



August 25, 2015

FOUNDATION INVESTIGATION REPORT

**Culverts at Lloydtown-Aurora Road Interchange
Highway 400 Widening from North of King Road
to South Canal Road
Ministry of Transportation, Ontario
G.W.P. 2835-02-00**

Submitted to:

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REPORT





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1.0 INTRODUCTION

Golder Associates Ltd. (Golder) has been retained by URS Canada Inc. (URS) on behalf of the Ministry of Transportation, Ontario (MTO) to provide foundation engineering services for new proposed culverts and the culvert replacements and extensions as part of the proposed widening of Highway 400 from north of King Road to South Canal Road in the Regional Municipality of York, Ontario.

This report addresses two new culverts and the replacement or extension of three existing culverts. The locations of the culverts were determined using MTO stationing for King Township from the survey plans provided by URS and are presented on Drawing 1. The proposed locations, dimensions, type, and invert elevation for the existing culverts that are to be replaced or extended and the new proposed culverts, as well as the approximate embankment height, are summarized as follows:

| Culvert ID | Station | Existing Culvert Dimensions/ Type | Proposed New or Replacement Structure/ Extension Details | Proposed Culvert or Extension Length (m) | Approximate Embankment Height (m) | Invert Elevation (m) | |
|-----------------|---------------------------|--|--|--|-----------------------------------|----------------------|--------|
| | | | | | | Inlet | Outlet |
| C38 Replacement | 20+310 (Hwy 400) | 1220 x 1220 mm x 59.9 m* Open Bottom With 1200 mm Corrugated Steel Pipe (CSP) Extension (East and West) | 1220 x 1220 mm Concrete Box** | E 15.2 W 15.5 | 3 | 307.1 | 307.0 |
| C39 Replacement | 20+670 (Hwy 400) | 1220 x 1000 mm x 59.7 m* Open Bottom With 1200 mm CSP Extension (East and West) | 1220 x 1000 mm Concrete Box** | E 20.0 W 18.2 | 3 | 305.0 | 305.0 |
| C40 Extension | 22+023 (Hwy 400) | 1220 x 650 mm x 49.7 m* Open Bottom | 1220 X 650 mm Concrete Box** | E13.1 W 12.2 | 2 | 290.6 | 290.5 |
| C5-6 New | 21+307 (Hwy 400) | N/A | 1800 x 900 mm Concrete Box | 71.0 | 2 | 302.4 | 302.0 |
| C5-7 New | 9+933 (E-S Ramp, Hwy 400) | N/A | 1800 x 900 mm Concrete Box | 30.0 | 2.5 | 302.6 | 302.0 |

*Culvert size at opening. Culvert type may vary along the length and details are unknown.

** Cast-in-place replacement box culvert. Dimensions vary for pre-cast box culvert.



The Terms of Reference and Scope of Work for the foundation engineering services are outlined in MTO's Request for Proposal, dated May 2008. The scope of services to be provided by Golder is outlined in Golder's proposal that form part of the Consultant's Agreement (Number 2007 E 0002) for this project. The work has been carried out in accordance with Golder's Supplementary Specialty Plan for this project, dated October 2010.

2.0 SITE DESCRIPTION

The culvert sites addressed in this report are located in the vicinity of the Lloydtown-Aurora interchange in the Regional Municipality of York, Ontario. The Lloydtown - Aurora Road underpass structure is located at the intersection of Highway 400 and Lloydtown - Aurora Road in the Regional Municipality of York, Ontario. Culverts C5-6 and C5-7 are located under the Highway 400 northbound lanes (NBL) and southbound lanes (SBL) and the E-S Ramp, respectively, at the Lloydtown-Aurora Road underpass. Culverts C38 to C40 are located under Highway 400 NBL and SBL to the south and to the north of the Lloydtown-Aurora Road underpass to about 300 m south of 18th Sideroad. It is understood that the culvert replacements and extensions will be completed using conventional open cut methods. It is further understood that the proposed new culverts (C5-6 and C5-7) may be installed using conventional open cut methods, with the alternative that C5-6 may be installed using trenchless methods depending on construction staging.

In general, the topography in the area of the overall project site consists of rolling terrain covered by agricultural fields and densely treed areas, with commercial facilities located along Highway 400. The existing natural ground surface 600 m south of the Lloydtown - Aurora Road is at approximately Elevation 307 m, sloping down to the Lloydtown - Aurora Road interchange area between approximately Elevations 303 m and 304.5 m. The topography continues sloping downward to approximately Elevation 291 m about 500 m north of the interchange. The existing Highway 400 grade is at about Elevation 305.0 m in the immediate vicinity of the underpass.

Lloydtown - Aurora Road has been constructed on embankment fill that is between approximately 6 m and 7 m high, with the pavement grade ranging from about Elevations 310.8 m to 311.0 m.

3.0 INVESTIGATION PROCEDURES

The field work for the subsurface investigation for Culverts C38 to C40 was carried out between the periods of November 24 to November 26 and December 8 and 9, 2010, March 24 and July 26, 2011 during which time a total of 12 boreholes (designated as C38-1 to C38-4, C39-1 to C39-4, and C40-1 to C40-4) were advanced approximately at the locations shown on Drawings 2 to 4. The field investigation for Culverts C38 to C40 was carried out using a D-50 track-mounted drill rig and a D-90 truck-mounted drill rig, supplied and operated by Walker Drilling Ltd. of Utopia, Ontario. Additionally, a CME-55 track-mounted drill rig supplied and operated by DBW Drilling of North York, Ontario was used to drill Borehole C40-4.

The field work for the subsurface investigation for Culverts C5-6 and C5-7 was carried out between November 27, 2013 and December 5, 2013 during which time a total of seven (7) boreholes (designated as C5-6-1 to C5-6-5, C5-7-1 and C5-7-2) were advanced approximately at the locations shown on Drawings 5 and 6. The field investigation for Culverts C5-6 and C5-7 was carried out using a track-mounted D-55 drill rig supplied and operated by Walker Drilling Ltd. of Utopia, Ontario.



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The boreholes from both investigations were advanced to depths ranging from about 4.3 m to 17.4 m below the existing ground surface. The boreholes were advanced using either 108 mm inside diameter or 200 mm outer diameter hollow stem augers, or 101 mm, 108 mm or 127 mm diameter solid stem augers. Soil samples were obtained at 0.75 m and 1.5 m intervals of depth, using 50 mm outside diameter split-spoon samplers driven by an automatic hammer, in accordance with the Standard Penetration Test (SPT) procedure. (ASTM D1586-08a).

The groundwater conditions in the open boreholes were observed during and immediately following the drilling operations. Standpipe piezometers were installed in each of Boreholes C38-4, C39-4, and C5-7-2 to permit monitoring of the groundwater level. The piezometers consist of a 50 mm diameter PVC pipe, with a slotted screen sealed at a select depth within the borehole. In two boreholes the borehole and annulus surrounding the piezometer pipe above the screen sand pack was backfilled to the ground surface with bentonite pellets/grout, whereas at one borehole a bentonite seal was placed above the sand pack and the remainder of the borehole was backfilled with sand to the ground surface. Piezometer installation details and water level readings are described on the Record of Borehole sheets presented in Appendix A. All boreholes in which standpipe piezometers were not installed were backfilled with bentonite upon completion in accordance with Ontario Regulation 903 (as amended by Ontario Regulation 372).

The field work was observed by members of Golder's engineering and technical staff, who located the boreholes, arranged for the clearance of underground services, observed the drilling, sampling and in situ testing operations, logged the boreholes, and examined and cared for the soil 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. All of the laboratory tests were carried out to MTO and/or ASTM Standards, as appropriate. Index and classification testing (water content, Atterberg limits and grain size distribution) was carried out on selected samples. The results of the laboratory testing are included in Appendix B.

The borehole locations and ground surface elevations were surveyed by Callon Dietz Incorporated, Ontario Land Surveyors, a professional surveying company retained by URS. The borehole locations, including MTM NAD 83 northing and easting coordinates and the ground surface elevations referenced to Geodetic datum, are presented below and on the Record of Borehole sheets in Appendix A and are summarized on Drawing 2 to 6.

| Culvert ID | Station | Borehole Number | MTM NAD83 Northing (m) | MTM NAD83 Easting (m) | Ground Surface Elevation (m) | Borehole Depth (m) |
|------------|---------------------|-----------------|------------------------|-----------------------|------------------------------|--------------------|
| C38 | 20+310 (Hwy 400) | C38-1 | 4,872,648.6 | 298,065.2 | 307.2 | 8.2 |
| | | C38-2 | 4,872,639.6 | 298,082.1 | 309.6 | 15.9 |
| | | C38-3 | 4,872,656.0 | 298,113.2 | 309.8 | 15.9 |
| | | C38-4 | 4,872,658.9 | 298,129.5 | 307.2 | 4.3 |
| C39 | 20+670 (Hwy 400) | C39-1 | 4,872,996.5 | 297,994.7 | 305.1 | 11.0 |
| | | C39-2 | 4,872,992.7 | 298,005.9 | 307.7 | 17.4 |



| Culvert ID | Station | Borehole Number | MTM NAD83 Northing (m) | MTM NAD83 Easting (m) | Ground Surface Elevation (m) | Borehole Depth (m) |
|------------|---------------------------|-----------------|------------------------|-----------------------|------------------------------|--------------------|
| | | C39-3 | 4,873,010.0 | 298,040.5 | 307.9 | 15.7 |
| | | C39-4 | 4,873,012.8 | 298,056.0 | 305.1 | 11.3 |
| C40 | 20+023 (Hwy 400) | C40-1 | 4,874,313.6 | 297,678.5 | 291.6 | 4.7 |
| | | C40-2 | 4,874,318.3 | 297,691.6 | 292.2 | 6.3 |
| | | C40-3 | 4,874,361.6 | 297,716.8 | 291.7 | 7.9 |
| | | C40-4 | 4,874,316.9 | 297,744.2 | 290.7 | 9.6 |
| C5-6 | 21+307 (Hwy 400) | C5-6-1 | 4,873,633.0 | 297,916.5 | 304.0 | 10.9 |
| | | C5-6-2 | 4,873,628.1 | 297,891.8 | 304.4 | 12.6 |
| | | C5-6-3 | 4,873,624.5 | 297,880.6 | 304.4 | 12.6 |
| | | C5-6-4 | 4,873,621.9 | 297,865.3 | 304.5 | 11.1 |
| | | C5-6-5 | 4,873,618.7 | 297,846.5 | 303.0 | 11.1 |
| C5-7 | 9+933 (E-S Ramp, Hwy 400) | C5-7-1 | 4,873,602.1 | 297,828.2 | 303.1 | 12.6 |
| | | C5-7-2 | 4,873,586.6 | 297,829.2 | 304.0 | 12.5 |

4.0 SITE GEOLOGY AND SUBSURFACE CONDITIONS

4.1 Regional Geology

The 23 km section of Highway 400 included in this project traverses, in a south–north direction, the physiographic regions known as South Slope, Oak Ridges Moraine and Simcoe Lowlands, according to *The Physiography of Southern Ontario (Chapman and Putman, 1984)*¹. Along Highway 400, the South Slope is present south of King Road, the Oak Ridge Moraines extends from north of King Road to south of Highway 9 and the Simcoe Lowlands occupy a 4 km wide strip extending from south of Highway 9 to Holland River. The Lloydtown - Aurora Road underpass structure is located within the Oak Ridges Moraine physiographic region.

The surficial soils of the South Slope region are generally cohesive tills. The Oak Ridges Moraine predominately consists of sand and gravel, although in the King Township area these soils are often overlain by till. It is understood that during grading for the initial construction of Highway 400 in this area, deep cuts exposed up to about 10 m of till overlying the sands and gravels.

The Holland River valley, which crosses Highway 400 in the vicinity of Highway 9 and South Canal Road, is located within the Simcoe Lowlands region. This valley extends to the southwest from Cook Bay at the south

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.



end of Lake Simcoe, and was once a shallow extension of the lake. The floor of the valley consists of peat, soft clays and loose sands. It is understood that during initial construction of Highway 400, a layer of peat about 2 m to 3 m thick was removed in order to construct the road upon the underlying sand and clay.

4.2 Subsurface Conditions

As part of the subsurface investigation, a total of 19 boreholes were advanced near the proposed culvert replacements, extensions and new culvert locations. The borehole locations, ground surface elevations and interpreted stratigraphic conditions at each culvert site are shown on Drawings 2 to 6.

The detailed subsurface soil and groundwater conditions encountered in the boreholes and the results of in situ and laboratory testing are given on the Record of Borehole sheets in Appendix A. The results of geotechnical laboratory testing are also presented on Figures B1 to B10 contained in Appendix B.

The stratigraphic boundaries shown on the Record of Borehole sheets and on the interpreted stratigraphic sections on Drawings 2 to 6 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 and the stratigraphy shown on the culvert centreline profile on Drawings 2 to 6 are interpretations of the subsurface conditions. 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. For the purposes of this report the, the Highway 400 alignment is a north-south orientation. Therefore, the directions indicated in the text may differ from those shown on the drawings.

In general, the stratigraphy consists of surficial layers of topsoil over native ground or asphalt overlying fill in the Highway platform/embankment areas. The fill is generally underlain by a clayey silt deposit that is further underlain by a till deposit that varies in composition from clayey silt to silt and sand. The till deposit is generally underlain by a cohesionless deposit that varies in composition from silt to sand. Interlayers and pockets of cohesive and cohesionless deposits were encountered throughout the till and silt to sand deposit.

Detailed descriptions of the subsurface conditions are provided on the following sections of this report. Where relatively significant thicknesses of overburden were encountered, the various soil types are described in detail for each main deposit.

4.2.1 Asphalt

Approximately 200 mm to 355 mm of asphalt was encountered immediately below the existing ground surface in Boreholes C39-3 and C5-6-2 to C5-6-4, which were drilled on Highway 400.

4.2.2 Topsoil

An approximately 100 mm to 200 mm thick layer of topsoil was encountered immediately below the existing ground surface in the following boreholes, which were advanced near the toe of the Highway 400 embankment, or within the Highway 400 median area:



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| Culvert Location | Borehole No. | Topsoil Thickness (mm) |
|-------------------------|---------------------|-------------------------------|
| C38 Station 20+310 | C38-4 | 100 |
| C39 Station 20 +670 | C39-1 | <100 |
| | C39-4 | 100 |
| C40 Station 22+023 | C40-1 | 200 |
| | C40-4 | 100 |
| C5-6 Station 21+307 | C5-6-1 | 200 |
| | C5-6-5 | 200 |
| C5-7 Station 9+933 | C5-7-1 | 200 |
| | C5-7-2 | 200 |

4.2.3 Fill

Fill was encountered in 12 of the boreholes immediately below the ground surface, topsoil or asphalt. The fill was generally encountered in boreholes drilled on Highway 400 or through the embankment. The elevation of the base of the fill and the thickness of the fill as encountered in the boreholes is summarized below.

| Culvert Location | Borehole No. | Thickness of Fill (m) | Elevation of Base of Fill (m) |
|-------------------------|---------------------|------------------------------|--------------------------------------|
| C38 Station 20+310 | C38-2 | 3.0 | 306.6 |
| | C38-3 | 3.7 | 306.1 |
| C39 Station 20 +670 | C39-1 | 1.1 | 304.0 |
| | C39-2 | 3.0 | 304.7 |
| | C39-3 | 3.5 | 304.2 |
| C40 Station 22+023 | C40-2 | 2.0 | 290.2 |
| | C40-3 | 3.0 | 288.7 |
| C5-6 Station 21+307 | C5-6-1 | 1.2 | 302.6 |
| | C5-6-2 | 1.8 | 302.2 |
| | C5-6-3 | 2.8 | 301.4 |
| | C5-6-4 | 1.9 | 302.4 |
| | C5-6-5 | 1.1 | 301.7 |

The fill encountered in the boreholes through the Highway 400 embankment generally consists of non-cohesive granular material underlain by cohesive earth materials. For boreholes drilled beyond / adjacent to the Highway 400 embankment, the fill generally consists of cohesive materials. The non-cohesive fill varies in composition from sand and gravel, to sandy silt containing some clay, trace gravel and organics, to sand and silt containing some clay, trace to some gravel, sand lenses and organics, to silty sand containing trace gravel, to sand containing trace to some silt and trace clay. In Borehole C40-2, a layer of organic silty sand fill was encountered at the ground surface with a thickness of about 0.3 m. The cohesive fill consists of clayey silt trace sand to clayey silt with sand, trace to some gravel, sand pockets, organics, and rootlets.



Grain size distribution tests were carried out on two (2) samples of the non-cohesive fill and the results are shown on Figure B1 in Appendix B. Grain size distribution tests were carried out on three (3) samples of the cohesive fill deposit and the results are shown on Figure B2 in Appendix B.

Atterberg limits testing was conducted on two (2) samples of the non-cohesive fill and measured plastic limits of about 10 per cent and 17 per cent, liquid limits of about 13 per cent and 20 per cent and corresponding plasticity indices of about 3 per cent and 4 per cent. The test results, which are plotted on a plasticity chart on Figure B3 in Appendix B, indicate that the fines of the non-cohesive fill exhibit slight plasticity. Atterberg limits testing was conducted on four (4) samples of the cohesive fill and measured plastic limits ranging from about 12 per cent to 17 per cent, liquid limits ranging from about 16 per cent to 29 per cent, and plasticity indices ranging from about 4 per cent to 12 per cent. The test results, which are plotted on a plasticity chart on Figure B4 in Appendix B, indicate that the cohesive fill consists of clayey silt of low plasticity.

The natural water content measured on twelve (12) selected samples of the cohesionless fill ranges from about 6 per cent to 18 per cent. The natural water measured on seven (7) samples of the cohesive fill ranges from about 12 per cent to 26 per cent.

The measured Standard Penetration Test (SPT) “N”-values within the non-cohesive portions of the fill range from 3 blows to 24 blows per 0.3 m of penetration, indicating a very loose to compact relative density. The SPT “N”-values recorded within the cohesive portions of the fill range from 3 blows to 13 blows per 0.3 m of penetration, suggesting that the cohesive fill has a soft to stiff consistency.

4.2.4 Clayey Silt to Clayey Silt with Sand

A deposit of clayey silt to clayey silt with sand was encountered in 12 of the boreholes. The clayey silt to clayey silt with sand deposit was encountered immediately below the existing ground surface, underlying surficial topsoil, or below the fill. The thickness of the clayey silt to clayey silt with sand deposit varies from about 0.5 m to 2.7 m. The elevations of the surface and base of the deposit and the thickness as encountered in the boreholes are summarized below.

| Culvert Location | Borehole No. | Depth to Surface of Deposit (m) | Deposit Surface Elevation (m) | Deposit Thickness (m) | Deposit Base Elevation (m) |
|---------------------------|--------------|---------------------------------|-------------------------------|-----------------------|----------------------------|
| C38 Station 20+310 | C38-1 | 0.0 | 307.2 | 1.5 | 305.7 |
| | C38-2 | 3.0 | 306.6 | 2.6 | 304.0 |
| C39 Station 20+670 | C39-2 | 3.0 | 304.7 | 1.5 | 303.2 |
| | C39-4 | 0.1 | 305.0 | 0.6 | 304.4 |
| C40 Station 22+023 | C40-1 | 0.2 | 291.4 | 0.5 | 290.9 |
| | C40-4 | 0.1 | 290.6 | 0.6 | 290.0 |
| C5-6 Station 21+307 | C5-6-1 | 1.4 | 302.6 | 0.8 | 301.8 |
| | C5-6-2 | 2.2 | 302.2 | 1.5 | 300.7 |
| | C5-6-3 | 3.0 | 301.4 | 0.7 | 300.7 |



| Culvert Location | Borehole No. | Depth to Surface of Deposit (m) | Deposit Surface Elevation (m) | Deposit Thickness (m) | Deposit Base Elevation (m) |
|-------------------------|---------------------|--|--------------------------------------|------------------------------|-----------------------------------|
| | C5-6-4 | 2.1 | 302.4 | 1.6 | 300.8 |
| | C5-6-5 | 1.3 | 301.7 | 0.9 | 300.8 |
| C5-7 Station 9+933 | C5-7-2 | 0.2 | 303.8 | 1.0 | 302.8 |

The clayey silt deposit contains trace to with sand and trace gravel. Sand pockets, organics, rootlets, and zones of oxidation staining were observed within the deposit at some locations as noted on the Record of Borehole sheets in Appendix A. The results of grain size distribution tests completed on five (5) samples of the clayey silt to clayey silt with sand deposit are shown on Figure B5 in Appendix B.

Atterberg limits testing was conducted on seven (7) samples of the clayey silt to clayey silt with sand deposit and measured plastic limits ranging from about 12 per cent to 19 per cent, liquid limits ranging from about 20 per cent to 27 per cent, and plasticity indices ranging from about 8 per cent to 13 per cent. The test results, which are plotted on a plasticity chart on Figure B6 in Appendix B, confirm that the deposit consists of clayey silt of low plasticity.

The natural water content measured on 14 selected samples of the clayey silt to clayey silt with sand ranged from about 9 per cent to 27 per cent.

The measured SPT “N”-values within the clayey silt to clayey silt with sand range from 2 blows to 13 blows per 0.3 m of penetration, suggesting a very soft to stiff consistency.

4.2.5 Sandy Silt to Sand Interlayer

A sandy silt to sand interlayer was encountered underlying the clayey silt deposit in Boreholes C40-1 and C5-6-4 and below the topsoil in Borehole C5-7-1. The elevations of the surface and base of the deposit and the thickness as encountered in the boreholes are summarized below.

| Culvert Location | Borehole No. | Depth to Surface of Deposit (m) | Deposit Surface Elevation (m) | Deposit Thickness (m) | Deposit Base Elevation (m) |
|-------------------------|---------------------|--|--------------------------------------|------------------------------|-----------------------------------|
| C40 Station 22+023 | C40-1 | 0.7 | 290.9 | 0.9 | 290.0 |
| C5-6 Station 21+307 | C5-6-4 | 3.7 | 300.8 | 1.9 | 298.9 |
| C5-7 Station 9+933 | C5-7-1 | 0.2 | 302.9 | 0.5 | 302.4 |



The deposit consists of sand and silt containing trace clay and trace gravel, to sand containing some silt and trace clay, to sandy silt containing trace gravel and rootlets. The result of the grain size distribution test completed on one sample of the sand portion of the deposit is presented on Figure B7 in Appendix B.

The natural water content measured on three samples of the deposit ranges from about 11 per cent to 22 per cent.

The measured SPT “N”-values within this deposit generally ranges from 4 blows to 57 blows per 0.3 m of penetration and typically range between 23 and 57 blows per 0.3 m of penetration, indicating that the deposit is generally very loose to very dense, but typically compact to dense in relative density.

