



April 29, 2015

REVISED REPORT



REVISED FOUNDATION INVESTIGATION REPORT

**OVERHEAD SIGNS
FUTURE HIGHWAY 5 / HIGHWAY 6 INTERCHANGE (IC) AND
ASSOCIATED MUNICIPAL ROADS, CITY OF HAMILTON
MINISTRY OF TRANSPORTATION, ONTARIO
GWP 2112-05-00**

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PART A

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1.0 INTRODUCTION

Golder Associates Ltd. (Golder) has been retained by IBI Group (IBI) on behalf of the Ministry of Transportation, Ontario (MTO) to provide detail foundation engineering services for the proposed Overhead Sign (OHS) support structures associated with the construction of a new interchange (IC) structure at the Highway 5 and Highway 6 intersection, which is to replace the existing Highway 5 and Highway 6 at-grade crossing. The proposed work is part of the overall future Highway 5 and Highway 6 Interchange and associated ramps and Municipal Roads in the City of Hamilton, Ontario, which includes: high fill embankments for the Highway 5 and Highway 6 re-alignments and interchange ramps; rock cut slope assessment; culvert extensions and replacements; retaining walls; high mast lights; and overhead signs. It is noted that this report was issued as a final report in April 2014; however, in preparing the Foundation Investigation Report for Borer's Creek Culvert and Retaining Wall it was noted that the location and ground surface elevation of Borehole OS-4 in the vicinity of the proposed Overhead Sign #4 location was incorrect. Further the location of Overhead Sign #4 has been moved from Station 20+480 to Station 20+506 and therefore the subsurface information at Boreholes BC-3A and BC-6A is now pertinent to Overhead Sign #4.

The Terms of Reference (TOR) and the Scope of Work for the foundation engineering services are outlined in MTO's Request for Proposal, dated January 2010, which forms part of the Consultant's Assignment Number (Number 2008-E-0038) for this project. Golder's proposal for the foundation engineering services is contained in Section 6.8 of IBI's Technical Proposal for this assignment. The work has been carried out in accordance with Golder's Supplementary Specialty Quality Control Plan for foundation engineering services for this project, dated September 10, 2012.

This report addresses the foundation investigation carried out for the four (4) proposed overhead sign support structures required for the proposed Highway 5/Highway 6 Interchange. The purpose of this investigation is to establish the subsurface conditions at the locations of the proposed overhead signs along the proposed re-aligned Highway 6 and the South to East/West (S-E/W) Ramp by borehole drilling, rock coring and in situ, and laboratory testing on selected soil and rock samples.

2.0 SITE DESCRIPTION

The proposed overhead signs are located in the vicinity of the existing Highway 5 and Highway 6 intersection, which is located west of Waterdown and approximately 3 km north of the Highway 403/Highway 6 Interchange at Clappison's Corners in the City of Hamilton, Ontario. The existing Highway 5 alignment in this area is oriented generally in a west-east direction extending through the City of Brantford to the west and the City of Mississauga to the east. The existing Highway 6 alignment is oriented generally in a north-south direction connecting with Highway 403 to the south and Highway 401 to the north of Highway 5, and was last widened in 2005. Based on the information provided by IBI, the proposed sign support structures, designation, location and corresponding structure type are summarized below and shown in plan on Drawing 1.



Sign Support Designation	Sign Location (Station Number)	Reference Stationing	Sign Support Structure Type
OHS #1	~ 750 m south of Highway 5/ Highway 6 Interchange (Station 19+220)	Highway 6	Cantilever
OHS #2	~ 350 m south of Highway 5/ Highway 6 Interchange (Station 19+610)	Highway 6	Tri-chord
OHS #3	Highway 6 South - Highway 5 East/West (S-E/W) Ramp (Station 10+260)	South-East/West Ramp	Steel Monotube
OHS #4	~ 480 m North of Highway 5/ Highway 6 Interchange (Station 20+506)	Highway 6	Tri-chord

The topography in the area of the proposed overhead signs within the project limits generally consists of relatively flat terrain which slopes downward to the south of the intersection along Highway 6 down the Niagara Escarpment (in the area of OHS #1).

3.0 INVESTIGATION PROCEDURES

The field work for the detail foundation investigation at the proposed overhead sign support structure locations was carried out on August 20 and September 3, 2013 during which time a total of four (4) boreholes (designated as Boreholes OS-1 to OS-4) were advanced, one (1) borehole at each of the proposed overhead signs as shown on Drawing 1. In addition, Boreholes BC-3A and BC-6A, drilled for the Borer's Creek culvert investigation on October 14, 2014, are also pertinent to the foundation investigation for Overhead Sign #4.

The borehole investigation was carried out using truck-mounted CME 55 and CME 75 drill rigs and a track-mounted CME 55 drill rig, supplied and operated by DBW Drilling Ltd. of Ajax, Ontario. The boreholes were advanced through the overburden using 121 mm outer diameter (O.D.), 150 mm O.D solid stem augers or 102 mm O.D. continuous flight solid stem augers. Soil samples were obtained at ground surface or below the layer of asphalt where practical, and at intervals of depth of about 0.75 m to 1.5 m, using a 50 mm O.D. split-spoon sampler driven by an automatic hammer in accordance with Standard Penetration Test (SPT) procedures¹. Samples of the bedrock were obtained using an 'NQ' size rock core barrel and coring techniques.

The boreholes were advanced to depths ranging from 3.5 m to 7.0 m below existing ground surface, including coring of bedrock for core lengths of between about 3.0 m and 3.4 m.

The groundwater conditions and water levels in the open boreholes were observed during and immediately following the drilling operations. The boreholes were backfilled to the ground surface with bentonite upon

¹ ASTM D1586-08a – *Standard Test Method for Standard Penetration Tests and Split Barrel Sampling of Soil.*



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completion in accordance with Ontario Regulation 903, Wells (as amended). The boreholes advanced through the Highway 6 asphalt pavement were sealed at the surface with cold patch asphalt, up to approximately 0.3 m thick.

The field work was observed by a member of Golder's engineering and technical staff, who located the boreholes in the field, arranged for the clearance of underground services, observed the drilling/coring, sampling and in situ testing operations, logged the boreholes, and examined and cared for the soil and rock samples. The samples were identified in the field, placed in appropriate containers, labelled and transported to our Mississauga geotechnical laboratory where the samples underwent further visual examination and laboratory testing. Classification testing (water content, organic content, Atterberg limits and grain size distribution) was carried out on selected soil samples in accordance with MTO and/or ASTM Standards, as applicable. Strength testing, such as unconfined compression and point load index, was carried out on selected specimens of the rock core. The results of the laboratory testing are presented on the Record of Borehole sheets and included in respective Appendices A to D for each overhead sign location.

The borehole locations were staked/marked in the field by Golder personnel. The as-drilled borehole location and ground surface elevation of Boreholes OS-1 and OS-2 were surveyed by Callon Dietz, a licensed surveying company retained by Golder. The as-drilled borehole locations of Boreholes OS-3 and OS-4 were measured relative to the existing on-site features and the overhead signs location shown on the digital terrain model for the site, provided by IBI. The approximate ground surface elevations at the location of Boreholes OS-3 and OS-4 were obtained from the topographic and contour maps provided by IBI.

The as-drilled borehole locations (positioned relative to MTM NAD 83 northing and easting coordinates) and the ground surface elevations (referenced to Geodetic datum) summarized below are provided on the individual Record of Borehole sheets and are shown on Drawing 1.

Borehole Number	Location (MTM NAD 83)		Ground Surface Elevation (m)	Borehole Depth (m)
	Northing (m)	Easting (m)		
OS-1	4796490.3	271454.1	190.6	6.6
OS-2	4796767.7	271175.4	216.7	7.0
OS-3	4797113.7	271100.9	223.8	6.9
OS-4	4797368.3	270547.7	220.5	6.4
BC-3A	4797364.8	270517.8	216.7	3.5
BC-6A	4797415.3	270555.1	218.5	5.5

*including between 3.0 m and 3.4 m of bedrock coring.



4.0 SITE GEOLOGY AND SUBSURFACE CONDITIONS

4.1 Regional Geology

The study area is located on the Niagara Escarpment¹, a topographic break that separates the two levels of the Niagara Peninsula, which is manifested in typically harder, resistant dolostone and limestone bedrock units forming vertical cliffs along the brow of the Escarpment, over the softer shale bedrock below. The Niagara Escarpment extends from the Niagara River to the northern tip of the Bruce Peninsula and is generally flanked by landscapes of glacial origin. Capping the Niagara Escarpment is the Lockport Formation consisting of white, grey and brown dolostone of Silurian Age (Karrow, 1987)² at the crest underlain by the Rochester, Irondequoit, Reynales, Thorold, Grimsby and Cabot Head Formations consisting of grey to reddish brown shaley dolostone, limestone, siltstone and sandstone (Blair and McFarland, 1992)³.

Overburden within the study area is comprised primarily of glacial till mapped as the Halton Till which extends as a sheet in the Hamilton area, terminating in the Waterdown Moraines east of the Niagara Escarpment between the Lake Iroquois and the Trafalgar Moraine. The Halton Till is generally considered a fine-grained diamicton with minor fine-grained lacustrine sediments incorporated within the body of the unit, likely from glacial reworking of underlying lacustrine sediments. The Halton Till also contains cobbles and boulders and in some areas, “boulder pavements” (Watt, 1955)⁴ can be encountered where boulders are nested or concentrated within the till unit.

During the retreat of the last ice sheet, lakes were formed in depressions on the land surface in which were deposited sand, gravel, silt and clay materials. The last major meltwater system along the Escarpment occurred when the Waterdown Moraines were formed. Several channels among the Waterdown Moraines functioned at various times, feeding melt waters southwest toward glacial lakes to create lacustrine and outwash sand deposits.

4.2 Subsurface Conditions

The detailed subsurface soil and groundwater conditions encountered in the boreholes advanced at each of the proposed overhead sign locations and the results of the in situ and laboratory testing carried out on selected soil and rock core samples are provided on the Record of Borehole and Drillhole sheets. The Record of Borehole and Drillhole sheets, together with the results of the laboratory tests are contained in Appendices A to D for OHS #1 to OHS #4, respectively. The results of the in situ field tests (i.e. SPT ‘N’-values) as presented on the Record of Borehole sheets and in Sections 4.3 to 4.6 are uncorrected.

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

² Karrow, P.F. 1987. *Quaternary Geology of the Hamilton-Cambridge Area, Southern Ontario*, Ontario Geological Survey, Report 255. Ministry of Northern Development and Mines, Ontario.

³ Blair, R. and McFarland, S. 1993. *Regional Correlation of the Middle and Lower Silurian Stratigraphy of the Niagara Escarpment Area*, Proceedings of the 1992 Conference of the Canadian National Chapter, International Association of Hydrogeologists, Hamilton, Ontario, 659-696.

⁴ Watt, A.K. 1955. *Pleistocene Geology and Groundwater Resources of the Township of North York, York County*, Ontario Department of Mines, Sixty Fourth Annual report, Volume LXIV, Part 7.



The stratigraphic boundaries shown on the Record of Borehole sheets are inferred from non-continuous sampling, observations of drilling progress and the results of Standard Penetration Tests. These boundaries, therefore, represent transitions between soil types rather than exact planes of geological change. Variation in the stratigraphic boundaries between and beyond boreholes will exist and is to be expected, however, the factual data presented in the Record of Borehole sheets governs any interpretation of the site conditions.

The following sections provide information on the subsurface and groundwater conditions encountered in the borehole advanced at each of the proposed overhead sign locations.

4.3 Overhead Sign Structure 1 (OHS #1)

The proposed OHS #1 is located on the Highway 6 Northbound Lanes (NBL) at approximately Station 19+220. The existing ground surface along the Highway 6 NBL, in the vicinity of the proposed overhead sign location, is at about Elevation 190.7 m.

The subsurface conditions, as encountered in Borehole OS-1, consist of a layer of asphalt underlain by fill associated with the existing Highway 6 embankment. The fill deposit consists of an upper portion of granular fill underlain by a lower portion of cohesive fill.

4.3.1 Asphalt

An approximately 150 mm thick layer of asphalt was encountered in Borehole OS-1 drilled through the pavement on existing Highway 6.

4.3.2 Fill

A 6.4 m thick deposit of fill associated with the construction of Highway 6 embankment was encountered underlying the asphalt, at about Elevation 190.4 m. The upper portion of the fill is granular, comprising of sand, trace to some gravel to sand and gravel, trace to some silt, trace to some clay. The upper 1.4 m of the granular fill contains clayey silt seams and a clayey silt pocket was encountered at a depth of about 2.3 m. Underlying the granular fill is a layer of cohesive fill comprised of clayey silt, trace to some sand and trace gravel. Borehole OS-1 was terminated within this deposit at a depth of about 6.6 m below ground surface (Elevation 184.0 m).

The SPT “N”-values measured within the granular fill range from 10 blows to 27 blows per 0.3 m of penetration, indicating a compact relative density. An SPT “N”-value of 31 blows per 0.3 m of penetration was recorded within the cohesive fill, suggesting that the clayey silt fill has a hard consistency. A grain size distribution test was carried out on one (1) sample of the sand and gravel fill, and the result is provided on Figure A1 in Appendix A. An Atterberg limits test was carried out on a sample of the clayey silt fill pocket encountered within the granular fill and on one (1) sample of the clayey silt fill. The measured liquid limit (on each sample) is about 18 per cent and 25 per cent, the plastic limit is about 14 per cent and 13 per cent, and the corresponding plasticity index is about 4 per cent and 12 per cent. The result of the Atterberg limits test on the clayey silt fill pocket and a layer of clayey silt fill is presented on the plasticity chart on Figure A2 and Figure A3, respectively, which classify the material as clayey silt of low plasticity.

The natural water content measured on four (4) samples of the granular fill ranges from about 4 per cent to 11 per cent; and the natural water content measured on one (1) sample of the cohesive fill is about 14 per cent.



4.3.3 Groundwater Conditions

The samples taken in Borehole OS-1 were generally moist to wet. The open borehole was observed to be dry upon completion of drilling. The groundwater conditions observation at this site is short term and may not represent the stabilized groundwater level at this site. In addition, the groundwater level will be subject to seasonal fluctuations and precipitation events, and should be expected to be higher during the spring season or during any period of heavy precipitation.

4.4 Overhead Sign Support Structure 2 (OHS #2)

The proposed OHS #2 is located on the Highway 6 NBL at approximately Station 19+610. The existing ground surface along the Highway 6 in the vicinity of the proposed sign location, is at about Elevation 216.7 m.

The subsurface conditions, as encountered in Borehole OS-2, consist of a layer of asphalt underlain by a deposit of granular fill associated with the existing Highway 6 embankment. The fill deposit is underlain by a deposit of sand and gravel which in turn is underlain by dolostone bedrock.

