



**April 2012**

## **FOUNDATION INVESTIGATION REPORT**

**CULVERTS IN SWAMPS 302, 305, 306, 307 AND 310 - PHASE 3  
HIGHWAY 69 FOUR-LANING  
FROM 3.5 KM NORTH OF HIGHWAY 522  
NORTHERLY TO 4.5 KM NORTH OF HIGHWAY 64  
MINISTRY OF TRANSPORTATION, ONTARIO  
G.W.P. 5203-06-00**

**Submitted to:**

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**REPORT**

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# **PART A**

## **FOUNDATION INVESTIGATION REPORT**

### **CULVERTS IN SWAMPS 302, 305, 306, 307 AND 310 – PHASE 3**

#### **HIGHWAY 69 FOUR-LANING**

#### **FROM 3.5 KM NORTH OF HIGHWAY 522**

#### **NORTHERLY TO 4.5 KM NORTH OF HIGHWAY 64**

#### **MINISTRY OF TRANSPORTATION, ONTARIO**

#### **G.W.P. 5203-06-00**





## 1.0 INTRODUCTION

Golder Associates Ltd. (Golder) has been retained by McCormick Rankin, a member of MMM Group Limited (MRC) on behalf of Ministry of Transportation, Ontario (MTO) to provide detail foundation investigation services for nine (9) culverts to be constructed within five (5) swamp crossing areas, which have been originally selected for wick drain foundation treatment, along the proposed new Highway 69 alignment. The proposed work is being carried out in support of the detail foundation investigation by Peto MacCallum Limited (Peto) in the Phase 3 section of Highway 69 Four-Laning from 3.5 km north of Highway 522 northerly to 4.5 km north of Highway 64 under G.W.P. 5378-02-00. The general location of this section of the Highway 69 four-laning alignment is shown on Drawing 1.

The terms of reference and the scope of work for the foundation investigation are outlined in MTO's Request for Proposal, dated January 2006. Golder's proposal for foundation engineering services associated with the wick drain areas is contained in Section 6.8 of MRC's Technical Proposal for this assignment and in Golder's letter titled "Proposal for Additional Foundation Engineering Services, Foundation Investigation and Design (Rev.1) for Culverts in Wick Drain Areas", dated February 2009. The work has been carried out in accordance with Golder's Supplemental Specialty Quality Control Plan for foundation engineering services for this project, dated June 2, 2006. The General Arrangement (GA) drawings showing the alignments of the proposed culverts were provided to Golder by MRC on October 2, 2009.

## 1.1 Background

Golder carried out a preliminary assessment based on available information provided by Peto, which was forwarded to us by MRC on March 25, April 3, 12 and 28, 2008, for seven (7) swamp crossings identified by Peto as potential candidate sites for wick drain foundation treatment. Based on our preliminary review of the subsurface information provided, we considered that the swamp crossings would be potentially suitable for such foundation treatment, as discussed in our Technical Memorandum dated July 4, 2008. At a meeting on December 9, 2008 between MTO, MRC, Peto and Golder, following further review of the July 4, 2008 Memorandum, additional subsurface information and re-evaluation of alternative foundation treatment methods, it was concurred that Golder would proceed with the investigation and gathering of pertinent subsurface information for the design of wick drain foundation treatments at five (5) of the seven (7) swamp crossings originally identified, namely:

Swamp Crossing	Designation
Highway 69 SBL and NBL STA 17+700 to 18+150	Swamp 302
Highway 69 SBL STA 16+050 to 16+350	Swamp 305
Highway 69 SBL STA 15+350 to 15+800	Swamp 306
Highway 69 SBL STA 14+415 to 14+500	Swamp 307
Highway 69 SBL STA 13+160 to 13+450	Swamp 310





Based on the areal extent of the above proposed swamp crossings for which wick drain foundation treatment were to be implemented, nine (9) culvert locations were identified within the candidate sites.

Following the completion of Peto's detail foundation investigation and analysis for the five (5) swamps noted above, only four (4) of the swamp crossings were ultimately chosen for wick drain foundation treatment. The perimeter limits of these four (4) swamp crossings was further refined after completion of the detail wick drain design. As a result, four (4) culvert locations are located outside of wick drain treatment areas and five (5) of the culvert locations are located within wick drain treatment areas.

This report addresses the investigation carried out at all nine (9) culvert locations within the five (5) swamp crossing areas where wick drain foundation investigation services were originally being considered. A detailed list of the culverts investigated is presented in Table 1. A separate report will detail the foundation investigation for the wick drain foundation treatment areas.

The purpose of this culvert investigation is to compliment the subsurface information obtained by Peto in the culvert areas along the highway alignment within the originally proposed wick drain areas by borehole drilling, cone penetration and in situ testing as well as laboratory testing of selected samples. Golder's investigation is specific to each culvert alignment located within the originally proposed wick drain treatment areas. In describing the subsurface conditions at one (1) culvert location (Culverts C5A-SBL and C5A-NBL), Golder has relied on the subsurface information provided by Peto in their Technical Memorandum titled "06TF033C 889Tech memo Wick Drain Swamps", dated December 14, 2007.

The proposed culvert alignments were located in the field by Callon Dietz Inc. (Callon Dietz), a professional surveying company retained by MRC. The investigation areas are shown in plan on Drawing 2.

## **2.0 SITE DESCRIPTION**

The proposed culvert alignments addressed in this report are located within the five (5) swamp crossings of the proposed new highway alignment which begins approximately 2.7 km north of the intersection with Highway 522 and approximately follows the alignment of the existing Highway 69 for about 3.7 km northerly to approximately 1 km north of Pickerel River Road. The future Highway 69 will run generally in a southwest-northeast direction with the project limits located within the Township of Mowat.

In general, the topography in the area of the overall project limits consists of rolling terrain including densely treed areas and numerous bedrock outcrops separated by low-lying swamps containing areas of standing water, various vegetation types and surficial organic soils. The ground surface within the limits of the study area varies between about Elevation 195 m and Elevation 186 m, referenced to Geodetic datum, and is gently sloping downward from northeast to southwest towards Georgian Bay. A detailed description of each investigated culvert alignment is presented in Section 4.0. The locations of these areas are shown on Drawing 2.

## **3.0 INVESTIGATION PROCEDURES**

### **3.1 Borehole Investigation by Golder**

The field work for the investigation at each culvert crossing was carried out between March 2 and 20, 2009 during which time a total of twenty-four (24) boreholes and one (1) Dynamic Cone Penetration Test (DCPT) were advanced at or adjacent to the culvert alignments. The locations of the boreholes and DCPT are shown in plan on Drawings A1 to G1, included in the respective appendices.

The field investigation was carried out using a D-25 track-mounted drill rig supplied and operated by Walker Drilling Ltd. of Utopia, Ontario. The boreholes were advanced through the overburden using 115 mm outside diameter solid-stem augers and NW casing. Soil samples were obtained at varying depths and depth intervals





using a 50 mm outer diameter (O.D.) split-spoon sampler operated by an automatic hammer, performed in accordance with Standard Penetration Test (SPT) procedures (ASTM D1586 Standard Test Method for Standard Penetration Test). Field vane shear tests were conducted in cohesive soils for measurement of undrained shear strengths (ASTM D2573 Standard Test Method for Field Vane Shear Test) using a MTO Standard 'N'-size vane. In one borehole, samples of the bedrock were obtained using an 'NQ'-size rock core barrel. All boreholes were backfilled with bentonite upon completion in accordance with Ontario Regulation 903 (as amended).

The boreholes and DCPT were advanced to depths up to 29 m below existing ground surface, generally penetrating at least 1.5 m below the cohesive stratum or terminated on refusal to further split-spoon and/or casing advancement or cone penetration. The depths to refusal do not confirm bedrock surface elevations, but may be inferred to indicate potential proximity to the bedrock surface. In one borehole where the depth to refusal/bedrock surface was observed to be shallow, bedrock was cored for a depth of 1.5 m below the surface of the bedrock to confirm its presence.

The groundwater conditions and water levels in the open boreholes were observed during the drilling operations and are described on the Record of Borehole sheets in Appendices A to G. It should be noted that groundwater elevations as encountered in the boreholes may not be representative of static groundwater levels since the groundwater levels in the boreholes may not have stabilized on completion of drilling. Furthermore, groundwater elevations will vary and fluctuate depending on seasonal precipitation and local soil permeability.

The field work was carried out under the overall supervision of members of our 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 and rock samples. The samples were identified in the field, placed in appropriate containers, labelled and transported to our Mississauga geotechnical laboratory where the samples underwent further visual examination and laboratory testing. All of the laboratory tests were carried out to MTO and/or ASTM Standards, as appropriate. Classification testing (water content, Atterberg limits and grain size distribution) was carried out on selected samples. The results of the laboratory testing for the culvert crossings are included in Appendices A to G.

The proposed centreline of the highway was staked in the field by Callon Dietz prior to drilling. The as-drilled borehole locations, in stations and offsets, were measured in reference to the centreline alignment and were subsequently converted into MTM NAD 83 coordinates in AutoCAD. Borehole elevations were surveyed by a member of our technical staff in reference to the ground surface elevations at the centreline median stakes which were referenced to the contour plan provided to Golder by Callon Dietz (received on April 23, 2009). The borehole locations presented in the Record of Borehole Sheets and shown on Drawings A1 to G1 are positioned relative to MTM NAD 83 northing and easting coordinates and the ground surface elevations are referenced to Geodetic datum.

### **3.2 Borehole Investigation by Others**

In addition to the foundation investigation carried out by Golder for the culverts, two boreholes advanced by Peto as part of their investigation for the swamps (as provided in their Technical Memorandum titled '06TF033C 889Tech memo Wick Drain Swamps' dated December 14, 2007) have been utilized to supplement the subsurface information, where appropriate. The location of the boreholes from the Peto investigation have been converted to MTM NAD 83 coordinates, as presented on Drawing B1.

The Record of Borehole sheets for the above referenced Peto boreholes are presented in Appendix H.





## **4.0 SITE GEOLOGY AND SUBSURFACE CONDITIONS**

### **4.1 Regional Geology**

As delineated in *The Physiography of Southern Ontario*<sup>1</sup>, this section of Highway 69 lies within the physiographic region known as the Georgian Bay Fringe, which extends along the east side of Georgian Bay through the Parry Sound and Muskoka areas, then eastward from Muskoka in patches into the area north of the Kawartha Lakes.

This part of the Georgian Bay Fringe physiographic region was never submerged during periods of glacial recession. As a result, the surficial soils in this area consist of very shallow deposits of sand, silt and clay overlying metamorphic bedrock and numerous bare knobs and ridges of bedrock are present throughout the area. Localised low-lying swampy areas, containing peat and/or organic soils overlying soft/loose native soils, are present in valleys between the bedrock knobs and ridges.

The bedrock in the area consists typically of gneisses of the Britt Domain of the Central Gneiss Belt, a subdivision of the Grenville Structural Province, as described in *Geology of Ontario, OGS Special Volume 4*<sup>2</sup>. Deposition of Paleozoic strata initially covered and later erosion during glaciation subsequently exposed these Precambrian rocks.

### **4.2 General Overview of Local Subsurface Conditions**

The detailed subsurface soil and groundwater conditions as encountered in the boreholes advanced during this investigation, together with the results of the laboratory tests carried out on selected soil samples, are given on the Record of Borehole and Record of Drillhole sheets in Appendices A to G. The detailed results of the laboratory testing are also provided in Appendices A to G. The stratigraphic boundaries shown on the Record of Borehole sheets are inferred from non-continuous sampling, observations of drilling progress and the results of Standard Penetration Tests (SPTs) and in situ testing. These boundaries, therefore, represent transitions between soil types rather than exact planes of geological change. Further, subsurface conditions will vary between and beyond the borehole locations.

The inferred soil stratigraphy as encountered in the boreholes and DCPT advanced for this investigation are shown on Drawings A1 to G1, inclusive. It should be noted that the orientation (i.e. north, south, east, west) stated in the text of the report is typically referenced to project north (along the proposed Highway 69 alignment) and therefore may differ from that shown on the drawings which represents magnetic north.

In general, the stratigraphy encountered at the culvert areas investigated is similar, however, the thickness of the overburden (soil materials) is variable, ranging from about 2.7 m to 29.1 m. The stratigraphy generally consists of:

- surficial layers of topsoil, clayey silt fill, peat and organic material up to about 4 m thick, but typically less than about 1.5 m thick;
- upper deposits of silt and sand in some areas up to about 4.5 m thick;
- deposits of cohesive silt and clay ranging in thickness from about 0.5 m to 18 m, interbedded with sand layers in some areas; and

<sup>1</sup> 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.

<sup>2</sup> *Geology of Ontario*, 1991. Ontario Geological Society, Special Volume 4, Part 2. Ministry of Northern Development and Mines, Ontario.





- silt, sand and gravel deposits below the cohesive deposits with thickness up to about 6 m where fully penetrated.

Detailed descriptions of the subsurface conditions at each investigated culvert alignment are provided in 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 or stratum.

### **4.3 Highway 69 SBL – STA 18+133 (Culvert C6)**

The plan and profile along the culvert centreline showing the borehole locations and interpreted stratigraphy at approximately STA 18+133 in the Township of Mowat are shown on Drawing A1 in Appendix A. The culvert will extend across a swamp area (Swamp 302) and the proposed Highway 69 SBL embankment which will be up to about 4.5 m above the existing grade at the proposed culvert location. A total of three (3) boreholes (Boreholes C6-S1 to C6-S3, inclusive) were advanced along the length of the culvert to investigate the subsurface conditions at this location. The topography in the area is generally flat to low-lying with ground cover consisting of wet grassy and moderately treed areas with occasional shallow open water, and upward sloping ground to the north of the swamp.

In general, the subsurface soils along the culvert alignment consist of a surficial layer of sandy peat underlain by a deposit of organic clayey silt, underlain by a stratum of clayey silt to silty clay. The clayey silt to silty clay stratum is in turn underlain by a deposit of silt, underlain by a deposit of sandy silt to sand which extends to the refusal depth. Bedrock outcrops are present to the north of the swamp.

#### **Ice**

Ice to a depth of about 0.1 m was encountered in Boreholes C6-S1 and C6-S2.

#### **Sandy Peat**

A deposit of black, wet, sandy peat containing rootlets was encountered underlying the ice cover in Boreholes C6-S1 and C6-S2 and at the ground surface in Borehole C6-S3. The top of the peat is at between about Elevation 185.9 m and 185.7 m and its thickness varies between about 0.4 m and 0.7 m.

The Standard Penetration Test (SPT) 'N'-values recorded within the sandy peat deposit are 0 blows (weight of hammer) and 1 blow per 0.3 m of penetration, indicating a very soft consistency.

#### **Organic Clayey Silt**

A deposit of grey to dark grey organic clayey silt containing rootlets was encountered below the sandy peat in all boreholes at this culvert location. The top of this deposit ranges from about Elevation 185.3 m to 185.1 m and its thickness is between about 0.5 m and 0.7 m.

The SPT 'N'-values measured within the organic clayey silt deposit are 0 blows (weight of hammer) and 1 blow per 0.3 m of penetration, indicating a very soft consistency.

The natural water content measured on one (1) sample of the organic clayey silt is about 87 percent.





### **Clayey Silt to Silty Clay**

A stratum of grey clayey silt to silty clay containing rootlets in the near surface zone was encountered below the deposit of organic clayey silt in all boreholes advanced at this culvert location. The top of this stratum ranges from about Elevation 184.7 m to 184.4 m and its thickness ranges from about 2.9 m to 3.3 m.

The SPT 'N'-values recorded within the cohesive deposit are 0 blows (weight of hammer) and 1 blow per 0.3 m of penetration. In situ field vane tests carried out within this stratum measured undrained shear strengths between about 14 kPa and 27 kPa and the sensitivity is calculated to range between about 3 and 4. The field vane tests results together with the SPT 'N'-values indicate that the clayey silt to silty clay stratum has a very soft to firm consistency.

The natural water content measured on samples of this stratum ranges from about 33 percent to 38 percent. The upper portion of the deposit in Borehole C6-S3 was observed to be slightly organic and a laboratory test conducted on this sample measured an organic content of about 1 percent.

A grain size distribution of one (1) sample from the clayey silt stratum is shown on Figure A.C6-1 in Appendix A.

Atterberg limits tests carried out on four (4) samples of the clayey silt to silty clay stratum measured liquid limits ranging from about 24 percent to 46 percent, plastic limits ranging from about 18 percent to 22 percent, and plasticity indices ranging from about 5 percent to 24 percent. The results of the Atterberg limits tests are shown on the plasticity chart on Figure A.C6-2 in Appendix A and indicate that the material is classified as clayey silt to silty clay of low to intermediate plasticity.

### **Silt**

Underlying the clayey silt to silty clay stratum in all boreholes at this location is a stratum of grey silt, trace to some sand and trace to some clay containing thin layers of sand. The top of this stratum is at between about Elevation 181.5 m and 181.4 m and its thickness is between about 1.0 m and 1.1 m.

The SPT 'N'-values recorded within this stratum are 3 blows and 5 blows per 0.3 m of penetration, indicating that the silt has a very loose to loose relative density.

The natural water content measured on samples of this stratum is about 25 percent and 26 percent.

The grain size distributions of two (2) samples from the silt stratum are shown on Figure A.C6-3 in Appendix A.

Atterberg limits tests carried out on three (3) samples of the silt stratum measured liquid limits ranging from about 18 percent to 22 percent, plastic limits ranging between about 16 percent and 19 percent, and plasticity indices ranging from about 1 percent to 3 percent. The results of the Atterberg limits tests are shown on the plasticity chart on Figure A.C6-4 in Appendix A and indicate the material to be a silt of low plasticity.

### **Sandy Silt to Sand**

A deposit of cohesionless soil comprised of grey sandy silt, sand and silt, and sand trace to some silt was encountered below the silt stratum in all boreholes at this culvert location. The deposit generally contains trace clay and the lower portion of the deposit contains trace gravel and thin layers of silt. The top of this deposit ranges from about Elevation 180.5 m to 180.3 m and its thickness ranges from about 4.2 m to 4.9 m. The bottom of this deposit was defined by refusal to further split-spoon and/or casing advancement.

The SPT 'N'-values recorded within this deposit typically range from 3 blows to 11 blows per 0.3 m of penetration, indicating a very loose to compact relative density.

The natural water content measured on two (2) samples of this deposit is about 22 percent and 27 percent.





The grain size distributions of two (2) samples from the sandy silt and sand and silt portion of this deposit are shown on Figure A.C6-5 in Appendix A. An Atterberg limits test on one (1) sample of the sandy silt deposit indicates this material to be non plastic.

## **Refusal**

In Boreholes C6-S1 to C6-S3, refusal to further split-spoon and/or casing advancement was encountered at depths between about 9.7 m and 10.2 m below ice surface, corresponding to Elevation 176.2 m and 175.6 m.

## **Groundwater Conditions**

In general, the samples taken in the boreholes were wet. The water levels observed in the boreholes upon completion of drilling are at about Elevation 185.9 m and 185.8 m, measured either at the ice or ground surface.

### **4.4 Highway 69 NBL – STA 18+133 (Culvert C6)**

The plan and profile along the culvert centreline showing the borehole locations and interpreted stratigraphy at approximately STA 18+133 in the Township of Mowat are shown on Drawing A1 in Appendix A. The culvert will extend across a swamp area (Swamp 302) and the proposed Highway 69 NBL embankment which will be up to about 4.5 m above the existing grade at the proposed culvert location. A total of three (3) boreholes (Boreholes C6-N1 to C6-N3, inclusive) were advanced along the length of the culvert to investigate the subsurface conditions at this location. The topography in the area is generally flat to low-lying with ground cover consisting of wet grassy and moderately treed areas with occasional shallow open water, and an upward sloping ground to the north of the swamp.

In general, the subsurface soils along the culvert alignment consist of a surficial layer of sandy peat underlain by a deposit of organic clayey silt or silty sand in places, underlain by a stratum of clayey silt to silty clay. The clayey silt to silty clay stratum is in turn underlain by a deposit of silt and by a deposit of sand and silt to sand which extends to the refusal depth. Bedrock outcrops are present to the north of the swamp.

## **Ice**

Ice to a depth of 0.2 m was encountered in Borehole C6-N1.

## **Sandy Peat**

A deposit of dark brown to black, wet, sandy peat containing rootlets was encountered underlying the ice cover in Borehole C6-N1 and at the ground surface in Boreholes C6-N2 and C6-N3. The top of the peat is at between about Elevation 185.9 m and 185.7 m and its thickness varies between about 0.3 m and 1.0 m.

The Standard Penetration Test (SPT) 'N'-values recorded within the sandy peat deposit range from 0 blows (weight of hammer) to 2 blows per 0.3 m of penetration, indicating a very soft consistency.

The natural water content measured on two (2) samples of this deposit is about 208 percent and 580 percent





### **Organic Clayey Silt / Silty Sand**

An approximately 0.5 m and 0.3 m thick layer of grey organic clayey silt and dark grey slightly organic silty sand containing rootlets was encountered below the sandy peat at about Elevation 185.2 m and 185.6 m in Boreholes C6-N3 and C6-N2, respectively.

The SPT 'N'-values recorded within the organic clayey silt/silty sand layers are 1 blow and 2 blows per 0.3 m of penetration, indicating a very soft consistency / very loose relative density.

The natural water content measured on the silty sand sample is about 33 percent and an organic content test carried out on this sample is about 4 percent.

### **Clayey Silt to Silty Clay**

A stratum of grey/dark grey clayey silt to silty clay was encountered below the sandy peat deposit in Borehole C6-N1 and below the organic clayey silt/silty sand in Boreholes C6-N2 and C6-N3. The near surface portion of this deposit was noted to be slightly organic and contains rootlets. The top of this stratum is at between about Elevation 185.3 m and 184.7 m and its thickness ranges from about 3.7 m to 4.9 m.

The SPT 'N'-values recorded within the cohesive deposit range from 0 blows (weight of hammer) to 3 blows per 0.3 m of penetration. In situ field vane tests carried out within this stratum measured undrained shear strengths between about 21 kPa and 38 kPa and the sensitivity is calculated to range between about 4 and 5. The field vane tests results together with the SPT 'N'-values indicate that the clayey silt to silty clay stratum has a very soft to firm consistency.

The natural water content measured on samples of this stratum ranges from about 32 percent to 79 percent.

Atterberg limits tests carried out on three (3) samples of the clayey silt to silty clay stratum measured liquid limits between about 25 percent and 48 percent, plastic limits ranging from about 17 percent to 20 percent and plasticity indices ranging from about 5 percent to 29 percent. The results of the Atterberg limits tests are shown on the plasticity chart on Figure A.C6-6 in Appendix A and indicate that the material is classified as clayey silt to silty clay of low to intermediate plasticity.

### **Silt**

A deposit of silt was encountered underlying the clayey silt to silty clay stratum in all boreholes at this culvert location. The deposit generally contains trace to some sand and trace to some clay. The top of this stratum ranges from about Elevation 181.6 to 179.8 m and its thickness ranges from about 1.1 m to 3.9 m.

The SPT 'N'-values recorded within this stratum range from 2 blows to 9 blows per 0.3 m of penetration, indicating a very loose to loose relative density.

The natural water content measured on two (2) samples of this stratum is about 25 percent and 31 percent.

The grain size distributions of two (2) samples from the silt stratum are shown on Figure A.C6-7 in Appendix A.

Atterberg limits tests carried out on two (2) samples of the silt stratum indicate the material to be non plastic. However, an Atterberg limits test carried out on a sample at the interface of the silt stratum with the overlying silty clay stratum measured a liquid limit of about 25 percent, a plastic limit of about 22 percent and a corresponding plasticity index of about 3 percent. The results of the Atterberg limits test are shown on the plasticity chart on Figure A.C6-8 in Appendix A and indicate the material to be a silt of low plasticity.





### **Sand and Silt to Sand**

A deposit of grey sand and silt to sand some silt, trace gravel and trace clay was encountered below the silt stratum in all boreholes at this culvert location. The top of this deposit ranges from about Elevation 178.9 m to 177.4 m and its thickness ranges from about 4.9 m to 9.5 m as encountered in the boreholes and inferred from the resistance to cone penetration in two of the boreholes. The bottom of this deposit was defined by refusal to further casing advancement or cone penetration.

The SPT 'N'-values measured within this deposit range from 3 blows to 12 blows per 0.3 m of penetration, indicating a very loose to compact relative density.

The natural water content measured on samples of this deposit ranges between about 19 percent and 24 percent.

The grain size distributions of three (3) samples of the sand and silt to sand deposit are shown on Figure A.C6-9 in Appendix A. Atterberg limits tests carried out on two (2) samples of the sandy silt deposit indicate the material to be non plastic.

### **Refusal**

In Boreholes C6-N1 to C6-N3, refusal to further casing advancement or cone penetration was encountered at depths between about 11.9 m and 18.0 m below ice/ground surface, corresponding to Elevation 174.0 m and 167.9 m.

### **Groundwater Conditions**

In general, the samples taken in the boreholes were wet. Water levels observed in the boreholes upon completion of drilling range between about Elevation 185.9 m and 185.7 m, measured at the ice surface and to a depth of about 0.2 m below ground surface.

## **4.5 Highway 69 SBL and N-E/W Ramp – STA 17+800 (Culvert C5A)**

The plan and profile along the culvert centreline showing the borehole locations and interpreted stratigraphy at approximately STA 17+800 in the Township of Mowat are shown on Drawing B1 in Appendix B. The culvert will extend across a swamp area (Swamp 302) and the proposed Highway 69 SBL and N-E/W Ramp embankment which will be up to about 4 m above the existing grade at the proposed culvert location. Two (2) boreholes (Boreholes C5A-S1 and C5A-S2) were completed by Golder to investigate the subsurface conditions along this culvert alignment, and augmented with Borehole 302-29 advanced by Peto for the foundation investigation for the embankment through Swamp 302. The topography in the area is relatively flat to low-lying with surface cover consisting of wet grassy areas and occasional bedrock outcrops, with downward sloping grass covered terrain towards the northern and eastern limits of the swamp.

In general, the subsurface soils along the culvert alignment consist of a surficial layer of peat or topsoil underlain by a stratum of clayey silt or silt, underlain by a deposit of sandy silt to sand. The sandy silt to sand deposit is in turn underlain by a stratum of clay to clayey silt and a deposit of silt, which in turn is underlain by a deposit of sand.





### **Peat / Topsoil**

An approximately 0.1 m thick layer of dark brown fibrous peat was encountered below the ground surface at about Elevation 189 m in Borehole 302-29, and an approximately 0.2 m thick layer of topsoil was encountered below the ground surface at about Elevation 188.6 m and 189 m in Boreholes C5A-S1 and C5A-S2.

### **Clayey Silt / Silt**

A stratum of brown clayey silt trace sand was encountered below the topsoil in Boreholes C5A-S1 and C5A-S2 and a stratum of dark brown silt, trace clay and trace sand was encountered underlying the peat in Borehole 302-29. The clayey silt and silt strata generally contains organics and rootlets. The top of the clayey silt/silt strata range from about Elevation 188.9 m to 188.4 m and its thickness ranges from about 1.2 m to 1.4 m.

The SPT 'N'-values measured within the clayey silt stratum range from 4 blows to 12 blows per 0.3 m of penetration, indicating a firm to stiff relative density and the SPT 'N'-values recorded within the silt stratum are 4 blows and 13 blows per 0.3 m of penetration, indicating a loose to compact relative density.

The natural water content measured on two (2) samples of the clayey silt stratum is about 30 percent and 35 percent, and the measured water content on two (2) samples of the silt stratum is about 22 percent.

An Atterberg limits test carried out by Golder on one (1) sample of the clayey silt stratum measured a liquid limit of about 34 percent, a plastic limit of about 17 percent and a corresponding plasticity index of about 17 percent. The results of the Atterberg limits test are shown on the plasticity chart on Figure B.C5A-1 in Appendix B and indicate that the material is clayey silt of low plasticity.

### **Sandy Silt to Sand**

A mottled brown and grey cohesionless deposit comprised of sandy silt, silty sand, and sand trace silt was encountered below the clayey silt/silt stratum in all boreholes at this culvert location. The deposit generally contains trace gravel, trace clay and occasional thin layers of silt were encountered within the sand portion of this deposit. The top of this deposit is at between about Elevation 187.5 m and 187.2 m and its thickness ranges from about 2.5 m to 4.3 m.

The SPT 'N'-values recorded within this deposit range from 5 blows to 32 blows per 0.3 m of penetration, but are typically greater than 11 blows per 0.3 m of penetration, generally indicating a compact to dense relative density.

The natural water content measured on samples of this deposit varies between about 19 percent and 21 percent.

A grain size distribution test carried out by Golder on one (1) sample of the sandy silt deposit is shown on Figure B.C5A-2 in Appendix B. Peto performed a grain size distribution test on a sample of the sand deposit and the results are summarized on the Record of Borehole No. 302-29 sheet in Appendix H.

An Atterberg limits test carried out by Golder on one (1) sample of the sandy silt deposit measured a liquid limit of about 18 percent, a plastic limit of about 17 percent and a corresponding plasticity index of about 1 percent. The results of the Atterberg limits test are shown on the plasticity chart on Figure B.C5A-3 in Appendix B and indicate that the material is a sandy silt of low plasticity.





## Clay to Clayey Silt

A stratum of grey clay to clayey silt trace sand was encountered below the deposit of sandy silt to sand in all boreholes at this culvert location. The top of this stratum ranges from about Elevation 184.7 m to 183.2 m and its thickness ranges from about 5.5 m to 9.2 m.

The SPT 'N'-values recorded within the cohesive stratum range from 0 blows (weight of hammer) to 9 blows per 0.3 m of penetration. In situ field vane tests carried out within this stratum measured undrained shear strengths between about 23 kPa and 63 kPa, typically greater than about 30 kPa. The sensitivity is calculated to range between about 2 and 6, typically about 4. The field vane tests results together with the SPT 'N'-values indicate that the clay to clayey silt stratum has a very soft to stiff consistency, typically firm to stiff.

The natural water content measured on samples of this stratum ranges from about 31 percent to 71 percent.

A grain size distribution test performed by Peto on one (1) specimen of this deposit classified the material as silty clay and the results are summarized on the Record of Borehole No. 302-29 sheet in Appendix H.

Atterberg limits tests were carried out by Golder on four (4) specimens of this cohesive stratum and by Peto on one (1) specimen of this stratum. In general, the liquid limits range from about 27 percent to 54 percent, the plastic limits range from about 16 percent to 22 percent, and the plasticity indices range from about 9 percent to 32 percent. The results of the Atterberg limits tests carried out by Golder are shown on the plasticity chart on Figure B.C5A-4 in Appendix B and indicate that the material is classified as a clayey silt of low plasticity to a clay of high plasticity.

## Silt

Underlying the clay to clayey silt stratum all the boreholes at this location penetrated a stratum of grey silt, trace to some sand and trace to some clay. The stratum contains sand seams at Borehole 302-29. The top of this stratum ranges from about Elevation 177.9 m to 175.5 m and its thickness varies between about 1.5 m and 3.2 m.

The SPT 'N'-values recorded within this stratum range from 5 blows to 21 blows per 0.3 m of penetration, indicating a loose to compact relative density.

The natural water content measured on a sample of this stratum is about 24 percent.

A grain size distribution test carried out by Golder on one (1) sample of the silt stratum is shown on Figure B.C5A-5 in Appendix B. Peto also performed a grain size distribution test on a sample of this stratum and the results are summarized on the Record of Borehole No. 302-29 sheet in Appendix H.

An Atterberg limits test carried out by Golder on a sample of the silt stratum indicates this material to be non plastic.

## Sand

A deposit of grey sand some silt was encountered below the silt stratum in Boreholes C5A-S1 and C5A-S2, and was inferred below the silt stratum in Borehole 302-29 based on the resistance values obtained from the Dynamic Cone Penetration Test. The top of this deposit ranges from about Elevation 174.7 m to 172.5 m and its thickness is about 0.6 m and 2.6 m in Boreholes C5A-S1 and C5A-S2, respectively, and extends to a thickness of about 4.3 m in Borehole 302-29 as inferred from the resistance to cone penetration. Boreholes C5A-S1 and C5A-S2 were terminated within the sand deposit at depths of about 16.8 m and 17.1 m below ground surface, corresponding to Elevation 171.8 m and 171.9 m, respectively.





The SPT 'N'-values recorded within this deposit range from 12 blows to 15 blows per 0.3 m of penetration, indicating a compact relative density.

### **Groundwater Conditions**

In general, the samples taken in the boreholes were moist to wet. The water level observed in Borehole C5A-S1 upon completion of drilling was at about Elevation 187.1 m, measured at a depth of about 1.5 m below ground surface, while Borehole 302-29 was observed to be dry upon completion of drilling.

## **4.6 Highway 69 NBL – STA 17+800 (Culvert C5A)**

The plan and profile along the culvert centreline showing the borehole locations and interpreted stratigraphy at approximately STA 17+800 in the Township of Mowat are shown on Drawing B1 in Appendix B. The culvert will extend across a swamp area (Swamp 302) and the proposed Highway 69 NBL embankment which will be up to about 4.5 m above the existing grade at the proposed culvert location. Two (2) boreholes (Boreholes C5A-N1 and C5A-N2) were completed by Golder to investigate the subsurface conditions along this culvert alignment, and augmented with Borehole 302-30 advanced by Peto for the foundation investigation for the embankment through Swamp 302. The topography in the area is relatively flat to low-lying with surface cover consisting of wet grassy areas and occasional bedrock outcrops, with downward sloping grass covered terrain towards the northern and eastern limits of the swamp.

In general, the subsurface soils along the culvert alignment consist of a surficial layer of peat or topsoil underlain by a layer of silt (where present), underlain by a deposit of sandy silt to sand. The sandy silt to sand deposit is in turn underlain by a stratum of silty clay underlain by a deposit of silt and by a deposit of sandy silt.

### **Peat / Topsoil**

An approximately 0.3 m thick layer of dark brown fibrous peat was encountered below the ground surface at about Elevation 188.0 m in Borehole 302-30, and approximately 0.2 m and 0.3 m thick layer of topsoil was encountered below the ground surface at about Elevation 187.4 m and 188.5 m in Boreholes C5A-N1 and C5A-N2, respectively.

### **Silt**

An approximately 0.5 m thick layer of brown silt, some clay and trace sand was encountered below the topsoil at about Elevation 188.2 m in Borehole C5A-N2.

A single SPT 'N'-value measured within this layer is 8 blows per 0.3 m of penetration, indicating a loose relative density.

### **Sandy Silt to Sand**

A mottled brown and grey cohesionless deposit comprised of sandy silt, sand and silt, silty sand and sand trace silt was encountered below the peat/topsoil in Boreholes C5A-N1 and 302-30, and below the silt layer in Borehole C5A-N2. The deposit generally contains trace to some clay and the upper portion of the deposit in Borehole C5A-N1 contains rootlets. The top of this deposit is at between about Elevation 187.7 m and 187.2 m and its thickness ranges from about 3.1 m to 4.3 m.





The SPT 'N'-values recorded within this deposit range from 5 blows to 77 blows per 0.3 m of penetration, but are typically greater than 14 blows per 0.3 m of penetration, generally indicating a compact to very dense relative density.

The natural water content measured on samples of this deposit varies between about 19 percent and 23 percent.

The grain size distribution tests carried out by Golder on two (2) samples of the sand and silt deposit are shown on Figure B.C5A-6 in Appendix B. Peto performed a grain size distribution test on a sample of the sand deposit and the results are summarized on the Record of Borehole No. 302-30 sheet in Appendix H.

An Atterberg limits test carried out by Golder on one (1) sample of the sand and silt deposit indicates this material to be non plastic.

### **Silty Clay**

A stratum of grey silty clay and trace sand containing thin layers of silt and clayey silt was encountered below the sandy silt to sand deposit in all boreholes at this culvert location. The top of this stratum ranges from about Elevation 184.6 m to 183.4 m and its thickness ranges from about 5.4 m to 6.3 m.

The SPT 'N'-values recorded within the cohesive stratum range from 1 blow to 4 blows per 0.3 m of penetration. In situ field vane tests carried out within this stratum measured undrained shear strengths between about 34 kPa and 69 kPa, typically greater than 44 kPa. The sensitivity is calculated to range between about 3 and 6. The field vane tests results together with the SPT 'N'-values indicate that the silty clay stratum has a very soft to stiff consistency, typically firm to stiff.

The natural water content measured on specimens of this stratum ranges from about 55 percent to 64 percent.

A grain size distribution test carried out by Golder on one (1) specimen of the silty clay stratum is shown on Figure B.C5A-7 in Appendix B. Peto performed a grain size distribution test on a sample of this stratum and the results are summarized on the Record of Borehole No. 302-30 sheet in Appendix H.

Atterberg limits tests were carried out by Golder on three (3) specimens of this cohesive stratum and by Peto on one (1) specimen of this stratum. In general, the liquid limits range from about 43 percent to 50 percent, the plastic limits range from about 18 percent to 22 percent, and the plasticity indices range from about 20 percent to 30 percent. The results of the Atterberg limits tests carried out by Golder are shown on the plasticity chart on Figure B.C5A-8 in Appendix B and indicate that the material is silty clay of intermediate plasticity.

### **Silt**

Underlying the silty clay stratum all the boreholes at this location penetrated a stratum of grey silt, trace to some clay and trace sand. The top of this stratum is at between about Elevation 178.4 m and 177.1 m and its thickness is between about 2.2 m and 4.1 m.

The SPT 'N'-values recorded within this stratum range from 2 blows to 19 blows per 0.3 m of penetration, but are typically greater than 6 blows per 0.3 m of penetration, generally indicating a loose to compact relative density.

The natural water content measured on samples of this stratum ranges from about 25 percent to 33 percent.

The grain size distribution tests carried out by Golder on two (2) samples of the silt stratum are shown on Figure B.C5A-9 in Appendix B. Peto performed a grain size distribution test on a sample of this stratum and the results are summarized on the Record of Borehole No. 302-30 sheet in Appendix H.





An Atterberg limits test carried out by Golder on one (1) sample at the interface of the silt stratum with the overlying silty clay stratum measured a liquid limit of about 25 percent, a plastic limit of about 21 percent and a corresponding plasticity index of about 4 percent. The results of the Atterberg limits test are shown on the plasticity chart on Figure B.C5A-10 in Appendix B and indicate the material to be a silt of low plasticity. An Atterberg limits test carried out by Peto on a sample of the silt stratum indicates the material to be non plastic.

### **Sandy Silt**

A deposit of grey sandy silt and trace clay containing layers of silty sand was encountered below the silt stratum in all boreholes at this culvert location. The top of this deposit is at between about Elevation 174.9 m and 174.3 m and its thickness is about 2.6 m and 1.0 m in Boreholes C5A-N1 and C5A-N2, and extends to a thickness of about 6.4 m in Borehole 302-30 as inferred from the resistance to cone penetration. Boreholes C5A-N1 and C5A-N2 were terminated within the sandy silt deposit at depths of about 15.7 m and 15.2 m below ground surface, corresponding to Elevation 171.7 m and 173.3 m, respectively.

The SPT 'N'-values recorded within this deposit range from 8 blows to 16 blows per 0.3 m of penetration, with an SPT 'N'-value of 3 blows per 0.3 m of penetration recorded at the bottom of Borehole 302-30, indicating very loose to compact relative density.

The natural water content measured on a sample of this stratum is about 21 percent.

A grain size distribution test carried out by Golder on one (1) sample of this deposit is shown on Figure B.C5A-11 in Appendix B.

### **Groundwater Conditions**

In general, the samples taken in the boreholes were moist to wet. Water levels observed in the boreholes upon completion of drilling range between about Elevation 185.1 m and 186.9 m, measured at a depth of between about 0.9 m and 2.9 m below ground surface.

## **4.7 Highway 69 SBL – STA 16+293 (Culvert C4A)**

The plan and profile along the culvert centreline showing the borehole locations and interpreted stratigraphy at approximately STA 16+293 in the Township of Mowat are shown on Drawing C1 in Appendix C. The culvert will extend across a swamp area (Swamp 305) and the proposed Highway 69 SBL embankment which will be up to about 3.5 m above the existing grade at the proposed culvert location. Two (2) boreholes (Boreholes C4A-S1 and C4A-S2) were advanced along the length of the culvert to investigate the subsurface conditions at this culvert location. The topography in the area is relatively low-lying with surface cover consisting of wet grassy areas, shallow open water and occasional bedrock outcrops, with upward sloping grass covered terrain towards the northern and eastern limits of the swamp.

In general, the subsurface soils along the culvert alignment consist of a surficial deposit of root mat/silty peat underlain by an upper deposit of silt containing a localized deposit of organic clayey silt, underlain by a stratum of clayey silt to silty clay containing a pocket of silty sand. The clayey silt to silty clay stratum is in turn underlain by a lower deposit of silt in places. Bedrock outcrops are present to the north and northeast of the swamp.

### **Ice**

Ice to depths of about 0.5 m and 0.2 m was encountered in Boreholes C4A-S1 and C4A-S2.





### **Root Mat / Silty Peat**

A deposit of dark grey to black, wet, root mat/silty peat was encountered below the ice cover at about Elevation 186.2 m and 186.4 m in Boreholes C4A-S1 and C4A-S2. The thickness of the root mat/silty peat deposit is about 0.9 m and 0.6 m in these boreholes.

The Standard Penetration Test (SPT) 'N'-values recorded within the root mat/silty peat deposit are 1 blow and 4 blows per 0.3 m of penetration, indicating a very soft to soft consistency.

### **Organic Clayey Silt**

Underlying the root mat/silty peat in Borehole C4A-S1 a stratum of organic clayey silt, trace sand and containing rootlets and a localized pocket of silt was encountered. The top of this deposit is at about Elevation 185.3 and its thickness is about 1 m.

A SPT 'N'-value measured within this stratum is 2 blows per 0.3 m of penetration, indicating a soft consistency.

The natural water content and organic content measured on one (1) sample of the organic clayey silt is about 64 percent and 7 percent, respectively.

The grain size distribution test carried out on one (1) specimen of this deposit is shown on Figure C.C4A-1 in Appendix C.

As noted above, an approximately 0.2 m thick pocket of grey silt, some sand and trace clay was encountered within the upper portion of the organic clayey silt stratum. A SPT 'N'-value recorded partially within the layer is 1 blow per 0.3 m of penetration, indicating a very loose relative density.

### **Silt to Clayey Silt**

A deposit of grey to brown silt, trace to some sand and trace to some clay to clayey silt, trace to some sand containing a localized pocket of silty sand was encountered underlying the root mat/silty peat deposit in Boreholes C4A-S1 and C4A-S2 at this culvert location. The top of the silt to clayey silt stratum is at about Elevation 184.3 m and 185.8 m and its thickness is about 1.6 m and 2.5 m in Boreholes C4A-S1 and C4A-S2, respectively.

The SPT 'N'-values measured within the silt stratum of the deposit are 0 blows (weight of hammer) and 5 blows per 0.3 m of penetration, indicating a very loose to loose relative density. The SPT 'N'-values recorded within the clayey silt stratum of the deposit range between 2 blows and 5 blows per 0.3 m of penetration, indicating a soft to firm consistency.

As noted above, an approximately 0.4 m thick pocket of grey silty sand, trace clay and containing rootlets was encountered in Borehole C4A-S2 within the lower portion of the clayey silt stratum. A SPT 'N'-value recorded within the layer is 3 blows per 0.3 m of penetration, indicating a very loose relative density.

The natural water content measured on two (2) samples of the silt stratum is about 26 percent and the natural water content measured on one (1) sample of the clayey silt stratum is 64 percent. The upper portion of the clayey silt stratum in Borehole C4A-S2 was observed to be slightly organic and the organic content of one (1) sample of this deposit is about 4 percent.

The grain size distribution test carried out on one (1) specimen of the cohesive portion of this deposit is shown on Figure C.C4A-2 in Appendix C.