4.2.6 Clayey Silt to Sand and Silt Till

A till deposit was encountered underlying the topsoil in Borehole C38-4; underlying the fill in Borehole C38-3, C39-1, C39-3, C40-2, and C40-3; underlying the clayey silt to clayey silt with sand in Boreholes C38-1, C39-2, C39-4, C40-4, C5-6-1 to C5-6-3, C5-6-5, and C5-7-2; and underlying the sandy silt to sand interlayer in Boreholes C39-3, C40-1, and C5-6-4. In Borehole C39-3, a lower till deposit composed of clayey silt with sand was encountered underlying the lower sand deposit. The elevations of the surface and base of the till deposit and the deposit thickness as encountered in the boreholes are summarized below.

| Culvert Location | Borehole No. | Depth to Surface of Deposit (m) | Deposit Surface Elevation (m) | Deposit Thickness (m) | Deposit Base Elevation (m) | Soil Type |
|--------------------------|--------------|---------------------------------|-------------------------------|-----------------------|----------------------------|----------------------------|
| C38 Station 20+310 | C38-1 | 1.5 | 305.7 | 4.1 | 301.6 | Sand and Silt Till |
| | C38-3 | 3.7 | 306.1 | 1.9 | 304.2 | Clayey Silt with Sand Till |
| | C38-4 | 0.1 | 307.1 | >4.2 | Below 302.9 | Sand and Silt Till |
| C39 Station 20+670 | C39-1 | 1.1 | 304.0 | 6.1 | 297.9 | Sand and Silt Till |
| | C39-2 | 4.5 | 303.2 | 7.7 | 295.5 | Sand and Silt Till |
| | C39-3 | 3.7 | 304.2 | 5.0 | 299.2 | Sand and Silt Till |
| | | 14.8 | 293.1 | >0.9 | Below 292.2 | Clayey Silt with Sand Till |
| | C39-4 | 0.7 | 304.4 | 0.8 | 303.7 | Clayey Silt Till |
| | | 1.5 | 303.7 | 4.2 | 299.5 | Sand and Silt Till |
| C40 Station 20+023 | C40-1 | 1.6 | 290.0 | >3.1 | Below 286.9 | Clayey Silt with Sand Till |
| | C40-2 | 2.0 | 290.2 | >4.3 | Below 285.9 | Sand and Silt Till |
| | C40-3 | 3.0 | 288.7 | >4.9 | Below 283.8 | Sand and Silt Till |
| | C40-4 | 0.7 | 290.0 | 1.7 | 288.4 | Sandy Silt Till |
| | | 2.3 | 288.4 | 3.3 | 285.1 | Sand and Silt Till |



**FOUNDATION REPORT - CULVERTS AT LLOYDTOWN-AURORA
ROAD INTERCHANGE, HIGHWAY 400 WIDENING
GWP 2835-02-22**

| Culvert Location | Borehole No. | Depth to Surface of Deposit (m) | Deposit Surface Elevation (m) | Deposit Thickness (m) | Deposit Base Elevation (m) | Soil Type |
|---------------------|--------------|---------------------------------|-------------------------------|-----------------------|----------------------------|---|
| | | 5.6 | 285.1 | >4.0 | Below 281.1 | Clayey Silt Till |
| C5-6 Station 21+307 | C5-6-1 | 2.2 | 301.8 | 6.9 | 294.9 | Sand and Silt to Silty Sand Till |
| | C5-6-2 | 3.7 | 300.7 | 4.1 | 296.6 | Clayey Silt with Sand Till |
| | C5-6-3 | 3.7 | 300.7 | 3.4 | 297.3 | Clayey Silt with Sand Till |
| | C5-6-4 | 5.6 | 298.9 | 3.0 | 295.9 | Clayey Silt with Sand to Sand and Silt Till |
| | C5-6-5 | 2.2 | 300.8 | 3.4 | 297.4 | Clayey Silt with Sand Till |
| C5-7 Station 9+933 | C5-7-1 | 0.7 | 302.4 | 5.5 | 296.9 | Clayey Silt with Sand Till |
| | C5-7-2 | 1.2 | 302.8 | 7.4 | 295.4 | Sand and Silt Till |

The till deposit varies in composition from sand and silt containing trace to some clay and trace to some gravel, to clayey silt containing trace to with sand and trace to some gravel. Sand pockets were observed within the deposit at some locations as noted on the Record of Borehole sheets in Appendix A. A 25 mm thick sand seam was encountered in Borehole C39-4 at a depth of about 4.5 m (Elevation 300.6 m). Sand seams and pockets were encountered in Borehole C39-1 to a depth of about 5.2 m (Elevation 299.9 m). The presence of cobbles is also inferred from difficulties advancing augers (auger grinding) in Boreholes C40-1, C40-2, C5-6-1 to C5-6-3, and C5-7-2 at depths ranging from about 2.3 m to 7.6 m below ground surface (about Elevations 299.4 m and 288.5 m) during the drilling operations. The results of grain size distribution tests completed on 31 samples of the deposit are shown on Figures B8A to B8E in Appendix B.

Atterberg limits testing was conducted on 19 selected samples of the till deposit. One test indicated that the material is non-plastic and the remainder of the tests measured plastic limits ranging from about 9 per cent to 13 per cent, liquid limits ranging from about 10 per cent to 18 percent, and plasticity indices ranging from about 1 per cent to 6 per cent. The test results, which are plotted on a plasticity chart on Figures B9A to B9C in Appendix B, confirm that the till deposit consists of clayey silt of low plasticity to sand and silt of slight plasticity and zone(s) of non-plastic fines.

The natural water content measured on 58 samples of the till deposit range from about 7 per cent to 19 per cent.

The SPT “N”-values recorded within the sand and silt till deposit range from 4 blows per 0.3 m of penetration to 100 blows per 0.18 m of penetration, indicating that the sand and silt till deposit has a loose to very dense relative density. The SPT “N”-values recorded within the clayey silt till portions of the deposit range from 4 blows per 0.3 m of penetration to 125 blows per 0.15 m of penetration suggesting a soft to hard consistency.



4.2.7 Silt to Sand

A silt to sand deposit was encountered below the clayey silt to clayey silt with sand deposit in Borehole C38-2 and below the till deposit in the remainder of the boreholes except Boreholes C38-4 and C40-1 to C40-4 at the location of Culverts C38 and C40, respectively. At some locations, this deposit is interlayered with clayey silt layers. The elevations of the surface and base of the silt to sand deposit and the deposit thickness as encountered in the boreholes are summarized below:

| Culvert Location | Borehole No. | Depth to Surface of Deposit (m) | Deposit Surface Elevation (m) | Deposit Thickness (m) | Deposit Base Elevation (m) | Soil Type |
|--------------------|---------------------|---------------------------------|-------------------------------|-----------------------|----------------------------|---------------|
| C38 Station 20+310 | C38-1 | 5.6 | 301.6 | >2.6 | Below 299.0 | Silt |
| | C38-2 | 5.6 | 304.0 | 3.5 | 300.5 | Sand and Silt |
| | | 9.1 | 300.5 | >6.8 | Below 293.8 | Silt |
| | C38-3 | 5.6 | 304.2 | 6.1 | 298.1 | Silty Sand |
| | | 11.7 | 298.1 | 1.6 | 296.5 | Silt |
| | | 13.3 | 296.5 | >2.6 | Below 293.9 | Sandy Silt |
| C39 Station 20+670 | C39-1 | 7.2 | 297.9 | 2.2 | 295.7 | Sand and Silt |
| | | 9.9 | 295.2 | >1.1 | Below 294.1 | Sand and Silt |
| | C39-2 | 12.2 | 295.5 | >5.2 | Below 290.3 | Silty Sand |
| | C39-3 | 8.7 | 299.2 | 6.1 | 293.1 | Sand |
| | C39-4 | 5.6 | 299.5 | 0.7 | 298.8 | Silty Sand |
| | | 6.3 | 298.8 | 0.9 | 297.9 | Silt |
| | | 7.2 | 297.9 | 0.8 | 297.1 | Silty Sand |
| | | 8.0 | 297.1 | 0.7 | 296.4 | Sandy Silt |
| | | 8.7 | 296.4 | >2.6 | Below 293.8 | Sand and Silt |
| | C5-6 Station 22+023 | C5-6-1 | 9.1 | 294.9 | >1.8 | Below 293.1 |
| C5-6-2 | | 7.8 | 296.6 | 2.3 | 294.3 | Sand and Silt |
| | | 10.1 | 294.3 | >2.5 | Below 291.8 | Sand |
| C5-6-3 | | 7.1 | 297.3 | 3.0 | 294.3 | Sand and Silt |
| | | 10.1 | 294.3 | >2.5 | Below 291.8 | Sand |
| C5-6-4 | | 8.6 | 295.9 | >2.5 | Below 293.4 | Sand |
| C5-6-5 | | 5.6 | 297.4 | 1.5 | 295.9 | Silty Sand |
| | | 7.1 | 295.9 | >4.0 | Below 291.9 | Sand |
| C5-7 Station 9+933 | C5-7-1 | 6.2 | 296.9 | >6.4 | Below 290.5 | Sand |
| | C5-7-2 | 8.6 | 295.4 | >3.9 | Below 291.5 | Sand |



This deposit varies in composition from sand containing trace clay, trace to some silt, to silty sand to sandy silt containing trace gravel and trace clay, to silt containing trace to some clay, trace to some sand, and trace gravel. Borehole C39-1 penetrated a clayey silt interlayer within the silt to sand deposit at a depth of about 9.4 m below ground surface (Elevation 295.7 m), for a thickness of about 0.5 m. The results of grain size distribution tests completed on 18 samples of the silt to sand deposit are shown on Figures B10A to B10C in Appendix B.

The natural water content measured on 37 samples of the silt to sand deposit range from about 8 per cent to 25 per cent.

The measured SPT “N”-values in this deposit generally range from 0 blows (weight of hammer) per 0.3 m of penetration to 50 blows per 0.13 m of penetration but typically SPT “N”-values one greater than 30 blows per 0.3 m of penetration, indicating that the deposit is generally loose to very dense, but typically dense to very dense in relative density.

4.2.8 Groundwater Conditions

The groundwater levels in the open boreholes were measured upon completion of drilling operations. A standpipe piezometer was installed in Boreholes C38-4, C39-4, and C5-7-2 to permit monitoring of the groundwater level at this site. Details of the piezometer installations and measured groundwater levels are shown on the Record of Borehole sheets in Appendix A. The groundwater levels recorded in the open boreholes and piezometers are summarized below:

| Borehole No. | Ground Surface Elevation (m) | Depth to Water Level (m) | Groundwater Elevation (m) | Date | Comments |
|--------------|------------------------------|--------------------------|---------------------------|-------------------|---------------|
| C38-1 | 307.2 | 4.6 | 302.6 | November 26, 2010 | Open Borehole |
| C38-2 | 309.6 | 6.1 | 303.5 | November 26, 2010 | Open Borehole |
| C38-3 | 309.8 | 10.1 | 299.7 | March 24, 2011 | Open Borehole |
| C38-4 | 307.2 | Dry | -- | November 24, 2010 | Open Borehole |
| | | 2.1 | 305.1 | December 16, 2010 | Piezometer |
| | | 2.0 | 305.0 | February 1, 2011 | Piezometer |
| | | 0.1 | 307.1 | April 7, 2011 | Piezometer |
| C39-1 | 305.1 | 3.0 | 302.1 | November 26, 2010 | Open Borehole |
| C39-2 | 307.7 | 6.1 | 301.6 | November 24, 2010 | Inside Augers |
| C39-3 | 307.9 | 10.1 | 297.8 | March 25, 2011 | Open Borehole |
| C39-4 | 305.1 | 2.4 | 302.7 | February 1, 2011 | Piezometer |
| | | 0.6 | 304.5 | April 7, 2011 | Piezometer |
| C40-1 | 291.6 | 2.2 | 289.4 | December 8, 2010 | Open Borehole |
| C40-2 | 292.2 | 1.4 | 290.8 | December 9, 2010 | Open Borehole |
| C40-3 | 291.7 | 3.8 | 287.9 | March 24, 2011 | Open Borehole |
| C40-4 | 290.7 | 4.3 | 286.4 | July 26, 2011 | Open Borehole |



**FOUNDATION REPORT - CULVERTS AT LLOYDTOWN-AURORA
ROAD INTERCHANGE, HIGHWAY 400 WIDENING
GWP 2835-02-22**

| Borehole No. | Ground Surface Elevation (m) | Depth to Water Level (m) | Groundwater Elevation (m) | Date | Comments |
|---------------------|-------------------------------------|---------------------------------|----------------------------------|-------------------------------------|-----------------------------|
| C5-6-1 | 304.0 | 5.3 | 298.7 | December 5, 2013 | Open Borehole |
| C5-6-2 | 304.4 | Dry | -- | December 5, 2013 | Open Borehole |
| C5-6-3 | 304.4 | Dry | -- | December 2, 2013 | Open Borehole |
| C5-6-4 | 304.5 | 4.3 | 300.2 | November 27, 2013 | Open Borehole |
| C5-6-5 | 303.0 | 3.0 | 300.0 | November 27, 2013 | Open Borehole |
| C5-7-1 | 303.1 | Dry | -- | November 28, 2013 | Open Borehole |
| C5-7-2 | 304.0 | Dry 4.6 | -- 299.4 | December 1, 2013 January 7, 2013 | Open Borehole Piezometer |

Blowing sands were encountered in the hollow stem augers in Borehole C39-2 prior to sampling at a depth of 10.7 m below ground surface (Elevation 297.0 m).

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



5.0 CLOSURE

This Foundation Investigation Report was prepared by Ms. Haley Schafer, EIT, and reviewed by Nikol Kochmanová, P.Eng., a geotechnical engineer with Golder. Mr. Jorge Costa, P.Eng., a Designated MTO Foundations Contact for Golder and a Principal of Golder, conducted an independent quality control review of this report.

GOLDER ASSOCIATES LTD.



Nikol Kochmanová ,Ph.D., P.Eng.
Geotechnical Engineer

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

HLS/NK/LCC/JMAC/nk/sm

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REFERENCES

Chapman, L.J., and Putnam, D.F., 1984. *The Physiography of Southern Ontario*, 3rd Edition. Ontario Geological Survey, Special Volume 2. Ontario Ministry of Natural Resources.

ASTM International

ASTM D1586 Standard Test Method for Standard Penetration Test (SPT) and Split-Barrel Sampling of Soils

Ontario Water Resources Act

Ontario Regulation 903/90 Wells: O. Reg. 468/10 Amendment to Ontario Regulation 903

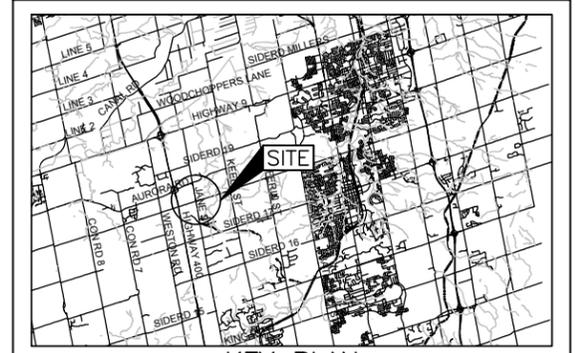
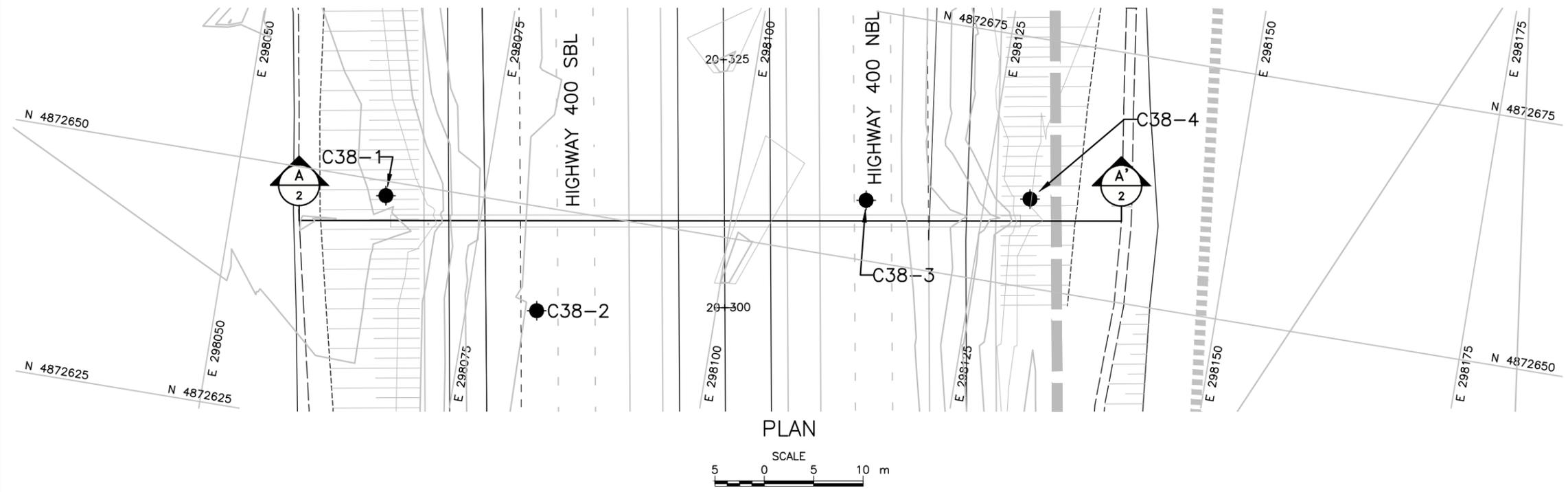
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 DIMENSIONS ARE IN METRES AND/OR MILLIMETRES UNLESS OTHERWISE SHOWN. STATIONS IN KILOMETRES + METRES.

CONT No. GWP No. 2835-02-00



HIGHWAY 400 WIDENING
 CULVERT C38 AT STATION 20+310
BOREHOLE LOCATIONS AND SOIL STRATA

SHEET



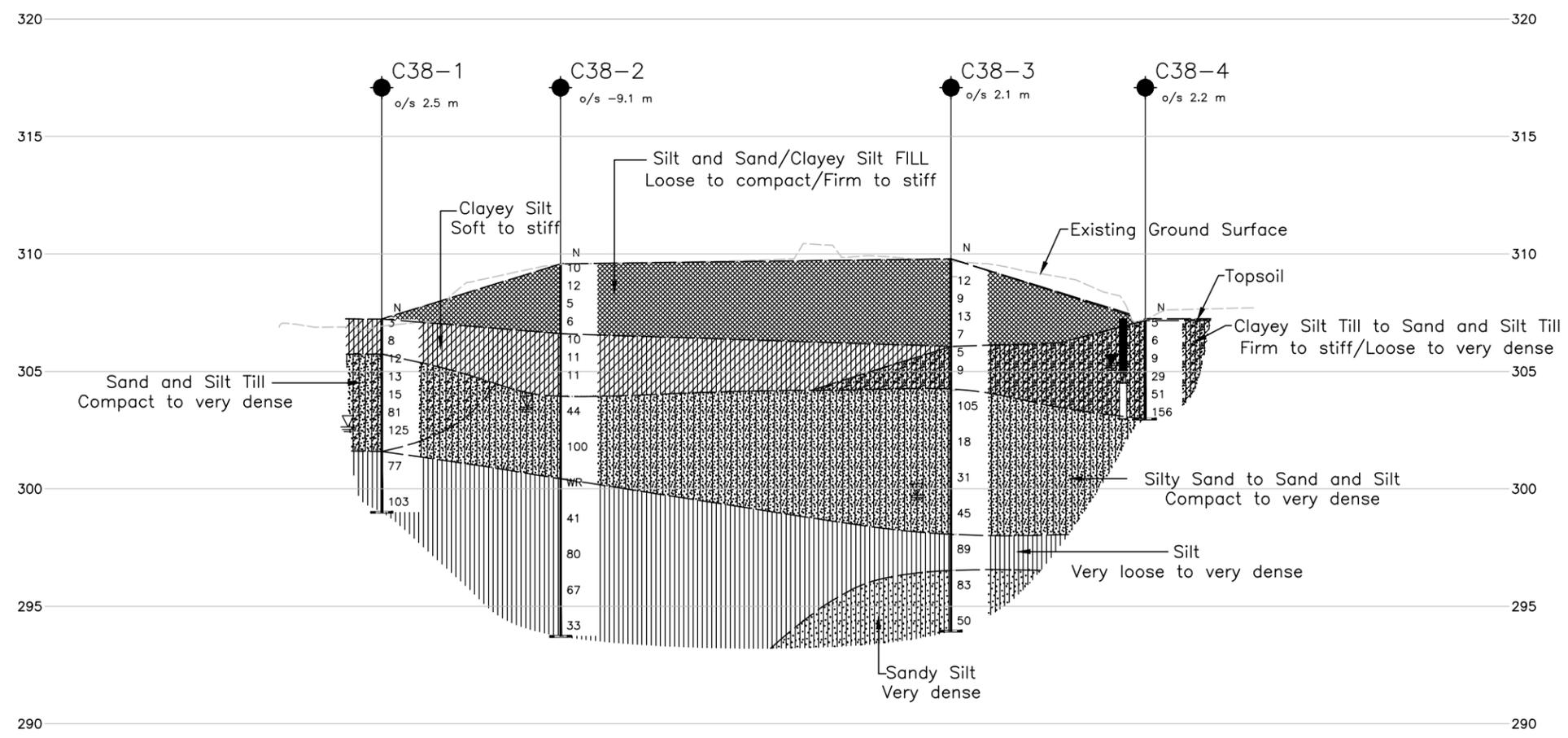
KEY PLAN
 SCALE 0 4 8 km

LEGEND

- Borehole - Current Investigation
- ⊥ Seal
- ⊏ Piezometer
- N Standard Penetration Test Value
- 16 Blows/0.3m unless otherwise stated (Std. Pen. Test, 475 j/blow)
- ▽ WL in piezometer, measured on April 7, 2011
- ▽ WL upon completion of drilling

BOREHOLE CO-ORDINATES

| No. | ELEVATION | NORTHING | EASTING |
|-------|-----------|-----------|----------|
| C38-1 | 307.2 | 4872648.6 | 298065.2 |
| C38-2 | 309.6 | 4872639.6 | 298082.1 |
| C38-3 | 309.8 | 4872656.0 | 298113.2 |
| C38-4 | 307.2 | 4872658.9 | 298129.5 |



NOTES

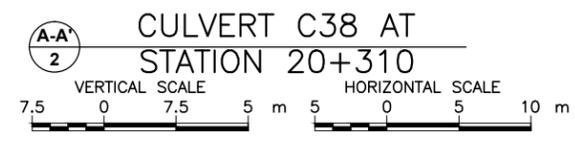
This drawing is for subsurface information only. The proposed structure details/works are shown for illustration purposes only and may not be consistent with the final design configuration as shown elsewhere in the Contracts Documents.

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 URS, drawing file Hwy400_plan.dwg, received July 28, 2014 and Hwy400_contours.dwg, received July 12, 2011.