4.4.1 Asphalt

An approximately 150 mm thick layer of asphalt was encountered in Borehole OS-2 drilled through the pavement on existing Highway 6.

4.4.2 Fill

A deposit of sand fill containing trace to some silt, trace to some gravel and trace clay was encountered underlying the asphalt layer in Borehole OS-2 at a depth of 0.2 m below ground surface (Elevation 216.5 m). The thickness of the sand fill deposit is about 2.8 m and the base of the fill material extends to about Elevation 213.7 m.

The SPT “N”-values measured within the sand fill range from 29 blows to 66 blows per 0.3 m of penetration, indicating a compact to very dense relative density.

The result of a grain size distribution test completed on one (1) sample of the granular fill deposit is shown on Figure B1 in Appendix B. The natural water content measured on a sample of the granular fill deposit is about 3 per cent.

4.4.3 Sand and Gravel

An approximately 0.4 m thick layer of sand and gravel, trace to some silt and trace clay was encountered underlying the fill deposit in Borehole OS-2. The top of this layer was encountered at about Elevation 213.7 m.

An SPT “N”-value of 59 blows per 0.28 m of penetration was measured at the interface of this deposit and the underlying dolostone rock fragment layer, indicating a very dense relative density.

A grain size distribution was completed on one (1) sample of the sand and gravel deposit and the result is presented on Figure B2 in Appendix B. The natural water content measured on a sample of this deposit is about 5 per cent.

4.4.4 Bedrock

An approximately 0.5 m thick layer of dolostone fragments was encountered between the sand and gravel layer and the underlying bedrock at a depth of 3.4 m below ground surface, corresponding to about Elevation 213.3 m.



Bedrock was encountered at Elevation 212.8 m, at about 3.9 m below ground surface, and core samples were recovered between depths of 3.9 m and 7.0 m. Based on the review of the bedrock core samples, the bedrock consists of dolostone of the Lockport Formation. In general, the bedrock samples are described as fresh to slightly weathered, medium bedded, fine to medium crystalline, faintly to moderately porous, light grey, as presented on the Record of Drillhole OS-2 in Appendix B, and shown on the photograph of the recovered core samples on Figures B3 in Appendix B. The degree of weathering of the bedrock samples (i.e. fresh to slightly weathered – W1 to W2), and the strength classification of the intact rock mass based on field identification (i.e. strong R4) are described in accordance with the International Society for Rock Mechanics (ISRM)¹ standard classification system.

The Rock Quality Designation (RQD) measured on the two core samples is about 67 per cent and 100 per cent, indicating a rock mass of good to excellent quality as per Table 3.10 of CFEM (2006).² The Total Core Recovery (TCR) of the core samples is about 100 per cent and the Solid Core Recovery (SCR) of the core samples is about 72 per cent and 98 per cent for the two core samples.

An Unconfined Compression (UC) test (ASTM D7012)³ was carried out on a selected core specimen of the dolostone bedrock and measured a Uniaxial Compressive Strength (UCS) of about 79 MPa, as detailed on Figure B4 in Appendix B. Point load strength index tests (ASTM D5731)⁴ were carried out on selected samples of the bedrock core. The axial and diametral point load strength index values are shown on the Record of Drillhole OS-2 and are presented in Table B1 in Appendix B. The axial tests carried out on two (2) samples of the dolostone bedrock core measured Is_{50} values of about 11.5 MPa and 17.0 MPa, and the diametral tests carried out on two (2) samples of the dolostone bedrock core measured Is_{50} values of about 1.6 MPa and 12.8 MPa.

Also presented in Table B1 are the estimated UCS values for each sample tested for point load strength index based on a relationship between Is_{50} and UCS, which is given by a correlation factor (K)⁹ which varies depending on the size of the core sample and the site specific strength of the rock as confirmed from the UC test completed on the selected core samples for the overall site of the overhead signs. For this site, the estimated UCS values are based on a correlation factor (K) of 7.

Based on the result of the laboratory UC test and in accordance with Table 3.5 in CFEM (2006)⁷, the dolostone bedrock is classified as strong (R4, 50 MPa < UCS < 100 MPa).

4.4.5 Groundwater Conditions

The samples taken in Borehole OS-2 were generally moist. The water level in open borehole was not recorded upon completion of drilling as water was introduced into the borehole for the coring operation.

The groundwater level at this site will be subject to seasonal fluctuations and precipitation events, and should be expected to be higher during the spring season or during any period of heavy precipitation.

¹ International Society for Rock Mechanics Commission on Test Methods, 1985. Int. J. Rock Mech.Min. Sci. & Geomech. Abstr. Vol 22, No. 2, pp. 51-60.

² Canadian Geotechnical Society, 2006. Canadian Foundation Engineering Manual, 4th Edition.

³ ASTM D7012 – Standard Test Method for Compressive Strength and Elastic Moduli of Intact Rock Core Specimens.

⁴ ASTM D5731 – Standard Test Method for Determination of the Point Load Strength Index of Rock and Application to Rock Strength Classification



4.5 Overhead Sign Support Structure 3 (OHS #3)

The proposed OHS #3 is located on the Highway 6 NBL-East/West (S-E/W) Ramp at approximately Station 10+260. The existing ground surface along the S-E/W Ramp, in the vicinity of the proposed sign location, is at about Elevation 223.8 m.

The subsurface conditions, as encountered in Borehole OS-3, consist of sand and gravel fill underlain by a deposit of clayey silt till containing silty sand interlayer.

4.5.1 Fill

An approximately 0.7 m thick layer of sand and gravel fill was encountered at the ground surface in Borehole OS-3.

4.5.2 Clayey Silt Till

A cohesive till deposit comprised of clayey silt, some sand and trace gravel was encountered underlying the fill in Borehole OS-3. An approximately 0.9 m thick interlayer of silty sand, some clay, was encountered within the lower portion of the till deposit at about Elevation 218.2 m. The surface of the till deposit is at about Elevation 223.1 m and the overall thickness of the till deposit is about 6.2 m.

The SPT 'N'-values measured within the cohesive till deposit range from 14 blows to 34 blows per 0.3 m of penetration, and a SPT "N" of 50 blows per 0.05 m of penetration was recorded prior to termination of the borehole, suggesting a stiff to hard consistency. Within the silty sand interlayer, a SPT 'N'-value of 8 blows per 0.3 m of penetration was measured, indicating a loose relative density.

The result of a grain size distribution test completed on one (1) sample of the cohesive till deposit is shown on Figure C1 in Appendix C and the result of the grain size distribution test carried out on one (1) sample of the silty sand interlayer is shown on Figure C2 in Appendix C.

Atterberg limits tests were completed on two (2) samples of the clayey silt till deposit and measured liquid limits of 25 per cent and 27 per cent, plastic limits of about 14 per cent and corresponding plasticity indices of about 11 per cent and 13 per cent. The results of the Atterberg limits tests are shown on the plasticity chart on Figure C3 in Appendix C and indicate that the material is classified as a clayey silt of low plasticity.

The natural water content measured on four (4) samples of the cohesive till deposit ranges from about 11 per cent to 18 per cent and the natural water content measured on a sample of the silty sand interlayer is about 19 per cent.

4.5.3 Groundwater Conditions

The samples taken Borehole OS-3 were generally moist to wet. The water level measured in the open borehole during the drilling operation was at about Elevation 218.0 m, measured at a depth of 5.8 m; and upon completion of drilling, the water level dropped to about Elevation 217.4 m, measured at a depth of about 6.4 m below ground surface. The groundwater conditions level observation at this site is short term and may not represent the stabilized groundwater level. In addition, the groundwater level will be subject to seasonal fluctuations and precipitation events, and should be expected to be higher during the spring season or during any period of heavy precipitation.



4.6 Overhead Sign Support Structure 4 (OHS #4)

The proposed OHS #4 is located on the Highway 6 Southbound Lanes (SBL) at approximately Station 20+506. The existing ground surface along the Highway 6 SBL, in the vicinity of the proposed sign location, is at about Elevation 220.5 m.

The subsurface conditions, as encountered in Borehole OS-4, consist of a layer of asphalt underlain by fill associated with the existing Highway 6 embankment, which in turn is underlain by dolostone bedrock. In Boreholes BC-3A and BC-6A, the subsurface conditions consist of a layer of topsoil underlain by fill and silty clay till at Borehole BC-6A, underlain by dolostone bedrock.

4.6.1 Asphalt

An approximately 150 mm thick layer of asphalt was encountered in Borehole OS-4 drilled through the pavement on existing Highway 6.

4.6.2 Topsoil

An approximately 300 mm and 100 mm thick layer of topsoil was encountered in Boreholes BC-3A and BC-6A, respectively.

4.6.3 Fill

A 3.0 m thick deposit of fill associated with the construction of Highway 6 embankment was encountered below the asphalt, at about Elevation 220.3 m, in Borehole OS-4. The upper portion of the fill comprises of sand, trace to some gravel to sand and gravel, trace to some silt and trace clay. Underlying the granular fill is a layer of cohesive fill comprised of clayey silt, trace to some sand, trace gravel, trace organics and containing rootlets. Underlying the topsoil in Borehole BC-6A cohesive fill material was encountered at a depth of 0.1 m below ground surface. The fill material extends to a depth of 0.7 m below ground surface (Elevation 217.8 m).

The SPT “N”-values measured within the granular zones of the fill are 16 blows and 33 blows per 0.3 m of penetration, indicating a compact to dense relative density. The SPT “N”-values measured within the cohesive portion of the fill are 6 blows and 8 blows per 0.3 m of penetration, suggesting a firm consistency. A SPT “N”-value of 50 blows per 0.05 m of penetration was recorded at the interface of the cohesive fill with the underlying dolostone fragments layer over the bedrock. A grain size distribution test was completed on one (1) sample of the sand and gravel fill and the result is shown on Figure D1 in Appendix D. An Atterberg limits test was completed on a sample of the clayey silt fill and measured a liquid limit of about 30 per cent, a plastic limit of about 18 per cent and a corresponding plasticity index of about 12 per cent. The result of the Atterberg limits test is shown on the plasticity chart on Figure D2 in Appendix D and indicates that the material is classified as a clayey silt of low plasticity.

The natural water content measured on one (1) sample of the sand and gravel fill is about 4 per cent and the natural water content measured on two (2) samples of the clayey silt fill is about 16 per cent and 28 per cent. An organic content measured on one (10) sample of the clayey silt fill is about 1.5 per cent.

4.6.4 Silty Clay Till

In Borehole BC-6A advanced near the toe of the slope on the east side of Highway 6, the fill material is underlain by a till deposit consisting of silty clay. The surface of the till deposit was encountered at a depth of 0.7 m below ground surface (Elevation 217.8 m) and extends to a depth of 1.9 m below ground surface (Elevation 216.6 m).



The SPT 'N'-values measured within the cohesive till deposit are 22 blows and 34 blows per 0.3 m of penetration, suggesting a very stiff to hard consistency.

The result of a grain size distribution test completed on one (1) sample of the cohesive till deposit is shown on Figure D3 in Appendix D.

An Atterberg limits test was completed on one (1) sample of the silty clay till deposit and measured a liquid limit of about 37 per cent, a plastic limit of about 17 per cent and a corresponding plasticity index of about 20 per cent. The result of the Atterberg limits test is shown on the plasticity chart on Figure D4 in Appendix D and indicates that the material is classified as a silty clay of intermediate plasticity.

The natural water content measured on one (1) samples of the cohesive till deposit was 14 per cent.

4.6.5 Bedrock

An approximately 0.2 m thick layer of dolostone fragments was encountered between the fill deposit and the underlying bedrock in Borehole OS-4 at a depth of 3.4 m below ground surface, corresponding to about Elevation 217.1 m.

Bedrock was encountered and core samples were recovered in Boreholes OS-4, BC-3A and BC-6A. The depths to bedrock below ground surface and the corresponding bedrock surface elevations are summarized below:

Borehole	Depth to Bedrock Surface (m)	Bedrock Surface Elevation (m)	Comments
OS-4	3.4	217.1	Bedrock Cored
BC-3A	0.3	216.4	Bedrock Cored
BC-6A	1.9	216.6	Bedrock Cored

Based on the review of the bedrock core samples, the bedrock consists of dolostone of the Lockport Formation. In general, the bedrock samples are described as fresh to slightly weathered, medium bedded, fine to medium crystalline, faintly to moderately porous, light grey, as presented on the Records of Drillholes OS-4, BC-3A and BC-6A in Appendix D, and shown on the photograph of the recovered core samples on Figure D5 in Appendix D. The degree of weathering of the bedrock samples (i.e. fresh to slightly weathered – W1 to W2), and the strength classification of the intact rock mass based on field identification (i.e. strong – R4) are described in accordance with the ISRM (1985)⁶.

The Total Core Recovery (TCR) the core samples is between about 92 per cent and 100 per cent and the Solid Core Recovery (SCR) of the core samples is about 77 per cent and 93 per cent. The Rock Quality Designation (RQD) measured on the core samples is between about 66 per cent and 100 per cent, indicating a rock mass of fair to excellent quality as per Table 3.10 of CFEM (2006)⁷.

Point load strength index tests (ASTM D5731 – Standard Test Method for Determination of the Point Load Strength Index of Rock and Application to Rock Strength Classification)⁹ were carried out on selected samples of the bedrock core. The axial and diametral point load strength index values are shown on the Records of Drillholes OS-4, BC-3A and BC-6A and are presented in Table D1 in Appendix D. The axial tests carried out on two (2) samples of the dolostone bedrock core measured Is_{50} values of about 3.5 MPa and 16.0 MPa, and the



diametral tests carried out on two (2) samples of the dolostone bedrock core measured Is_{50} values of about 17.3 MPa and 18.3 MPa.

Two (2) Unconfined Compression (UC) test (ASTM D7012)⁸ were carried out on selected core samples of the dolostone bedrock and measured a UCS of about 96 MPa and 119 MPa, as detailed on Figures D6 and D7 in Appendix D.

Also presented in Table D1 are the estimated UCS values for each sample tested for point load strength index based on a relationship between Is_{50} and UCS, which is given by a correlation factor (K)⁹ which varies depending on the size of the core sample and the site specific strength of the rock as confirmed from the UC test completed on the selected core samples for the overall site of the overhead signs. For this site, the estimated UCS values are based on a correlation factor (K) of 8.

Based on the result of the laboratory UC test and in accordance with Table 3.5 in CFEM (2006)⁷, the dolostone bedrock is generally classified as strong (R4, 50 MPa < UCS < 100 MPa).

4.6.6 Groundwater Conditions

The samples taken in Borehole OS-4 were generally moist to wet and samples taken from Boreholes BC-6A were generally moist. The water level in open borehole was not noted upon completion of drilling as water was introduced into the borehole for the coring operation. Open Borehole BC-3A was dry upon completion of drilling and prior to rock coring.

The groundwater level at this site will be subject to seasonal fluctuations and precipitation events, and should be expected to be higher during the spring season or during any period of heavy precipitation.