An Atterberg limits test carried out on one (1) sample of the silt stratum measured a liquid limit of about 20 percent, a plastic limit of about 17 percent and a corresponding plasticity index of about 3 percent. An





Atterberg limits test carried out on one (1) sample of the clayey silt stratum measured a liquid limit of 24 percent, a plastic limit of about 17 percent and a corresponding plasticity index of about 7 percent. The results of the Atterberg limits test are shown on the plasticity chart on Figure C.C4A-3 in Appendix C and classified the material as silt of slight plasticity and clayey silt of low plasticity, respectively.

### **Clayey Silt to Silty Clay**

A deposit of grey to brown clayey silt to silty clay, trace to some sand and containing clay seams, layers of silt and sand was encountered below the silt to clayey silt in the two (2) boreholes at this culvert location. The top of this stratum is at about Elevation 183.3 m and 182.7 m and its thickness is about 8.3 m and 9.4 m in Boreholes C4A-S1 and C4A-S2, respectively. Borehole C4A-S2 was terminated within this stratum upon refusal to further casing advancement.

The SPT 'N'-values recorded within the cohesive stratum are 0 blows (weight of hammer/weight of sampler and rod) and 1 blow per 0.3 m of penetration. In situ field vane tests carried out within this stratum measured undrained shear strengths between about 16 kPa and 46 kPa, typically greater than about 25 kPa. The sensitivity is calculated to range between about 2 and 5. The field vane tests results together with the SPT 'N'-values indicate that the clayey silt to silty clay stratum has a very soft to firm consistency.

The natural water content measured on samples of this stratum ranges from about 28 percent to 66 percent.

Grain size distribution tests were carried out on three (3) specimens of this deposit and the results are shown on Figure C.C4A-4 in Appendix C.

Atterberg limits tests were carried out on four (4) specimens of this cohesive stratum. The liquid limits range from about 23 percent to 44 percent, the plastic limits range from about 15 percent to 18 percent, and the plasticity indices range from about 8 percent to 26 percent. The results of the Atterberg limits tests are shown on the plasticity chart on Figure C.C4A-5 in Appendix C and indicate that the material is clayey silt of low plasticity to silty clay of intermediate plasticity.

### **Silt**

Underlying the clayey silt to silty clay stratum in Borehole C4A-S1 a deposit of grey silt some clay containing layers of sand was encountered. The top of this deposit is at about Elevation 173.3 and its thickness is about 0.9 m. The bottom of this deposit was defined by refusal to further casing advancement.

A SPT 'N'-value of 3 blows per 0.3 m of penetration was recorded within this deposit, indicating a very loose relative density.

The natural water content measured on a sample of this deposit is about 29 percent.

### **Refusal**

In Boreholes C4A-S1 and C4A-S2, refusal to further casing advancement was encountered at depths between about 14.3 m and 11.6 m below ice surface, corresponding to Elevation 172.4 m and 175.0 m, respectively.

### **Groundwater Conditions**

In general, the samples taken in the boreholes were wet. The water levels observed in the boreholes upon completion of drilling were at about Elevation 186.7 m and 186.6 m, measured at the ice surface.





## **4.8 Highway 69 SBL – STA 16+232 (Culvert C4)**

The plan and profile along the culvert centreline showing the borehole locations and interpreted stratigraphy at approximately STA 16+232 in the Township of Mowat are shown on Drawings D1 and D2 in Appendix D. The culvert will extend across a swamp area (Swamp 305) and the proposed Highway 69 SBL embankment which will be up to about 3.5 m above the existing grade at the proposed culvert location. Two (2) boreholes (Boreholes C4-S1 and C4-S2) were advanced along the length of the culvert to investigate the subsurface conditions at this culvert location. The topography in the area is relatively low-lying with surface cover consisting of wet grassy areas, shallow open water and occasional bedrock outcrops, with upward sloping grass covered terrain towards the northern and eastern limits of the swamp.

In general, the subsurface soils along the culvert alignment consist of surficial deposits of root mat/sandy peat underlain by deposits of organic silty clay to organic silt, underlain by an upper deposit of sand in places and an upper stratum of silt. The upper silt stratum is in turn underlain by a thick stratum of clay to clayey silt, underlain by a lower deposit of silt in places, and a deposit of sand. Bedrock outcrops are present to the north and northeast of the swamp area.

### **Ice / Water**

Ice and water to depths of about 1.2 m and 0.9 m was encountered in Boreholes C4-S1 and C4-S2.

### **Root Mat / Sandy Peat**

A deposit of dark brown to dark grey, wet, root mat/sandy peat containing a localized pocket of silt was encountered underlying the ice and water cover at about Elevation 185.5 m and 185.8 m in Boreholes C4-S1 and C4-S2. The thickness of the root mat/sandy peat deposit is about 2.2 m in these boreholes.

The Standard Penetration Test (SPT) 'N'-values recorded within the root mat/sandy peat deposit are 0 blows (weight of hammer/weight of sampler and rod) per 0.3 m of penetration, indicating a very soft consistency.

An approximately 0.3 m thick layer of silt and some sand containing organics and rootlets was encountered within the sandy peat deposit at about Elevation 184.4 m in Borehole C4-S2. The natural water content measured on a specimen of this layer is about 40 percent.

### **Organic Silty Clay to Organic Silt**

A stratum of dark grey organic silty clay to organic silt some clay was encountered underlying the root mat/sandy peat deposit in the two boreholes at this culvert location. The top of this stratum is at about Elevation 183.4 m and 183.3 m and its thickness is about 1.1 m and 1.3 m in Boreholes C4-S1 and C4-S2, respectively.

The SPT 'N'-values measured within this stratum are 0 blows (weight of hammer/weight of sampler and rod) and 2 blows per 0.3 m of penetration, indicating a very soft consistency / very loose relative density.

The natural water content measured on two (2) samples of this stratum is about 96 percent and 98 percent, and the organic content measured on one (1) sample of this stratum is about 8 percent.

Atterberg limits tests carried out on two (2) samples of this stratum measured liquid limits of about 47 percent and 55 percent, plastic limits of about 25 percent and 36 percent, and corresponding plasticity indices of about 22 percent and 19 percent. The results of the Atterberg limits tests are shown on the plasticity chart on Figure D.C4-1 in Appendix D and indicate the material to be organic silty clay of intermediate plasticity to organic silt of high plasticity.





### **Sand (Upper)**

A deposit of grey sand, trace to some silt and trace clay was encountered below the organic silty clay in Borehole C4-S1. The top of this deposit is at about Elevation 182.2 m and its thickness is about 2.4 m.

The SPT 'N'-values recorded within this deposit are 1 blow and 4 blows per 0.3 m of penetration, indicating a very loose relative density.

The natural water content measured on a sample of this deposit is about 26 percent.

A grain size distribution test carried out on a sample of this deposit is shown on Figure D.C4-2 in Appendix D. An Atterberg limits test carried out on a sample of this deposit indicates this material to be non plastic.

### **Silt (Upper)**

A stratum of grey silt, trace to some sand and trace to some clay containing layers of sand and clay was encountered below the sand in Borehole C4-S1 and below the organic silt in Borehole C4-S2. The top of the silt stratum is at about Elevation 179.8 m and 182.0 m and its thickness is about 1.2 m and 3.8 m in Boreholes C4-S1 and C4-S2, respectively.

The SPT 'N'-values measured within the silt stratum range from 0 blows (weight of hammer) to 2 blows per 0.3 m of penetration, indicating a very loose relative density.

The natural water content measured on two (2) samples of this stratum is about 29 percent.

A grain size distribution test carried out on a sample of this deposit is shown on Figure D.C4-3 in Appendix D.

An Atterberg limits test carried out on one (1) sample of the silt stratum measured a liquid limit of about 18 percent, a plastic limit of about 17 percent and a corresponding plasticity index of about 1 percent. The results of the Atterberg limits test are shown on the plasticity chart on Figure D.C4-4 in Appendix D and classified the material as silt of low plasticity.

### **Clay to Clayey Silt**

A thick stratum of grey to brownish grey clay to clayey silt, trace gravel and trace sand containing layers of sand and silt with clay seams in the lower portion of the stratum was encountered below the silt deposit in the boreholes at this location. The top of this stratum is at about Elevation 178.6 m and 178.2 m and its thickness is about 14.5 m and 18.0 m in Boreholes C4-S1 and C4-S2, respectively.

The SPT 'N'-values recorded within the cohesive stratum typically range from 0 blows (weight of hammer) to 5 blows per 0.3 m of penetration, with an SPT 'N'-value of 14 blows per 0.3 m of penetration recorded near the bottom of the stratum in Borehole C4-S2. In situ field vane tests carried out within this stratum measured undrained shear strengths between about 23 kPa and 73 kPa, typically greater than about 30 kPa. The sensitivity is calculated to range between about 2 and 5, typically about 4. The field vane tests results together with the SPT 'N'-values indicate that the clay to clayey silt stratum has a very soft to stiff consistency.

The natural water content measured on samples of this stratum ranges from about 30 percent to 85 percent.

The grain size distribution tests carried out on three (3) specimens from the silty clay and clayey silt portion of this deposit are shown on Figure D.C4-5 in Appendix D.

Atterberg limits tests were carried out on four (4) specimens of this cohesive stratum. The liquid limits range from about 26 percent to 52 percent, the plastic limits range from about 19 percent to 22 percent, and the plasticity indices range from about 5 percent to 32 percent. The results of the Atterberg limits tests are shown on





the plasticity chart on Figure D.C4-6 in Appendix D and indicate that the material may be classified as clay of high plasticity to clayey silt of low plasticity.

### **Silt (Lower)**

Underlying the clay to clayey silt stratum Borehole C4-S1 penetrated a deposit of grey silt, trace to some sand and trace to some clay containing layers of clay. The top of this deposit is at about Elevation 164.1 and its thickness is about 5.4 m.

The SPT 'N'-values recorded within this deposit are 3 blows and 14 blows per 0.3 m of penetration, indicating a very loose to compact relative density.

The natural water content measured on a sample of this deposit is about 25 percent.

A grain size distribution test carried out on a sample of this deposit is shown on Figure D.C4-7 in Appendix D.

An Atterberg limits test carried out on one (1) sample of the silt deposit measured a liquid limit of about 20 percent, a plastic limit of about 18 percent and a corresponding plasticity index of about 2 percent. The results of the Atterberg limits test are shown on the plasticity chart on Figure D.C4-8 in Appendix D and classified the material as silt of low plasticity.

### **Sand (Lower)**

A deposit of grey sand, some gravel and trace silt was encountered below the silt deposit in Borehole C4-S1 and below the clay to clayey silt stratum in Borehole C4-S2. The top of this deposit is at about Elevation 158.7 m and 160.2 m in Boreholes C4-S1 and C4-S2, and its thickness is about 1.1 m. Boreholes C4-S1 and C4-S2 were terminated within the sand deposit at depths of about 29.1 m and 27.6 m below ice surface, corresponding to Elevation 157.6 m and 159.1 m, respectively.

The SPT 'N'-values recorded within this deposit are 16 blows and 27 blows per 0.3 m of penetration, indicating a compact relative density.

### **Groundwater Conditions**

In general, the samples taken in the boreholes were wet. The water level observed in the boreholes upon completion of drilling was at about Elevation 186.7 m, measured at the ice surface.

## **4.9 Highway 69 SBL – STA 15+654 (Culvert C3)**

The plan and profile along the culvert centreline showing the borehole locations and interpreted stratigraphy at approximately STA 15+654 in the Township of Mowat are shown on Drawing E1 in Appendix E. The culvert is within a swamp area (Swamp 306) and will extend across the proposed Highway 69 SBL embankment which will be up to about 2.0 m above the existing grade at the proposed culvert location. A total of three (3) boreholes (Boreholes C3-S1 to C3-S3, inclusive) were advanced along the length of the culvert to investigate the subsurface conditions at this culvert location. The topography is generally flat to gently sloping towards the west along the creek that traverses the area and the surface cover consists of grassy and densely treed areas. The culvert will be constructed along and partially across an existing swale which was excavated and will be partially re-aligned to convey surface water flow from the east side of and under the existing Highway 69 embankment.





In general, the subsurface soils along the culvert alignment consist of a deposit of clayey silt fill underlain by a sand and silt deposit and a stratum of clayey silt to silty clay. The clayey silt to silty clay stratum is in turn underlain by a deposit of silt which extends to refusal depth. Bedrock outcrops are present to the north of the culvert.

### **Ice / Water**

Ice and water to a depth of about 0.8 m was encountered in Borehole C3-S3.

### **Clayey Silt Fill**

A deposit of brown clayey silt fill, trace sand containing topsoil, organics and rootlets was encountered at the ground surface at about Elevation 191.1 m and 190.6 m in Boreholes C3-S1 and C3-S2. The thickness of the fill deposit is about 0.7 m and 0.8 m in the respective boreholes.

The Standard Penetration Test (SPT) 'N'-values recorded within the clayey silt fill are 2 blows and 4 blows per 0.3 m of penetration, indicating a soft consistency.

The natural water content measured on a sample of this deposit is about 28 percent.

### **Sand and Silt**

A deposit of brown and grey sand and silt trace to some clay was encountered below the clayey silt fill in Boreholes C3-S1 and C3-S2. The top of this deposit is at about Elevation 190.4 m and 189.8 m and its thickness is about 1.1 m and 0.8 m in Boreholes C3-S1 and C3-S2, respectively.

The SPT 'N'-values recorded within this deposit range from 2 blows to 13 blows per 0.3 m of penetration, indicating a very loose to compact relative density.

The natural water content measured on samples of this deposit ranges from about 22 percent to 27 percent.

A grain size distribution test carried out on a sample of this deposit is shown on Figure E.C3-1 in Appendix E.

### **Clayey Silt to Clay**

A stratum of brown and grey clayey silt to grey clay, trace to some silt and trace sand containing silt layers and silty clay seams was encountered below the sand and silt deposit in Boreholes C3-S1 and C3-S2, and below the ice and water cover in Borehole C3-S3. The upper portion of this stratum contains organics and rootlets in Borehole C3-S3. The top of this stratum ranges from about Elevation 189.3 m to 188.9 m and its thickness ranges from about 4.9 m to 7.9 m. Borehole C3-S3 was terminated within this stratum upon refusal to casing advancement.

The SPT 'N'-values recorded within the cohesive stratum range from 0 blows (weight of hammer) to 3 blows per 0.3 m of penetration. In situ field vane tests carried out within this stratum measured undrained shear strengths typically between about 19 kPa and 31 kPa, but a shear strength of about 96 kPa was measured at the transition between the silty clay to clayey silt in Borehole C3-S3. The sensitivity is calculated to range between about 3 and 5. The field vane tests results together with the SPT 'N'-values indicate that the clayey silt to clay stratum has a very soft to stiff consistency, typically soft to firm.

The natural water content measured on samples of this stratum ranges from about 34 percent to 92 percent.





The grain size distribution tests carried out on two (2) specimens from the clayey silt and silty clay portion of this cohesive stratum are shown on Figure E.C3-2 in Appendix E.

Atterberg limits tests were carried out on five (5) specimens of this cohesive stratum. The liquid limits range from about 27 percent to 63 percent, the plastic limits range from about 17 percent to 23 percent, and the plasticity indices range from about 6 percent to 40 percent. The results of the Atterberg limits tests are shown on the plasticity chart on Figure E.C3-3 in Appendix E and indicate that the material is classified as clayey silt of low plasticity to clay of high plasticity.

### **Silt**

Underlying the clayey silt to clay stratum Boreholes C3-S1 and C3-S2 encountered a deposit of grey silt, trace to some sand and trace to some clay containing layers of silty clay and sand at discrete intervals. The top of this deposit is at about Elevation 184.4 m and 183.4 m and its thickness is about 0.6 m and 1.7 m in Boreholes C3-S1 and C3-S2, respectively. The bottom of this deposit was defined by refusal to further split-spoon and/or casing advancement in these boreholes.

The SPT 'N'-values recorded within this deposit are 3 blows and 26 blows per 0.3 m of penetration, with an SPT 'N'-value of 25 blows per 0.18 m of penetration recorded prior to split-spoon refusal, generally indicating a very loose to compact relative density.

The natural water content measured on two (2) samples of this deposit is about 24 percent and 29 percent.

The grain size distribution tests carried out on two (2) specimens of this deposit are shown on Figure E.C3-4 in Appendix E.

Atterberg limits tests were carried out on two (2) specimens of this stratum. One of the Atterberg limits tests indicates the material to be non plastic and the other Atterberg limits test measured a liquid limit of about 21 percent, a plastic limit of about 18 percent and a corresponding plasticity index of about 3 percent. The results of the Atterberg limits test are shown on the plasticity chart on Figure E.C3-5 in Appendix E and classified the material as silt of low plasticity.

### **Refusal**

In Boreholes C3-S1 to C3-S3, refusal to further split-spoon and/or casing advancement was encountered at depths between about 7.3 m and 8.9 m below ground or ice surface, corresponding to Elevation 183.8 m and 181.0 m.

### **Groundwater Conditions**

In general, the samples taken in the boreholes were moist to wet. The water levels observed in the boreholes upon completion of drilling range between about Elevation 189.7 m and 189.1 m, measured either at the ice surface or at a depth of about 1.5 m below ground surface.

## **4.10 Highway 69 SBL – STA 14+415 (Culvert C1)**

The plan and profile along the culvert centreline showing the borehole locations and interpreted stratigraphy at approximately STA 14+415 in the Township of Mowat are shown on Drawing F1 in Appendix F. The culvert will extend across a swamp area (Swamp 307) and the proposed Highway 69 SBL embankment which will be up to about 3 m above the existing grade at the proposed culvert location. A total of three (3) boreholes





(Boreholes C1-S1 to C1-S3, inclusive) were advanced along the length of the culvert to investigate the subsurface conditions at this culvert location. The topography in the area consists of a flat to low-lying swamp with wet grassy areas and shallow ponded water in places, located within the confines of tree covered valley slopes to the north and south.

In general, the subsurface soils along the culvert alignment consist of a surficial deposit of root mat/sandy peat to peat underlain by a stratum of clayey silt to silty clay which extends to refusal depth/granite gneiss bedrock. Bedrock outcrops are present to the north and south of the swamp.

### **Ice / Water**

Ice and/or water to depths of about 0.1 m and 0.5 m was encountered in all boreholes at this culvert location.

### **Root Mat / Sandy Peat to Peat**

A deposit of dark brown to black, wet, root mat/sandy peat to peat containing rootlets was encountered underlying the ice and/or water in all boreholes at this culvert location. The top of this deposit ranges from about Elevation 192.7 m to 192.3 m and its thickness ranges from about 0.8 m to 1.0 m.

The natural water content measured on a sample of this deposit is about 299 percent.

### **Clayey Silt to Silty Clay**

A stratum of grey clayey silt to silty clay, trace gravel and trace sand containing peat and rootlets was encountered below the root mat/sandy peat to peat deposit in all boreholes at this culvert location. The top of this stratum ranges from about Elevation 191.8 m to 191.4 m and its thickness ranges from about 0.4 m to 3.1 m. The bottom of this deposit was defined by refusal to further split-spoon and casing advancement or cone penetration in Boreholes C1-S1 and C1-S3 and by bedrock in Borehole C1-S2.

The SPT 'N'-values recorded within the cohesive stratum typically range from 0 blows (weight of hammer) to 9 blows per 0.3 m of penetration, with an SPT 'N'-value of 28 blows per 0.08 m of penetration recorded prior to split-spoon refusal in Borehole C1-S1. In situ field vane tests carried out within this stratum measured undrained shear strengths between about 45 kPa and 96 kPa, and the sensitivity is calculated to be about 4 and 5. The field vane tests results together with the SPT 'N'-values indicate that the clayey silt to silty clay stratum has a very soft to stiff consistency, typically firm to stiff.

The natural water content measured on samples of this stratum ranges from about 28 percent to 36 percent.

A grain size distribution test carried out on a sample from the clayey silt portion of this cohesive stratum is shown on Figure F.C1-1 in Appendix F.

Atterberg limits tests were carried out on four (4) specimens of this cohesive stratum. The liquid limits range from about 28 percent to 41 percent, the plastic limits range from about 16 percent to 20 percent, and the plasticity indices range from about 8 percent to 25 percent. The results of the Atterberg limits tests are shown on the plasticity chart on Figure F.C1-2 in Appendix F and indicate that the material is clayey silt to silty clay of low to intermediate plasticity.





## **Bedrock / Refusal**

In Boreholes C1-S1 and C1-S3, refusal to further split-spoon and casing advancement or cone penetration was encountered at depths of about 4.5 m and 2.7 m below ice surface, corresponding to about Elevation 188.3 m and 190.0 m.

Bedrock was encountered and core samples were recovered from Borehole C1-S2. The depth to the surface of the bedrock is about 1.5 m below ice surface, corresponding to about Elevation 191.3 m. The bedrock consists of granite gneiss and the core samples are described as dark grey with reddish pink lenses. The Rock Quality Designation (RQD) measured on the core sample is 70 percent, indicating a rock mass of fair quality. The Total Core Recovery (TCR) and Solid Core Recovery (SCR) of the core sample are 95 percent and 83 percent, respectively.

## **Groundwater Conditions**

In general, the samples taken in the boreholes were wet. The water levels observed in the boreholes upon completion of drilling range between about Elevation 192.8 m and 192.7 m, measured at the ice surface.

### **4.11 Highway 69 SBL – STA 13+426 (Culvert C346)**

The plan and profile along the culvert centreline showing the borehole locations and interpreted stratigraphy at approximately STA 13+426 in the Township of Mowat are shown on Drawing G1 in Appendix G. The culvert will extend across a swamp area (Swamp 310) and the proposed Highway 69 SBL embankment which will be up to about 2 m above the existing grade at the proposed culvert location. A total of three (3) boreholes (Boreholes C346-1 to C346-3, inclusive) were advanced along the length of the culvert to investigate the subsurface conditions at this culvert location. In addition, a Dynamic Cone Penetration Test (DCPT C346-DC01) was advanced near the east end of culvert to further confirm the depth to refusal in this area. The topography in the area is relatively low-lying with surface cover consisting of wet grassy areas, shallow open water and occasional bedrock outcrops, with upward sloping grass covered terrain towards the northern limit of the swamp.

In general, the subsurface soils along the culvert alignment consist of a surficial deposit of root mat/peat underlain by a deposit of organic silt and a stratum of clayey silt to silty clay. The clayey silt to silty clay stratum is in turn underlain by a deposit of silt which extends to refusal depth in places or underlain by a deposit of gravel. Bedrock outcrops are present to the north of the swamp.

## **Ice / Water**

Ice and/or water to depths of about 0.2 m and 0.3 m was encountered in all boreholes at this culvert location.

## **Root Mat / Peat**

A deposit of dark brown, wet, root mat/peat was encountered underlying the ice and/or water cover between about Elevation 194.4 m and 194.3 m in all boreholes at this culvert location. The thickness of the root mat/peat deposit is between about 1.4 m and 1.8 m.

The Standard Penetration Test (SPT) 'N'-values recorded within the root mat/peat deposit are 0 blows (weight of hammer/weight of sampler and rod) per 0.3 m of penetration, indicating a very soft consistency.

The natural water content measured on a sample of this deposit is about 916 percent.





## Organic Silt

A stratum of grey organic silt, some sand and trace to some clay containing peat and rootlets was encountered underlying the root mat/peat deposit in all boreholes at this culvert location. The top of this stratum ranges from about Elevation 193.0 m to 192.6 m and its thickness ranges from about 0.4 m to 0.7 m.

The SPT 'N'-values measured within this stratum are 0 blows (weight of hammer/weight of sampler and rod), indicating a very loose relative density.

The natural water content measured on a sample of this stratum is about 158 percent and the organic content measured on a sample of this stratum is about 13 percent.

A grain size distribution test carried out on a sample of this stratum is shown on Figure G.C346-1 in Appendix G.

## Clayey Silt to Silty Clay

A stratum of grey clayey silt to silty clay and trace sand containing layers of silt was encountered below the organic silt deposit in all boreholes at this culvert location. The top of this stratum ranges from about Elevation 192.6 m to 192.0 m and its thickness ranges from about 1.2 m to 3.7 m.

The SPT 'N'-values recorded within the cohesive stratum are 0 blows (weight of hammer) and 1 blow per 0.3 m of penetration. In situ field vane tests carried out within this stratum measured undrained shear strengths between about 10 kPa and 23 kPa, and the sensitivity is calculated to be about 3 and 4. The field vane tests results together with the SPT 'N'-values indicate that the clayey silt to silty clay stratum has a very soft to soft consistency.

The natural water content measured on samples of this stratum ranges from about 45 percent to 108 percent.

A grain size distribution test carried out on a sample from the clayey silt portion of this cohesive stratum is shown on Figure G.C346-2 in Appendix G.

Atterberg limits tests were carried out on four (4) specimens of this cohesive stratum. The liquid limits range from about 31 percent to 43 percent, the plastic limits range from about 17 percent to 20 percent, and the plasticity indices range from about 11 percent to 23 percent. The results of the Atterberg limits tests are shown on the plasticity chart on Figure G.C346-3 in Appendix G and indicate that the material is clayey silt to silty clay of low to intermediate plasticity.

## Silt

A deposit of grey silt, trace to some sand, trace to some clay and trace gravel containing silty clay and sand seams was encountered below the clayey silt to silty clay stratum in all boreholes at this culvert location. The top of this deposit ranges from about Elevation 191.4 m to 188.5 m and its thickness ranges from about 0.5 m to 1.0 m. Boreholes C346-1 and C346-3 and a DCPT driven from the bottom of Borehole C346-3 were terminated within this deposit upon refusal to further split-spoon and casing advancement or cone penetration.

The SPT 'N'-values measured within the silt stratum range from 1 blow to 28 blows per 0.3 m of penetration, indicating a very loose to compact relative density.

The natural water content measured on two (2) samples of this stratum is about 27 percent and 36 percent.

The grain size distribution tests carried out on two (2) samples of this deposit are shown on Figure G.C346-4 in Appendix G.





Atterberg limits tests were carried out on two (2) specimens of this stratum. One of the Atterberg limits tests indicate the material to be non plastic and the other Atterberg limits test measured a liquid limit of about 23 percent, a plastic limit of about 20 percent and a corresponding plasticity index of about 3 percent. The results of the Atterberg limits test are shown on the plasticity chart on Figure G.C346-5 in Appendix G and classified the material as silt of low plasticity.

### **Gravel**

An approximately 0.5 m thick deposit of grey gravel and some sand was encountered below the silt deposit at about Elevation 189.0 m in Borehole C346-S2. The bottom of this deposit was defined by refusal to further split-spoon and casing advancement.

A SPT 'N'-value recorded within this deposit prior to split-spoon and casing refusal is 45 blows per 0.18 m of penetration, indicating a dense relative density.

### **Refusal**

In Boreholes C346-S1 to C346-S3 and DCPT C346-DC01, refusal to further split-spoon and casing advancement or cone penetration was encountered at depths between about 3.9 m and 6.6 m, corresponding to about Elevation 190.7 m and 188.0 m.

### **Groundwater Conditions**

In general, the samples taken in the boreholes were wet. The water level observed in the boreholes upon completion of drilling was at about Elevation 194.6 m, measured at the ice/water surface.

## **5.0 CLOSURE**

The field technicians directing the drilling program were Messrs. Matt Rhody and Domenic Mattiazzi. This report was prepared by Ms. T. Veronica Ayetan, P. Eng., and was reviewed by Mr. J. Paul Dittrich, Ph.D., P. Eng., a Senior Geotechnical Engineer and Principal with Golder. Mr. Jorge M. A. Costa, P. Eng., Golder's Designated MTO Contact for this project and Principal with Golder, conducted an independent quality control review of the report.





## FOUNDATION REPORT – CULVERTS – PHASE 3 HIGHWAY 69 G.W.P. 5203-06-00

### Report Signature Page

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Golder Associates Ltd. 2012. Foundation Investigation and Design Report, Wick Drain Foundation Treatment Areas – Phase 3, Highway 69 Four-laning, From 3.5 km North of Highway 522 Northerly to 4.5 km North of Highway 64, Ministry of Transportation, Ontario, G.W.P. 5203-06-00. Geocres No. 41H-106.

### STANDARDS:

ASTM International:

ASTM D1586	Standard Test Method for Standard Penetration Test (SPT) and Split-Barrel Sampling of Soils
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ASTM D2573	Standard Test Method for Field Vane Shear Test in Cohesive Soil
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Ontario Water Resources Act:

Ontario Regulation 903	Wells
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## LIST OF SYMBOLS

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

### I. GENERAL

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

### II. STRESS AND STRAIN

$\gamma$	shear strain
$\Delta$	change in, e.g. in stress: $\Delta \sigma$
$\varepsilon$	linear strain
$\varepsilon_v$	volumetric strain
$\eta$	coefficient of viscosity
$\nu$	Poisson's ratio
$\sigma$	total stress
$\sigma'$	effective stress ( $\sigma' = \sigma - u$ )
$\sigma'_{vo}$	initial effective overburden stress
$\sigma_1, \sigma_2, \sigma_3$	principal stress (major, intermediate, minor)
$\sigma_{oct}$	mean stress or octahedral stress $= (\sigma_1 + \sigma_2 + \sigma_3)/3$
$\tau$	shear stress
u	porewater pressure
E	modulus of deformation
G	shear modulus of deformation
K	bulk modulus of compressibility

### III. SOIL PROPERTIES

#### (a) Index Properties

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

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

#### (a) Index Properties (continued)

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

#### (b) Hydraulic Properties

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

#### (c) Consolidation (one-dimensional)

$C_c$	compression index (normally consolidated range)
$C_r$	recompression index (over-consolidated range)
$C_s$	swelling index
$C_{\alpha}$	secondary compression index
$m_v$	coefficient of volume change
$c_v$	coefficient of consolidation (vertical direction)
$c_h$	coefficient of consolidation (horizontal direction)
$T_v$	time factor (vertical direction)
U	degree of consolidation
$\sigma'_p$	pre-consolidation stress
OCR	over-consolidation ratio = $\sigma'_p / \sigma'_{vo}$

#### (d) Shear Strength

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

Notes: 1  
2

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





## LIST OF ABBREVIATIONS

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

### I. SAMPLE TYPE

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

### II. PENETRATION RESISTANCE

#### Standard Penetration Resistance (SPT), N:

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

#### Dynamic Cone Penetration Resistance; $N_d$ :

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

**PH:** Sampler advanced by hydraulic pressure

**PM:** Sampler advanced by manual pressure

**WH:** Sampler advanced by static weight of hammer

**WR:** Sampler advanced by weight of sampler and rod

#### Piezo-Cone Penetration Test (CPT)

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

### III. SOIL DESCRIPTION

#### (a) 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

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

### IV. SOIL TESTS

w	water content
$w_p$	plastic limit
$w_l$	liquid limit
C	consolidation (oedometer) test
CHEM	chemical analysis (refer to text)
CID	consolidated isotropically drained triaxial test <sup>1</sup>
CIU	consolidated isotropically undrained triaxial test with porewater pressure measurement <sup>1</sup>
$D_R$	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)
$\gamma$	unit weight

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

### V. MINOR SOIL CONSTITUENTS

Percent 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 (cohesionless) or With (cohesive)	Sand and Gravel Silty Clay with sand / Clayey Silt with sand





# LITHOLOGICAL AND GEOTECHNICAL ROCK DESCRIPTION TERMINOLOGY

## WEATHERINGS STATE

**Fresh:** no visible sign of weathering

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

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

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

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

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

## BEDDING THICKNESS

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

## JOINT OR FOLIATION SPACING

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

## GRAIN SIZE

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

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

## CORE CONDITION

### Total Core Recovery (TCR)

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

### Solid Core Recovery (SCR)

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

### Rock Quality Designation (RQD)

The percentage of solid drill core, greater than 100 mm length, recovered at full diameter, measured relative to the length of the total core run. RQD varied from 0% for completely broken core to 100% for core in solid sticks.

## DISCONTINUITY DATA

### Fracture Index

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

### Dip with Respect to Core Axis

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

### Description and Notes

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

### Abbreviations

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





## FOUNDATION REPORT – CULVERTS – PHASE 3 HIGHWAY 69 G.W.P. 5203-06-00

**TABLE 1  
SUMMARY OF CULVERT DETAILS**

<b>Culvert Designation</b>	<b>Culvert Location (Associated Swamp)</b>	<b>Approximate Proposed Embankment Height (m)</b>	<b>Invert Elevations<sup>1</sup></b>		<b>Culvert Dimensions<sup>2</sup></b>			<b>Head Walls and Wing Walls<sup>2</sup></b>	<b>Boreholes / DCPTs</b>
			<b>East End of Culvert (m)</b>	<b>West End of Culvert (m)</b>	<b>Width (m)</b>	<b>Height (m)</b>	<b>Length (m)</b>		
C6	Highway 69 SBL STA 18+133 (Swamp 302)	4.5	185.36	185.36	3	2.4	24	Yes	3 Boreholes (C6-S1, C6-S2 and C6-S3)
	Highway 69 NBL STA 18+133 (Swamp 302)	4.5	185.36	185.36	3	2.4	24	Yes	3 Boreholes (C6-N1, C6-N2 and C6-S3)
C5A	Highway 69 SBL and N-E/W Ramp STA 17+800 (Swamp 302)	4.0	188.78	188.78	3	2.4	28	Yes	3 Boreholes (C5A-S1, C5A-S2 AND 302-29)
	Highway 69 NBL STA 17+800 (Swamp 302)	4.5	189.12	189.12	3	2.4	20	Yes	3 Boreholes (C5A-N1, C5A-N2 AND 302-30)
C4A	Highway 69 SBL STA 16+293 (Swamp 305)	3.5	186.70	186.70	3	2.1	21	Yes	2 Boreholes (C4A-S1 and C4A-S2)
C4	Highway 69 SBL STA 16+232 (Swamp 305)	3.5	185.71	185.77	4	2.5	21	Yes	2 Boreholes (C4-S1 and C4-S2)
C3	Highway 69 SBL STA 15+653 (Swamp 306)	2.0	187.52	187.45	3	1.8	25	Yes	3 Boreholes (C3-S1, C3-S2 and C3-S3)
C1	Highway 69 SBL STA 14+415 (Swamp 307)	3.0	192.09	192.09	3	1.8	30	No	3 Boreholes (C1-S1, C1-S2 and C1-S3)





## FOUNDATION REPORT – CULVERTS – PHASE 3 HIGHWAY 69 G.W.P. 5203-06-00

**TABLE 1  
SUMMARY OF CULVERT DETAILS**

<b>Culvert Designation</b>	<b>Culvert Location (Associated Swamp)</b>	<b>Approximate Proposed Embankment Height (m)</b>	<b>Invert Elevations<sup>1</sup></b>		<b>Culvert Dimensions<sup>2</sup></b>			<b>Head Walls and Wing Walls<sup>2</sup></b>	<b>Boreholes / DCPTs</b>
			<b>East End of Culvert (m)</b>	<b>West End of Culvert (m)</b>	<b>Width (m)</b>	<b>Height (m)</b>	<b>Length (m)</b>		
C346	Highway 69 SBL STA 13+426 (Swamp 310)	2.0	193.24	193.34	3	1.8	27	No	3 Boreholes (C346-1, C346-2 and C346-3) 1 DCPT (C346-DC01)

Note: <sup>1</sup> Invert elevations and culvert dimensions provided by MRC on October 2, 2009.

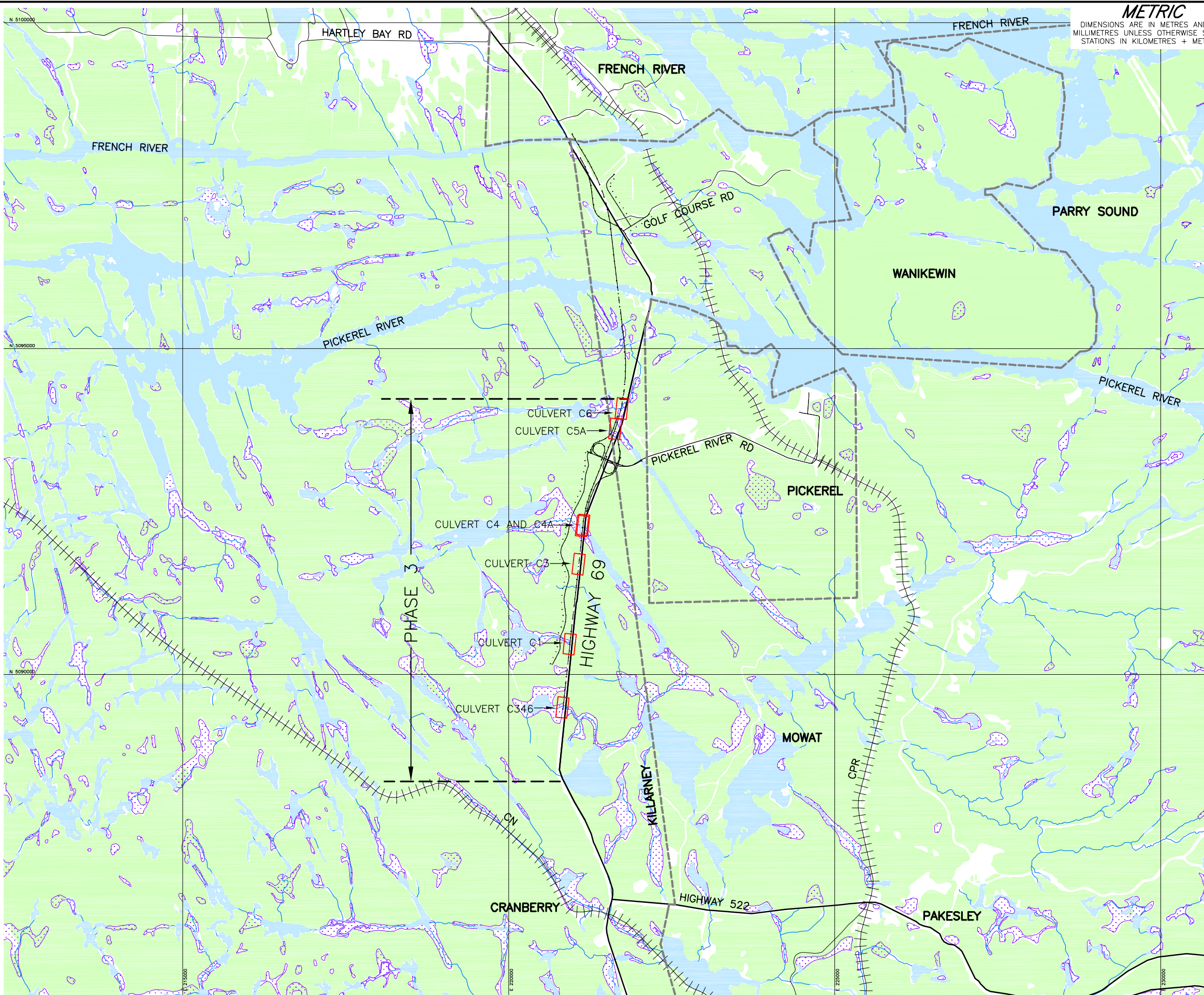
<sup>2</sup> Culvert dimensions/details provided by MRC on August 31, 2009.

\\mis1-s-filesrv1\data\active\2006\1111\06-1111-025 mrc hwy 69-522 to 64 french river\reporting\culverts\final\figures and tables\06-1111-025-2 tbl1 summary of culvert details.docx

Prepared By: TZ/VA

Reviewed By: JPD/JMAC





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

CONT No.  
GWP No. 5203-06-00

HIGHWAY 69  
CULVERTS IN WICK DRAIN  
FOUNDATION TREATMENT AREAS  
SITE LOCATION PLAN

SHEET

**Golder Associates**

**Golder Associates Ltd.**  
MISSISSAUGA, ONTARIO, CANADA

KEY PLAN  
NOT TO SCALE

NOTE

NOTE  
[Red rectangle symbol] APPROXIMATE LOCATION OF CULVERT AREAS  
(REFER TO DRAWING 2)

REFERENCE  
Base Data - MNR NRVIS, obtained 2004, CANMAP v2006.4  
Produced by Golder Associates Ltd under licence from  
Ontario Ministry of Natural Resources, © Queens Printer 2008  
Datum : NAD 83 Projection : MTM Zone 10

NO.	DATE	BY	REVISION

Geocres No.

HWY. 69	PROJECT NO. 06-1111-025	DIST.
SUBM'D. VA	CHKD. VA	DATE: Apr. 2012
DRAWN: DD/RJ	CHKD. JPD	APPD. JPD/JMAC
		DWG. 1





MFTRIC



SHEET



800 0 800 m

Base plans provided in digital format by MRC, drawing file no. PHASE 3 Plan 090211 – Golder.dwg, received February 11, 2009. Culverts provided in digital format by MRC, drawing file no. 6454 Culvert xsect Phase 3 – Mainline 090930.dwg received Oct. 02, 2009. KEY PLAN obtained from a digital file provided by CALLON DIETZ drawing file no. C-748-069-2.dwg received April 23, 2009.

NO.	DATE	BY	REVISION		
Geocres No.					
HWY.		PROJECT NO. 06-1111-025			SITE.
SUBM'D. VA		CHKD. VA	DATE: Apr. 2012		SITE:
DRAWN: JFC/RJ		CHKD. VA	APPD. JPD/JMAC		DWG. 2

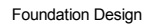




# **APPENDIX A**

## **Highway 69 SBL and NBL – STA 18+133 (Culvert C6)**



1 OF 1 **METRIC**

— CHECKED BY \_\_\_\_\_ VA \_\_\_\_\_

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

MIS-MTO 001 06-1111-025.GPJ GAL-MISS.GDT 1/25/12 SAC



**RECORD OF BOREHOLE No C6-S2**

1 OF 1 **METRIC**

PROJECT 06-1111-025

G.W.P. 5203-06-00

LOCATION N 5094095.8 ; E 221707.1

ORIGINATED BY MR

DIST HWY 69

BOREHOLE TYPE 115 mm O.D. Continuous Flight Solid Stem Augers and NW Casing, Wash Boring

COMPILED BY MWK/TZ

DATUM Geodetic

DATE March 3, 2009

CHECKED BY VA

SOIL PROFILE			SAMPLES			GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT			PLASTIC LIMIT   NATURAL MOISTURE CONTENT   LIQUID LIMIT			UNIT WEIGHT  γ  kN/m³	REMARKS & GRAIN SIZE DISTRIBUTION (%)			
ELEV DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE	"N" VALUES			SHEAR STRENGTH kPa			WATER CONTENT (%)							
								○ UNCONFINED      + FIELD VANE										
						● QUICK TRIAXIAL      × REMOULDED												
185.8	ICE SURFACE						20	40	60	80	100	10	20	30	GR	SA	SI	CL
0.0	Ice		1	SS	WH													
185.3	Sandy PEAT, containing rootlets																	
0.5	Very soft Black Wet		2A	SS	WH													
184.6	Organic CLAYEY SILT, containing roots		2B	SS	WH													
1.2	Very soft Dark grey Wet																	
	CLAYEY SILT, containing rootlets		3	SS	WH													
	Soft Grey Wet																	
			4	SS	1													
181.4																		
4.4	SILT, trace to some clay, trace sand, containing thin layers of sand		5	SS	5													
180.3	Loose Grey Wet																	
5.5	Sandy SILT, trace clay		6	SS	4													
	Very loose to Loose Grey Wet																	
			7	SS	5													
177.4																		
8.4	SAND, trace silt																	
	Very loose Grey Wet		8	SS	3													
175.8																		
10.0	END OF BOREHOLE CASING REFUSAL																	
	NOTE:  1. Water level in open borehole at ice surface (Elev. 185.8 m) upon completion of drilling.																	

