPa									
68.7 0.0	GROUND SURFACE (SW) Sand (FILL) Brown Moist to wet		1	SS	3												0 94 (6)
66.0 2.7	(SM) Silty sand, trace gravel, contains roots, wood and cobbles (FILL) Brown to dark brown Wet		3	SS	5												
64.7 4.0	PORTLAND CEMENT CONCRETE (FOOTING)		1	RC	-												
				2A	RC	-											
63.1 5.6	Limestone (BEDROCK) Bedrock cored from depths 5.6 m to 7.2 m For bedrock coring details refer to Record of Drillhole 18-1108		2B	RC	REC 100%												RQD = 43%
				3	RC	REC 88%											RQD = 81%
61.5 7.2	END OF BOREHOLE NOTES: 1. A reduced hammer drop of 0.61 m was used for all split spoon samples. "N" values are not representative of ASTM D1586 SPT N values and should be interpreted in consideration of this reduced energy.																

PROJECT: 1655214-1110

RECORD OF DRILLHOLE: 18-1108

SHEET 2 OF 2

LOCATION: N 5029563.3 ; E 366782.6

DRILLING DATE: April 22, 2019

DATUM: Geodetic

INCLINATION: -90° AZIMUTH: ---

DRILL RIG: EXPLO 220

DRILLING CONTRACTOR: Marathon Drilling

DEPTH SCALE METRES	DRILLING RECORD		DESCRIPTION	SYMBOLIC LOG	ELEV. DEPTH (m)	RUN No.	FLUSH RETURN	NOTE: For abbreviations, symbols and descriptions refer to LITHOLOGICAL AND GEOTECHNICAL ROCK DESCRIPTION TERMINOLOGY														FEATURES																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																								
								RECOVERY		R.Q.D. %	FRACT. INDEX PER	DISCONTINUITY DATA				HYDRAULIC CONDUCTIVITY K, cm/sec		WEATH- ERING INDEX																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																												
								TOTAL CORE %	SOLID CORE %			TYPE AND SURFACE DESCRIPTION	Jr	Ja	10 ⁻⁵ 10 ⁻⁴ 10 ⁻³ 10 ⁻² 10 ⁻¹	10 ⁻⁵ 10 ⁻⁴ 10 ⁻³ 10 ⁻² 10 ⁻¹	W1 W2 W3 W4 W5 W6																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																													
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			Continued from Record of Borehole 18-1108		64.64																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																									

DEPTH SCALE

1 : 50

**GOLDER**

LOGGED: RI

CHECKED: KCP

GTA-RCK 031 \\GOLDER\GDS\GALOTTAWA\ACTIVE\SPATIAL_IMMTO\HWY417\REHAB&WIDENING\02_DATA\GINT\1655214.GPJ_GAL-MISS.GDT_19-8-1_JM

PROJECT		1655214-1110		RECORD OF BOREHOLE No 18-1109		SHEET 1 OF 1		METRIC																
G.W.P.		4173-15-00		LOCATION		N 5029583.4; E 366730.9 NAD 83 MTM ZONE 9 (LAT. 45.403450; LONG. -75.708890)		ORIGINATED BY																
DIST		Eastern HWY 417		BOREHOLE TYPE		Power Auger, 200 mm Diam. (Hollow Stem)		COMPILED BY																
DATUM		Geodetic		DATE		October 11-12, 2018		CHECKED BY																
KCP																								
SOIL PROFILE			SAMPLES			GROUND WATER CONDITIONS			ELEVATION SCALE			DYNAMIC CONE PENETRATION RESISTANCE PLOT			PLASTIC LIMIT NATURAL MOISTURE CONTENT LIQUID LIMIT			UNIT WEIGHT			REMARKS & GRAIN SIZE DISTRIBUTION (%)			
ELEV	DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE	"N" VALUES																		
69.3		GROUND SURFACE																						
0.0		ASPHALTIC CONCRETE																						
68.9		PORTLAND CEMENT CONCRETE																						
0.4		(SP) Sand and gravel (FILL) Grey																						
68.6		(SP) Sand, trace silt (FILL) Very dense Brown Moist		1	SS	52																		
0.7																								
				2	SS	53																		
				3	SS	58																		
				4	SS	54																		
				5	SS	75																		
65.0		(GM/SM) Sandy Silty CLAYEY GRAVEL, contains shale bedrock fragments, contains cobbles (TILL) Dense Brown Moist		6	SS	60/0.15																		
4.3																								
				7	SS	50/0.08																		
				8	SS	54/0.08																		
63.7		END OF BOREHOLE AUGER REFUSAL																						
5.6		NOTES: 1. Borehole dry upon completion of drilling.																						

SHEET 1 OF 1

DATUM: Geodetic

DRILLING CONTRACTOR: Downing Drilling

[illegible]

DEPTH SCALE

1 : 50



GOLDER

LOGGED: RI

CHECKED: KCP

PROJECT		1655214-1110		RECORD OF BOREHOLE No 18-1110		SHEET 1 OF 1		METRIC									
G.W.P.		4173-15-00		LOCATION		N 5029566.6; E 366733.4 NAD 83 MTM ZONE 9 (LAT. 45.403300; LONG. -75.708860)		ORIGINATED BY		RI							
DIST		Eastern HWY 417		BOREHOLE TYPE		Power Auger, 200 mm Diam. (Hollow Stem)		COMPILED BY		ZS							
DATUM		Geodetic		DATE		October 3-4, 2018		CHECKED BY		KCP							
SOIL PROFILE			SAMPLES			GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT					PLASTIC LIMIT W _p	NATURAL MOISTURE CONTENT W	LIQUID LIMIT W _L	UNIT WEIGHT γ	REMARKS & GRAIN SIZE DISTRIBUTION (%)
ELEV DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE	"N" VALUES			SHEAR STRENGTH kPa									
69.2	GROUND SURFACE																
0.0	ASPHALTIC CONCRETE																
68.9																	
0.3	(SM/SW) Gravel and sand (FILL) Grey Moist		1	GS	-												
68.4																	
0.8	(SP) Sand, trace silt (FILL) Very dense Brown Moist		2	SS	85												
			3	SS	54												
			4	SS	60												
			5	SS	63												
65.4			6	SS	53/0.13												
3.8	(GM/SM) Sandy Silty CLAYEY GRAVEL, contains cobbles (TILL) Dense Brown Moist																
			7	SS	53/0.13												
64.5																	
4.7	END OF BOREHOLE AUGER REFUSAL																

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PROJECT		1655214-1110		RECORD OF BOREHOLE No 18-1111		SHEET 1 OF 1		METRIC									
G.W.P.		4173-15-00		LOCATION		N 5029583.0; E 366771.4 NAD 83 MTM ZONE 9 (LAT. 45.403440; LONG. -75.708370)		ORIGINATED BY									
DIST		Eastern HWY 417		BOREHOLE TYPE		Power Auger, 200 mm Diam. (Hollow Stem)		COMPILED BY									
DATUM		Geodetic		DATE		October 4-5, 2018		CHECKED BY									
KCP																	
SOIL PROFILE			SAMPLES			GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT					PLASTIC LIMIT W _p	NATURAL MOISTURE CONTENT W	LIQUID LIMIT W _L	UNIT WEIGHT γ	REMARKS & GRAIN SIZE DISTRIBUTION (%)
ELEV DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE	"N" VALUES			SHEAR STRENGTH kPa									
70.3	GROUND SURFACE																
0.0	ASPHALTIC CONCRETE																
70.0																	
0.3	(SW) Gravel and sand (FILL) Grey Moist																
69.4																	
0.9	(SP) Sand, trace silt (FILL) Dense to compact Brown Moist		1	SS	32												
			2	SS	25												
			3	SS	19												
			4	SS	22												
			5	SS	25												
			6	SS	29												
65.0																	
5.3	(SM) Gravel and sand, trace silt and clay (FILL) Compact Brown Moist		7	SS	17												
			8	SS	55/0.13												
63.9																	
6.4	END OF BOREHOLE SAMPLER REFUSAL																

PROJECT		1655214-1110		RECORD OF BOREHOLE No 18-1112		SHEET 1 OF 1		METRIC										
G.W.P.		4173-15-00		LOCATION		N 5029567.3; E 366779.6 NAD 83 MTM ZONE 9 (LAT. 45.403300; LONG. -75.708270)		ORIGINATED BY										
DIST		Eastern HWY 417		BOREHOLE TYPE		Power Auger, 200 mm Diam. (Hollow Stem)		COMPILED BY										
DATUM		Geodetic		DATE		October 9-10, 2018		CHECKED BY										
KCP																		
SOIL PROFILE		SAMPLES			GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT					PLASTIC LIMIT NATURAL MOISTURE CONTENT LIQUID LIMIT			UNIT WEIGHT γ	REMARKS & GRAIN SIZE DISTRIBUTION (%)		
ELEV DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE			"N" VALUES	SHEAR STRENGTH kPa					W _p	W			W _L	
70.5	GROUND SURFACE						20	40	60	80	100							
70.3	ASPHALTIC CONCRETE																	
70.1	CONCRETE																	
0.4	(SW) Gravelly sand, angular (FILL) Grey Moist		1	GS	-	70												
69.7																		
0.8	(SP) Sand, trace silt (FILL) Very dense to very loose Brown Moist		2	SS	40													
						69												
			3	SS	26													
			4	SS	61	68												1 92 (7)
			5	SS	42	67												
			6	SS	72													0 93 (7)
						66												
			7	SS	67													
			8	SS	19	65												
			9	SS	2	64												
63.3			10	SS	54													
63.1	(SM) Sandy Silty CLAYEY GRAVEL (TILL) Very dense Grey Moist																	
7.4	END OF BOREHOLE AUGER REFUSAL																	
NOTES: 1. Water level in well screen at a depth of 7.4 m below ground surface (Elev. 63.1 m), measured on Dec. 6, 2018.																		

SHEET 1 OF 1

DATUM: Geodetic

DRILLING CONTRACTOR: Downing Drilling

GTA-RCK 031 \\GOLDER.GDS\GAL\OTTAWA\ACTIVE\SPATIAL IM\IMTO\HWY417\REHAB&WIDENING\02 DATA\GINT\1655214.GPJ GAL-MISS.GDT 19-8-1 JM

LOGGED: RI
CHECKED: KCP

PROJECT <u>1655214-1110</u>		RECORD OF BOREHOLE No 18-1113		SHEET 1 OF 1		METRIC	
G.W.P. <u>4173-15-00</u>		LOCATION <u>N 5029656.7; E 366528.9 NAD 83 MTM ZONE 9 (LAT. 45.404130; LONG. -75.711460)</u>		ORIGINATED BY <u>PAH</u>			
DIST <u>Eastern</u> HWY <u>417</u>		BOREHOLE TYPE <u>Power Auger, 200 mm Diam. (Hollow Stem)</u>		COMPILED BY <u>ZS</u>			
DATUM <u>Geodetic</u>		DATE <u>November 20, 2018</u>		CHECKED BY <u>KCP</u>			

SOIL PROFILE			SAMPLES			GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT					PLASTIC LIMIT NATURAL MOISTURE LIQUID CONTENT LIMIT			UNIT WEIGHT γ kN/m³	REMARKS & GRAIN SIZE DISTRIBUTION (%) GR SA SI CL
ELEV DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE	"N" VALUES			SHEAR STRENGTH kPa					WATER CONTENT (%)				
								○ UNCONFINED + FIELD VANE ● QUICK TRIAXIAL × REMOULDED									
59.1	GROUND SURFACE						20	40	60	80	100						
0.0	TOPSOIL																
58.9																	
0.2	(SP) Sand (FILL) Loose Brown to red-brown Moist		1	SS	7												
58.3																	
0.8	(CL-ML) Clayey silt, trace gravel, occasional sand seams (FILL) Loose Brown Moist		2	SS	8												
57.7																	
1.4	(SM) Silty sand (FILL) Compact Brown Moist		3	SS	10												
57.0																	
2.1	(GP) Sand and gravel, trace silt (FILL) Compact Brown Moist		4	SS	15												
55.8																	
3.3	END OF BOREHOLE AUGER REFUSAL		5	SS	75/0.10												

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SHEET 1 OF 1

DATUM: Geodetic

DRILLING CONTRACTOR: Marathon Drilling

[illegible]

DEPTH SCALE

1 : 50



GOLDER

LOGGED: PAH

CHECKED: KCP

GTA-RCK 031 \\GOLDER.GDS\GAL\OTTAWA\ACTIVE\SPATIAL_IMMTO\HWY417\REHAB&WIDENING\02_DATA\GINT\1655214.GPJ GAL-MISS.GDT 19-8-1 JM

PROJECT 1655214-1110		RECORD OF BOREHOLE No 18-1114		SHEET 1 OF 1		METRIC	
G.W.P. 4173-15-00		LOCATION N 5029639.5; E 366600.0 NAD 83 MTM ZONE 9 (LAT. 45.403970; LONG. -75.710560)		ORIGINATED BY PAH			
DIST Eastern HWY 417		BOREHOLE TYPE Power Auger, 200 mm Diam. (Hollow Stem)		COMPILED BY ZS			
DATUM Geodetic		DATE November 19, 2018		CHECKED BY KCP			

SOIL PROFILE			SAMPLES			GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT		PLASTIC LIMIT NATURAL MOISTURE LIQUID LIMIT CONTENT			UNIT WEIGHT γ kN/m³	REMARKS & GRAIN SIZE DISTRIBUTION (%) GR SA SI CL				
ELEV DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE	"N" VALUES			SHEAR STRENGTH kPa							WATER CONTENT (%)			
								○ UNCONFINED + FIELD VANE ● QUICK TRIAXIAL × REMOULDED							w _p w w _L			
59.6	GROUND SURFACE							20	40	60	80	100		25	50	75		
0.0	TOPSOIL																	
0.2	(SM) Silty sand, contains organic matter (FILL)		1	SS	6		59											
59.2	Loose Dark brown moist																	
0.5	(SP) Sand, trace gravel (FILL)																	
58.5	Compact Brown Moist		2	SS	32													
1.1	(GP) Sandy gravel, trace silt, contains cobbles (FILL)						58											
			3	SS	9													
57.5	(GP/SP) Gravel and sand, mixed with concrete, brick debris and organic matter (FILL)																	
2.1			4	SS	4		57											
			5	SS	9		56											
55.9	MARL, contains shells Light brown to grey Very loose																	
3.7			6	SS	WH													
55.1	Limestone (BEDROCK)																	
4.6	END OF BOREHOLE AUGER REFUSAL		7	SS	-		55											

SHEET 1 OF 1

DATUM: Geodetic

DRILLING CONTRACTOR: Marathon Drilling

[illegible]

DEPTH SCALE

1 : 50



GOLDER

LOGGED: PAH

CHECKED: KCP

PROJECT		1655214-1110		RECORD OF BOREHOLE No 18-1115		SHEET 1 OF 1		METRIC								
G.W.P.		4173-15-00		LOCATION		N 5029594.6; E 366557.5 NAD 83 MTM ZONE 9 (LAT. 45.403560; LONG. -75.711110)		ORIGINATED BY PAH								
DIST		Eastern HWY 417		BOREHOLE TYPE		Power Auger, 200 mm Diam. (Hollow Stem)		COMPILED BY ZS								
DATUM		Geodetic		DATE		November 19, 2018		CHECKED BY KCP								
SOIL PROFILE			SAMPLES			GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT				PLASTIC LIMIT W _p	NATURAL MOISTURE CONTENT W	LIQUID LIMIT W _L	UNIT WEIGHT γ	REMARKS & GRAIN SIZE DISTRIBUTION (%)
ELEV DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE	"N" VALUES			SHEAR STRENGTH kPa								
59.3	GROUND SURFACE															
0.0	TOPSOIL															
0.2	(SP) Sand (FILL) Loose Brown to red-brown Moist		1	SS	7		59									
58.5																
0.8	(GP) Sandy gravel (FILL) Compact Brown Moist		2	SS	25		58									
			3	SS	23											
			4	SS	18		57									
			5	SS	31/0.15		56									
56.0	END OF BOREHOLE AUGER REFUSAL															
3.4																

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SHEET 1 OF 1

DATUM: Geodetic

DRILLING CONTRACTOR: Marathon Drilling

[illegible]

