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FOUNDATION INVESTIGATION REPORT

South Canal Bridges Highway 400 Widening from North of King Road to North of South Canal Road, Regional Municipality of York GWP 2025-13-00

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REPORT





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APPENDIX C Borehole Records from Previous Investigation

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1.0 INTRODUCTION

Golder Associates Ltd. (Golder) has been retained by URS Canada Inc. (URS) on behalf of the Ministry of Transportation, Ontario (MTO) to provide foundation engineering services in support of the detail design of the widening of Highway 400 from north of King Road to north of South Canal Road in the Regional Municipality of York, Ontario.

This report addresses the results of the foundation investigation carried out for the replacement of the existing northbound and southbound Highway 400-South Canal bridges. The current investigation was supplemented with information from a previous investigation at this structure site, as follows:

- **MTO GEOCRETS No. 31D-029:** Report titled "Foundation Investigation Report for Proposed Extensions to the Overpass Structures at the Crossing of Hwy. #400 and the South Drainage Canal and Road, Township of King – County of York, District No. 6 (Toronto), W.O. 7C-11089 – W.P. 105-70-04", by the Department of Highways Ontario (DHO), Foundations Section, Materials and Testing Office, dated December 8, 1970.

The previous boreholes as used in this report have been renumbered to show the MTO GEOCRETS reference number followed by the original borehole designation. For this site, the boreholes from MTO GEOCRETS 31D-029 have been renumbered to "29-X", where "X" is the original borehole number.

The terms of reference and scope of work for the foundation investigation are outlined in MTO's Request for Proposal (RFP) dated May 2008, and MTO's revised Terms of Reference in an Addendum dated October 14, 2011. The work has been carried out in accordance with Golder's Supplementary Specialty Plan for this project, dated October 2010.

2.0 SITE DESCRIPTION

The existing South Canal bridges are located approximately 0.5 km north of Highway 9 in King Township, in the Regional Municipality of York. The South Canal bridges span over an approximately 18 m wide excavated canal and South Canal Bank Road. Both bridges consist of six-span structures constructed in 1948, with the original structures supported on driven timber piles. The bridges were widened toward the outside in 1971, with the widened portion supported on driven steel H-piles.

In general, the terrain at the South Canal site and in the adjacent Holland Marsh is relatively flat-lying, at approximately Elevation 219 m to 220 m. The natural ground surface rises immediately to the south of the structure site, to the higher "tableland" of the Oak Ridges Moraine. At the structure site, Highway 400 has been constructed on embankment fill approximately 5 m to 7 m high, with the highway grade rising toward the south from approximately Elevation 226 m to 228 m.

3.0 INVESTIGATION PROCEDURES

The field work for this subsurface investigation was carried out in November 2011, May 2012 and June 2012, during which time thirteen boreholes (Boreholes SC-1 to SC-5, SC-7 to SC-11, SC-13, SC-14, and BO-9) were drilled associated with the NBL and SBL bridges, supplemented with four boreholes (Boreholes OHS7, F8-2, F8-3 and F8-6) drilled in January, March and April 2011 associated with an adjacent overhead sign and fill



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embankments. The boreholes were advanced using a CME-55 truck-mounted drill rig, D-25 track-mounted drill rig, and a D-90 truck-mounted drill rig supplied and operated by DBW Drilling Ltd. of North York, Ontario and Walker Drilling Ltd. of Utopia, Ontario. The boreholes were advanced through the overburden using 108 mm inside diameter hollow stem augers and 76 mm outer diameter wash boring using N-size casing.

Soil samples were obtained at 0.75 m and 1.5 m intervals of depth in the boreholes, using a 50 mm outside diameter split-spoon sampler driven by an automatic hammer in accordance with the Standard Penetration Test (SPT) procedure (*ASTM D1586-08a – Standard Test Method for Standard Penetration Test*). In situ field vane testing, using MTO standard "N"-sized vanes, was carried out in the soft to stiff portions of cohesive soils, where encountered, to measure the undrained shear strength of the deposit. Thin-walled Shelby tube samples (ASTM) were also taken within the cohesive materials at selected intervals.