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

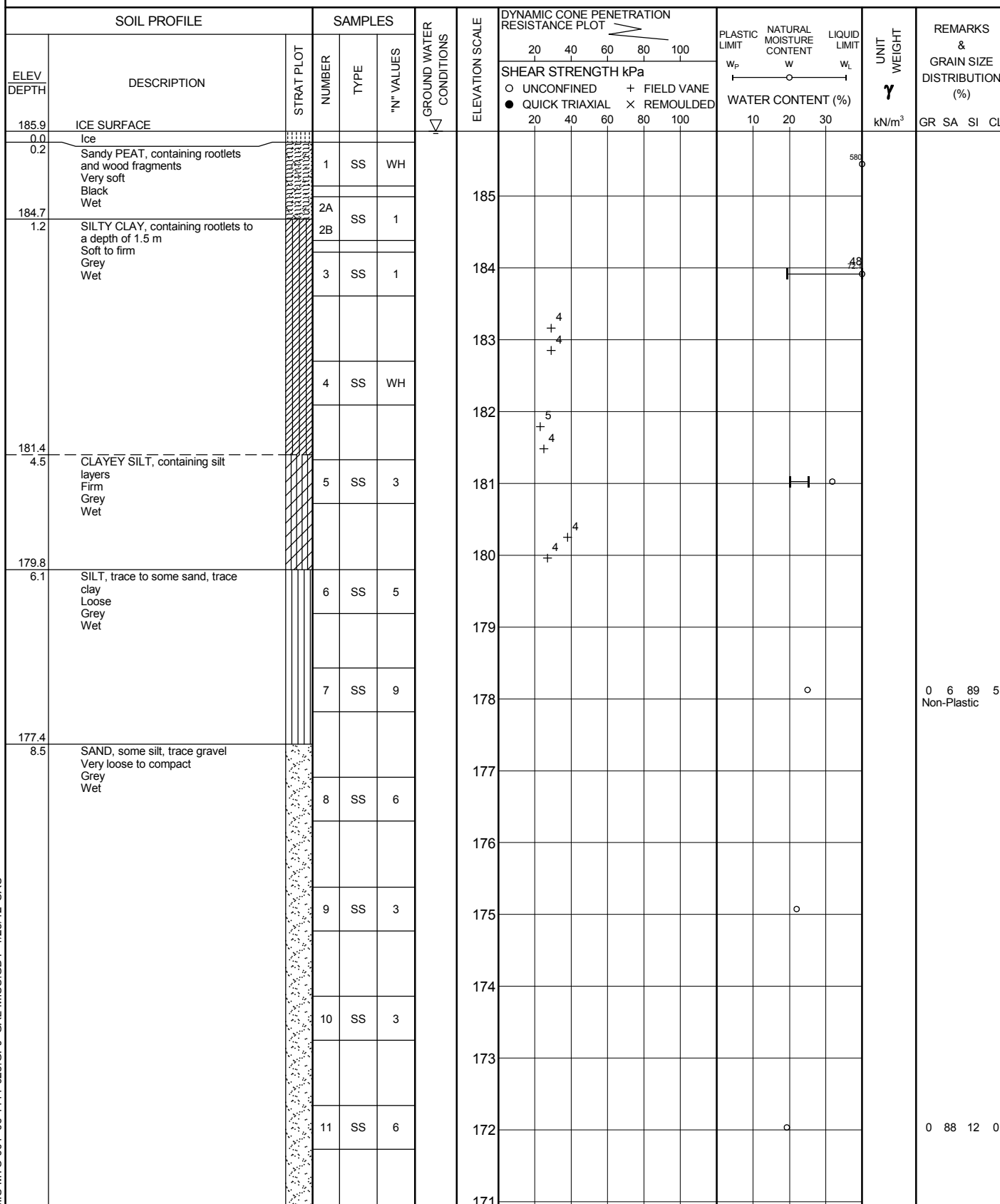


PROJECT		06-1111-025		<b>RECORD OF BOREHOLE No C6-S3</b>		1 OF 1 <b>METRIC</b>								
G.W.P.		5203-06-00		LOCATION		N 5094093.4 ; E 221717.8								
DIST		HWY 69		BOREHOLE TYPE		115 mm O.D. Continuous Flight Solid Stem Augers and NW Casing, Wash Boring								
DATUM		Geodetic		DATE		March 3, 2009								
				ORIGINATED BY		MR								
				COMPILED BY		MWK/TZ								
				CHECKED BY		VA								
SOIL PROFILE			SAMPLES			GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT		PLASTIC LIMIT W <sub>p</sub>	NATURAL MOISTURE CONTENT W	LIQUID LIMIT W <sub>L</sub>	UNIT WEIGHT γ kN/m <sup>3</sup>	REMARKS & GRAIN SIZE DISTRIBUTION (%) GR SA SI CL
ELEV DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE	"N" VALUES			SHEAR STRENGTH kPa						
185.9	GROUND SURFACE													
0.0	Sandy PEAT, containing rootlets Very soft Black Wet		1	SS	WH									
185.2														
0.7	Organic CLAYEY SILT, containing rootlets Very soft Dark grey Wet		2	SS	1									
184.7														
1.2	CLAYEY SILT, slightly organic and containing rootlets Soft Grey Wet		3	SS	1									
182.9														
3.0	SILTY CLAY Soft Grey Wet		4	SS	1									
181.4														
4.5	SILT, trace to some clay, trace sand Very loose Grey Wet		5	SS	3									
180.4														
5.5	Sandy SILT Loose Grey Wet		6	SS	7									
179.2														
6.7	SAND, trace to some silt, trace gravel, containing silt layers Loose to compact Grey Wet		7	SS	6									
			8	SS	11									
176.2														
9.7	END OF BOREHOLE CASING REFUSAL													
	NOTE:  1. Water level in open borehole at ground surface (Elev. 185.9 m) upon completion of drilling													

MIS-MTO 001 06-1111-025.GPJ GAL-MISS.GDT 1/25/12 SAC




PROJECT <u>06-1111-025</u>		<b>RECORD OF BOREHOLE No C6-N1</b>		1 OF 2		<b>METRIC</b>	
G.W.P. <u>5203-06-00</u>		LOCATION <u>N 5094085.1 ;E 221756.9</u>		ORIGINATED BY <u>MR</u>			
DIST <u>        </u> HWY <u>69</u>		BOREHOLE TYPE <u>115 mm O.D. Continuous Flight Solid Stem Augers and NW Casing, Wash Boring</u>		COMPILED BY <u>MWK/TZ</u>			
DATUM <u>Geodetic</u>		DATE <u>March 4, 2009</u>		CHECKED BY <u>VA</u>			



Continued Next Page

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



PROJECT <u>06-1111-025</u>				<b>RECORD OF BOREHOLE No C6-N1</b>				2 OF 2 <b>METRIC</b>										
G.W.P. <u>5203-06-00</u>		LOCATION <u>N 5094085.1 ; E 221756.9</u>				ORIGINATED BY <u>MR</u>												
DIST <u>          </u> HWY <u>69</u>		BOREHOLE TYPE <u>115 mm O.D. Continuous Flight Solid Stem Augers and NW Casing, Wash Boring</u>				COMPILED BY <u>MWK/TZ</u>												
DATUM <u>Geodetic</u>		DATE <u>March 4, 2009</u>				CHECKED BY <u>VA</u>												
SOIL PROFILE		SAMPLES			GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT					PLASTIC NATURAL LIQUID LIMIT MOISTURE LIMIT CONTENT			UNIT WEIGHT  $\gamma$ kN/m <sup>3</sup>	REMARKS & GRAIN SIZE DISTRIBUTION (%) GR SA SI CL		
ELEV DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE			"N" VALUES	SHEAR STRENGTH kPa					WATER CONTENT (%)					
	--- CONTINUED FROM PREVIOUS PAGE ---						<div style="display: flex; justify-content: space-between;"> <span>20 40 60 80 100</span> <span>20 40 60 80 100</span> </div> <div style="display: flex; justify-content: space-between;"> <span>○ UNCONFINED + FIELD VANE</span> <span>● QUICK TRIAXIAL × REMOULDED</span> </div>					<div style="display: flex; justify-content: space-between;"> <span>W<sub>p</sub></span> <span>W</span> <span>W<sub>L</sub></span> </div>						
170.4 15.5	END OF BOREHOLE		12	SS	12		170											
167.9 18.0	END OF DCPT Refusal to Further Penetration (50 Blows / 0.03 m)  NOTES:  1. Water level in open borehole at ice surface (Elev. 185.9 m) upon completion of drilling.  2. A Dynamic Cone Penetration Test was carried out below a depth of 15.5 m; refusal encountered at a depth of 18.0 m (Elev. 167.9 m)						169											
							168											



MIS-MTO 001 06-1111-025.GPJ GAL-MISS.GDT 1/25/12 SAC

Continued Next Page


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



PROJECT <u>06-1111-025</u>		<b>RECORD OF BOREHOLE No C6-N2</b>				2 OF 2 <b>METRIC</b>											
G.W.P. <u>5203-06-00</u>		LOCATION <u>N 5094087.6 ;E 221745.2</u>				ORIGINATED BY <u>MR</u>											
DIST <u>          </u> HWY <u>69</u>		BOREHOLE TYPE <u>115 mm O.D. Continuous Flight Solid Stem Augers and NW Casing, Wash Boring</u>				COMPILED BY <u>MWK/TZ</u>											
DATUM <u>Geodetic</u>		DATE <u>March 4, 2009</u>				CHECKED BY <u>VA</u>											
SOIL PROFILE		SAMPLES			GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT					PLASTIC NATURAL LIQUID LIMIT MOISTURE LIMIT CONTENT			UNIT WEIGHT  <b>γ</b>  kN/m <sup>3</sup>	REMARKS & GRAIN SIZE DISTRIBUTION (%)  GR SA SI CL	
ELEV DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE			"N" VALUES	SHEAR STRENGTH kPa					W <sub>p</sub>	W			W <sub>L</sub>
	--- CONTINUED FROM PREVIOUS PAGE ---																
	END OF DCPT Refusal to Further Penetration (50 Blows / 0.20 m)  NOTES:  1. Water level in open borehole at 0.2 m below ground surface (Elev. 185.7 m) upon completion of drilling.  2. A Dynamic Cone Penetration Test was carried out below a depth of 12.3 m; refusal encountered at a depth of 14.6 m (Elev. 171.3 m).																

MIS-MTO 001 06-1111-025.GPJ GAL-MISS.GDT 1/25/12 SAC

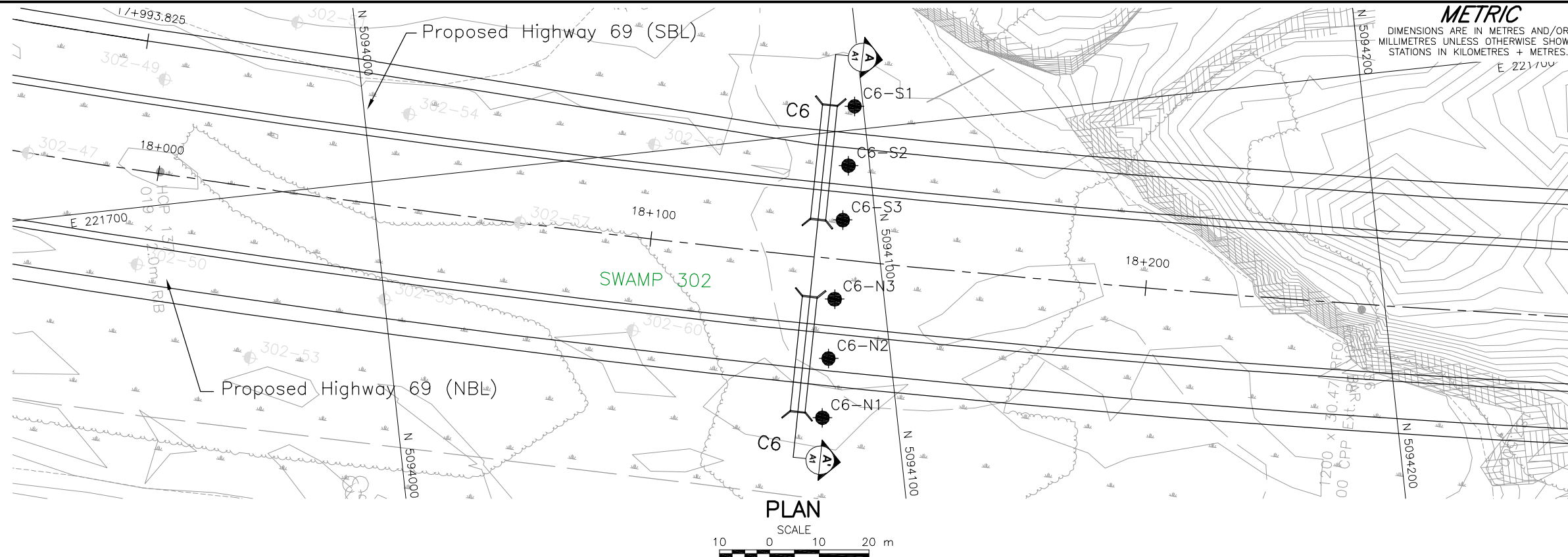


PROJECT 06-1111-025			<b>RECORD OF BOREHOLE No C6-N3</b>			1 OF 1 <b>METRIC</b>															
G.W.P. 5203-06-00			LOCATION N 5094090.1 ; E 221733.5			ORIGINATED BY MR															
DIST _____ HWY 69			BOREHOLE TYPE 115 mm O.D. Continuous Flight Solid Stem Augers and NW Casing, Wash Boring			COMPILED BY MWK/TZ															
DATUM Geodetic			DATE March 4 & 5, 2009			CHECKED BY VA															
SOIL PROFILE			SAMPLES			DYNAMIC CONE PENETRATION RESISTANCE PLOT			PLASTIC LIMIT NATURAL MOISTURE CONTENT LIQUID LIMIT			UNIT WEIGHT			REMARKS & GRAIN SIZE DISTRIBUTION (%)						
ELEV DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE	"N" VALUES	GROUND WATER CONDITIONS	ELEVATION SCALE	SHEAR STRENGTH kPa					WATER CONTENT (%)			γ			GR SA SI CL		
185.9	GROUND SURFACE							20 40 60 80 100	20 40 60 80 100	W <sub>p</sub>	W	W <sub>L</sub>	10 20 30								
0.0	Sandy PEAT, containing rootlets Very soft Dark Brown Wet		1	SS	2																
185.2	Organic CLAYEY SILT, containing rootlets Very soft Grey Wet		2	SS	1			185													
184.7	CLAYEY SILT, containing rootlets to a depth of 2.6 m Soft to firm Grey Wet		3	SS	WH			184													
1.2			4	SS	WH			183	5 +												
			5	SS	1			182	4 +												
								181													
								180	5 +												
180.0	SILT, some clay, trace sand Loose Grey Wet		6	SS	6			179													
178.9	SAND and SILT, trace clay Very loose to Loose Grey Wet		7	SS	6			178													
							177														
			8	SS	4		176														
							175														
			9	SS	5		174														
174.0	END OF BOREHOLE CASING REFUSAL																				
11.9	NOTE:  1. Water level in open borehole at a depth of 0.2 m below ground surface (Elev. 185.7 m) upon completion of drilling.																				

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

MIS-MTO 001 06-1111-025.GPJ GAL-MISS.GDT 1/25/12 SAC





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

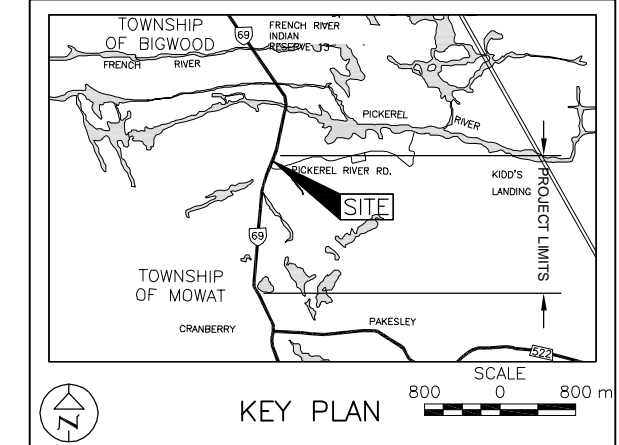
CONT No.  
 GWP No.5203-06-00

HIGHWAY 69 (SBL AND NBL)  
 CULVERT STA 18+133

SHEET

BOREHOLE LOCATION AND SOIL STRATA

**Golder Associates Ltd.**  
 MISSISSAUGA, ONTARIO, CANADA



**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
- R Refusal

No.	ELEVATION	CO-ORDINATES	
		NORTHING	EASTING
C6-S1	185.8	5094098.3	221695.3
C6-S2	185.8	5094095.8	221707.1
C6-S3	185.9	5094093.4	221717.8
C6-N1	185.9	5094085.1	221756.9
C6-N2	185.9	5094087.6	221745.2
C6-N3	185.9	5094090.1	221733.5

**NOTES**

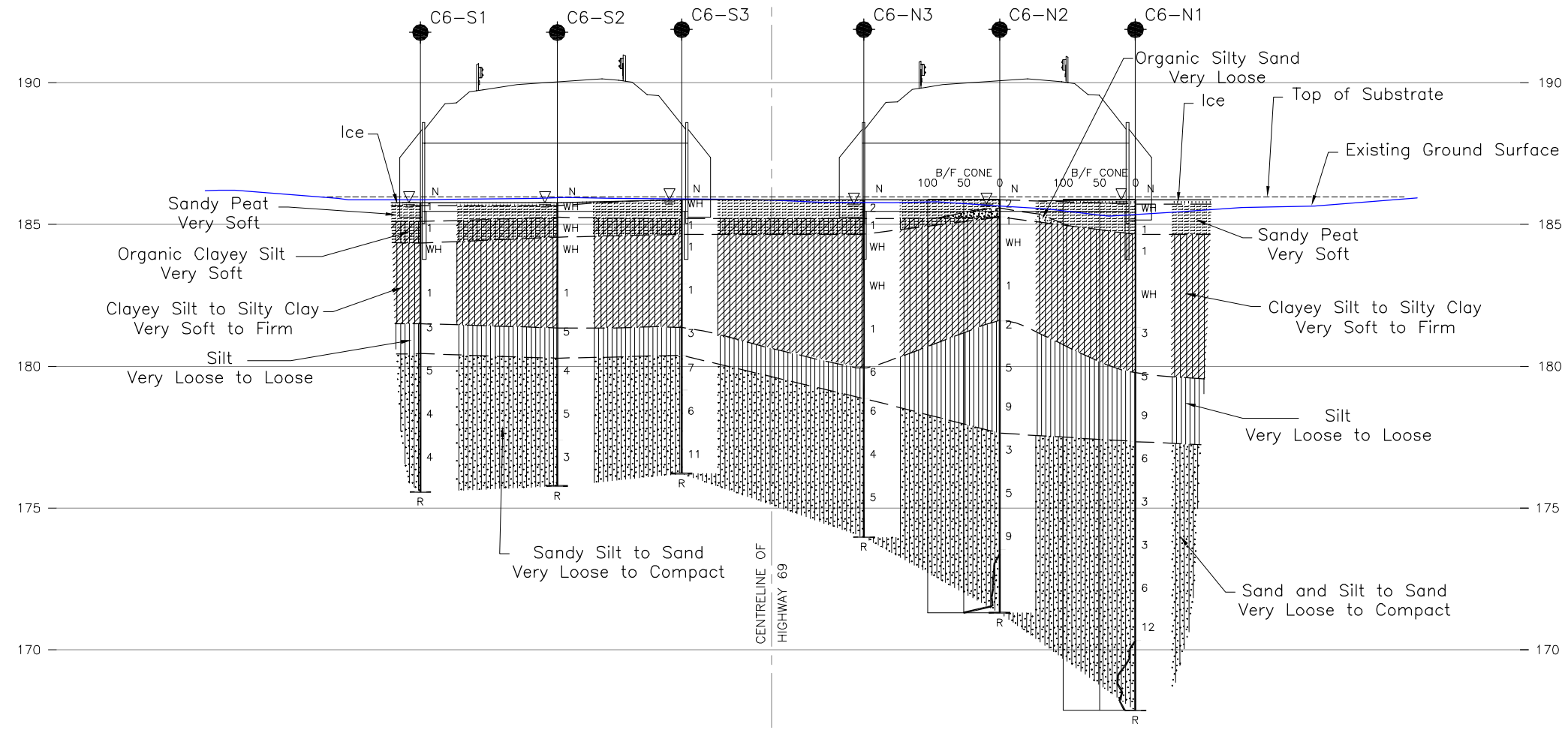
This drawing is for subsurface information only. The proposed structure details/works are shown for illustration purposes only and may not be consistent with the final design configuration as shown elsewhere in the Contracts Documents.

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 MRC, drawing file no. PHASE 3 Plan 090211 - Golder.dwg, received February 11, 2009. Culverts provided in digital format by MRC, drawing file no. 6454 Culvert xsect Phase 3 - Mainline 090930.dwg received Oct. 02, 2009. KEY PLAN obtained from a digital file provided by CALLON DIETZ drawing file no. C-748-069-2.dwg received April 23, 2009.



**CULVERT C6 PROFILE**

HORIZONTAL SCALE: 5 0 5 10 m  
 VERTICAL SCALE: 2 0 2 4 m

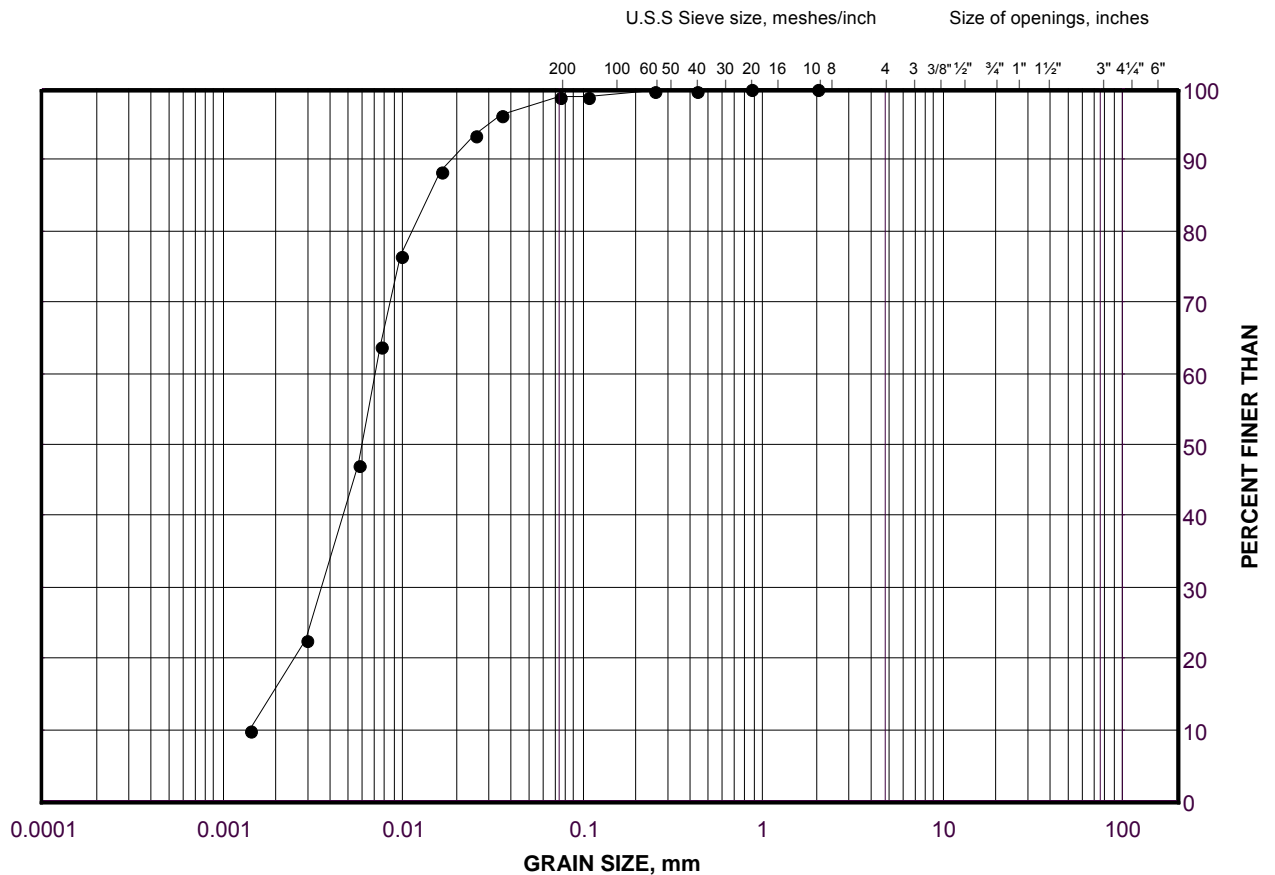
NO.	DATE	BY	REVISION
Geocres No. 41H-107			
HWY: 69			PROJECT NO. 06-1111-025 DIST.
SUBM'D. VA	CHKD. VA	DATE: Jan. 2012	SITE: 44-554/C1 & C2
DRAWN: JFC/RJ	CHKD. VA	APPD. JPD/JMAC	DWG. A1