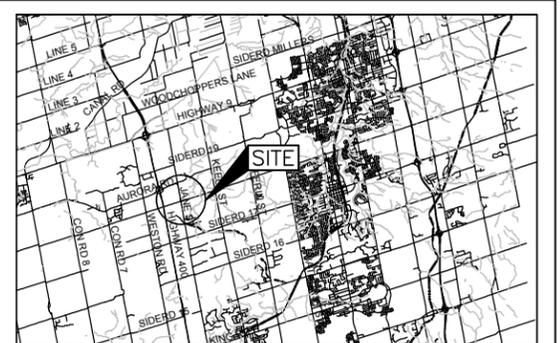
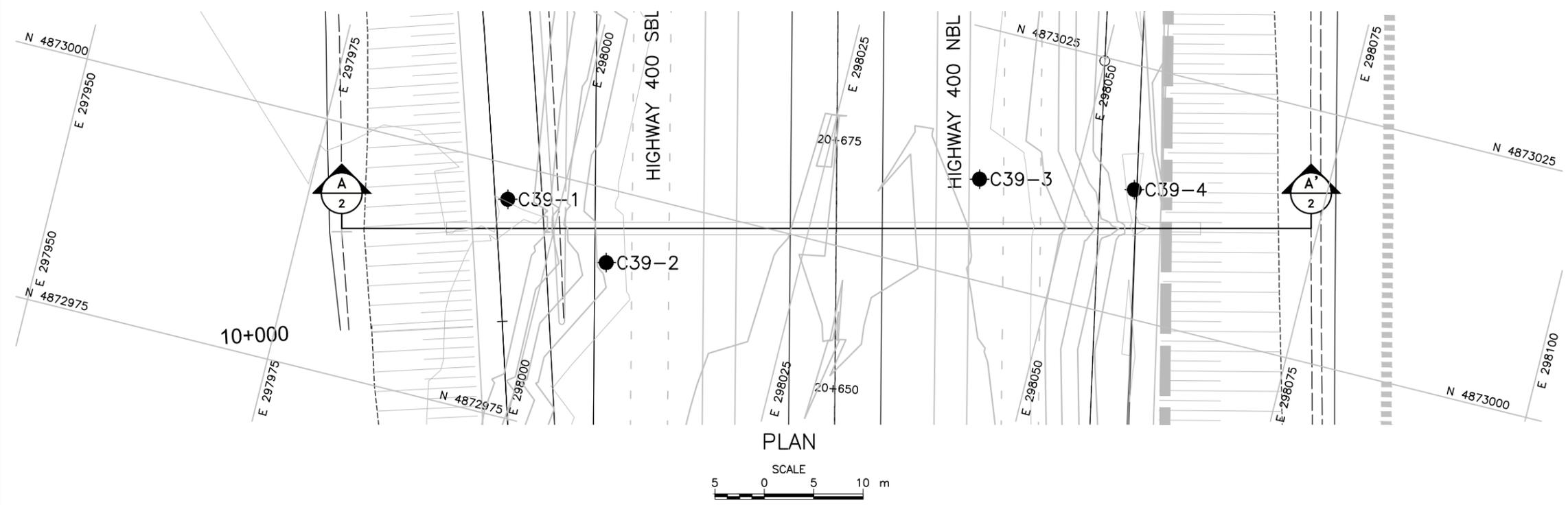
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| | | |
|-------------|--------------------------|------------------|
| Geocres No. | PROJECT NO. 09-1111-0018 | DIST. |
| HWY. 400 | CHKD. NK | DATE: 27/07/2015 |
| SUBM'D. HLS | CHKD. NK | APPD. JMAC |
| DRAWN: JFC | | DWG. 2 |

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

CONT No. GWP No. 2835-02-00
HIGHWAY 400 WIDENING
CULVERT C39 AT STATION 20+670
BOREHOLE LOCATIONS AND SOIL STRATA

SHEET

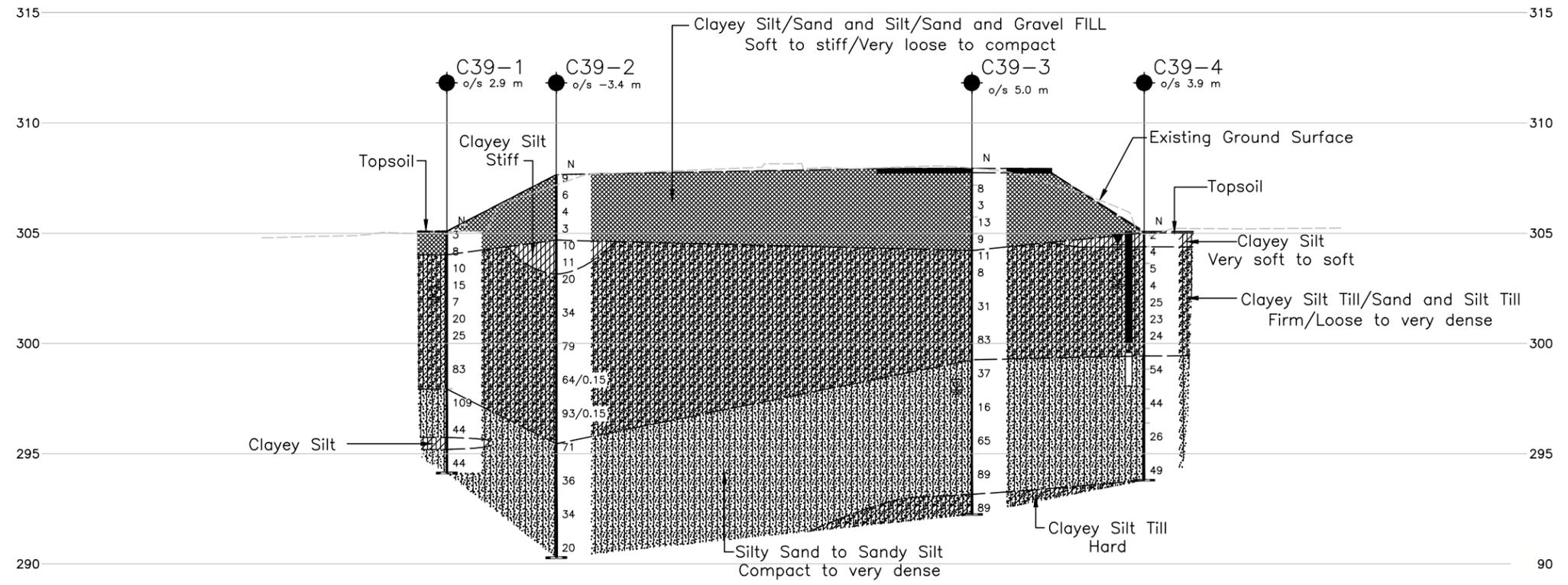


KEY PLAN
SCALE
0 4 8 km

- LEGEND**
- Borehole - Current Investigation
 - ⊥ Seal
 - ⊥ Piezometer
 - N Standard Penetration Test Value
 - 16 Blows/0.3m unless otherwise stated (Std. Pen. Test, 475 j/blow)
 - ▽ WL in piezometer, measured on April 7, 2011
 - ▽ WL upon completion of drilling

BOREHOLE CO-ORDINATES

| No. | ELEVATION | NORTHING | EASTING |
|-------|-----------|-----------|----------|
| C39-1 | 305.1 | 4872996.5 | 297994.7 |
| C39-2 | 307.7 | 4872992.7 | 298005.9 |
| C39-3 | 307.9 | 4873010.0 | 298040.5 |
| C39-4 | 305.1 | 4873012.8 | 298056.0 |



NOTES

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REFERENCE

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A-A'
3
CULVERT C39 AT STATION 20+670
VERTICAL SCALE
HORIZONTAL SCALE



| NO. | DATE | BY | REVISION |
|-----|------|----|----------|
| | | | |

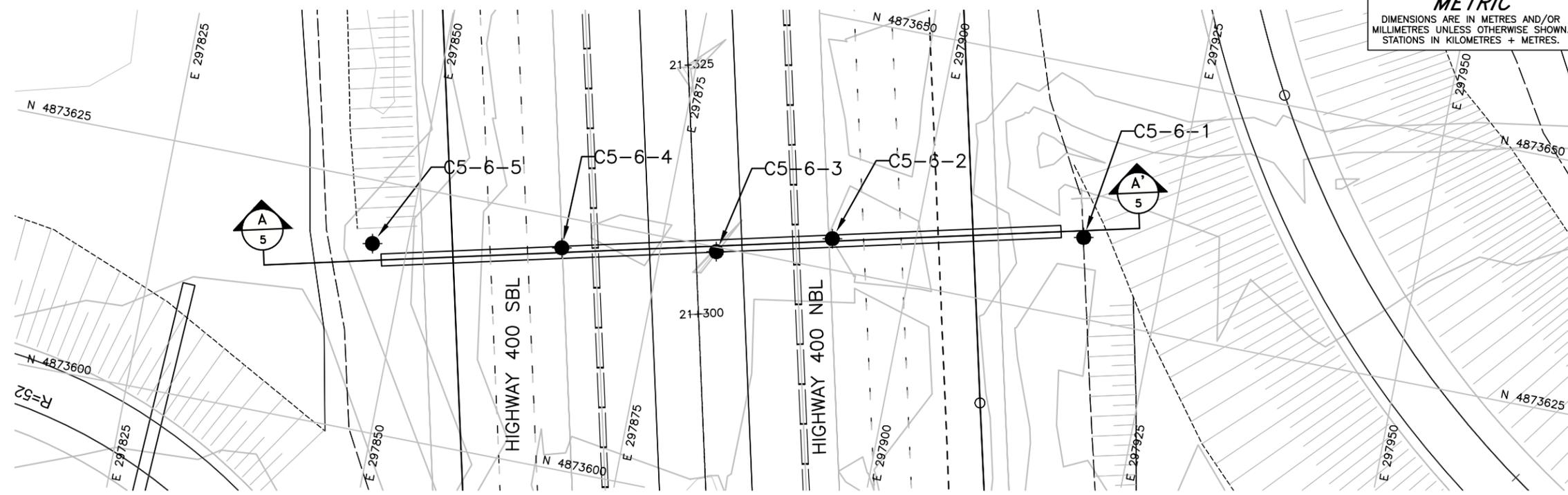
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HWY. 400
SUBM'D. HLS CHKD. NK DATE: 27/07/2015 SITE: .
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METRIC
DIMENSIONS ARE IN METRES AND/OR MILLIMETRES UNLESS OTHERWISE SHOWN. STATIONS IN KILOMETRES + METRES.

CONT No.
GWP No. 2835-02-00

HIGHWAY 400 WIDENING
CULVERT C5-6 AT STATION 21+307
BOREHOLE LOCATIONS AND SOIL STRATA

SHEET



PLAN



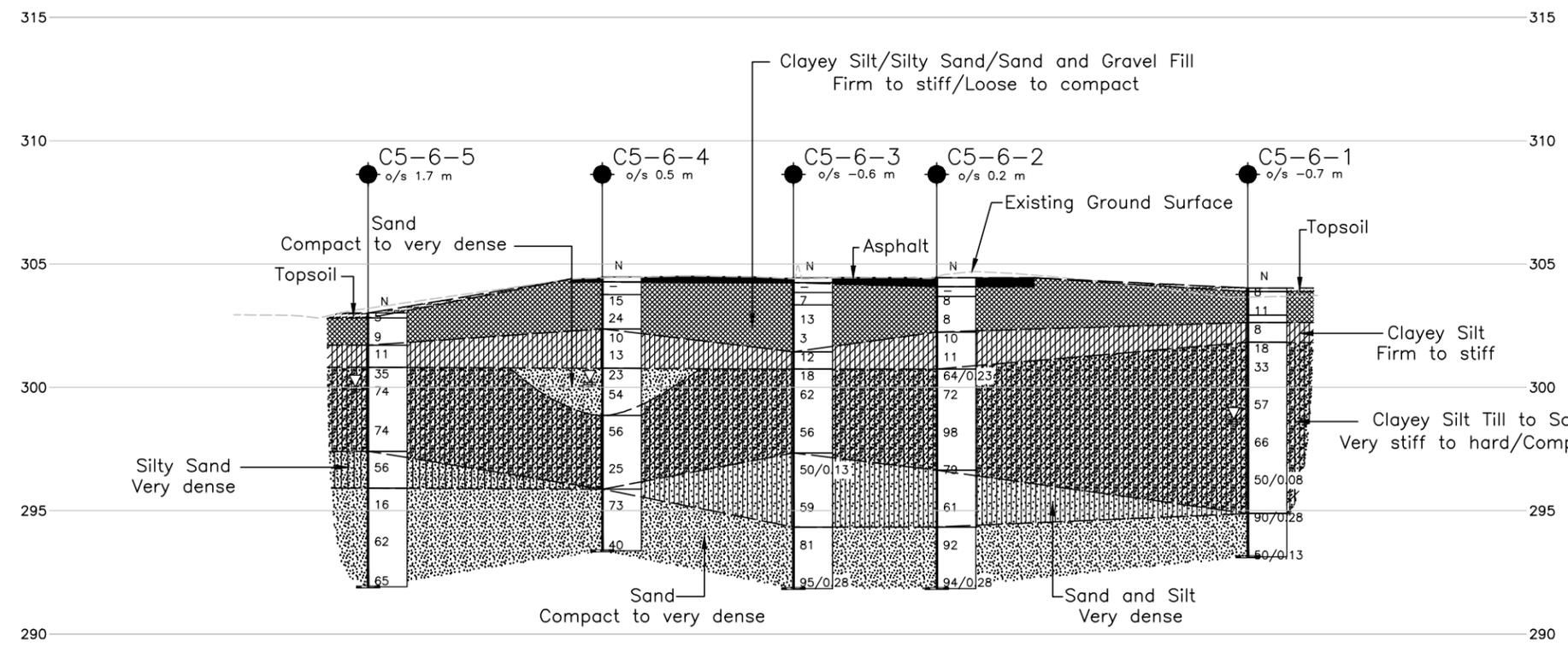
KEY PLAN
SCALE
4 0 4 8 km

LEGEND

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

BOREHOLE CO-ORDINATES

| No. | ELEVATION | NORTHING | EASTING |
|--------|-----------|-----------|----------|
| C5-6-1 | 304.0 | 4873633.0 | 297916.5 |
| C5-6-2 | 304.4 | 4873628.1 | 297891.8 |
| C5-6-3 | 304.4 | 4873624.5 | 297880.6 |
| C5-6-4 | 304.5 | 4873621.9 | 297865.3 |
| C5-6-5 | 303.0 | 4873618.7 | 297846.5 |



NOTES

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REFERENCE

Base plans provided in digital format by URS, drawing file Hwy400_plan.dwg, received July 28, 2014, Hwy400_contours.dwg, received July 12, 2011 and Hwy400_plan+culverts.dwg, received March 9, 2015.

A-A'
5

CULVERT C5-6 AT STATION 21+307

VERTICAL SCALE
7.5 0 7.5 5 m

HORIZONTAL SCALE
5 0 5 10 m



| NO. | DATE | BY | REVISION |
|-----|------|----|----------|
| | | | |

Geocres No., PROJECT NO. 09-1111-0018 DIST. . .

HWY. 400

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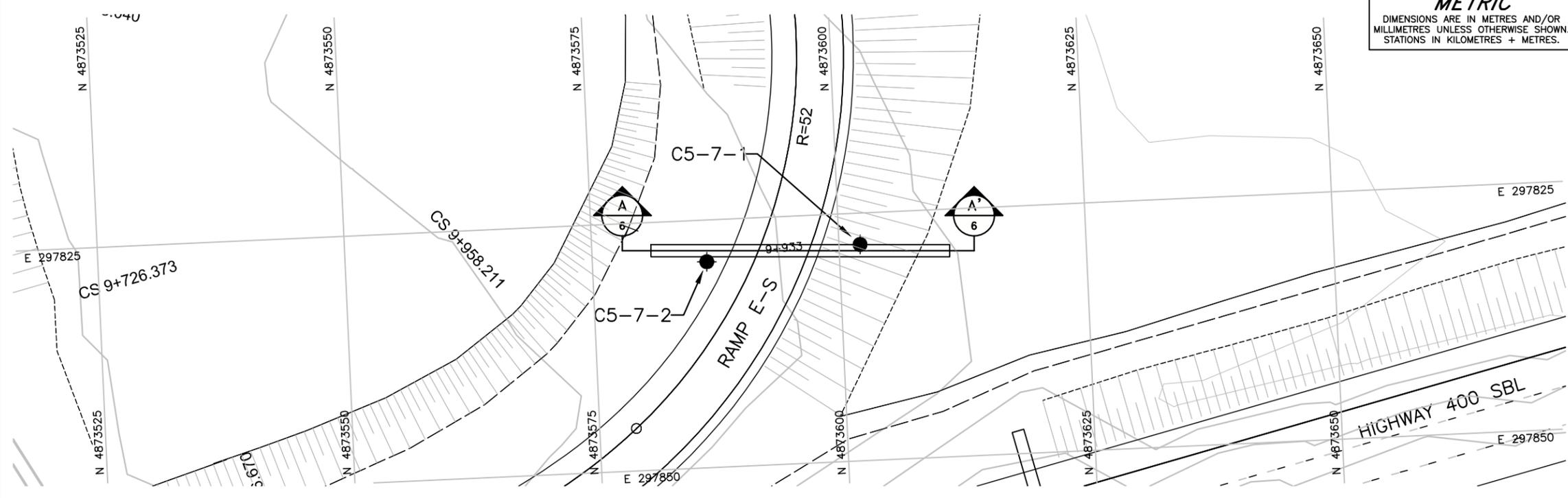
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METRIC
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 STATIONS IN KILOMETRES + METRES.

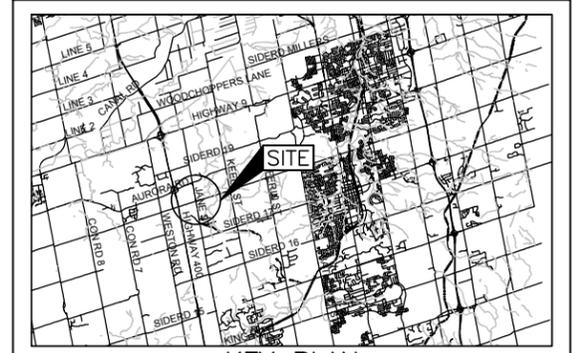
CONT No. GWP No. 2835-02-00
 HIGHWAY 400 WIDENING
 CULVERT C5-7 AT RAMP STATION 9+933
 BOREHOLE LOCATIONS AND
 SOIL STRATA



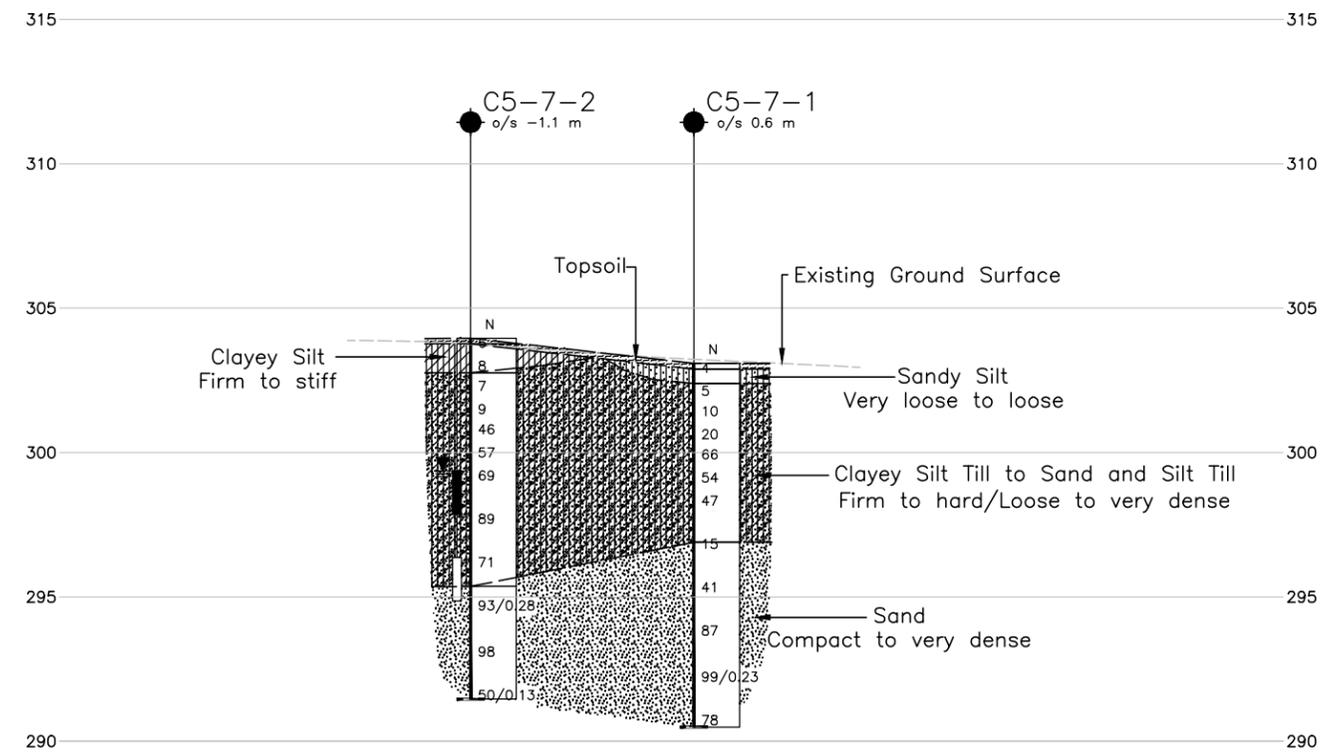
SHEET



PLAN
 SCALE
 5 0 5 10 m



KEY PLAN
 SCALE
 4 0 4 8 km



A-A' CULVERT C5-7 AT RAMP STATION 9+933
 VERTICAL SCALE HORIZONTAL SCALE
 7.5 0 7.5 5 m 5 0 5 10 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)
 - ▽ WL in piezometer, measured on April 7, 2011
 - ▽ WL upon completion of drilling

BOREHOLE CO-ORDINATES

| No. | ELEVATION | NORTHING | EASTING |
|--------|-----------|-----------|----------|
| C5-7-1 | 303.1 | 4873602.1 | 297828.2 |
| C5-7-2 | 304.0 | 4873586.6 | 297829.2 |

NOTES

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REFERENCE

Base plans provided in digital format by URS, drawing file Hwy400_plan.dwg, received July 28, 2014, Hwy400_contours.dwg, received July 12, 2011 and Hwy400_plan+culverts.dwg, received March 9, 2015.

| NO. | DATE | BY | REVISION |
|-----|------|----|----------|
| | | | |

Geocres No.:

| | | |
|-------------|--------------------------|------------------|
| HWY. 400 | PROJECT NO. 09-1111-0018 | DIST. . |
| SUBM'D. HLS | CHKD. NK | DATE: 27/07/2015 |
| DRAWN: JFC | CHKD. NK | APPD. JMAC |
| | | DWG. 6 |





APPENDIX A

Record of Borehole Sheets



LIST OF SYMBOLS

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

| | | | |
|--------------------------------|--|------------------|--|
| I. | GENERAL | (a) | Index Properties (continued) |
| π | 3.1416 | w | water content |
| $\ln x$, | natural logarithm of x | w_l or LL | liquid limit |
| \log_{10} | x or log x, logarithm of x to base 10 | w_p or PL | plastic limit |
| g | acceleration due to gravity | I_p or PI | plasticity index = $(w_l - w_p)$ |
| t | time | w_s | shrinkage limit |
| FoS | factor of safety | 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) |
| II. | STRESS AND STRAIN | (b) | Hydraulic Properties |
| γ | shear strain | h | hydraulic head or potential |
| Δ | change in, e.g. in stress: $\Delta \sigma$ | q | rate of flow |
| ε | linear strain | v | velocity of flow |
| ε_v | volumetric strain | i | hydraulic gradient |
| η | coefficient of viscosity | k | hydraulic conductivity (coefficient of permeability) |
| ν | Poisson's ratio | j | seepage force per unit volume |
| σ | total stress | | |
| σ' | effective stress ($\sigma' = \sigma - u$) | (c) | Consolidation (one-dimensional) |
| σ'_{vo} | initial effective overburden stress | C_c | compression index (normally consolidated range) |
| $\sigma_1, \sigma_2, \sigma_3$ | principal stress (major, intermediate, minor) | C_r | recompression index (over-consolidated range) |
| σ_{oct} | mean stress or octahedral stress $= (\sigma_1 + \sigma_2 + \sigma_3)/3$ | C_s | swelling index |
| τ | shear stress | C_α | secondary compression index |
| u | porewater pressure | m_v | coefficient of volume change |
| E | modulus of deformation | C_v | coefficient of consolidation (vertical direction) |
| G | shear modulus of deformation | C_h | coefficient of consolidation (horizontal direction) |
| K | bulk modulus of compressibility | T_v | time factor (vertical direction) |
| | | U | degree of consolidation |
| | | σ'_p | pre-consolidation stress |
| | | OCR | over-consolidation ratio = σ'_p / σ'_{vo} |
| III. | SOIL PROPERTIES | (d) | Shear Strength |
| (a) | Index Properties | τ_p, τ_r | peak and residual shear strength |
| $\rho(\gamma)$ | bulk density (bulk unit weight)* | ϕ' | effective angle of internal friction |
| $\rho_d(\gamma_d)$ | dry density (dry unit weight) | δ | angle of interface friction |
| $\rho_w(\gamma_w)$ | density (unit weight) of water | μ | coefficient of friction = $\tan \delta$ |
| $\rho_s(\gamma_s)$ | density (unit weight) of solid particles | c' | effective cohesion |
| γ' | unit weight of submerged soil ($\gamma' = \gamma - \gamma_w$) | C_u, S_u | undrained shear strength ($\phi = 0$ analysis) |
| D_R | relative density (specific gravity) of solid particles ($D_R = \rho_s / \rho_w$) (formerly G_s) | p | mean total stress $(\sigma_1 + \sigma_3)/2$ |
| e | void ratio | p' | mean effective stress $(\sigma'_1 + \sigma'_3)/2$ |
| n | porosity | q | $(\sigma_1 - \sigma_3)/2$ or $(\sigma'_1 - \sigma'_3)/2$ |
| S | degree of saturation | 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.