DEPTH SCALE

1 : 50



GOLDER

LOGGED: PAH

CHECKED: KCP

PROJECT <u>1655214-1120</u>		RECORD OF BOREHOLE No 18-1209		SHEET 1 OF 1		METRIC	
G.W.P. <u>4173-15-00</u>		LOCATION <u>N 5029514.3; E 366806.2 NAD 83 MTM ZONE 9 (LAT. 45.402820; LONG. -75.707940)</u>		ORIGINATED BY <u>PAH</u>			
DIST <u>Eastern</u> HWY <u>417</u>		BOREHOLE TYPE <u>Power Auger, 200 mm Diam. (Hollow Stem)</u>		COMPILED BY <u>ZS</u>			
DATUM <u>Geodetic</u>		DATE <u>January 27, 2019</u>		CHECKED BY <u>KCP</u>			

SOIL PROFILE			SAMPLES			GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT					PLASTIC LIMIT NATURAL MOISTURE LIQUID CONTENT			UNIT WEIGHT γ kN/m³	REMARKS & GRAIN SIZE DISTRIBUTION (%)			
ELEV DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE	"N" VALUES			SHEAR STRENGTH kPa					WATER CONTENT (%)				GR	SA	SI	CL
								○ UNCONFINED + FIELD VANE	20	40	60	80	100	W _p	W		W _L			
65.3	GROUND SURFACE					● QUICK TRIAXIAL × REMOULDED	20	40	60	80	100									
64.8	ASPHALTIC CONCRETE (40 mm) (SP) Gravelly sand, angular (FILL) Grey		1	GS	-															
64.7			2	GS	-															
64.3	(SM) Silty sand, trace gravel, angular (FILL) Grey brown		3	GS	-															
1.0	END OF BOREHOLE AUGER REFUSAL NOTE: 1. Borehole dry upon completion of drilling																			

PROJECT <u>1655214-1120</u>		RECORD OF BOREHOLE No 18-1210		SHEET 1 OF 1		METRIC	
G.W.P. <u>4173-15-00</u>		LOCATION <u>N 5029529.9; E 366838.3 NAD 83 MTM ZONE 9 (LAT. 45.402960; LONG. -75.707530)</u>		ORIGINATED BY <u>PAH</u>			
DIST <u>Eastern</u> HWY <u>417</u>		BOREHOLE TYPE <u>Power Auger, 200 mm Diam. (Hollow Stem)</u>		COMPILED BY <u>ZS</u>			
DATUM <u>Geodetic</u>		DATE <u>January 27, 2019</u>		CHECKED BY <u>KCP</u>			

SOIL PROFILE			SAMPLES			GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT					PLASTIC LIMIT NATURAL MOISTURE CONTENT LIQUID LIMIT			UNIT WEIGHT γ kN/m³	REMARKS & GRAIN SIZE DISTRIBUTION (%)			
ELEV DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE	"N" VALUES			SHEAR STRENGTH kPa					WATER CONTENT (%)				GR	SA	SI	CL
								20	40	60	80	100	W _p	W	W _L					
66.0	GROUND SURFACE																			
65.7	ASPHALTIC CONCRETE (50 mm) (SP) Gravelly sand, angular (FILL) Grey		1	GS	-															
65.4	(SM) Silty sand, angular (FILL) Grey brown		2	SS	50/0.225															
65.0	END OF BOREHOLE AUGER REFUSAL																			
1.0	NOTE: 1. Borehole dry upon completion of drilling																			

+ ³, × ³: Numbers refer to Sensitivity ○ 3% STRAIN AT FAILURE

GTA-MTO 001 N:\ACTIVE\SPATIAL_IMMT\HWHY417REHAB&WIDENING\02_DATA\GINT\1655214.GPJ GAL-GTA.GDT 6/12/19 JM

PROJECT		1655214-1120		RECORD OF BOREHOLE No 18-1211		SHEET 1 OF 1		METRIC									
G.W.P.		4173-15-00		LOCATION		N 5029545.2; E 366884.1 NAD 83 MTM ZONE 9 (LAT. 45.403090; LONG. -75.706940)		ORIGINATED BY PAH									
DIST		Eastern HWY 417		BOREHOLE TYPE		Power Auger, 200 mm Diam. (Hollow Stem)		COMPILED BY ZS									
DATUM		Geodetic		DATE		January 27, 2019		CHECKED BY KCP									
SOIL PROFILE			SAMPLES			GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT					PLASTIC LIMIT W _p	NATURAL MOISTURE CONTENT W	LIQUID LIMIT W _L	UNIT WEIGHT γ	REMARKS & GRAIN SIZE DISTRIBUTION (%)
ELEV DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE	"N" VALUES			SHEAR STRENGTH kPa									
66.8	GROUND SURFACE																
66.8	ASPHALTIC CONCRETE (40 mm)	X	1	GS	-												
	(SW) Gravelly sand (FILL)		2	GS	-												
66.3	Grey																
0.5	(SM) Silty sand, angular (FILL)		3	SS	56												
	Very dense																
	Grey brown																
65.2	END OF BOREHOLE		4	SS	50/0.08												
1.6	AUGER REFUSAL																

PROJECT <u>1655214-1120</u>		RECORD OF BOREHOLE No 18-1212		SHEET 1 OF 1		METRIC	
G.W.P. <u>4173-15-00</u>		LOCATION <u>N 5029556.0; E 366916.4 NAD 83 MTM ZONE 9 (LAT. 45.403190; LONG. -75.706520)</u>		ORIGINATED BY <u>KM</u>			
DIST <u>Eastern</u> HWY <u>417</u>		BOREHOLE TYPE <u>Power Auger, 200 mm Diam. (Hollow Stem)</u>		COMPILED BY <u>ZS</u>			
DATUM <u>Geodetic</u>		DATE <u>November 19, 2018</u>		CHECKED BY <u>KCP</u>			

SOIL PROFILE			SAMPLES			GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT			PLASTIC NATURAL LIQUID LIMIT MOISTURE LIMIT CONTENT			UNIT WEIGHT γ kN/m ³	REMARKS & GRAIN SIZE DISTRIBUTION (%) GR SA SI CL	
ELEV DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE	"N" VALUES			SHEAR STRENGTH kPa			WATER CONTENT (%)					
								○ UNCONFINED	+	FIELD VANE	● QUICK TRIAXIAL	×	REMOULDED			W _p
67.2	GROUND SURFACE						20	40	60	80	100					
0.0	ASPHALTIC CONCRETE (70 mm)															
0.1	(GM/SM) Gravel and sand, contains cobbles and boulders (FILL) Dense Brown Moist		1	SS	31											
			2	SS	36											
65.6	END OF BOREHOLE AUGER REFUSAL		3	SS	50/0.05											
1.6	NOTE: 1. Borehole dry upon completion of drilling															

GTA-MTO 001 N:\ACTIVE\SPATIAL_IMMTO\HWY417REHAB&WIDENING\02_DATA\GINT\1655214.GPJ GAL-GTA.GDT 6/12/19 JM

PROJECT <u>1655214-1120</u>		RECORD OF BOREHOLE No 18-1213		SHEET 1 OF 1		METRIC	
G.W.P. <u>4173-15-00</u>		LOCATION <u>N 5029572.0; E 366933.6 NAD 83 MTM ZONE 9 (LAT. 45.403330; LONG. -75.706300)</u>		ORIGINATED BY <u>IAN</u>			
DIST <u>Eastern</u> HWY <u>417</u>		BOREHOLE TYPE <u>Power Auger, 200 mm Diam. (Hollow Stem)</u>		COMPILED BY <u>ZS</u>			
DATUM <u>Geodetic</u>		DATE <u>November 19, 2018</u>		CHECKED BY <u>KCP</u>			

SOIL PROFILE			SAMPLES			GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT					PLASTIC LIMIT NATURAL MOISTURE CONTENT LIQUID LIMIT			UNIT WEIGHT γ kN/m³	REMARKS & GRAIN SIZE DISTRIBUTION (%) GR SA SI CL
ELEV DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE	"N" VALUES			SHEAR STRENGTH kPa					WATER CONTENT (%)				
								20 40 60 80 100	○ UNCONFINED + FIELD VANE	● QUICK TRIAXIAL × REMOULDED							
67.8	GROUND SURFACE																
0.0 0.1	ASPHALTIC CONCRETE (80 mm) (GM/SM) Gravel and sand, some silt, contains cobbles (FILL) Dense Brown Moist																
66.4			1	SS	31												
1.4	END OF BOREHOLE AUGER REFUSAL NOTE: 1. Borehole dry upon completion																

GTA-MTO 001 N:\ACTIVE\SPATIAL_IMMTO\HWY417REHAB&WIDENING\02_DATA\GINT\1655214.GPJ GAL-GTA.GDT 6/12/19 JM

Corehole 17A-01 (Dry)
Core Box 1 of 1

Top of Footing Elevation 63.17 m



Elevation 61.74 m EOH



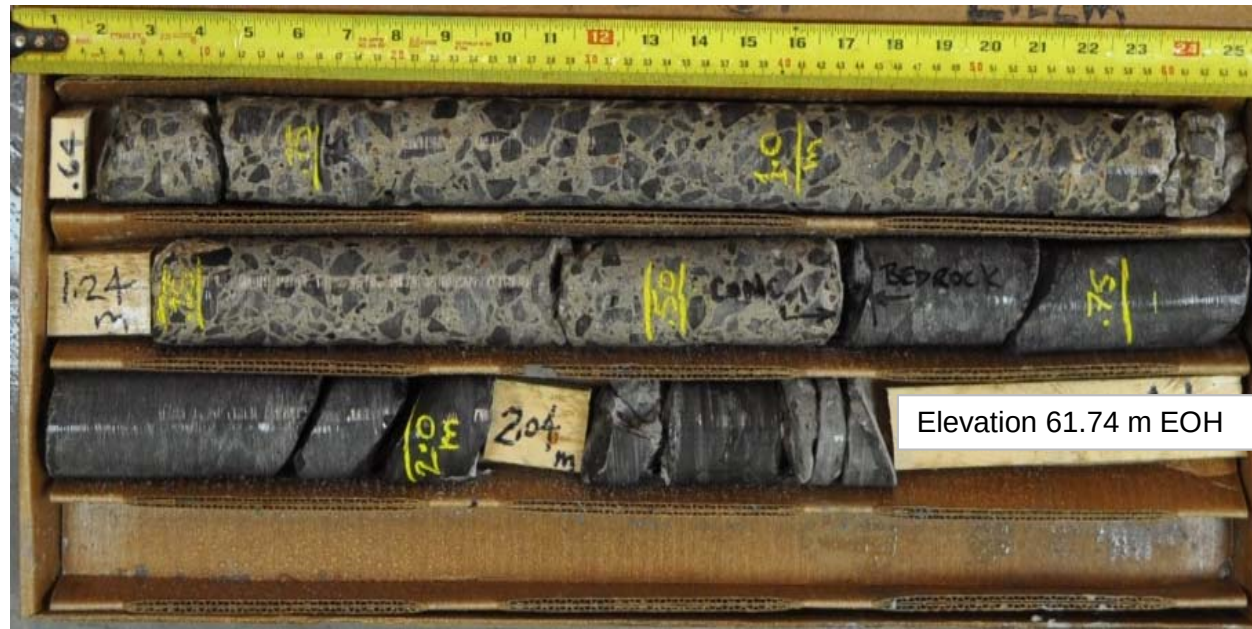
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Figure A1

CH 17A-01 (Wet)
Core Box 1 of 1

Top of Footing Elevation 63.17 m



Elevation 61.74 m EOH



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Figure A2

CH 17A-04 (Dry)
Core Box 1 of 1

Top of Footing Elevation 63.11 m



Elevation 62.14 m EOH



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Figure A3

CH 17A-04 (Wet)
Core Box 1 of 1

Top of Footing Elevation 63.11 m



Elevation 62.14 m EOH



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Figure A4

CH 17A-08 (Dry)
Core Box 1 of 1

Top of Footing Elevation 63.06 m



Elevation 61.86 m EOH



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Figure A5

CH 17A-08 (Wet)
Core Box 1 of 1

Top of Footing Elevation 63.06 m



Elevation 61.86 m EOH



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Figure A6

CH 17A-12 (Dry)
Core Box 1 of 1

Top of Footing Elevation 63.05 m



Elevation 61.38 m EOH



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Figure A7

CH 17A-12 (Wet)
Core Box 1 of 1

Top of Footing Elevation 63.05 m



Elevation 61.38 m EOH



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Figure A8

CH 17A-13 (Dry)
Core Box 1 of 1

Top of Footing Elevation 63.17 m



Elevation 61.50 m EOH



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Figure A9

CH 17A-13 (Wet)
Core Box 1 of 1

Top of Footing Elevation 63.17 m



Elevation 61.50 m EOH



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Figure A10

CH 17A-16 (Dry)
Core Box 1 of 1

Top of Footing Elevation 63.18 m



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Figure A11

CH 17A-16 (Wet)
Core Box 1 of 1

Top of Footing Elevation 63.18 m



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Figure A12

CH 17A-20 (Dry)
Core Box 1 of 1

Top of Footing Elevation 63.18 m



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Figure A13

CH 17A-20 (Wet)
Core Box 1 of 1

Top of Footing Elevation 63.18 m



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Figure A14

CH 17A-24 (Dry)
Core Box 1 of 1

Top of Footing Elevation 63.19 m



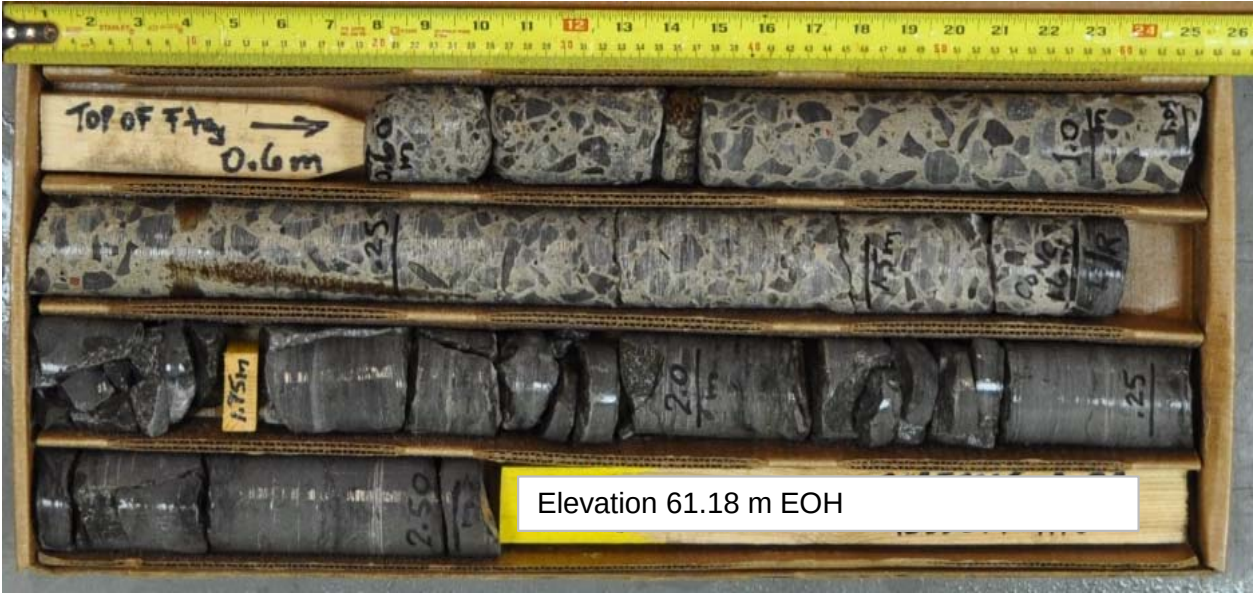
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Figure A15