# GRAIN SIZE DISTRIBUTION

Clayey Silt  
Highway 69 (SBL) STA 18+133

FIGURE A.C6-1



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

## LEGEND

SYMBOL	BOREHOLE	SAMPLE	ELEVATION(m)
•	C6-S3	3	184.1

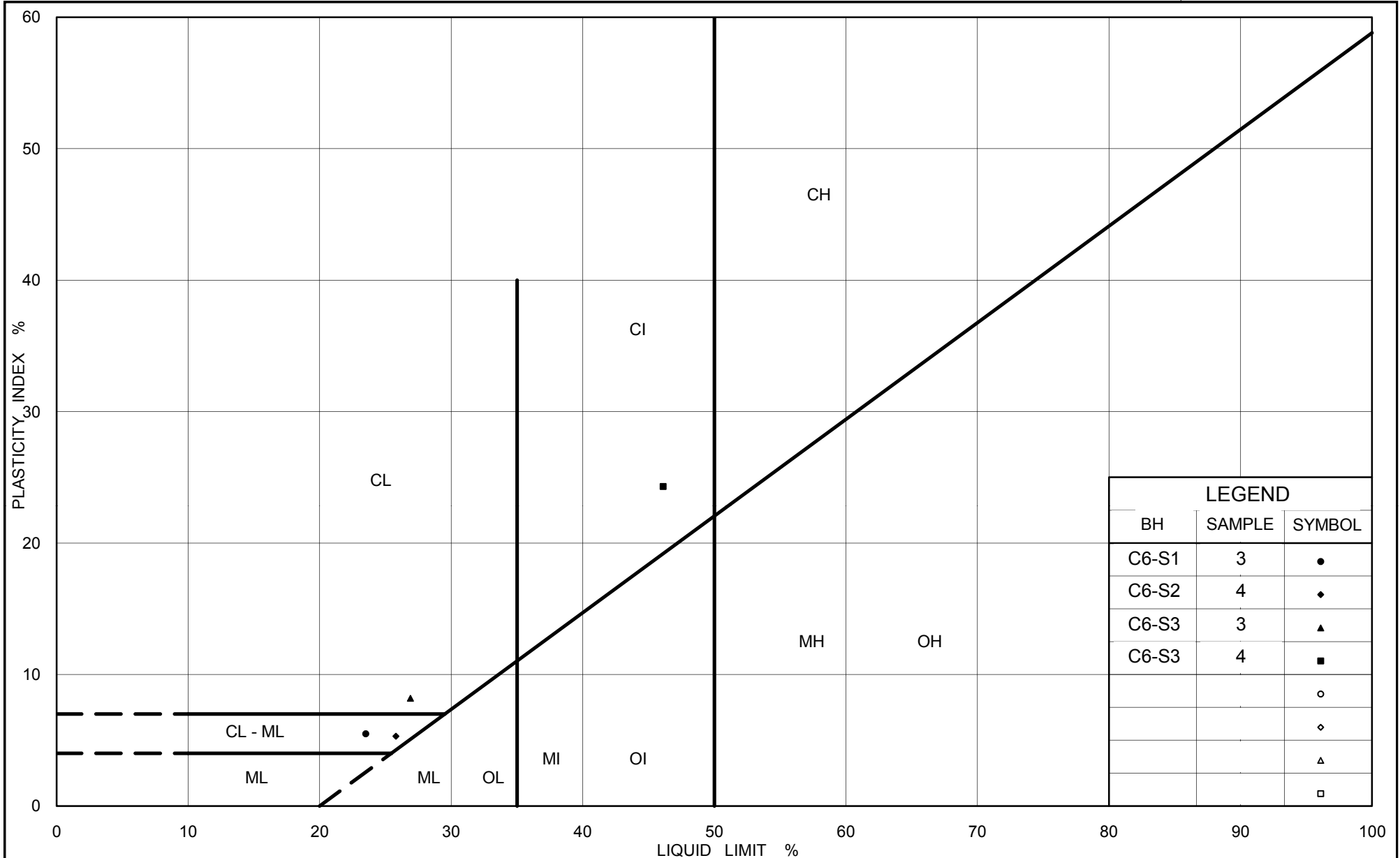
Project Number: 06-1111-025

Checked By: TVA

Golder Associates

Date: 04-Nov-09





Ministry of Transportation

Ontario

**PLASTICITY CHART**  
 Clayey Silt to Silty Clay  
 Highway 69 (SBL) STA 18+133

Figure No. A.C6-2

Project No. 06-1111-025

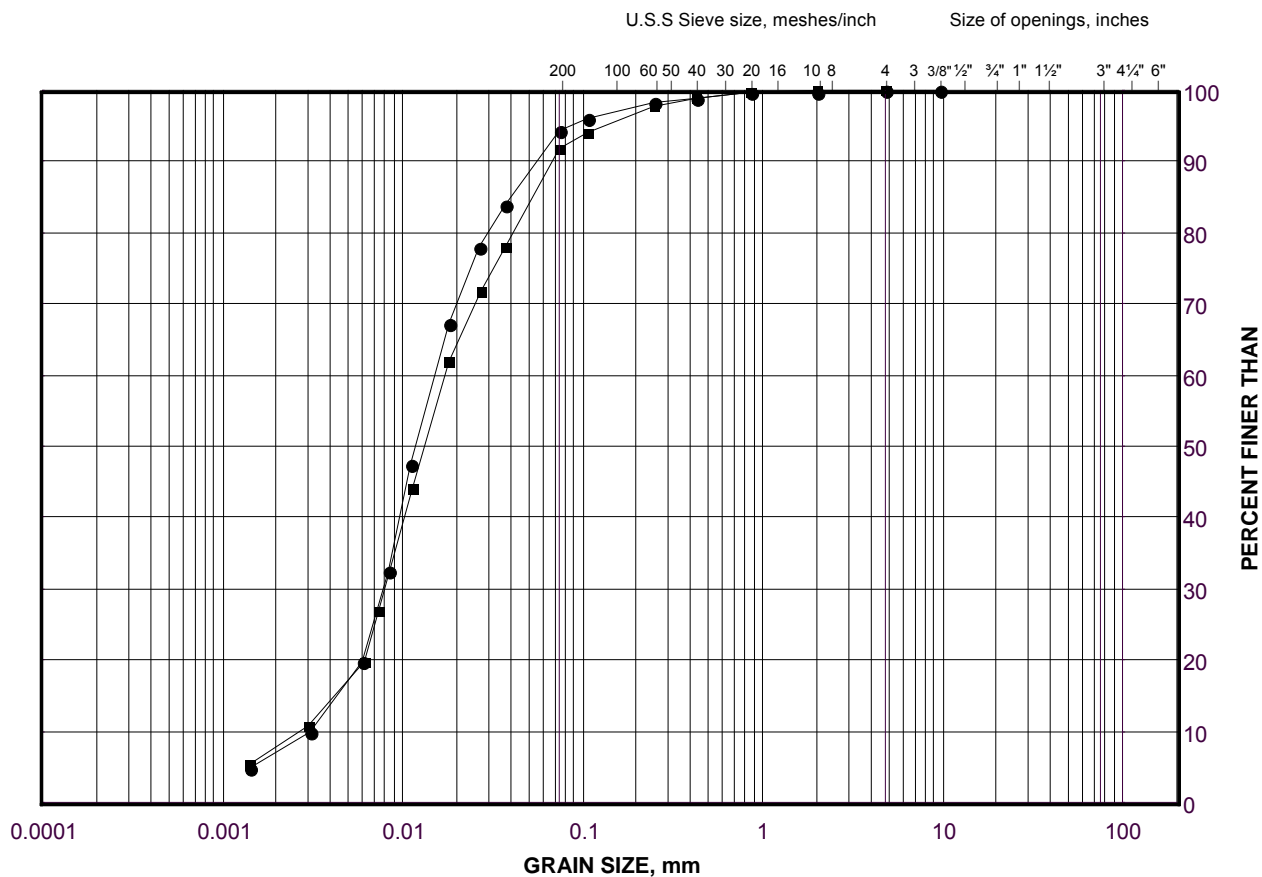
Checked By: TVA



# GRAIN SIZE DISTRIBUTION

Silt  
Highway 69 (SBL) STA 18+133

FIGURE A.C6-3



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

## LEGEND

SYMBOL	BOREHOLE	SAMPLE	ELEVATION(m)
●	C6-S3	5	181.0
■	C6-S1	5	181.2

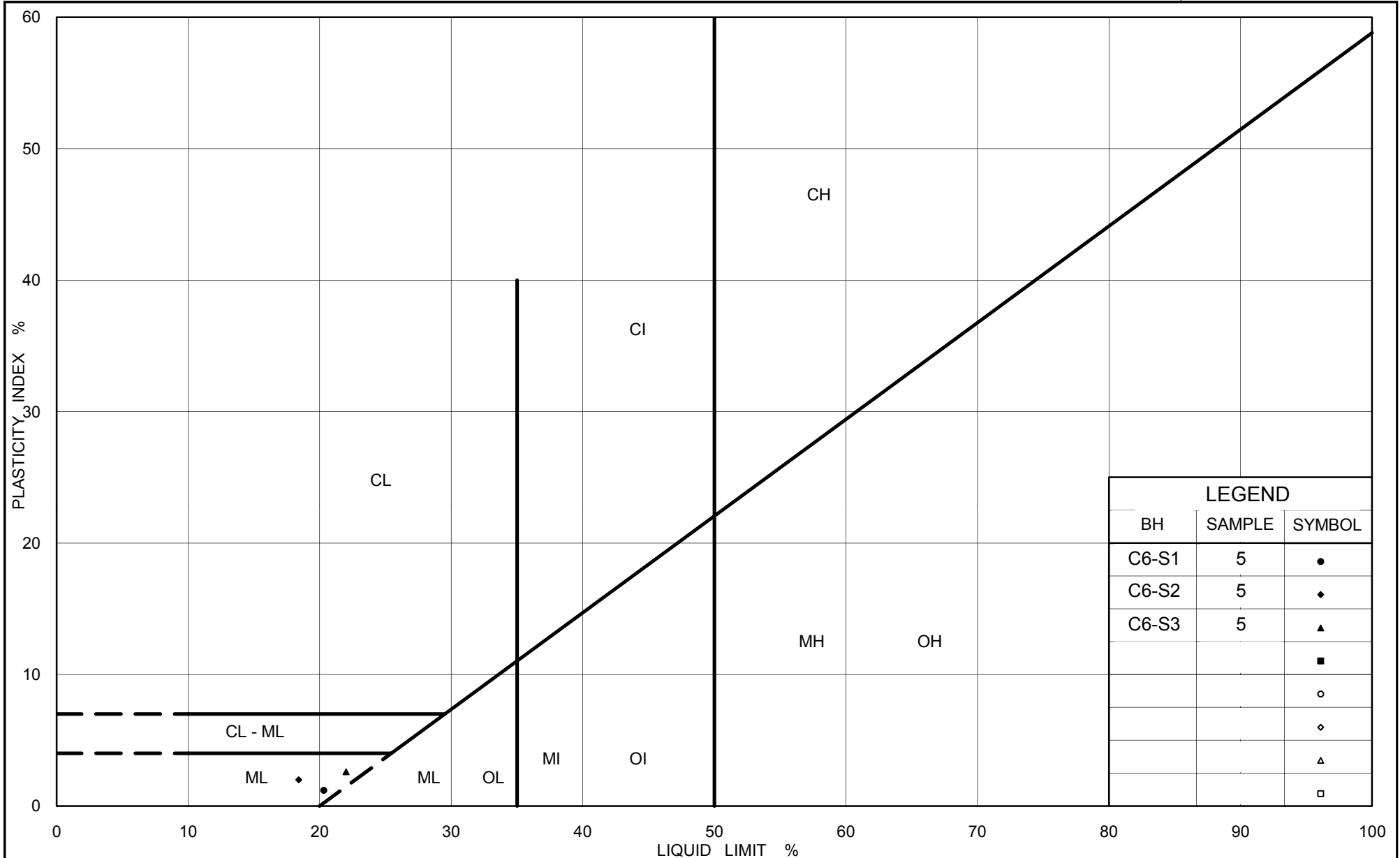
Project Number: 06-1111-025

Checked By: TVA

**Golder Associates**

Date: 04-Nov-09





Ministry of Transportation

Ontario

PLASTICITY CHART  
Silt  
Highway 69 (SBL) STA 18+133

Figure No. A.C6-4

Project No. 06-1111-025

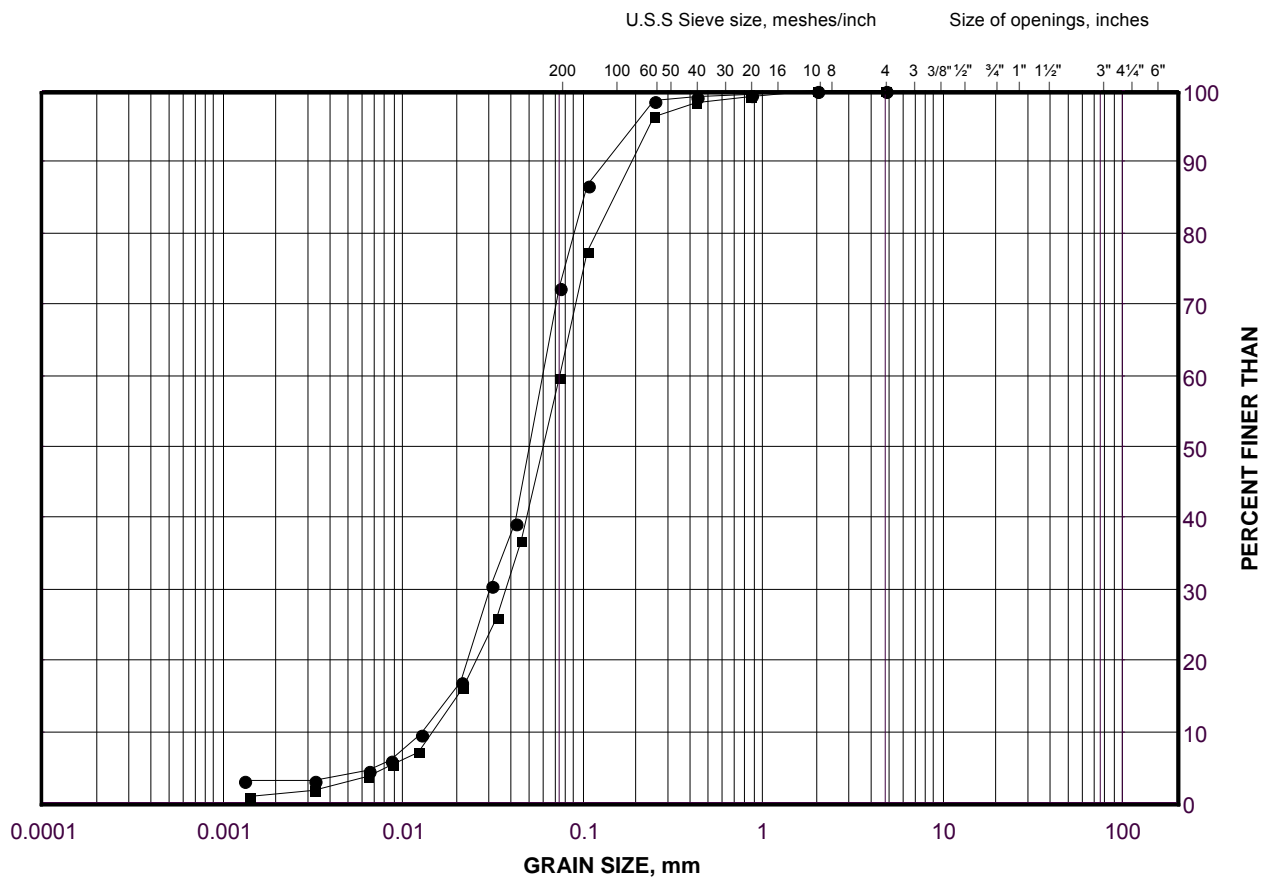
Checked By: TVA



# GRAIN SIZE DISTRIBUTION

Sandy Silt to Sand and Silt  
Highway 69 (SBL) STA 18+133

FIGURE A.C6-5



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

## LEGEND

SYMBOL	BOREHOLE	SAMPLE	ELEVATION(m)
●	C6-S2	7	178.2
■	C6-S1	7	178.2

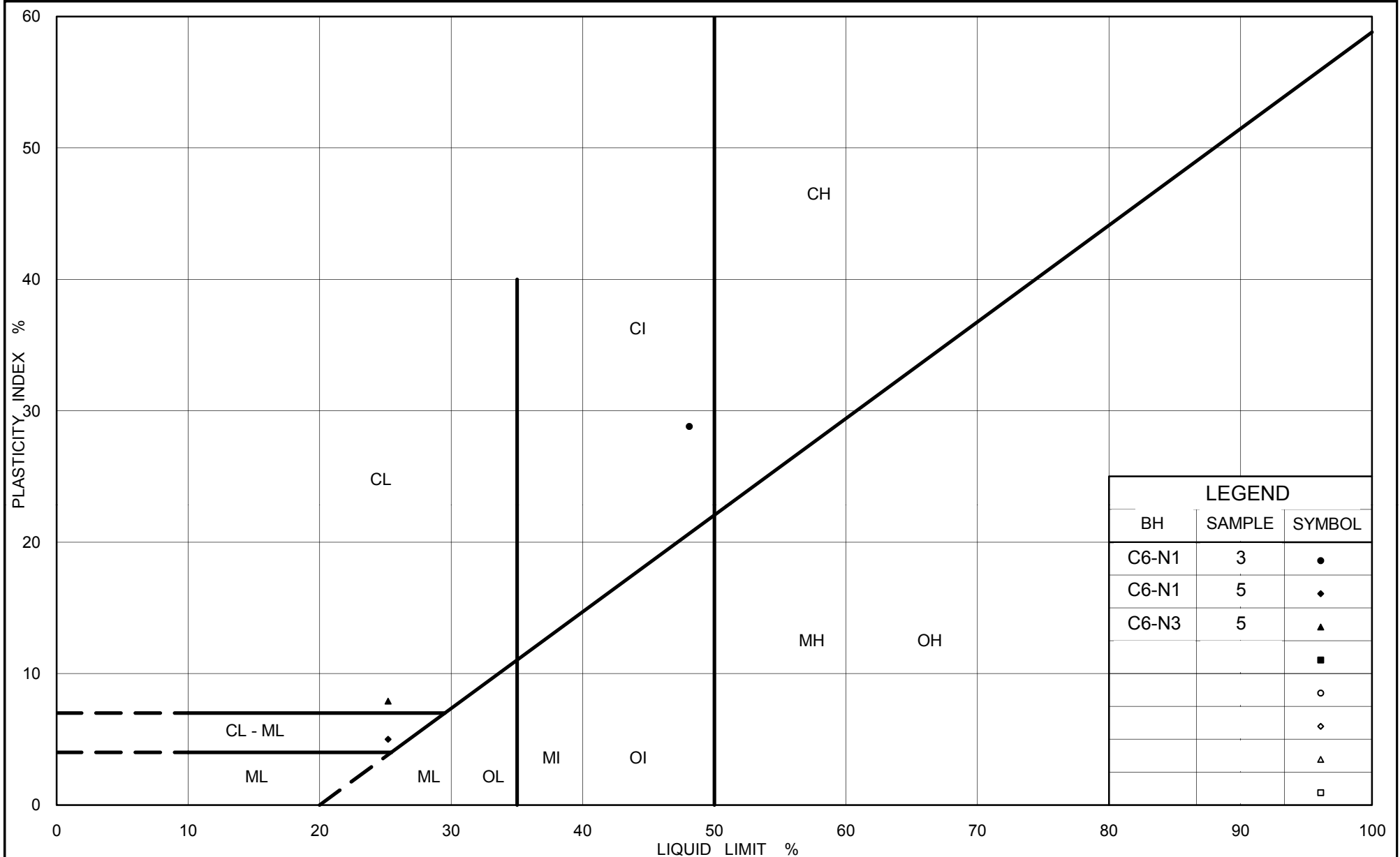
Project Number: 06-1111-025

Checked By: TVA

**Golder Associates**

Date: 04-Nov-09





Ministry of Transportation

Ontario

**PLASTICITY CHART**  
 Clayey Silt to Silty Clay  
 Highway 69 (NBL) STA 18+133

Figure No. A.C6-6

Project No. 06-1111-025

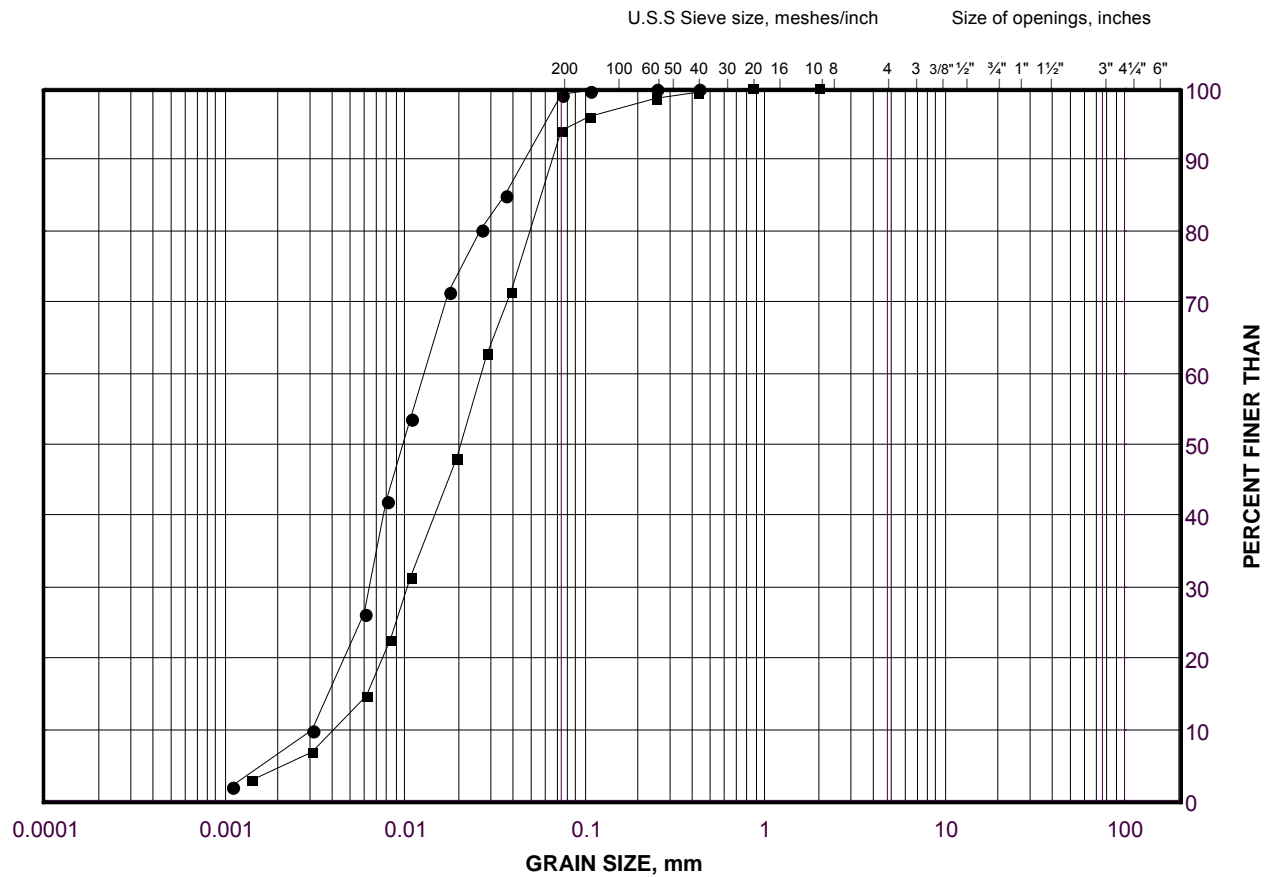
Checked By: TVA



# GRAIN SIZE DISTRIBUTION

Silt  
Highway 69 (NBL) STA 18+133

FIGURE A.C6-7



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

## LEGEND

SYMBOL	BOREHOLE	SAMPLE	ELEVATION(m)
●	C6-N2	6	179.9
■	C6-N1	7	178.1

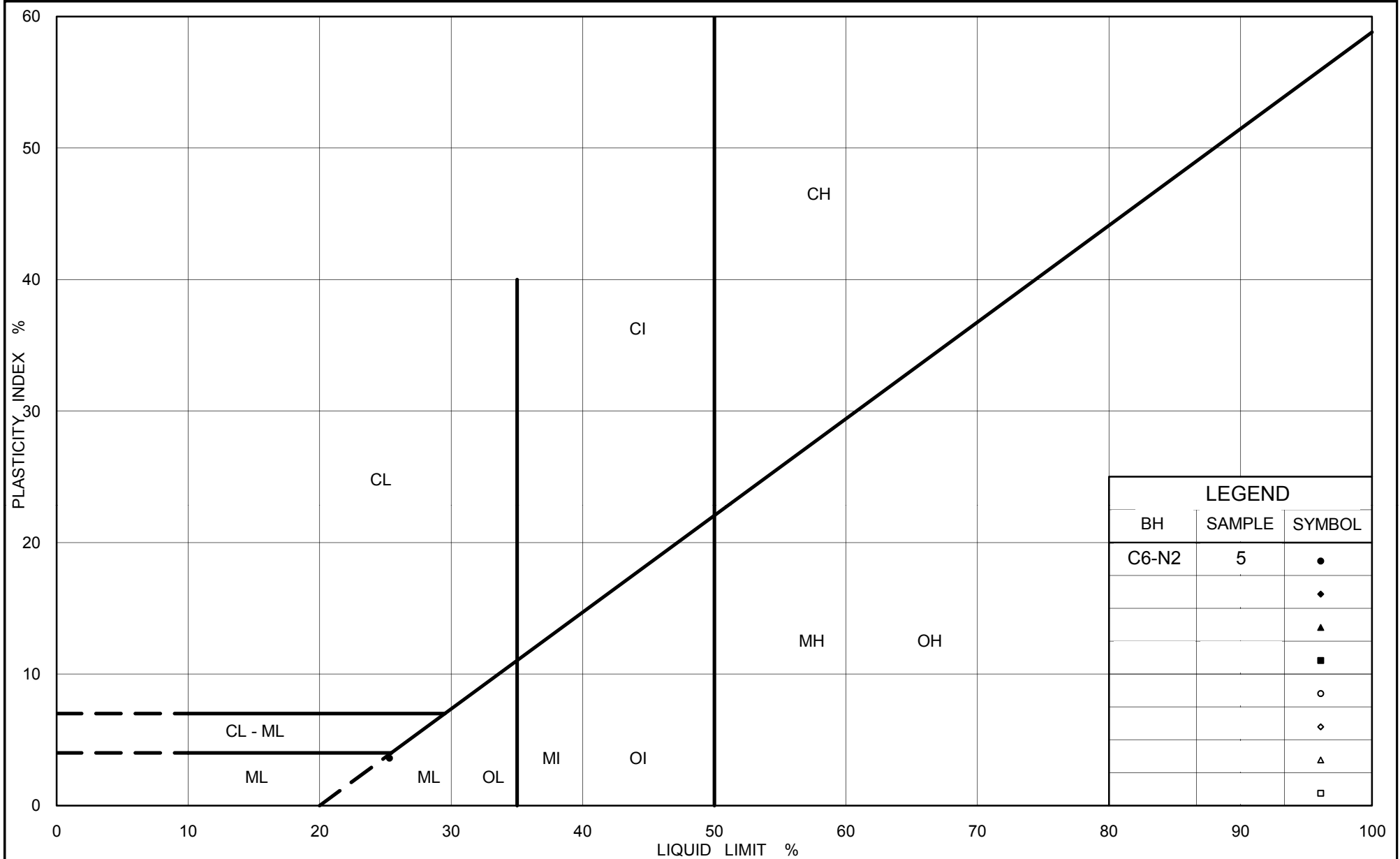
Project Number: 06-1111-025

Checked By: TVA

**Golder Associates**

Date: 06-Jan-10





Ministry of Transportation

Ontario

**PLASTICITY CHART**  
Silt  
Highway 69 (NBL) STA 18+133

Figure No. A.C6-8

Project No. 06-1111-025

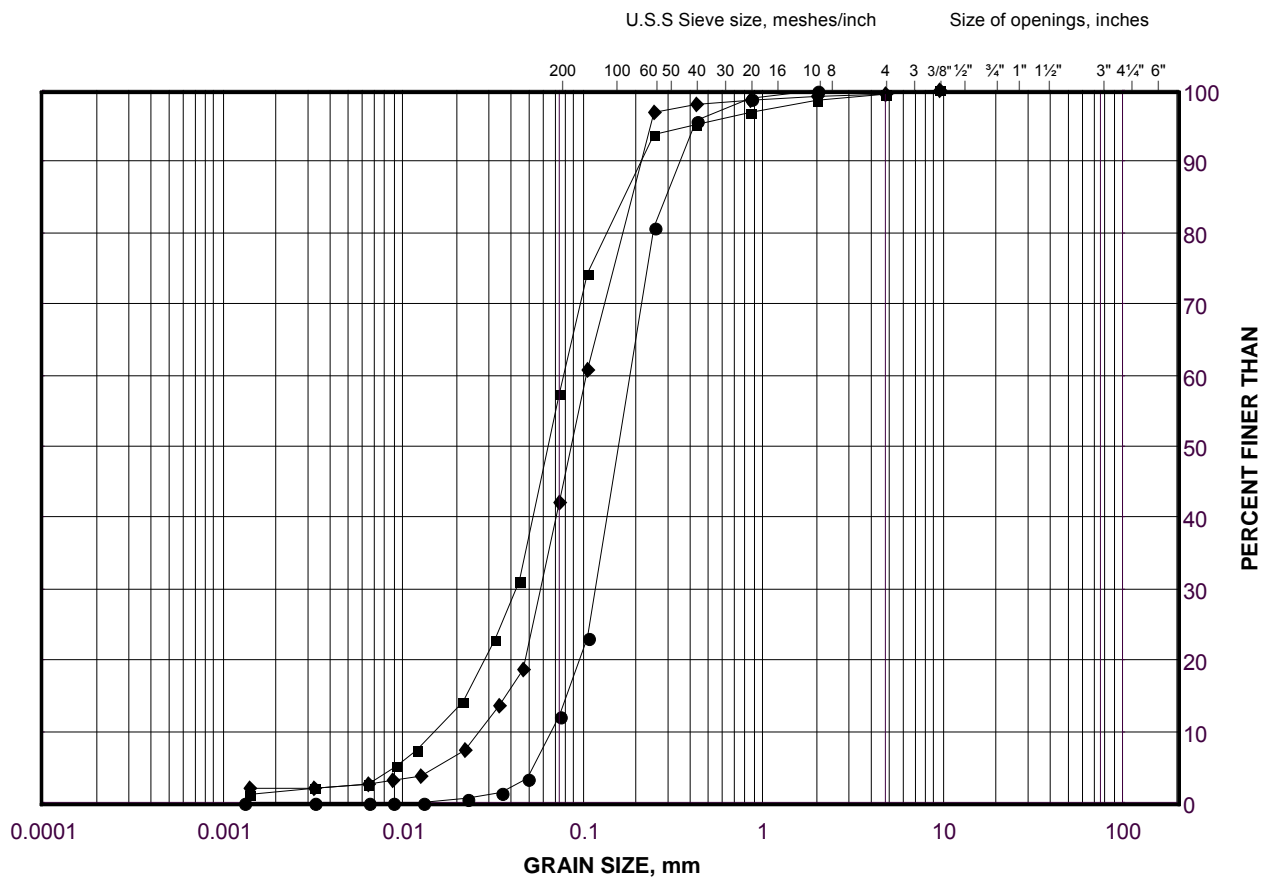
Checked By: TVA



# GRAIN SIZE DISTRIBUTION

Sand and Silt to Sand  
Highway 69 (NBL) STA 18+133

FIGURE A.C6-9



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

## LEGEND

SYMBOL	BOREHOLE	SAMPLE	ELEVATION(m)
●	C6-N1	11	172.0
■	C6-N3	8	176.8
◆	C6-N2	8	176.9

Project Number: 06-1111-025

Checked By: TVA

Golder Associates

Date: 04-Nov-09



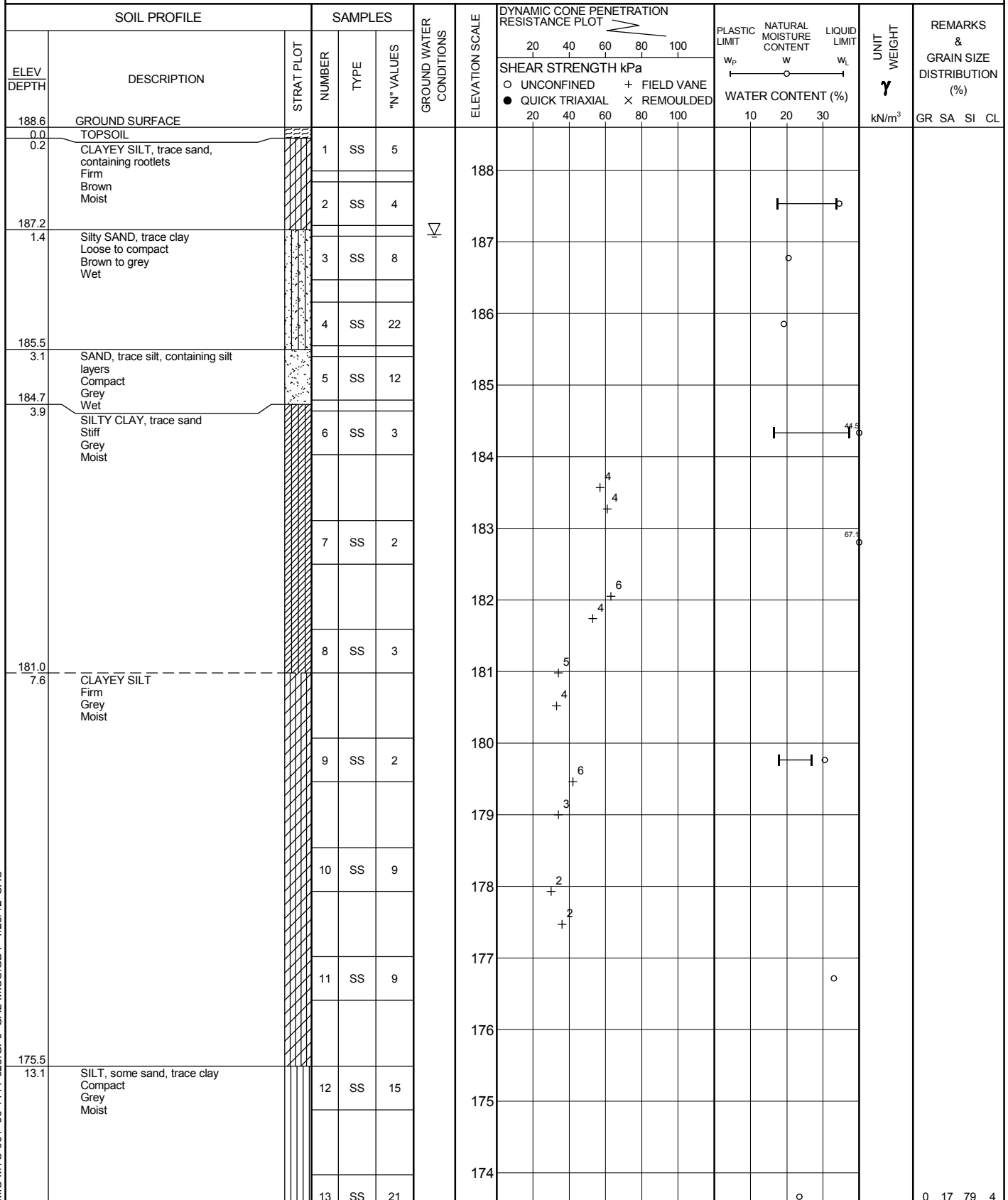


# **APPENDIX B**

**Highway 69 N-E/W Ramp, SBL and NBL – STA 17+800  
(Culvert 5A)**



PROJECT <u>06-1111-025</u>		<b>RECORD OF BOREHOLE No C5A-S1</b>		1 OF 2 <b>METRIC</b>	
G.W.P. <u>5203-06-00</u>		LOCATION <u>N 5093768.8 ; E 221627.8</u>		ORIGINATED BY <u>MR/DM</u>	
DIST <u>          </u> HWY <u>69</u>		BOREHOLE TYPE <u>115 mm O.D. Continuous Flight Solid Stem Augers and NW Casing, Wash Boring</u>		COMPILED BY <u>MWK/TZ</u>	
DATUM <u>Geodetic</u>		DATE <u>March 10, 2009</u>		CHECKED BY <u>VA</u>	





Continued Next Page

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

MIS-MTO 001 06-1111-025.GPJ GAL-MISS.GDT 125/12 SAC



PROJECT <u>06-1111-025</u>		<b>RECORD OF BOREHOLE No C5A-S1</b>				2 OF 2 <b>METRIC</b>										
G.W.P. <u>5203-06-00</u>		LOCATION <u>N 5093768.8 ;E 221627.8</u>				ORIGINATED BY <u>MR/DM</u>										
DIST <u>          </u> HWY <u>69</u>		BOREHOLE TYPE <u>115 mm O.D. Continuous Flight Solid Stem Augers and NW Casing, Wash Boring</u>				COMPILED BY <u>MWK/TZ</u>										
DATUM <u>Geodetic</u>		DATE <u>March 10, 2009</u>				CHECKED BY <u>VA</u>										
SOIL PROFILE		SAMPLES			GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT					PLASTIC LIMIT W <sub>p</sub>	NATURAL MOISTURE CONTENT W	LIQUID LIMIT W <sub>L</sub>	UNIT WEIGHT  <b>γ</b>  kN/m <sup>3</sup>	REMARKS & GRAIN SIZE DISTRIBUTION (%)  GR SA SI CL
ELEV DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE			"N" VALUES	SHEAR STRENGTH kPa								
	--- CONTINUED FROM PREVIOUS PAGE ---						20 40 60 80 100 ○ UNCONFINED + FIELD VANE ● QUICK TRIAXIAL × REMOULDED									
172.5	SILT, some sand, trace clay Compact Grey Moist					173										
16.2	SAND, some silt Compact Grey Moist		14	SS	15	172										
171.8	END OF BOREHOLE															
16.8	NOTE:  1. Water level in open borehole at a depth of 1.5 m below ground surface (Elev. 187.1 m) upon completion of drilling.															



PROJECT <u>06-1111-025</u>		<b>RECORD OF BOREHOLE No C5A-S2</b>		1 OF 2 <b>METRIC</b>	
G.W.P. <u>5203-06-00</u>		LOCATION <u>N 5093777.7 ; E 221601.3</u>		ORIGINATED BY <u>DM</u>	
DIST <u>          </u> HWY <u>69</u>		BOREHOLE TYPE <u>115 mm O.D. Continuous Flight Solid Stem Augers and NW Casing, Wash Boring</u>		COMPILED BY <u>MWK/TZ</u>	
DATUM <u>Geodetic</u>		DATE <u>March 11, 2009</u>		CHECKED BY <u>VA</u>	

SOIL PROFILE			SAMPLES			GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT		PLASTIC LIMIT  w <sub>p</sub>	NATURAL MOISTURE CONTENT  w	LIQUID LIMIT  w <sub>L</sub>	UNIT WEIGHT  γ  kN/m <sup>3</sup>	REMARKS & GRAIN SIZE DISTRIBUTION (%)  GR SA SI CL		
ELEV DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE	"N" VALUES			SHEAR STRENGTH kPa							WATER CONTENT (%)	
								○ UNCONFINED ● QUICK TRIAXIAL	+ FIELD VANE × REMOULDED							
189.0	GROUND SURFACE															
0.0	TOPSOIL															
0.2	CLAYEY SILT, trace sand, containing organics Stiff Brown Moist		1	SS	12											
			2	SS	11											
187.5																
1.5	Sandy SILT, trace clay Compact Grey Moist		3	SS	11											
186.7																
2.3	Silty SAND, trace clay Compact to dense Brown to grey Moist		4	SS	32											
			5	SS	15											
			6	SS	23											
183.2																
5.8	CLAY Firm to stiff Grey Moist		7	SS	WH											
182.0																
7.0	CLAYEY SILT Soft to firm Grey Moist		8	SS	WH											
			9	SS	2											
			10	SS	5											
			11	SS	8											
176.0																
13.0	SILT, some sand, trace clay Compact Grey Wet		12	SS	15											
174.5																
14.5																

Continued Next Page

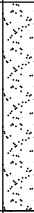
+<sup>3</sup>, ×<sup>3</sup>: Numbers refer to Sensitivity      ○ 3% STRAIN AT FAILURE

MIS-MTO 001 06-1111-025.GPJ GAL-MISS.GDT 12/5/12 SAC



PROJECT <u>06-1111-025</u>		<b>RECORD OF BOREHOLE No C5A-S2</b>				2 OF 2 <b>METRIC</b>	
G.W.P. <u>5203-06-00</u>		LOCATION <u>N 5093777.7 ; E 221601.3</u>				ORIGINATED BY <u>DM</u>	
DIST <u>          </u> HWY <u>69</u>		BOREHOLE TYPE <u>115 mm O.D. Continuous Flight Solid Stem Augers and NW Casing, Wash Boring</u>				COMPILED BY <u>MWK/TZ</u>	
DATUM <u>Geodetic</u>		DATE <u>March 11, 2009</u>				CHECKED BY <u>VA</u>	

SOIL PROFILE		SAMPLES			GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT					PLASTIC LIMIT   NATURAL MOISTURE CONTENT   LIQUID LIMIT			UNIT WEIGHT  $\gamma$ kN/m <sup>3</sup>	REMARKS & GRAIN SIZE DISTRIBUTION (%)
ELEV DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE			"N" VALUES	20	40	60	80	100	W <sub>p</sub>	W		
	--- CONTINUED FROM PREVIOUS PAGE ---															
	SAND, some silt Compact Grey Wet		13	SS	12											
						173										
171.9			14	SS	14											
17.1	END OF BOREHOLE					172										
	NOTE:  1. Water level in open borehole not noted.															



PROJECT 06-1111-025		<b>RECORD OF BOREHOLE No C5A-N1</b>		1 OF 2 <b>METRIC</b>	
G.W.P. 5203-06-00		LOCATION N 5093756.4 ; E 221664.8		ORIGINATED BY MR	
DIST _____ HWY 69		BOREHOLE TYPE 115 mm O.D. Continuous Flight Solid Stem Augers and NW Casing, Wash Boring		COMPILED BY MWK/TZ	
DATUM Geodetic		DATE March 10, 2009		CHECKED BY VA	

SOIL PROFILE			SAMPLES			GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT		PLASTIC NATURAL LIQUID LIMIT MOISTURE LIMIT CONTENT			UNIT WEIGHT $\gamma$ kN/m <sup>3</sup>	REMARKS & GRAIN SIZE DISTRIBUTION (%) GR SA SI CL			
ELEV DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE	"N" VALUES			SHEAR STRENGTH kPa							WATER CONTENT (%)		
								20	40	60	80	100			W <sub>p</sub>	W	W <sub>L</sub>
187.4	GROUND SURFACE																
0.0	TOPSOIL		1A	SS	5												
0.2	Silty SAND, containing rootlets		1B														
186.7	Loose Brown Moist																
0.7	SAND and SILT, trace to some clay		2	SS	22												
	Compact Brown Wet		3	SS	27												
			4	SS	24												
184.2			5A	SS	14												
183.8	SAND Compact Grey Wet		5B														
3.6	SILTY CLAY, containing silt layers		6	SS	4												
	Firm to stiff Brown to grey Wet		7	SS	2												
			8	SS	2												
			9	SS	2												
178.4																	
9.0	SILT, trace to some clay		10	SS	2												
	Very loose to compact Grey Wet																
			11	SS	11												
			12	SS	16												
174.3																	
13.1	Sandy SILT, trace clay		13	SS	10												
	Compact Grey Wet																

Continued Next Page

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

MIS-MTO 001 06-1111-025.GPJ GAL-MISS.GDT 125/12 SAC



PROJECT <u>06-1111-025</u>		<b>RECORD OF BOREHOLE No C5A-N1</b>				2 OF 2 <b>METRIC</b>	
G.W.P. <u>5203-06-00</u>		LOCATION <u>N 5093756.4 ; E 221664.8</u>				ORIGINATED BY <u>MR</u>	
DIST <u>          </u> HWY <u>69</u>		BOREHOLE TYPE <u>115 mm O.D. Continuous Flight Solid Stem Augers and NW Casing, Wash Boring</u>				COMPILED BY <u>MWK/TZ</u>	
DATUM <u>Geodetic</u>		DATE <u>March 10, 2009</u>				CHECKED BY <u>VA</u>	

SOIL PROFILE		SAMPLES			GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT					PLASTIC NATURAL LIQUID LIMIT MOISTURE LIMIT CONTENT			UNIT WEIGHT  $\gamma$ kN/m <sup>3</sup>	REMARKS & GRAIN SIZE DISTRIBUTION (%)  GR SA SI CL
ELEV DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE			"N" VALUES	20	40	60	80	100	W <sub>p</sub>	W		
171.7	--- CONTINUED FROM PREVIOUS PAGE ---	[Pattern]	14	SS	13	172										
15.7	END OF BOREHOLE  NOTE:  1. Water level in open borehole at a depth of 0.9 m below ground surface (Elev. 186.5 m) upon completion of drilling.															

MIS-MTO 001 06-1111-025.GPJ GAL-MISS.GDT 1/25/12 SAC





PROJECT 06-1111-025		<b>RECORD OF BOREHOLE No C5A-N2</b>		1 OF 2		<b>METRIC</b>	
G.W.P. 5203-06-00		LOCATION N 5093764.1 ; E 221642.0		ORIGINATED BY		MR	
DIST HWY 69		BOREHOLE TYPE 115 mm O.D. Continuous Flight Solid Stem Augers and NW Casing, Wash Boring		COMPILED BY		MWK/TZ	
DATUM Geodetic		DATE March 9, 2009		CHECKED BY		VA	

[illegible]

Continued Next Page

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

○ 3% STRAIN AT FAILURE





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

MIS-MTO 001 06-1111-025.GPJ GAL-MISS.GDT 1/25/12 SAC





HORIZONTAL SCALE

5 0 5 10 m

2 0 2 4 m

VERTICAL SCALE

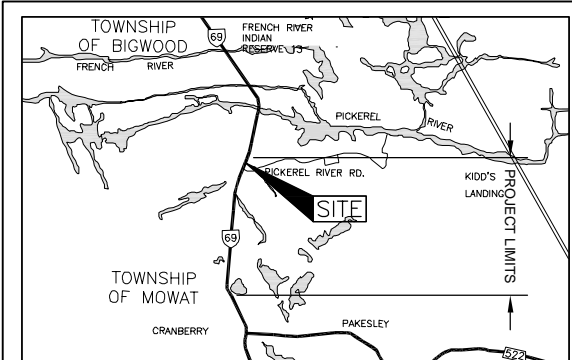
**METRIC**  
DIMENSIONS ARE IN METRES AND/OR  
MILLIMETRES UNLESS OTHERWISE SHOWN.  
STATIONS IN KILOMETRES + METRES.

CONT No.  
GWP No. 5203-06-00

HIGHWAY 69 (SBL AND N-E/W RAMP)  
HIGHWAY 69 (NBL)  
CULVERT STA 17+800  
BOREHOLE LOCATION AND SOIL STRATA






**Golder Associates Ltd.**  
MISSISSAUGA, ONTARIO, CANADA



## KEY PLAN

SCALE  
0 800 m

## LEGEND

- |   |  |
|---|--|
|  | Borehole – Current Investigation                                   |
|  | Borehole – Previous Investigation<br>(Peto MacCallum Ltd.)         |
| N   | Standard Penetration Test Value                                    |
| 16  | Blows/0.3m unless otherwise stated<br>(Std. Pen. Test, 475 j/blow) |
|  | WL upon completion of drilling                                     |

No.	ELEVATION	CO-ORDINATES	
		NORTHING	EASTING
C5A-S1	188.6	5093768.8	221627.8
C5A-S2	189.0	5093777.7	221601.3
C5A-N1	187.4	5093756.4	221664.8
C5A-N2	188.5	5093764.1	221642.0
302-29	189.0	5093771.9	221618.5
302-30	188.0	5093760.0	221654.2

## 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.

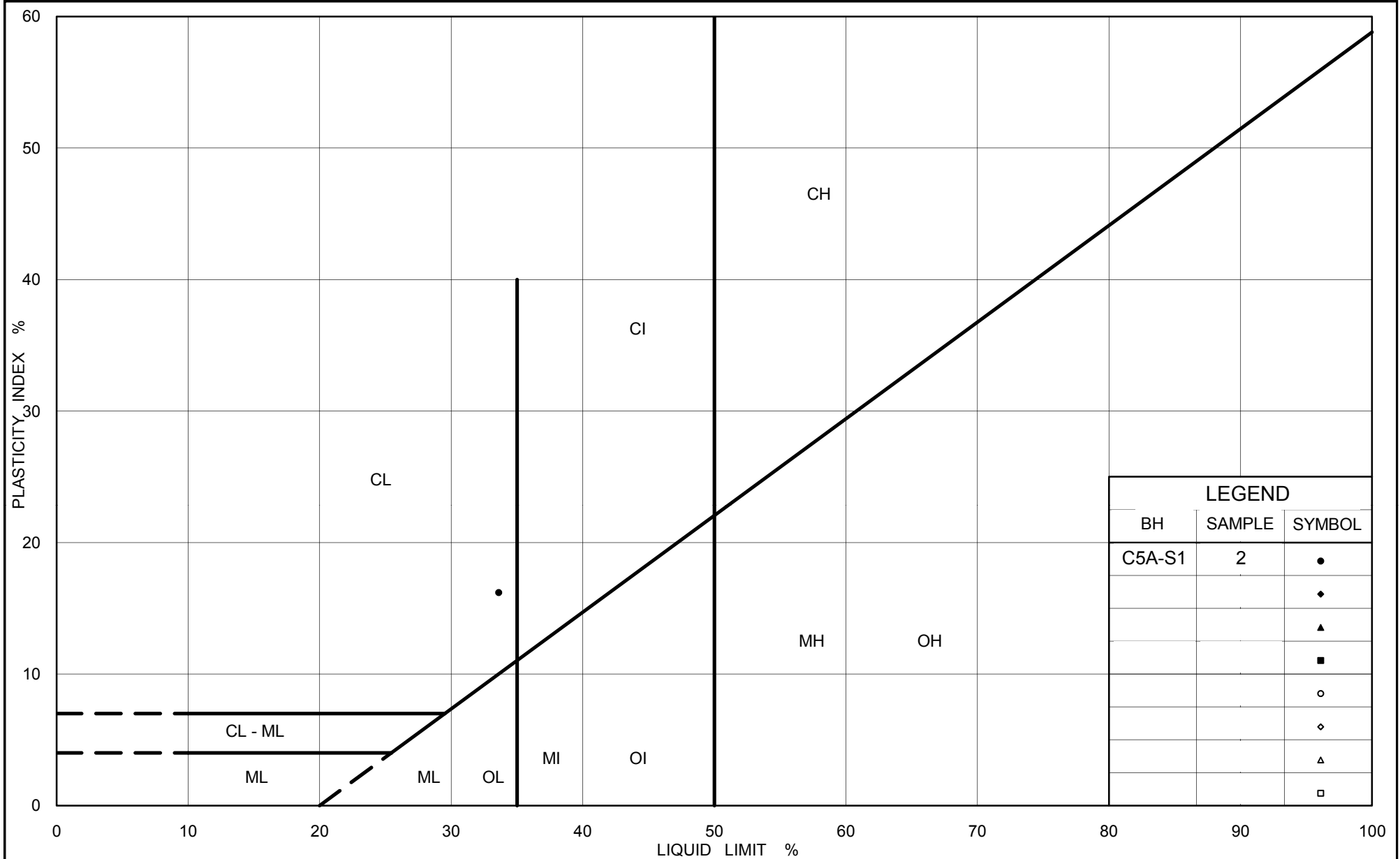
The complete foundation investigation and design report for this project and other related documents may be examined at the Materials Engineering and Research Office, Downsview. Information contained in this report and related documents is specifically excluded in accordance with Section GC 2.01 of OPS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

## REFERENCE

Base plans provided in digital format by MRC, drawing file no. PHASE 3 Plan 090211 – Golder.dwg, received February 11, 2009. Culverts provided in digital format by MRC, drawing file no. 6454\_Culvert xsect Phase 3 – Mainline 090930.dwg received Oct. 02, 2009. KEY PLAN obtained from a digital file provided by CALLON DIETZ drawing file no. C-748-069-2.dwg received April 23, 2009.

NO.	DATE	BY	REVISION	
Geocres No. 41H-107				
HWY. 69		PROJECT NO. 06-1111-025		DIST.
SUBM'D. VA	CHKD. VA	DATE: Jan. 2012	SITE: 44-553/C1 & C2	
DRAWN: JFC/RJ	CHKD. VA	APP'D. JPD/JMAC		DWG. B1





LEGEND		
BH	SAMPLE	SYMBOL
C5A-S1	2	•
		◆
		▲
		■
		○
		◇
		△
		□



Ministry of Transportation

Ontario

# PLASTICITY CHART Clayey Silt

Highway 69 (SBL and N-E/W Ramp) STA 17+800

Figure No. B.C5A-1

Project No. 06-1111-025

Checked By: TVA

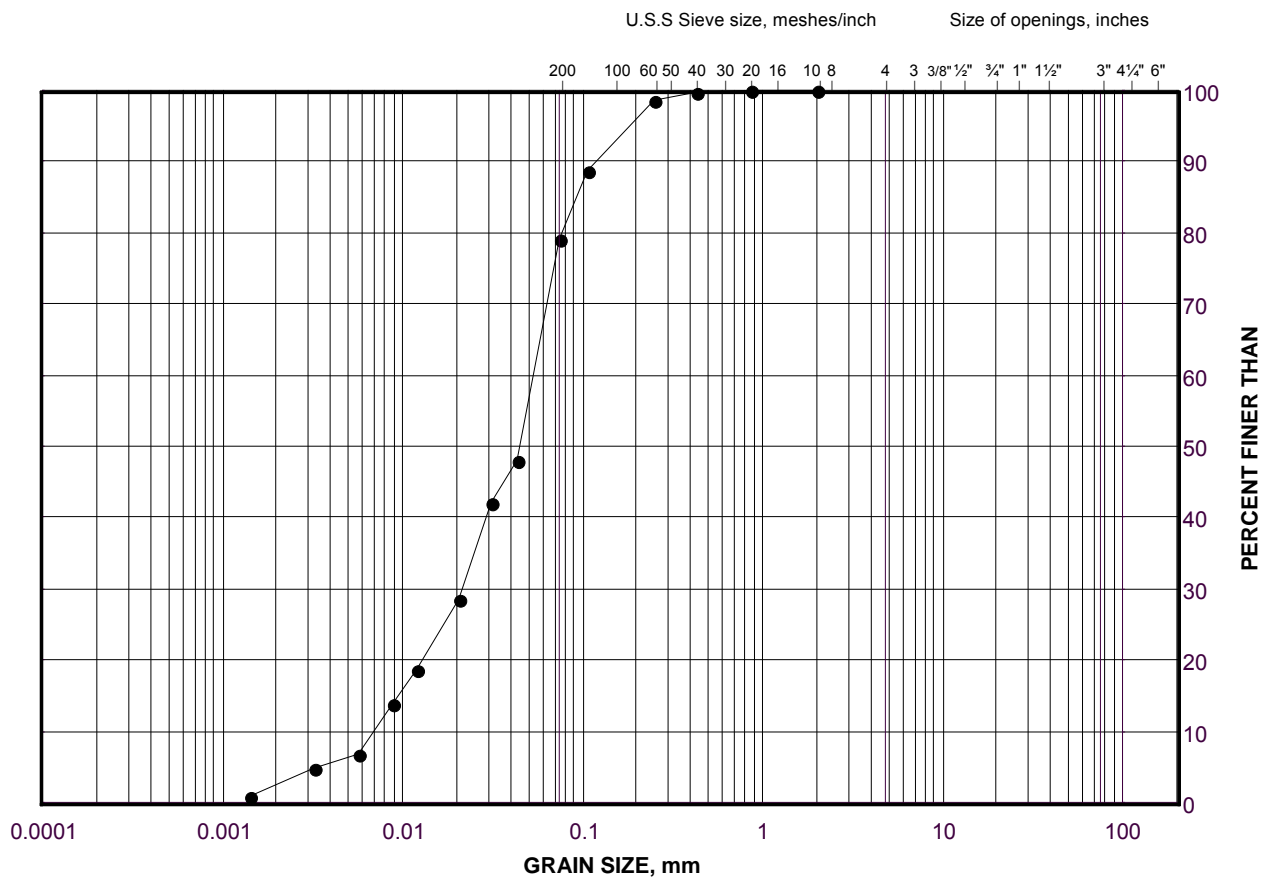


# GRAIN SIZE DISTRIBUTION

Sandy Silt

Highway 69 (SBL and N-E/W Ramp) STA 17+800

FIGURE B.C5A-2



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

## LEGEND

SYMBOL	BOREHOLE	SAMPLE	ELEVATION(m)
•	C5A-S2	3	187.2

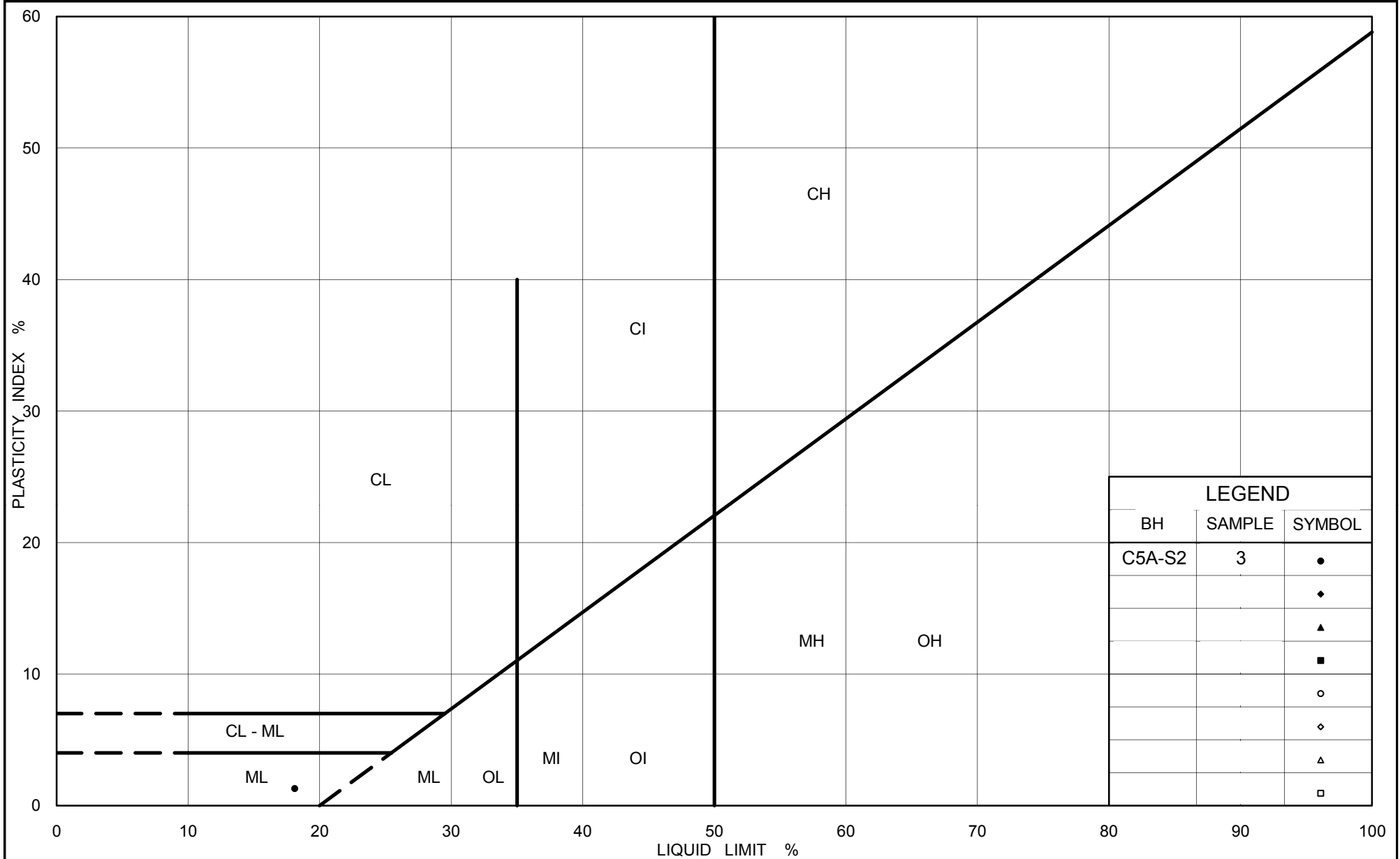
Project Number: 06-1111-025

Checked By: —TVA—

**Golder Associates**

Date: 06-Jan-10





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### PLASTICITY CHART Sandy Silt