The groundwater conditions were observed in the open boreholes during and immediately following the drilling operations and a standpipe piezometer was installed in one borehole (Borehole SC-1) to permit monitoring of the groundwater level. The piezometer consist of 50 mm diameter PVC pipe, with a slotted screen sealed within a sand filter pack at a selected depth interval within the borehole. Above the sand filter pack and piezometer screen, the annulus surrounding the piezometer pipe was backfilled to the ground surface with bentonite pellets. The piezometer installation details and water level readings are indicated on the record for Borehole SC-1 contained in Appendix A. Boreholes where artesian groundwater conditions were noted were backfilled with cement grout and all other boreholes were backfilled with bentonite, in accordance with Ontario Regulation 903 (as amended).

The field work was supervised on a full-time basis by a member of Golder's staff who located the boreholes in the field, cleared these locations for underground utilities, directed the drilling, sampling, and in situ testing operations, and logged the boreholes. The soil samples were identified in the field, placed in labelled containers and transported to Golder's laboratory in Mississauga for further examination and laboratory testing. Index and classification tests consisting of water content determinations, Atterberg limits and grain size distributions were carried out on selected soil samples. In addition, three one-dimensional consolidation (oedometer) tests were carried out on selected samples of the clayey silt to silt deposit.

The borehole locations were established in the field by Golder personnel relative to site features. The ground surface elevation at each borehole was estimated from the digital terrain model for the site as provided by URS. The borehole locations (referenced to the MTM NAD83 co-ordinate system) and ground surface elevations (referenced to Geodetic datum) are summarized below and are shown on the Borehole Location and Soil Strata drawings contained in the Contract Documents. These drawings also show the locations of boreholes advanced as part of the previous investigation at the site.

Borehole Number	MTM NAD83 Northing (m)	MTM NAD83 Easting (m)	Ground Surface Elevation (m)	Borehole Depth (m)
SC-1	4,877,070.0	297,189.1	223.0	12.8
SC-2	4,877,082.3	297,188.1	222.0	17.4
SC-3	4,877,124.8	297,177.2	220.1	17.2
SC-4	4,877,151.8	297,171.4	220.8	27.9
SC-5	4,877,176.1	297,165.0	221.1	15.9



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Borehole Number	MTM NAD83 Northing (m)	MTM NAD83 Easting (m)	Ground Surface Elevation (m)	Borehole Depth (m)
SC-7	4,877,117.8	297,113.1	220.7	40.1
SC-8	4,877,130.1	297,103.5	220.5	12.8
SC-9	4,877,070.2	297,116.5	221.0	20.4
SC-10	4,877,033.5	297,122.5	222.1	15.9
SC-11	4,877,019.1	297,122.9	221.8	14.3
SC-13	4,877,052.4	297,161.4	229.0	30.9
SC-14	4,877,041.9	297,120.6	222.0	18.1
BO-9	4,877,161.8	297,169.1	221.0	26.5
OHS7	4,877,043.3	297,113.2	220.4	6.7
F8-2	4,877,031.6	297,183.6	229.2	15.8
F8-3	4,877,098.8	297,187.5	221.0	6.7
F8-6	4,877,028.4	297,140.7	229.1	17.2
29-1	4,877,089.0	297,166.0	227.4	18.4
29-2	4,877,083.0	297,134.0	223.9	18.3
29-3	4,877,114.0	297,164.0	220.6	13.9
29-4	4,877,119.0	297,129.0	221.1	16.9
29-5	4,877,149.0	297,157.0	221.1	20.0
29-6	4,877,146.0	297,122.0	225.8	20.3
29-8	4,877,128.0	297,143.0	221.1	20.3
29-9	4,877,092.9	297,183.9	221.1	7.0

4.0 SITE GEOLOGY AND SUBSURFACE CONDITIONS

4.1 Regional Geology

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

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

¹ Chapman, L.J., and Putnam, D.F., 1984. *The Physiography of Southern Ontario*, 3rd Edition. Ontario Geological Survey, Special Volume 2. Ontario Ministry of Natural Resources.