CH 17A-24 (Wet)
Core Box 1 of 1

Top of Footing Elevation 63.19 m



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Figure A16

BH 17-111 (Dry)
Core Box 1 and 2 of 2

Top of Bedrock Elevation 62.54 m



Elevation 59.24 m EOH



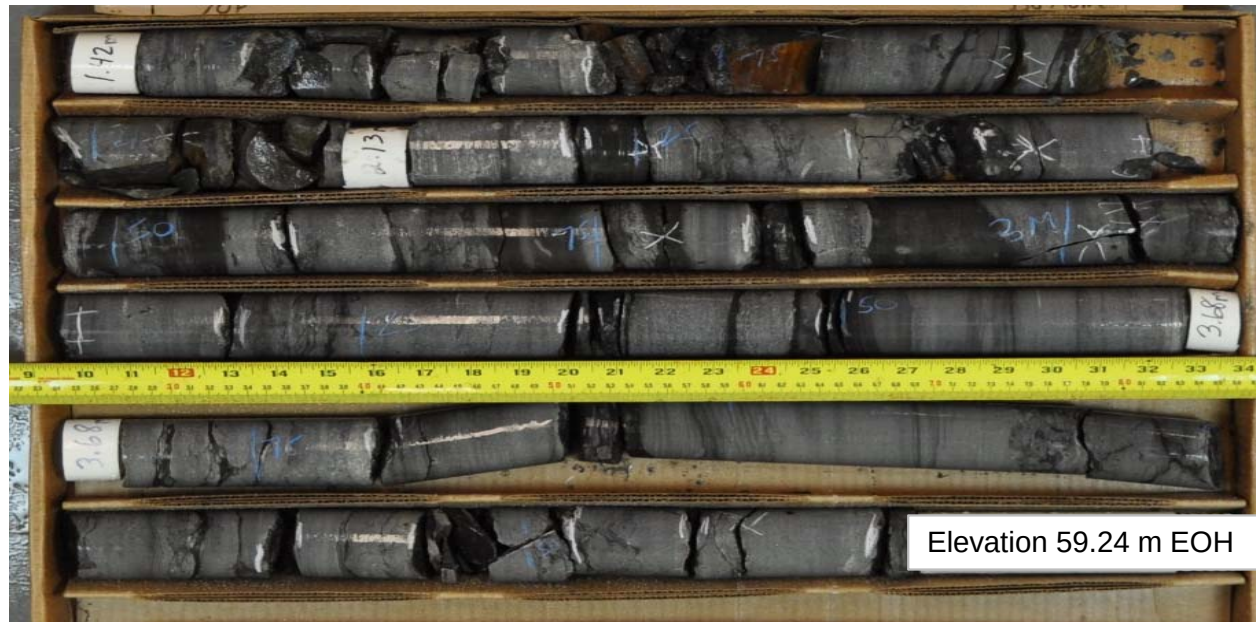
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Figure A17

BH 17-111 (Wet)
Core Box 1 and 2 of 2

Top of Bedrock Elevation 62.54 m



Elevation 59.24 m EOH



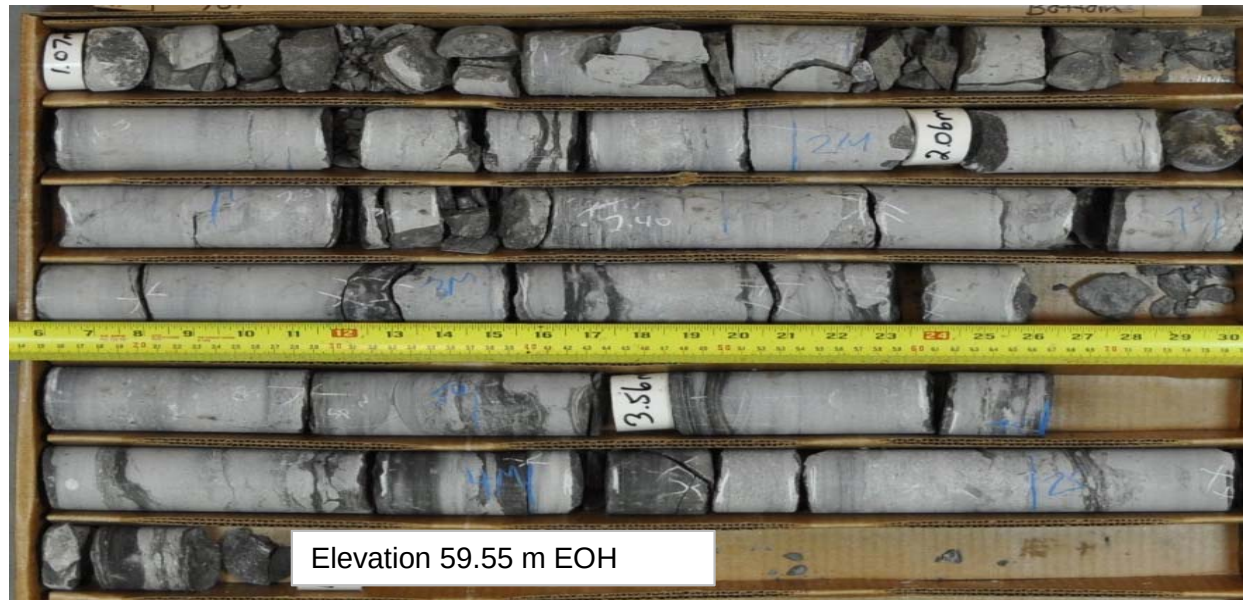
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Figure A18

BH 17-112 (Dry)
Core Box 1 and 2 of 2

Top of Bedrock Elevation 62.90 m



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Figure A19

BH 17-112 (Wet)
Core Box 1 and 2 of 2

Top of Bedrock Elevation 62.90 m



Elevation 59.55 m EOH



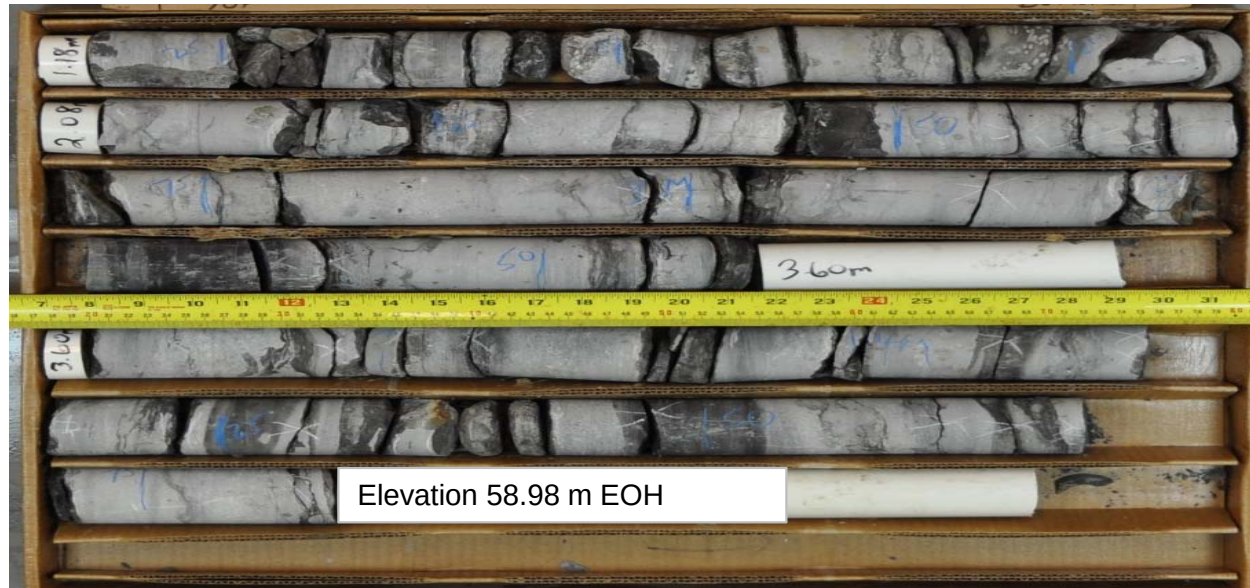
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Figure A20

BH 17-113 (Dry)
Core Box 1 and 2 of 2

Top of Bedrock Elevation 62.65 m



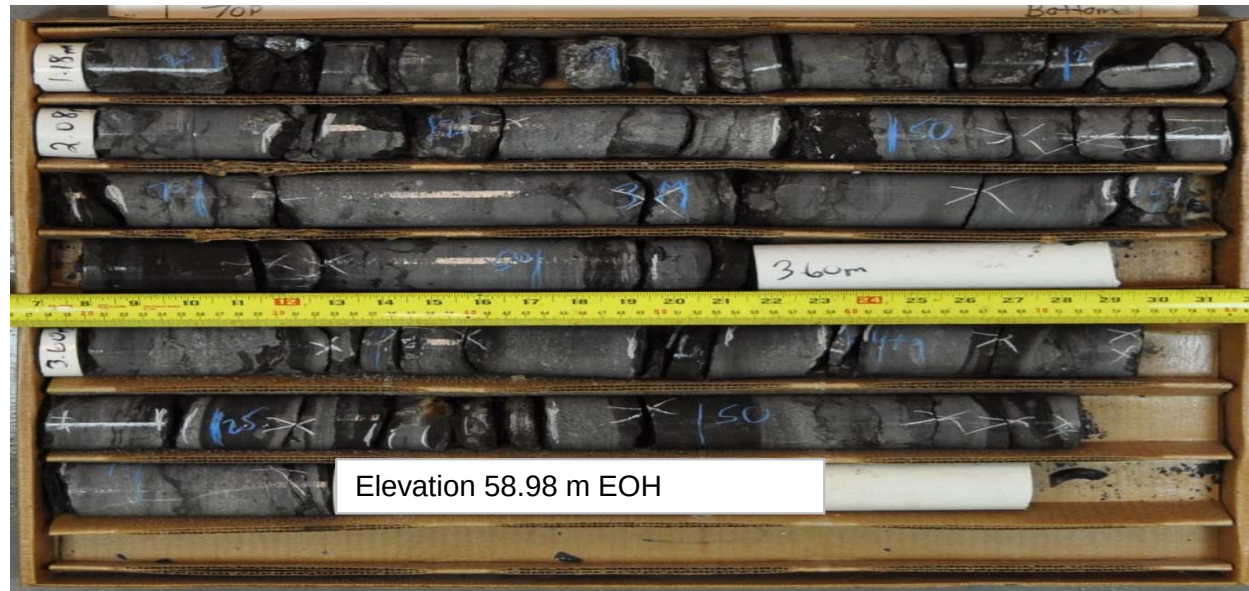
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Figure A21

BH 17-113 (Wet)
Core Box 1 and 2 of 2

Top of Bedrock Elevation 62.65 m



Elevation 58.98 m EOH



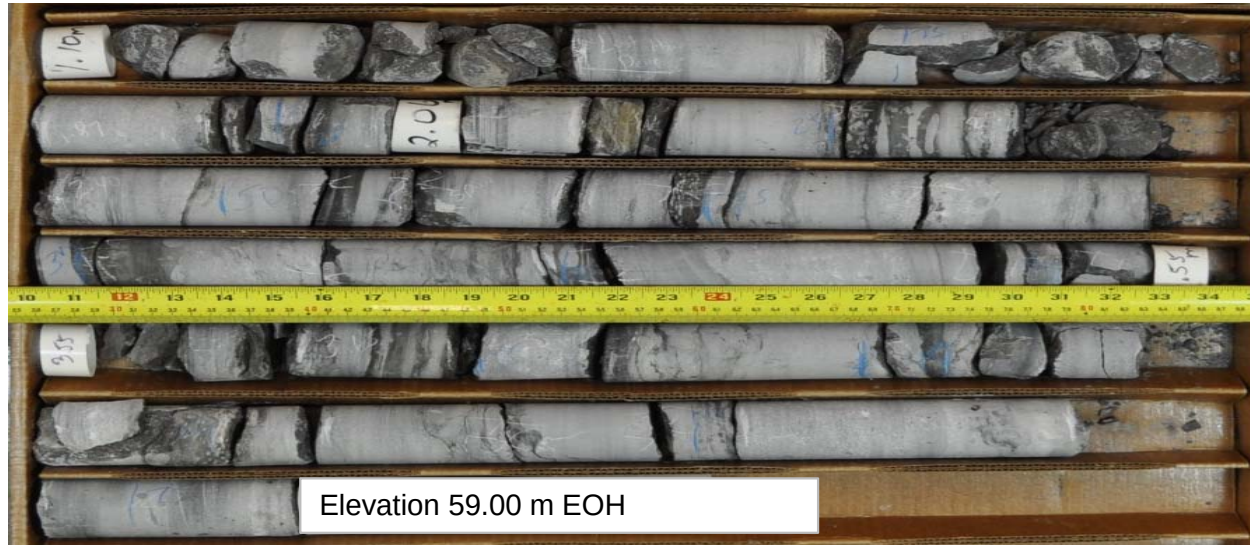
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Figure A22

BH 17-114 (Dry)
Core Box 1 and 2 of 2

Top of Bedrock Elevataion 62.73 m



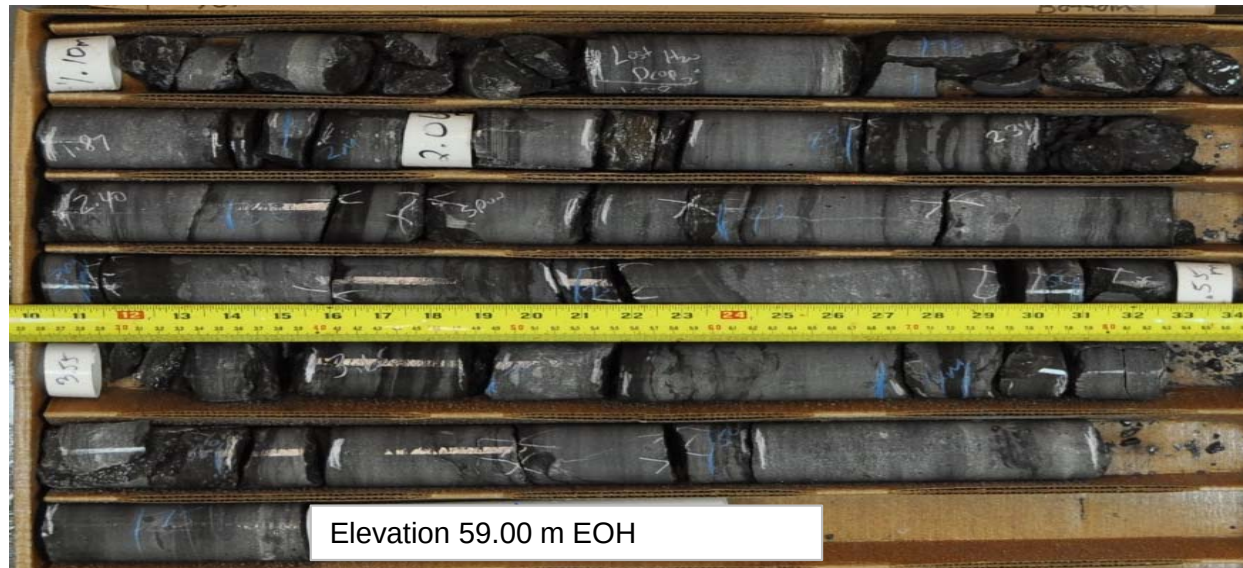
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Figure A23

BH 17-114 (Wet)
Core Box 1 and 2 of 2

Top of Bedrock Elevation 62.73 m



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Figure A24

BH 18-1101 (Dry)
Core Box 1 of 1

Top of Footing Elevation 63.69 m



Elevation 60.62 m EOH



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Figure A25

BH 18-1101 (Wet)
Core Box 1 of 1

Top of Footing Elevation 63.69 m



Elevation 60.62 m EOH



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Figure A26

BH 18-1102 (Dry)
Core Box 1 of 1

Top of Footing Elevation 63.07 m



Elevation 60.33 m EOH



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Figure A27

BH 18-1102 (Dry)
Core Box 1 of 1

Top of Footing Elevation 63.07 m



Elevation 60.33 m EOH



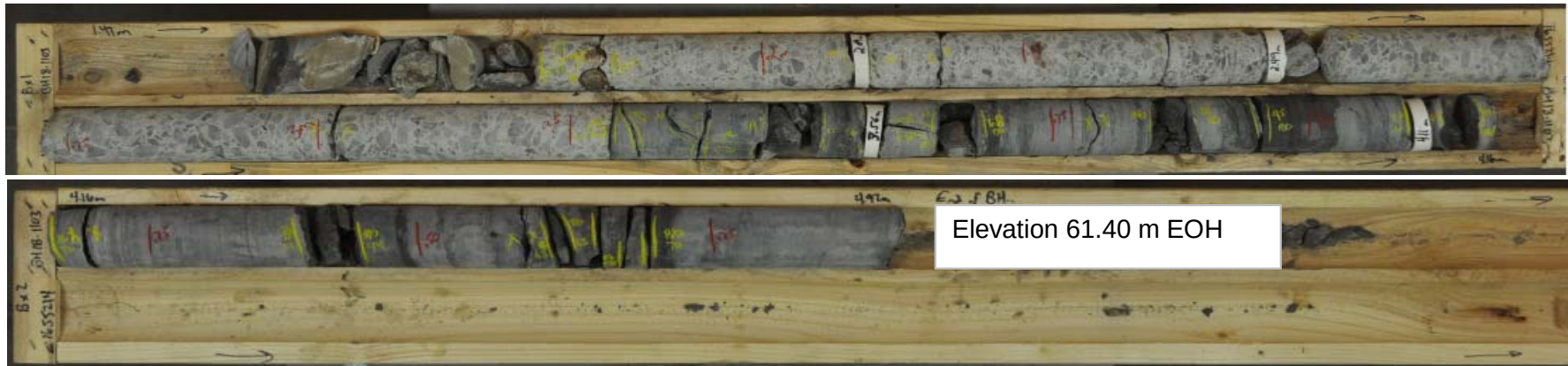
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Figure A28