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 |

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

| | <u>kPa</u> | <u>C_u, S_u</u> | <u>psf</u> |
|------------|------------|-------------------------------------|----------------|
| 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.

| | | | |
|------------------------------------|---|--------------------------|---------------|
| PROJECT <u>09-1111-0018</u> | RECORD OF BOREHOLE No C38-2 | SHEET 2 OF 2 | METRIC |
| G.W.P. <u>2835-02-00</u> | LOCATION <u>N 4872639.6 ; E 298082.1</u> | ORIGINATED BY <u>SB</u> | |
| DIST <u>Central</u> HWY <u>400</u> | BOREHOLE TYPE <u>D-90 Truck Mount, 108 mm Inner Diameter Hollow Stem Augers</u> | COMPILED BY <u>TT/HS</u> | |
| DATUM <u>Geodetic</u> | DATE <u>November 25 and 26, 2010</u> | CHECKED BY <u>LCC</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 kN/m ³ | REMARKS & GRAIN SIZE DISTRIBUTION (%) GR SA SI CL |
|--------------|--|------------|--------|------|-------------------------|-----------------|--|----|----|----|----|---------------------------------|-------------------------------|--------------------------------|--|--|
| ELEV. DEPTH | DESCRIPTION | STRAT PLOT | NUMBER | TYPE | | | "N" VALUES | 20 | 40 | 60 | 80 | | | | | |
| | --- CONTINUED FROM PREVIOUS PAGE --- | | | | | | | | | | | | | | | |
| 293.7 | SILT, some sand, trace clay Very loose to very dense Brown Wet | | 14 | SS | 33 | | | | | | | | ○ | | | |
| 15.9 | END OF BOREHOLE NOTE: 1. Water level in open borehole at a depth of 6.1 m (Elev. 303.5 m) upon completion of drilling. | | | | | | | | | | | | | | | |

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

| | | | |
|------------------------------------|---|--------------------------|---------------|
| PROJECT <u>09-1111-0018</u> | RECORD OF BOREHOLE No C38-3 | SHEET 2 OF 2 | METRIC |
| G.W.P. <u>2835-02-00</u> | LOCATION <u>N 4872656.0 ; E 298113.2</u> | ORIGINATED BY <u>AM</u> | |
| DIST <u>Central</u> HWY <u>400</u> | BOREHOLE TYPE <u>D-50 Track Mount, 108 mm Inner Diameter Hollow Stem Augers</u> | COMPILED BY <u>CS/HS</u> | |
| DATUM <u>Geodetic</u> | DATE <u>March 24, 2011</u> | CHECKED BY <u>LCC</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 (%) | | | | | | | | | |
|---------------|--|---|--------|------|----------------------------|-----------------|---|----|----|----|----|---|----------------|---|---|---|----|----|----|----|----|----|----|---|--|
| ELEV DEPTH | DESCRIPTION | STRAT PLOT | NUMBER | TYPE | | | "N" VALUES | 20 | 40 | 60 | 80 | 100 | W _p | W | | W _L | 10 | 20 | 30 | GR | SA | SI | CL | | |
| 293.9 | Sandy SILT, trace clay Very dense Grey Wet |  | 13 | SS | 50 | | | | | | | | | | | o | | | | | 0 | 23 | 73 | 4 | |
| 15.9 | END OF BOREHOLE NOTES: 1. Water level in open borehole at a depth of 10.1 m (Elev. 299.7 m) upon completion of drilling. | | | | | | | | | | | | | | | | | | | | | | | | |

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+³, X³: Numbers refer to Sensitivity ○ 3% STRAIN AT FAILURE

| | | | |
|------------------------------------|--|--------------------------|---------------|
| PROJECT <u>09-1111-0018</u> | RECORD OF BOREHOLE No C38-4 | SHEET 1 OF 1 | METRIC |
| G.W.P. <u>2835-02-00</u> | LOCATION <u>N 4872658.9 ; E 298129.5</u> | ORIGINATED BY <u>SKB</u> | |
| DIST <u>Central</u> HWY <u>400</u> | BOREHOLE TYPE <u>D-50 Track Mount, 101 mm Diameter Solid Stem Augers</u> | COMPILED BY <u>SB/HS</u> | |
| DATUM <u>Geodetic</u> | DATE <u>November 24, 2010</u> | CHECKED BY <u>LCC</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 (%) | | | | | | | | | | | | | | | | | | | | | | | |
|---------------|---|--------------|-----------|-----------|----------------------------|-----------------|---|----------|-----|-------|----------|---|----------------|---|---|---|----------------|----|----|----|----|-----|----|----|----|----|----|----|----|--|--|--|--|--|--|--|--|--|--|
| ELEV DEPTH | DESCRIPTION | STRAT PLOT | NUMBER | TYPE | | | "N" VALUES | 20 | 40 | 60 | 80 | 100 | W _p | W | | | W _L | 20 | 40 | 60 | 80 | 100 | 10 | 20 | 30 | GR | SA | SI | CL | | | | | | | | | | |
| 307.2 | GROUND SURFACE | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| 0.9 | TOPSOIL | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| | SAND and SILT, trace clay, trace gravel, sand pockets to 1.4 m (TILL) Loose to very dense Brown Moist Wet between depths of 0.7 m and 2.2 m | [Strat Plot] | 1 | SS | 5 | [Water Table] | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| | | | 2 | SS | 6 | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| | | | 3 | SS | 9 | | | | | | | | | | | | | | | | | | | 4 | 42 | 46 | 8 | | | | | | | | | | | | |
| | | | 4 | SS | 29 | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| | | | 5 | SS | 51 | | | | | | | | | | | | | | | | | | 2 | 39 | 53 | 6 | | | | | | | | | | | | | |
| 302.9 | END OF BOREHOLE | | 6 | SS | 156 | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| 4.3 | Split-spoon sampler refusal | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| | NOTES: 1. Open borehole dry upon completion of drilling. 2. Water level measurements in monitoring well: <table style="margin-left: 20px;"> <tr> <td>Date</td> <td>Depth (m)</td> <td>Elev. (m)</td> </tr> <tr> <td>12/16/10</td> <td>2.1</td> <td>305.1</td> </tr> <tr> <td>02/01/11</td> <td>2.0</td> <td>305.0</td> </tr> <tr> <td>04/07/11</td> <td>0.1</td> <td>307.1</td> </tr> </table> | Date | Depth (m) | Elev. (m) | 12/16/10 | 2.1 | 305.1 | 02/01/11 | 2.0 | 305.0 | 04/07/11 | 0.1 | 307.1 | | | | | | | | | | | | | | | | | | | | | | | | | | |
| Date | Depth (m) | Elev. (m) | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| 12/16/10 | 2.1 | 305.1 | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| 02/01/11 | 2.0 | 305.0 | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| 04/07/11 | 0.1 | 307.1 | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |

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

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|------------------------------------|---|--------------------------|---------------|
| PROJECT <u>09-1111-0018</u> | RECORD OF BOREHOLE No C39-3 | SHEET 2 OF 2 | METRIC |
| G.W.P. <u>2835-02-00</u> | LOCATION <u>N 4873010.0 ; E 298040.5</u> | ORIGINATED BY <u>AM</u> | |
| DIST <u>Central</u> HWY <u>400</u> | BOREHOLE TYPE <u>D-50 Track Mount, 108 mm Inner Diameter Hollow Stem Augers</u> | COMPILED BY <u>CS/HS</u> | |
| DATUM <u>Geodetic</u> | DATE <u>March 24 and 25, 2011</u> | CHECKED BY <u>LCC</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 | 20 | 40 | 60 | 80 | 100 | W _p | W | | |
| 292.2 15.7 | --- CONTINUED FROM PREVIOUS PAGE --- CLAYEY SILT with SAND, trace gravel (TILL) Hard Brown Moist END OF BOREHOLE NOTES: 1. Water level in open borehole at a depth of 10.1 m (Elev. 297.8 m) upon completion of drilling. | [Hatched Box] | 13 | SS | 89 | | | | | | | | | | | |

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

| | | | |
|------------------------------------|--|---------------------------|---------------|
| PROJECT <u>09-1111-0018</u> | RECORD OF BOREHOLE No C39-4 | SHEET 1 OF 1 | METRIC |
| G.W.P. <u>2835-02-00</u> | LOCATION <u>N 4873012.8 ; E 298056.0</u> | ORIGINATED BY <u>SKB</u> | |
| DIST <u>Central</u> HWY <u>400</u> | BOREHOLE TYPE <u>D-50 Track Mount, 127 mm Diameter Solid Stem Augers</u> | COMPILED BY <u>ARM/HS</u> | |
| DATUM <u>Geodetic</u> | DATE <u>November 25, 2010</u> | CHECKED BY <u>LCC</u> | |

| ELEV DEPTH | SOIL PROFILE DESCRIPTION | STRAT PLOT | 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 (%) | | | | |
|---------------|--|------------|---------|------|------------|----------------------------|-----------------|---|----|----|----|-----|------------------------------------|-------------------------------------|-----------------------------------|---------------------|---|-------------------|----|----|----|
| | | | NUMBER | TYPE | "N" VALUES | | | SHEAR STRENGTH kPa | | | | | | | | | | WATER CONTENT (%) | | | |
| | | | | | | | | 20 | 40 | 60 | 80 | 100 | | | | | | GR | SA | SI | CL |
| 305.1 | GROUND SURFACE | | | | | | | | | | | | | | | | | | | | |
| 0.9 | TOPSOIL | | | | | | | | | | | | | | | | | | | | |
| 304.4 | CLAYEY SILT, trace to some sand, rootlets and organics Very soft Brown Moist | | 1 | SS | 2 | | | | | | | | | | | | | | | | |
| 0.7 | | | 2 | SS | 4 | | | | | | | | | | | | | | | | |
| 303.6 | CLAYEY SILT, trace to some sand, trace gravel, zones of oxidation staining (TILL) Firm Brown Wet | | 3 | SS | 5 | | | | | | | | | | | | | | | | |
| 1.5 | SAND and SILT, trace to some clay, trace to some gravel, sand pockets (TILL) Loose to compact Brown Wet | | 4 | SS | 4 | | | | | | | | | | | | | 2 | 44 | 46 | 8 |
| | | | 5 | SS | 25 | | | | | | | | | | | | | | | | |
| | | | 6 | SS | 23 | | | | | | | | | | | | | 7 | 45 | 38 | 10 |
| | 25 mm thick sand seams below a depth of 4.5 m | | 7 | SS | 24 | | | | | | | | | | | | | | | | |
| 299.5 | Silty SAND, some gravel Very dense Brown Wet | | 8A | | | | | | | | | | | | | | | | | | |
| 298.8 | SILT, trace to some sand, trace clay Very dense Brown Wet | | 8B | SS | 54 | | | | | | | | | | | | | 0 | 10 | 87 | 3 |
| 297.9 | Silty SAND, trace gravel Dense Brown Wet | | 9A | | | | | | | | | | | | | | | | | | |
| 297.1 | Sandy SILT Dense Brown Wet | | 9B | | | | | | | | | | | | | | | | | | |
| 296.4 | SAND and SILT, trace clay, trace gravel Compact to dense Brown Wet | | 10 | SS | 26 | | | | | | | | | | | | | 2 | 59 | 31 | 8 |
| 293.8 | | | 11 | SS | 49 | | | | | | | | | | | | | | | | |
| 11.3 | END OF BOREHOLE | | | | | | | | | | | | | | | | | | | | |

NOTES:

- Borehole caved to a depth of 7.0 m (Elev. 298.1 m) upon completion of drilling.
- Water level measurements in piezometer:

| | | |
|----------|-----------|-----------|
| Date | Depth (m) | Elev. (m) |
| 02/01/11 | 2.4 | 302.7 |
| 04/07/11 | 0.6 | 304.5 |

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

RECORD OF BOREHOLE No C40-1 SHEET 1 OF 1 **METRIC**

PROJECT 09-1111-0018 G.W.P. 2835-02-00 LOCATION N 4874313.6 ; E 297678.5 ORIGINATED BY TT

DIST Central HWY 400 BOREHOLE TYPE D-50 Track Mount, 108 mm Diameter Solid Stem Augers COMPILED BY MAS/HS

DATUM Geodetic DATE December 8, 2010 CHECKED BY LCC

| 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 (%) | |
|--------------|--|------------|--------|------|-------------------------|-----------------|--|----|----|----|-----|----------------|--------------------------|----------------|----------------------|---------------------------------------|-------------------|
| | | | | | | | SHEAR STRENGTH kPa | | | | | | | | | | WATER CONTENT (%) |
| ELEV DEPTH | DESCRIPTION | STRAT PLOT | NUMBER | TYPE | "N" VALUES | | 20 | 40 | 60 | 80 | 100 | W _p | W | W _L | kN/m ³ | GR SA SI CL | |
| 291.6 | GROUND SURFACE | | | | | | | | | | | | | | | | |
| 0.0 | TOPSOIL | | | | | | | | | | | | | | | | |
| 0.2 | CLAYEY SILT, some sand, trace gravel Firm Brown Moist | | 1 | SS | 8 | | | | | | | | | | | | |
| 290.9 | | | 2 | SS | 39 | | | | | | | | | | | | |
| 0.7 | SAND and SILT, trace clay, trace gravel Dense Brown Moist | | 3 | SS | 47 | | | | | | | ○ | — | | | | |
| 290.0 | | | 4 | SS | 104 | | | | | | | | | | | | |
| 1.6 | CLAYEY SILT with SAND, trace to some gravel (TILL) Hard Brown Moist Augers grinding at a depth of 2.3 m. | | 5 | SS | 46/0.1 | | | | | | | ○ | — | | | 5 40 46 9 | |
| | | | 6 | SS | 107/15 | | | | | | | | | | | | |
| | | | 7 | SS | 125/15 | | | | | | | | | | | | |
| 286.9 | END OF BOREHOLE | | | | | | | | | | | | | | | | |
| 4.7 | NOTES: 1. Water level in open borehole at a depth of 2.2 m (Elev. 289.4 m) upon completion of drilling. 2. Borehole caved at a depth of 3.5 m (Elev. 288.1 m) upon completion of drilling. | | | | | | | | | | | | | | | | |

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

RECORD OF BOREHOLE No C40-2 SHEET 1 OF 1 **METRIC**

PROJECT 09-1111-0018 G.W.P. 2835-02-00 LOCATION N 4874318.3 ; E 297691.6 ORIGINATED BY TT

DIST Central HWY 400 BOREHOLE TYPE D-50 Track Mount, 108 mm Diameter Solid Stem Augers COMPILED BY SKB/HS

DATUM Geodetic DATE December 9, 2010 CHECKED BY LCC

| SOIL PROFILE | | SAMPLES | | | GROUND WATER CONDITIONS | ELEVATION SCALE | DYNAMIC CONE PENETRATION RESISTANCE PLOT | | | | | PLASTIC NATURAL 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 | GR | SA | SI |
| 292.2 | GROUND SURFACE | | | | | | | | | | | | | | | | | | | |
| 0.0 | Organic silty sand, trace rootlets (FILL) | [Cross-hatched pattern] | 1A | SS | 4 | | | | | | | | | | | | | | | |
| 0.3 | Loose Black Moist | | 1B | | | | | | | | | | | | | | | | | |
| 291.1 | Clayey silt, some sand (FILL) | [Cross-hatched pattern] | 2A | SS | 4 | | | | | | | | | | | | | | | |
| 1.1 | Soft Brown Moist | | 2B | | | | | | | | | | | | | | | | | |
| 290.2 | Sand and silt, trace gravel, trace clay, trace organics (FILL) | [Cross-hatched pattern] | 3A | SS | 15 | | | | | | | | | | | | | | | |
| 2.0 | Firm to stiff Brown Moist to wet | | 3B | | | | | | | | | | | | | | | | | |
| | SAND and SILT, trace to some gravel, trace clay, some sand pockets (TILL) | [Dotted pattern] | 4 | SS | 59 | | | | | | | | | | | | 5 | 45 | 45 | 5 |
| | Very dense Brown to grey below 5.4 m Moist | | 5 | SS | 104 | | | | | | | | | | | | | 16 | 41 | 40 |
| | Augers grinding at a depth of 3.7 m | | 6 | SS | 100/23 | | | | | | | | | | | | | | | |
| | | | 7 | SS | 100/20 | | | | | | | | | | | | | | | |
| 285.9 | END OF BOREHOLE | | 8 | SS | 100/18 | | | | | | | | | | | | | | | |
| 6.3 | NOTE: 1. Water level in open borehole at a depth of 1.4 m (Elev. 290.8 m) upon completion of drilling. | | | | | | | | | | | | | | | | | | | |

GTA-MTO 001 T:\PROJECTS\2009\09-1111-0018 (URS, YORK REGION)\LOG\0911110018.GPJ GAL-GTA.GDT 8/17/15 SIB

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

| | | | |
|------------------------------------|---|--------------------------|---------------|
| PROJECT <u>09-1111-0018</u> | RECORD OF BOREHOLE No C40-3 | SHEET 1 OF 1 | METRIC |
| G.W.P. <u>2835-02-00</u> | LOCATION <u>N 4874361.6 ; E 297716.8</u> | ORIGINATED BY <u>SB</u> | |
| DIST <u>Central</u> HWY <u>400</u> | BOREHOLE TYPE <u>D-90 Truck Mount, 108 mm Inner Diameter Hollow Stem Augers</u> | COMPILED BY <u>CS/HS</u> | |
| DATUM <u>Geodetic</u> | DATE <u>March 24, 2011</u> | CHECKED BY <u>LCC</u> | |

| ELEV DEPTH | SOIL PROFILE DESCRIPTION | STRAT PLOT | 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 |
|---------------|--|------------|---------|------|------------|----------------------------|-----------------|---|----|----|----|-----|------------------------------------|-------------------------------------|-----------------------------------|---|--|
| | | | NUMBER | TYPE | "N" VALUES | | | SHEAR STRENGTH kPa | | | | | | | | | |
| | | | | | | | | 20 | 40 | 60 | 80 | 100 | | | | | |
| | | | | | | | | ○ UNCONFINED + FIELD VANE ● QUICK TRIAXIAL × REMOULDED | | | | | WATER CONTENT (%) | | | | |
| | | | | | | | | 20 | 40 | 60 | 80 | 100 | 10 | 20 | 30 | | |
| 291.7 | GROUND SURFACE | | | | | | | | | | | | | | | | |
| 0.0 | Sand and gravel (FILL) Compact Brown Moist | | | | | | | | | | | | | | | | |
| 290.9 | | | | | | | 291 | | | | | | | | | | |
| 0.8 | Clayey silt, trace sand, trace gravel (FILL) Firm to stiff Brown Moist | | 1 | SS | 5 | | | | | | | | | | | | |
| | | | 2 | SS | 9 | | 290 | | | | | | | | | | |
| | | | 3 | SS | 10 | | 289 | | | | | | | | | | |
| 288.7 | | | | | | | | | | | | | | | | | |
| 3.0 | SAND and SILT, trace to some clay, trace gravel (TILL) Compact to very dense Brown to grey below 7.0 m Moist | | 4 | SS | 16 | | 288 | | | | | | | | | | 5 44 46 5 |
| | | | 5 | SS | 30 | | 287 | | | | | | | | | | 3 36 48 13 |
| | | | 6 | SS | 40 | | 286 | | | | | | | | | | |
| | | | 7 | SS | 76/15 | | 285 | | | | | | | | | | |
| 283.8 | | | 8 | SS | 70/15 | | 284 | | | | | | | | | | 3 37 54 6 |
| 7.9 | END OF BOREHOLE | | | | | | | | | | | | | | | | |
| | NOTES: 1. Water level in open borehole at a depth of 3.8 m (Elev. 287.9 m) upon completion of drilling. | | | | | | | | | | | | | | | | |

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

RECORD OF BOREHOLE No C40-4 SHEET 1 OF 1 **METRIC**

PROJECT 09-1111-0018 G.W.P. 2835-02-00 LOCATION N 4874316.9 ; E 297744.2 ORIGINATED BY TT

DIST Central HWY 400 BOREHOLE TYPE CME-55 Track Mount, 108 mm Diameter Solid and Inner Diameter Hollow Stem Auger COMPILED BY JC/HS

DATUM Geodetic DATE July 26, 2011 CHECKED BY LCC

| 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 (%) | | | | | | |
| | | | | | | 20 | 40 | 60 | 80 | 100 | 20 | 40 | 60 | 80 | 100 | 10 | 20 | 30 | GR | SA | SI | CL | |
| 290.7 | GROUND SURFACE | | | | | | | | | | | | | | | | | | | | | | |
| 0.0 | TOPSOIL | | | | | | | | | | | | | | | | | | | | | | |
| 290.0 | CLAYEY SILT, some sand, trace gravel, trace organics and rootlets Soft | | 1 | SS | 4 | | | | | | | | | | | | | | | | | | |
| 0.7 | Brown Moist | | 2 | SS | 15 | | | | | | | | | | | | | | | | | | |
| | SANDY SILT, trace gravel, some clay (TILL) Very stiff | | 3A | SS | 28 | | | | | | | | | | | | | | | | | | |
| | Brown and grey Moist | | 3B | | | | | | | | | | | | | | | | | | | | |
| 288.4 | SAND and SILT, trace clay, trace gravel (TILL) Very dense | | 4 | SS | 72 | | | | | | | | | | | | | | | | | | |
| 2.3 | Grey Moist | | 5 | SS | 101 | | | | | | | | | | | | | | | | | | |
| | | | 6 | SS | 102 | | | | | | | | | | | | | | | | | | |
| | | | 7 | SS | 95 | | | | | | | | | | | | | | | | | | |
| 285.1 | CLAYEY SILT, trace sand, trace gravel (TILL) Hard | | 8 | SS | 63 | | | | | | | | | | | | | | | | | | |
| 5.6 | Grey Moist | | 9 | SS | 63 | | | | | | | | | | | | | | | | | | |
| | | | 10 | SS | 104 | | | | | | | | | | | | | | | | | | |
| 281.1 | END OF BOREHOLE | | | | | | | | | | | | | | | | | | | | | | |
| 9.6 | NOTES: 1. Water level in open borehole at a depth of 4.3 m (Elev. 286.4 m) upon completion of drilling. 2. Open borehole caved at a depth of 5.2 m (Elev. 285.5 m) upon completion of drilling. | | | | | | | | | | | | | | | | | | | | | | |