5.0 CLOSURE

Mr. Robin Nowensky, a senior technician with Golder and Mr. Joel Gopaul, a member of Golder's Engineering staff supervised the field drilling program. This report was prepared by Ms. Sandra McGaghran, P.Eng a geotechnical engineer and Associated with Golder. Mr. Jorge M. A. Costa, P.Eng., Golder's Designated MTO Foundations Contact for this project and Principal with Golder, conducted an independent review and quality control audit of this report.

GOLDER ASSOCIATES LTD.



Sandra McGaghran, P.Eng.
Geotechnical Engineer, Associate



Jorge M. A. Costa, P.Eng.
Designated MTO Foundations Contact, Principal

SMM/JMAC/jl

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ASTM International

- ASTM D1586 – Standard Test Method for Standard Penetration Test (SPT) and Split Barrel Sampling of Soils.
- ASTM D7012 – Standard Test Method for Compressive Strength and Elastic Moduli of Intact Rock Core Specimens.
- ASTM D5731 – Standard Test Method for Determination of the Point Load Strength Index of Rock and Application to Rock Strength Classification

Ontario Water Resources Act:

Ontario Regulation 903/90 Wells



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, intermediate, 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_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

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



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

Density Index	N
Relative Density	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

	c_u, s_u	
	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	50 to 100	1,000 to 2,000
Very stiff	100 to 200	2,000 to 4,000
Hard	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 5	Trace	Trace sand
5 to 12	Trace to Some (or Little)	Trace to some sand
12 to 20	Some	Some sand
20 to 30	(ey) or (y)	Sandy
over 30	And (non-cohesive (cohesionless)) or With (cohesive)	Sand and Gravel Silty Clay with sand / Clayey Silt with sand



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

Description	Bedding Plane Spacing
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

Description	Spacing
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

Term	Size*
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, recovered at full diameter, measured relative to the length of the total core run. RQD varied from 0% for completely broken core to 100% for core in solid sticks.

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

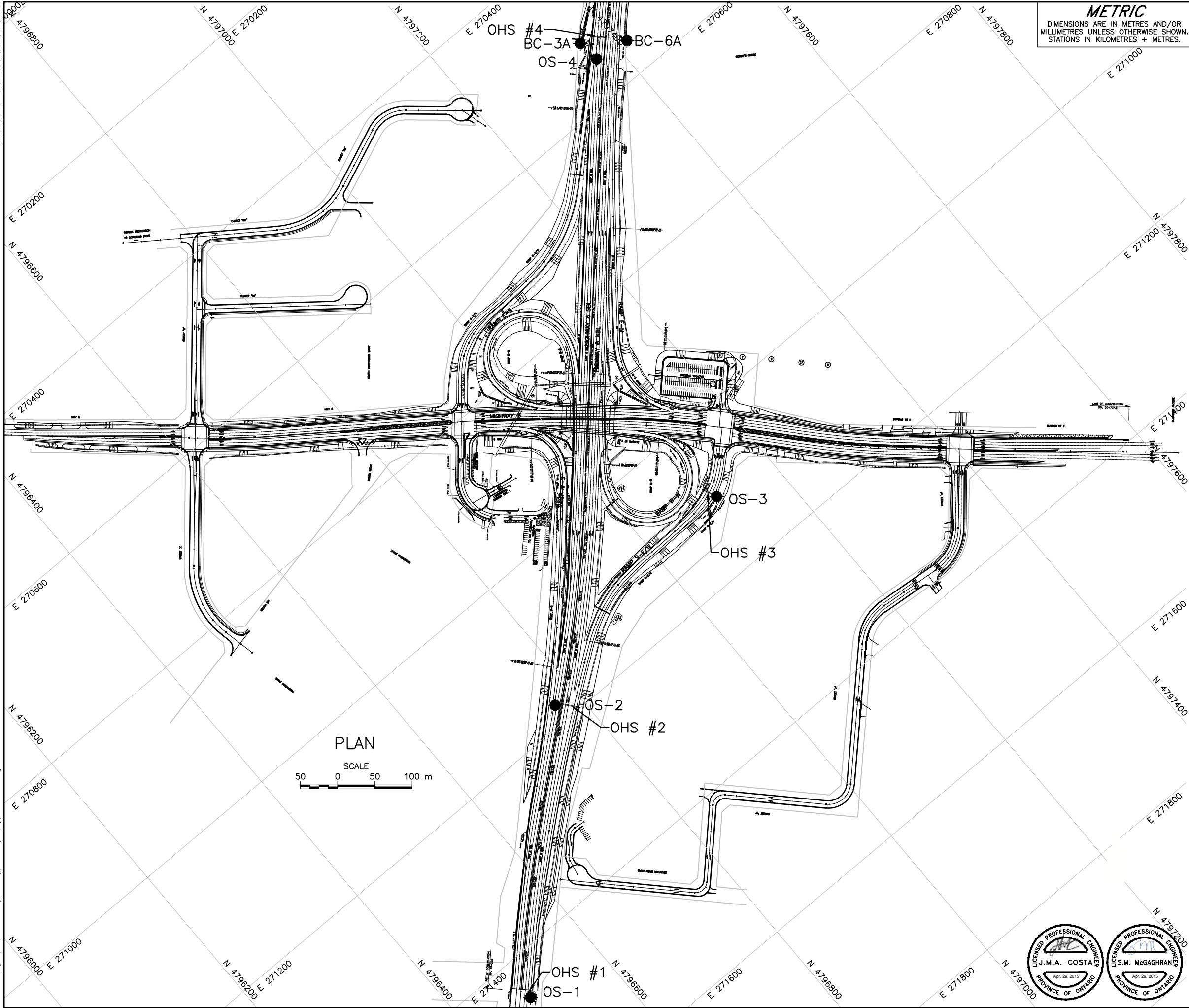
The angle of the discontinuity relative to the axis (length) of the core. In a vertical borehole a discontinuity with a 90° angle is horizontal.

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	

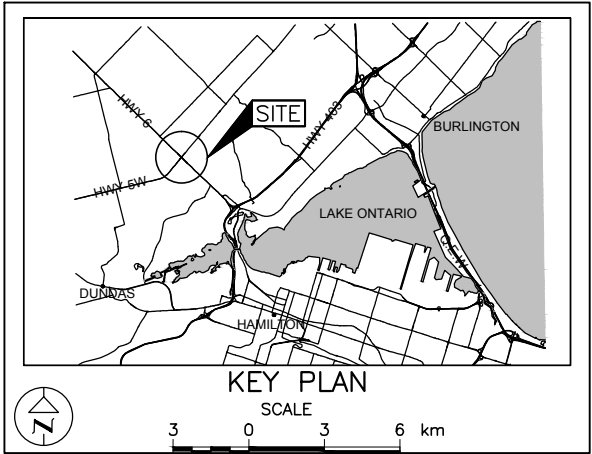


METRIC
DIMENSIONS ARE IN METRES AND/OR
MILLIMETRES UNLESS OTHERWISE SHOWN.
STATIONS IN KILOMETRES + METRES.

CONT No. 2112-05-00
GWP No. 2112-05-00

HIGHWAY 5 OVER HIGHWAY 6
OVERHEAD SIGNS
BOREHOLE LOCATIONS

SHEET



BOREHOLE CO-ORDINATES			
No.	ELEVATION	NORTHING	EASTING
BC-3A	216.7	4797364.8	270517.8
BC-6A	218.5	4797415.3	270555.1
OS-1	190.6	4796490.3	271454.1
OS-2	216.7	4796767.7	271175.4
OS-3	223.8	4797113.7	271100.9
OS-4	220.5	4797368.3	270547.7

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.

The complete Foundation Investigation and Design Report for this project and other related documents may be examined at the Materials Engineering and Research Office, Downsview. Information contained in this report and related documents is specifically excluded in accordance with Section GC 2.01 of OPS General Conditions.

REFERENCE			
Base plans provided in digital format by IBI, drawing file nos. Highway 5&6 Plan.dwg, modified January 30, 2015.			
NO.	DATE	BY	REVISION
Geocres No. 30M5-305			
HWY. 5 & 6		PROJECT NO. 10-1184-0016	DIST. .
SUBM'D. AJS	CHKD. SMM	DATE: March 2015	SITE: .
DRAWN: JFC	CHKD. SMM	APPD. JMAC	DWG. 1





APPENDIX A

Record of Borehole Sheet and Laboratory Test Results – Overhead Sign 1 (OHS #1) – Station 19+220

PROJECT		10-1184-0016		RECORD OF BOREHOLE No OS-1		SHEET 1 OF 1		METRIC								
G.W.P.		2112-05-00		LOCATION		N 4796490.3 ; E 271454.1		ORIGINATED BY								
DIST		Central HWY 5 & 6		BOREHOLE TYPE		150 mm O.D. Continuous Flight Solid Stem Augers		COMPILED BY								
DATUM		Geodetic		DATE		September 3, 2013		CHECKED BY								
								SMM								
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								
190.6	GROUND SURFACE															
0.0	ASPHALT (150 mm)															
0.2	Sand, trace to some gravel, trace to some silt, containing clayey silt seams (FILL) Compact Grey Moist		1	SS	27											
189.2			2	SS	16											
1.4	Sand and gravel, some silt, trace to some clay (FILL) Compact Brown and grey Moist		3	SS	12											
	-----clayey silt pocket		4	SS	10											
187.7																
2.9	Sand, some silt, trace gravel (FILL) Compact Brown Moist to wet		5	SS	10											
			6	SS	13											
			7	SS	17											
185.0																
5.6	Clayey silt, trace to some sand, trace gravel (FILL) Hard Mottled brown and grey Wet		8	SS	31											
184.0																
6.6	END OF BOREHOLE															
NOTES:																
1. Open borehole dry upon completion of drilling.																
2. Borehole caved at a depth of 5.8 m upon completion of drilling.																

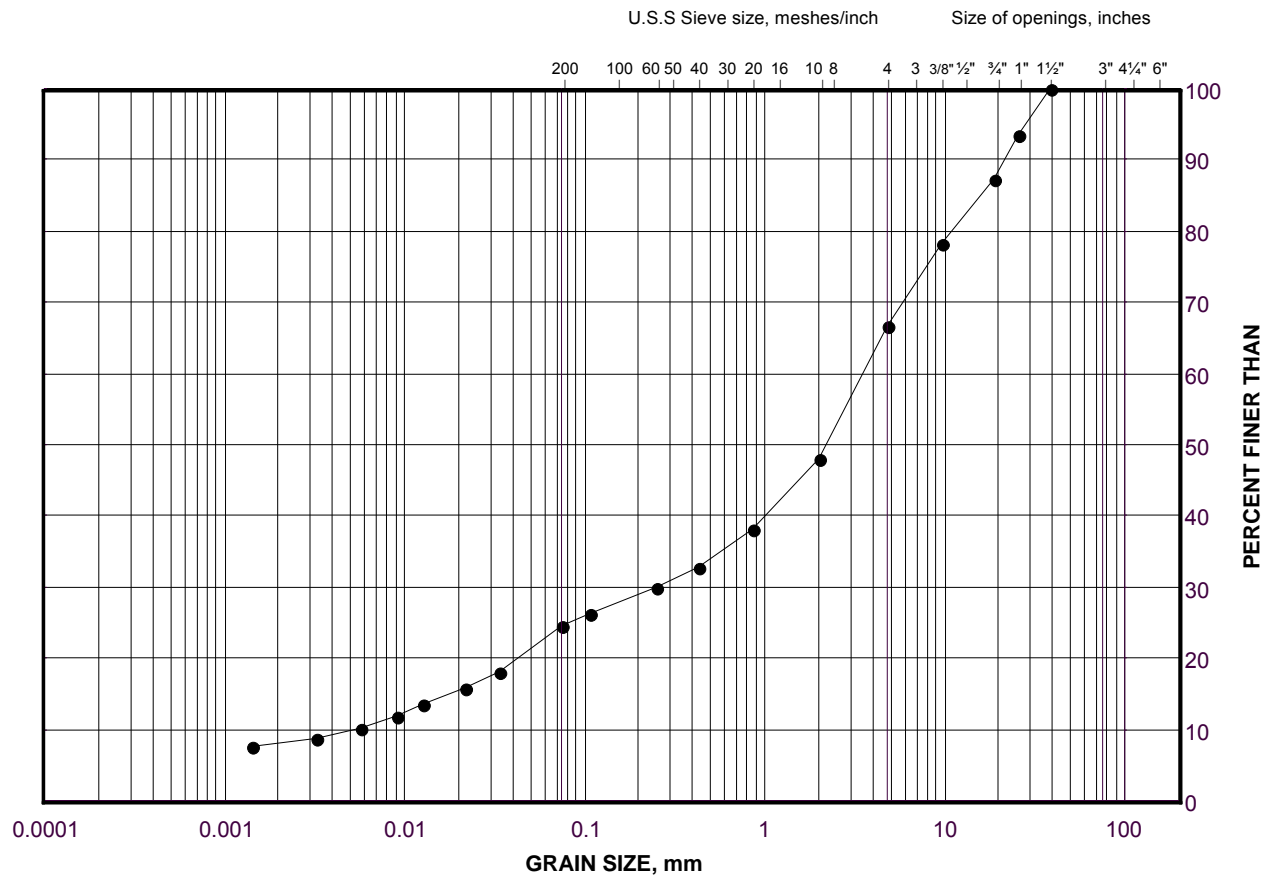
GTA-MTO 001 T:\PROJECTS\2010\10-1184-0016 (IG, HAMILTON)\LOG\10-1184-0016.GPJ GAL-GTA.GDT 4/29/15 DD

GRAIN SIZE DISTRIBUTION

Sand and Gravel (Fill)