BH 18-1103 (Dry)
Core Box 1 and 2 of 2

Top of Footing Elevation 64.55 m



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Figure A29

**BH 18-1103 (Wet)
Core Box 1 and 2 of 2**

Top of Footing Elevation 64.55 m



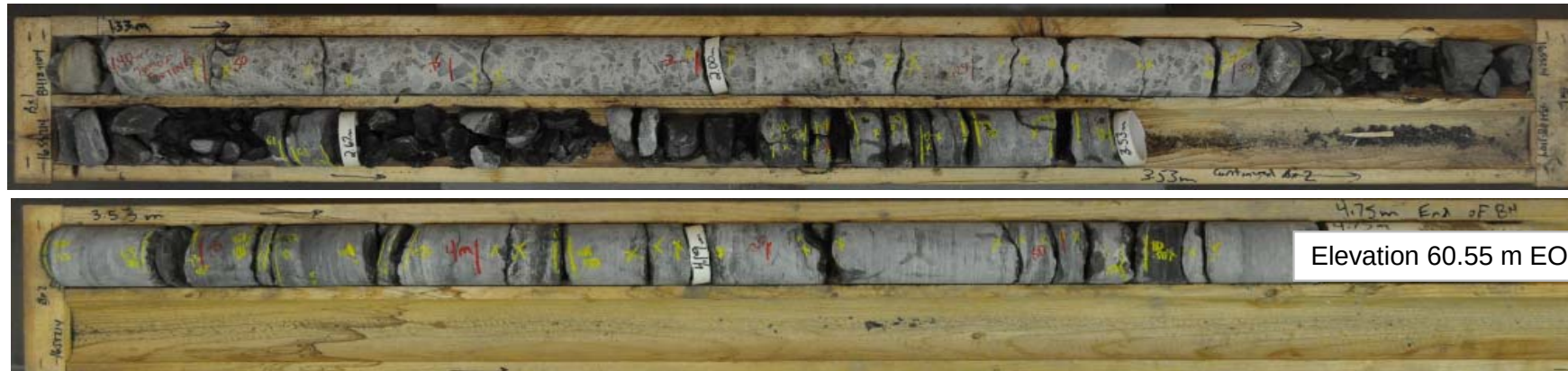
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Figure A30

BH 18-1104 (Dry)
Core Box 1 and 2 of 2

Top of Footing Elevation 63.90 m



Elevation 60.55 m EOH



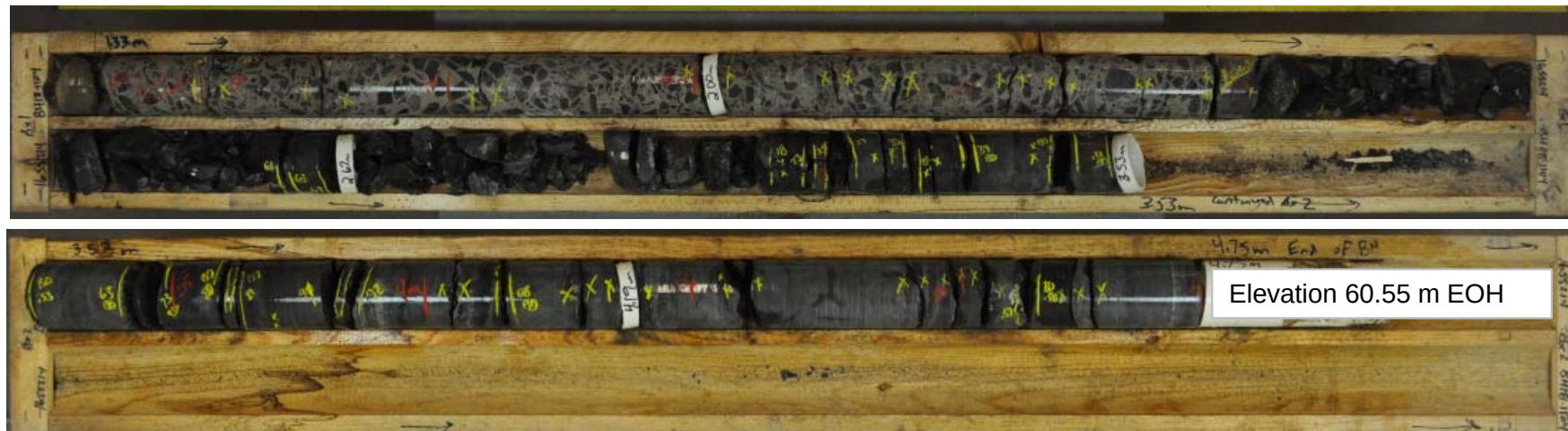
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Figure A31

BH 18-1104 (Wet)
Core Box 1 and 2 of 2

Top of Footing Elevation 63.90 m



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Figure A32

BH 18-1105 (Dry)
Core Box 1 of 1

Top of Footing Elevation 64.16 m



Elevation 61.50 m EOH



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Figure A33

BH 18-1105 (Wet)
Core Box 1 of 1

Top of Footing Elevation 64.16 m



Elevation 61.50 m EOH



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Figure A34

BH 18-1106 (Dry)
Core Box 1 of 1

Top of Footing Elevation 63.61 m



Elevation 60.98 m EOH



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Figure A35

BH 18-1106 (Wet)
Core Box 1 of 1

Top of Footing Elevation 63.61 m



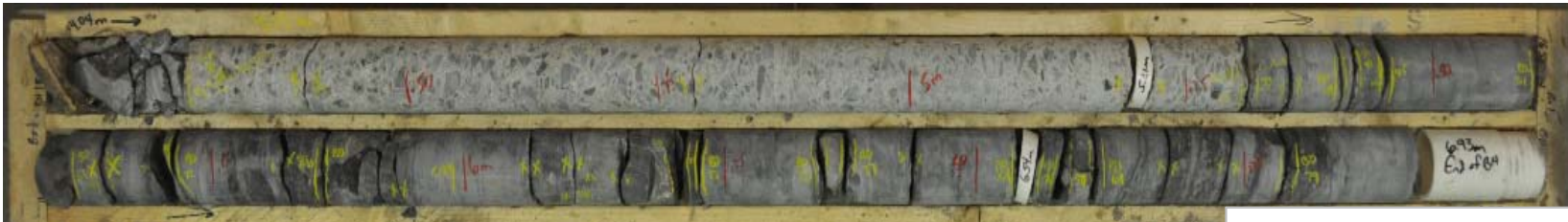
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Figure A36

BH 18-1107 (Dry)
Core Box 1 of 1

Top of Footing Elevation 64.62 m



Elevation 61.96 m EOH



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Figure A37

BH 18-1107 (Wet)
Core Box 1 of 1

Top of Footing Elevation 64.62 m



Elevation 61.96 m EOH



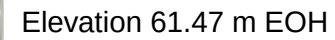
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Figure A38

Core Box 1 and 2 of 2

Top of Footing Elevation 64.64 m



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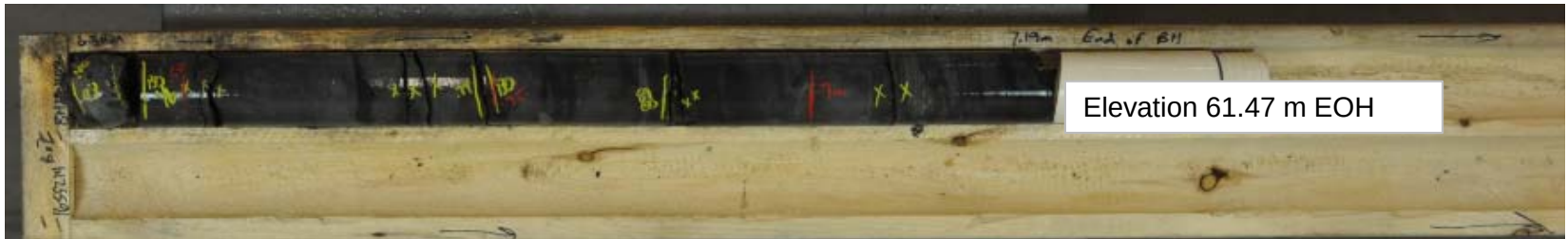
Figure A39

BH 18-1108 (Wet)
Core Box 1 and 2 of 2

Top of Footing Elevation 64.64 m



Elevation 61.47 m EOH



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Figure A40

**Table A1: Concrete Core Condition Assessment
Existing Concrete Footing - Rochester Street****Project No. 1655214 - 1110****2017-10-20 / 2019-04-30****CNM / KM****Rochester Street****A-01 : - 0.64 - 1.59**

- No original top surface remaining.
- Heavily voided layer or cold joint 1.20 - 1.25
- Otherwise good condition, with only mechanical breaks.
- Poor bond to rock (spun, may have been de-bonded)

A-04 : - 0.58 - 1.50

- Intact top surface.
- Several re-bars with mechanical breaks.
- Otherwise good condition.
- No bond to rock, washed-out appearance
(recovered rock is all gravel sized, with no intact piece)

A-08 : - 0.63 - 1.40

- Cored along piece of wood (formwork ?) entire length. Wood extends into previous corehole in rock.
- 0.63-1.24 : Good condition, with only mechanical breaks.
- 1.24-1.40 : Very poor condition, washed out, punky paste. Likely poured in water. Likely < 1 MPa.
- No bond to rock.

A-12 : - 0.76 - 1.62

- Intact top surface.
- Wood along edge from 0.90-1.47
- Good condition, with only mechanical breaks.
- Good bond to rock.

A-13 : - 0.75 - 1.82

- Intact top surface.
- Good condition, with only mechanical breaks.
 - Possible break due to voids at 1.14. Too much coring damage to confirm.
- No bond to rock. Mud in joint.

A-16 : - 0.63 - 1.54

- Intact top surface.
- Good condition, with only mechanical breaks, especially at re-bar.
- Excellent bond to rock.

A-20 : - 0.54 - 1.64

- Intact top surface.
- Good condition, with only mechanical breaks.
- No bond to rock. Mud in joint.

A-24 : - 0.60 - 1.60

- Intact top surface.
- Good condition, with only mechanical breaks.
- Excellent bond to rock.

18-1103 1.77 - 3.29

- Break in concrete at 1.83 due to coring through rebar
- 2.09; mechanical break has coring damage
- Break at 2.49 m due to coring through rebar
- Areas of abraded paste
- Well formed but unbonded to rock

18-1104 1.40 m to 2.52

- Good bond to rock, poor quality rock/well formed but not bonded to bedrock
- Good quality concrete, only mechanical breaks
- Area of abrasion

18-1107 4.27 m to 5.31 m

- Good condition, mechanical breaks only
- Well formed but unbounded joint to rock

18-1108 4.02 - 5.61

- Good condition, mechanical breaks
- Slightly degraded top of surface, voids and mechanical break at 4.20 likely due to spinning during coring
- 'Mechanical break at 5.04 - 5.06
- Good bond to rock

APPENDIX B

Laboratory Test Results, Current Investigation

Figure B1 – Grain Size Distribution Test Results – Sand (Fill)

Figure B2 – Grain Size Distribution Test Results – Sand (Fill)

Figure B3 – Grain Size Distribution Test Results – Gravel and Sand (Fill)

Figure B4 – Grain Size Distribution Test Results – Sandy Silty Clayey Gravel (Till)

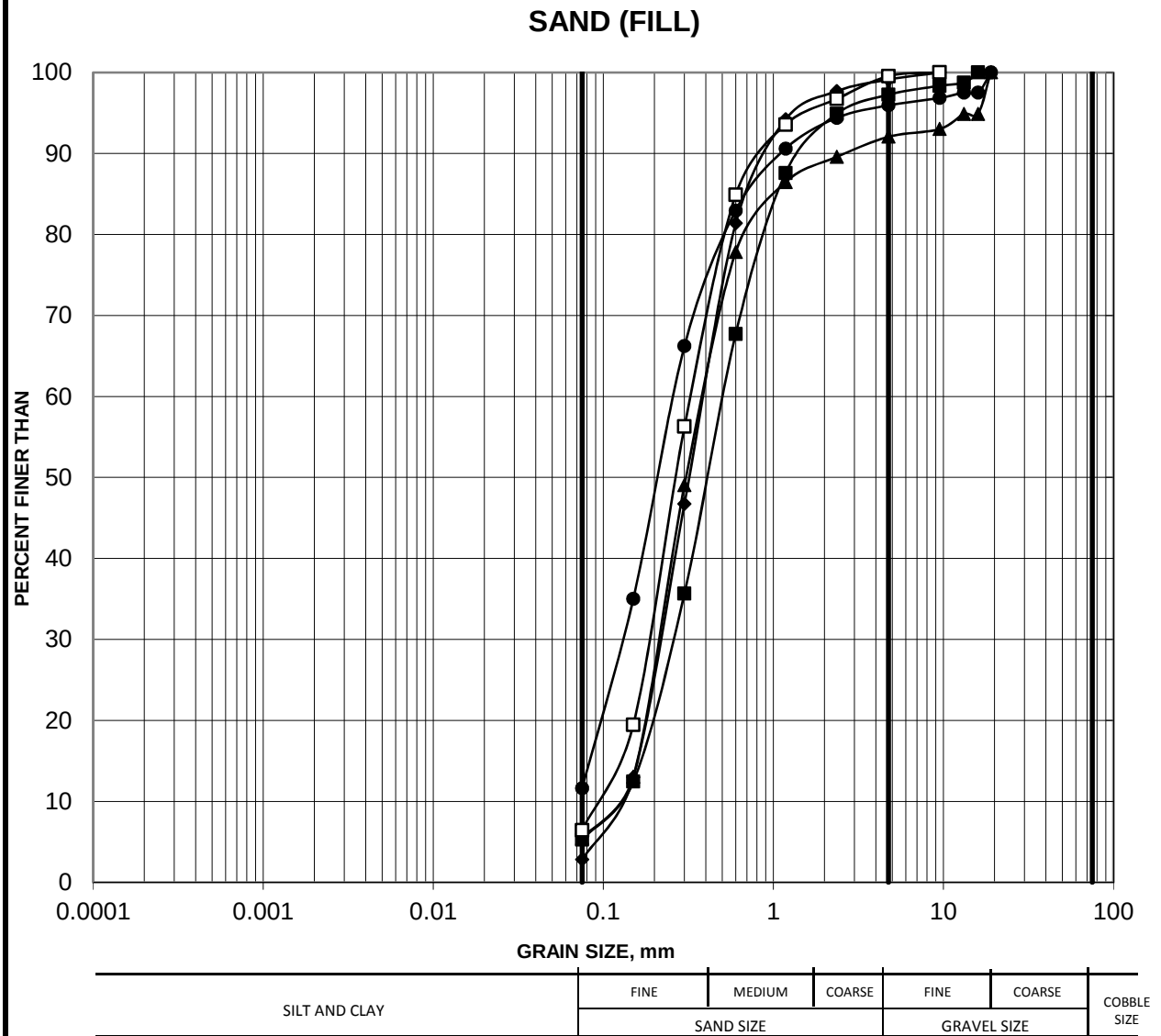
Figure B5 – Grain Size Distribution Test Results – Sand to Sand and Gravel (Fill)

Figure B6 – Grain Size Distribution Test Results – Gravel and Sand (Fill)

Figure B7 – Summary of Laboratory Compressive Strength
Unconfined Compression Tests