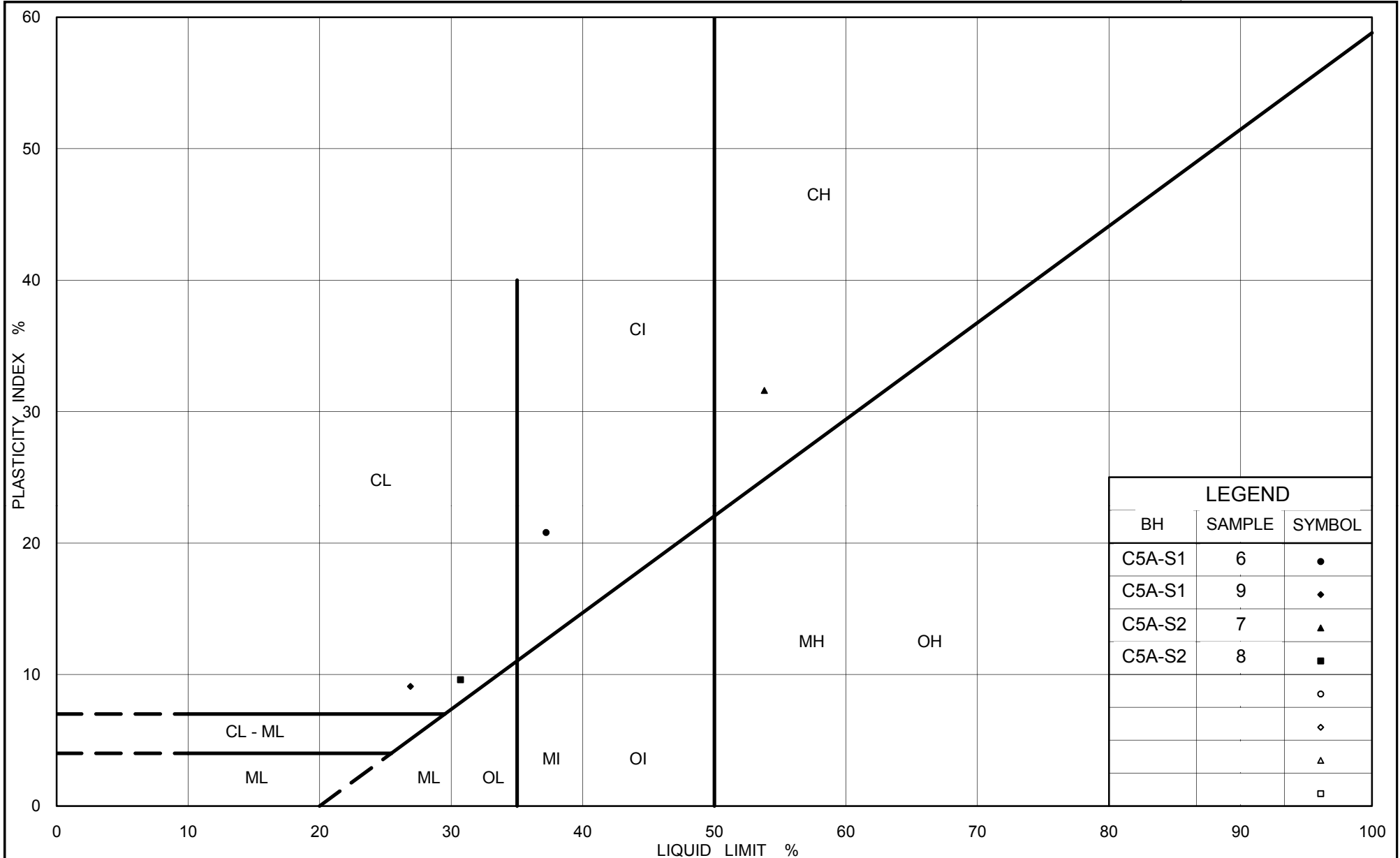
Highway 69 (SBL and N-E/W Ramp) STA 17+800

Figure No. B.C5A-3

Project No. 06-1111-025

Checked By: TVA





Ministry of Transportation

Ontario

PLASTICITY CHART  
Clay to Clayey Silt  
Highway 69 (SBL and N-E/W Ramp) STA 17+800

Figure No. B.C5A-4

Project No. 06-1111-025

Checked By: TVA

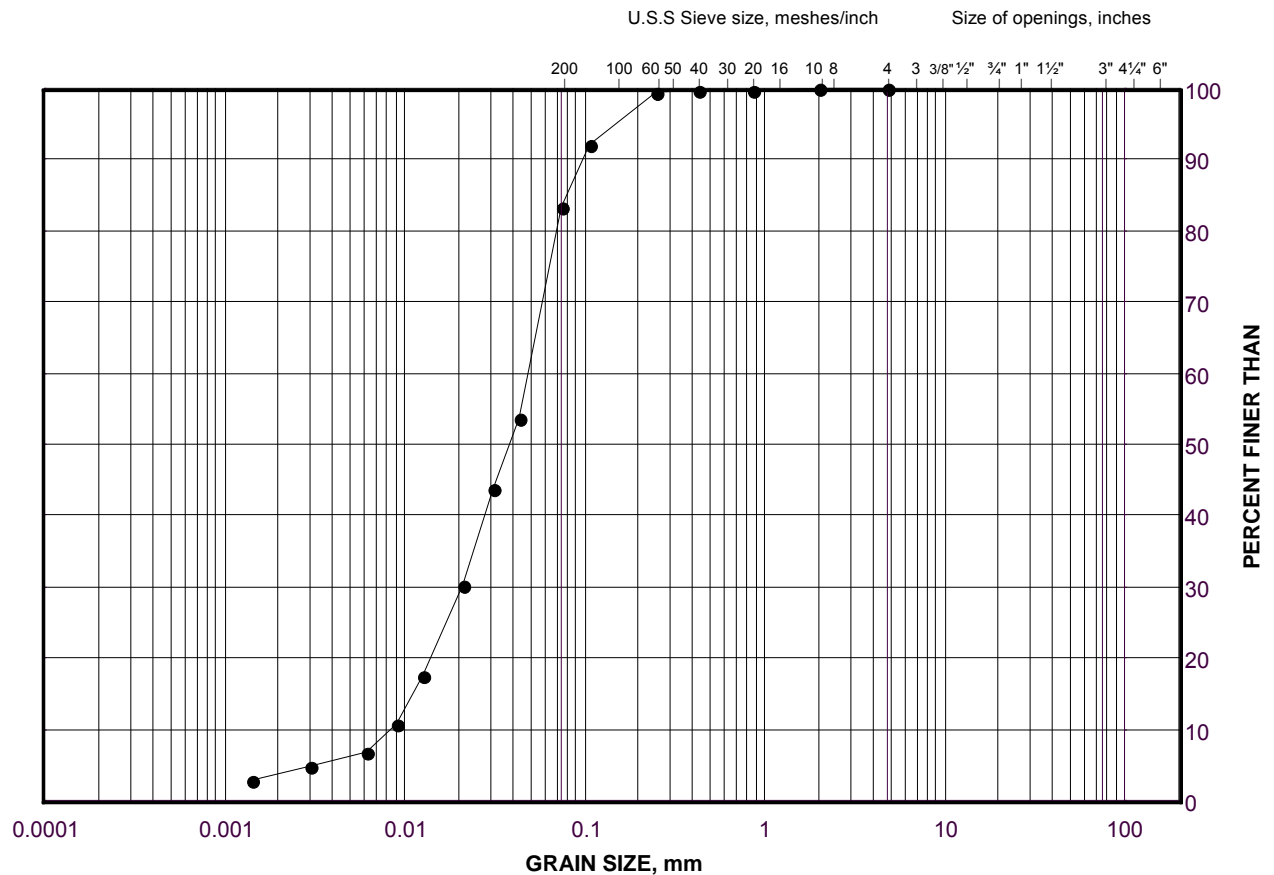


# GRAIN SIZE DISTRIBUTION

Silt

Highway 69 (SBL and N-E/W Ramp) STA 17+800

FIGURE B.C5A-5



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

## LEGEND

SYMBOL	BOREHOLE	SAMPLE	ELEVATION(m)
•	C5A-S1	13	173.7

Project Number: 06-1111-025

Checked By: TVA

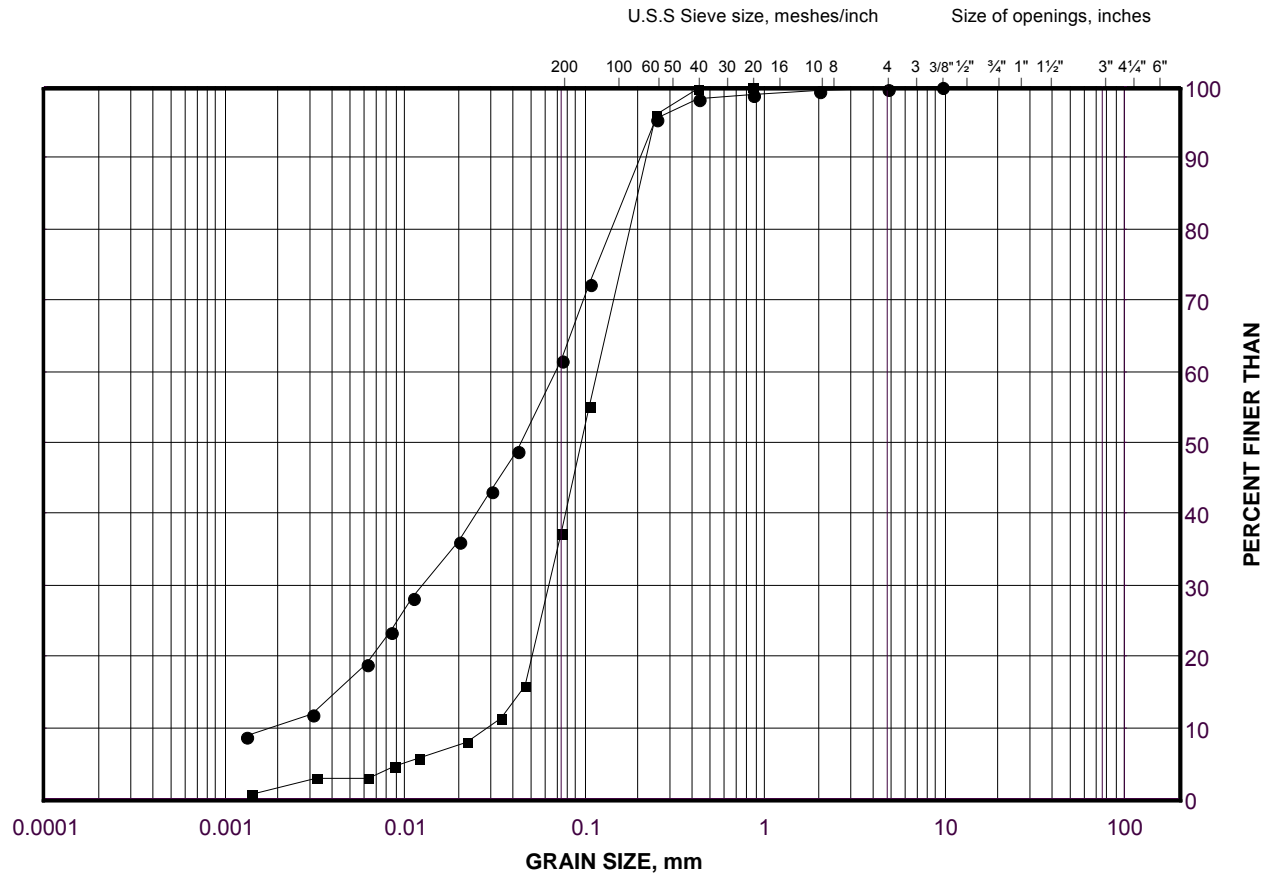
Golder Associates

Date: 06-Jan-10



## Highway 69 (NBL) STA 17+800

FIGURE B.C5A-6



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

## LEGEND

SYMBOL	BOREHOLE	SAMPLE	ELEVATION(m)
●	C5A-N2	3	186.5
■	C5A-N1	4	184.8

Project Number: 06-1111-025

Checked By: TVA

## Golder Associates

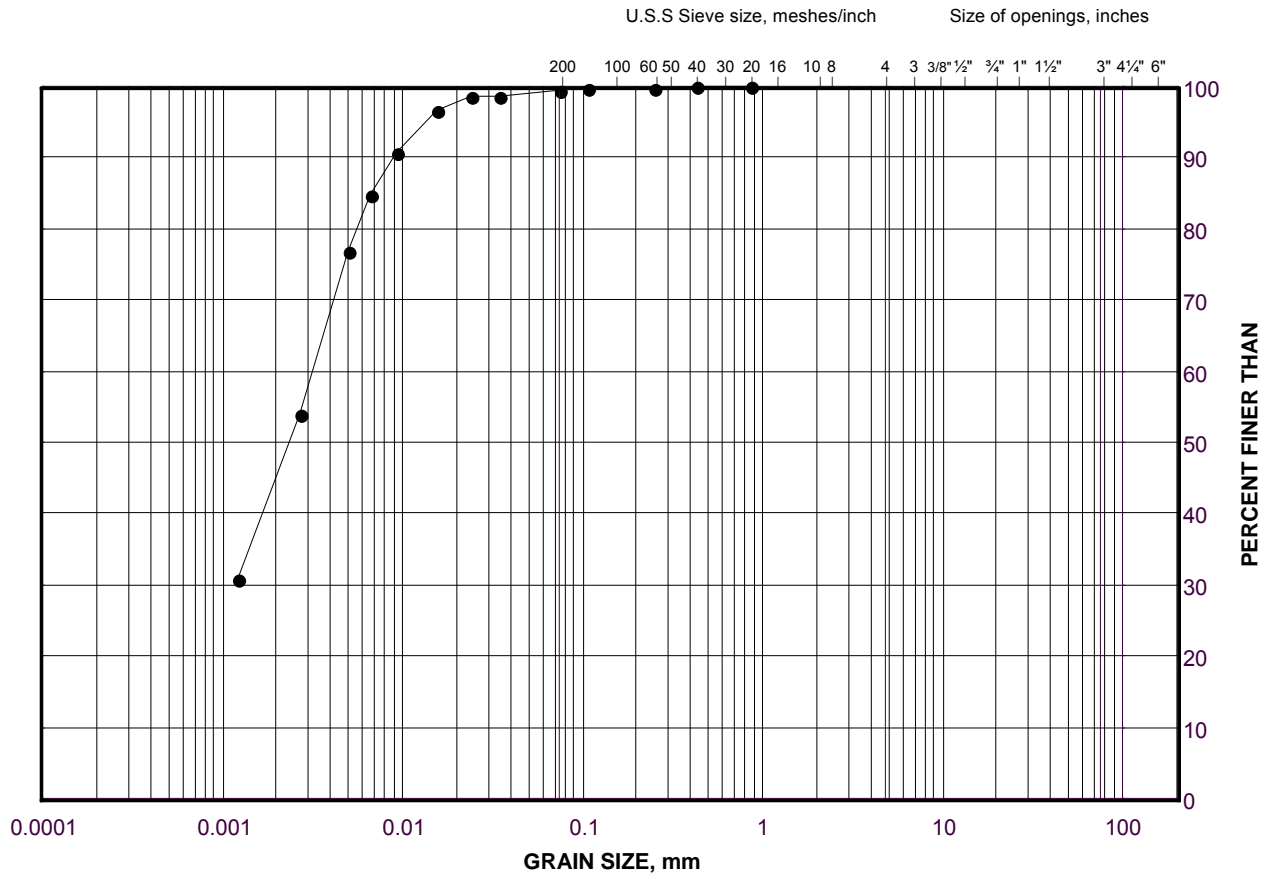
Date: 04-Nov-09



# GRAIN SIZE DISTRIBUTION

Silty Clay  
Highway 69 (NBL) STA 17+800

FIGURE B.C5A-7



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

## LEGEND

SYMBOL	BOREHOLE	SAMPLE	ELEVATION(m)
•	C5A-N2	8	181.2

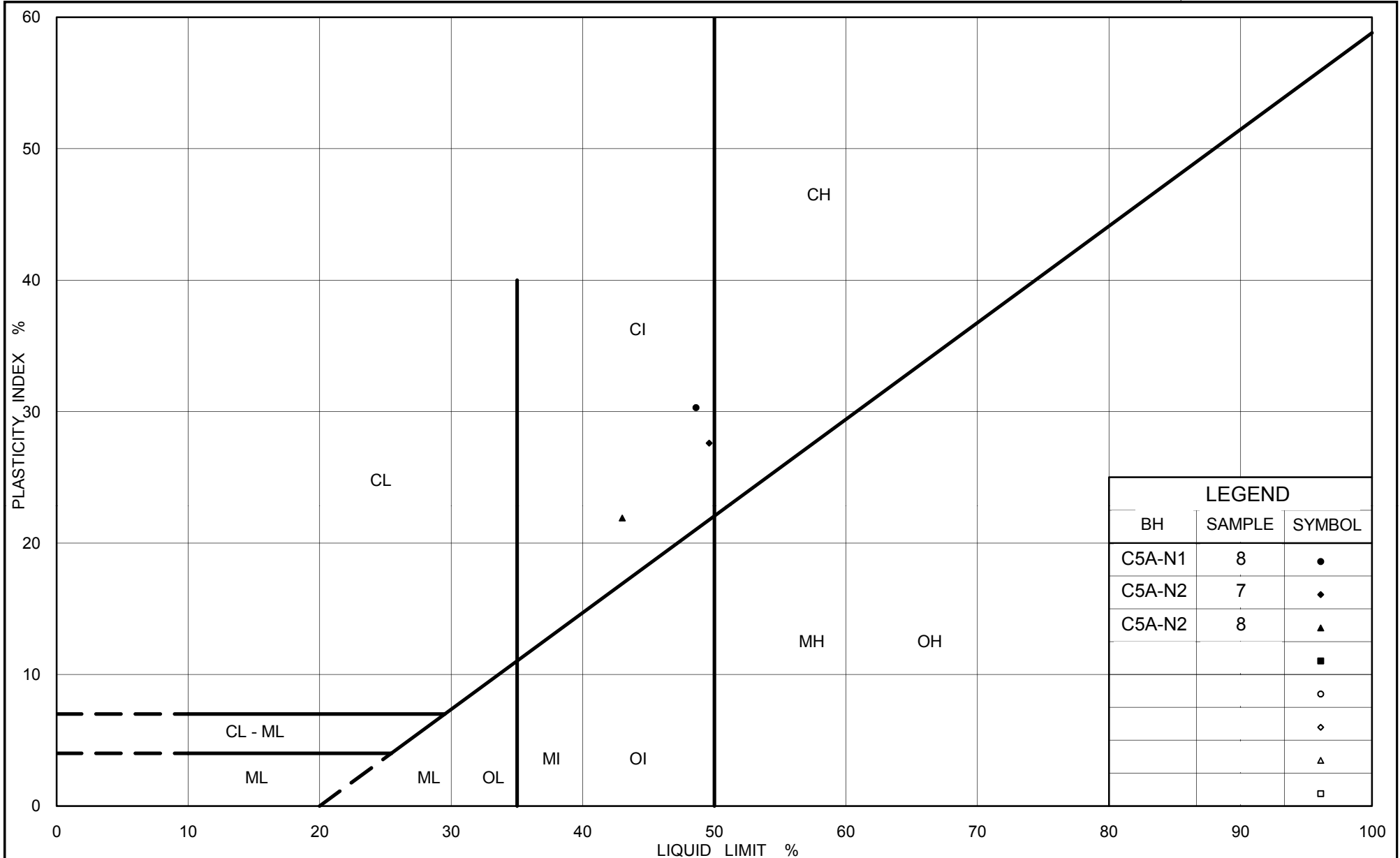
Project Number: 06-1111-025

Checked By: TVA

**Golder Associates**

Date: 04-Nov-09





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Ontario

**PLASTICITY CHART**  
**Silty Clay**  
**Highway 69 (NBL) STA 17+800**

Figure No. B.C5A-8

Project No. 06-1111-025

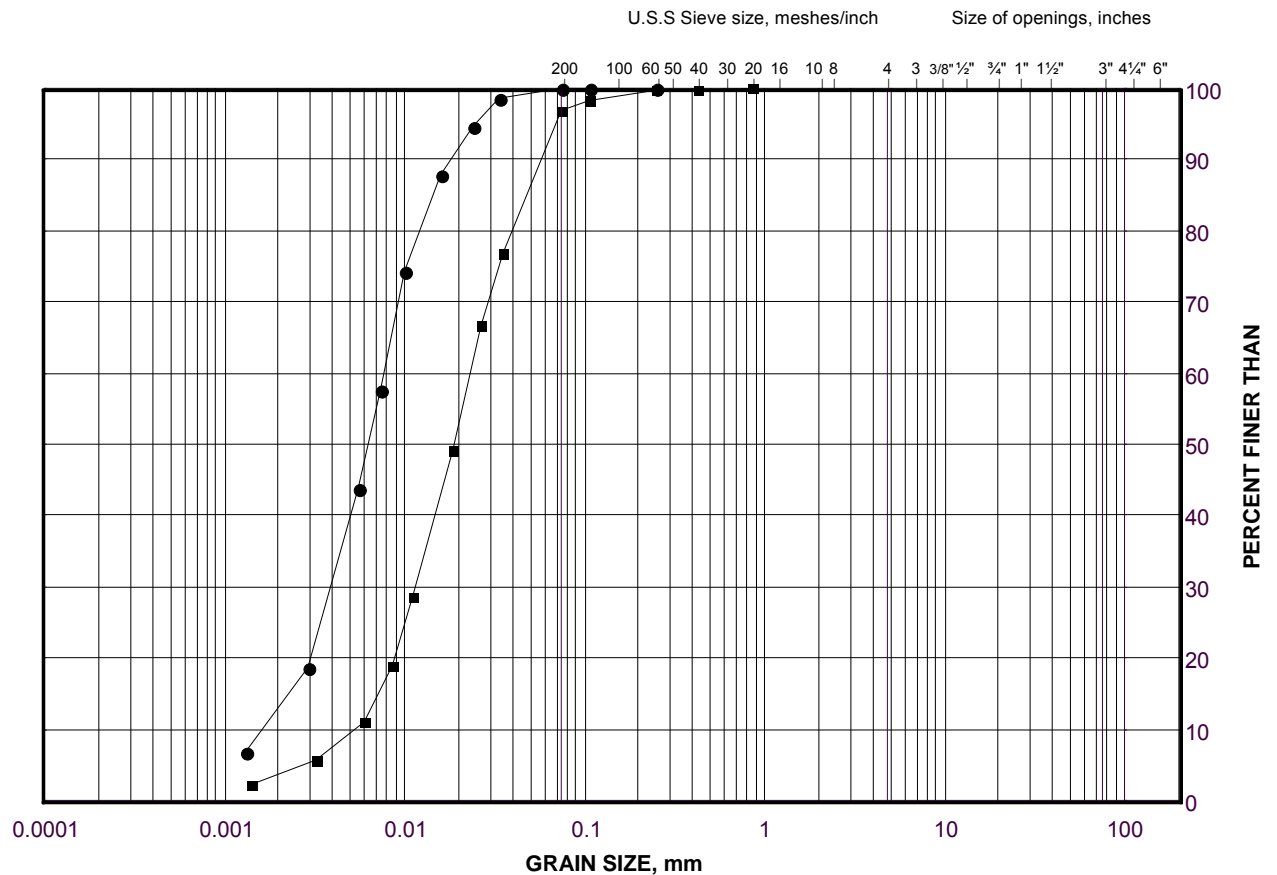
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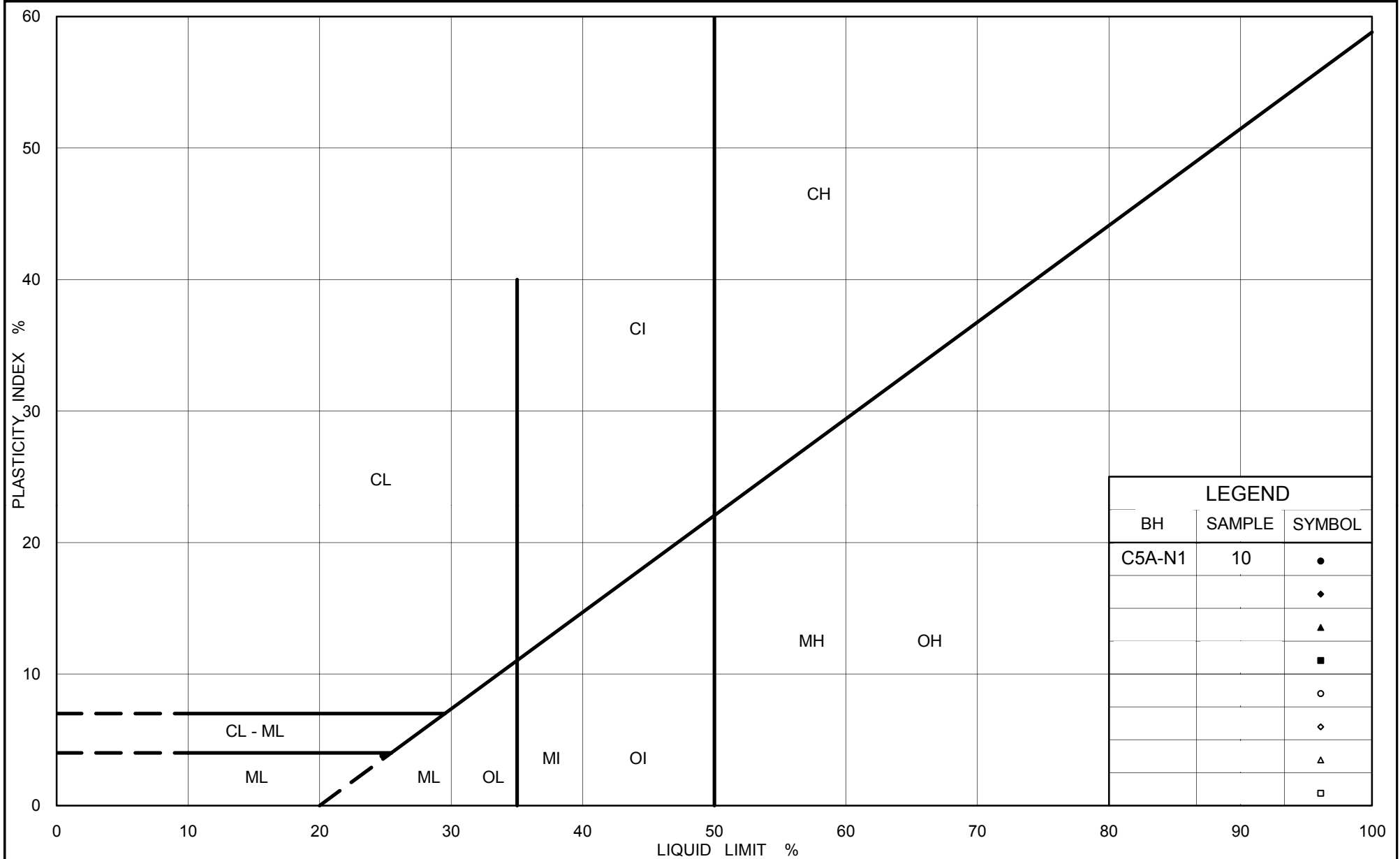
# GRAIN SIZE DISTRIBUTION

Silt  
Highway 69 (NBL) STA 17+800

FIGURE B.C5A-9







Ministry of Transportation

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**PLASTICITY CHART**  
Silt  
Highway 69 (NBL) STA 17+800

Figure No. B.C5A-10

Project No. 06-1111-025

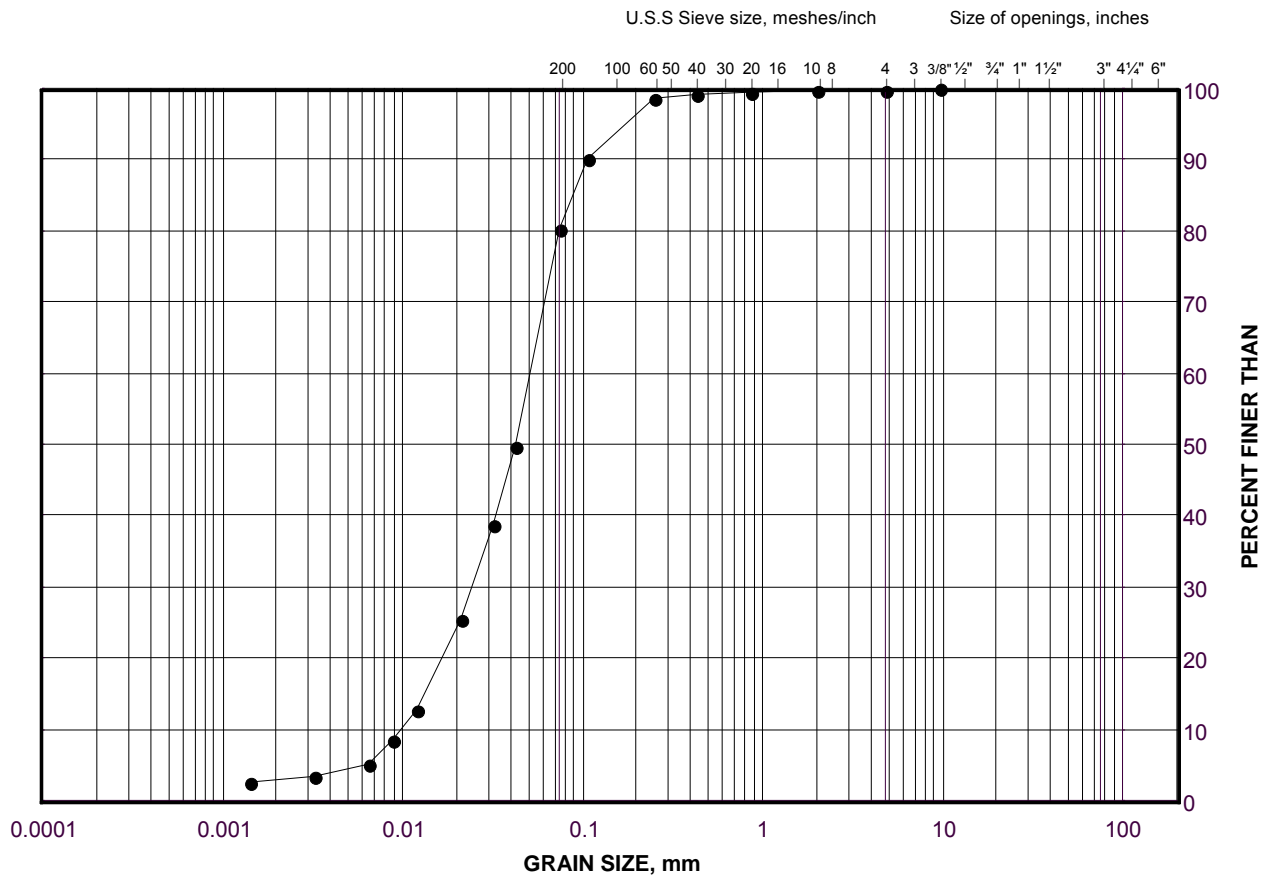
Checked By: TVA



# GRAIN SIZE DISTRIBUTION

Sandy Silt  
Highway 69 (NBL) STA 17+800

FIGURE B.C5A-11



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

## LEGEND

SYMBOL	BOREHOLE	SAMPLE	ELEVATION(m)
•	C5A-N1	13	173.6

Project Number: 06-1111-025

Checked By: TVA

**Golder Associates**

Date: 05-Nov-09





# **APPENDIX C**

## **Highway 69 SBL – STA 16+293 (Culvert C4A)**



PROJECT 06-1111-025		RECORD OF BOREHOLE No C4A-S1		1 OF 2		METRIC	
G.W.P. 5203-06-00		LOCATION N 5092357.1 ; E 221098.6		ORIGINATED BY		MR	
DIST HWY 69		BOREHOLE TYPE 115 mm O.D. Continuous Flight Solid Stem Augers and NW Casing, Wash Boring		COMPILED BY		MWK/TZ	
DATUM Geodetic		DATE March 8, 2009		CHECKED BY		VA	

[illegible]

Continued Next Page

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

MIS-MTO 001 06-1111-025.GPJ GAL-MISS.GDT 1/25/12 SAC





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

MIS-MTO 001 06-1111-025.GPJ GAL-MISS.GDT 1/25/12 SAC

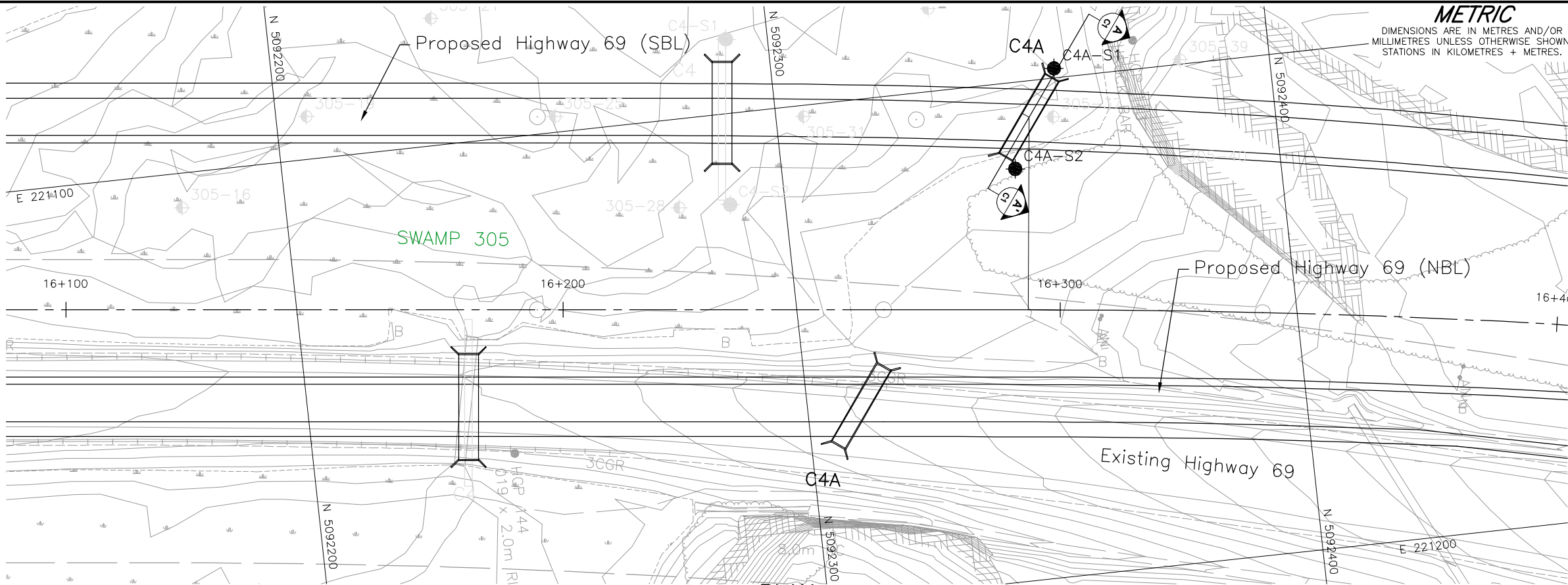


PROJECT		06-1111-025		<b>RECORD OF BOREHOLE No C4A-S2</b>		1 OF 1 <b>METRIC</b>								
G.W.P.		5203-06-00		LOCATION		N 5092345.1 ; E 221115.4								
DIST		HWY 69		BOREHOLE TYPE		115 mm O.D. Continuous Flight Solid Stem Augers and NW Casing, Wash Boring								
DATUM		Geodetic		DATE		March 8, 2009								
				ORIGINATED BY		MR								
				COMPILED BY		MWK/TZ								
				CHECKED BY		VA								
SOIL PROFILE			SAMPLES			DYNAMIC CONE PENETRATION RESISTANCE PLOT		PLASTIC LIMIT NATURAL MOISTURE CONTENT LIQUID LIMIT		UNIT WEIGHT		REMARKS & GRAIN SIZE DISTRIBUTION (%)		
ELEV	DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE	"N" VALUES	GROUND WATER CONDITIONS	ELEVATION SCALE	SHEAR STRENGTH kPa		WATER CONTENT (%)		GR SA SI CL	
186.6	0.0	ICE SURFACE							20 40 60 80 100 ○ UNCONFINED + FIELD VANE ● QUICK TRIAXIAL × REMOULDED		W <sub>p</sub> — W — W <sub>L</sub> 10 20 30			
185.8	0.3	Ice												
185.8	0.3	Root mat												
185.8	0.3	Silty PEAT, containing rootlets		1	SS	4		186						
185.8	0.3	Soft Black Wet												
185.8	0.9	SILT, some sand		2	SS	5		185						
185.8	0.9	Loose Grey Moist												
185.8	0.9	CLAYEY SILT, trace to some sand, slightly organic		3	SS	2		184						
185.8	0.9	Soft to firm Brown and grey Wet												
183.7	3.3	Silty SAND, trace clay, containing rootlets		4A	SS	3		183						
183.7	3.3	Very loose Grey Wet		4B	SS	3								
183.7	3.3	CLAYEY SILT, trace sand		5	SS	WR		182						
183.7	3.3	Soft Grey Wet												
183.7	3.3			6	SS	WR		181						
183.7	3.3													
183.7	3.3			7	SS	WH		180						
183.7	3.3													
179.9	6.7	SILTY CLAY, trace sand, containing silt layers		8	SS	WH		179						
179.9	6.7	Soft to firm Brown to grey Wet												
179.9	6.7													
179.9	6.7			9	SS	WH		178						
179.9	6.7													
179.9	6.7													
179.9	6.7			10	SS	1		177						
179.9	6.7													
179.9	6.7													
175.0	11.6	END OF BOREHOLE CASING REFUSAL						176						
175.0	11.6	NOTE:												
175.0	11.6	1. Water level in open borehole at ice surface (Elev. 186.6 m) upon completion of drilling.						175						

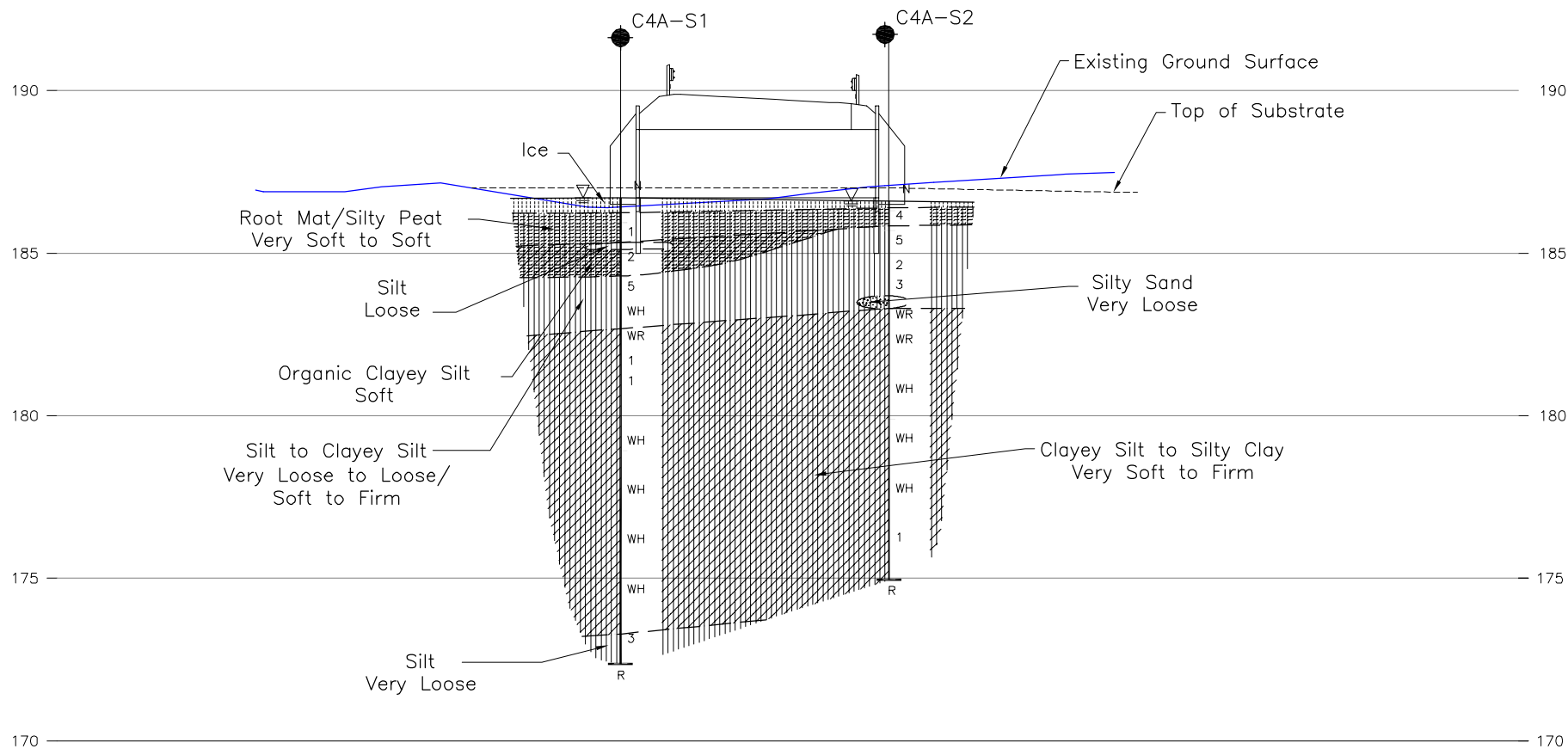
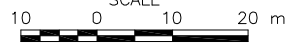
+ 3, × 3: Numbers refer to Sensitivity      ○ 3% STRAIN AT FAILURE

MIS-MTO 001 06-1111-025.GPJ GAL-MISS.GDT 12/5/12 SAC



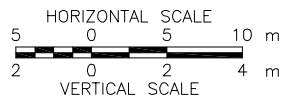


PLAN



A-A'  
C1

CULVERT C4A PROFILE



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

CONT No.  
GWP No. 5203-06-00

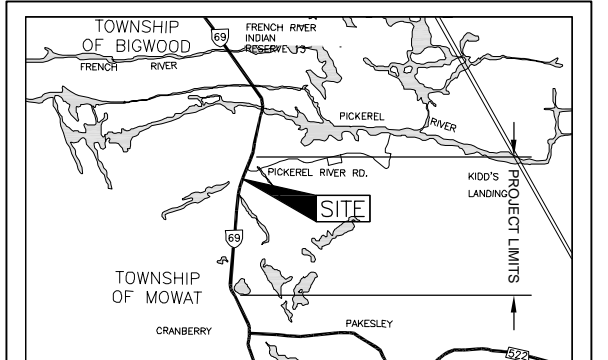


HIGHWAY 69 (SBL)  
CULVERT STA 16+293  
BOREHOLE LOCATION AND SOIL STRATA

SHEET



**Golder Associates Ltd.**  
MISSISSAUGA, ONTARIO, CANADA



KEY PLAN

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
- R Refusal

No.	ELEVATION	CO-ORDINATES	
		NORTHING	EASTING
C4A-S1	186.7	5092357.1	221098.6
C4A-S2	186.6	5092345.1	221115.4

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 MRC, drawing file no. PHASE 3 Plan 090211 - Golder.dwg, received February 11, 2009. Culverts provided in digital format by MRC, drawing file no. 6454 Culvert xsect Phase 3 - Mainline 090930.dwg received Oct. 02, 2009. KEY PLAN obtained from a digital file provided by CALLON DIETZ drawing file no. C-748-069-2.dwg received April 23, 2009.