Overhead Sign #1

FIGURE A1



SILT AND CLAY SIZES		FINE	MEDIUM	COARSE	FINE	COARSE	COBBLE
FINE GRAINED		SAND SIZE			GRAVEL SIZE		SIZE

LEGEND

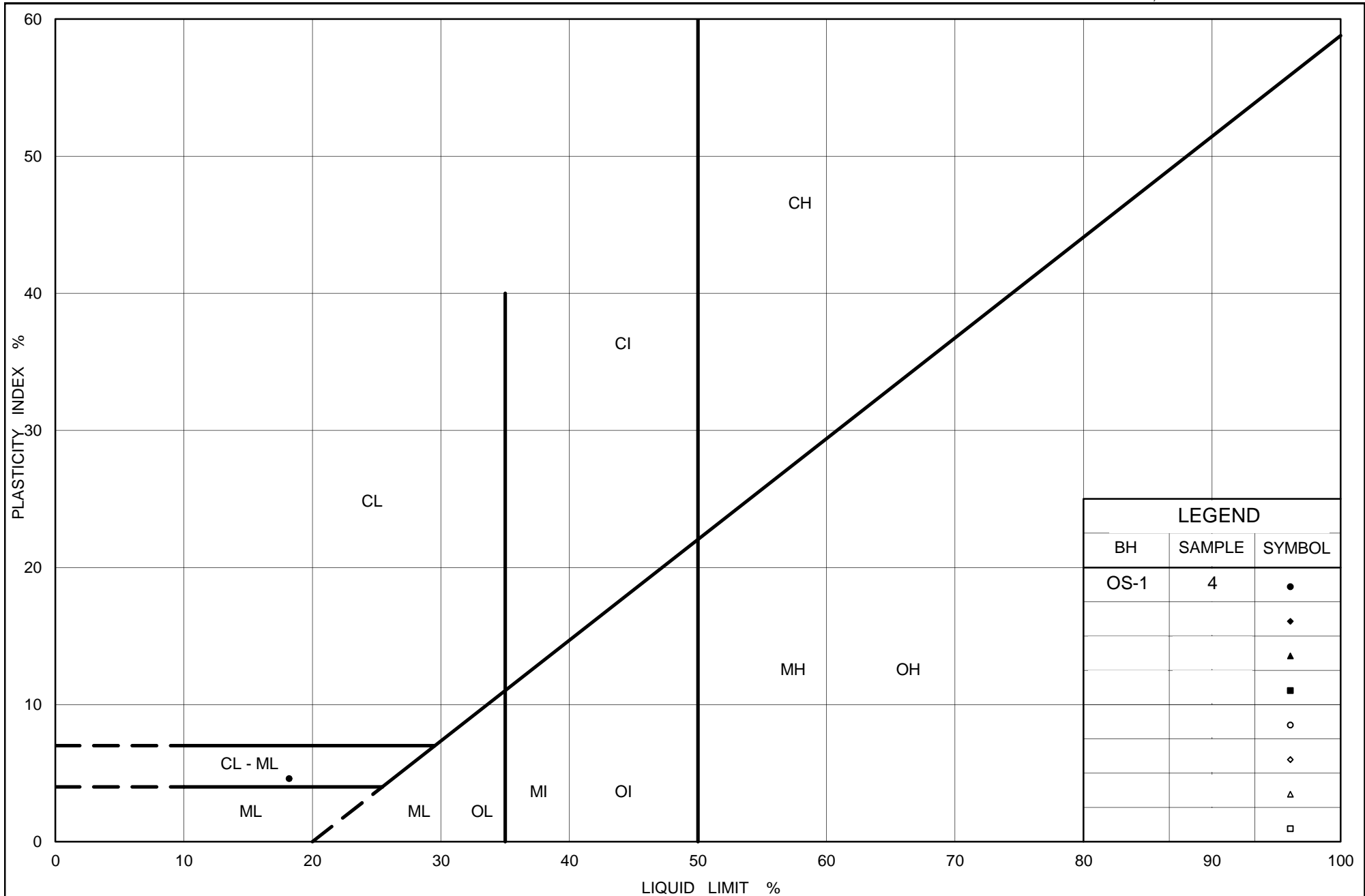
SYMBOL	BOREHOLE	SAMPLE	ELEVATION(m)
•	OS-1	4	188.1

Project Number: 10-1184-0016

Checked By: AV

Golder Associates

Date: 28-Mar-14



Ministry of Transportation

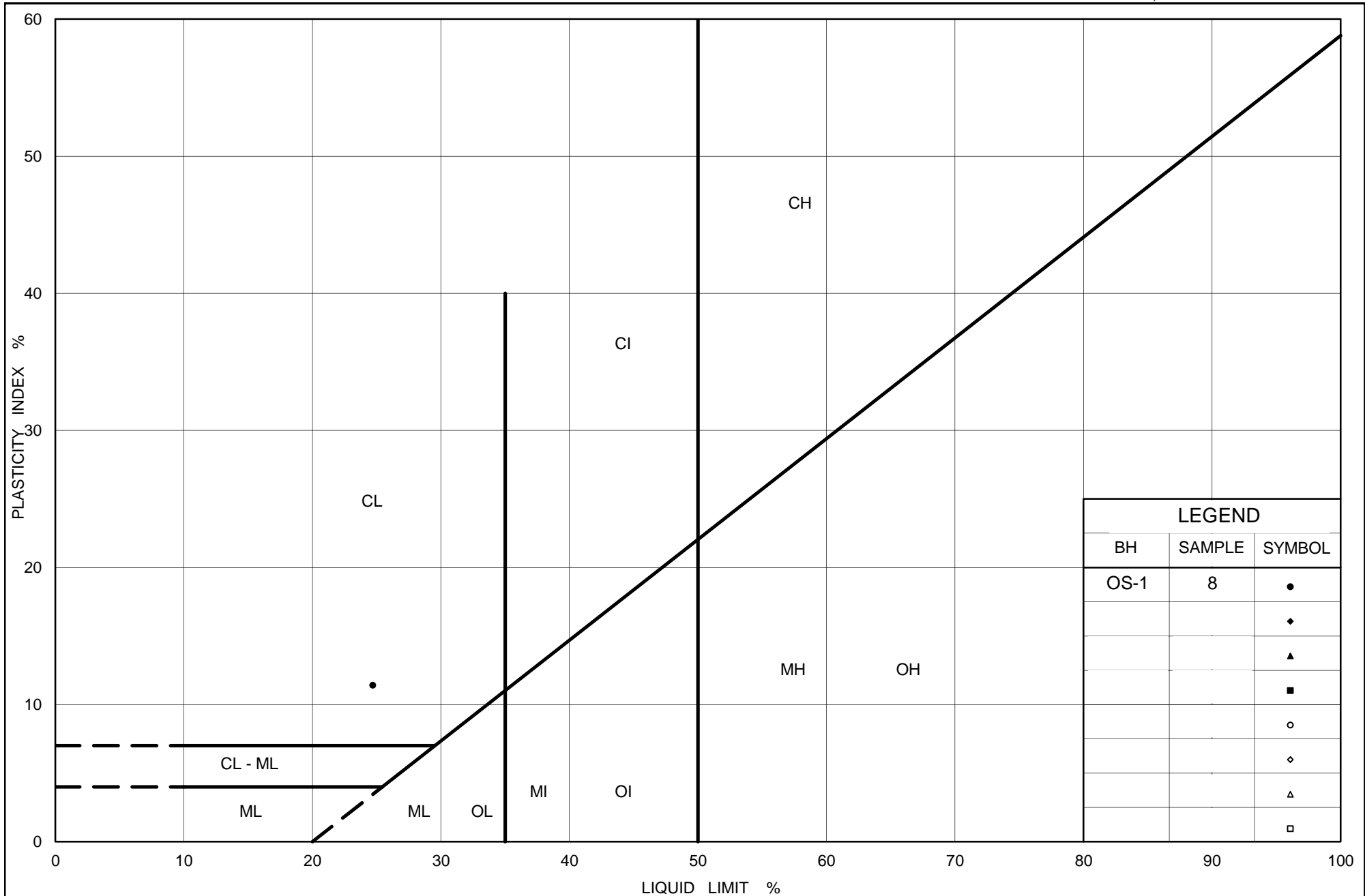
Ontario

PLASTICITY CHART
 Clayey Silt (Fill Pocket)
 Overhead Sign #1

Figure No. A2

Project No. 10-1184-0016

Checked By: AV



Ministry of Transportation

Ontario

PLASTICITY CHART Clayey Silt (Fill) Overhead Sign #1

Figure No. A3

Project No. 10-1184-0016

Checked By: AV



APPENDIX B

Record of Borehole Sheet and Laboratory Test Results – Overhead Sign 2 (OHS #2) – Station 19+610

PROJECT		10-1184-0016		RECORD OF BOREHOLE No OS-2		SHEET 1 OF 1		METRIC									
G.W.P.		2112-05-00		LOCATION		N 4796767.7 ; E 271175.4		ORIGINATED BY		JG							
DIST		Central HWY 5 & 6		BOREHOLE TYPE		150 mm O.D. Continuous Flight Solid Stem Augers and NQ Casing		COMPILED BY		AV							
DATUM		Geodetic		DATE		September 3, 2013		CHECKED BY		SMM							
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									
216.7	GROUND SURFACE							20	40	60	80	100					
0.0	ASPHALT (150 mm)																
0.2	Sand, trace to some silt, trace to some gravel, trace clay (FILL) Compact to very dense Grey Moist		1	SS	66		216										
			2	SS	66												
			3	SS	63		215										14 72 10 4
			4	SS	29		214										
213.7	SAND and GRAVEL, trace to some silt, trace clay Very dense Grey Moist		5A	SS	59/0.28		213										39 47 10 4
213.3			5B														
3.4	DOLOSTONE fragments Grey																
212.8	DOLOSTONE (BEDROCK)		1	RC	REC 100%		212										RQD = 67%
3.9	Bedrock cored from depths of 3.9 m to 7.0 m For bedrock coring details, refer to Record of Drillhole OS-2.		2	RC	REC 100%		211										RQD = 100%
							210										
209.7	END OF BOREHOLE																
7.0	NOTES: 1. Split spoon bouncing and auger grinding at a depth of 3.3 m (Elev. 213.4 m). 2. Water level in open borehole not recorded as water was introduced for bedrock coring.																

GTA-MTO 001 T:\PROJECTS\2010\10-1184-0016 (IG, HAMILTON)\LOG\10-1184-0016.GPJ GAL-GTA.GDT 4/29/15 DD

SHEET 1 OF 1

DATUM: Geodetic

DRILLING CONTRACTOR: DBW Drilling

CHECKED: SMM

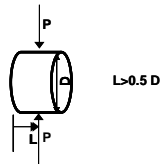
TABLE B1
POINT LOAD TEST RESULTS ON ROCK SAMPLES

Borehole Number	Run Number	Sample Depth (m)	Sample Elevation (m)	Bedrock Description	Test Type	Is (50mm) (MPa)	Approx. UCS Value ⁽¹⁾ (MPa)
OS-2	1	5.18	211.5	Dolostone	Axial	17.00	119
OS-2	1	5.34	211.4	Dolostone	Diametral	12.84	90
OS-2	2	6.22	210.5	Dolostone	Axial	11.52	81
OS-2	2	6.26	210.4	Dolostone	Diametral	1.62	11

⁽¹⁾ $I_{S50} \times K$ (actual value could be confirmed by UCS testing) from ISRM. This range has been given based on $K = 7$, calculated from I_{S50} Average of 4 tests on Axial Orientations and UCS Average of 2 tests conducted at the OHS sites.
Refer to "Suggested Methods for Determining Point Load Strength", International Society for Rock Mechanics Commission on Testing Methods, Int.J.Rock. Mech. Min.Sci. and Geomechanical Abstr., Vol 22, No. 2 1985, PP 51-60.

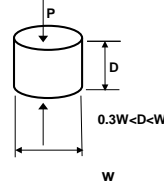
DIAMETRAL SPECIMEN SHAPE REQUIREMENTS

note: Diametral tests are perpendicular to core axis
(planes of weakness)



AXIAL SPECIMEN SHAPE REQUIREMENTS

note: Axial tests are parallel to core axis
(planes of weakness)