GRAIN SIZE DISTRIBUTION

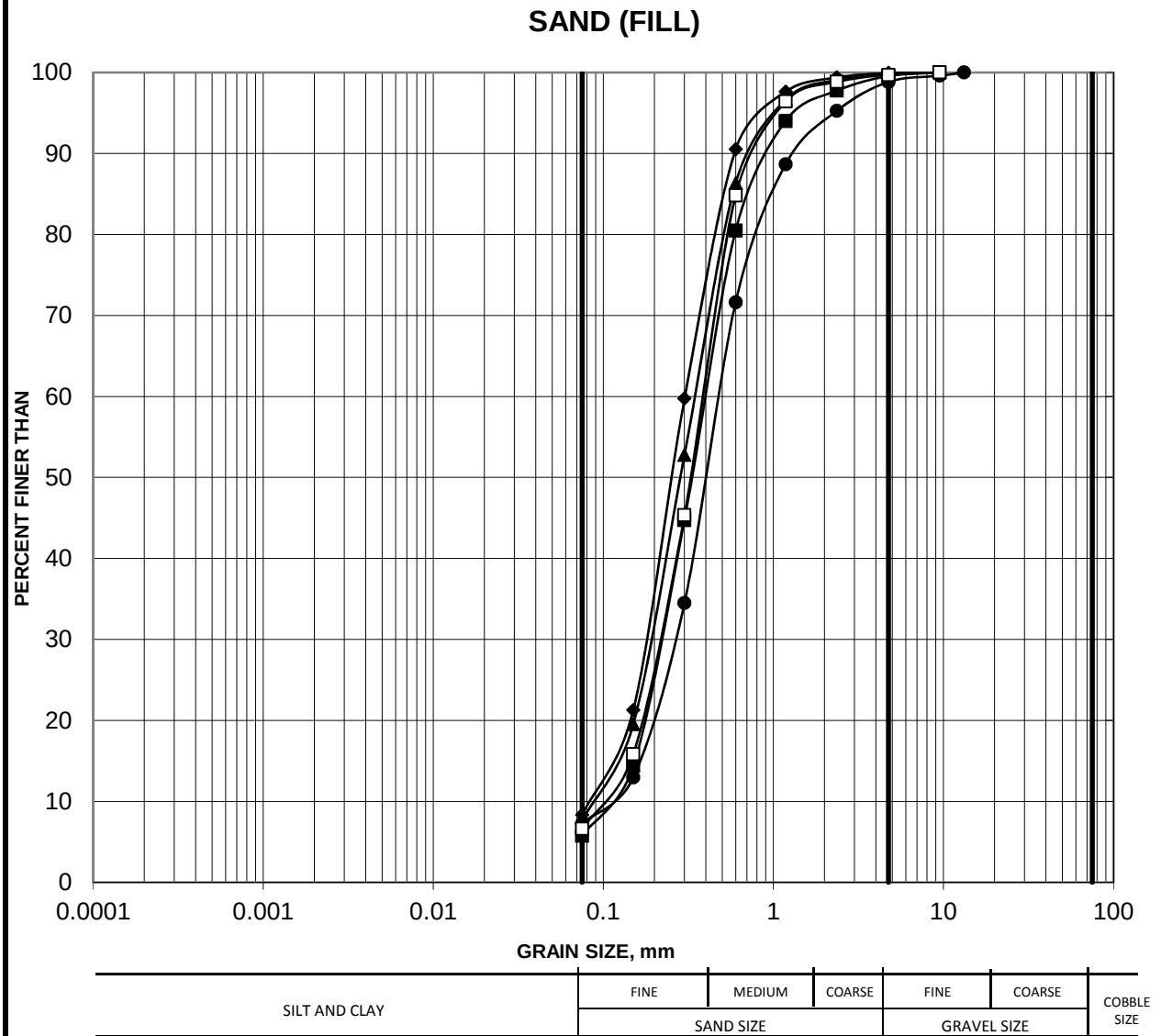
FIGURE B1



Borehole	Sample	Depth (m)
18-1102	2	0.61-1.22
18-1105	3	1.22-1.83
18-1106	5	2.44-3.05
18-1107	2	1.22-1.83
18-1108	1	0.00-0.61

GRAIN SIZE DISTRIBUTION

FIGURE B2

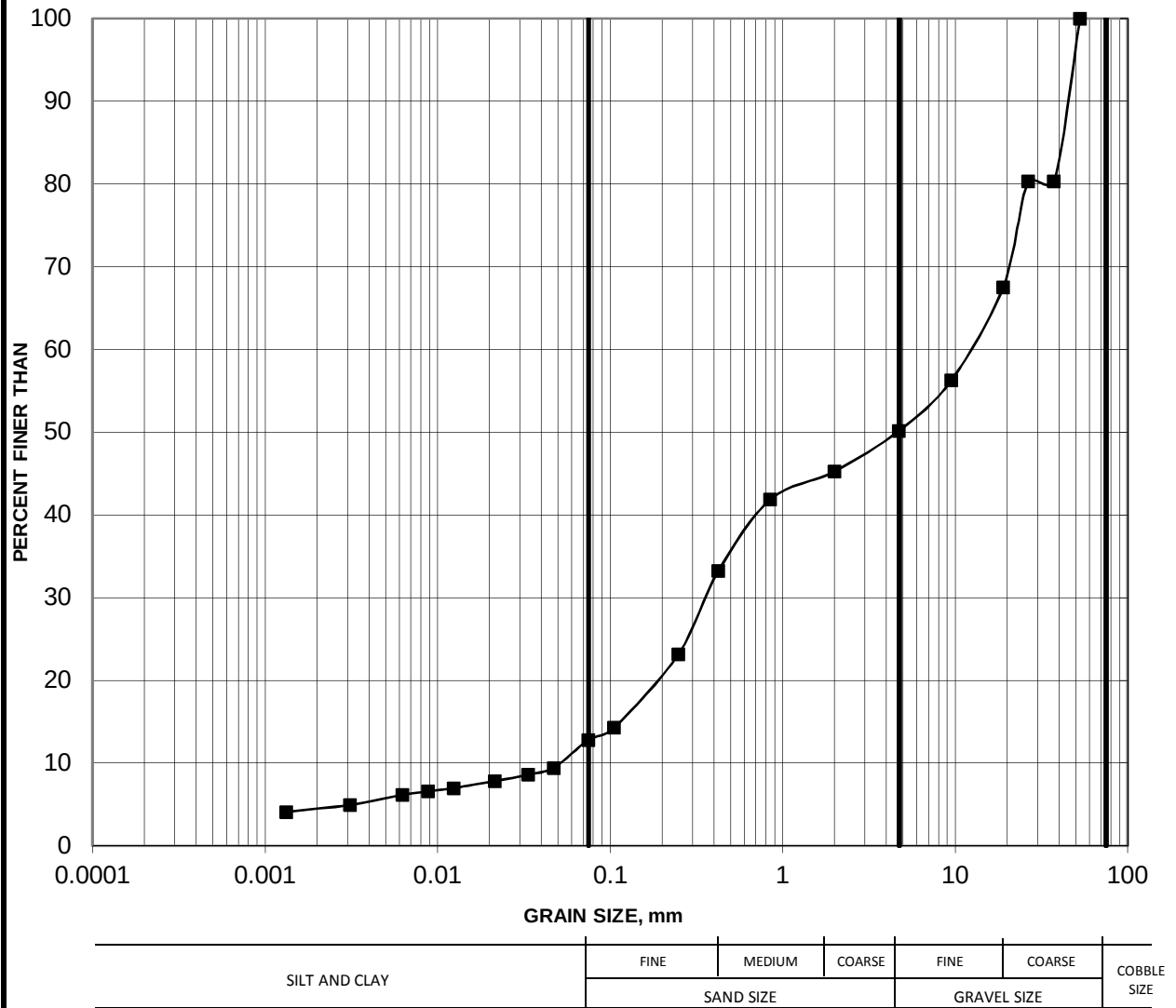


Borehole	Sample	Depth (m)
■ 18-1109	3	2.29-2.90
◆ 18-1110	5	3.05-3.66
▲ 18-1111	5	3.81-4.42
● 18-1112	4	2.29-2.90
□ 18-1112	6	3.81-4.42

GRAIN SIZE DISTRIBUTION

FIGURE B3

GRAVEL AND SAND (FILL)

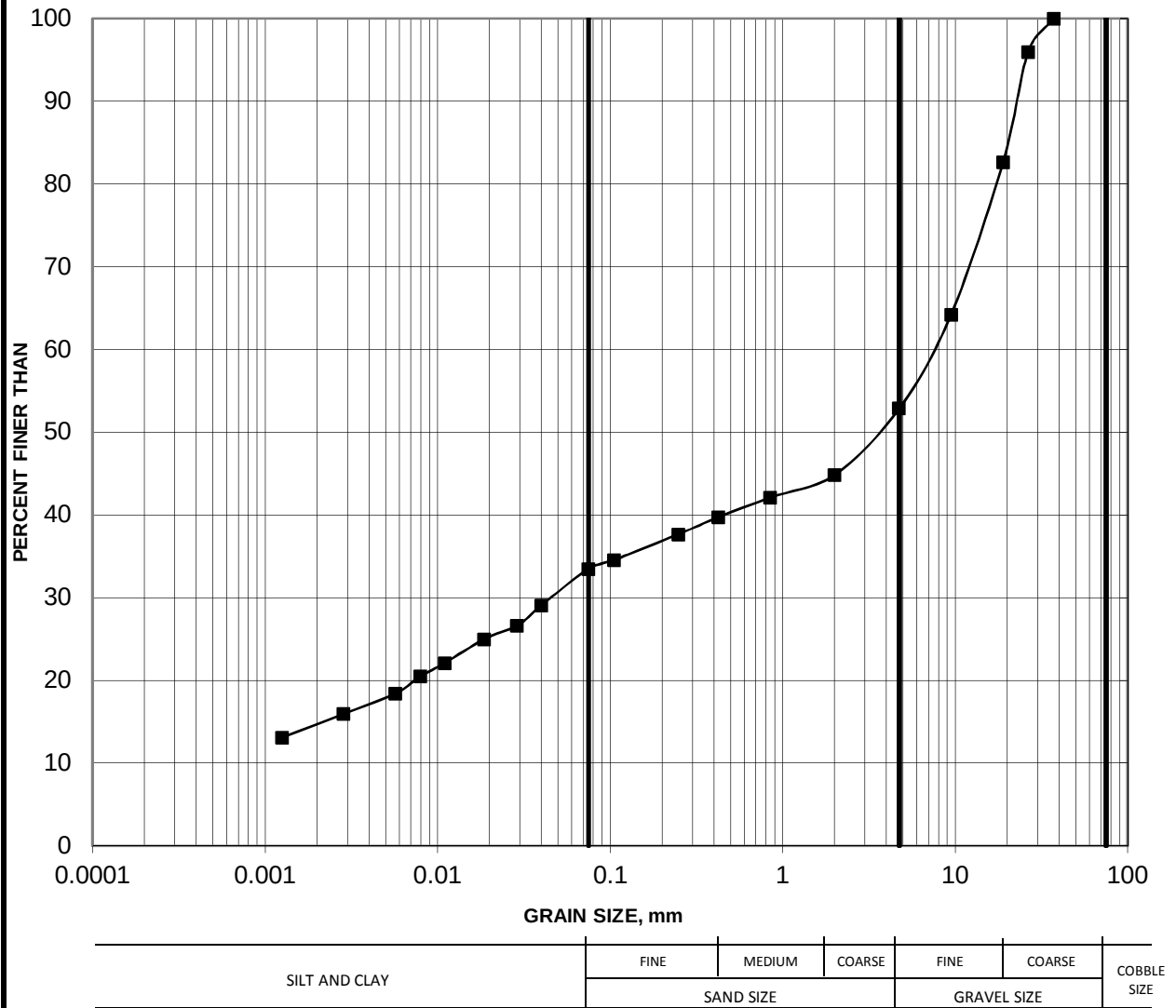


Borehole	Sample	Depth (m)
18-1111	7	5.34-5.95

GRAIN SIZE DISTRIBUTION

FIGURE B4

SANDY SILTY CLAYEY GRAVEL (TILL)

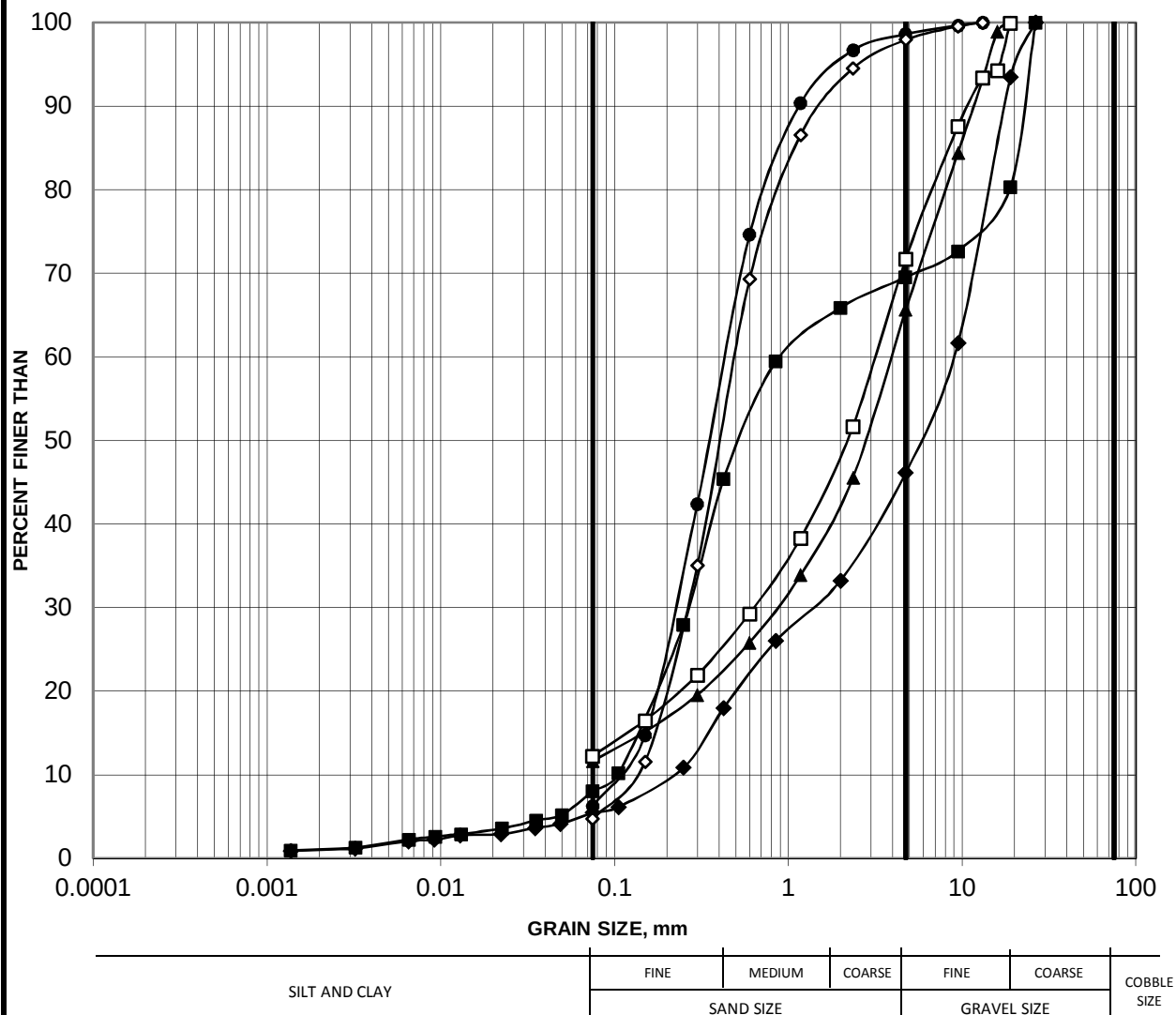


Borehole	Sample	Depth (m)
—■— 18-1109	6	4.57-4.88

GRAIN SIZE DISTRIBUTION

FIGURE B5

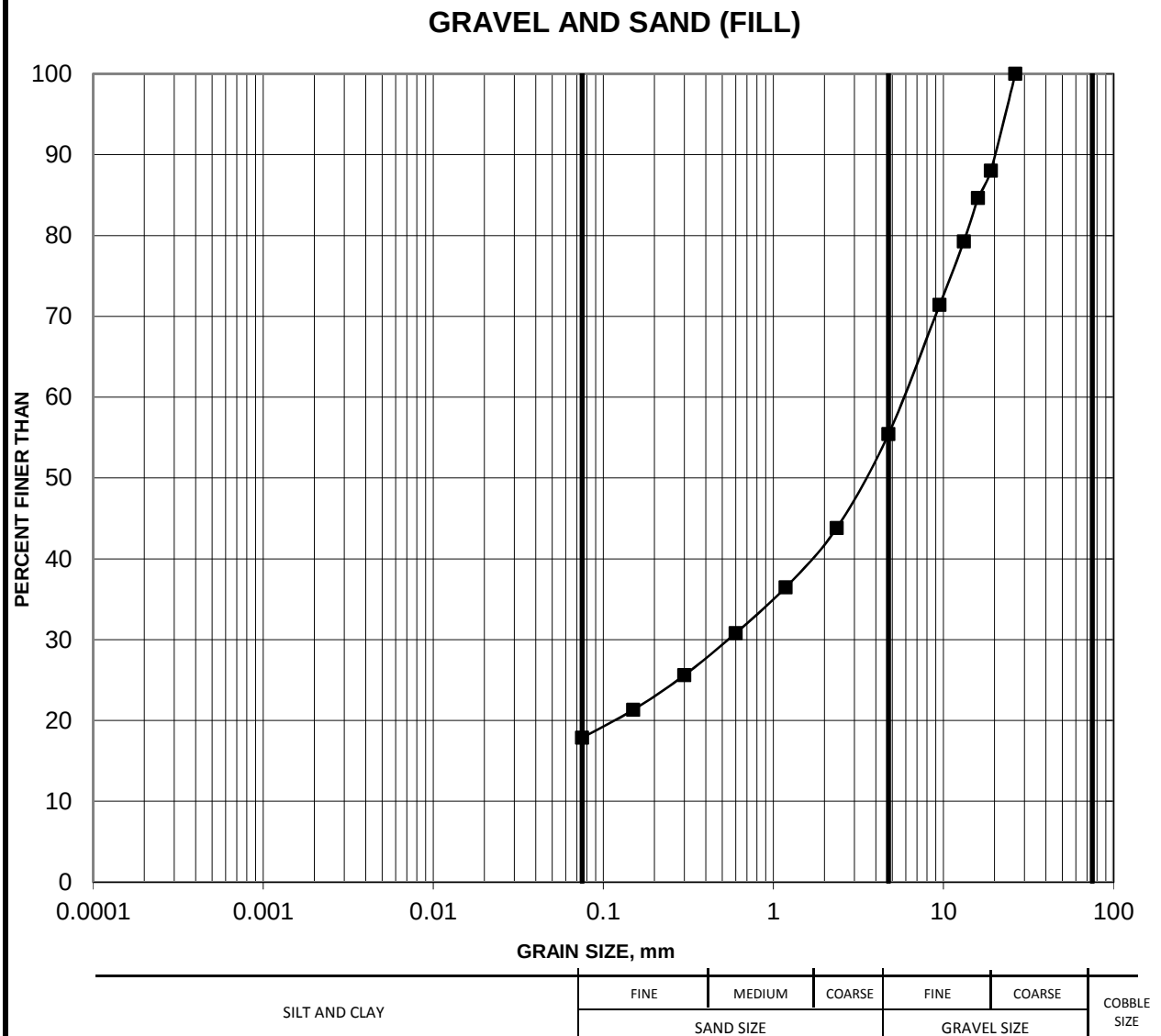
SAND TO SAND AND GRAVEL (FILL)