NO.	DATE	BY	REVISION
Geocres No. 41H-107			
HWY. 69		PROJECT NO. 06-1111-025	
SUBM'D. VA		DIST.	
CHKD. VA/TZ		DATE: Jan. 2012	
DRAWN: JFC/RJ		SITE: Site 44-552/C2	
APPD. JPD/JMAC		DWG. C1	



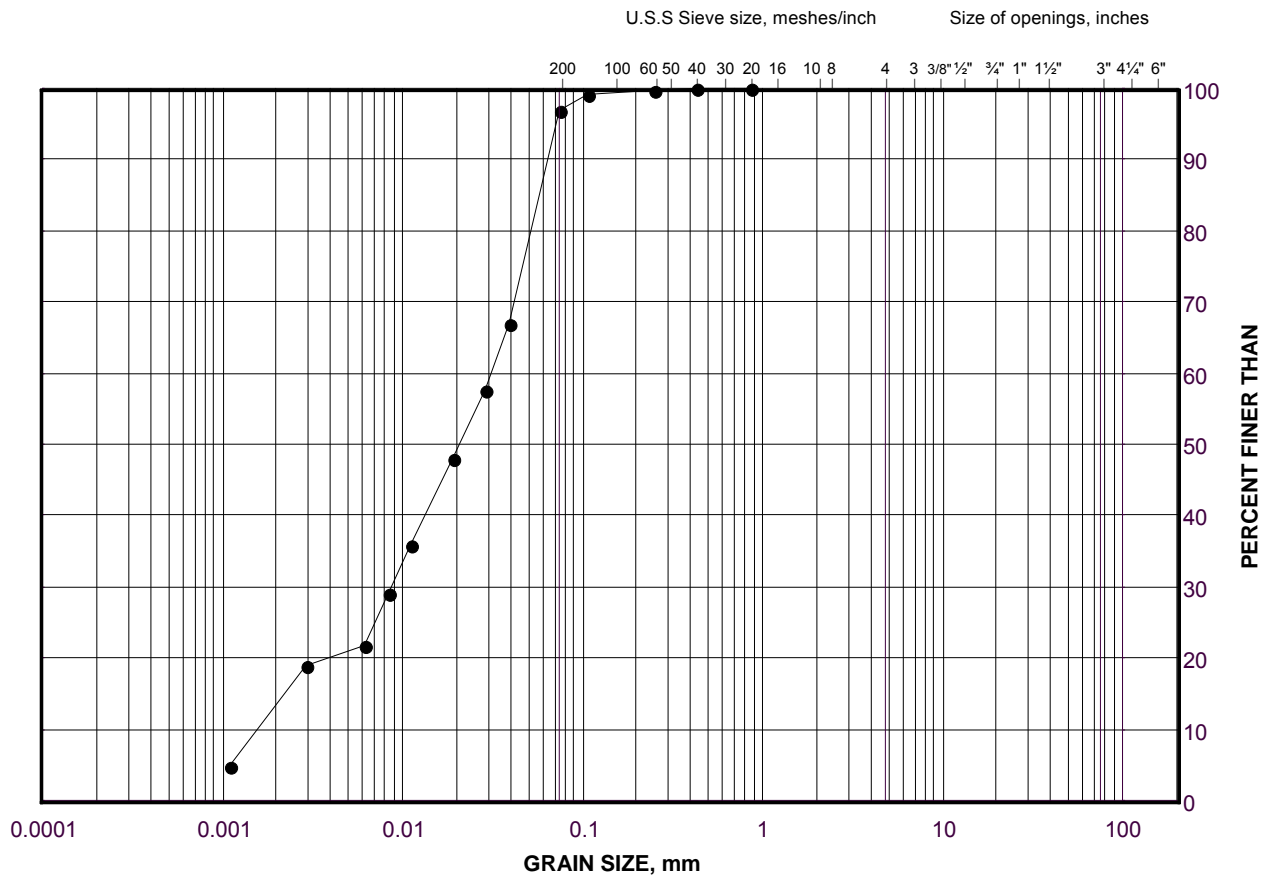


# GRAIN SIZE DISTRIBUTION

Organic Clayey Silt

Highway 69 (SBL) STA 16+293

FIGURE C.C4A-1



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

## LEGEND

SYMBOL	BOREHOLE	SAMPLE	ELEVATION(m)
•	C4A-S1	2	184.7

Project Number: 06-1111-025

Checked By: TVA

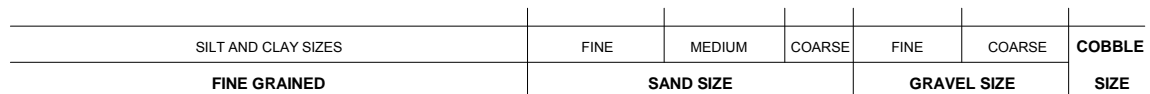
**Golder Associates**

Date: 05-Nov-09



## Highway 69 (SBL) 16+293

FIGURE C.C4A-2

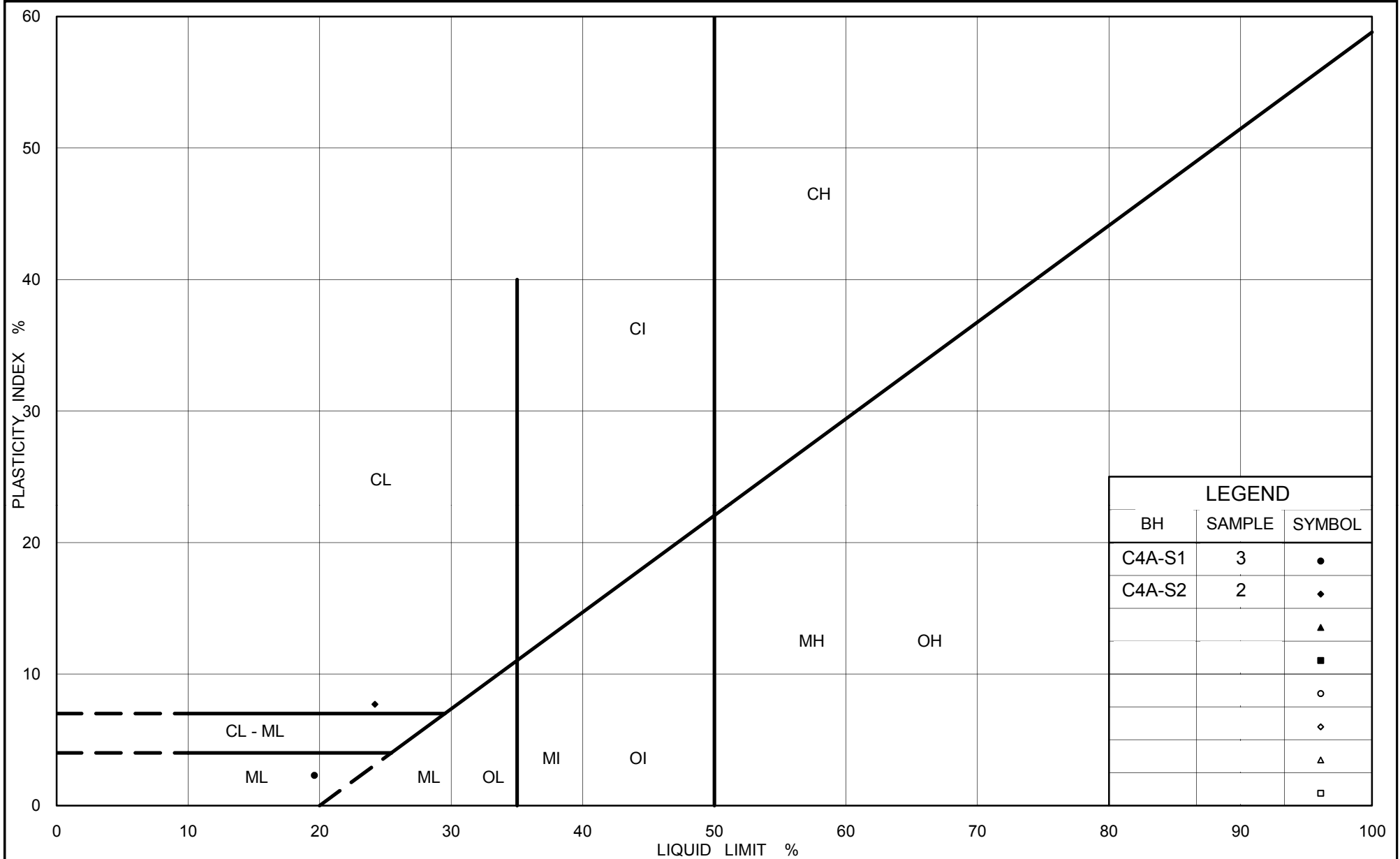


## LEGEND

SYMBOL	BOREHOLE	SAMPLE	ELEVATION(m)
●	C4A-S2	4A	183.9

Date: 23-Feb-10





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PLASTICITY CHART  
Silt to Clayey Silt  
Highway 69 (SBL) STA 16+293

Figure No. C.C4A-3

Project No. 06-1111-025

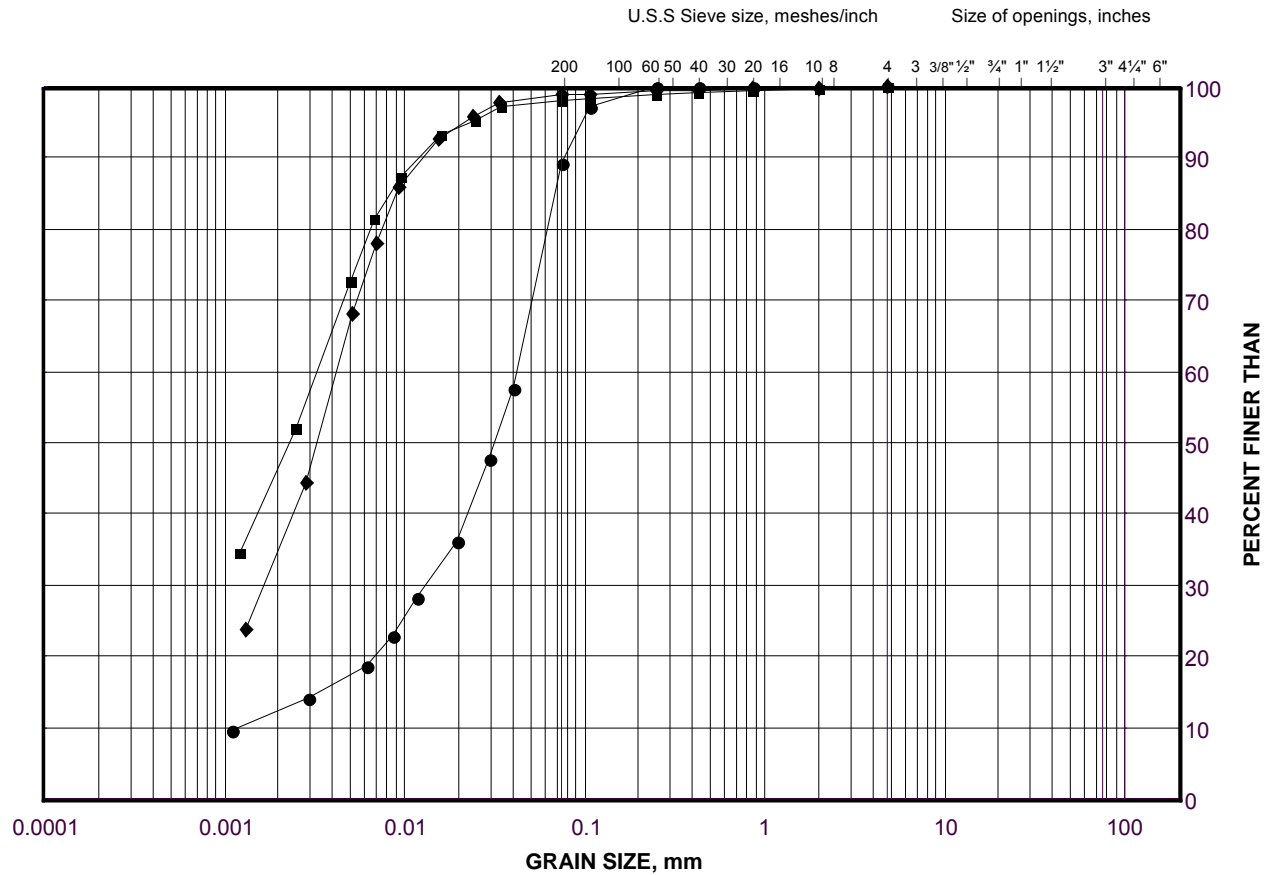
Checked By: TVA



# GRAIN SIZE DISTRIBUTION

Clayey Silt to Silty Clay  
Highway 69 (SBL) STA 16+293

FIGURE C.C4A-4



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

## LEGEND

SYMBOL	BOREHOLE	SAMPLE	ELEVATION(m)
●	C4A-S1	5	182.3
■	C4A-S2	9	177.6
◆	C4A-S1	9	177.6

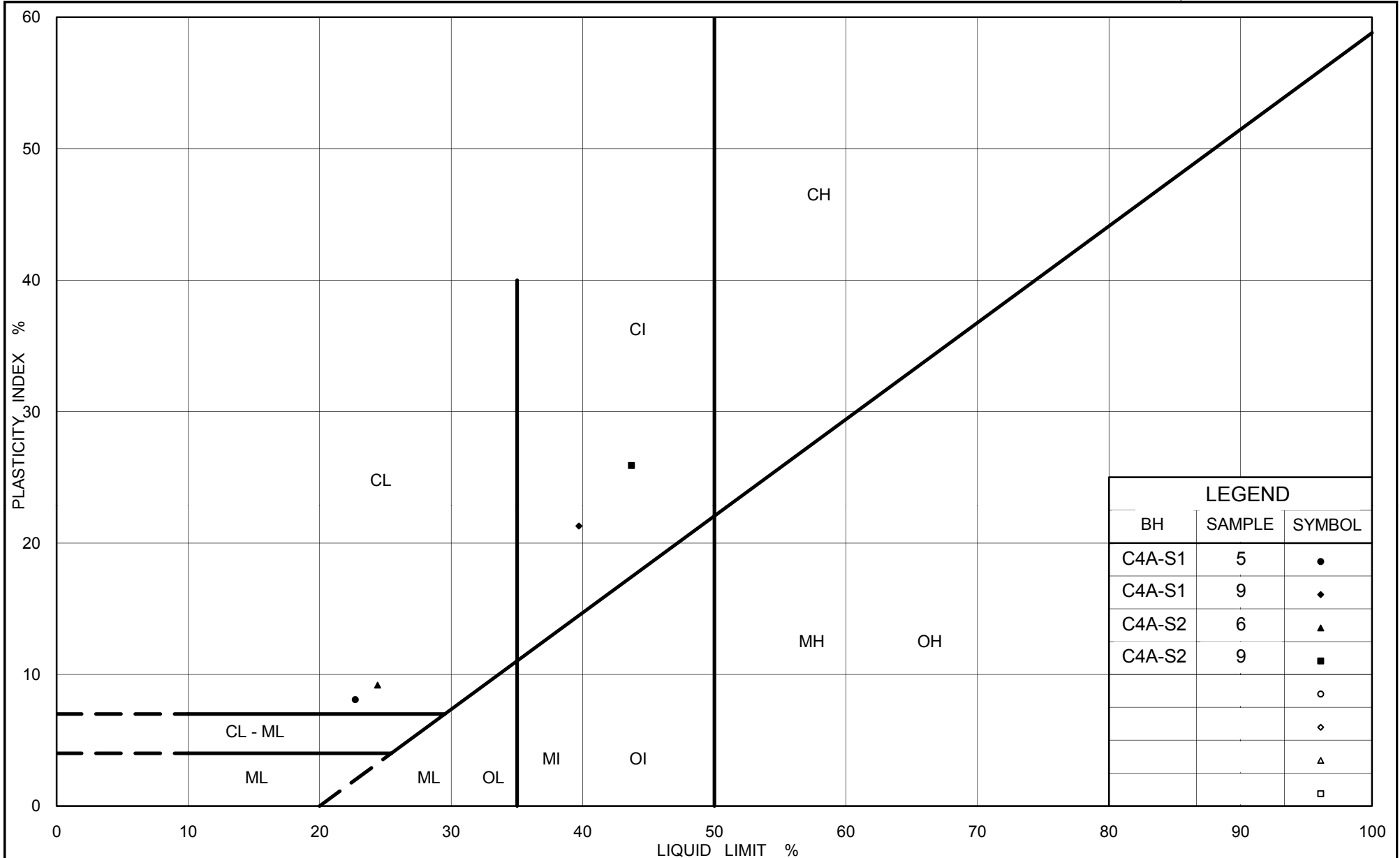
Project Number: 06-1111-025

Checked By: TVA

**Golder Associates**

Date: 23-Feb-10





Ministry of Transportation

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**PLASTICITY CHART**  
 Clayey Silt to Silty Clay  
 Highway 69 (SBL) STA 16+293

Figure No. C.C4A-5

Project No. 06-1111-025

Checked By: TVA





# **APPENDIX D**

## **Highway 69 SBL – STA 16+232 (Culvert C4)**



**RECORD OF BOREHOLE No C4-S1**

1 OF 3 **METRIC**

PROJECT 06-1111-025

G.W.P. 5203-06-00

LOCATION N 5092291.0 ; E 221084.4

ORIGINATED BY MR

DIST HWY 69

BOREHOLE TYPE 115 mm O.D. Continuous Flight Solid Stem Augers and NW Casing, Wash Boring

COMPILED BY MWK/TZ

DATUM Geodetic

DATE March 6, 2009

CHECKED BY VA

SOIL PROFILE			SAMPLES			GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT		PLASTIC LIMIT w <sub>p</sub>	NATURAL MOISTURE CONTENT w	LIQUID LIMIT w <sub>L</sub>	UNIT WEIGHT γ kN/m <sup>3</sup>	REMARKS & GRAIN SIZE DISTRIBUTION (%) GR SA SI CL	
ELEV DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE	"N" VALUES			SHEAR STRENGTH kPa							WATER CONTENT (%)
								○ UNCONFINED	+ FIELD VANE						
186.7	ICE SURFACE						20 40 60 80 100	20 40 60 80 100	10 20 30						
0.0	Ice														
186.1							186								
0.6	Water														
185.5															
1.2	Sandy PEAT, containing rootlets and wood fragments Very soft Dark brown Wet		1	SS	WR		185								
			2	SS	WR										
							184								
183.4			3A	SS	WR										
3.4	Organic SILTY CLAY Very soft Dark grey Wet		3B	SS	WR		183								
			4	SS	2										
182.2															
4.5	SAND, trace to some silt, trace clay Very loose Grey Wet		5	SS	4		182								
			6	SS	1		181								
179.8							180								
6.9	SILT, trace sand, trace clay, containing clay layers Very loose Grey Wet		7	SS	WH		179								
178.6															
8.1	CLAY, containing silt layers between depths of 11.6 m and 16.3 m Soft to stiff Grey Wet		8	SS	WH		178	4 + 3 +							
			9	SS	WH		177	4 + 3 +							
							176								
							175	3 + 4 +							
			10	SS	WH										
							174	3 + 3 +							
			11	SS	WH		173								
							172	4 + 3 +							

Continued Next Page

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

MIS-MTO 001 06-1111-025.GPJ GAL-MISS.GDT 1/25/12 SAC



**RECORD OF BOREHOLE No C4-S1**

2 OF 3 **METRIC**

PROJECT 06-1111-025

G.W.P. 5203-06-00

LOCATION N 5092291.0 ; E 221084.4

ORIGINATED BY MR

DIST HWY 69

BOREHOLE TYPE 115 mm O.D. Continuous Flight Solid Stem Augers and NW Casing, Wash Boring

COMPILED BY MWK/TZ

DATUM Geodetic

DATE March 6, 2009

CHECKED BY VA

SOIL PROFILE			SAMPLES			GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT		PLASTIC LIMIT W <sub>p</sub>	NATURAL MOISTURE CONTENT W	LIQUID LIMIT W <sub>L</sub>	UNIT WEIGHT γ kN/m <sup>3</sup>	REMARKS & GRAIN SIZE DISTRIBUTION (%)					
ELEV DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE	"N" VALUES			SHEAR STRENGTH kPa							WATER CONTENT (%)				
								○ UNCONFINED	+ FIELD VANE							● QUICK TRIAXIAL	× REMOULDED		
--- CONTINUED FROM PREVIOUS PAGE ---								20	40	60	80	100	10	20	30	GR	SA	SI	CL
170.4	CLAY, containing silt layers between depths of 11.6 m and 16.3 m Soft to stiff Grey Wet		12	SS	1		171												
16.3	CLAYEY SILT, trace gravel, trace sand, containing silt layers Firm to stiff Brown to brownish grey Wet		13	SS	5		170												
			14	SS	3		169												
							168												
						167													
						166													
			15	SS	3		165												
164.1	SILT, trace to some sand, trace to some clay, containing clay layers between depths of 22.6 m and 24.4 m Very loose to compact Grey Wet						164												
22.6	Containing sand layer at a depth of 24.4 m		16A 16B	SS	3		163												
							162												
							161												
						160													
			17	SS	14		159												
158.7	SAND, trace silt Compact Grey Wet						158												
157.6	END OF BOREHOLE		18	SS	16														
29.1																			

Continued Next Page

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

MIS-MTO 001 06-1111-025.GPJ GAL-MISS.GDT 1/25/12 SAC





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

MIS-MTO 001 06-1111-025.GPJ GAL-MISS.GDT 1/25/12 SAC



**RECORD OF BOREHOLE No C4-S2**

1 OF 2 **METRIC**

PROJECT 06-1111-025

G.W.P. 5203-06-00

LOCATION N 5092287.4 ; E 221118.2

ORIGINATED BY MR

DIST HWY 69

BOREHOLE TYPE 115 mm O.D. Continuous Flight Solid Stem Augers and NW Casing, Wash Boring

COMPILED BY MWK/TZ

DATUM Geodetic

DATE March 7, 2009

CHECKED BY VA

SOIL PROFILE			SAMPLES			GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT		PLASTIC LIMIT   NATURAL MOISTURE CONTENT   LIQUID LIMIT			UNIT WEIGHT  γ  kN/m³	REMARKS & GRAIN SIZE DISTRIBUTION (%)
ELEV DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE	"N" VALUES			SHEAR STRENGTH kPa		WATER CONTENT (%)				
								○ UNCONFINED   + FIELD VANE						
						● QUICK TRIAXIAL   × REMOULDED								
186.7	ICE SURFACE						20   40   60   80   100	20   40   60   80   100	10   20   30				GR   SA   SI   CL	
0.0	Ice													
186.1														
185.8	Water													
0.9	Root mat													
185.2														
1.5	Sandy PEAT, containing wood fragments and rootlets Very soft Dark Brown Wet		1	SS	WR									
184.4			2A	SS	WH									
184.1	SILT, some sand, containing organics and rootlets Very loose Grey Wet		2B	SS	WH							40.4		
2.6														
183.3			3	SS	WH									
3.4	Sandy PEAT, containing wood fragments Very soft Dark grey Wet		4	SS	WR							55.1	OC = 8.4%	
182.0	Organic SILT, some clay Very loose Dark grey Wet		5A	SS	WH									
4.7			5B	SS	WH									
	SILT, some sand, trace to some clay, containing sand and clay layers between depths of 5.5 m and 6.9 m Very loose Grey Wet													
			6	SS	1							H   ○	0   14   77   9	
			7	SS	2									
178.2														
8.5	SILTY CLAY, trace sand, containing silt layers between depths of 10.4 m and 21.6 m Firm to stiff Grey Wet		8	SS	WH							85.1		
			9	SS	WH								0   3   57   40	
			10	SS	WH							64.2		
			11	SS	WH							53.1		

Continued Next Page

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

MIS-MTO 001 06-1111-025.GPJ GAL-MISS.GDT 12/5/12 SAC



**RECORD OF BOREHOLE No C4-S2**

2 OF 2 **METRIC**

PROJECT 06-1111-025  
 G.W.P. 5203-06-00 LOCATION N 5092287.4 ; E 221118.2 ORIGINATED BY MR  
 DIST            HWY 69 BOREHOLE TYPE 115 mm O.D. Continuous Flight Solid Stem Augers and NW Casing, Wash Boring COMPILED BY MWK/TZ  
 DATUM Geodetic DATE March 7, 2009 CHECKED BY VA

SOIL PROFILE			SAMPLES			GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT			PLASTIC LIMIT w <sub>p</sub>	NATURAL MOISTURE CONTENT w	LIQUID LIMIT w <sub>L</sub>	UNIT WEIGHT γ kN/m <sup>3</sup>	REMARKS & GRAIN SIZE DISTRIBUTION (%)								
ELEV DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE	"N" VALUES			SHEAR STRENGTH kPa							WATER CONTENT (%)			GR	SA	SI	CL		
								○ UNCONFINED	+ FIELD VANE	● QUICK TRIAXIAL					× REMOULDED	20	40					60	80
	--- CONTINUED FROM PREVIOUS PAGE ---																						
	SILTY CLAY, trace sand, containing silt layers between depths of 10.4 m and 21.6 m Firm to stiff Grey Wet		12	SS	1		171										0	1	61	38			
				13	SS	1		170															
								169															
								168															
			14	SS	2		167																
							166																
165.1 21.6	CLAYEY SILT, containing clay seams between depths of 21.6 m and 24.2 m and sand layers between depths of 24.2 m and 26.5 m Soft to stiff Grey Wet		15	SS	3		165										0	0	87	13			
							164																
							163																
							162																
			16	SS	14		161																
160.2 26.5	SAND, some gravel, trace silt Compact Grey Wet						160																
			17	SS	27																		
159.1 27.6	END OF BOREHOLE																						
	NOTE:  1. Water level in open borehole at ice surface (Elev. 186.7 m) upon completion of drilling.																						

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

MIS-MTO 001 06-1111-025.GPJ GAL-MISS.GDT 12/5/12 SAC



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

CONT No.  
GWP No. 5203-06-00

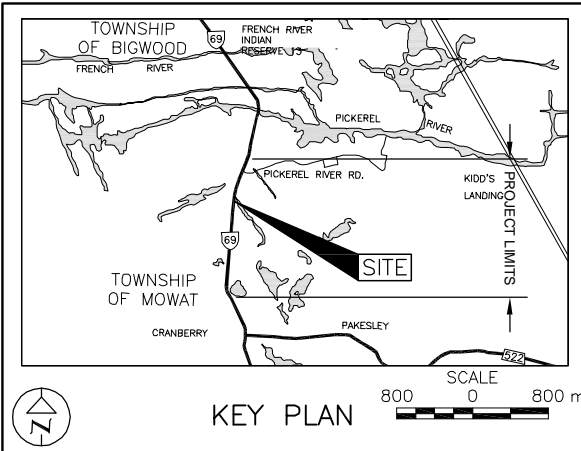


HIGHWAY 69 (SBL)  
CULVERT STA 16+232  
BOREHOLE LOCATION

SHEET



Golder Associates Ltd.  
MISSISSAUGA, ONTARIO, CANADA



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

No.	ELEVATION	CO-ORDINATES	
		NORTHING	EASTING
C4-S1	186.7	5092291.0	221084.4
C4-S2	186.7	5092287.4	221118.2

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 MRC, drawing file no. PHASE 3 Plan 090211 – Golder.dwg, received February 11, 2009. Culverts provided in digital format by MRC, drawing file no. 6454 Culvert xsect Phase 3 – Mainline 090930.dwg received Oct. 02, 2009. KEY PLAN obtained from a digital file provided by CALLON DIETZ drawing file no. C-748-069-2.dwg received April 23, 2009.

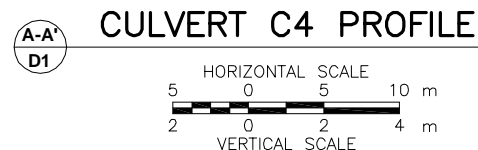
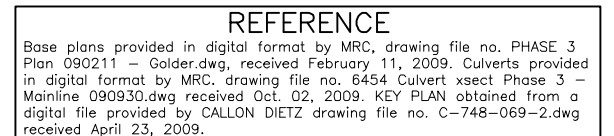


PLAN



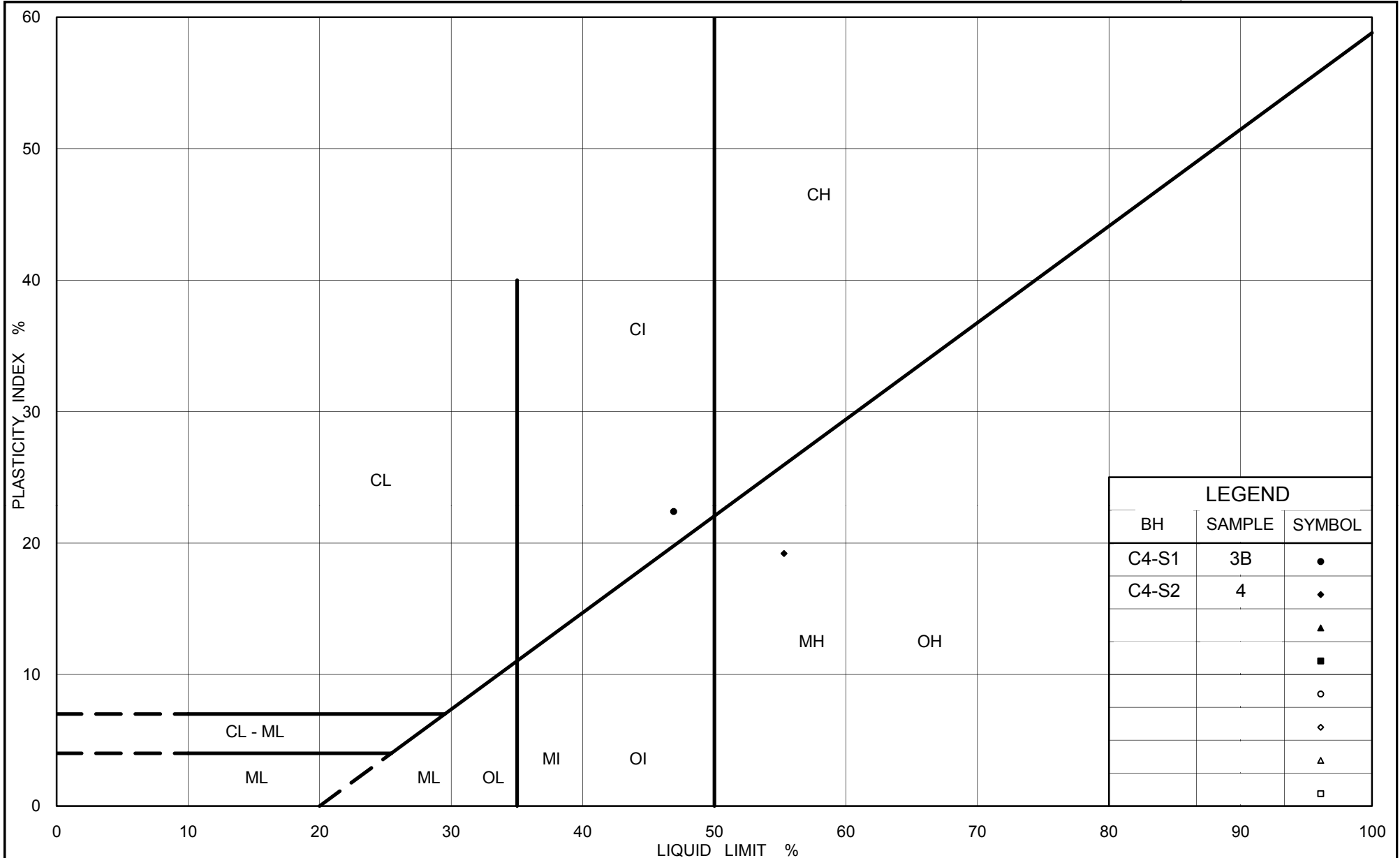


SHEET



NO.	DATE	BY	REVISION	
Geocres No. 41H-107				
HWY. 69		PROJECT NO. 06-1111-025		DIST.
SUBM'D. VA	CHKD. VA	DATE: Jan. 2012	SITE: 44-551/C2	
DRAWN: JFC/RJ	CHKD. VA	APPD. JPD/JMAC	DWG. D2	





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PLASTICITY CHART  
Organic Silty Clay to Organic Silt  
Highway 69 (SBL) STA 16+232

Figure No. D.C4-1

Project No. 06-1111-025

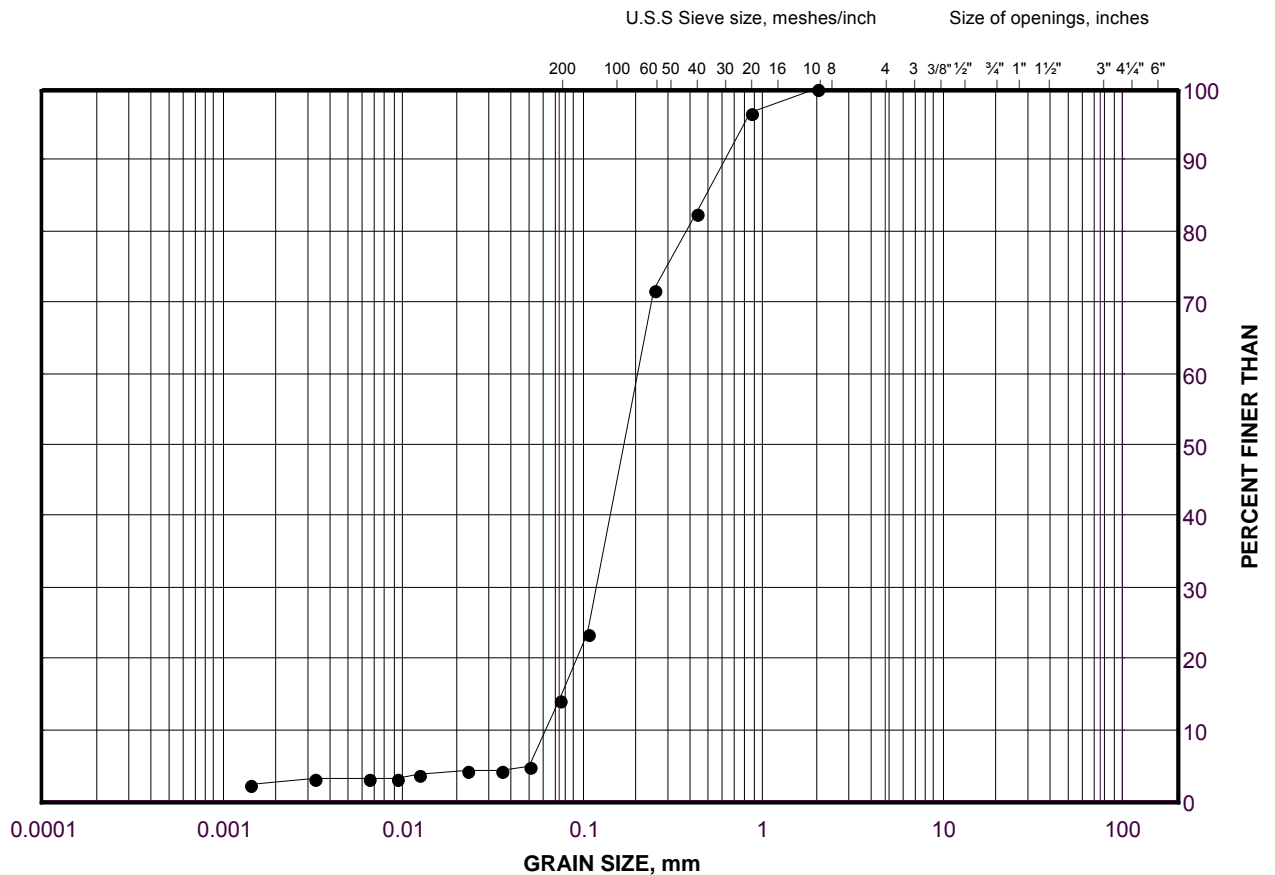
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# GRAIN SIZE DISTRIBUTION

Sand (Upper)  
Highway 69 (SBL) STA 16+232

FIGURE D.C4-2



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

## LEGEND

SYMBOL	BOREHOLE	SAMPLE	ELEVATION(m)
•	C4-S1	5	181.8

Project Number: 06-1111-025

Checked By: TVA

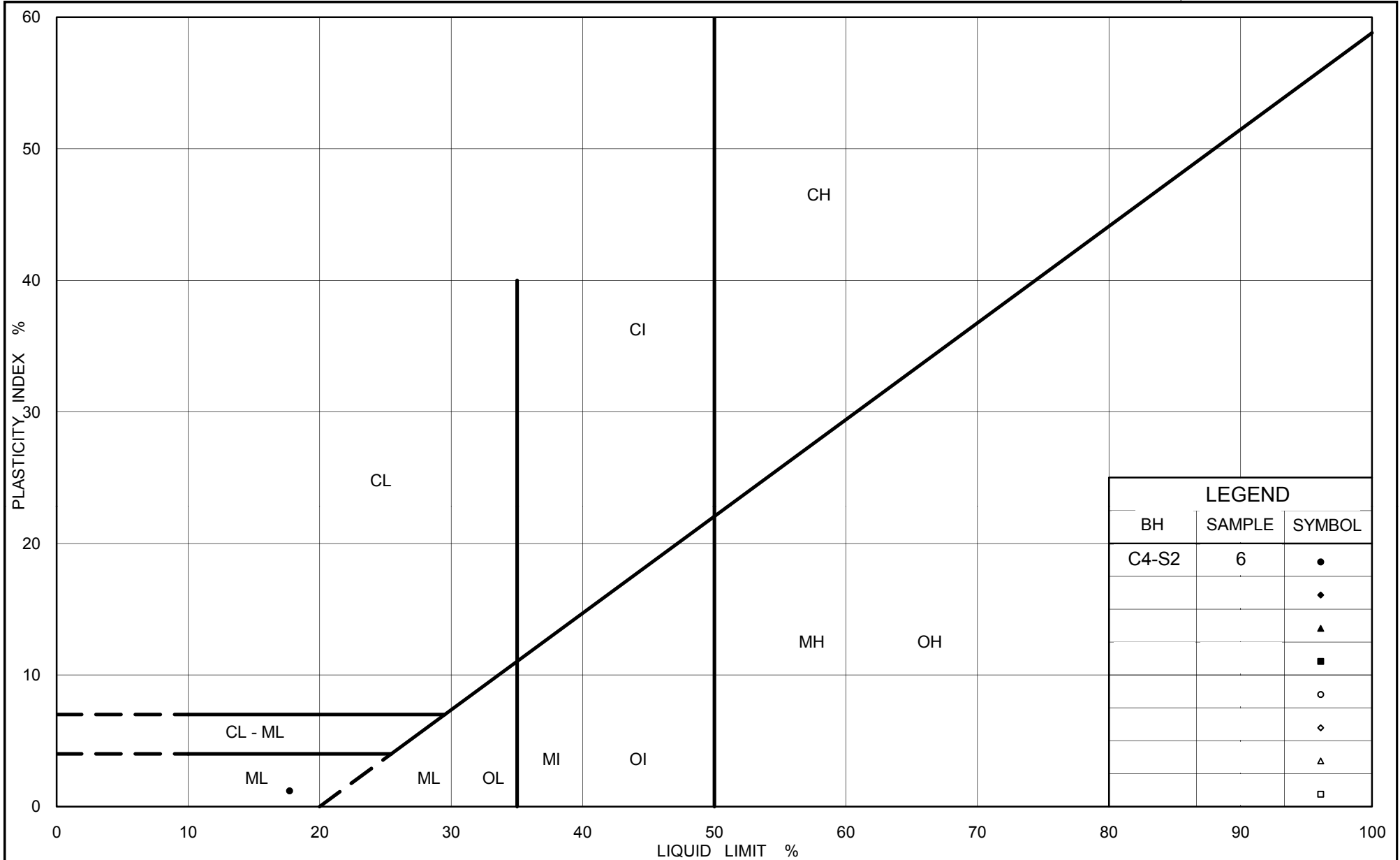
**Golder Associates**

Date: 05-Nov-09



FIGURE D.C4-3





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Ontario

**PLASTICITY CHART**  
 Silt (Upper)  
 Highway 69 (SBL) STA 16+232

Figure No. D.C4-4

Project No. 06-1111-025

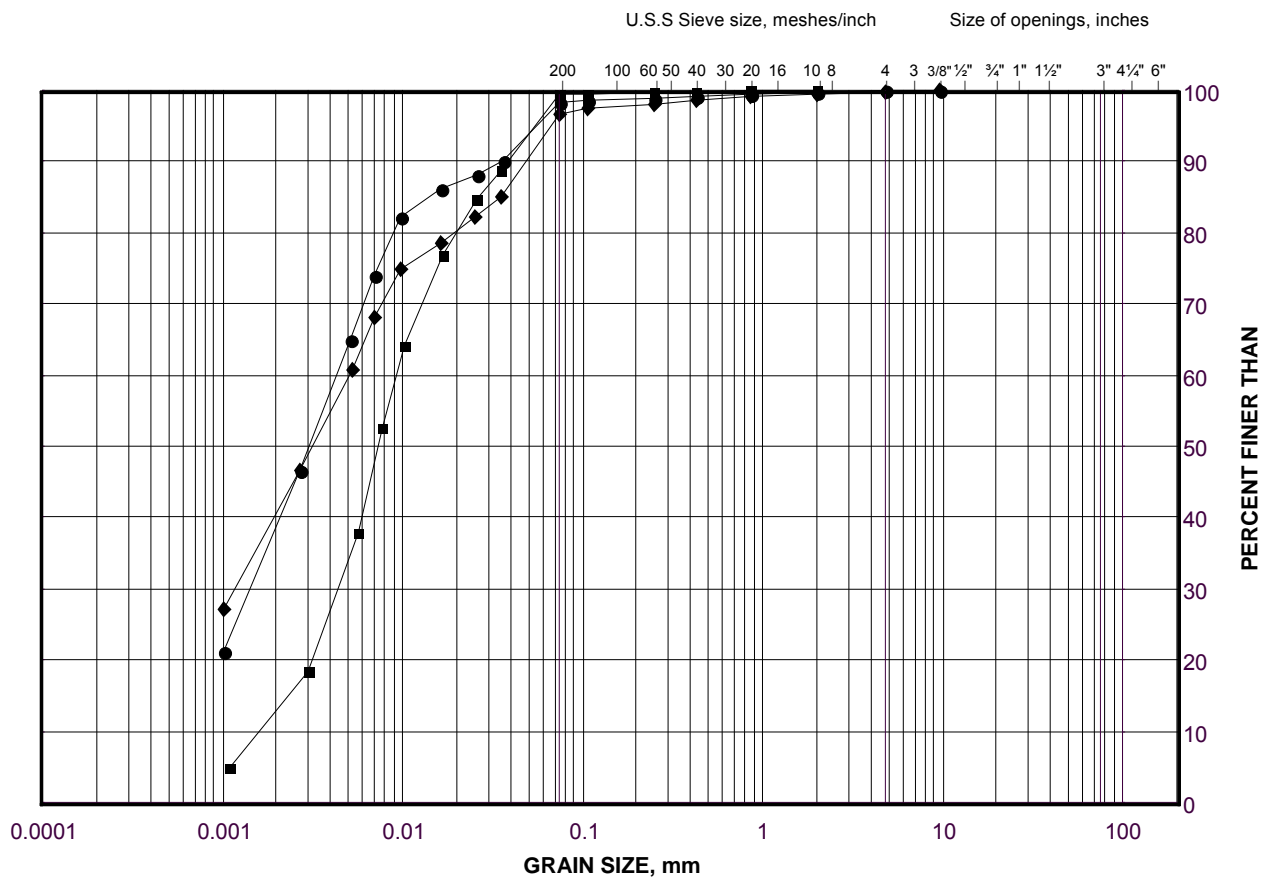
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# GRAIN SIZE DISTRIBUTION

Silty Clay to Clayey Silt  
Highway 69 (SBL) STA 16+232

FIGURE D.C4-5



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

## LEGEND

SYMBOL	BOREHOLE	SAMPLE	ELEVATION(m)
●	C4-S2	12	171.5
■	C4-S2	15	164.0
◆	C4-S2	9	176.0

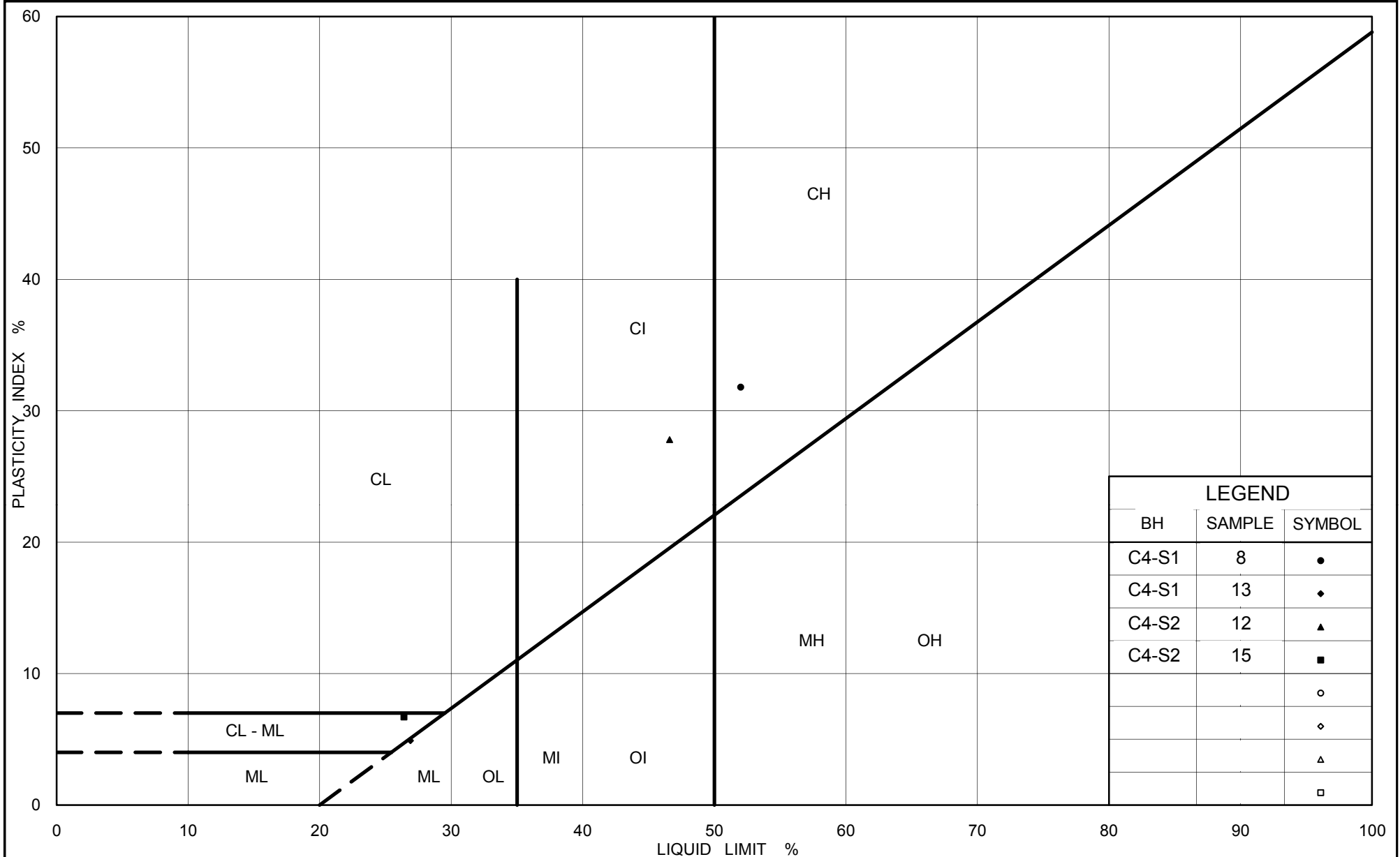
Project Number: 06-1111-025

Checked By: TVA

Golder Associates

Date: 05-Nov-09





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**PLASTICITY CHART**  
 Clay to Clayey Silt  
 Highway 69 (SBL) STA 16+232