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

PROJECT 09-1111-0018 **RECORD OF BOREHOLE No C5-6-1** SHEET 1 OF 1 **METRIC**
G.W.P. 2835-02-00 **LOCATION** N 4873633.0 ; E 297916.5 **ORIGINATED BY** RA
DIST Central **HWY** 400 **BOREHOLE TYPE** 200 mm O.D. Continuous Flight Hollow Stem Augers **COMPILED BY** HS/NK
DATUM Geodetic **DATE** December 2 to 5, 2013 **CHECKED BY** LCC

| 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 (%) | | | | | | |
| | | | | | | 20 | 40 | 60 | 80 | 100 | 20 | 40 | 60 | 80 | 100 | 10 | 20 | 30 | GR | SA | SI | CL | |
| 304.0 | GROUND SURFACE | | | | | | | | | | | | | | | | | | | | | | |
| 0.0 | TOPSOIL | | 1A | | | | | | | | | | | | | | | | | | | | |
| 0.2 | Clayey silt, trace sand, trace gravel, trace to some sand lenses and rootlets (FILL) Firm to stiff Brown Moist | | 1B | SS | 8 | | | | | | | | | | | | | | | | | | |
| 302.9 | | | 2A | | | | | | | | | | | | | | | | | | | | |
| 302.6 | Silty sand, trace gravel (FILL) Compact Brown Moist | | 2B | SS | 11 | | | | | | | | | | | | | | | | | | |
| 302.6 | | | 3 | SS | 8 | | | | | | | | | | | | | | | | | | |
| 301.8 | CLAYEY SILT, trace sand, trace gravel Firm Brown Moist | | 4 | SS | 18 | | | | | | | | | | | | | | | | | | |
| 2.2 | | | 5 | SS | 33 | | | | | | | | | | | | | | | | | | |
| | SAND and SILT to Silty SAND, trace clay, trace to some gravel (TILL) Compact to very dense Brown with oxidation staining to grey below 6.1 m Moist to wet below 4.0 m | | 6 | SS | 57 | | | | | | | | | | | | | | | | | | |
| | | | 7 | SS | 66 | | | | | | | | | | | | | | | | | | |
| | Augers grinding below a depth of 6.6 m | | 8 | SS | 50/0.08 | | | | | | | | | | | | | | | | | | |
| | | | 9 | SS | 90/0.28 | | | | | | | | | | | | | | | | | | |
| 294.9 | SAND, some silt, trace clay Very dense Grey Wet | | 10 | SS | 50/0.13 | | | | | | | | | | | | | | | | | | |
| 293.1 | | | | | | | | | | | | | | | | | | | | | | | |
| 10.9 | END OF BOREHOLE | | | | | | | | | | | | | | | | | | | | | | |
| | NOTE: 1. Water level in augers measured at a depth of 5.3 m (Elev. 298.7) on December 5, 2013. | | | | | | | | | | | | | | | | | | | | | | |

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

RECORD OF BOREHOLE No C5-6-2 SHEET 1 OF 1 **METRIC**

PROJECT 09-1111-0018

G.W.P. 2835-02-00 LOCATION N 4873628.1 ; E 297891.8 ORIGINATED BY RA

DIST Central HWY 400 BOREHOLE TYPE 200 mm O.D. Continuous Flight Hollow Stem Augers COMPILED BY HS/NK

DATUM Geodetic DATE December 5, 2013 CHECKED BY LCC

| 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 (%) | | | | | | |
| | | | | | | 20 | 40 | 60 | 80 | 100 | 20 | 40 | 60 | 80 | 100 | 10 | 20 | 30 | GR | SA | SI | CL | |
| 304.4 | GROUND SURFACE | | | | | | | | | | | | | | | | | | | | | | |
| 0.0 | ASPHALT (355 mm) | | | | | | | | | | | | | | | | | | | | | | |
| 304.0 | | | | | | | | | | | | | | | | | | | | | | | |
| 303.6 | Sand and gravel (FILL) Brown Moist | | 1 | AS | - | | | | | | | | | | | | | | | | | | |
| 0.8 | | | | | | | | | | | | | | | | | | | | | | | |
| 303.6 | Sand and silt, some clay, trace gravel, trace organics, sand lenses (FILL) Loose Brown with black staining Moist | | 2 | SS | 8 | | | | | | | | | | | | | | | | | | |
| | | | | | | | | | | | | | | | | | | | | | | | |
| 302.2 | | | 3 | SS | 8 | | | | | | | | | | | | | | | | | | |
| | | | | | | | | | | | | | | | | | | | | | | | |
| 302.2 | CLAYEY SILT, some sand, trace gravel Stiff Brown Moist | | 4 | SS | 10 | | | | | | | | | | | | | | | | | | |
| | | | | | | | | | | | | | | | | | | | | | | | |
| 300.7 | | | 5 | SS | 11 | | | | | | | | | | | | | | | | | | |
| | | | | | | | | | | | | | | | | | | | | | | | |
| 300.7 | CLAYEY SILT with SAND, trace to some gravel (TILL) Hard Brown Moist | | 6 | SS | 64/0.23 | | | | | | | | | | | | | | | | | | 0 18 56 26 |
| | | | | | | | | | | | | | | | | | | | | | | | |
| 300.7 | | | 7 | SS | 72 | | | | | | | | | | | | | | | | | | |
| | | | | | | | | | | | | | | | | | | | | | | | |
| 300.7 | | | 8 | SS | 98 | | | | | | | | | | | | | | | | | | |
| | | | | | | | | | | | | | | | | | | | | | | | |
| | Augers grinding below a depth of 6.6 m | | | | | | | | | | | | | | | | | | | | | | |
| | | | | | | | | | | | | | | | | | | | | | | | |
| 296.6 | | | 9A | | | | | | | | | | | | | | | | | | | | |
| 7.8 | SAND and SILT, trace clay Very dense Brown and grey Wet | | 9B | SS | 79 | | | | | | | | | | | | | | | | | | |
| | | | | | | | | | | | | | | | | | | | | | | | |
| 296.6 | | | | | | | | | | | | | | | | | | | | | | | |
| | | | | | | | | | | | | | | | | | | | | | | | |
| 294.3 | | | 10 | SS | 61 | | | | | | | | | | | | | | | | | | 0 53 43 4 |
| | | | | | | | | | | | | | | | | | | | | | | | |
| 294.3 | SAND, trace to some silt Very dense Brown and grey Wet | | 11 | SS | 92 | | | | | | | | | | | | | | | | | | |
| | | | | | | | | | | | | | | | | | | | | | | | |
| 294.3 | | | | | | | | | | | | | | | | | | | | | | | |
| 291.8 | | | 12 | SS | 94/0.28 | | | | | | | | | | | | | | | | | | |
| | | | | | | | | | | | | | | | | | | | | | | | |
| 291.8 | END OF BOREHOLE | | | | | | | | | | | | | | | | | | | | | | |
| 12.6 | NOTE: 1. Borehole dry on completion of drilling. | | | | | | | | | | | | | | | | | | | | | | |

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

RECORD OF BOREHOLE No C5-6-3 SHEET 1 OF 1 **METRIC**

PROJECT 09-1111-0018

G.W.P. 2835-02-00 LOCATION N 4873624.5 ; E 297880.6 ORIGINATED BY RA

DIST Central HWY 400 BOREHOLE TYPE 200 mm O.D. Continuous Flight Hollow Stem Augers COMPILED BY HS/NK

DATUM Geodetic DATE December 1 and 2, 2013 CHECKED BY LCC

| SOIL PROFILE | | STRAT PLOT | 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 | | NUMBER | TYPE | "N" VALUES | | | 20 | 40 | 60 | 80 | 100 | | | | | | 20 | 40 | 60 | 80 | 100 | 10 |
| 304.4 | GROUND SURFACE | | | | | | | | | | | | | | | | | | | | | | |
| 0.0 | ASPHALT (200 mm) | | | | | | | | | | | | | | | | | | | | | | |
| 303.8 | Sand and gravel (FILL) Brown Moist | | 1 | AS | - | | | | | | | | | | | | | | | | | | |
| 0.6 | | | | | | | | | | | | | | | | | | | | | | | |
| 303.3 | Sand, trace silt (FILL) Loose Brown Moist | | 2A | SS | 7 | | | | | | | | | | | | | | | | | | |
| 1.1 | | | 2B | | | | | | | | | | | | | | | | | | | | |
| | Clayey silt with sand, trace gravel, trace organics and topsoil inclusions (FILL) Soft to stiff Brown Moist | | 3 | SS | 13 | | | | | | | | | | | | | | | | | | |
| | | | | | | | | | | | | | | | | | | | | | | | |
| | | | 4 | SS | 3 | | | | | | | | | | | | | | | | | | |
| 301.4 | | | | | | | | | | | | | | | | | | | | | | | |
| 3.0 | CLAYEY SILT, trace to some sand, trace gravel Stiff Brown Moist | | 5 | SS | 12 | | | | | | | | | | | | | | | | | | |
| 300.7 | | | | | | | | | | | | | | | | | | | | | | | |
| 3.7 | CLAYEY SILT with SAND, trace to some gravel (TILL) Very stiff to hard Brown becoming grey below 6.1 m Moist | | 6 | SS | 18 | | | | | | | | | | | | | | | | | | |
| | | | | | | | | | | | | | | | | | | | | | | | |
| | Augers grinding between depths of 5.0 m and 7.6 m | | 7 | SS | 62 | | | | | | | | | | | | | | | | | | |
| | | | | | | | | | | | | | | | | | | | | | | | |
| | | | 8 | SS | 56 | | | | | | | | | | | | | | | | | | |
| | | | | | | | | | | | | | | | | | | | | | | | |
| 297.3 | SAND and SILT, trace clay, trace to some gravel Very dense Grey Moist to wet below 8.5 m | | 9 | SS | 50/0.13 | | | | | | | | | | | | | | | | | | |
| 7.1 | | | | | | | | | | | | | | | | | | | | | | | |
| | | | | | | | | | | | | | | | | | | | | | | | |
| | | | 10 | SS | 59 | | | | | | | | | | | | | | | | | | |
| | | | | | | | | | | | | | | | | | | | | | | | |
| 294.3 | SAND, trace to some silt Very dense Grey Wet | | 11 | SS | 81 | | | | | | | | | | | | | | | | | | |
| 10.1 | | | | | | | | | | | | | | | | | | | | | | | |
| | | | | | | | | | | | | | | | | | | | | | | | |
| | | | | | | | | | | | | | | | | | | | | | | | |
| 291.8 | END OF BOREHOLE | | 12 | SS | 95/0.28 | | | | | | | | | | | | | | | | | | |
| 12.6 | | | | | | | | | | | | | | | | | | | | | | | |
| | NOTE: 1. Borehole dry on completion of drilling. | | | | | | | | | | | | | | | | | | | | | | |

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

PROJECT 09-1111-0018 **RECORD OF BOREHOLE No C5-6-4** SHEET 1 OF 1 **METRIC**
G.W.P. 2835-02-00 **LOCATION** N 4873621.9 ; E 297865.3 **ORIGINATED BY** RA
DIST Central **HWY** 400 **BOREHOLE TYPE** 200 mm O.D. Continuous Flight Hollow Stem Augers **COMPILED BY** HS/NK
DATUM Geodetic **DATE** November 27, 2013 **CHECKED BY** LCC

| 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 (%) | | | | | | |
| | | | | | | 20 | 40 | 60 | 80 | 100 | 20 | 40 | 60 | 80 | 100 | 10 | 20 | 30 | GR | SA | SI | CL | |
| 304.5 | GROUND SURFACE | | | | | | | | | | | | | | | | | | | | | | |
| 0.0 | ASPHALT (200 mm) | | | | | | | | | | | | | | | | | | | | | | |
| 0.2 | Sand and gravel (FILL) | | 1 | AS | - | | | | | | | | | | | | | | | | | | |
| 303.8 | Compact Brown Moist | | | | | | | | | | | | | | | | | | | | | | |
| 0.7 | Sandy silt, some clay, trace gravel, trace organics (FILL) | | 2 | SS | 15 | | | | | | | | | | | | | | | | | | |
| | Compact Brown with black staining Moist to wet | | | | | | | | | | | | | | | | | | | | | | |
| 302.4 | | | 3 | SS | 24 | | | | | | | | | | | | | | | | | | |
| 2.1 | CLAYEY SILT, some sand, trace gravel | | | | | | | | | | | | | | | | | | | | | | |
| | Stiff Dark brown to brown Wet | | 4 | SS | 10 | | | | | | | | | | | | | | | | | | |
| | | | | | | | | | | | | | | | | | | | | | | | |
| 300.8 | | | 5 | SS | 13 | | | | | | | | | | | | | | | | | | 3 17 48 32 |
| 3.7 | SAND, some silt, trace clay | | | | | | | | | | | | | | | | | | | | | | |
| | Compact to very dense Brown with oxidation stains Moist to wet | | 6 | SS | 23 | | | | | | | | | | | | | | | | | | 0 88 11 1 |
| | | | | | | | | | | | | | | | | | | | | | | | |
| 298.9 | | | 7 | SS | 54 | | | | | | | | | | | | | | | | | | |
| 5.6 | CLAYEY SILT with SAND to SILT and SAND, trace clay, trace gravel (TILL) | | | | | | | | | | | | | | | | | | | | | | |
| | Very stiff to hard/Compact to very dense Brown to brown and grey below 7.1 m Moist to wet below 7.1 m | | 8 | SS | 56 | | | | | | | | | | | | | | | | | | 1 43 45 11 |
| | | | | | | | | | | | | | | | | | | | | | | | |
| | | | | | | | | | | | | | | | | | | | | | | | |
| 295.9 | | | 9 | SS | 25 | | | | | | | | | | | | | | | | | | 7 58 27 8 |
| 8.6 | SAND, some silt | | | | | | | | | | | | | | | | | | | | | | |
| | Dense to very dense Brown and grey Wet | | 10 | SS | 73 | | | | | | | | | | | | | | | | | | |
| | | | | | | | | | | | | | | | | | | | | | | | |
| 293.4 | | | | | | | | | | | | | | | | | | | | | | | |
| | | | 11 | SS | 40 | | | | | | | | | | | | | | | | | | |
| 11.1 | END OF BOREHOLE | | | | | | | | | | | | | | | | | | | | | | |
| | NOTE: 1. Water level in open borehole at a depth of 4.3 m below ground surface (Elev. 300.2 m) upon completion of drilling. | | | | | | | | | | | | | | | | | | | | | | |

GTA-MTO 001 T:\PROJECTS\2009\09-1111-0018 (URS, YORK REGION)\LOG\0911110018.GPJ GAL-GTA.GDT 8/17/15 SIB

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

| | | | |
|------------------------------------|---|--------------------------|---------------|
| PROJECT <u>09-1111-0018</u> | RECORD OF BOREHOLE No C5-6-5 | SHEET 1 OF 1 | METRIC |
| G.W.P. <u>2835-02-00</u> | LOCATION <u>N 4873618.7 ; E 297846.5</u> | ORIGINATED BY <u>RA</u> | |
| DIST <u>Central</u> HWY <u>400</u> | BOREHOLE TYPE <u>200 mm O.D. Continuous Flight Hollow Stem Augers</u> | COMPILED BY <u>HS/NK</u> | |
| DATUM <u>Geodetic</u> | DATE <u>November 27, 2013</u> | CHECKED BY <u>LCC</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 | | | | | | | | | WATER CONTENT (%) | | | |
| | | | | | | 20 | 40 | 60 | 80 | 100 | | 10 | 20 | 30 | | GR | SA | SI | CL | |
| 303.0 | GROUND SURFACE | | | | | | | | | | | | | | | | | | | |
| 0.0 | TOPSOIL | | 1A | | | | | | | | | | | | | | | | | |
| 0.2 | Clayey silt, trace to some sand, trace gravel, containing rootlets (FILL) Firm to stiff Brown to dark brown Moist | | 1B | SS | 5 | | | | | | | | | | | | | | | |
| 301.7 | | | 2 | SS | 9 | | | | | | | | | | | | | | | |
| 1.3 | Sandy CLAYEY SILT, trace gravel Stiff Brown Moist | | 3 | SS | 11 | | | | | | | | | | | | | | | |
| 300.8 | | | | | | | | | | | | | | | | | | | | |
| 2.2 | CLAYEY SILT with SAND, trace gravel (TILL) Hard Brown Moist to wet | | 4 | SS | 35 | | | | | | | | | | | | | | | |
| 300.0 | | | 5 | SS | 74 | | | | | | | | | | | | | | | |
| 299.9 | | | 6 | SS | 74 | | | | | | | | | | | | | | | |
| 297.4 | Silty SAND, trace clay, silt seams Very dense Brown Wet | | 7 | SS | 56 | | | | | | | | | | | | | | | |
| 295.9 | | | | | | | | | | | | | | | | | | | | |
| 7.1 | SAND, trace to some silt, trace clay Compact to very dense Brown to grey Wet | | 8 | SS | 16 | | | | | | | | | | | | | | | |
| 295.0 | | | | | | | | | | | | | | | | | | | | |
| 294.0 | | | 9 | SS | 62 | | | | | | | | | | | | | | | |
| 293.0 | | | | | | | | | | | | | | | | | | | | |
| 291.9 | END OF BOREHOLE | | 10 | SS | 65 | | | | | | | | | | | | | | | |
| 11.1 | | | | | | | | | | | | | | | | | | | | |

GTA-MTO 001 T:\PROJECTS\2009\09-1111-0018 (URS, YORK REGION)\LOG\0911110018.GPJ GAL-GTA.GDT 8/17/15 SIB

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

RECORD OF BOREHOLE No C5-7-2 SHEET 1 OF 2 **METRIC**

PROJECT 09-1111-0018 G.W.P. 2835-02-00 LOCATION N 4873586.6 ; E 297829.2 ORIGINATED BY RA

DIST Central HWY 400 BOREHOLE TYPE 200 mm O.D. Continuous Flight Hollow Stem Augers COMPILED BY HS/NK

DATUM Geodetic DATE November 28, 2013 to December 1, 2013 CHECKED BY LCC

| 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 | NUMBER | TYPE | "N" VALUES | | | 20 | 40 | | | | | | 60 | 80 | 100 | 20 | 40 | 60 | 80 | 100 |
| 304.0 | GROUND SURFACE | | | | | | | | | | | | | | | | | | | | |
| 0.0 | TOPSOIL | 1A | | | | | | | | | | | | | | | | | | | |
| 0.2 | CLAYEY SILT, some sand, trace gravel, sandy silt pockets and rootlets Firm to stiff Brown to dark brown Moist | 1B | SS | 6 | | | | | | | | | | | | | | | | | |
| 302.8 | | 2 | SS | 8 | | | | | | | | | | | | | | | | | |
| 1.2 | SAND and SILT, trace clay, trace to some gravel (TILL) Loose to very dense Brown Moist Augers grinding below a depth of 5.0 m | 3 | SS | 7 | | | | | | | | | | | | | | | | | |
| | | 4 | SS | 9 | | | | | | | | | 3 42 46 9 | | | | | | | | |
| | | 5 | SS | 46 | | | | | | | | | | | | | | | | | |
| | | 6 | SS | 57 | | | | | | | | | | | | | | | | | |
| | | 7 | SS | 69 | | | | | | | | | 3 49 40 8 | | | | | | | | |
| | | 8 | SS | 89 | | | | | | | | | | | | | | | | | |
| | | 9 | SS | 71 | | | | | | | | | | | | | | | | | |
| 295.4 | SAND, trace to some silt, trace clay Very dense Brown Wet Containing sandy silt seams below a depth of 10.7 m | 10 | SS | 93/0.28 | | | | | | | | | 0 93 6 1 | | | | | | | | |
| | | 11 | SS | 98 | | | | | | | | | | | | | | | | | |
| | | 12 | SS | 50/0.13 | | | | | | | | | | | | | | | | | |
| 291.5 | | | | | | | | | | | | | | | | | | | | | |
| 12.5 | | | | | | | | | | | | | | | | | | | | | |

GTA-MTO 001 T:\PROJECTS\2009\09-1111-0018 (URS, YORK REGION)\LOG\0911110018.GPJ GAL-GTA.GDT 8/17/15 SIB

Continued Next Page

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

| | | | |
|------------------------------------|---|--------------------------|---------------|
| PROJECT <u>09-1111-0018</u> | RECORD OF BOREHOLE No C5-7-2 | SHEET 2 OF 2 | METRIC |
| G.W.P. <u>2835-02-00</u> | LOCATION <u>N 4873586.6 ; E 297829.2</u> | ORIGINATED BY <u>RA</u> | |
| DIST <u>Central</u> HWY <u>400</u> | BOREHOLE TYPE <u>200 mm O.D. Continuous Flight Hollow Stem Augers</u> | COMPILED BY <u>HS/NK</u> | |
| DATUM <u>Geodetic</u> | DATE <u>November 28, 2013 to December 1, 2013</u> | CHECKED BY <u>LCC</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 | | | 20 | 40 | 60 | 80 | 100 | W _p | W | W _L | | | | | | |
| | END OF BOREHOLE | | | | | | | | | | | | | | | | | | | |
| | NOTES: 1. Borehole caved in to a depth of 9.1 m (Elev. 294.9 m) upon removal of augers. 2. Borehole dry on completion of drilling. 3. Water level measurements in piezometer: <table style="margin-left: 20px; border-collapse: collapse;"> <tr> <td style="padding-right: 10px;">Date</td> <td style="padding-right: 10px;">Depth (m)</td> <td>Elev. (m)</td> </tr> <tr> <td>01/07/14</td> <td>4.6</td> <td>299.4</td> </tr> </table> | Date | Depth (m) | Elev. (m) | 01/07/14 | 4.6 | 299.4 | | | | | | | | | | | | | |
| Date | Depth (m) | Elev. (m) | | | | | | | | | | | | | | | | | | |
| 01/07/14 | 4.6 | 299.4 | | | | | | | | | | | | | | | | | | |

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+³, X³: Numbers refer to Sensitivity ○ 3% STRAIN AT FAILURE



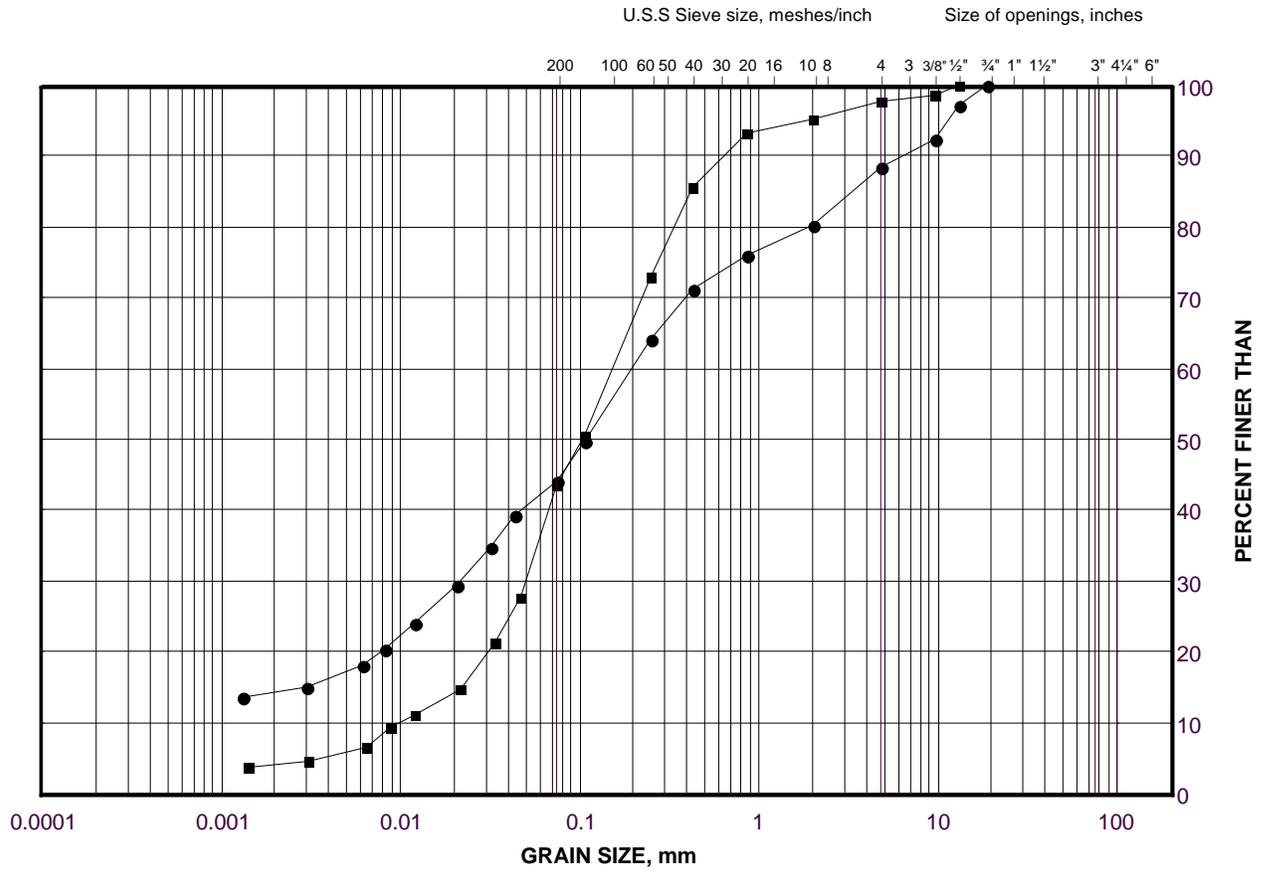
APPENDIX B

Laboratory Test Results

GRAIN SIZE DISTRIBUTION

Sand and Silt (Fill)