Borehole	Sample	Depth (m)
17-111	1	0.26-0.86
17-114	1	0.10-1.10
17-A04	1	0.06-0.26
17-A11	2	0.30-0.60
17-A13	1	0.10-0.30
17-A20	2	0.30-0.50

GRAIN SIZE DISTRIBUTION

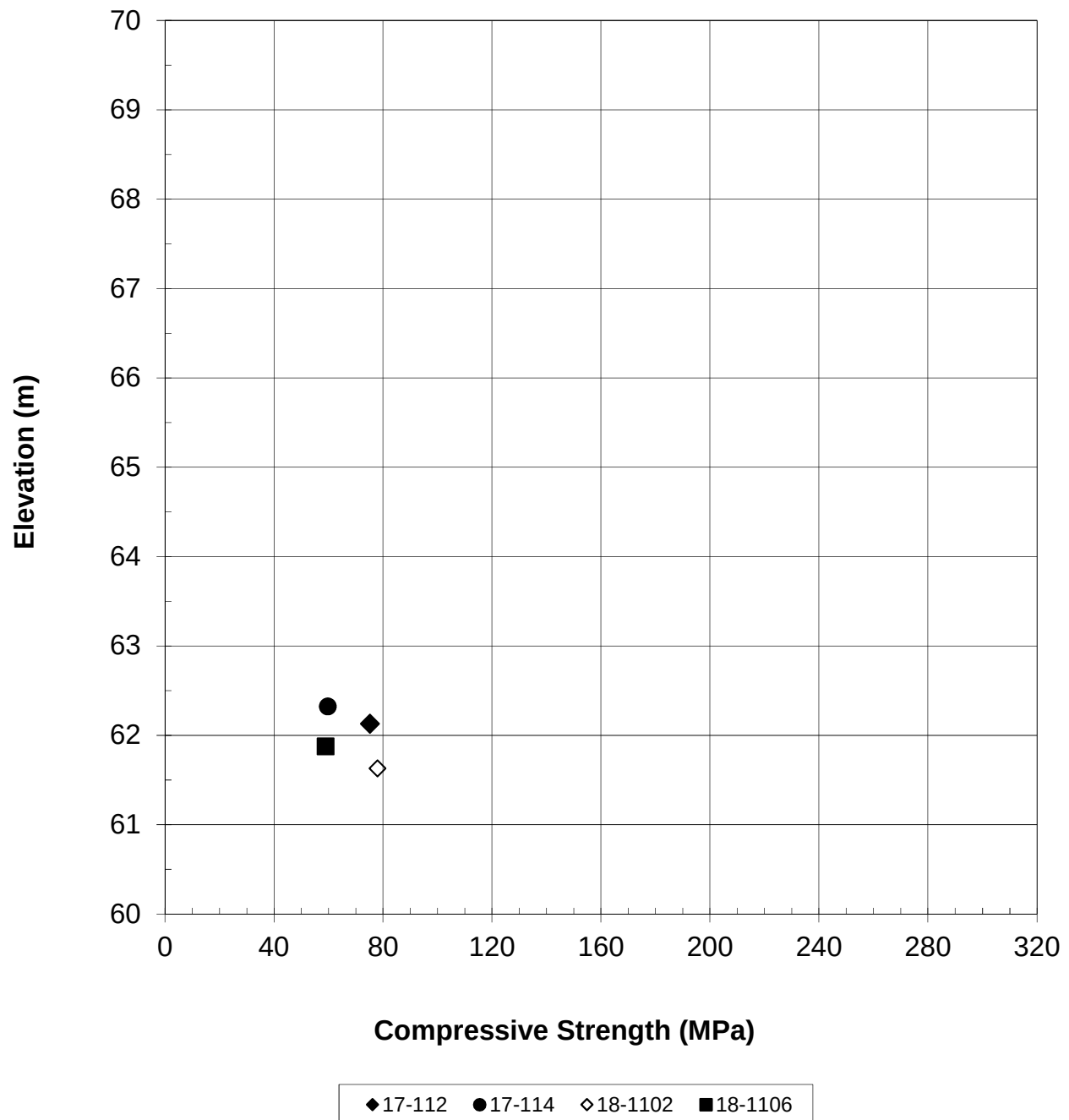
FIGURE B6



Borehole	Sample	Depth (m)
18-1212	2	0.76-1.37

**SUMMARY OF LABORATORY COMPRESSIVE STRENGTH
UNCONFINED COMPRESSION TESTS**

FIGURE B7



APPENDIX C

Previous Investigations, GEOCRE 31G05-029 (1959)
Soil Profile & Laboratory Tests Sheets No. 1 to 6
Test Boring Plan

[illegible]

Rochester and Kenny
Ottawa

Elevation (Zero Depth): 213.6

Remarks: **Test Borings**

Sheet No. 2 of 6

Hole No. 2

Drilling by: F.E. Johnston Drilling Co., Ltd.

Date: Sept. 3, 1959

TILLOWS PER FOOT	SOIL DESCRIPTION	SAMPLES		Uncon. Comp. Strength Tons/Sq.Ft.	Depth in Feet	Elev.	Moisture Content Per Cent.								
		Type	No.				10	19	50	6	7	80	90		
	Ground Surface				0	213.6									
	Fill Material														
	Bedrock				1										
	Limestone with minor interbedding of shale, fissures replaced by carbonate and minor fossilisation.				2										
					3										
					4										
					5	208.6									
					6										
					7										
					8										
					9										
					10	203.6									
					11	202.6									

JOHN D. PATERSON
CONSULTING ENGINEER
OTTAWA CANADA

SOIL PROFILE
&
LABORATORY TESTS

Location: Bridge No. 16
Rochester and Kenny,
Ottawa.

Elevation (Zero Depth): 214.7

Remarks: Test Borings

Sheet No.
3 of 6

Hole No. 3

Borings by: F. E. Johnston Drilling Co., Ltd. Date: Sept. 8, 1959.

BLOWS PER FOOT	SOIL DESCRIPTION	SAMPLES		Uncon. Comp. Strength Tons/Sq. Ft.	Depth in Feet	Elev.	Moisture Content Per Cent.							
		Type	No.				30	40	50	6	7	80	90	
	Ground Surface													
	Cinders 0-6"				0	214.7								
	Clayey Gravel - probably Fill on surface 4-6"													
	Bedrock - Limestone with shale bands. Carbonate Fissures and Fossils.	Core Recovery		73%	5	209.7								
		Core Recovery		93%	10	204.7								
		Core Recovery		100%	15	199.7								
		Core	3	645		196.0								
					20									

JOHN D. PATERSON
CONSULTING ENGINEER
OTTAWA CANADA

SOIL PROFILE

&

LABORATORY TESTS

Location: Bridge No. 16
Rochester and Kenny
Ottawa

Elevation (Zero Depth): 214.1

Remarks: Test Borings

Sheet No. 4 of 6

Hole No.

4

Borings by: F.E. Johnston Drilling Co., Ltd.

Date: Sept. 8, 1959.

BLOWS PER FOOT	SOIL DESCRIPTION	SAMPLES		Uncons. Comp. Strength Tons/Sq. Ft.	Depth in Feet	Elev.	Moisture Content Per Cent.							
		Type	No.				20	40	50	60	70	80	90	
	Ground Surface				0	214.1								
	Clayey Gravel													
	2' 6"													
	Bedrock	Core		85%	5	209.1								
	Limestone with	Recovery												
	narrow bands of													
	shale, carbonate													
	fissures and fossil													
	replacement	Core Recovery 97%			10	204.1								
		Core		98%	15	199.1								
		Recovery												
		Core	4	618		196.4								
	17' 7"				20									

JOHN D. PATTERSON
CONSULTING ENGINEER
OTTAWA CANADA

SOIL PROFILE

&

LABORATORY TESTS

Location: Bridge No. 16
Rochester and Kenny
Ottawa.

Elevation (Zero Depth): 213.8

Remarks: Test Borings

Sheet No. 5 of 6

Hole No.

5

Borings by: F.E. Johnston Drilling Co., Ltd.

Date: Sept. 2 & 4, 1959

Elev. Feet	SOIL DESCRIPTION	SAMPLES		Uncons. Comp. Strength Tons/Sq. Ft.	Depth in Feet	Elev.	Moisture Content Per Cent.					
		Type	No.				30	40	50	60	70	80
	Ground Surface		0		0	213.8						
	Gravel and Clay Fill		2'		1							
					2							
	Bedrock Limestone with narrow shale bands, carbonate fissures and carbonate fossil replacement.	Core Recovery		88%	3							
					4							
					5	206.8						
					6							
					7							
					8							
					9							
		Core Recovery		75%	10	203.8						
					11							
		Core	5	375	12							
					13							
					14	199.6						
					15							

14' 2"

JOHN D. PATERSON
CONSULTING ENGINEER
OTTAWA CANADA

SOIL PROFILE

&

LABORATORY TESTS

Location: Bridge No. 16
Rochester and Kenny
Ottawa

Sheet No. 6 of 6

Hole No. 6

Elevation (Zero Depth): 212.9

Remarks: Test Borings

Borings by: F.E. Johnston Drilling Co., Ltd.

Date: Sept. 3 & 4 / 59.

BLAWS
PER
FOOT

SOIL
DESCRIPTION

SAMPLES

Uncon.
Comp.
Strength
Tons/Sq. Ft.

Depth
in
Feet

Elev.

Moisture Content
Per Cent.

Type No.

30 40 50 60 70 80 90

Ground Surface 0
Cinder Fill 6"
Gravel and Clay
Fill Material 219"

Bedrock
Limestone with
thin shale layers,
carbonate fissures
and fossils

Core
Recovery 96%

Core 6 850

0 212.9

5 207.9

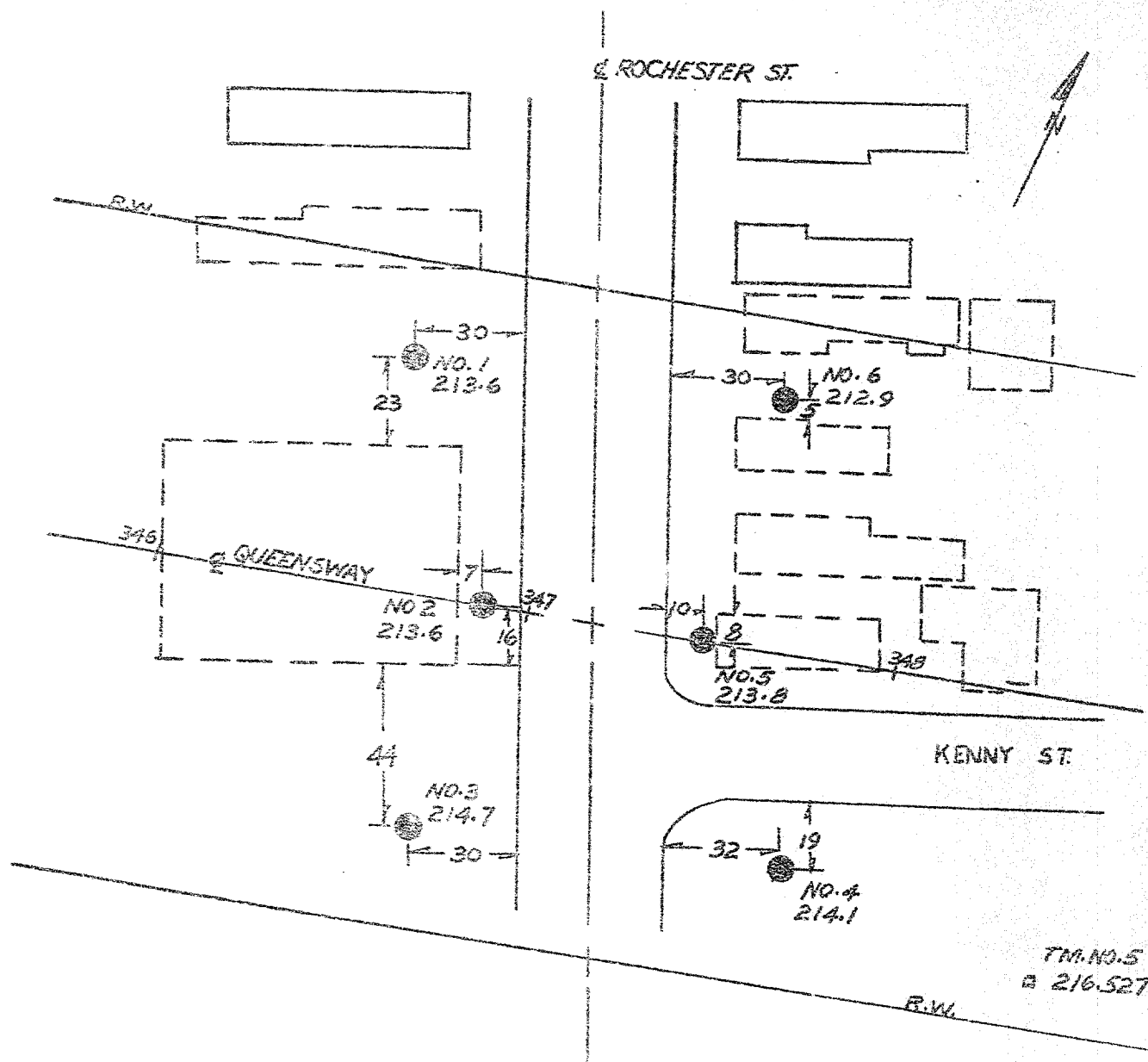
10 202.9

15 197.9

194.3

20

1817"



TEST BORING PLAN
PROPOSED BRIDGE NO. 16
AT ROCHESTER ST.
OTTAWA, ONT.

SCALE 1"=40'
JOB NO C-44-K

SEPT, 1959
STAGE III

APPENDIX D

Results of Chemical Analysis
Eurofins Environment Testing Report No. 1706533



Environment Testing

Certificate of Analysis

Client: Golder Associates Ltd. (Ottawa)
1931 Robertson Road
Ottawa, ON
K2H 5B7
Attention: Ms. Susan Trickey
PO#:
Invoice to: Golder Associates Ltd. (Ottawa)

Report Number: 1706533
Date Submitted: 2017-05-02
Date Reported: 2017-05-09
Project: 1655214.1120
COC #: 817721

Lab I.D.
Sample Matrix
Sample Type
Sampling Date
Sample I.D.