Figure No. D.C4-6

Project No. 06-1111-025

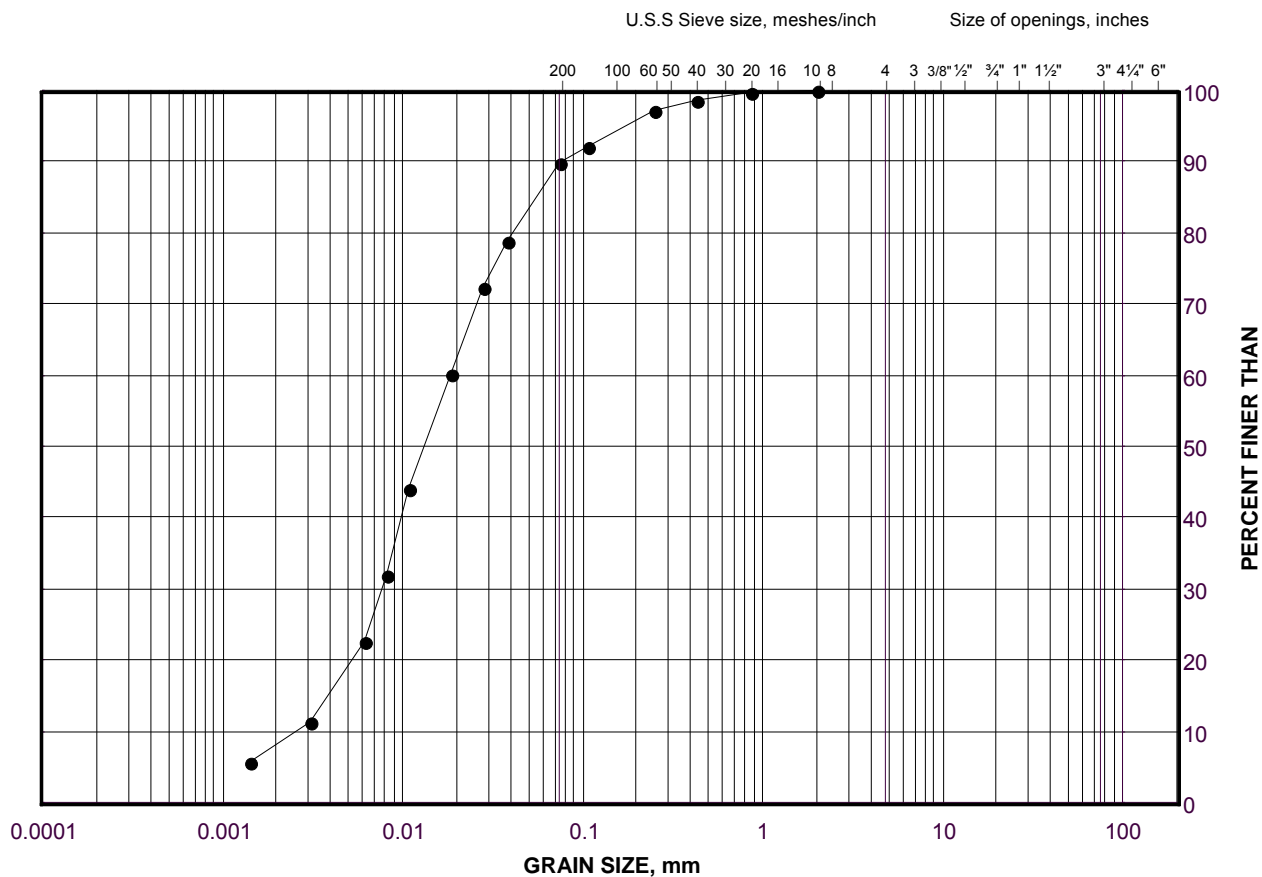
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# GRAIN SIZE DISTRIBUTION

Silt (Lower)  
Highway 69 (SBL) STA 16+232

FIGURE D.C4-7



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

## LEGEND

SYMBOL	BOREHOLE	SAMPLE	ELEVATION(m)
•	C4-S1	17	159.4

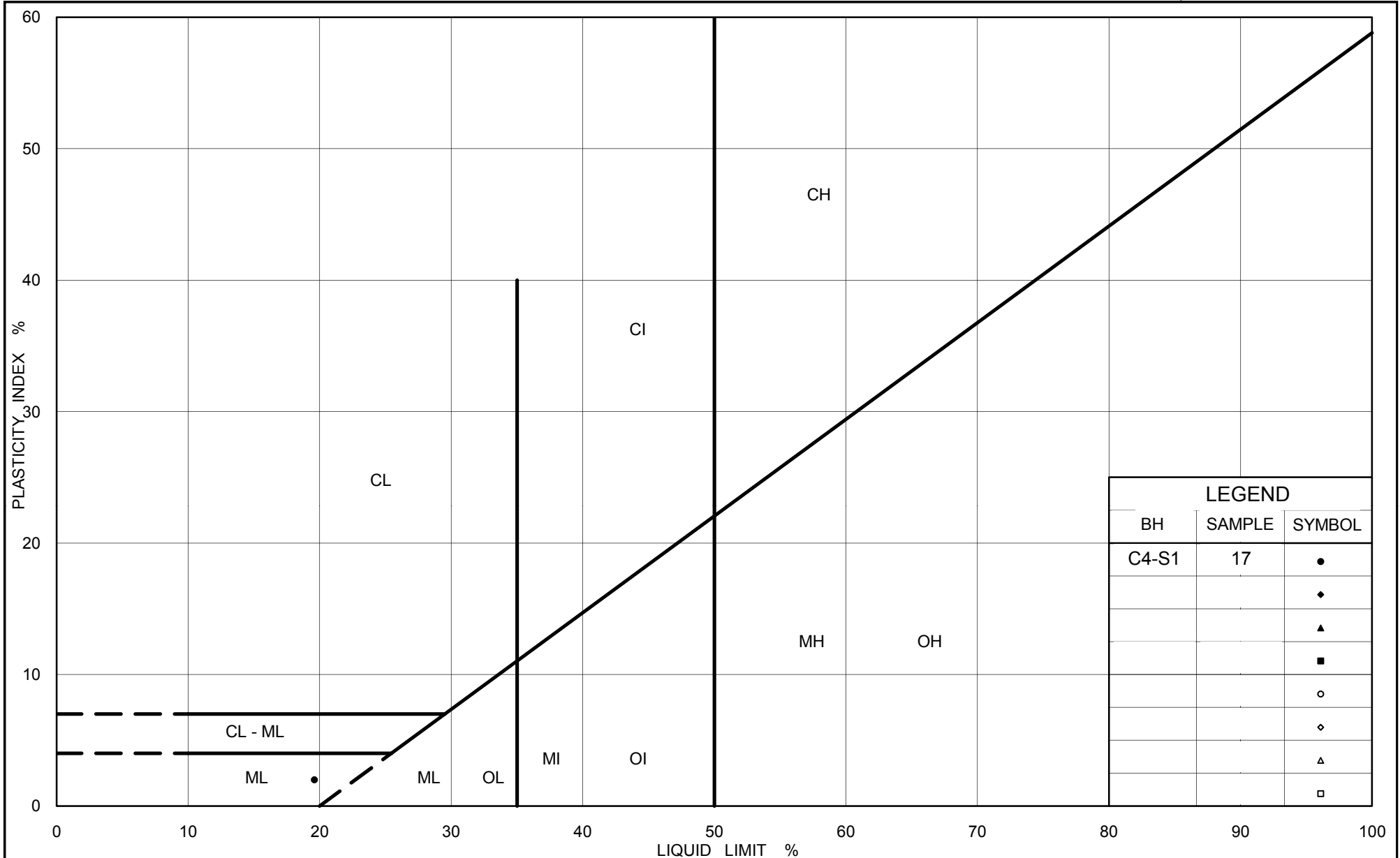
Project Number: 06-1111-025

Checked By: TVA

Golder Associates

Date: 05-Nov-09





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PLASTICITY CHART  
Silt (Lower)  
Highway 69 (SBL) STA 16+232

Figure No. D.C4-8

Project No. 06-1111-025

Checked By: TVA





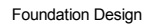
# **APPENDIX E**

## **Highway 69 SBL – STA 15+654 (Culvert C3)**



PROJECT 06-1111-025			RECORD OF BOREHOLE No C3-S1			1 OF 1 METRIC														
G.W.P. 5203-06-00			LOCATION N 5091721.3 ; E 221028.0			ORIGINATED BY MR														
DIST _____ HWY 69			BOREHOLE TYPE 115 mm O.D. Continuous Flight Solid Stem Augers and NW Casing, Wash Boring			COMPILED BY MWK/TZ														
DATUM Geodetic			DATE March 16, 2009			CHECKED BY VA														
SOIL PROFILE			SAMPLES			GROUND WATER CONDITIONS			DYNAMIC CONE PENETRATION RESISTANCE PLOT			PLASTIC LIMIT NATURAL MOISTURE CONTENT LIQUID LIMIT			UNIT WEIGHT			REMARKS & GRAIN SIZE DISTRIBUTION (%)		
ELEV DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE	"N" VALUES		ELEVATION SCALE	SHEAR STRENGTH kPa					WATER CONTENT (%)			γ kN/m <sup>3</sup>	GR SA SI CL			
							20 40 60 80 100	○ UNCONFINED + FIELD VANE	● QUICK TRIAXIAL × REMOULDED	W <sub>p</sub>	W	W <sub>L</sub>								
191.1	GROUND SURFACE						191													
0.0	Clayey silt, trace sand, containing topsoil, organics and rootlets (FILL)		1	SS	4		190										0 56 37 7			
190.4	Soft Brown Moist		2	SS	13															
0.7	SAND and SILT, trace to some clay																			
189.3	Very loose to compact Brown to brown and grey Wet		3A	SS	3		189													
189.0	CLAYEY SILT, trace sand		3B	SS																
2.1	Soft Brown and grey Wet		4	SS	2		188													
	CLAY, trace to some silt, trace sand, containing silt layers below a depth of 5.0 m						187													
	Soft to firm Grey Wet		5	SS	WH		186													
			6	SS	WH		185													
184.4	SILT, some sand, trace clay		7	SS	26		184										0 20 77 3 Non-Plastic			
6.7	Compact Grey Wet																			
183.8	END OF BOREHOLE CASING REFUSAL																			
7.3	NOTE: 1. Water level in open borehole at a depth of 1.5 m below ground surface (Elev. 189.6 m) upon completion of drilling.																			



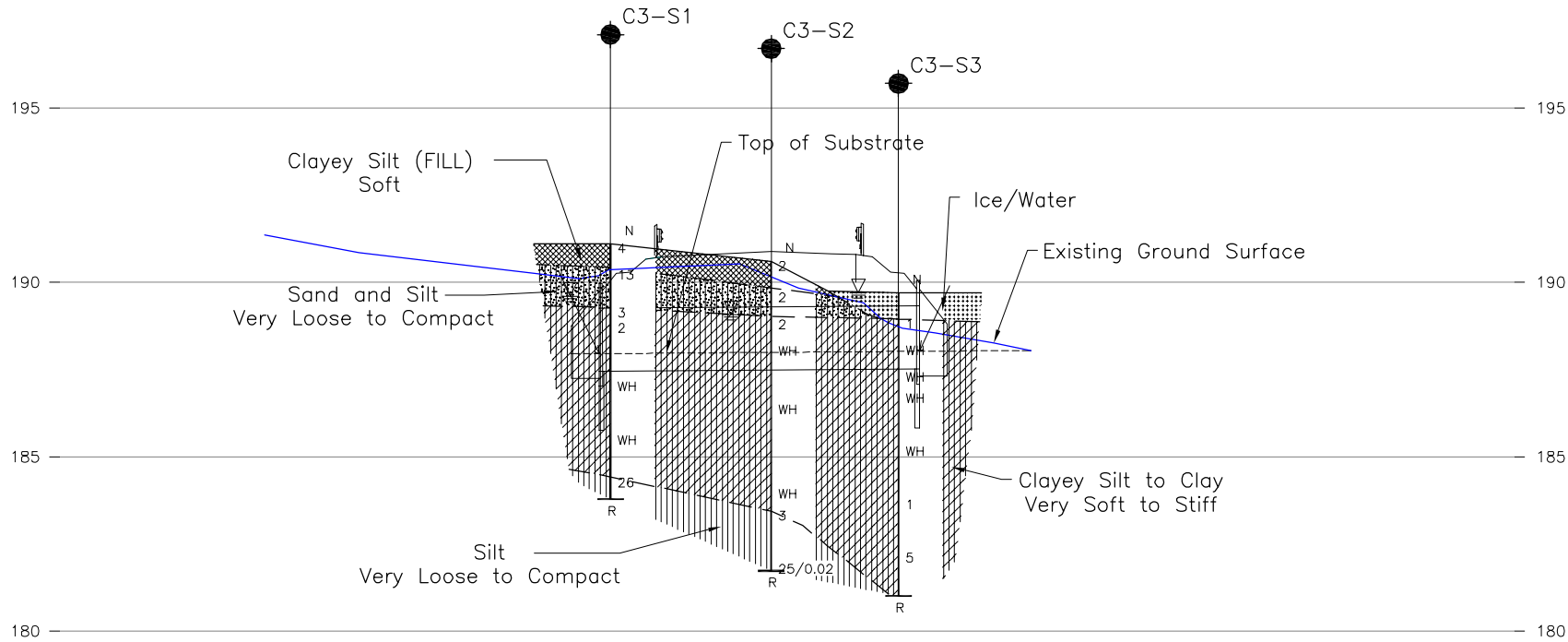
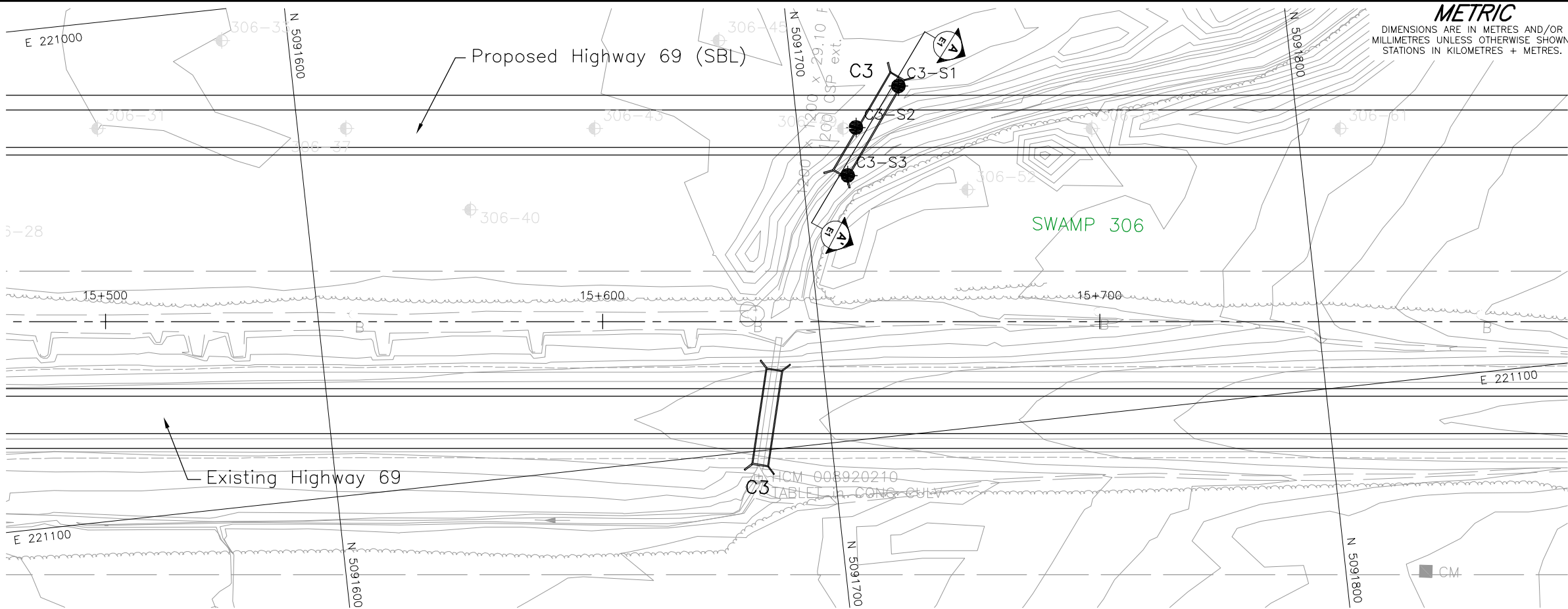


+<sup>3</sup>, ×<sup>3</sup>: Numbers refer to Sensitivity      ○<sup>3%</sup> STRAIN AT FAILURE

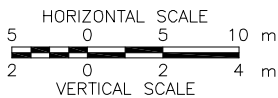


PROJECT 06-1111-025		<b>RECORD OF BOREHOLE No C3-S3</b>				1 OF 1 <b>METRIC</b>								
G.W.P. 5203-06-00		LOCATION N 5091707.7 ; E 221046.6				ORIGINATED BY MR								
DIST _____ HWY 69		BOREHOLE TYPE 115 mm O.D. Continuous Flight Solid Stem Augers and NW Casing, Wash Boring				COMPILED BY MWK/TZ								
DATUM Geodetic		DATE March 17, 2009				CHECKED BY VA								
SOIL PROFILE			SAMPLES			GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT		PLASTIC LIMIT W <sub>p</sub>	NATURAL MOISTURE CONTENT W	LIQUID LIMIT W <sub>L</sub>	UNIT WEIGHT γ kN/m <sup>3</sup>	REMARKS & GRAIN SIZE DISTRIBUTION (%) GR SA SI CL
ELEV DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE	"N" VALUES			SHEAR STRENGTH kPa						
189.7	ICE SURFACE													
0.0	Ice													
189.2	Water													
0.8	CLAYEY SILT, trace sand, containing organics and rootlets to a depth of 1.1 m Very soft Brown and grey Wet		1	SS	1									
187.5			2	SS	WH									
2.2	SILTY CLAY, containing silt layers below a depth of 5.6 m Soft to firm Grey Wet		3	SS	WH									
			4	SS	WH								92.4	
							4 + 4 +							
			5	SS	WH									
							4 + 3 +							
			6	SS	1								52.3	0 0 69 31
182.5							3 +							
7.2	CLAYEY SILT, trace sand, containing silty clay seams Firm to stiff Grey Wet		7	SS	5			+						0 1 76 23
181.0														
8.7	END OF BOREHOLE CASING REFUSAL  NOTE:  1. Water level in open borehole at ice surface (Elev. 189.7 m) upon completion of drilling.													





CULVERT C3 PROFILE



METRIC

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

CONT No.  
GWP No. 5203-06-00

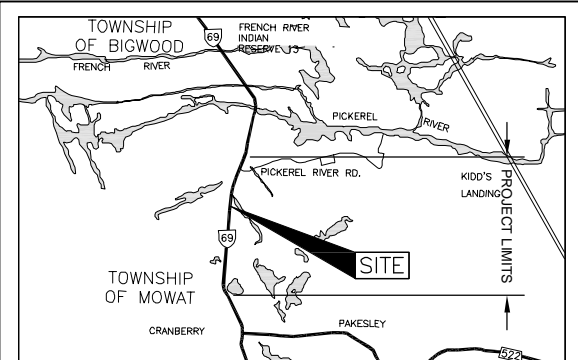


HIGHWAY 69 (SBL)  
CULVERT STA 15+653  
BOREHOLE LOCATION AND SOIL STRATA

SHEET



Golder Associates Ltd.  
MISSISSAUGA, ONTARIO, CANADA



KEY PLAN

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
- R Refusal

No.	ELEVATION	CO-ORDINATES	
		NORTHING	EASTING
C3-S1	191.1	5091721.3	221028.0
C3-S2	190.6	5091713.6	221038.2
C3-S3	189.7	5091707.7	221046.6

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.

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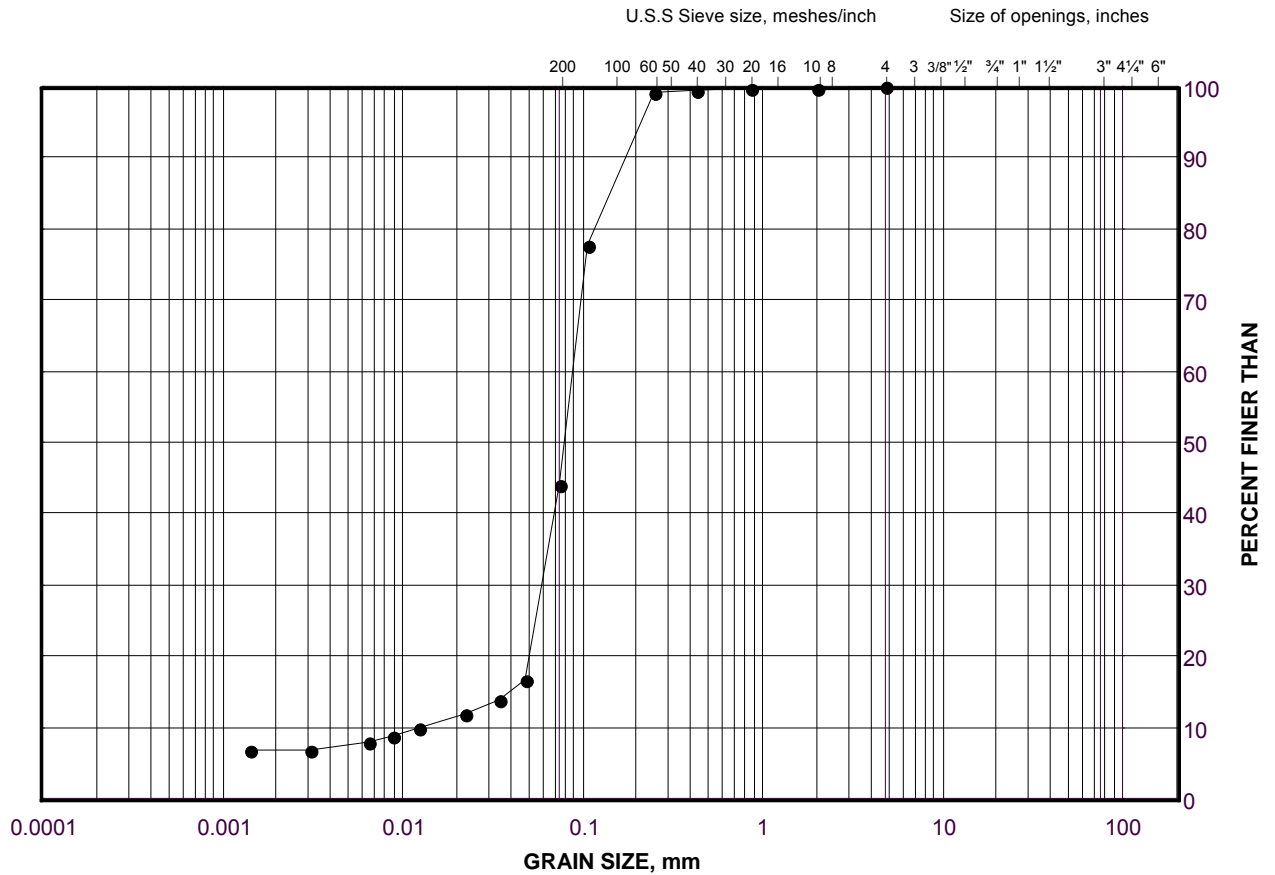
NO.	DATE	BY	REVISION
Geocres No. 41H-107			
HWY. 69		PROJECT NO. 06-1111-025	
SUBM'D. VA		CHKD. VA	SITE: 44-550/C2
DRAWN: JFC/RJ		APPD. JPD/JMAC	DWG. E1



# GRAIN SIZE DISTRIBUTION

Sand and Silt  
Highway 69 (SBL) STA 15+654

FIGURE E.C3-1



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

## LEGEND

SYMBOL	BOREHOLE	SAMPLE	ELEVATION(m)
•	C3-S1	2	190.0

Project Number: 06-1111-025

Checked By: TVA

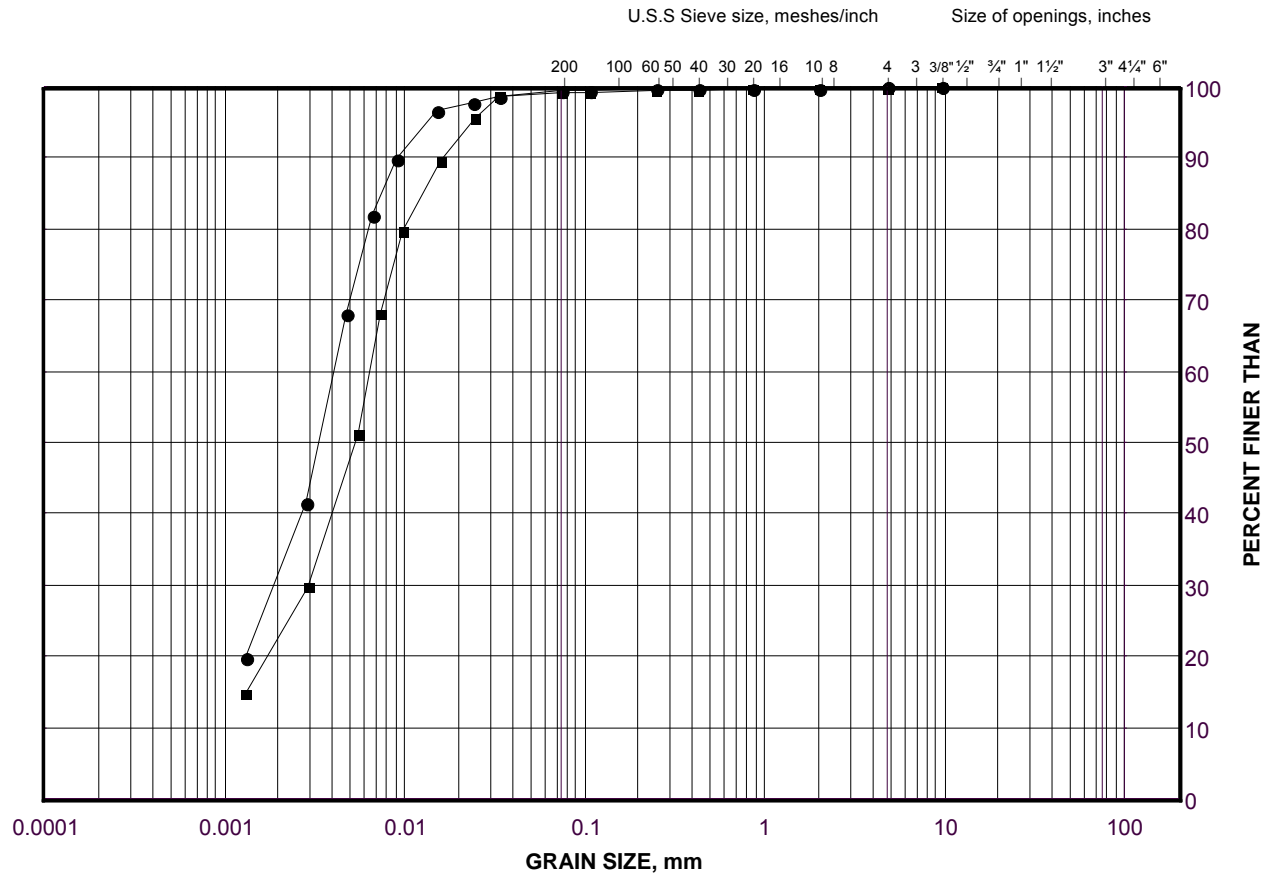
Golder Associates

Date: 09-Nov-09



## Highway 69 (SBL) STA 15+654

FIGURE E.C3-2



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

## LEGEND

SYMBOL	BOREHOLE	SAMPLE	ELEVATION(m)
●	C3-S3	6	183.5
■	C3-S3	7	181.9

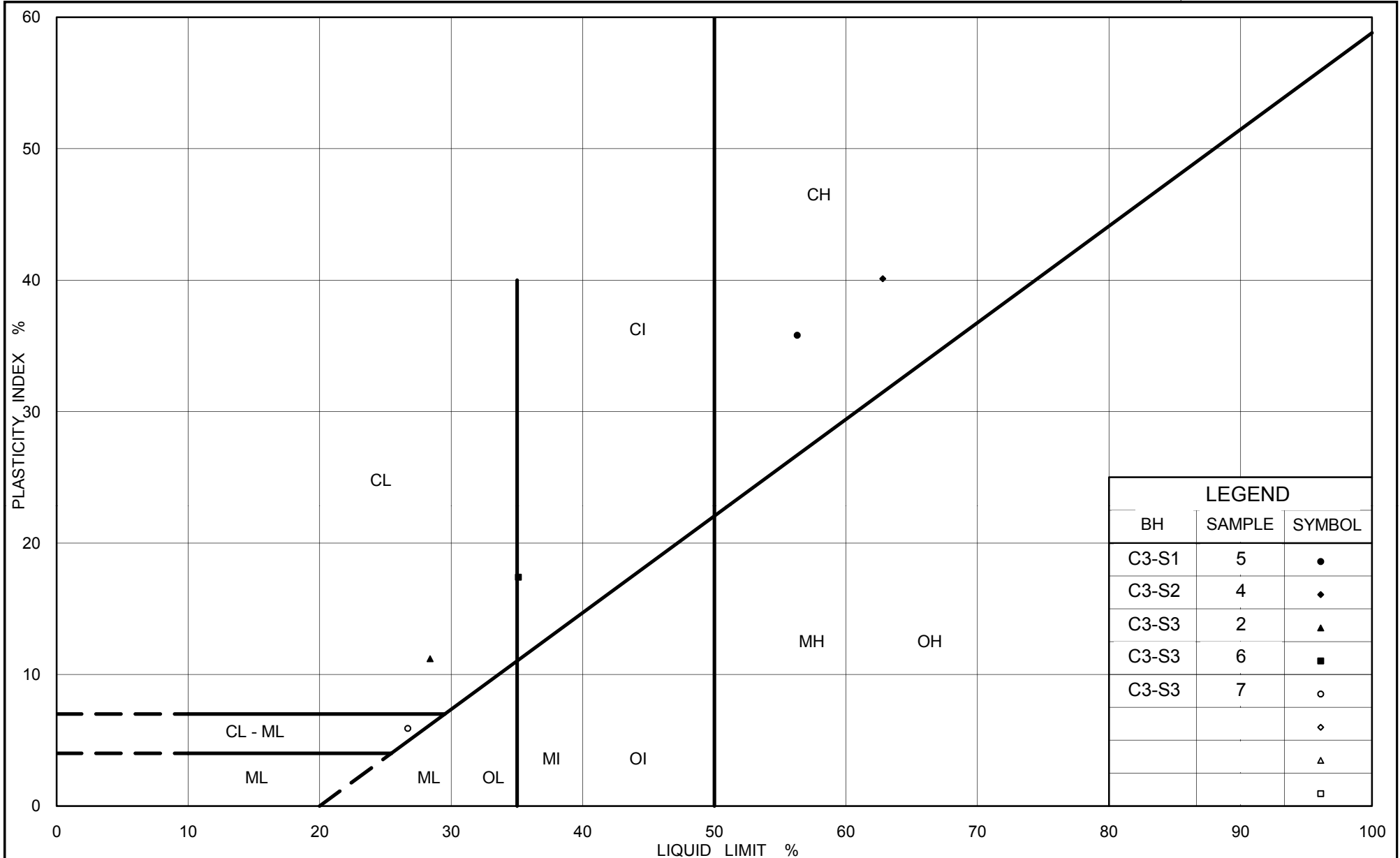
Project Number: 06-1111-025

Checked By: TVA

## Golder Associates

Date: 09-Nov-09





Ministry of Transportation

Ontario

**PLASTICITY CHART**  
 Clayey Silt to Clay  
 Highway 69 (SBL) STA 15+654

Figure No. E.C3-3

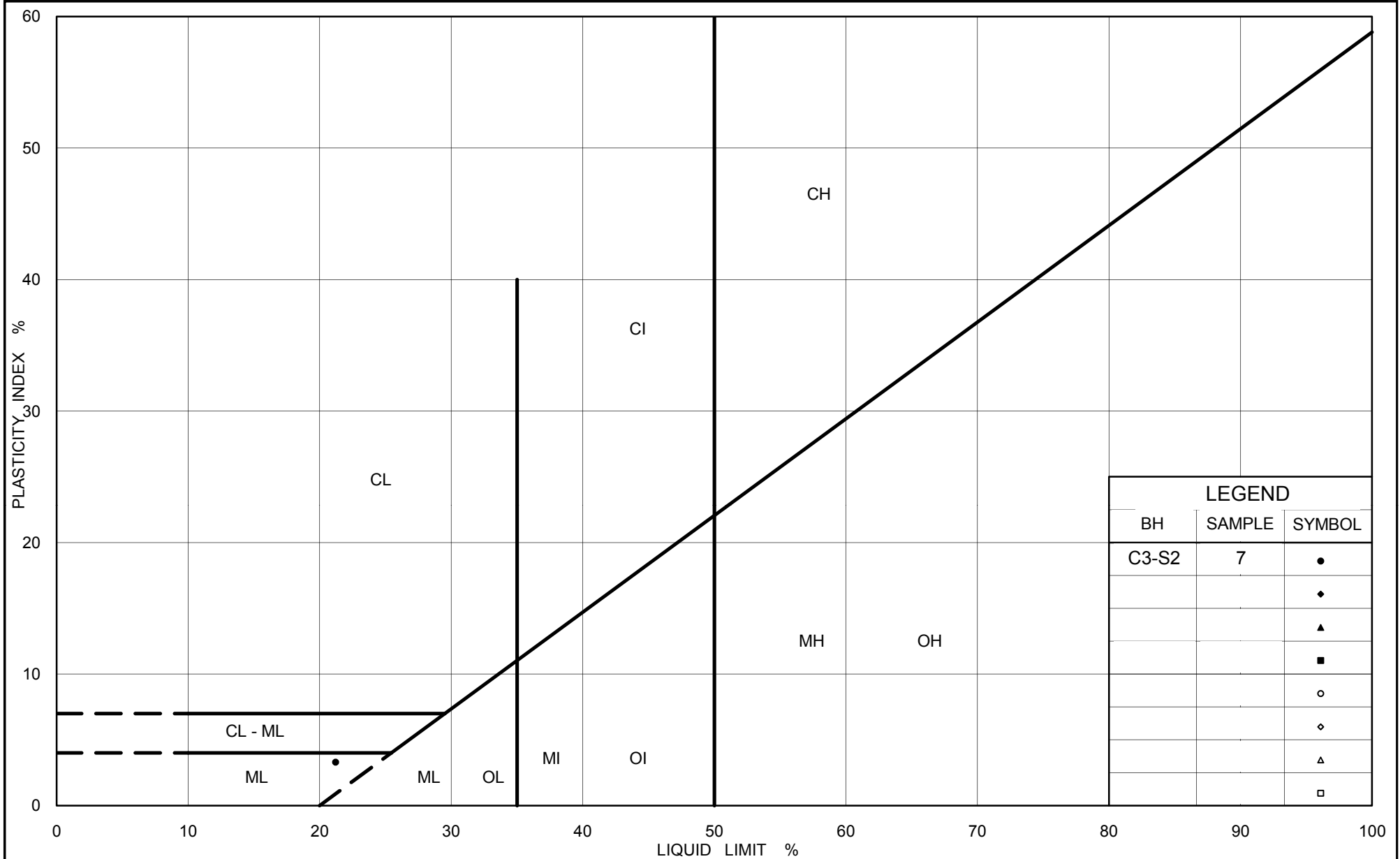
Project No. 06-1111-025

Checked By: TVA



## FIGURE E.C3-4





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PLASTICITY CHART  
Silt  
Highway 69 (SBL) STA 15+654

Figure No. E.C3-5

Project No. 06-1111-025

Checked By: TVA





# **APPENDIX F**

## **Highway 69 SBL – STA 14+415 (Culvert C1)**



PROJECT 06-1111-025		<b>RECORD OF BOREHOLE No C1-S1</b>				1 OF 1 <b>METRIC</b>								
G.W.P. 5203-06-00		LOCATION N 5090481.5 ; E 220916.9				ORIGINATED BY MR								
DIST _____ HWY 69		BOREHOLE TYPE 115 mm O.D. Continuous Flight Solid Stem Augers and NW Casing, Wash Boring				COMPILED BY MWK/TZ								
DATUM Geodetic		DATE March 20, 2009				CHECKED BY VA								
SOIL PROFILE			SAMPLES			GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT		PLASTIC LIMIT W <sub>p</sub>	NATURAL MOISTURE CONTENT W	LIQUID LIMIT W <sub>L</sub>	UNIT WEIGHT γ	REMARKS & GRAIN SIZE DISTRIBUTION (%)
ELEV DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE	"N" VALUES			SHEAR STRENGTH kPa						
192.8	ICE SURFACE													
0.0	Ice/Water													
192.3														
	Root mat													
0.8	Sandy PEAT, containing rootlets		1	AS	-									
191.4	Black Wet													
1.4	SILTY CLAY, trace gravel, trace sand, containing organics and rootlets to a depth of 2.0 m		2	SS	WH									
	Firm to stiff													
	Grey Wet		3	SS	4									
188.3			4	SS	28/0.08									
4.5	END OF BOREHOLE SPOON AND CASING REFUSAL													
	NOTE: 1. Water level in open borehole at ice surface (Elev. 192.8 m) upon completion of drilling.													