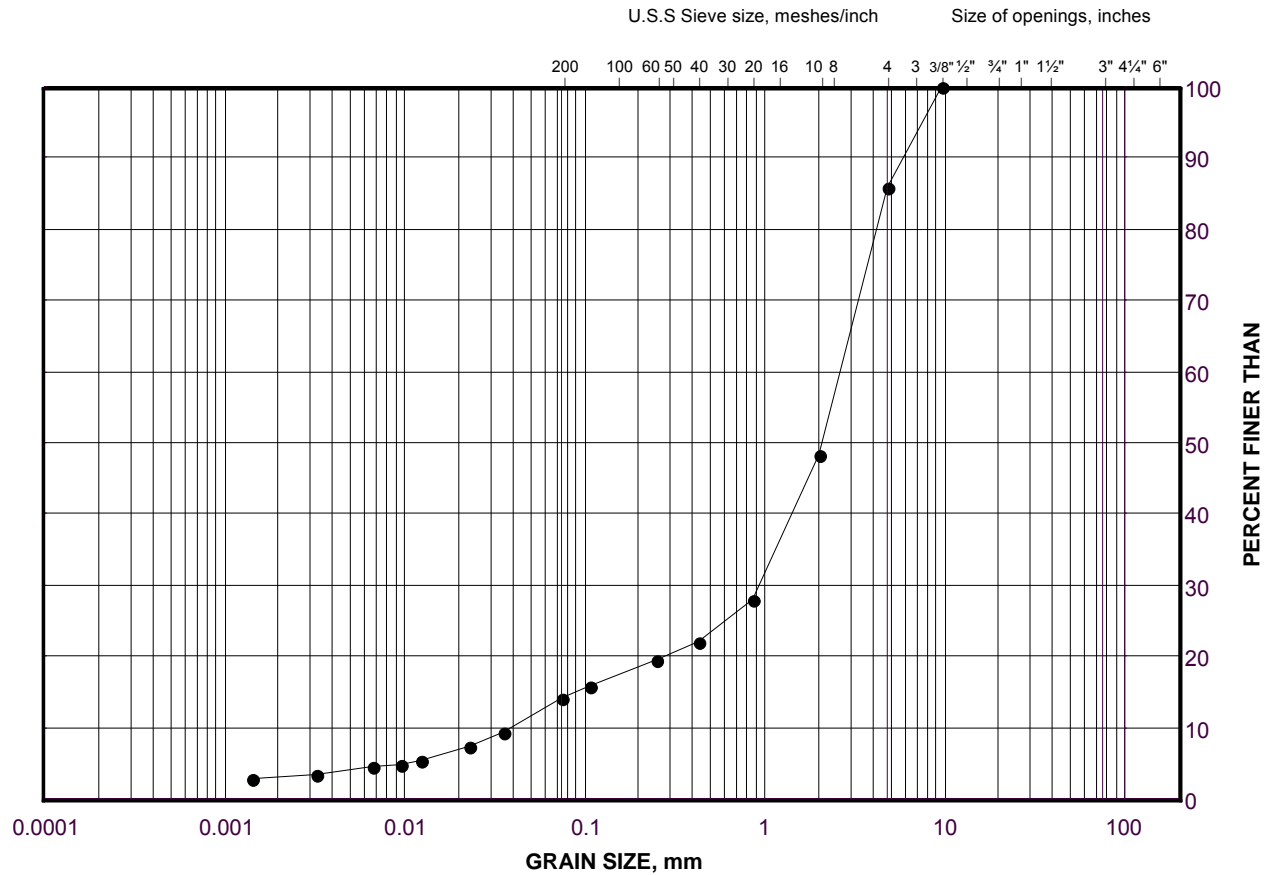


Compiled By: AJS
Checked By: SMM
Reviewed By: JMAC

GRAIN SIZE DISTRIBUTION

Sand (Fill)
Overhead Sign #2

FIGURE B1



SILT AND CLAY SIZES			FINE	MEDIUM	COARSE	FINE	COARSE	COBBLE
FINE GRAINED			SAND SIZE			GRAVEL SIZE		SIZE

LEGEND

SYMBOL	BOREHOLE	SAMPLE	ELEVATION(m)
•	OS-2	3	214.9

Project Number: 10-1184-0016

Checked By: SMM

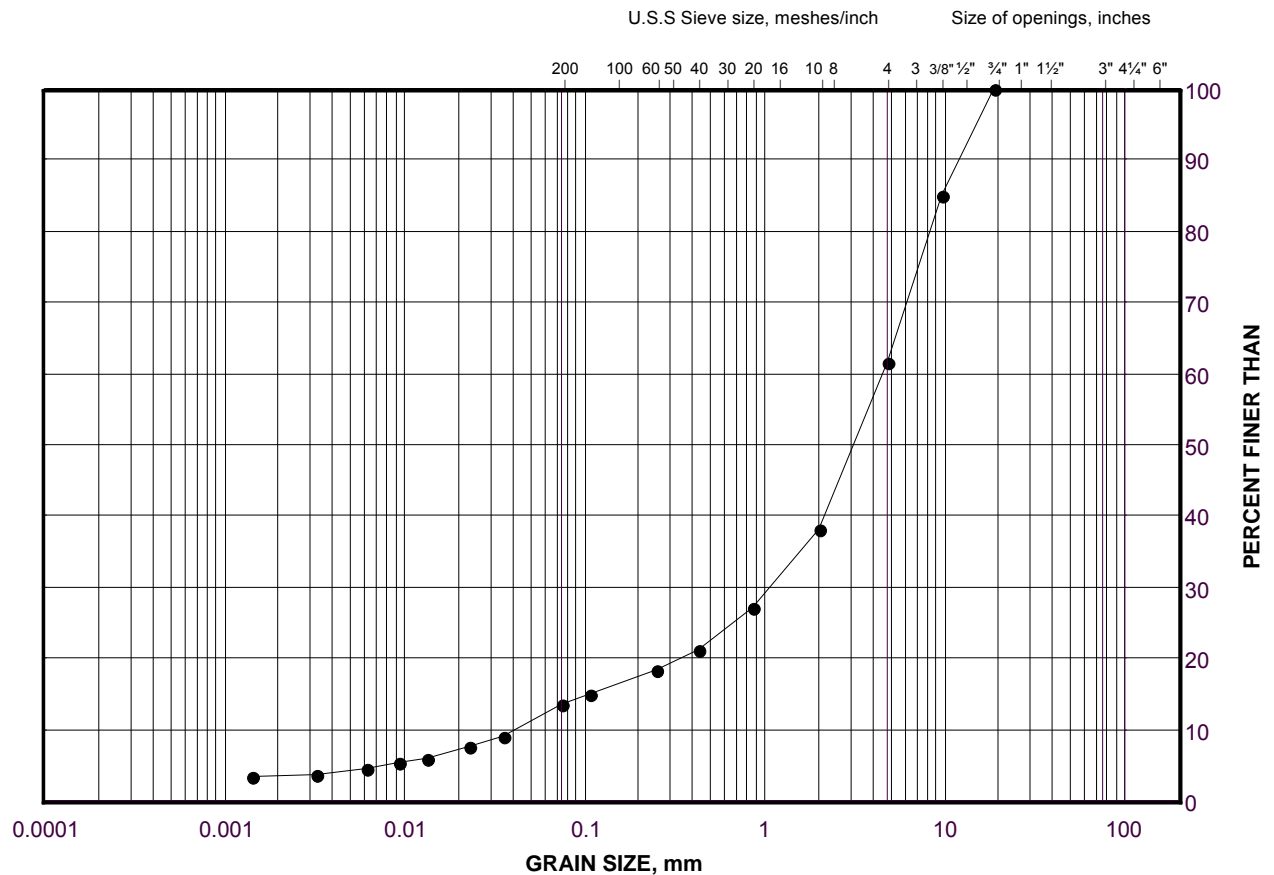
Golder Associates

Date: 28-Apr-15

GRAIN SIZE DISTRIBUTION

Sand and Gravel
Overhead Sign #2

FIGURE B2



SILT AND CLAY SIZES			FINE	MEDIUM	COARSE	FINE	COARSE	COBBLE
FINE GRAINED			SAND SIZE			GRAVEL SIZE		SIZE

LEGEND

SYMBOL	BOREHOLE	SAMPLE	ELEVATION(m)
•	OS-2	5A	213.5

Project Number: 10-1184-0016

Checked By: SMM

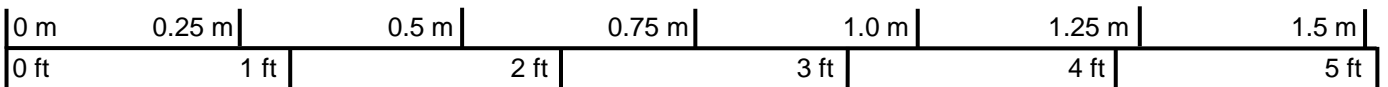
Golder Associates

Date: 28-Apr-15

Borehole OS-2



Depths: 3.91 m – 6.99 m



Scale

PROJECT **OVERHEAD SIGN SUPPORT STRUCTURES**
Future Highway 5/ Highway 6 Interchange and Associated Ramps, GWP 2112-05-00

TITLE
Bedrock Core Photograph – OS-2



PROJECT No. 10-1184-0016			FILE No. ----		
DESIGN	AV	MAR 14	SCALE	NTS	REV.
CADD	--		FIGURE B3		
CHECK	TVA	APR 14			
REVIEW	JMAC	APR 14			

UNCONFINED COMPRESSION (UC) TEST**ASTM D 7012-07****FIGURE B4****Sheet 1 of 2****SAMPLE IDENTIFICATION**

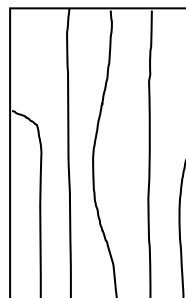
PROJECT NUMBER	10-1184-0016	RUN NUMBER	1
BOREHOLE NUMBER	OS-2	SAMPLE DEPTH, m	5.3

TEST CONDITIONS

MACHINE SPEED, mm/min	-	TYPE OF SPECIMEN	Rock Core
DURATION OF TEST, min	>2 <15	L/D	2.19

SPECIMEN INFORMATION

SAMPLE HEIGHT, cm	10.33	WATER CONTENT, (specimen) %	0.09
SAMPLE DIAMETER, cm	4.73	UNIT WEIGHT, kN/m ³	26.19
SAMPLE AREA, cm ²	17.56	DRY UNIT WT., kN/m ³	26.17
SAMPLE VOLUME, cm ³	181.40	SPECIFIC GRAVITY	-
WET WEIGHT, g	484.65	VOID RATIO	-
DRY WEIGHT, g	484.21		

VISUAL INSPECTION**FAILURE SKETCH****TEST RESULTS**

STRAIN AT FAILURE, %	-	COMPRESSIVE STRESS, MPa	78.5
----------------------	---	-------------------------	------

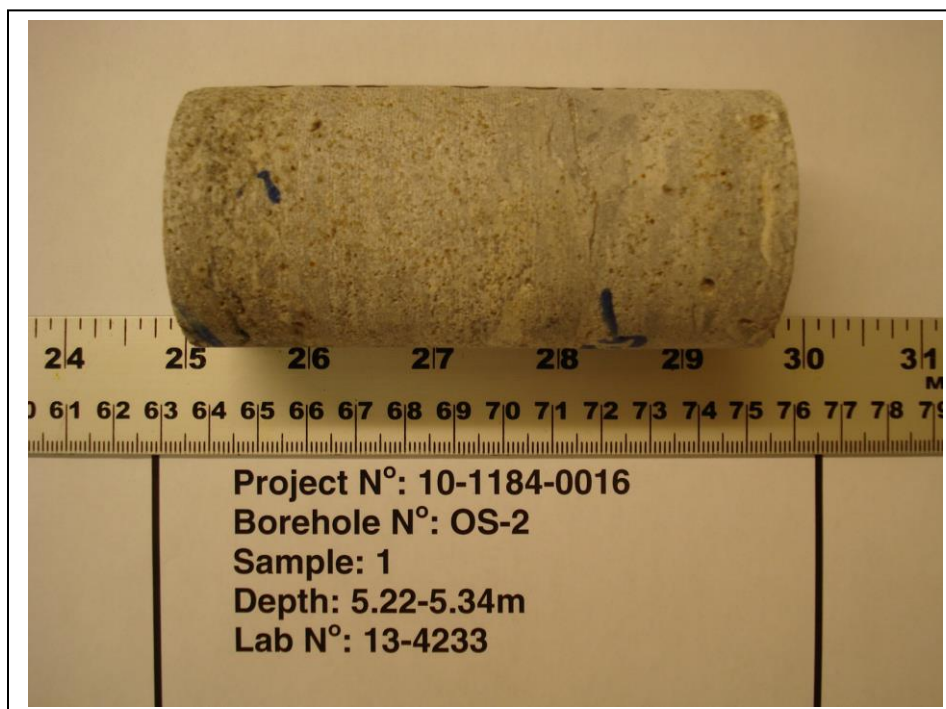
REMARKS:

DATE:

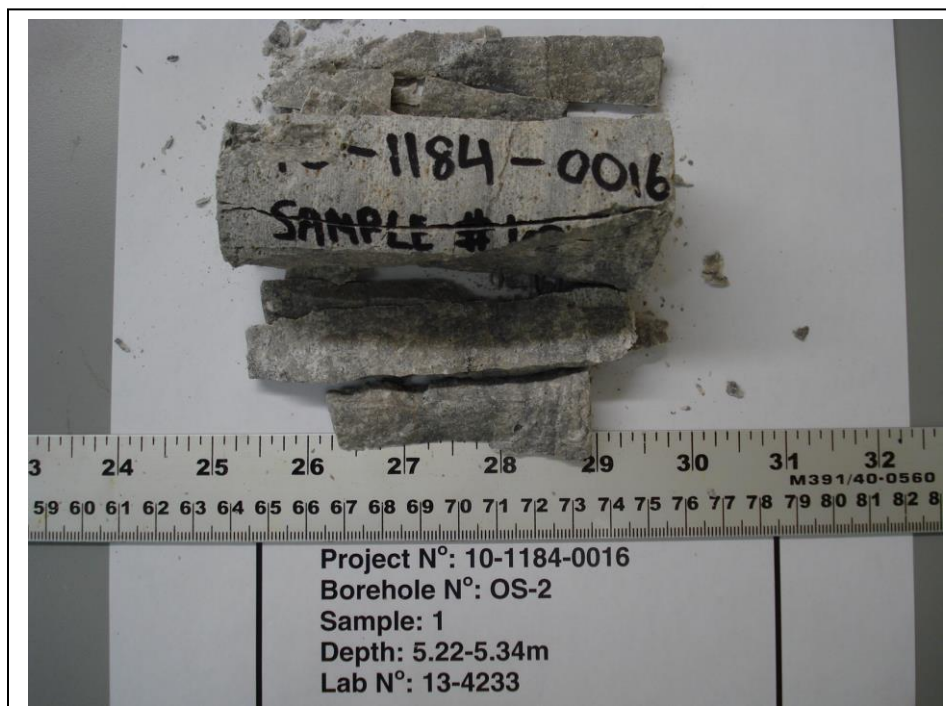
10/23/2013

UNCONFINED COMPRESSION (UC) TEST
ASTM D7012-07

FIGURE B4
Sheet 2 of 2



BEFORE COMPRESSION



AFTER COMPRESSION

Date 11/4/2013
Project 10-1184-0016

Golder Associates

Drawn Frank
Chkd TVA



APPENDIX C

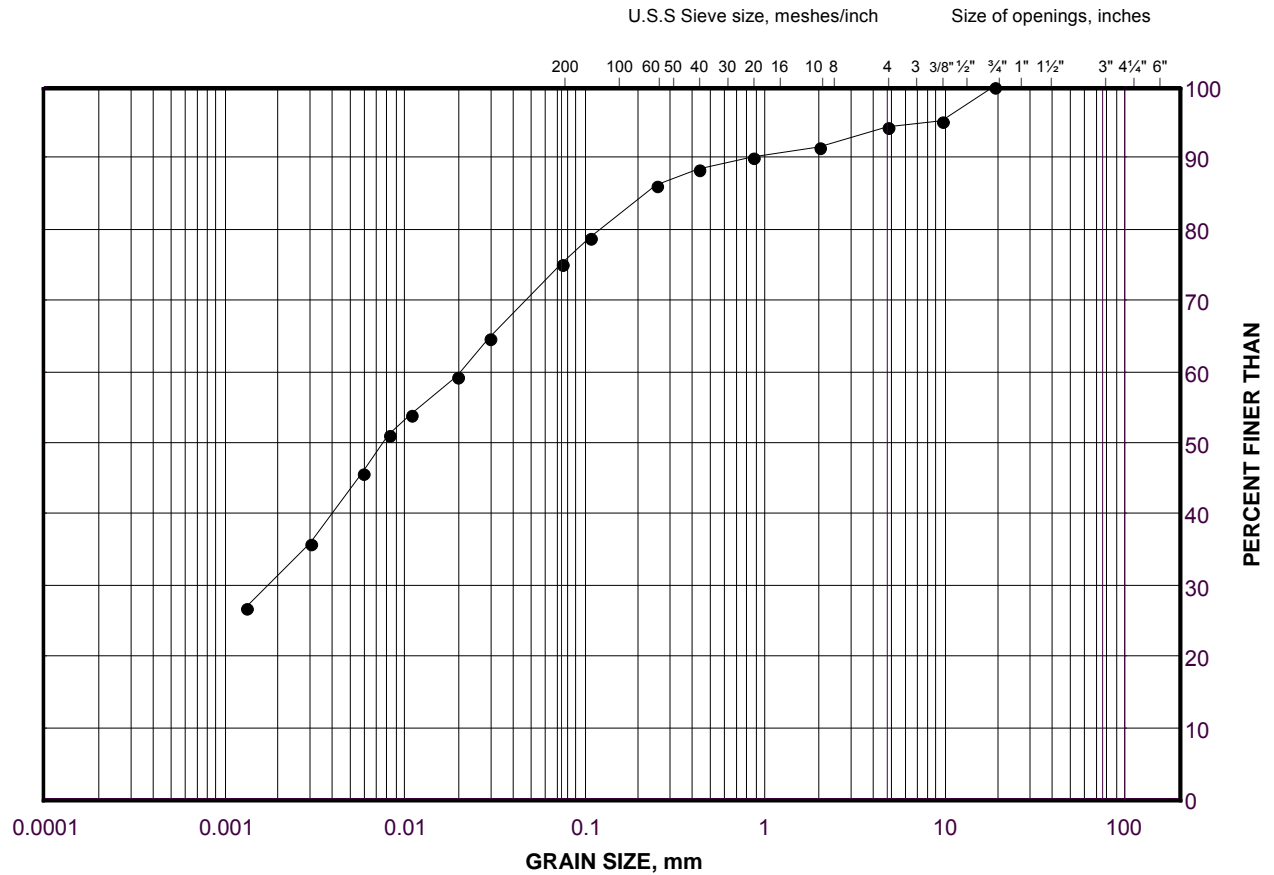
Record of Borehole Sheet and Laboratory Test Results – Overhead Sign 3 (OHS #3) – Station 10+260