1290761
Soil

2017-04-26
17-113 SA1

Group	Analyte	MRL	Units	Guideline	
Agri. - Soil	pH	2.0			8.5
General Chemistry	Electrical Conductivity	0.05	mS/cm		0.38
	Resistivity	1	ohm-cm		2630
	SO4	0.01	%		<0.01
Subcontract	Cl	0.002	%		0.018

Guideline = * = Guideline Exceedence

All analysis completed in Ottawa, Ontario (unless otherwise indicated by ** which indicates analysis was completed in Mississauga, Ontario).
Results relate only to the parameters tested on the samples submitted.
Methods references and/or additional QA/QC information available on request.

146 Colonnade Rd. Unit 8, Ottawa, ON K2E 7Y1

MRL = Method Reporting Limit, AO = Aesthetic Objective, OG = Operational Guideline, MAC = Maximum Acceptable Concentration, IMAC = Interim Maximum Acceptable Concentration, STD = Standard, PWQO = Provincial Water Quality Guideline, IPWQO = Interim Provincial Water Quality Objective, TDR = Typical Desired Range

APPENDIX E

MASW Test Results and Report
Sites 3-56/1 and 3-56/2 Highway 417 Overpass at Rochester Street

DATE December 8, 2017**PROJECT No.** 1655214/1500**TO** Susan Trickey
Golder Associates Ltd.**FROM** Stephane Sol
Christopher Phillips**EMAIL** ssol@golder.com
cphillips@golder.com**CHBDC SEISMIC SITE CLASS TESTING RESULTS – HWY417 (ROCHESTER ST EXIT)
OTTAWA, ONTARIO**

This technical memorandum presents the results of one Multichannel Analysis of Surface Waves (MASW) test performed for the purpose of the Canadian Highway Bridge Design Code (CHBDC 2014) Seismic Site Classification for a site located near the HWY417 off ramp to Rochester Street just east of Preston Street in Ottawa, Ontario (Figure 1). The MASW line was located on a grassy area on north of the off ramp. The geophysical testing was performed by Golder personnel on October 18, 2017.

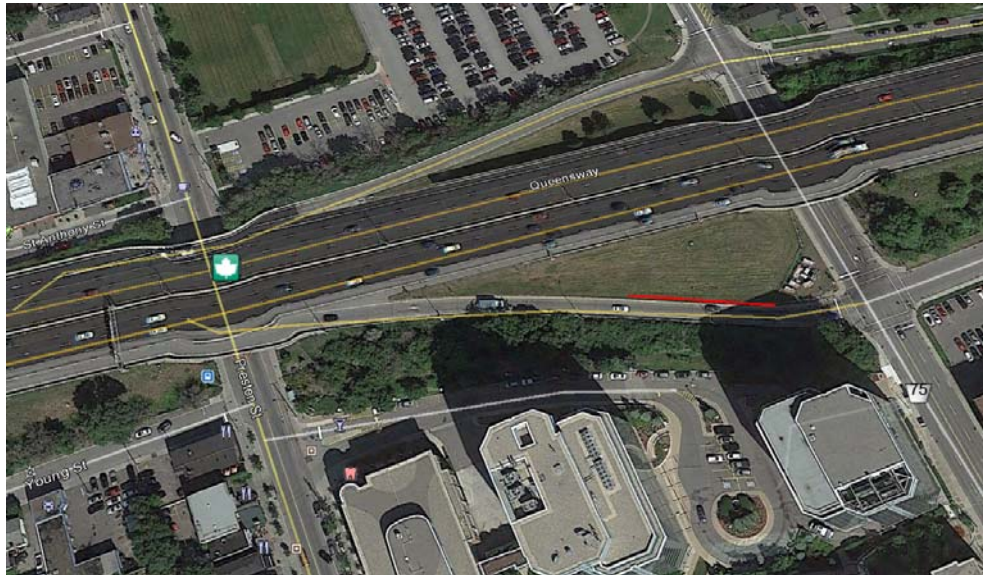


Figure 1: MASW Location Site Map (MASW Line in red)

Golder Associates Ltd.6925 Century Avenue, Suite #100, Mississauga, Ontario, Canada L5N 7K2
Tel: +1 (905) 567 4444 Fax: +1 (905) 567 6561 www.golder.com**Golder Associates: Operations in Africa, Asia, Australasia, Europe, North America and South America**

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Methodology

The MASW method measures variations in surface-wave velocity with increasing distance and wavelength and can be used to infer the rock/soil types, stratigraphy and soil conditions.

A typical MASW survey requires a seismic source, to generate surface waves, and a minimum of two geophone receivers, to measure the ground response at some distance from the source. Surface waves are a special type of seismic wave whose propagation is confined to the near surface medium.

The depth of penetration of a surface wave into a medium is directly proportional to its wavelength. In a non-homogeneous medium, surface waves are dispersive, i.e., each wavelength has a characteristic velocity owing to the subsurface heterogeneities within the depth interval that particular wavelength of surface wave propagates through. The relationship between surface-wave velocity and wavelength is used to obtain the shear-wave velocity and attenuation profile of the medium with increasing depth.

The seismic source used can be either active or passive, depending on the application and location of the survey. Examples of active sources include explosives, weight-drops, sledge hammer and vibrating pads. Examples of passive sources are road traffic, micro-tremors, and water-wave action (in near-shore environments).

The geophone receivers measure the wave-train associated with the surface wave travelling from a seismic source at different distances from the source.

The participation of surface waves with different wavelengths can be determined from the wave-train by transforming the wave-train results into the frequency domain. The surface-wave velocity profile with respect to wavelength (called the 'dispersion curve') is determined by the delay in wave propagation measured between the geophone receivers. The dispersion curve is then matched to a theoretical dispersion curve using an iterative forward-modelling procedure. The result is a shear-wave velocity profile of the tested medium with depth, which can be used to estimate the dynamic shear-modulus of the medium as a function of depth.

Field Work

The MASW field work was conducted on October 18, 2017, by personnel from the Golder Mississauga and Ottawa offices. For the MASW line, a series of 24 low frequency (4.5 Hz) geophones were laid out at 2 metre intervals. Both active and passive readings were recorded along the MASW line. For the active investigation, a seismic drop of 34 kg and a 9.9 kg sledge hammer were used as seismic sources. Active seismic records were collected with seismic sources located 5, 10, 15, and 20 metres from and collinear to the geophone array. An example of active seismic records collected is shown in Figure 2 below.

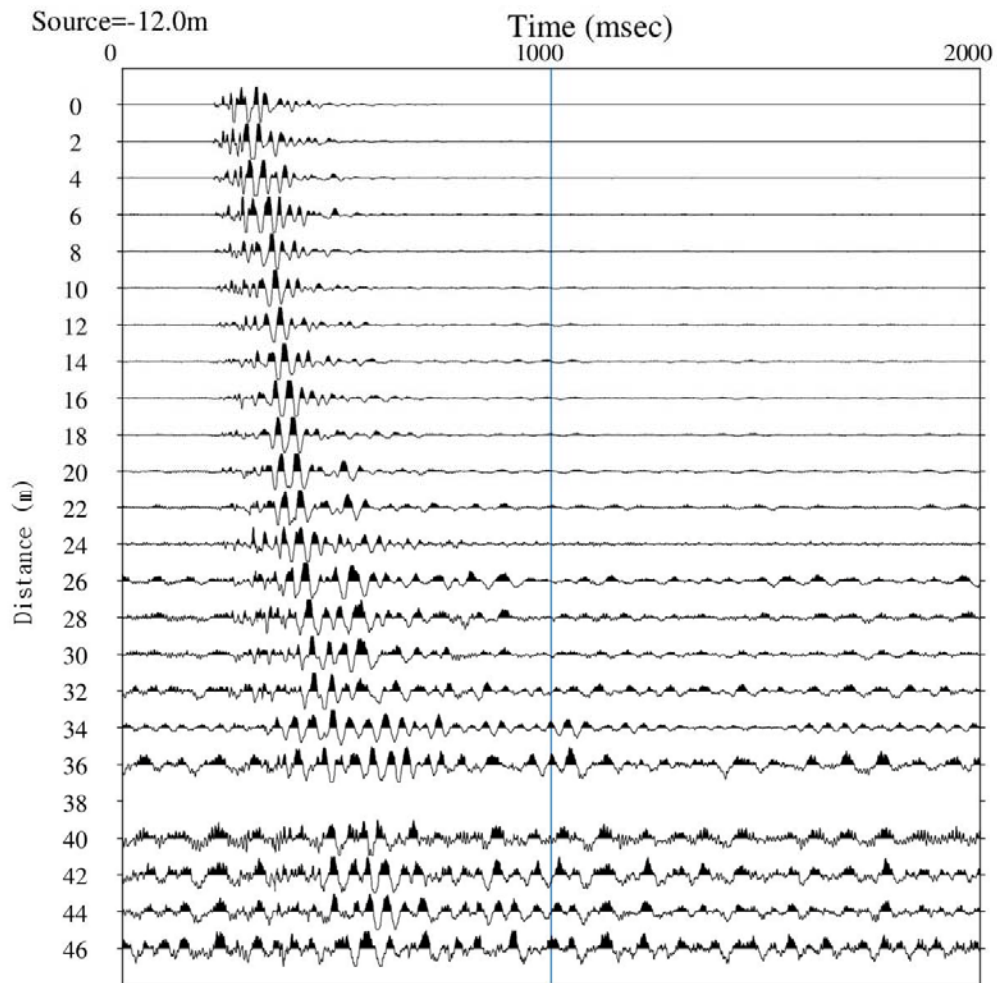


Figure 2: Typical seismic record collected along MASW Line 1

Data Processing

Processing of the MASW test results consisted of the following main steps:

- 1) Transformation of the time domain data into the frequency domain using a Fast-Fourier Transform (FFT) for each source location;
- 2) Calculation of the phase for each frequency component;
- 3) Linear regression to calculate phase velocity for each frequency component;
- 4) Filtering of the calculated phase velocities based on the Pearson correlation coefficient (r^2) between the data and the linear regression best fit line used to calculate phase velocity;
- 5) Generation of the dispersion curve by combining calculated phase velocities for each shot location of a single MASW test; and,
- 6) Generation of the stiffness profile, through forward iterative modelling and matching of model data to the field collected dispersion curve.

Processing of the MASW data was completed using the SeisImager/SW software package (Geometrics Inc.). The calculated phase velocities for a seismic shot point were combined and the dispersion curve generated by choosing the minimum phase velocity calculated for each frequency component as shown on Figure 3 and 4. Shear wave velocity profiles were generated through inverse modelling to best fit the calculated dispersion curves. The active survey provided a dispersion curve with a suitable frequency range (14 -33 Hz). The minimum measured surface wave frequency with sufficient signal-to-noise ratio to accurately measure phase velocity was approximately 14 Hz.

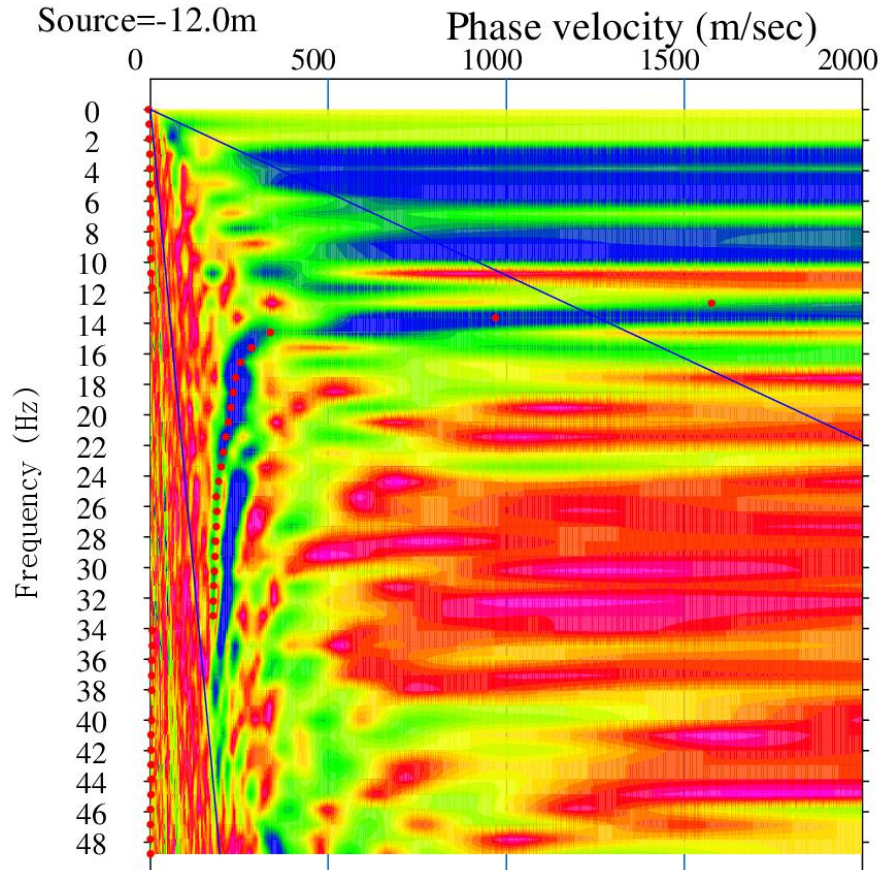


Figure 3: Active MASW Dispersion Curve Picks (red dots) along MASW Line 1

Results

The MASW test results are presented in Figure 4, which presents the calculated shear wave velocity profile derived from the field testing. The results along MASW Line 1 have been calculated using a weight-drop located at 15 m from the last geophone. The field collected dispersion curves are compared with the model generated dispersion curves on Figure 5. There is a satisfactory correlation between the field collected and model calculated dispersion curves, with a root mean squared error of less than 11%.