PROJECT 06-1111-025		<b>RECORD OF BOREHOLE No C1-S2</b>				1 OF 1 <b>METRIC</b>											
G.W.P. 5203-06-00		LOCATION N 5090482.9 ; E 220904.0				ORIGINATED BY MR											
DIST _____ HWY 69		BOREHOLE TYPE 115 mm O.D. Continuous Flight Solid Stem Augers and NW Casing, Wash Boring				COMPILED BY MWK/TZ											
DATUM Geodetic		DATE March 20, 2009				CHECKED BY VA											
SOIL PROFILE			SAMPLES			GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT					PLASTIC LIMIT W <sub>p</sub>	NATURAL MOISTURE CONTENT W	LIQUID LIMIT W <sub>L</sub>	UNIT WEIGHT $\gamma$ kN/m <sup>3</sup>	REMARKS & GRAIN SIZE DISTRIBUTION (%) GR SA SI CL
ELEV DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE	"N" VALUES			SHEAR STRENGTH kPa									
192.8	ICE SURFACE																
0.0	Ice																
192.3	Root mat																
0.5	Sandy PEAT, containing rootlets Black Wet		1	AS	-												
191.7																	
1.1	SILTY CLAY, trace sand, containing organics Soft Grey Wet		2	SS	2												
191.3																	
1.5	Granite Gneiss (BEDROCK)																
	Bedrock cored from depth of 1.5 m to 3.0 m		1	RC	REC 95%												RQD = 70%
189.8	For bedrock coring details, refer to Record of Drillhole C1-S2																
3.0	END OF BOREHOLE																
NOTE: 1. Water level in open borehole at ice surface (Elev. 192.8 m) upon completion of drilling																	



PROJECT: 06-1111-025

## RECORD OF DRILLHOLE: C1-S2

SHEET 1 OF 1

LOCATION: N 5090482.9 ; E 220904.0

DRILLING DATE: March 20, 2009

DATUM: Geodetic

INCLINATION: -90° AZIMUTH: ---

DRILL RIG: D25

DRILLING CONTRACTOR: Walker Drilling

DEPTH SCALE METRES	DRILLING RECORD	DESCRIPTION	SYMBOLIC LOG	ELEV. DEPTH (m)	RUN No.	FLUSH	COLOUR % RETURN	JN - Joint FLT - Fault SH - Shear VN - Vein CJ - Conjugate	BD - Bedding FO - Foliation CO - Contact OR - Orthogonal CL - Cleavage	PL - Planar CU - Curved UN - Undulating ST - Stepped IR - Irregular	PO - Polished K - Slickensided SM - Smooth RO - Rough VR - Very Rough	MB - Mechanical Break BR - Broken Rock NOTE: For additional abbreviations refer to list of abbreviations & symbols.	NOTES
1	NORC March 20, 2009	Continued from Record of Borehole C1-S2		191.3	1	100							
2		GRANITE GNEISS Dark grey with reddish pink lenses		1.5									
3		END OF DRILLHOLE		189.8									
4				3.0									
5													
6													
7													
8													
9													
10													
11													

DEPTH SCALE

1 : 50



LOGGED: MR

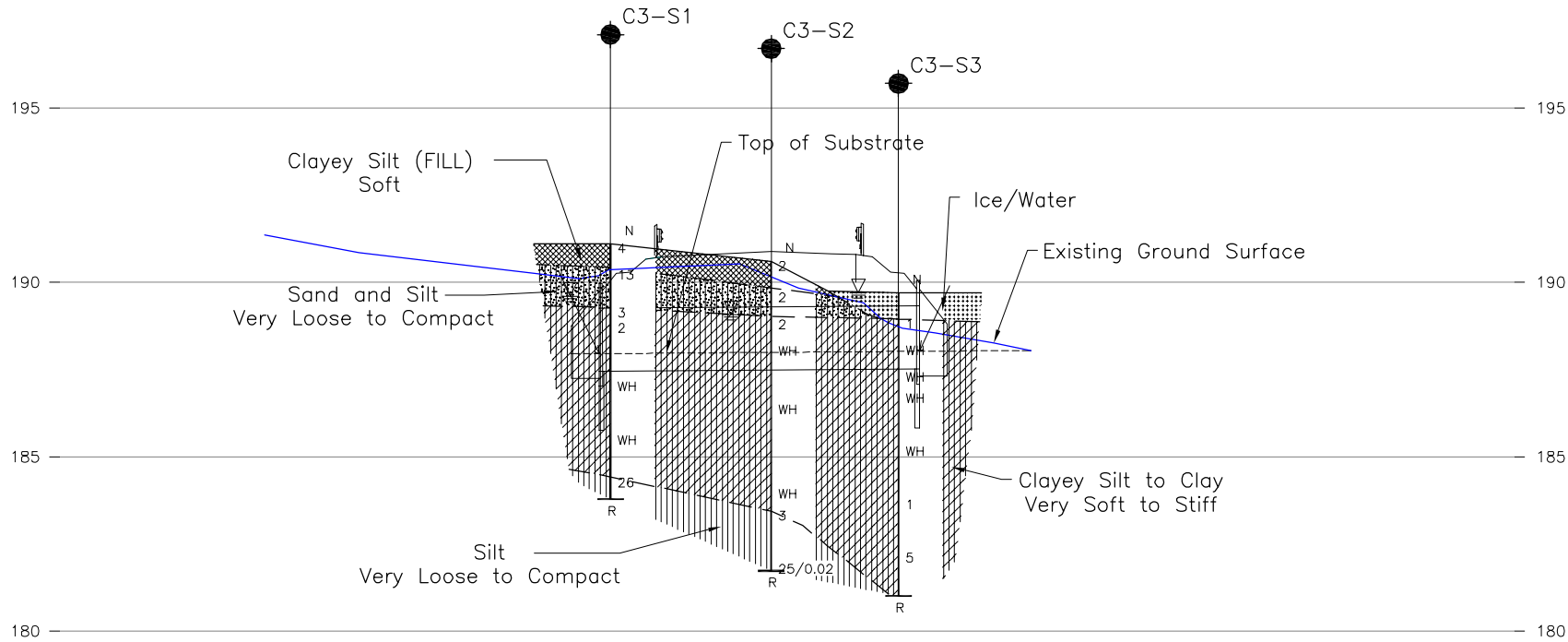
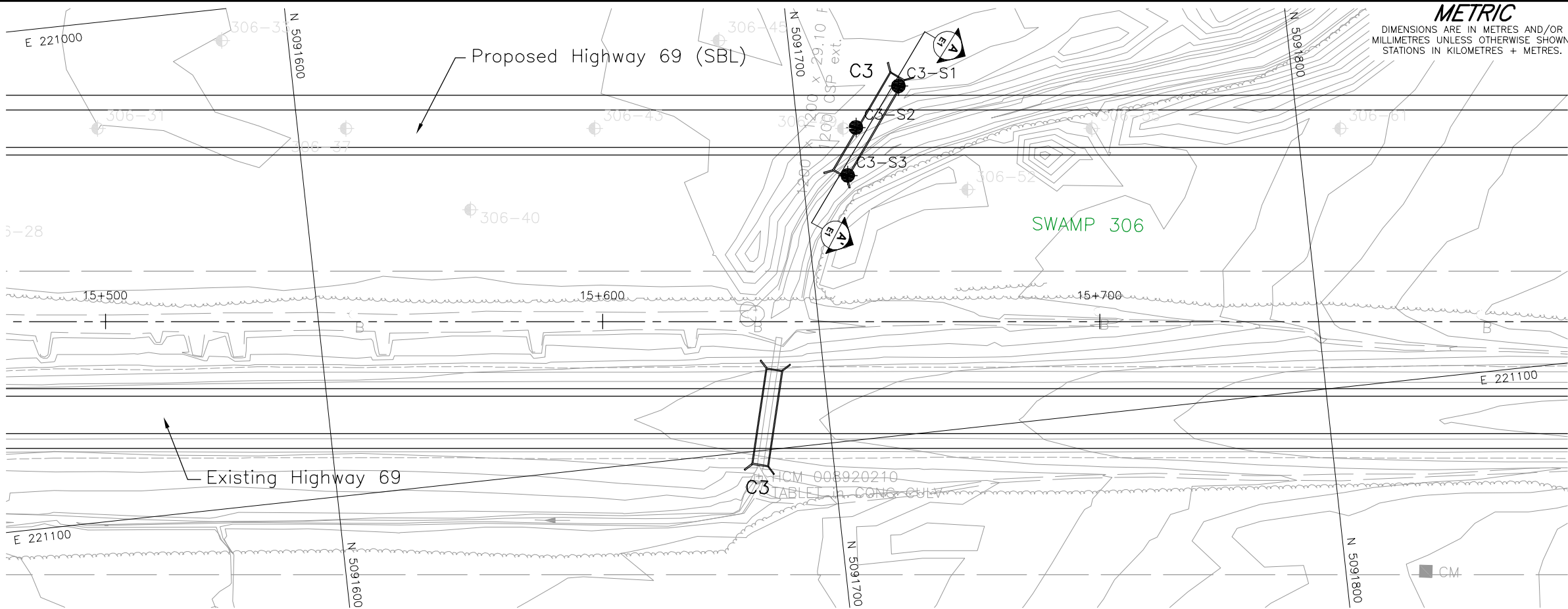
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MIS-RCK 018 06-1111-025.GPJ GAL-MISS.GDT 1/25/12 SAC

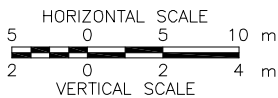


PROJECT 06-1111-025		<b>RECORD OF BOREHOLE No C1-S3</b>				1 OF 1 <b>METRIC</b>											
G.W.P. 5203-06-00		LOCATION N 5090484.4 ; E 220890.6				ORIGINATED BY MR											
DIST _____ HWY 69		BOREHOLE TYPE 115 mm O.D. Continuous Flight Solid Stem Augers and NW Casing, Wash Boring				COMPILED BY MWK/TZ											
DATUM Geodetic		DATE March 20, 2009				CHECKED BY VA											
SOIL PROFILE			SAMPLES			GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT					PLASTIC LIMIT W <sub>p</sub>	NATURAL MOISTURE CONTENT W	LIQUID LIMIT W <sub>L</sub>	UNIT WEIGHT $\gamma$ kN/m <sup>3</sup>	REMARKS & GRAIN SIZE DISTRIBUTION (%) GR SA SI CL
ELEV DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE	"N" VALUES			SHEAR STRENGTH kPa									
192.7	ICE SURFACE																
0.9	Ice																
	Root mat																
192.1	PEAT																
191.8	Dark brown		1A	SS	5		192										
0.9	Wet		1B	SS	7												
	CLAYEY SILT, trace sand, containing organics to a depth of 2.0 m		2	SS	7		191										0 5 74 21
	Firm to stiff																
	Grey																
	Wet		3	SS	9												
190.1	END OF BOREHOLE SPOON AND CASING REFUSAL																
2.7	END OF DCPT Refusal to Further Penetration (40 Blows / 0.23 m)																
NOTES: 1. Water level in open borehole at ice surface (Elev. 192.7 m) upon completion of drilling. 2. A Dynamic Cone Penetration Test was advanced 1.5 m west of Borehole C1-S3; refusal encountered at a depth of 2.7 m below ice surface (Elev. 190.0 m).																	





### CULVERT C3 PROFILE



CONT No.  
GWP No. 5203-06-00

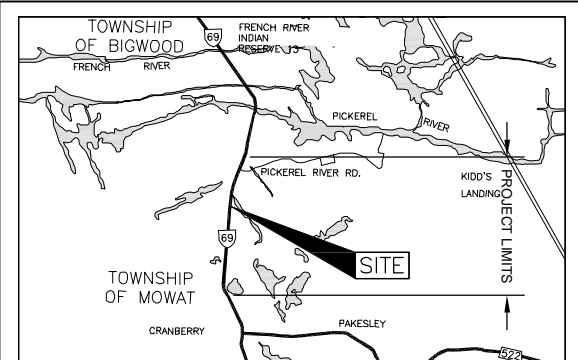


HIGHWAY 69 (SBL)  
CULVERT STA 15+653  
BOREHOLE LOCATION AND SOIL STRATA

SHEET



Golder Associates Ltd.  
MISSISSAUGA, ONTARIO, CANADA



### 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
- R Refusal

No.	ELEVATION	CO-ORDINATES	
		NORTHING	EASTING
C3-S1	191.1	5091721.3	221028.0
C3-S2	190.6	5091713.6	221038.2
C3-S3	189.7	5091707.7	221046.6

### 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 MRC, drawing file no. PHASE 3 Plan 090211 - Golder.dwg, received February 11, 2009. Culverts provided in digital format by MRC, drawing file no. 6454 Culvert xsect Phase 3 - Mainline 090930.dwg received Oct. 02, 2009. KEY PLAN obtained from a digital file provided by CALLON DIETZ drawing file no. C-748-069-2.dwg received April 23, 2009.

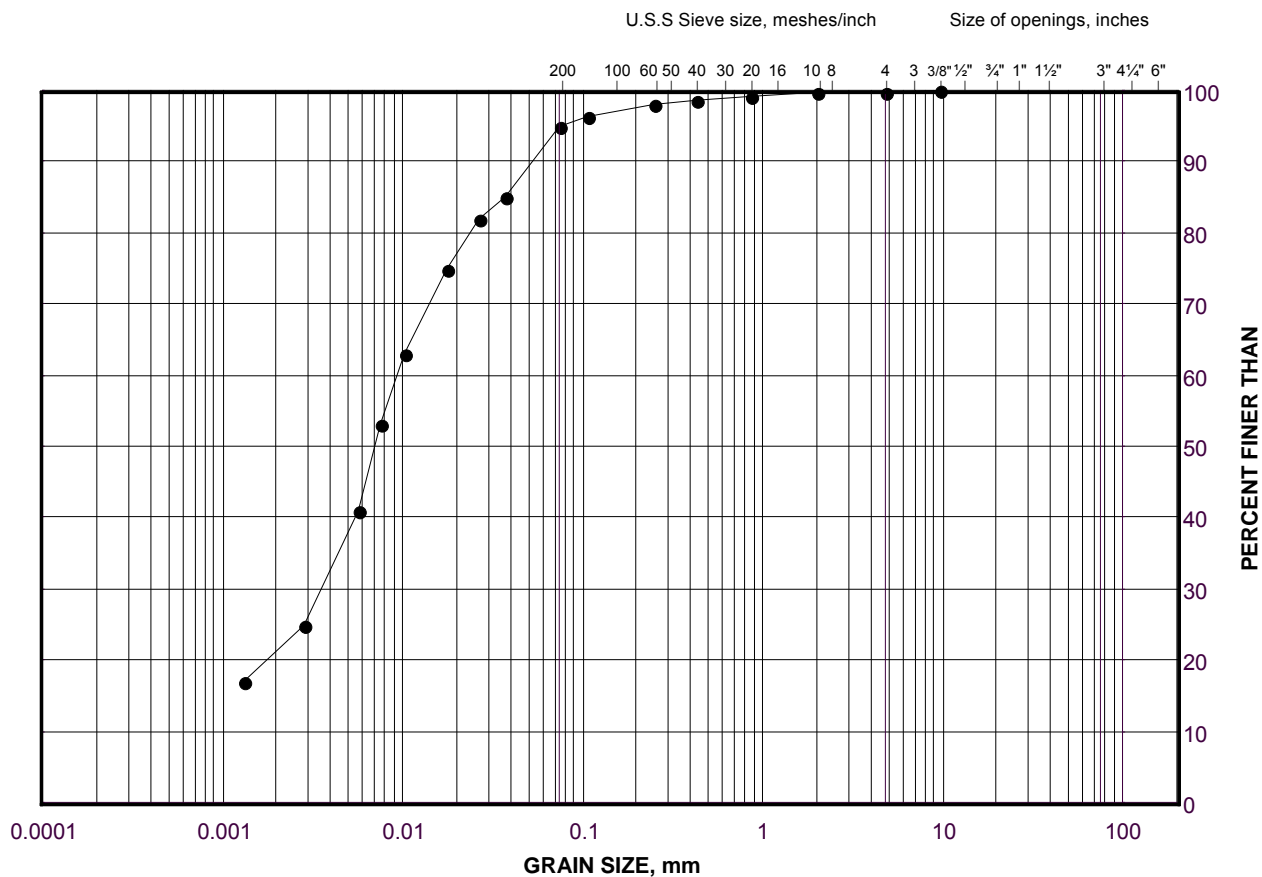
NO.	DATE	BY	REVISION
Geocres No. 41H-107			
HWY. 69		PROJECT NO. 06-1111-025	
SUBM'D. VA		DIST.	
CHKD. VA	DATE: Jan. 2012	SITE: 44-550/C2	
DRAWN: JFC/RJ	CHKD. VA	APPD. JPD/JMAC	DWG. E1



# GRAIN SIZE DISTRIBUTION

Clayey Silt  
Highway 69 (SBL) STA 14+415

FIGURE F.C1-1



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

## LEGEND

SYMBOL	BOREHOLE	SAMPLE	ELEVATION(m)
•	C1-S3	2	191.0

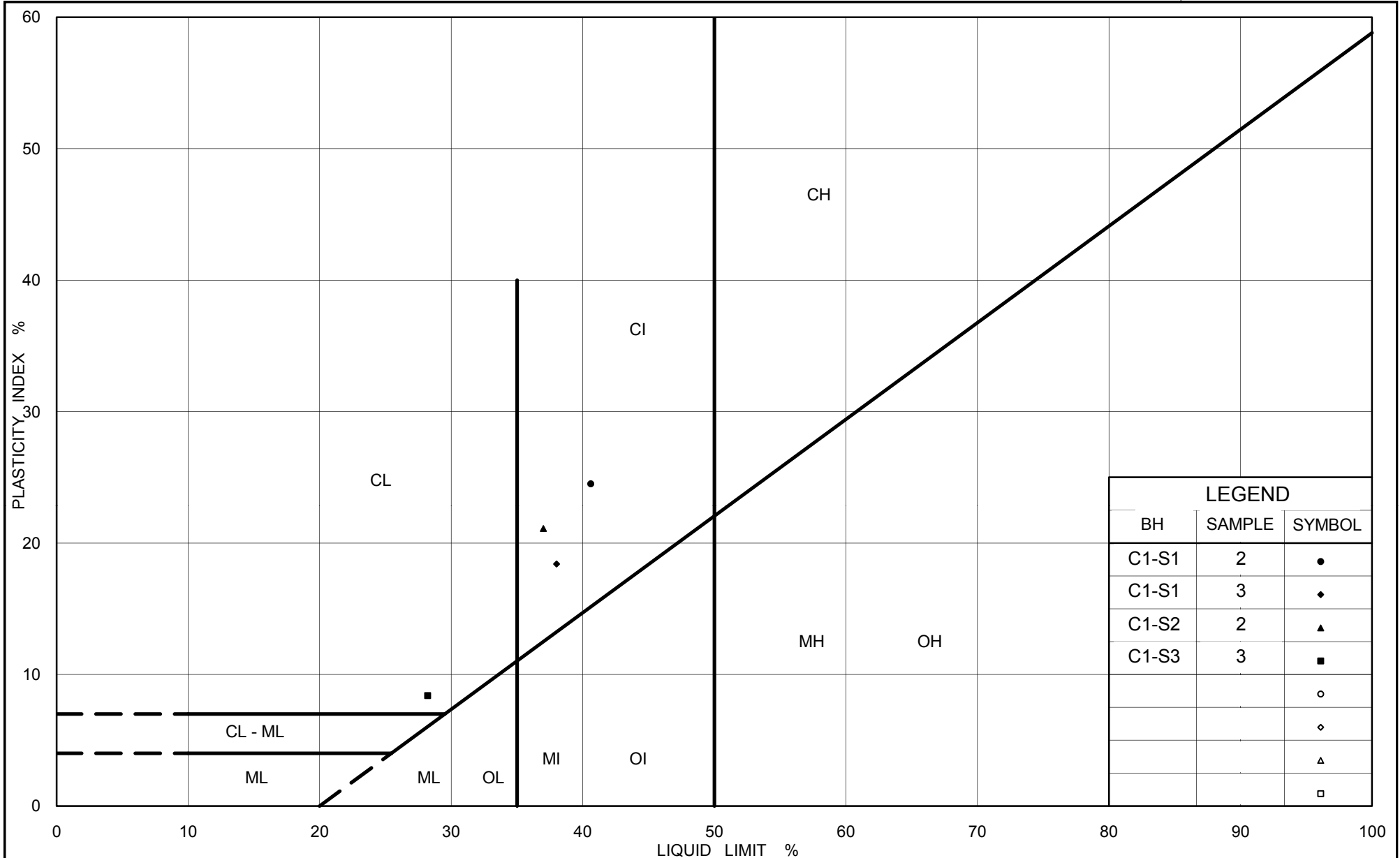
Project Number: 06-1111-025

Checked By: TVA

Golder Associates

Date: 09-Nov-09





Ministry of Transportation

Ontario

**PLASTICITY CHART**  
 Clayey Silt to Silty Clay  
 Highway 69 (SBL) STA 14+415

Figure No. F.C1-2

Project No. 06-1111-025

Checked By: TVA





# **APPENDIX G**

**Highway 69 SBL – STA 13+426 (Culvert C346)**



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



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

MIS-MTO 001 06-1111-025.GPJ GAL-MISS.GDT 1/25/12 SAC



PROJECT 06-1111-025		<b>RECORD OF BOREHOLE No C346-3</b>				1 OF 1 <b>METRIC</b>								
G.W.P. 5203-06-00		LOCATION N 5089504.4 ; E 220809.7				ORIGINATED BY MR								
DIST _____ HWY 69		BOREHOLE TYPE 115 mm O.D. Continuous Flight Solid Stem Augers and NW Casing, Wash Boring				COMPILED BY MWK/TZ								
DATUM Geodetic		DATE March 18, 2009				CHECKED BY VA								
SOIL PROFILE			SAMPLES			GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT		PLASTIC LIMIT W <sub>p</sub>	NATURAL MOISTURE CONTENT W	LIQUID LIMIT W <sub>L</sub>	UNIT WEIGHT γ	REMARKS & GRAIN SIZE DISTRIBUTION (%)
ELEV DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE	"N" VALUES			SHEAR STRENGTH kPa						
194.6	WATER SURFACE													
0.0	Water													
0.2	PEAT Very soft Dark brown Wet		1	AS	-									
			2	SS	WH									
193.0														
192.6	Organic SILT, some sand, trace to some clay, containing rootlets Very loose Grey Wet		3A	SS	WH									
2.0			3B	SS	WH									
	CLAYEY SILT, trace sand Soft Grey Wet													
191.4														
3.2	SILT, trace to some sand, trace clay, containing sand seams Compact Grey Wet		4	SS	28									
190.8														
3.9	END OF BOREHOLE SPOON AND CASING REFUSAL END OF DCPT Refusal to Further Penetration (30 Blows / 0.28 m)													
	NOTES:  1. Water level in open borehole at surface (Elev. 194.6 m) upon completion of drilling.  2. A Dynamic Cone Penetration Test was advanced 1.5 m south of Borehole C346-3; refusal encountered at a depth of 3.9 m below water surface (Elev. 190.7 m).													





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

MIS-MTO 001 06-1111-025.GPJ GAL-MISS.GDT 1/25/12 SAC





HORIZONTAL SCALE

5 0 5 10 m

2 0 2 4 m

VERTICAL SCALE

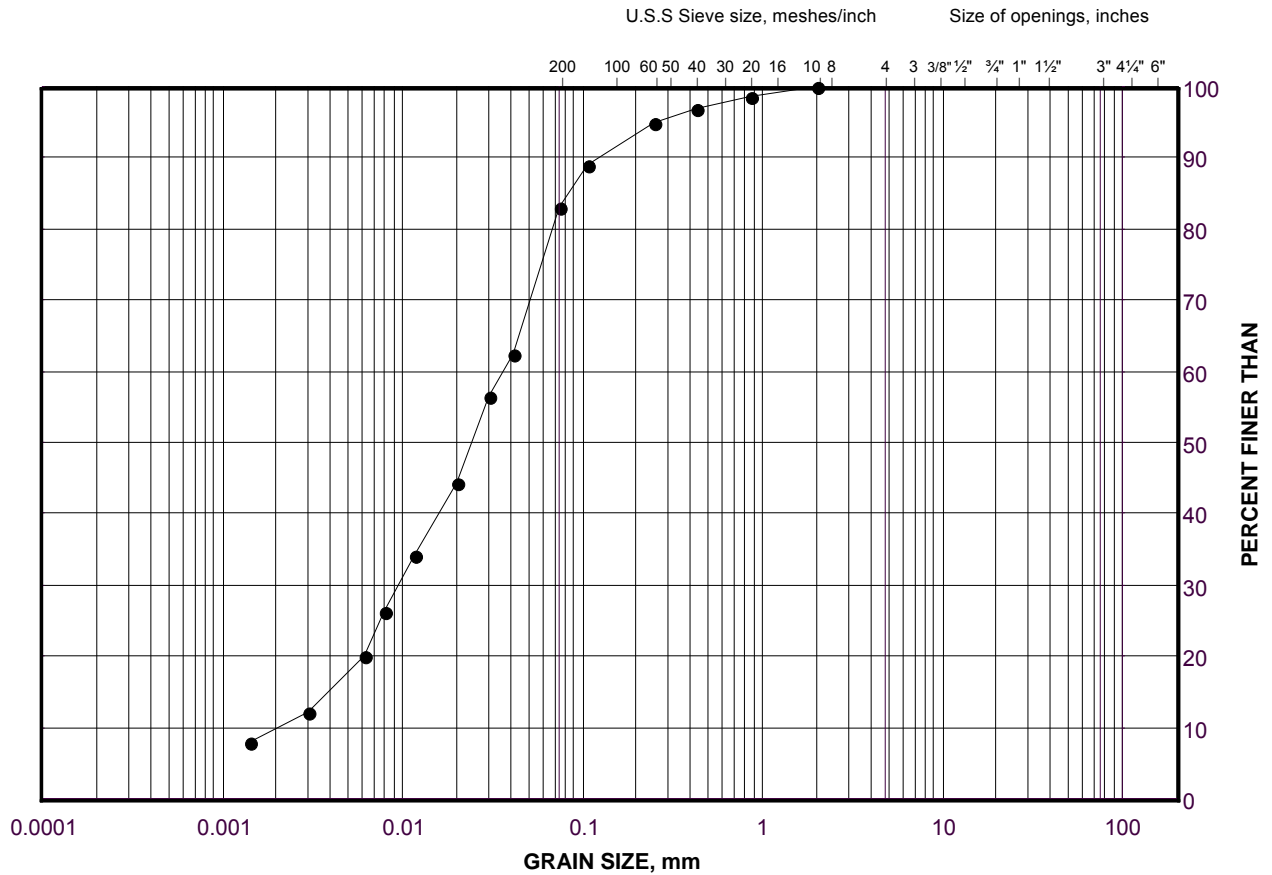
REVISION					
Geocres No. 41H-107					
HWY. 69		PROJECT NO. 06-1111-025			DISC.
SUBM'D. VA		CHKD. VA	DATE: Jan. 2012		SITE: 44-548/C2
DRAWN: JFC/RJ		CHKD. VA	APPD. JPD/JMAC		DWG. G1



# GRAIN SIZE DISTRIBUTION

Organic Silt  
Highway 69 (SBL) STA 13+426

FIGURE G.C346-1



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

## LEGEND

SYMBOL	BOREHOLE	SAMPLE	ELEVATION(m)
•	C346-1	3	192.5

Project Number: 06-1111-025

Checked By: TVA

**Golder Associates**

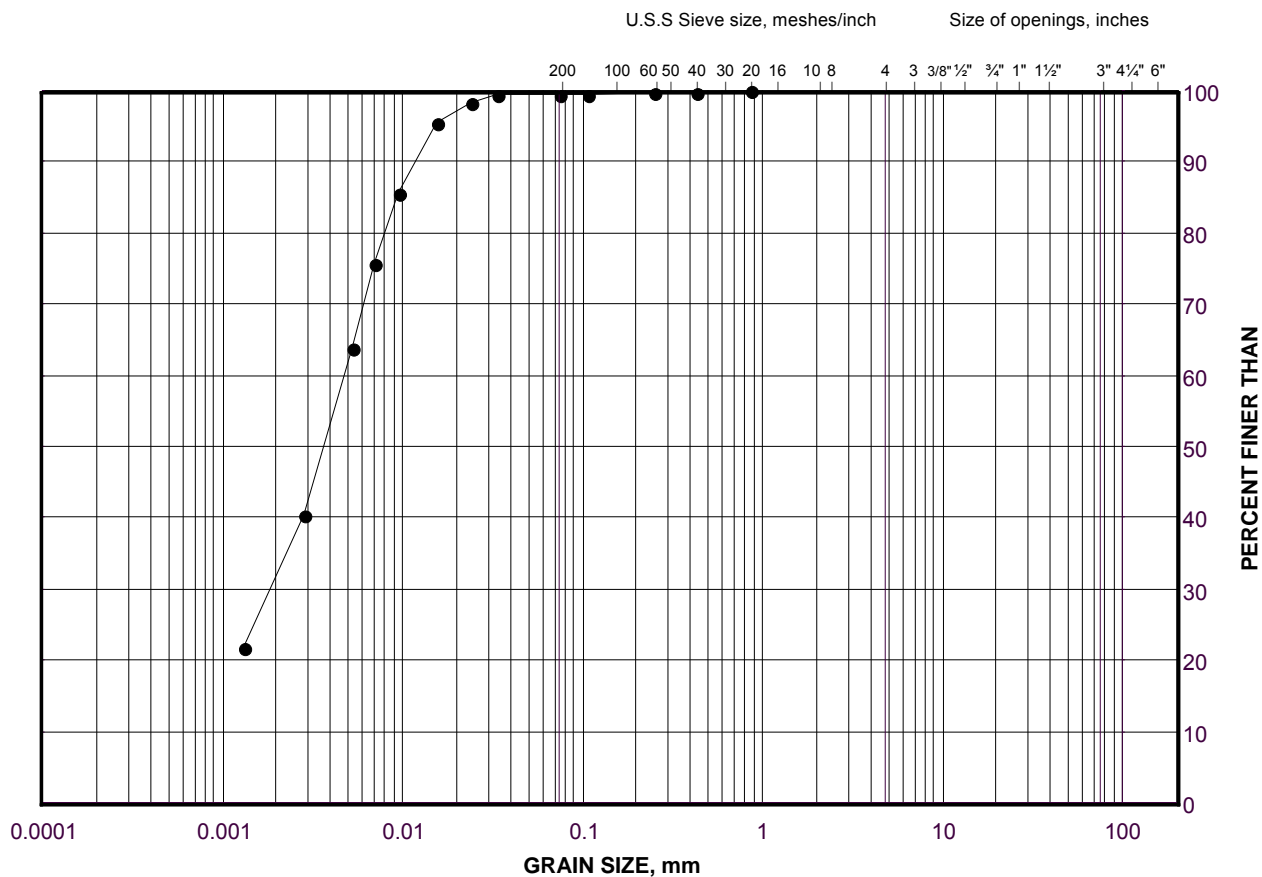
Date: 09-Nov-09



# GRAIN SIZE DISTRIBUTION

Clayey Silt  
Highway 69 (SBL) STA 13+426

FIGURE G.C346-2



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

## LEGEND

SYMBOL	BOREHOLE	SAMPLE	ELEVATION(m)
•	C346-1	6	189.7

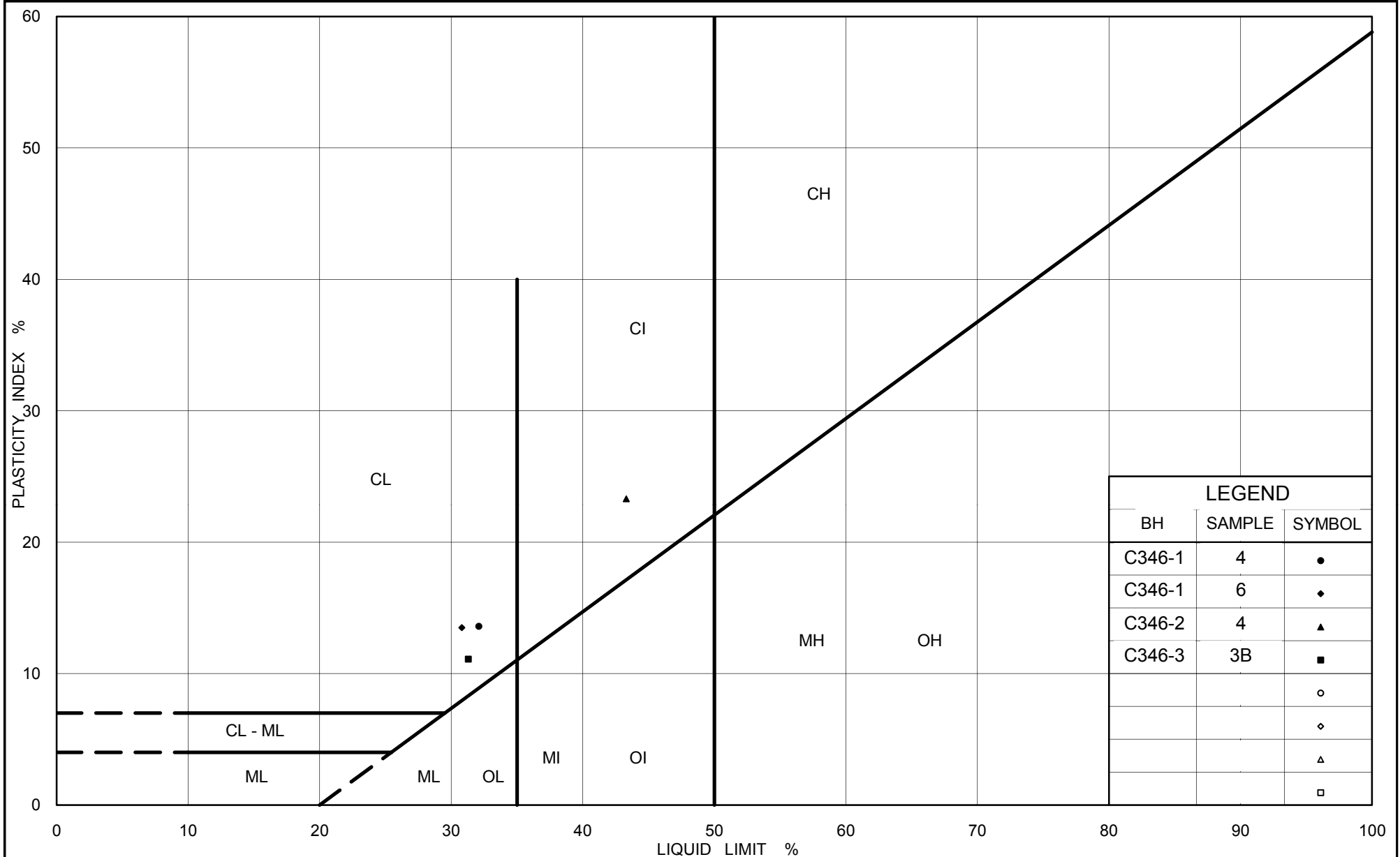
Project Number: 06-1111-025

Checked By: TVA

**Golder Associates**

Date: 09-Nov-09





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Ontario

**PLASTICITY CHART**  
 Clayey Silt to Silty Clay  
 Highway 69 (SBL) STA 13+426

Figure No. G.C346-3

Project No. 06-1111-025

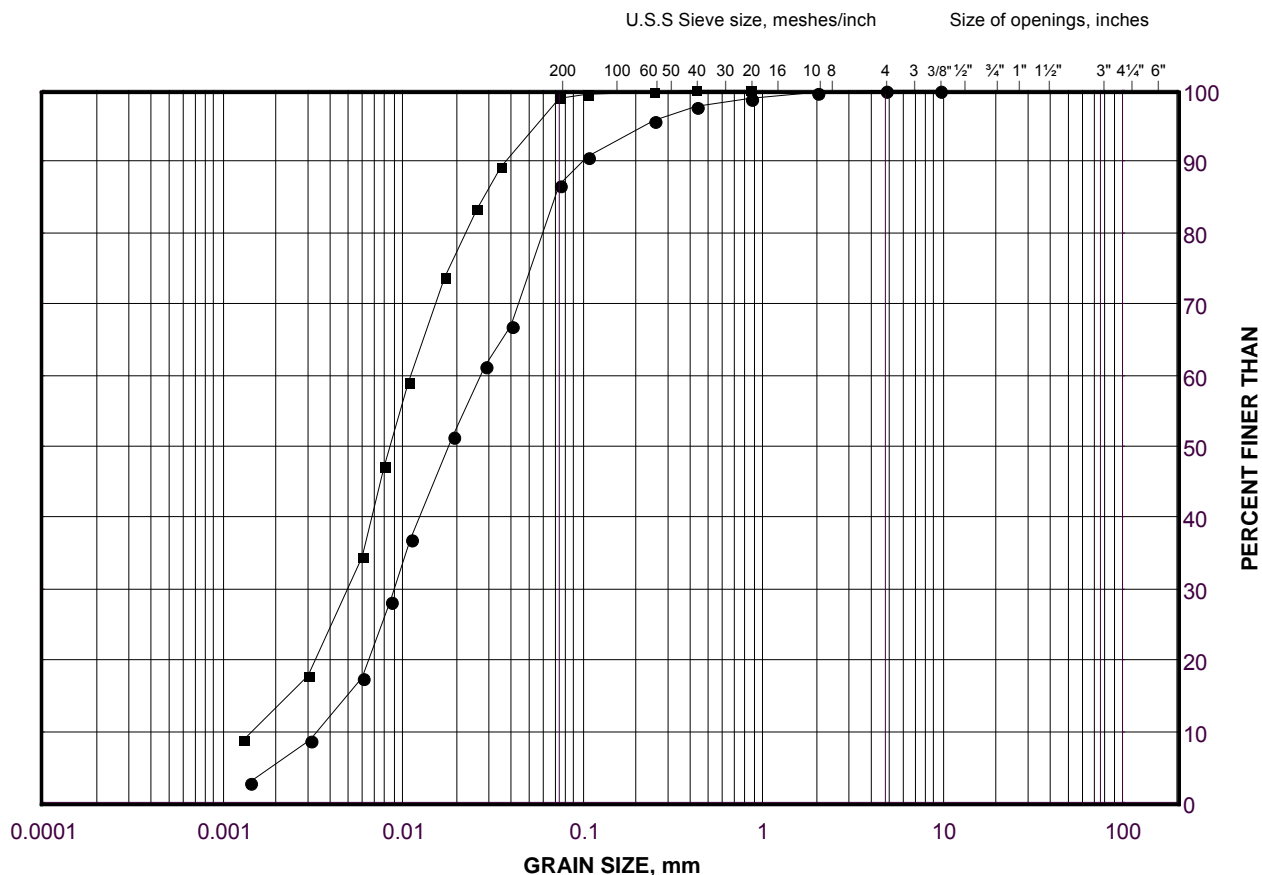
Checked By: TVA



# GRAIN SIZE DISTRIBUTION

Silt  
Highway 69 (SBL) STA 13+426

FIGURE G.C346-4



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

## LEGEND

SYMBOL	BOREHOLE	SAMPLE	ELEVATION(m)
●	C346-3	4	191.0
■	C346-2	5B	189.9

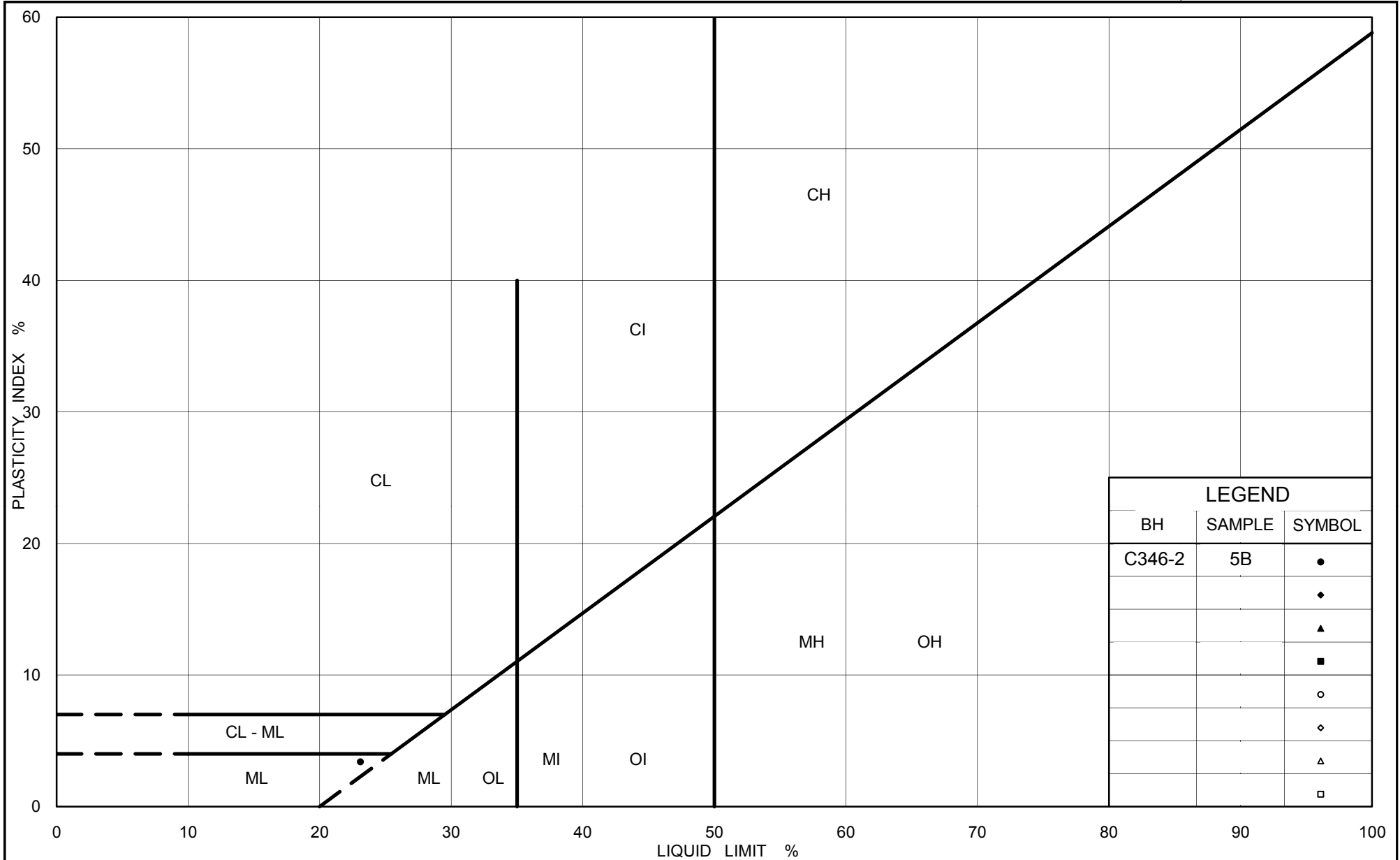
Project Number: 06-1111-025

Checked By: TVA

**Golder Associates**

Date: 09-Nov-09





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PLASTICITY CHART  
Silt  
Highway 69 (SBL) STA 13+426

Figure No. G.C346-5

Project No. 06-1111-025

Checked By: TVA





# **APPENDIX H**

## **Borehole Investigation by Others**



**RECORD OF BOREHOLE No 302-29**

1 of 2

**METRIC**

G.W.P. 5203-06-00 LOCATION Hwy 69 (New), Sta. 17+800, o/s 18.8m Lt. CL Med. ORIGINATED BY T.X.  
DIST 54 HWY 69 BOREHOLE TYPE C.F.H.S.A. + Dynamic Cone Penetration Test COMPILED BY N.S.B.  
DATUM Geodetic DATE March 04, 2007 CHECKED BY G.D.

SOIL PROFILE			SAMPLES			GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT					PLASTIC LIMIT W <sub>P</sub>	NATURAL MOISTURE CONTENT W	LIQUID LIMIT W <sub>L</sub>	UNIT WEIGHT γ kN/m <sup>3</sup>	REMARKS & GRAIN SIZE DISTRIBUTION (%)
ELEV DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE	"N" VALUES			SHEAR STRENGTH kPa									
189.0	Ground Surface					*											GR SA SI CL
0.0	Peat, coarse fibrous		1	SS	13			○ UNCONFINED + FIELD VANE									
0.1	Dark brown							● QUICK TRIAXIAL × LAB VANE									
	Silt trace clay, trace sand organics and rootlets																
	Compact Dark Moist to loose brown to wet	2	SS	4													
187.5																	
1.5	Sandy silt, trace clay	3	SS	5													
	Loose Mottled Wet brown/grey																
186.4																	
2.6	Sand trace silt, trace gravel																
	Compact Brown Wet		4	SS	19												
			5	SS	15												
183.4																	
5.6	Silty clay, trace sand layers of clayey silt																
	Firm Grey Wet		6	SS	1												
			7	TW	-												
				FV													
			8	SS	WH**												
				FV													
177.9			9	SS	1												
11.1	Silt some clay, trace sand																
	Very loose Grey Wet to loose																
			10	SS	7												
	sand seams		11	SS	5												
174.7																	
14.3	End of borehole																

Cont'd







**RECORD OF BOREHOLE No 302-30**

1 of 2

**METRIC**

G.W.P. 5203-06-00 LOCATION Hwy 69 (New), Sta. 17+800, o/s 18.8m Rt. CL Med. ORIGINATED BY N.R.  
DIST 54 HWY 69 BOREHOLE TYPE C.F.H.S.A. and Dynamic Cone Penetration Test COMPILED BY N.S.B.  
DATUM Geodetic DATE February 28 and March 01, 2007 CHECKED BY G.D.

SOIL PROFILE				SAMPLES			GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT					PLASTIC LIMIT NATURAL MOISTURE CONTENT LIQUID LIMIT			UNIT WEIGHT  $\gamma$  kN/m <sup>3</sup>	REMARKS & GRAIN SIZE DISTRIBUTION (%)			
ELEV DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE	"N" VALUES	SHEAR STRENGTH kPa					W <sub>P</sub>	W	W <sub>L</sub>	GR	SA	SI		CL			
						○ UNCONFINED			● QUICK TRIAXIAL	+ FIELD VANE									× LAB VANE	WATER CONTENT (%)	
188.0	Ground Surface																				
0.0	Peat, fine fibrous Dark brown																				
0.3	Sandy silt																				
186.7	Compact Mottled Moist brown/grey		1	SS	25																
1.3	Sand with silt, trace clay																				
	Compact Brown Wet		2	SS	20																
	trace silt																				
	Dense to Grey very dense		3	SS	77																
183.4	Silty clay, trace sand layers of clayey silt		4	SS	2																
4.6	Firm Grey Wet																				
			5	SS	1																
				FV																	
			6	SS	2																
	thin layers of silt			FV																	
			7	SS	3																
177.1	Silt some clay, trace sand		8	SS	6																
10.9	Loose Grey Wet																				
			9	SS	10																
174.9	Sandy silt layers of silty sand																				
13.1	Loose to Grey Wet very loose		10	SS	8																

Cont'd



**RECORD OF BOREHOLE No 302-30**

2 of 2

**METRIC**

G.W.P. 5203-06-00 LOCATION Hwy 69 (New), Sta. 17+800, o/s 18.8m Rt. CL Med. ORIGINATED BY N.R.  
DIST 54 HWY 69 BOREHOLE TYPE C.F.H.S.A. and Dynamic Cone Penetration Test COMPILED BY N.S.B.  
DATUM Geodetic DATE February 28 and March 01, 2007 CHECKED BY G.D.

SOIL PROFILE			SAMPLES			GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT					PLASTIC LIMIT W <sub>p</sub>	NATURAL MOISTURE CONTENT W	LIQUID LIMIT W <sub>L</sub>	UNIT WEIGHT γ kN/m <sup>3</sup>	REMARKS & GRAIN SIZE DISTRIBUTION (%) GR SA SI CL
ELEV. DEPTH	DESCRIPTION	STRAT. PLOT	NUMBER	TYPE	"N" VALUES			SHEAR STRENGTH kPa									
						○ UNCONFINED + FIELD VANE ● QUICK TRIAXIAL × LAB VANE					WATER CONTENT (%)						
						20	40	60	80	100							
173.0																	
172.2			11	SS	3												
15.8	End of borehole Probable sandy silt Loose					172											
						171											
						170											
						169											
168.5	End of dynamic cone penetration test																
19.5																	
	* 2007 02 28 and 2007 03 01 ▽ Water level observed during drilling																



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