PROJECT		10-1184-0016		RECORD OF BOREHOLE No OS-3		SHEET 1 OF 1		METRIC						
G.W.P.		2112-05-00		LOCATION		N 4797113.7 ; E 271100.9		ORIGINATED BY						
DIST		Central HWY 5 & 6		BOREHOLE TYPE		121 mm O.D. Continuous Flight Solid Stem Augers		COMPILED BY						
DATUM		Geodetic		DATE		August 20, 2013		CHECKED BY						
								TVA						
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						
223.8	GROUND SURFACE							20 40 60 80 100						
0.0	Sand and gravel (FILL) Grey Dry		1	AS	-									
223.1														
0.7	CLAYEY SILT, some sand, trace gravel (TILL) Stiff to hard Brown Moist		2	SS	18		223							
			3	SS	22		222							
			4	SS	33		221							5 20 44 31
			5	SS	34		220							
			6	SS	23		219							
			7	SS	14		218							
218.2														
5.6	Silty SAND, some clay Loose Grey Wet		8	SS	8		217							0 63 22 15
217.1														
6.9	CLAYEY SILT, trace sand, trace gravel (TILL) Hard Grey Wet END OF BOREHOLESPOON REFUSAL NOTES: 1. Water level encountered in the borehole at a depth of 5.8 m below ground surface (Elev 218.0 m) during drilling. 2. Water level measured in open borehole at a depth of 6.4 m below ground surface (Elev. 217.4 m) u		9	SS	50/0.05		217							

GRAIN SIZE DISTRIBUTION

Clayey Silt (Till)
Overhead Sign #3

FIGURE C1



SILT AND CLAY SIZES		FINE	MEDIUM	COARSE	FINE	COARSE	COBBLE
FINE GRAINED		SAND SIZE			GRAVEL SIZE		SIZE

LEGEND

SYMBOL	BOREHOLE	SAMPLE	ELEVATION(m)
•	OS-3	4	221.2

Project Number: 10-1184-0016

Checked By: AV

Golder Associates

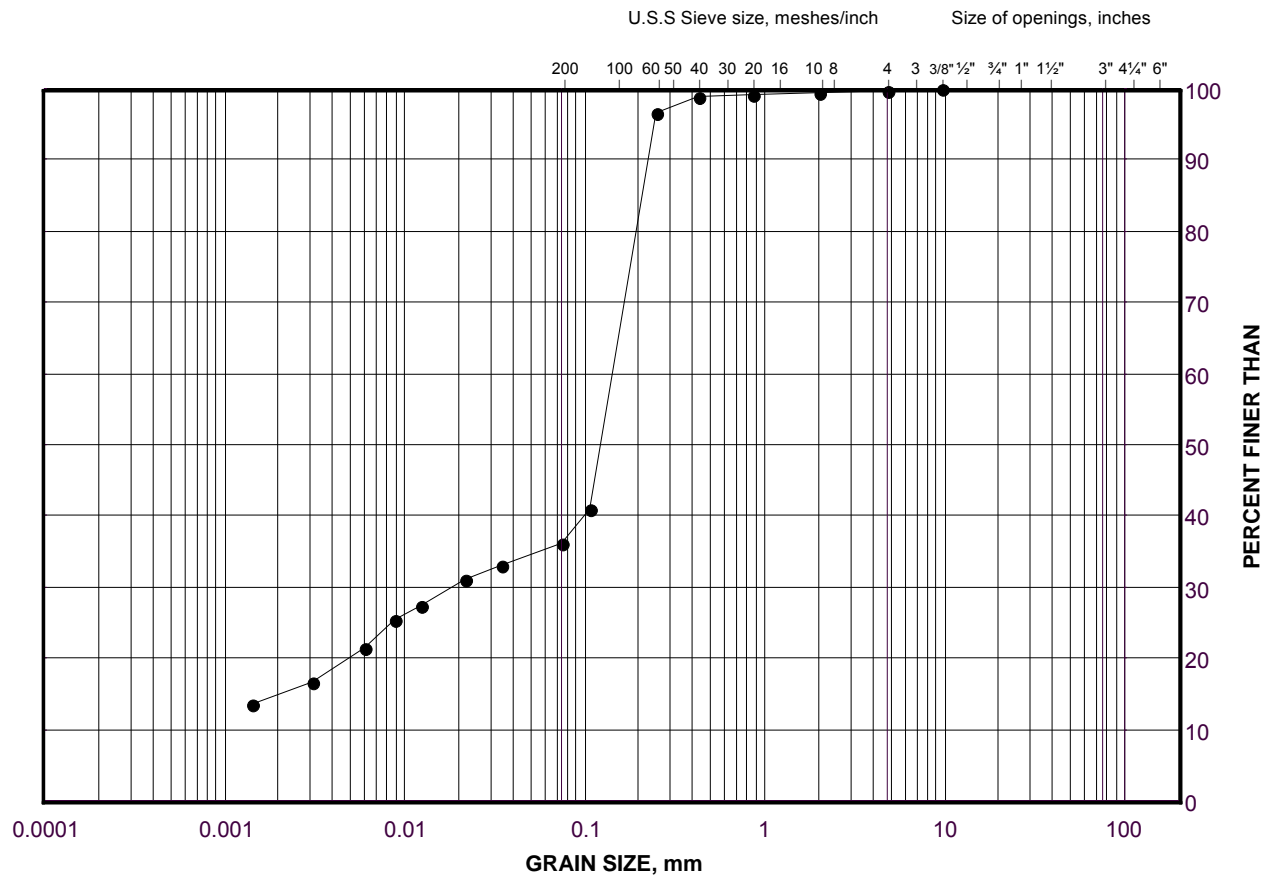
Date: 28-Mar-14

GRAIN SIZE DISTRIBUTION

Silty Sand (Interlayer)

Overhead Sign #3

FIGURE C2



SILT AND CLAY SIZES	FINE	MEDIUM	COARSE	FINE	COARSE	COBBLE
FINE GRAINED	SAND SIZE			GRAVEL SIZE		SIZE

LEGEND

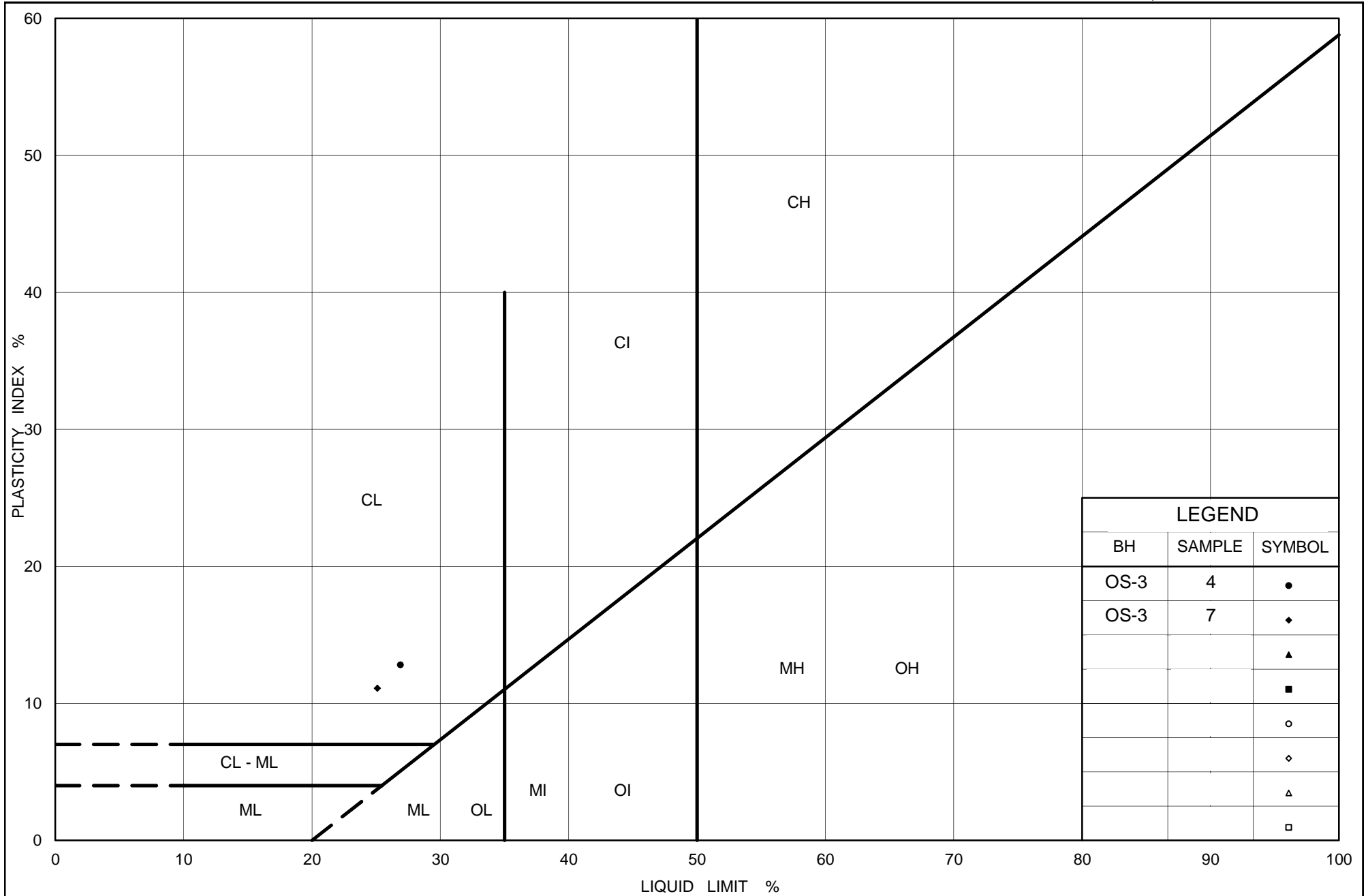
SYMBOL	BOREHOLE	SAMPLE	ELEVATION(m)
•	OS-3	8	217.4

Project Number: 10-1184-0016

Checked By: AV

Golder Associates

Date: 28-Mar-14



Ministry of Transportation

Ontario

PLASTICITY CHART
Clayey Silt (Till)
Overhead Sign #3

Figure No. C3

Project No. 10-1184-0016

Checked By: AV



APPENDIX D

Record of Borehole Sheet and Laboratory Test Results – Overhead Sign 4 (OHS #4) – Station 20+506

PROJECT		10-1184-0016		RECORD OF BOREHOLE No OS-4		SHEET 1 OF 1		METRIC									
G.W.P.		2112-05-00		LOCATION		N 4797368.3 ; E 270547.7		ORIGINATED BY									
DIST		Central HWY 5 & 6		BOREHOLE TYPE		150 mm O.D. Continuous Flight Solid Stem Augers and NQ Casing		COMPILED BY									
DATUM		Geodetic		DATE		September 3, 2013		CHECKED BY									
								SMM									
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									
								20	40	60	80	100					
220.5	GROUND SURFACE																
0.0	ASPHALT (150 mm)																
0.2	Sand, trace to some gravel, trace silt (FILL)		1	SS	33												
219.7	Dense Brown Moist		2	SS	16												
0.8																	
219.1	Sand and gravel, trace to some silt, trace clay (FILL)																
1.4	Compact Brown Moist		3	SS	8												
	Clayey silt, trace to some sand, trace gravel, trace organics, containing rootlets (FILL)		4	SS	7												
	Firm Mottled brown and grey Wet																
217.3			5A	SS	50/0.05												
			5B														
3.4	DOLOSTONE fragments Grey																
	DOLOSTONE (BEDROCK)																
	Bedrock cored from depths of 3.4 m to 6.4 m.		1	RC	REC 94%												
	For bedrock coring details, refer to Record of Drillhole OS-4.																
			2	RC	REC 100%												
214.1	END OF BOREHOLE																
6.4	NOTES:																
	1. Split spoon bouncing and auger grinding at a depth of 3.2 m (Elev. 214.3 m).																
	2. Water level in open borehole not recorded as water was introduced for bedrock coring.																

GTA-MTO 001 T:\PROJECTS\2010\10-1184-0016 (IG, HAMILTON)\LOG\10-1184-0016.GPJ GAL-GTA GDT 4/29/15 DD

PROJECT: 10-1184-0016

RECORD OF DRILLHOLE: OS-4

SHEET 1 OF 1

LOCATION: N 4797368.3 ;E 270547.7

DRILLING DATE: September 3, 2013

DATUM: Geodetic

INCLINATION: -90° AZIMUTH: —

DRILL RIG: CME-75 Truck-mounted

DRILLING CONTRACTOR: DBW Drilling

DEPTH SCALE METRES	DRILLING RECORD	DESCRIPTION	SYMBOLIC LOG	ELEV. DEPTH (m)	RUN No.	COLOUR % RETURN	FLUSH	JN - Joint FLT - Fault SH - Shear VN - Vein CJ - Conjugate	BD - Bedding FO - Foliation CO - Contact OR - Orthogonal CL - Cleavage	PL - Planar CU - Curved UN - Undulating ST - Stepped IR - Irregular	PO - Polished K - Slickensided SM - Smooth RO - Rough VR - Very Rough	MB - Mechanical Break BR - Broken Rock NOTE: For additional abbreviations refer to list of abbreviations & symbols.	NOTES
		Continued from Record of Borehole OS-4		217.15									
	NW Casing Rock Coring	Fresh to slightly weathered, medium bedded, fine to medium crystalline, faintly to moderately porous, strong light grey, DOLOSTONE (Lockport Formation, Gasport Member)		3.35									
4					1								
	NORC Casing Rock Coring												
5													
					2								
6													
		END OF DRILLHOLE		214.10									
				6.40									
7													
8													
9													
10													
11													
12													
13													

DEPTH SCALE

1 : 50



LOGGED: JG

CHECKED: SMM

GTA-RCK 018 T:\PROJECTS\2010\10-1184-0016 (IG, HAMILTON)\LOG\10-1184-0016.GPJ GAL-MISS.GDT 4/29/15 DD

PROJECT		10-1184-0016		RECORD OF BOREHOLE No BC-3A		SHEET 1 OF 1		METRIC									
G.W.P.		2112-05-00		LOCATION		N 4797364.8 ; E 270517.8		ORIGINATED BY									
DIST		Central HWY 5 & 6		BOREHOLE TYPE		102 mm O.D. Continuous Flight Solid Stem Augers		COMPILED BY									
DATUM		Geodetic		DATE		October 14, 2014		CHECKED BY									
								SMM									
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 kN/m ³	REMARKS & GRAIN SIZE DISTRIBUTION (%) GR SA SI CL
ELEV DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE	"N" VALUES			SHEAR STRENGTH kPa									
216.7	GROUND SURFACE																
0.0	TOPSOIL		1	-	REC												
216.4			1	RC	REC 100%												RQD = 0%
0.3	DOLOSTONE (BEDROCK)																
	Bedrock cored from depths of 0.3 m to 3.5 m																
	For bedrock coring details, refer to Record of Drillhole BC-3A.																
			2	RC	REC 97%												RQD = 82%
			3	RC	REC 92%												RQD = 88%
213.2	END OF BOREHOLE																
3.5	NOTE: 1. Open borehole dry upon completion of drilling and prior to rock coring.																