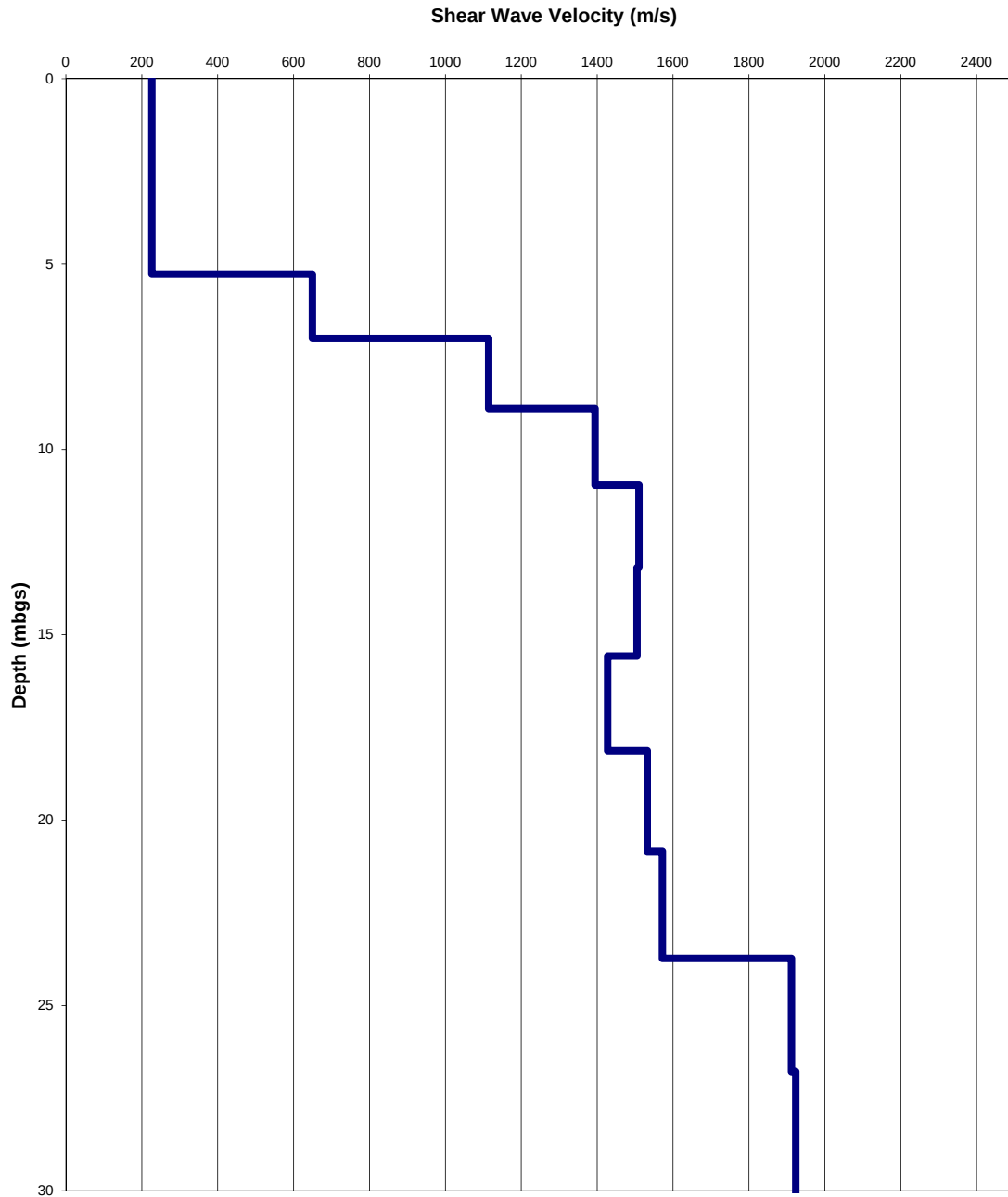


Figure 4: MASW Modelled Shear-Wave Velocity Depth profile along MASW Line 1

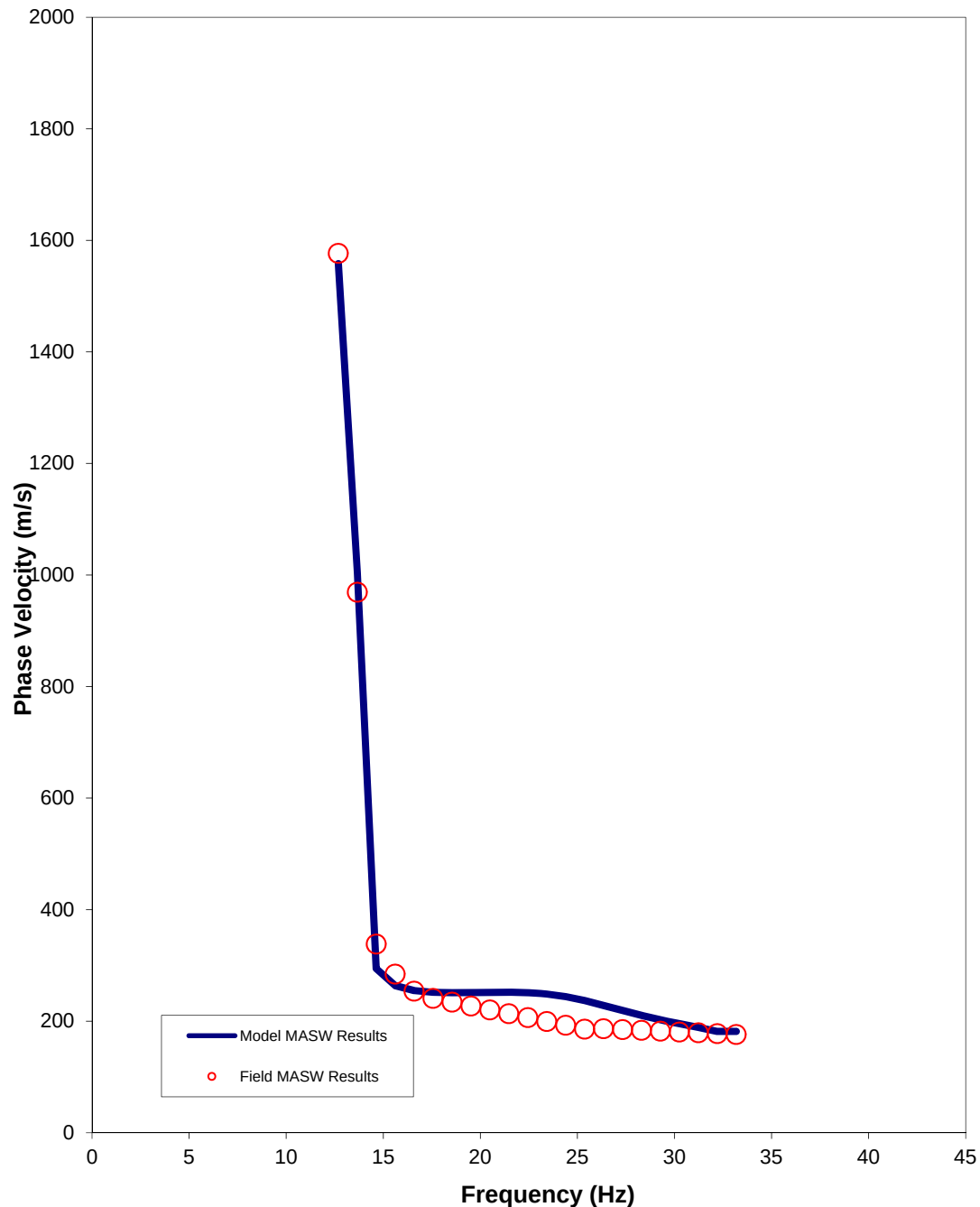


Figure 5: Comparison of Field (red dots) vs. Modelled Data (blue line) along MASW Line 1

To calculate the average shear-wave velocity as required by the Canadian Highway Bridge Design Code (CHBDC, 2014), the results were modelled to 30 metres below ground surface. The average shear-wave velocity along MASW Line 1 was found to be 734 m/s (Table 1).

The Canadian Highway Bridge Design Code (CHBDC, 2014) requires special site-specific evaluation if certain soil types are encountered on the site, so the site classification stated here should be reviewed, and modified if necessary, according to borehole stratigraphy, standard penetration resistance results, and undrained shear strength measurements, if available for this site.

Table 1: Shear-Wave Velocity Profile along MASW Line 1

Model Layer (mbgs)		Layer Thickness (m)	Shear Wave Velocity (m/s)	Shear Wave Travel Time Through Layer (s)
Top	Bottom			
0.00	1.07	1.07	226	0.004732
1.07	2.31	1.24	226	0.005460
2.31	3.71	1.40	226	0.006188
3.71	5.27	1.57	226	0.006916
5.27	7.01	1.73	650	0.002664
7.01	8.90	1.90	1114	0.001701
8.90	10.96	2.06	1395	0.001478
10.96	13.19	2.23	1510	0.001473
13.19	15.58	2.39	1505	0.001588
15.58	18.13	2.55	1428	0.001789
18.13	20.85	2.72	1532	0.001775
20.85	23.74	2.88	1572	0.001835
23.74	26.79	3.05	1912	0.001595
26.79	30.00	3.21	1924	0.001671
Vs Average to 30 mbgs (m/s)			734	

Limitations

This technical memorandum, which specifically includes all tables, figures and attachments, is based on data and information collected by Golder Associates Ltd. and is based solely on the conditions of the properties at the time of the work, supplemented by historical information and data obtained by Golder Associates Ltd. as described in this memo.

Golder Associates Ltd. has relied in good faith on all information provided and does not accept responsibility for any deficiency, misstatements, or inaccuracies contained in the reports as a result of omissions, misinterpretation, or fraudulent acts of the persons contacted or errors or omissions in the reviewed documentation.

The services performed, as described in this memo, were conducted in a manner consistent with that level of care and skill normally exercised by other members of the engineering and science professions currently practicing under similar conditions, subject to the time limits and financial and physical constraints applicable to the services.

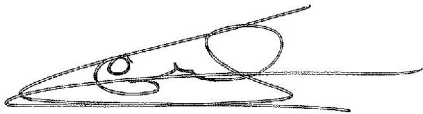
Any use which a third party makes of this memo, or any reliance on, or decisions to be made based on it, are the responsibilities of such third parties. Golder Associates Ltd. accepts no responsibility for damages, if any, suffered by any third party as a result of decisions made or actions based on this memo.

The findings and conclusions of this memo are valid only as of the date of this memo. If new information is discovered in future work, including excavations, borings, or other studies, Golder Associates Ltd. should be requested to re-evaluate the conclusions of this memo, and to provide amendments as required.

Closure

We trust that this technical memorandum meets your needs at the present time. If you have any questions or require clarification, please contact the undersigned at your convenience.

GOLDER ASSOCIATES LTD.



Stephane Sol, Ph.D, P. Geo.
Senior Geophysicist



Christopher Phillips, M. Sc., P. Geo.
Senior Geophysicist, Principal

SS/CRP/mvrd

n:\active\2016\3 proj\1655214 mto 4016-e-0001hwy 417 ottawa\foundations\3 - field work\geophysics\1655214_1500 mto\preston\report\1655214_1500 masw tech memo
preston2017_8dec2017.docx

APPENDIX F

Site Photographs



Photograph 1: Looking north along Rochester Street towards the Highway 417 Overpass at Rochester Street; 2019-03-13



Photograph 2: Looking south along Rochester Street towards the Highway 417 Overpass at Rochester Street; 2019-03-13



Photograph 3: Looking southeast towards the northeast embankment; 2019-03-13



Photograph 4: Looking southwest towards the northwest embankment; 2019-03-13



Photograph 5: Looking northeast towards the southeast embankment; 2019-03-13



Photograph 6: Looking northwest towards the southwest embankment; 2019-03-13

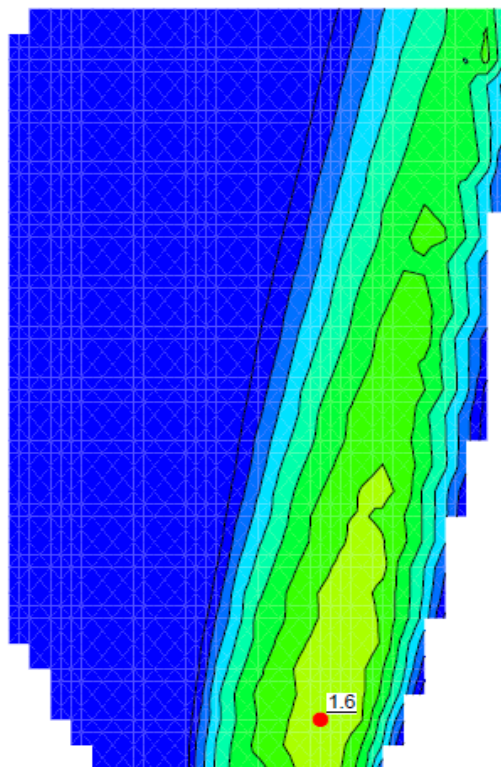
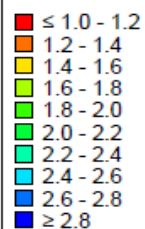
APPENDIX G

Results of Slope Stability Analysis

Figure G1 – Static Condition

Figure G2 – Seismic Condition

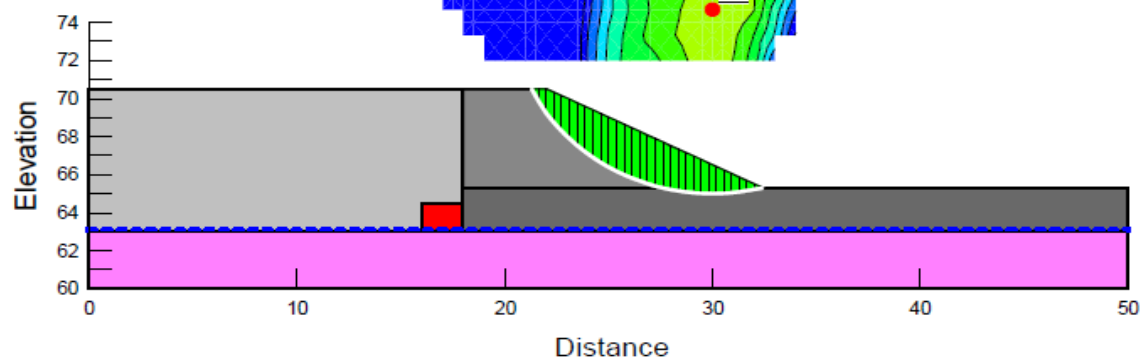
Factor of Safety



File Name: 1655214-1110 Rochester Street Overpass Global Failures _ RKJune_2019.gsz
 Title: Rochester Street Overpass - South Section
 Name: 1.1 Static Drained
 Method: Morgenstern-Price
 Direction of movement: Left to Right
 Horz Seismic Load: 0

Groundwater Elevation of 63.1 Metres
 Minimum Slip Surface Depth of 2.5 Metres

Color	Name	Model	Unit Weight (kN/m³)	Cohesion* (kPa)	Phi* (°)
	Bedrock	Bedrock (Impenetrable)			
	Existing Embankment Fill	Mohr-Coulomb	20	0	33
	Existing Grade Fill	Mohr-Coulomb	19	0	30
	Footing	Bedrock (Impenetrable)			
	Widening Embankment Fill	Mohr-Coulomb	20	0	33



Foundation Investigation

Highway 417 Overpass Structures at Rochester Street

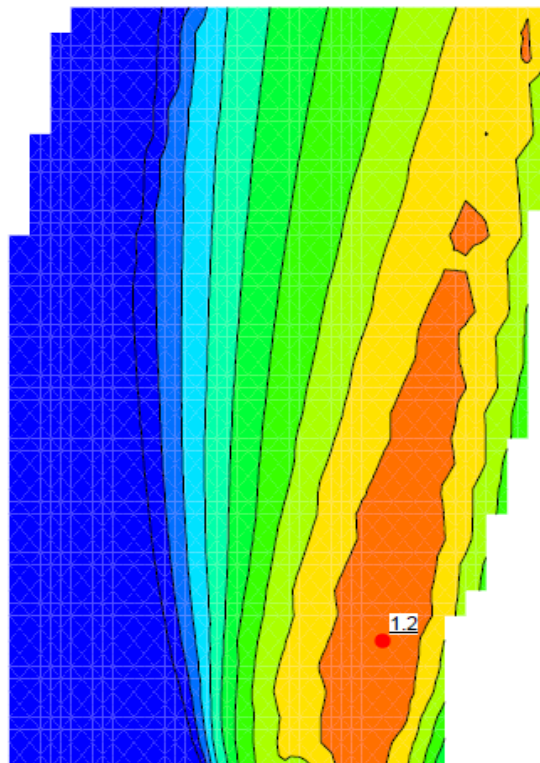
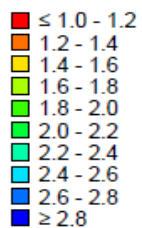
Slope Stability - Static Analysis

Ottawa, Ontario

Project No. 1655214-1110
 Drawn: RK
 Date: 2019-06-24
 Checked: KP
 Review:

Figure G1

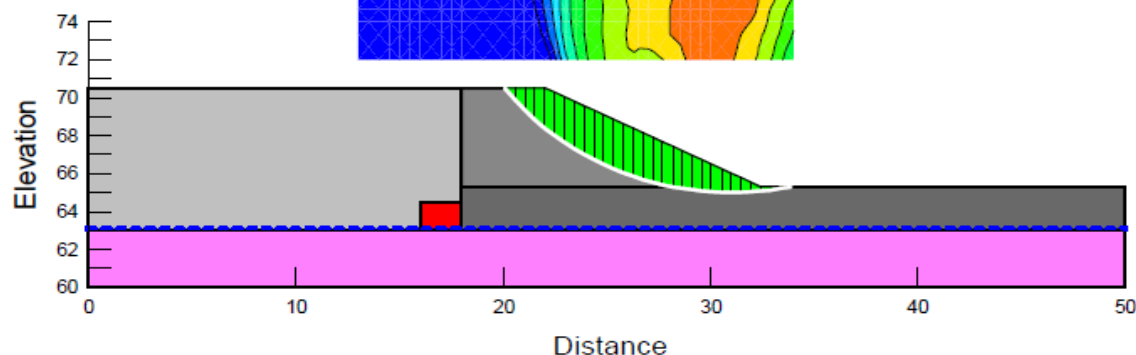
Factor of Safety



File Name: 1655214-1110 Rochester Street Overpass Global Failures _ RKJune_2019.gsz
 Title: Rochester Street Overpass - South Section
 Name: 1.2 Seismic Load
 Method: Morgenstern-Price
 Direction of movement: Left to Right
 Horz Seismic Load: 0.126

Groundwater Elevation of 63.1 Metres
 Minimum Slip Surface Depth of 2.5 Metres

Color	Name	Model	Unit Weight (kN/m ³)	Cohesion* (kPa)	Phi* (°)
	Bedrock	Bedrock (Impenetrable)			
	Existing Embankment Fill	Mohr-Coulomb	20	0	33
	Existing Grade Fill	Mohr-Coulomb	19	0	30
	Footing	Bedrock (Impenetrable)			
	Widening Embankment Fill	Mohr-Coulomb	20	0	33



Foundation Investigation

Highway 417 Overpass Structures at Rochester Street Slope Stability - Seismic Analysis

Ottawa, Ontario

Project No.	1655214-1110
Drawn:	RK
Date:	2019-06-24
Checked:	KP
Review:	

Figure G2



golder.com