FIGURE B1



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

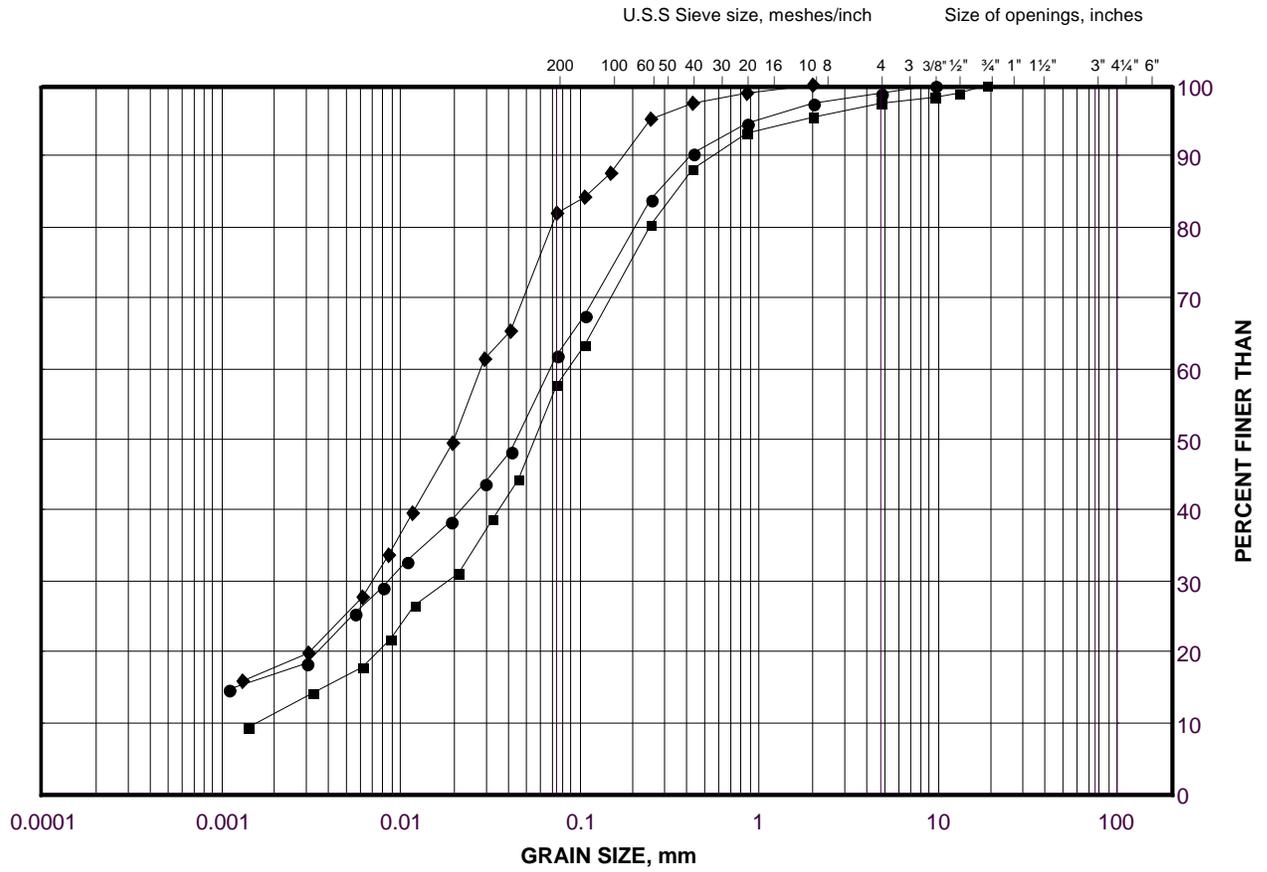
LEGEND

| SYMBOL | BOREHOLE | SAMPLE | ELEVATION(m) |
|--------|----------|--------|--------------|
| ● | C38-2 | 3 | 307.8 |
| ■ | C39-2 | 3 | 305.9 |

GRAIN SIZE DISTRIBUTION

Clayey Silt to Clayey Silt with Sand (Fill)

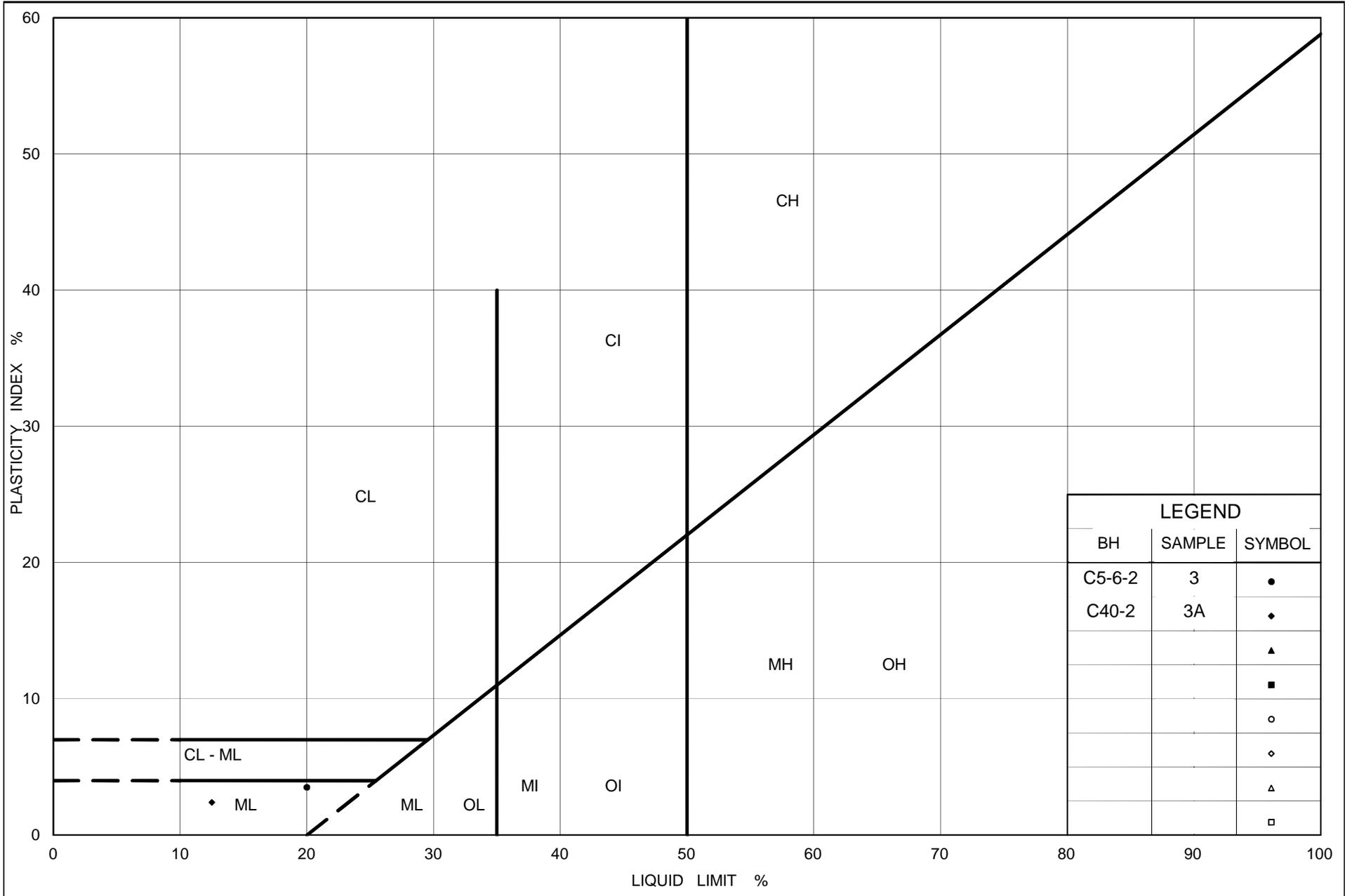
FIGURE B2



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

LEGEND

| SYMBOL | BOREHOLE | SAMPLE | ELEVATION(m) |
|--------|----------|--------|--------------|
| ● | C39-3 | 2 | 306.1 |
| ■ | C5-6-3 | 3 | 302.6 |
| ◆ | C38-3 | 3 | 307.2 |



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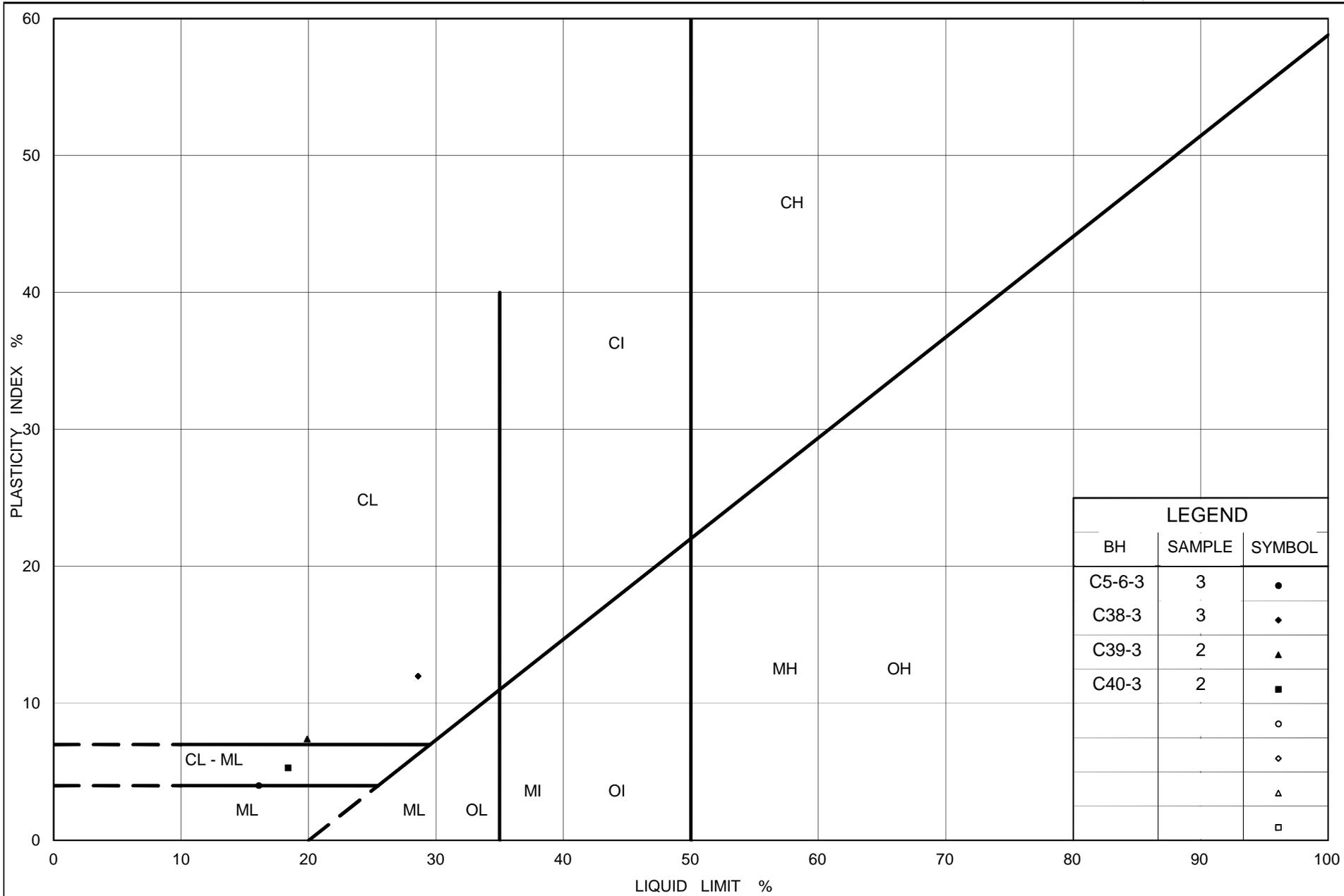
Ontario

PLASTICITY CHART Sand and Silt (Fill)

Figure No. B3

Project No. 09-1111-0018

Checked By: NK



Ministry of Transportation

Ontario

PLASTICITY CHART

Clayey Silt to Clayey Silt with Sand (Fill)

Figure No. B4

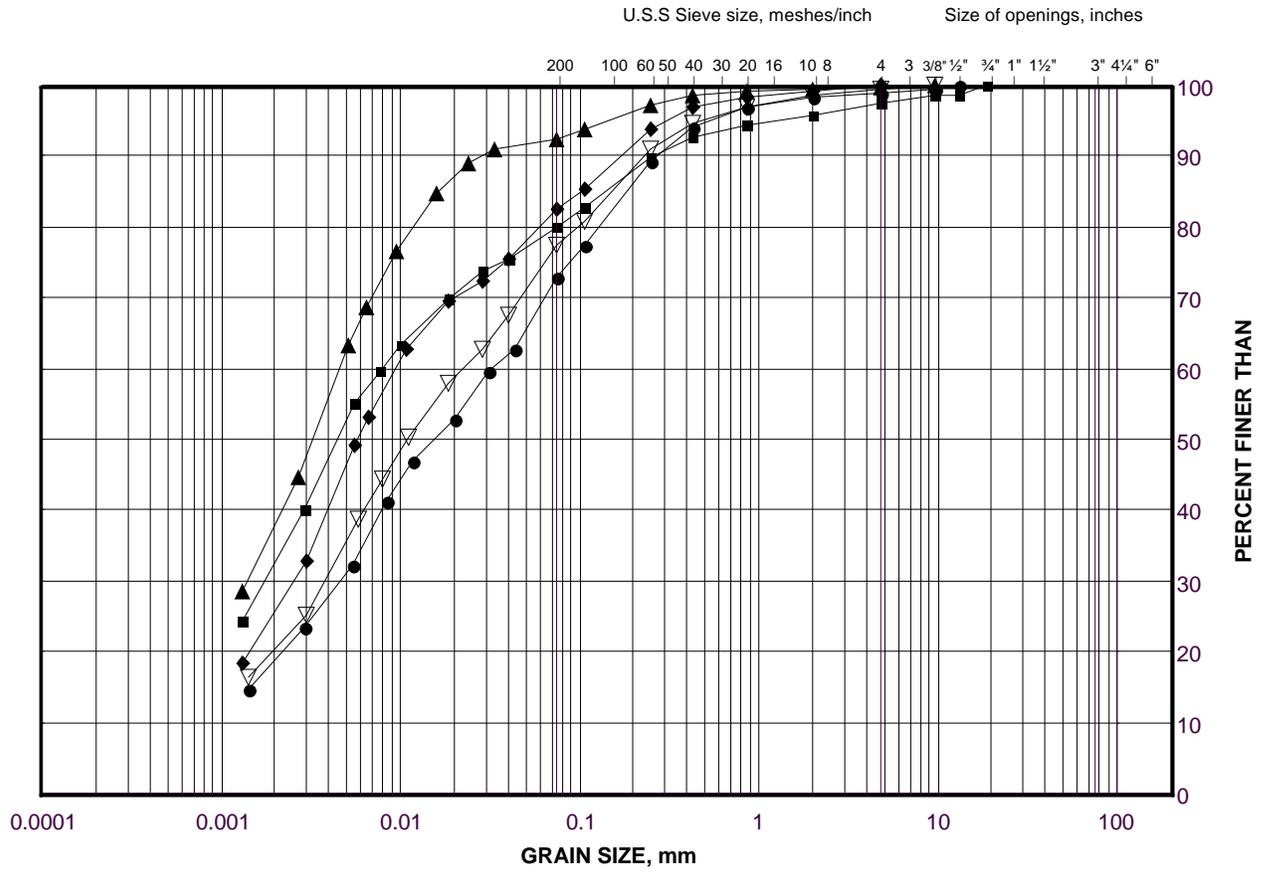
Project No. 09-1111-0018

Checked By: NK

GRAIN SIZE DISTRIBUTION

Clayey Silt to Sandy Clayey Silt

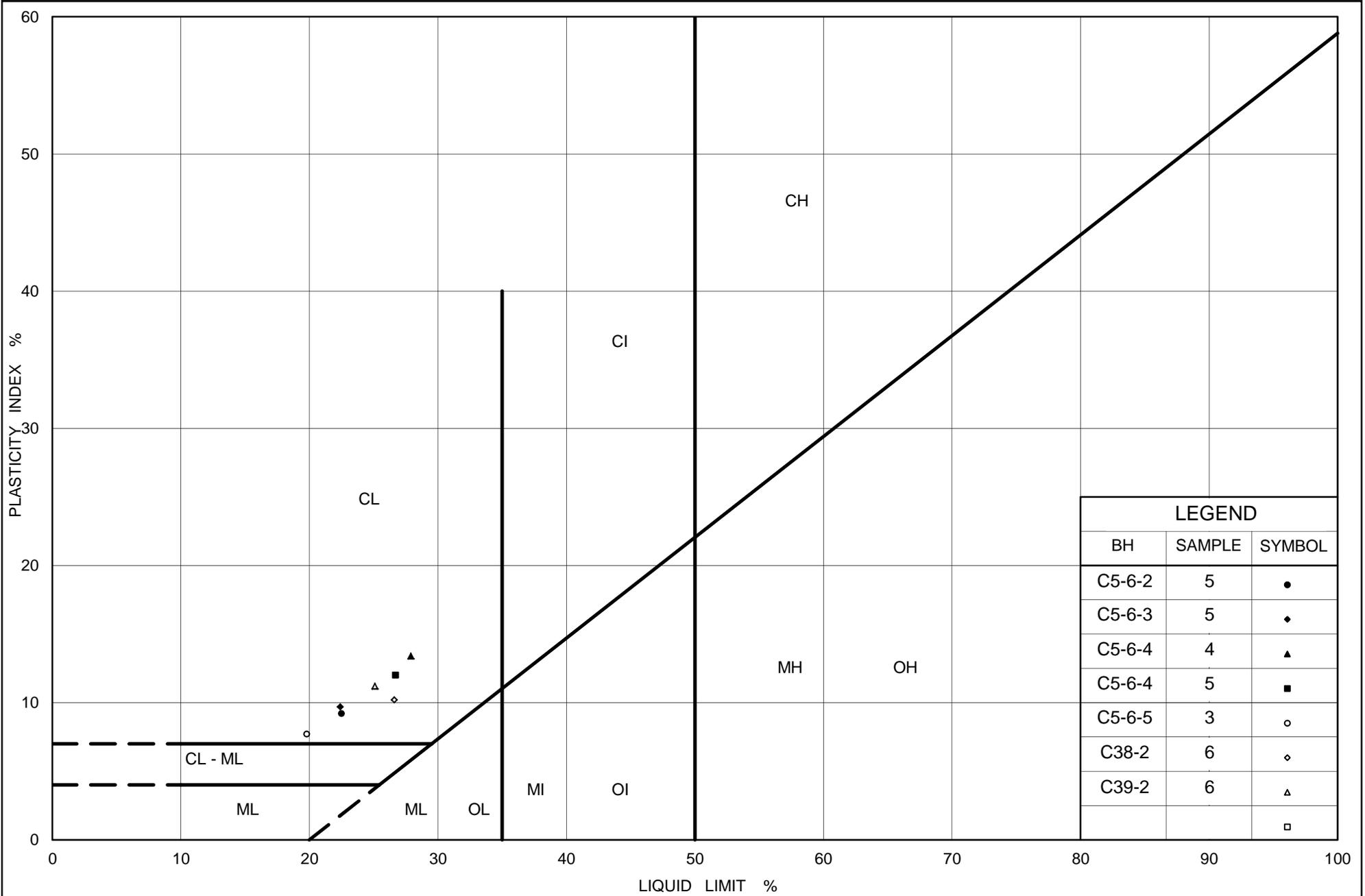
FIGURE B5



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

LEGEND

| SYMBOL | BOREHOLE | SAMPLE | ELEVATION(m) |
|--------|----------|--------|--------------|
| ● | C5-6-5 | 3 | 301.2 |
| ■ | C5-6-4 | 5 | 301.2 |
| ◆ | C5-6-2 | 5 | 301.1 |
| ▲ | C38-2 | 6 | 305.6 |
| ▽ | C39-2 | 6 | 303.6 |