GTA-MTO 001 T:\PROJECTS\2010\10-1184-0016 (IG, HAMILTON)\LOG\10-1184-0016.GPJ GAL-GTA.GDT 4/1/15 DD

PROJECT: 10-1184-0016

RECORD OF DRILLHOLE: BC-3A

SHEET 1 OF 1

LOCATION: N 4797364.8 ;E 270517.8

DRILLING DATE: October 14, 2014

DATUM: Geodetic

INCLINATION: -90° AZIMUTH: —

DRILL RIG: CME-55 Track

DRILLING CONTRACTOR: DBW Drilling

DEPTH SCALE METRES	DRILLING RECORD	DESCRIPTION	SYMBOLIC LOG	ELEV. DEPTH (m)	RUN No.	FLUSH	COLOUR % RETURN	JN - Joint FLT - Fault SH - Shear VN - Vein CJ - Conjugate	BD - Bedding FO - Foliation CO - Contact OR - Orthogonal CL - Cleavage	PL - Planar CU - Curved UN - Undulating ST - Stepped IR - Irregular	PO - Polished K - Slickensided SM - Smooth RO - Rough VR - Very Rough	MB - Mechanical Break BR - Broken Rock NOTE: For additional abbreviations refer to list of abbreviations & symbols.	NOTES
		Continued from Record of Borehole BC-3A		216.43									
				0.25	1								
1		Slightly weathered, thinly to medium bedded, grey, fine grained, faintly porous, strong, nodular DOLOSTONE (Lockport Formation, Goat Island Member)											
					2								
2		Slightly weathered to fresh, thinly to thickly bedded, grey, medium to coarse grained, moderately to highly porous, medium strong to strong, DOLOSTONE (Lockport Formation, Gasport Member)		214.98									
				1.70									
					3								
3													
		END OF DRILLHOLE		213.18									
				3.50									
4													
5													
6													
7													
8													
9													
10													

DEPTH SCALE

1 : 50



LOGGED: AJS

CHECKED: SMM

GTA-RCK 018 T:\PROJECTS\2010\10-1184-0016 (IG, HAMILTON)\LOG\10-1184-0016.GPJ GAL-MISS.GDT 4/1/15 DD

PROJECT		10-1184-0016		RECORD OF BOREHOLE No BC-6A		SHEET 1 OF 1		METRIC									
G.W.P.		2112-05-00		LOCATION		N 4797415.3 ; E 270555.1		ORIGINATED BY									
DIST		Central HWY 5 & 6		BOREHOLE TYPE		102 mm O.D. Continuous Flight Solid Stem Augers		COMPILED BY									
DATUM		Geodetic		DATE		October 9, 2014		CHECKED BY									
								SMM									
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									
218.5	GROUND SURFACE																
0.0	TOPSOIL																
0.1	Silty clay, some sand, trace gravel, containing rootlets (FILL)		1	SS	6												
217.8	Firm																
0.7	Brown Moist		2	SS	22												
	SILTY CLAY, trace to some sand, trace gravel (TILL)																
	Very stiff to hard																
216.6	Brown Moist		3A	SS	34												
1.9	DOLOSTONE (BEDROCK)		3B														
	Bedrock cored from depths of 2.1 m to 5.5 m.		4	SS	100/0												
	For bedrock coring details, refer to Record of Drillhole BC-6A.		1	RC	REC 100%												
			2	RC	REC 100%												
			3	RC	REC 100%												
213.0	END OF BOREHOLE																
5.5	NOTE:																
	1. Spoon bouncing and auger refusal at a depth of 2.3 m below ground surface (Elev. 216.2 m)																
	2. Open borehole dry upon completion of drilling.																

GTA-MTO 001 T:\PROJECTS\2010\10-1184-0016 (IG, HAMILTON)\LOG\10-1184-0016.GPJ GAL-GTA.GDT 4/1/15 DD

PROJECT: 10-1184-0016

RECORD OF DRILLHOLE: BC-6A

SHEET 1 OF 1

LOCATION: N 4797415.3 ;E 270555.1

DRILLING DATE: October 9, 2014

DATUM: Geodetic

INCLINATION: -90° AZIMUTH: —

DRILL RIG: CME-55 Track

DRILLING CONTRACTOR: DBW Drilling

DEPTH SCALE METRES	DRILLING RECORD	DESCRIPTION	SYMBOLIC LOG	ELEV. DEPTH (m)	RUN No.	FLUSH	COLOUR % RETURN	RECOVERY		R.Q.D. %	FRACT. INDEX PER 25	DISCONTINUITY DATA					HYDRAULIC CONDUCTIVITY K, cm/sec		Diametral Point Load Index (MPa)	RMC -Q AVG	NOTES			
								TOTAL CORE %	SOLID CORE %			TYPE AND SURFACE DESCRIPTION		Jr	Ja	Un	10	10				10		
								80 60 40 20	80 60 40 20			B Angle	DIP w.r.t CORE AXIS				10	10				10		
								80 60 40 20	80 60 40 20			15 15 15 15	0 150 270	0 90 45 30				10				10	10	
		Continued from Record of Borehole BC-6A		216.45																				
3	NQRc NW Casing Rock Coring	Slightly weathered, thinly to medium bedded, grey, fine grained, faintly porous, strong, DOLOSTONE (Lockport Formation, Goat Island Member)		2.10	1																			UC=119 MPa
4		Slightly weathered to fresh, thinly to thickly bedded, grey, medium to coarse grained, moderately to highly porous, moderately strong, DOLOSTONE (Lockport Formation, Gasport Member)		215.15	2																			
5				3.40	3																			
		END OF DRILLHOLE		213.05																				
6				5.50																				
7																								
8																								
9																								
10																								
11																								
12																								

DEPTH SCALE

1 : 50



LOGGED: AJS

CHECKED: SMM

GTA-RCK 018 T:\PROJECTS\2010\10-1184-0016 (IG, HAMILTON)\LOG\10-1184-0016.GPJ GAL-MISS.GDT 4/1/15 DD

TABLE D1
POINT LOAD TEST RESULTS ON ROCK SAMPLES

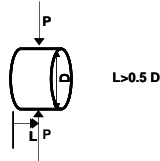
Borehole Number	Run Number	Sample Depth (m)	Sample Elevation (m)	Bedrock Description	Test Type	Is (50mm) (MPa)	Approx. UCS Value ⁽¹⁾ (MPa)
OS-4	1	3.80	216.7	Dolostone	Diametral	17.30	138.40
OS-4	1	3.90	216.6	Dolostone	Axial	16.04	128.32
OS-4	2	5.00	215.5	Dolostone	Axial	3.46	27.68
OS-4	2	5.30	215.2	Dolostone	Diametral	18.32	146.56

⁽¹⁾ $Is_{50} \times K$ (actual value could be confirmed by UCS testing) from ISRM. This range has been given based on $K = 8$, calculated from Is_{50} Average of 4 tests on Axial Orientations and UCS Average of 2 tests conducted at the OHS sites.

Refer to "Suggested Methods for Determining Point Load Strength", International Society for Rock Mechanics Commission on Testing Methods, Int.J.Rock. Mech. Min.Sci. and Geomechanical Abstr., Vol 22, No. 2 1985, PP 51-60.

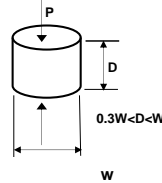
DIAMETRAL SPECIMEN SHAPE REQUIREMENTS

note: Diametral tests are perpendicular to core axis (planes of weakness)



AXIAL SPECIMEN SHAPE REQUIREMENTS

note: Axial tests are parallel to core axis (planes of weakness)



Compiled By: AJS
Checked By: SMM
Reviewed By: JMAC

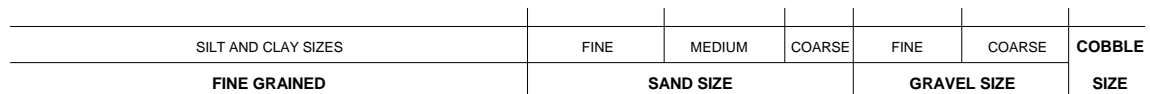
TABLE D2
SUMMARY OF UNIAXIAL COMPRESSIVE STRENGTH TEST RESULTS
OVERHEAD SIGN #4
HIGHWAY 6, HAMILTON, ONTARIO

Borehole Number (Core Run)	Sample Depth (m)	Sample Elevation (m)	Rock Type	Core Diameter (mm)	Uniaxial Compressive Strength (MPa)
BC-6A (1)	2.8	215.7	Dolostone	4.74	119
OS-4 (2)	5.2	215.3	Dolostone	4.73	96

Compiled By: AJSReviewed By: SMM

Overhead Sign #4

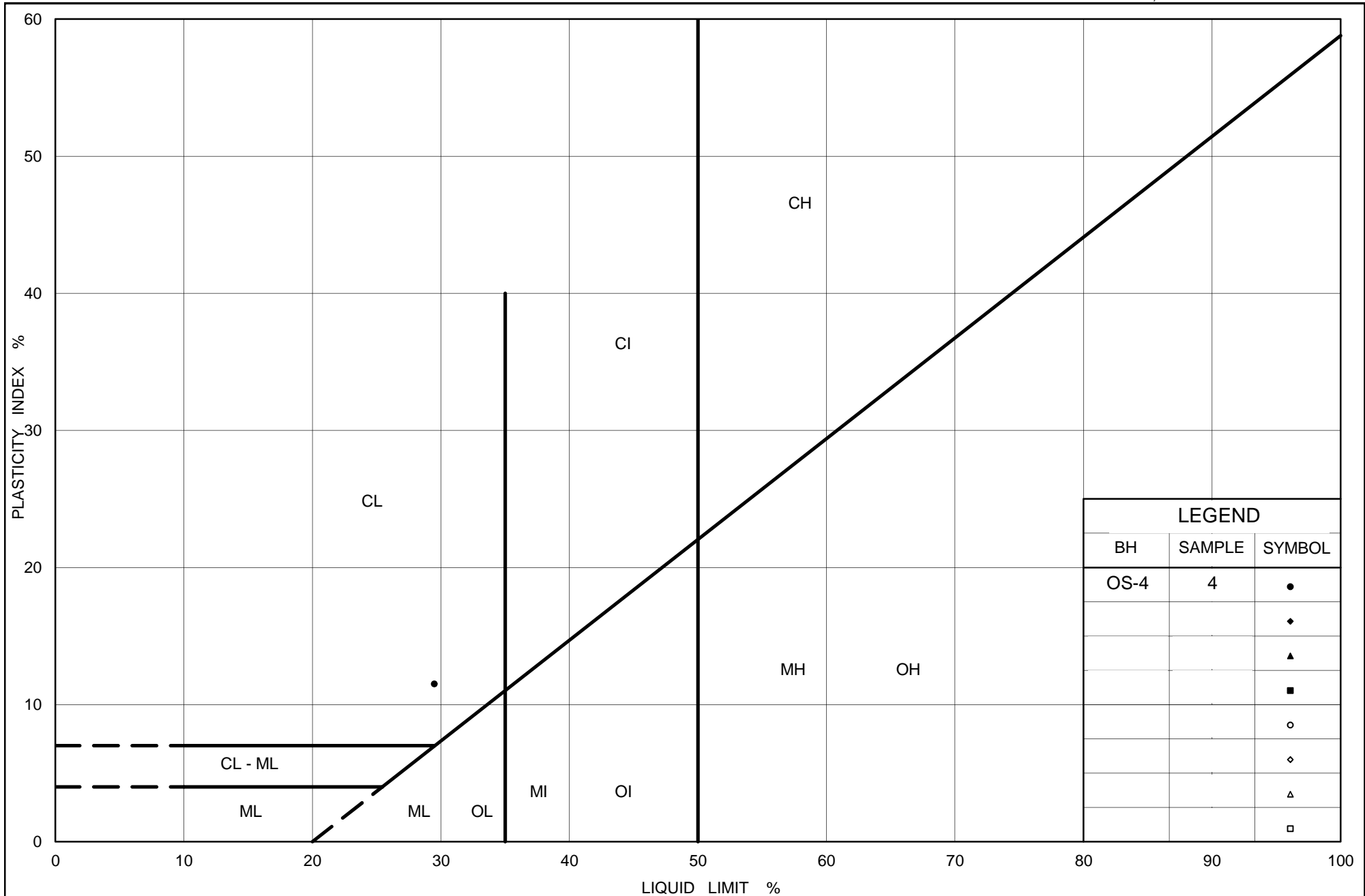
FIGURE D1



LEGEND

SYMBOL	BOREHOLE	SAMPLE	ELEVATION(m)
●	OS-4	2	219.5

Date: 31-Mar-15



Ministry of Transportation

Ontario

PLASTICITY CHART Clayey Silt (Fill) Overhead Sign #4

Figure No. D2

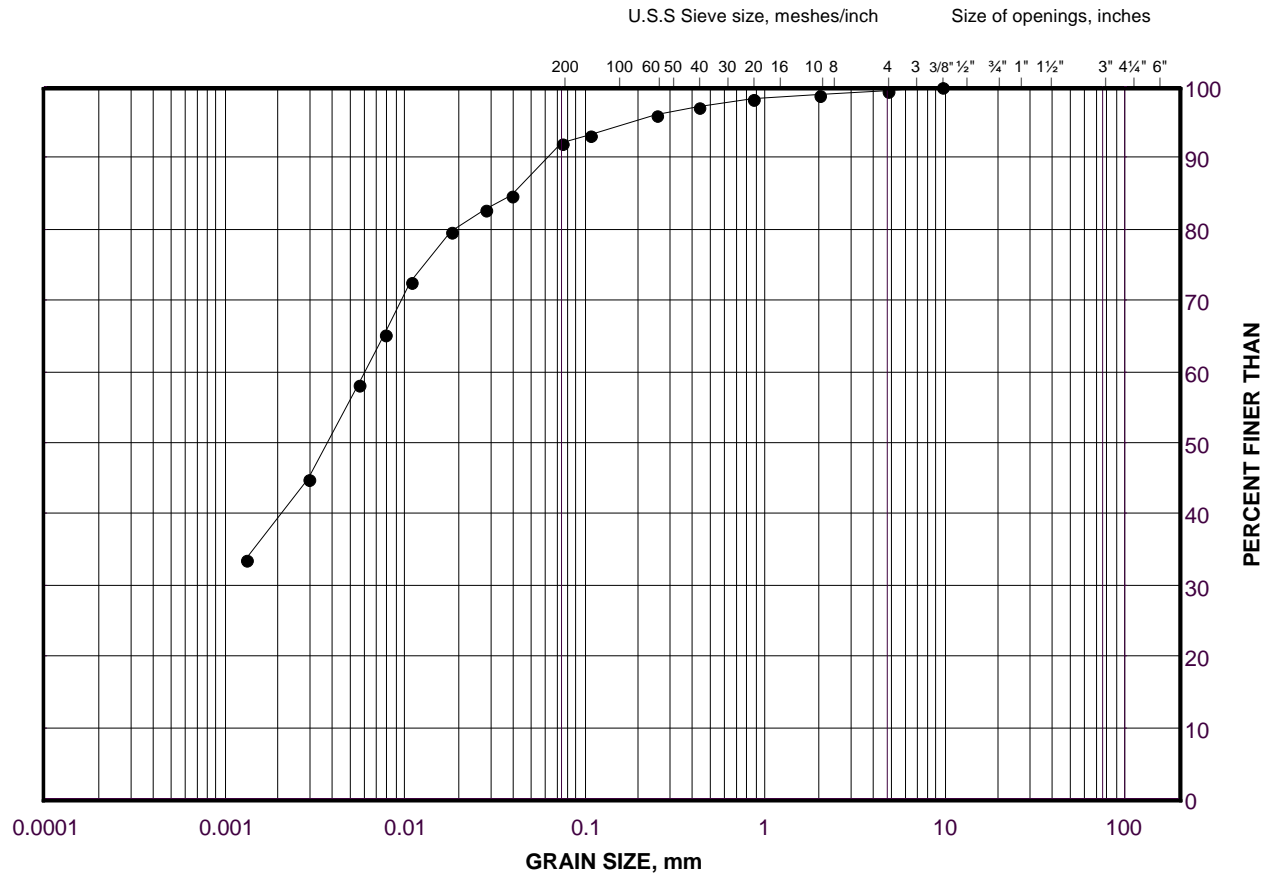
Project No. 10-1184-0016

Checked By: AV

GRAIN SIZE DISTRIBUTION

Silty Clay (Till)

FIGURE D3



SILT AND CLAY SIZES		FINE	MEDIUM	COARSE	FINE	COARSE	COBBLE
FINE GRAINED		SAND SIZE			GRAVEL SIZE		SIZE

LEGEND

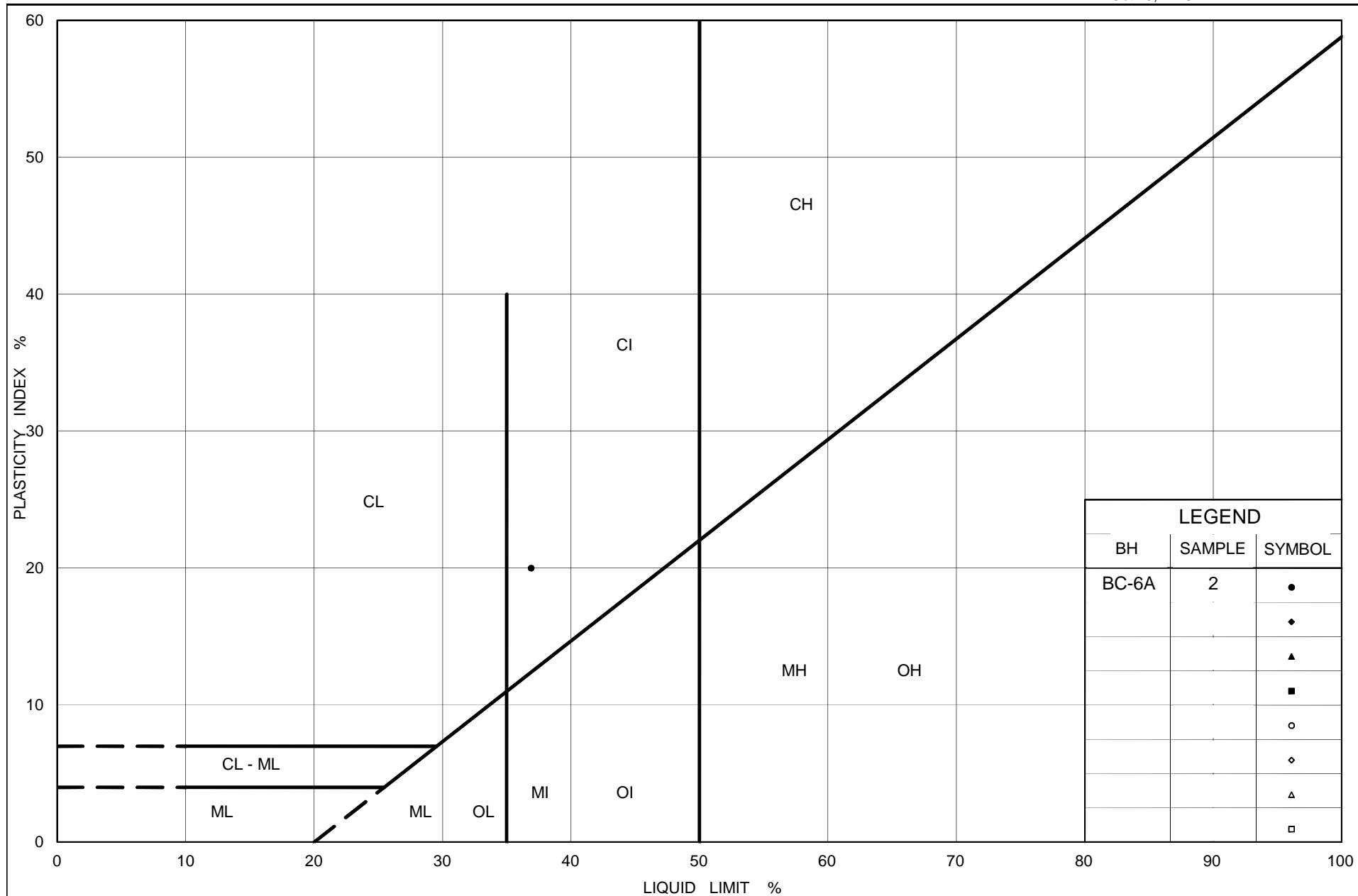
SYMBOL	BOREHOLE	SAMPLE	ELEVATION(m)
•	BC-6A	2	217.4

Project Number: 10-1184-0016

Checked By: SMM

Golder Associates

Date: 31-Mar-15



Ministry of Transportation

Ontario

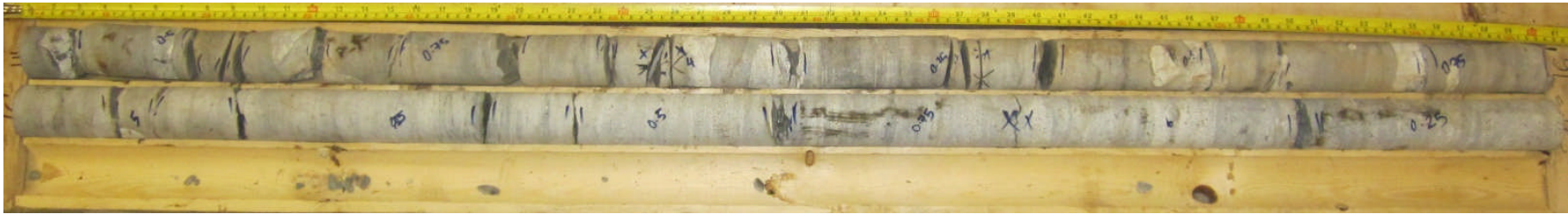
PLASTICITY CHART

Silty Clay (Till)

Figure No. D4

Project No. 10-1184-0016

Checked By: SMM




BH OS-4: Box 1 of 1: 3.35 m to 6.40 m



BH BC-3A: Box 1 of 1: 0.25 m to 3.50 m depth



BH BC-6A: Box 1 of 1: 1.9 m to 5.49 m depth

PROJECT	OVERHEAD SIGNS, HIGHWAY 5/6 INTERCHANGE, CITY OF HAMILTON, MINISTRY OF TRANSPORTATION, ONTARIO GWP 2112-05-00				
TITLE	Bedrock Core Photographs Borehole OS-4, BC-3A and BC-6A				
	PROJECT No.:	10-1184-0016	FILE No.	----	
	DESIGN	--	SCALE	AS SHOWN	REV.
	CADD	--	FIGURE D5		
	CHECK	SMM			
	REVIEW	JMAC			
		MARCH 2015			

UNCONFINED COMPRESSION (UC) TEST
ASTM D 7012-07

FIGURE D6
Sheet 1 of 2

SAMPLE IDENTIFICATION

PROJECT NUMBER	10-1184-0016	RUN NUMBER	2
BOREHOLE NUMBER	OS-4	SAMPLE DEPTH, m	5.2

TEST CONDITIONS

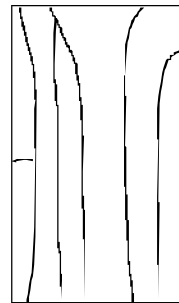
MACHINE SPEED, mm/min	-	TYPE OF SPECIMEN	Rock Core
DURATION OF TEST, min	>2 <15	L/D	2.03

SPECIMEN INFORMATION

SAMPLE HEIGHT, cm	9.59	WATER CONTENT, (specimen) %	0.08
SAMPLE DIAMETER, cm	4.73	UNIT WEIGHT, kN/m ³	26.41
SAMPLE AREA, cm ²	17.54	DRY UNIT WT., kN/m ³	26.39
SAMPLE VOLUME, cm ³	168.23	SPECIFIC GRAVITY	-
WET WEIGHT, g	453.15	VOID RATIO	-
DRY WEIGHT, g	452.79		

VISUAL INSPECTION

FAILURE SKETCH



TEST RESULTS

STRAIN AT FAILURE, %	-	COMPRESSIVE STRESS, MPa	96.4
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REMARKS:	DATE:	10/23/2013
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UNCONFINED COMPRESSION (UC) TEST
ASTM D7012-07

FIGURE D6
Sheet 2 of 2



BEFORE COMPRESSION



AFTER COMPRESSION

Date 11/4/2013
Project 10-1184-0016

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UNCONFINED COMPRESSION TEST (UC)
ASTM D 7012-07

Figure D7
Sheet 1 of 2

SAMPLE IDENTIFICATION

PROJECT NUMBER	10-1184-0016	SAMPLE NUMBER	-
BOREHOLE NUMBER	BC-6A	SAMPLE DEPTH, m	2.7-2.9

TEST CONDITIONS

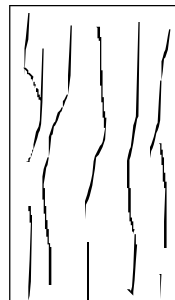
MACHINE SPEED, mm/min	-	TYPE OF SPECIMEN	Rock Core
DURATION OF TEST, min	>2 <15	L/D	2.24

SPECIMEN INFORMATION

SAMPLE HEIGHT, cm	10.63	WATER CONTENT, (specimen) %	0.12
SAMPLE DIAMETER, cm	4.74	UNIT WEIGHT, kN/m ³	25.99
SAMPLE AREA, cm ²	17.62	DRY UNIT WT., kN/m ³	25.96
SAMPLE VOLUME, cm ³	187.26	SPECIFIC GRAVITY	-
WET WEIGHT, g	496.50	VOID RATIO	-
DRY WEIGHT, g	495.90		

VISUAL INSPECTION

FAILURE SKETCH



TEST RESULTS

STRAIN AT FAILURE, %	-	COMPRESSIVE STRESS, MPa	118.7
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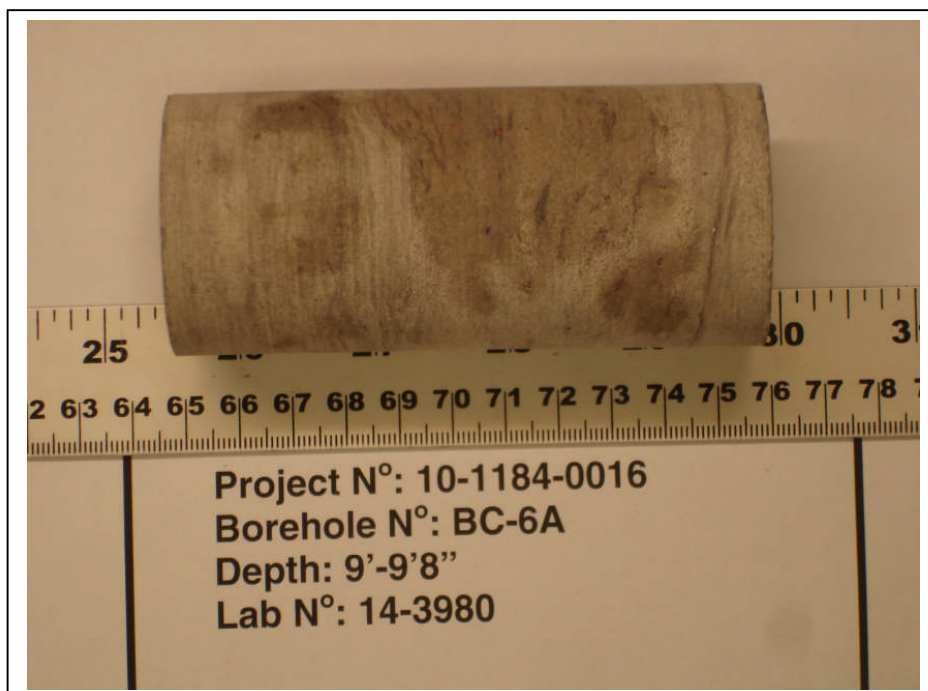
REMARKS:	DATE:	11/26/2014
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Checked By:

Golder Associates

UNCONFINED COMPRESSION TEST
ASTM D7012-07

FIGURE D7
Sheet 2 of 2



BEFORE COMPRESSION



AFTER COMPRESSION

Date Nov. 25, 2014
Project 10-1184-0016

Golder Associates

Drawn Frank
Chkd. SMM

At Golder Associates we strive to be the most respected global group of companies specializing in ground engineering and environmental services. Employee owned since our formation in 1960, we have created a unique culture with pride in ownership, resulting in long-term organizational stability. Golder professionals take the time to build an understanding of client needs and of the specific environments in which they operate. We continue to expand our technical capabilities and have experienced steady growth with employees now operating from offices located throughout Africa, Asia, Australasia, Europe, North America and South America.

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