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Ontario

PLASTICITY CHART

Clayey Silt to Sandy Clayey Silt

Figure No. B6

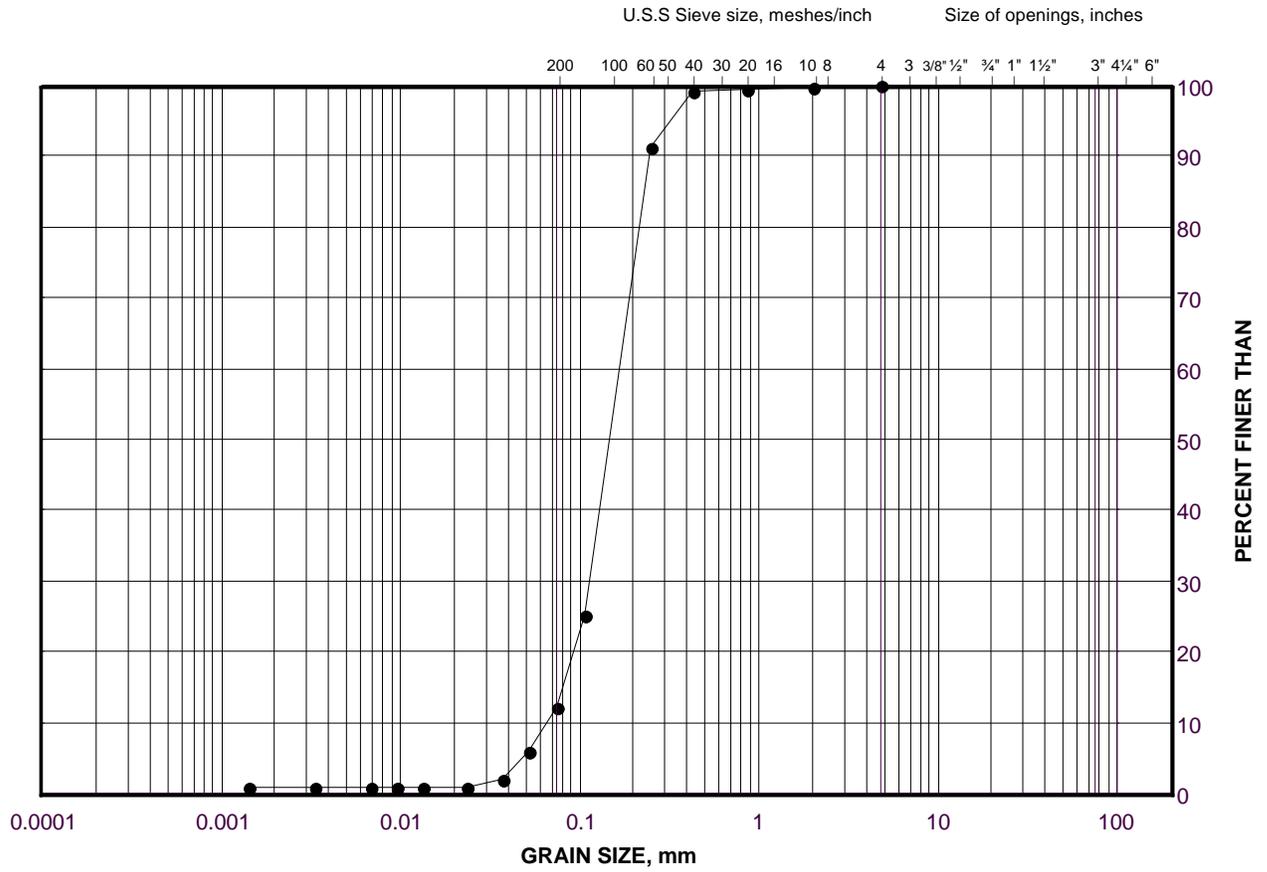
Project No. 09-1111-0018

Checked By: NK

GRAIN SIZE DISTRIBUTION

Sand

FIGURE B7



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

LEGEND

| SYMBOL | BOREHOLE | SAMPLE | ELEVATION(m) |
|--------|----------|--------|--------------|
| • | C5-6-4 | 7 | 299.7 |

Project Number: 09-1111-0018

Checked By: NK

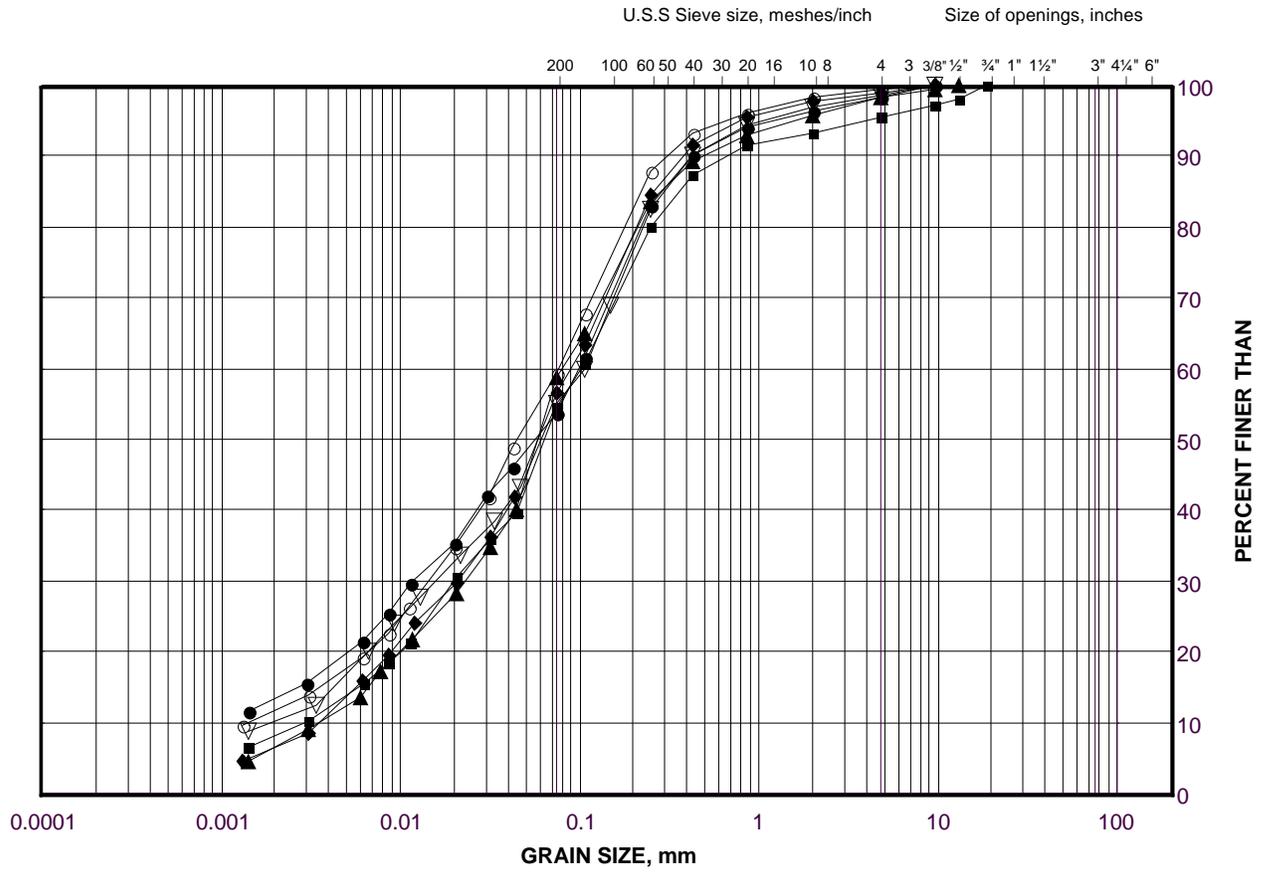
Golder Associates

Date: 15-Jul-15

GRAIN SIZE DISTRIBUTION

Sand and Silt (Till)

FIGURE B8A



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

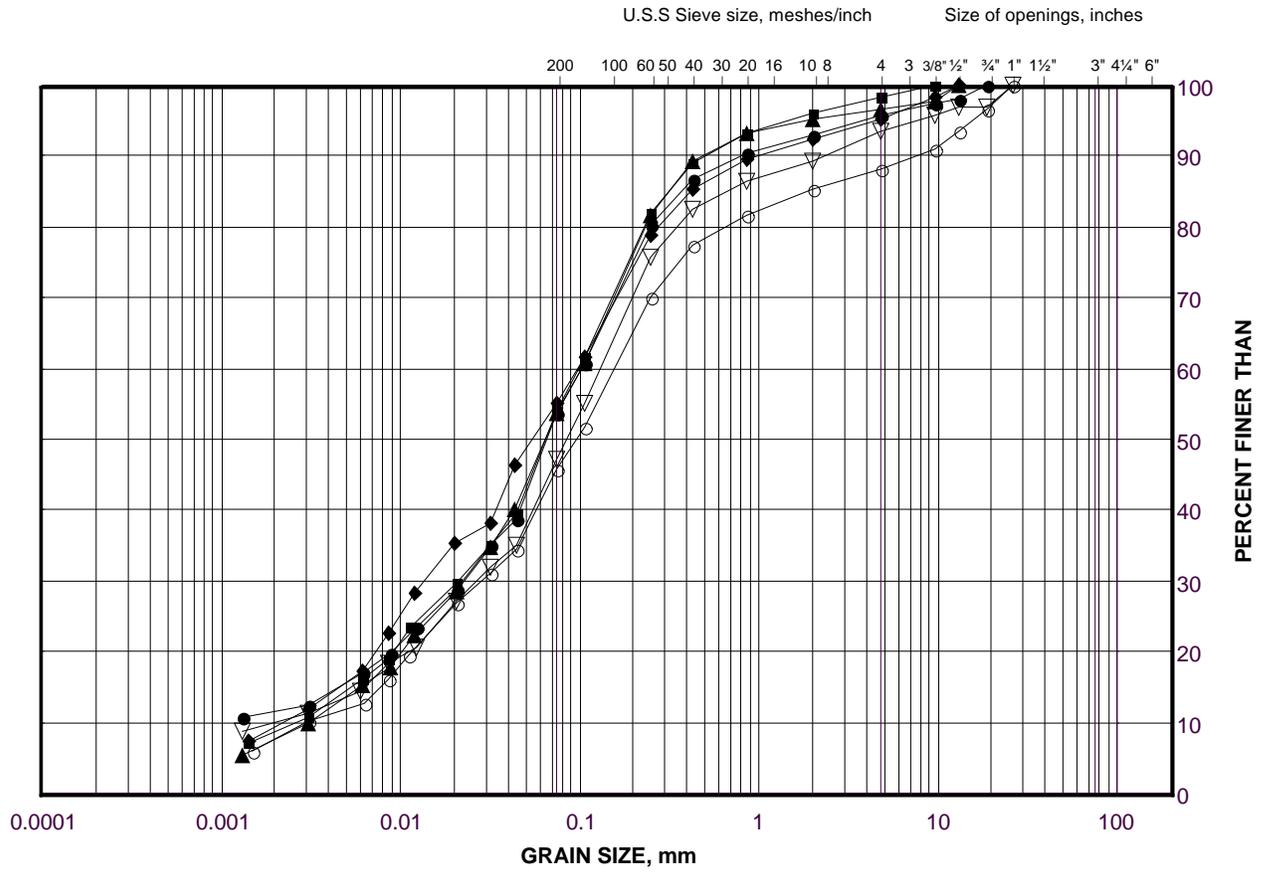
LEGEND

| SYMBOL | BOREHOLE | SAMPLE | ELEVATION(m) |
|--------|----------|--------|--------------|
| ● | C38-1 | 3 | 305.4 |
| ■ | C38-4 | 3 | 305.4 |
| ◆ | C39-1 | 3 | 303.3 |
| ▲ | C38-4 | 5 | 303.8 |
| ▽ | C38-3 | 6 | 304.9 |
| ○ | C38-1 | 7 | 302.3 |

GRAIN SIZE DISTRIBUTION

Clayey Silt to Sand and Silt (Till)

FIGURE B8B



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

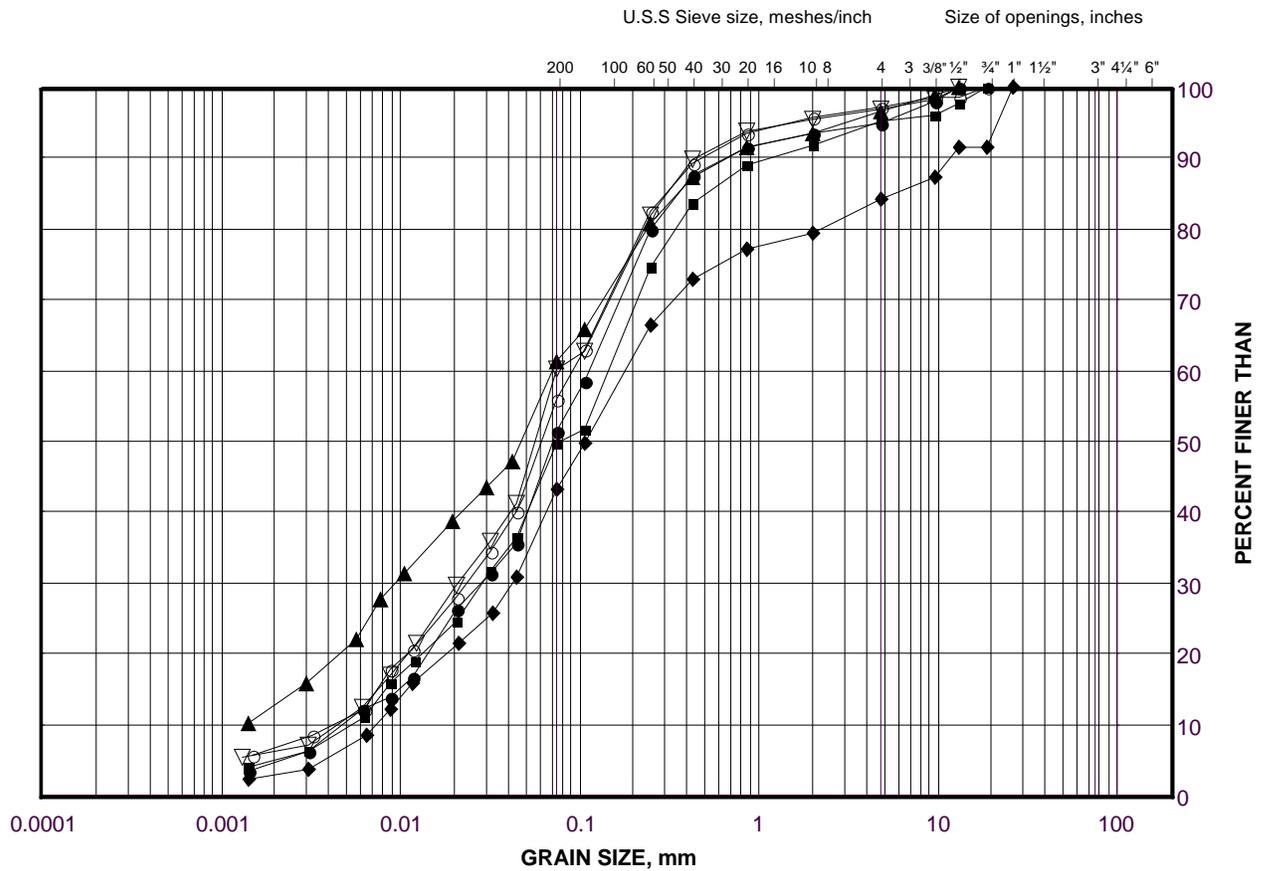
LEGEND

| SYMBOL | BOREHOLE | SAMPLE | ELEVATION(m) |
|--------|----------|--------|--------------|
| ● | C39-2 | 11 | 296.9 |
| ■ | C39-4 | 4 | 302.5 |
| ◆ | C40-1 | 5 | 288.4 |
| ▲ | C39-1 | 5 | 301.7 |
| ▽ | C39-4 | 6 | 301.0 |
| ○ | C39-2 | 9 | 299.9 |

GRAIN SIZE DISTRIBUTION

Sand and Silt (Till)

FIGURE B8C



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

LEGEND

| SYMBOL | BOREHOLE | SAMPLE | ELEVATION(m) |
|--------|----------|--------|--------------|
| ● | C40-3 | 4 | 288.3 |
| ■ | C40-2 | 4 | 289.6 |
| ◆ | C40-2 | 5 | 288.9 |
| ▲ | C40-3 | 6 | 286.8 |
| ▽ | C40-3 | 8 | 283.9 |
| ○ | C40-2 | 8 | 286.0 |

Project Number: 09-1111-0018

Checked By: NK

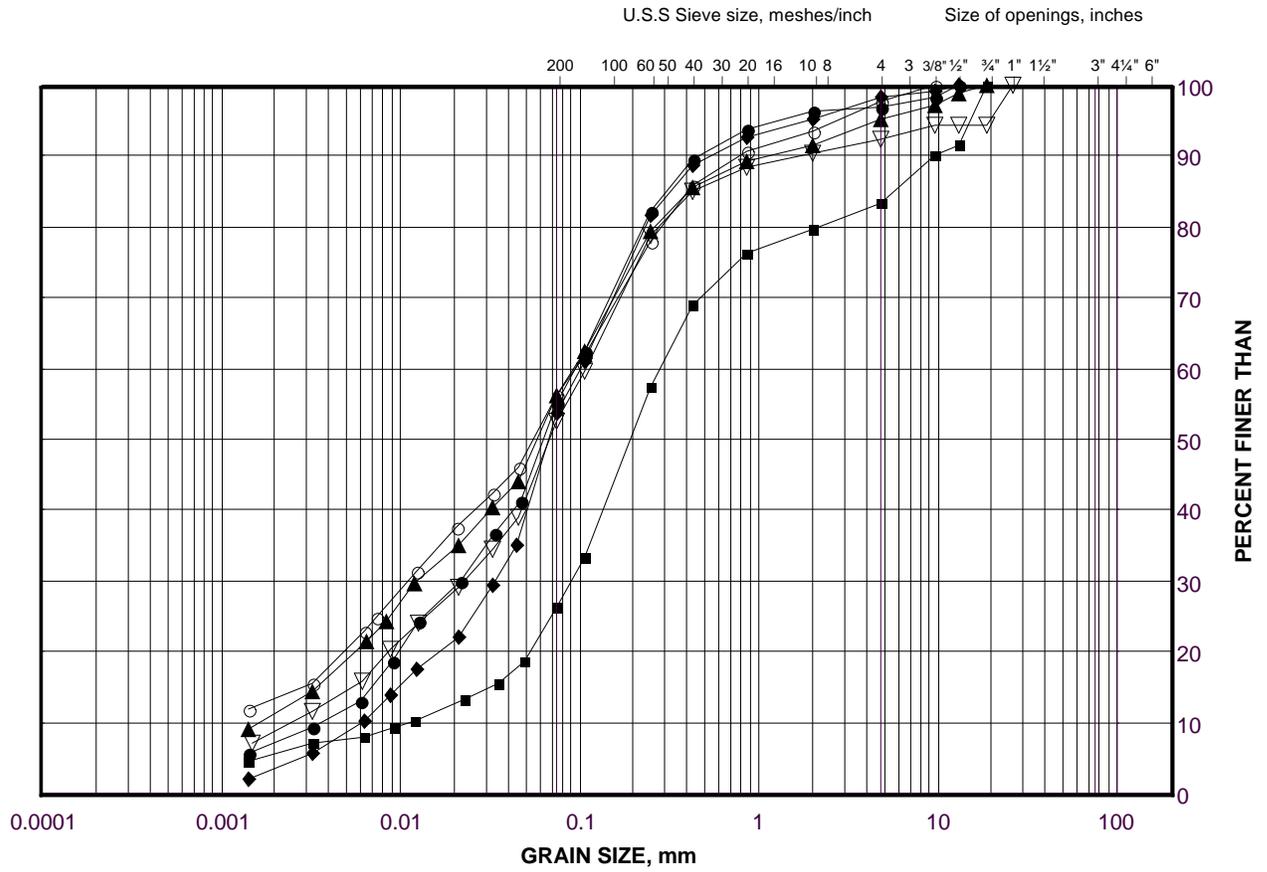
Golder Associates

Date: 15-Jul-15

GRAIN SIZE DISTRIBUTION

Clayey Silt to Silty Sand (Till)

FIGURE B8D



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

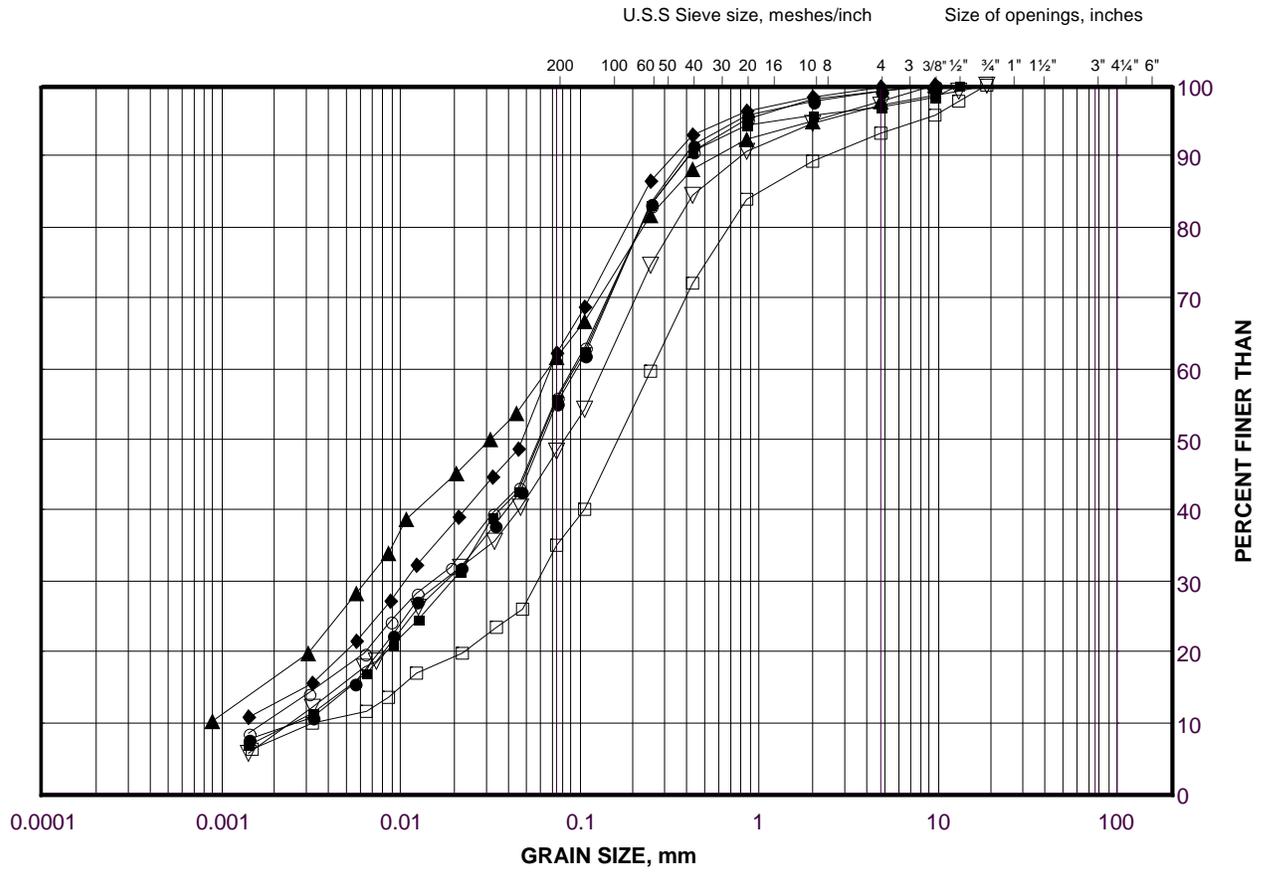
LEGEND

| SYMBOL | BOREHOLE | SAMPLE | ELEVATION(m) |
|--------|----------|--------|--------------|
| ● | C5-6-1 | 4 | 301.4 |
| ■ | C5-6-1 | 6 | 299.2 |
| ◆ | C40-4 | 6 | 286.6 |
| ▲ | C5-6-2 | 7 | 299.6 |
| ▽ | C5-6-3 | 7 | 299.6 |
| ○ | C5-6-3 | 8 | 298.1 |

GRAIN SIZE DISTRIBUTION

Clayey Silt to Sand and Silt (Till)

FIGURE B8E



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

LEGEND

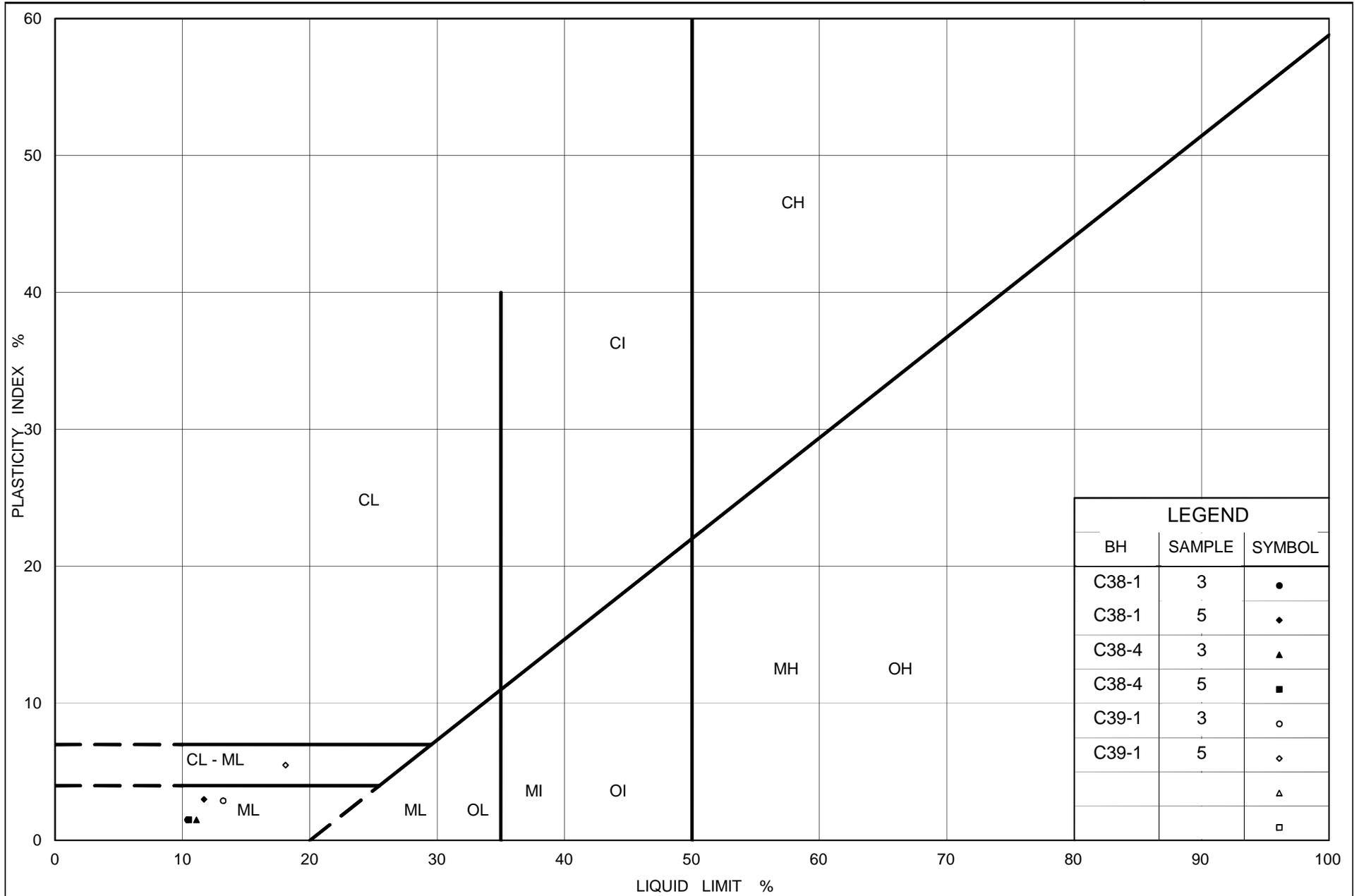
| SYMBOL | BOREHOLE | SAMPLE | ELEVATION(m) |
|--------|----------|--------|--------------|
| ● | C5-7-1 | 3 | 301.3 |
| ■ | C5-7-2 | 4 | 301.4 |
| ◆ | C5-6-5 | 5 | 299.8 |
| ▲ | C5-7-1 | 6 | 299.1 |
| ▽ | C5-7-2 | 7 | 299.2 |
| ○ | C5-6-4 | 8 | 298.2 |
| □ | C5-6-4 | 9 | 296.7 |

Project Number: 09-1111-0018

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Date: 15-Jul-15



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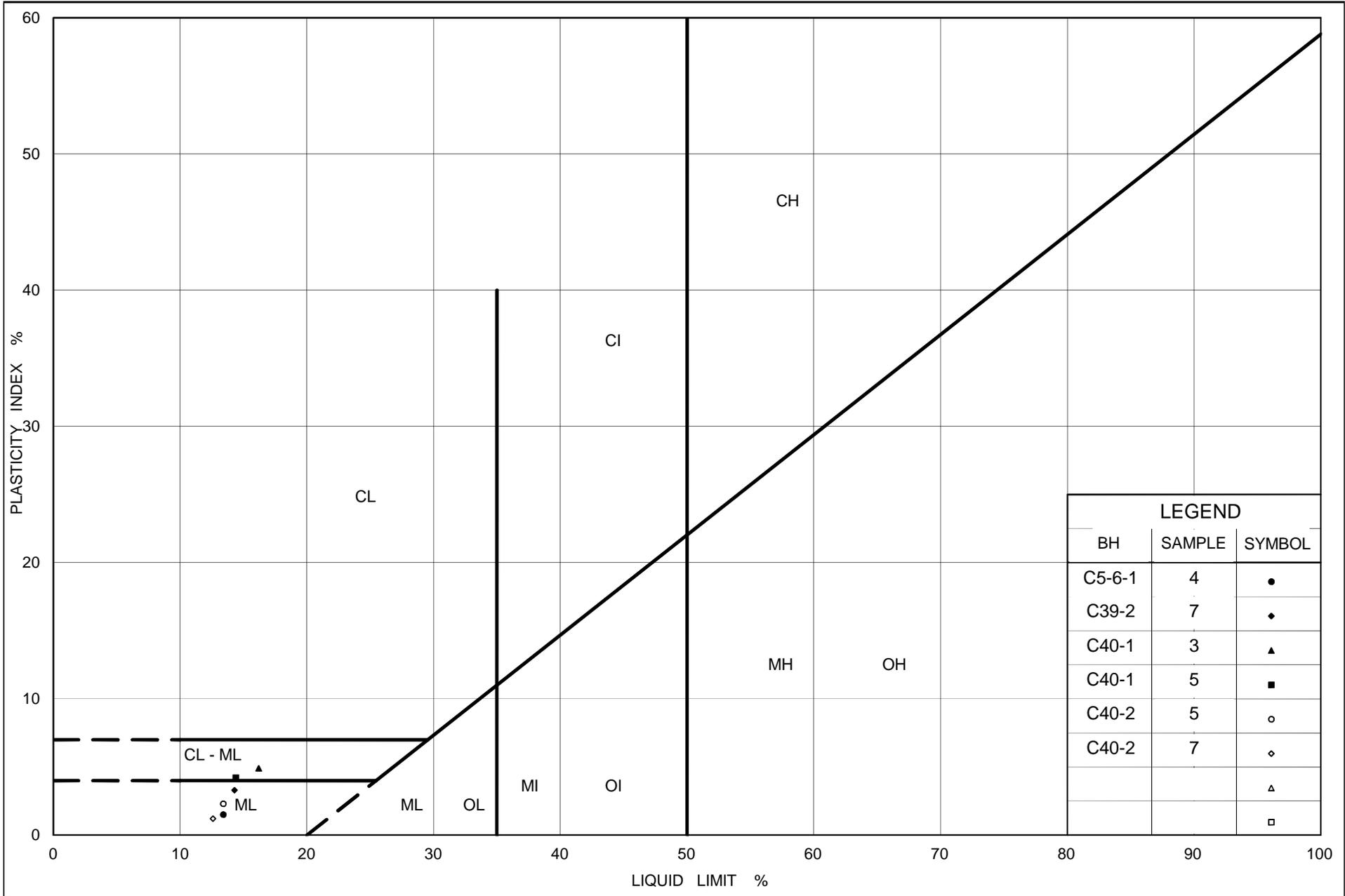
PLASTICITY CHART

Clayey Silt to Sand and Silt (Till)

Figure No. B9A

Project No. 09-1111-0018

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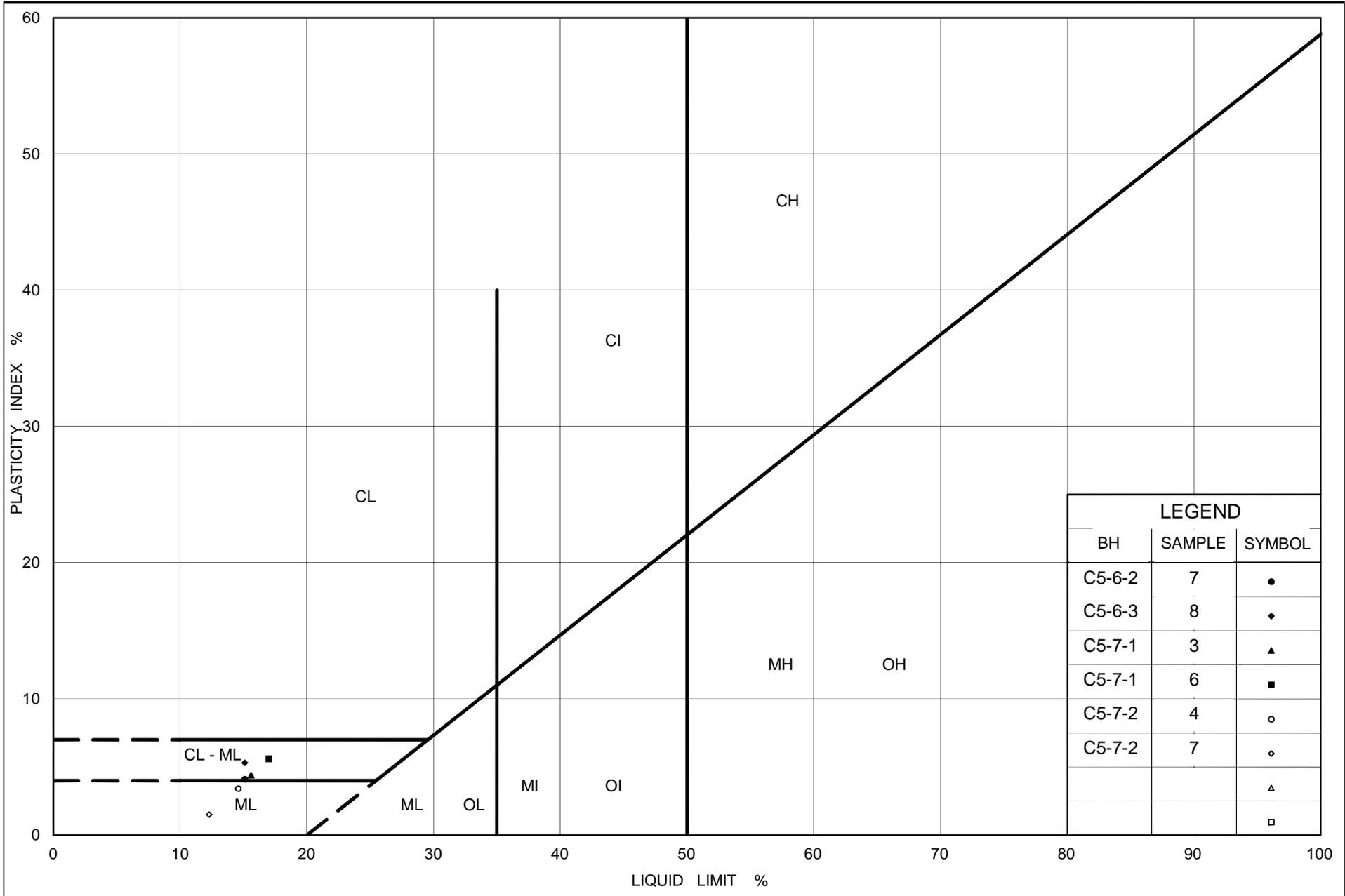
PLASTICITY CHART

Clayey Silt with Sand to Sand and Silt (Till)

Figure No. B9B

Project No. 09-1111-0018

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PLASTICITY CHART

Clayey Silt to Sand and Silt (Till)

Figure No. B9C

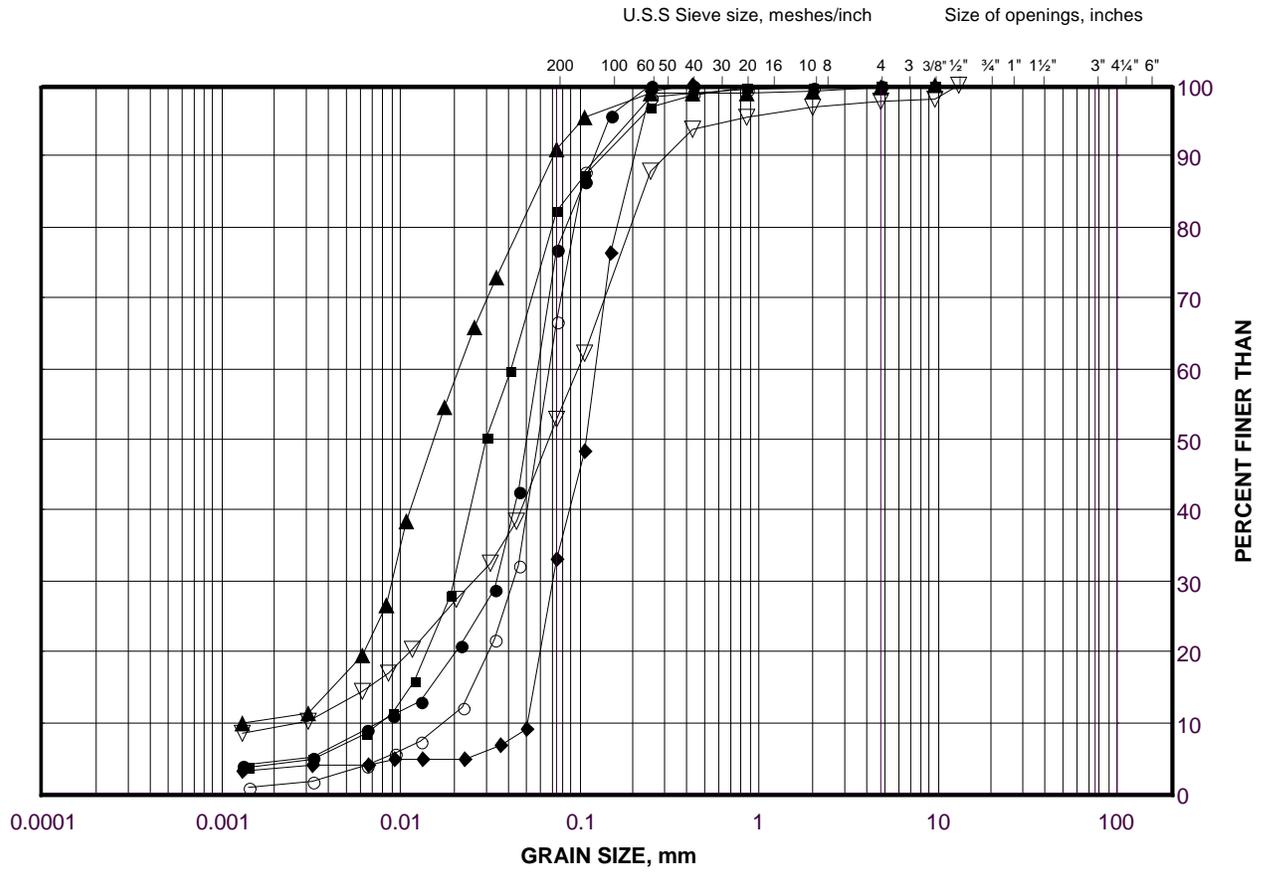
Project No. 09-1111-0018

Checked By: NK

GRAIN SIZE DISTRIBUTION

Sand to Silt

FIGURE B10A



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

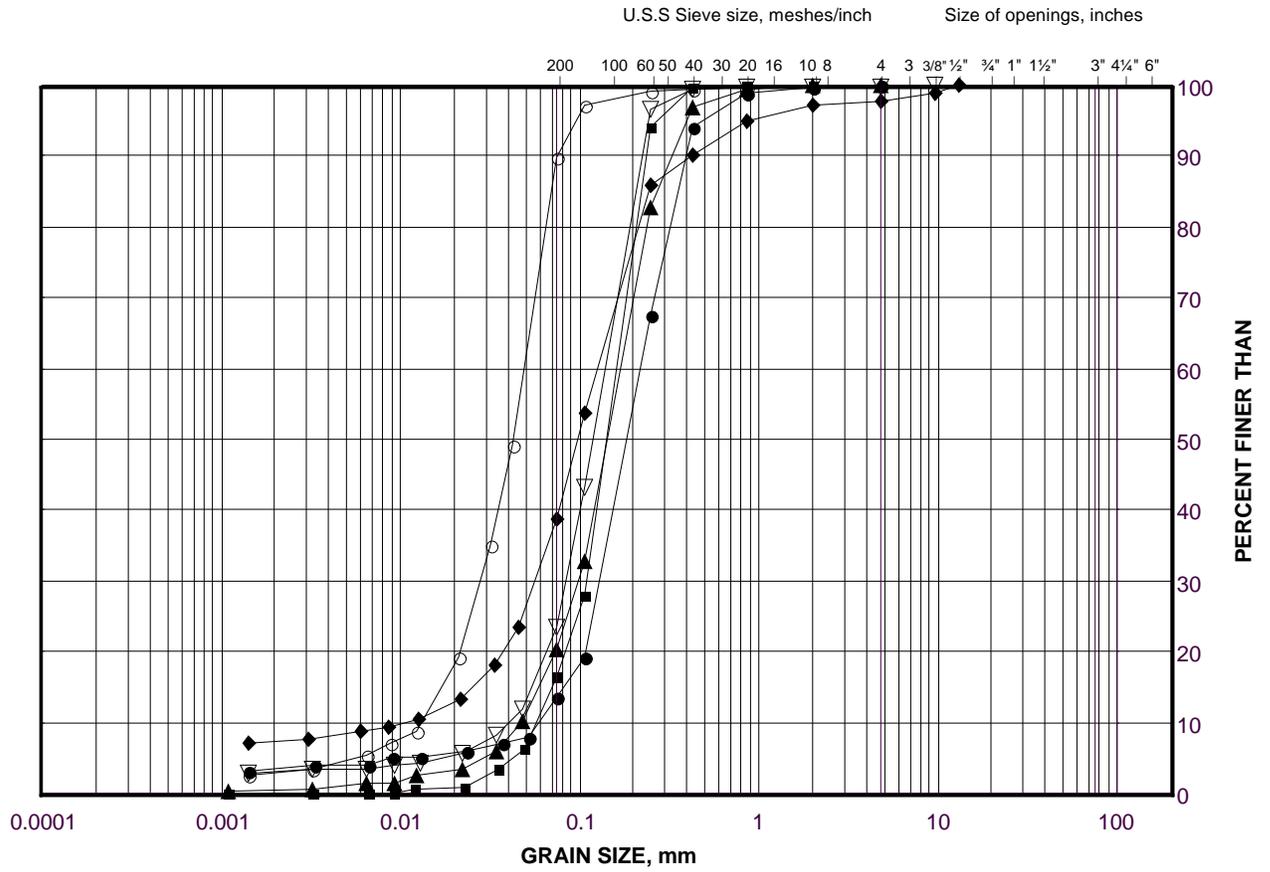
LEGEND

| SYMBOL | BOREHOLE | SAMPLE | ELEVATION(m) |
|--------|----------|--------|--------------|
| ● | C38-3 | 13 | 294.3 |
| ■ | C38-2 | 13 | 295.6 |
| ◆ | C38-3 | 8 | 301.9 |
| ▲ | C38-1 | 8 | 300.8 |
| ▽ | C38-2 | 9 | 301.7 |
| ○ | C39-1 | 9 | 297.2 |

GRAIN SIZE DISTRIBUTION

Sand to Silt

FIGURE B10B



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

LEGEND

| SYMBOL | BOREHOLE | SAMPLE | ELEVATION(m) |
|--------|----------|--------|--------------|
| ● | C5-6-1 | 10 | 293.2 |
| ■ | C39-3 | 10 | 297.0 |
| ◆ | C39-4 | 10 | 295.7 |
| ▲ | C39-3 | 12 | 294.0 |
| ▽ | C39-2 | 14 | 292.2 |
| ○ | C39-4 | 8B | 298.6 |

Project Number: 09-1111-0018

Checked By: NK

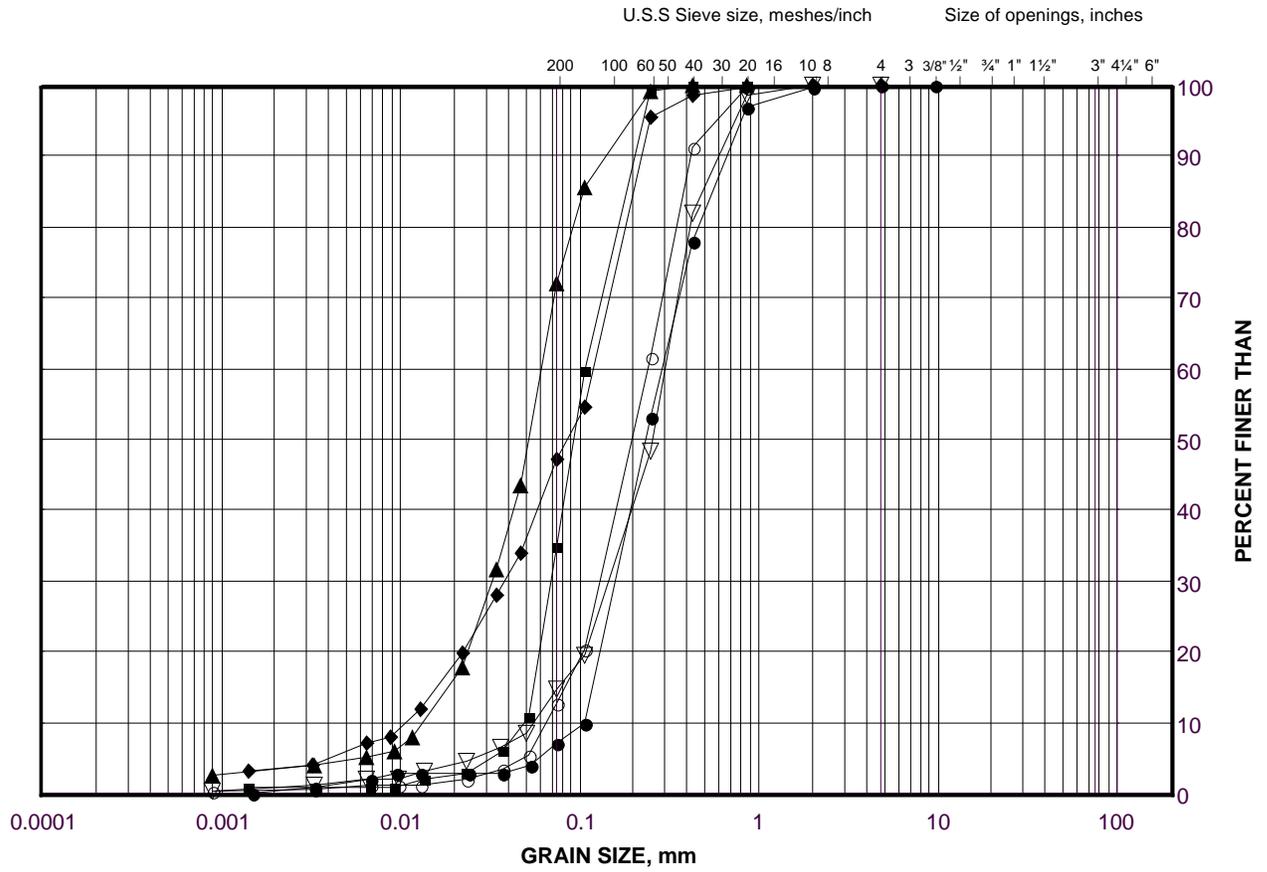
Golder Associates

Date: 15-Jul-15

GRAIN SIZE DISTRIBUTION

Sand to Silt

FIGURE B10C



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

LEGEND

| SYMBOL | BOREHOLE | SAMPLE | ELEVATION(m) |
|--------|----------|--------|--------------|
| ● | C5-7-2 | 10 | 294.7 |
| ■ | C5-6-3 | 10 | 295.0 |
| ◆ | C5-6-2 | 10 | 295.0 |
| ▲ | C5-6-5 | 7 | 296.7 |
| ▽ | C5-7-1 | 9 | 295.3 |
| ○ | C5-6-5 | 9 | 293.7 |

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