The Holland River valley, which crosses Highway 400 just north of Highway 9 and South Canal Road, is located within the Simcoe Lowlands region. This valley extends to the southwest from Cook Bay at the south end of Lake Simcoe, and was once a shallow extension of the lake. The floor of the valley consists of peat, soft clays and loose sands. It is understood that during initial construction of Highway 400 through this area, a layer of peat about 2 m to 3 m thick was removed in order to construct the road upon the underlying sand and clay.

4.2 Subsurface Conditions

As part of the current subsurface investigation, thirteen boreholes (Boreholes SC-1 to SC-5, SC-7 to SC-11, SC-13, SC-14, and BO-9) were advanced at the South Canal bridges site, supplemented with three boreholes (F8-2, F8-3 and F8-6) drilled for adjacent high fill embankment areas, and one borehole (OHS7) drilled for a nearby overhead sign. The borehole locations, ground surface elevations and interpreted stratigraphic conditions are shown on the Borehole Location and Soil Strata drawings contained in the Contract Documents.

The detailed subsurface soil and groundwater conditions encountered in the boreholes advanced as part of the current investigations and the results of in situ and laboratory testing are given on the borehole records contained in Appendix A. The results of geotechnical laboratory testing are also presented on Figures B1 to B14 contained in Appendix B. The borehole information from the previous MTO investigations is presented in Appendix C.

The stratigraphic boundaries shown on the borehole records and on the interpreted stratigraphic profile and cross-sections on the Borehole Location and Soil Strata drawings contained in the Contract Documents are inferred observations of drilling progress and from non-continuous sampling and, therefore, represent transitions between soil types rather than exact planes of geological change. The subsoil conditions will vary between and beyond the borehole locations.

In general, the subsurface conditions at the site consist of surficial layers of topsoil, asphalt and roadway base granular fill and cohesive fill in the vicinity of Highway 400, underlain by a clayey silt deposit containing silty sand to sandy silt interlayers. The clayey silt deposit is underlain by a clayey silt till deposit in places underlain by or interlayered with a sand and silt till deposit. A silty sand to sand and silt to sand and gravel deposit with clayey silt interlayers underlies the till deposits.

A more detailed description of the subsurface conditions encountered in the boreholes is provided in the following sections.

4.2.1 Topsoil

Approximately 100 mm to 200 mm of topsoil was encountered immediately below the existing ground surface in Boreholes BO-9, SC-1 to SC-3, SC-8 to SC-11, SC-14 and F8-3 which were drilled at the toes of the Highway 400 embankment.

4.2.2 Fill

Approximately 100 mm to 300 mm of asphalt was encountered immediately below the existing ground surface in Borehole SC-5, which was drilled on Wist Road east of Highway 400, and at Boreholes F8-2 and F8-6 drilled on the shoulders of Highway 400. An approximately 0.6 m to 10.7 m thick layer of fill was encountered immediately below ground surface in Boreholes SC-4, SC-7, SC13 and OHS7, below the asphalt in Boreholes SC-5, F8-2



and F8-6 and underlying the topsoil in Boreholes SC-1, SC-3, SC-11 and F8-3. The base of the fill layer was encountered between Elevation 223.6 m and 218.3 m.

The fill generally consists of an upper layer of non-cohesive material, where present, underlain by cohesive material. The non-cohesive fill consists of sand and silt to sandy silt containing trace to some gravel and trace clay, and sand and gravel containing some silt and trace clay. Organic matter, rootlets and wood fragments were noted in the non-cohesive fill in Boreholes SC-1, SC-3 and SC-4. The cohesive fill consists of clayey silt containing trace to some sand and trace to some gravel. Organic matter, rootlets and wood fragments were noted in the cohesive fill in Boreholes SC-3, SC-4, SC-7 and SC-11. The results of grain size distribution tests completed on two selected samples of the non-cohesive fill and three selected samples of the cohesive fill are shown on Figures B1A and B1B, respectively, in Appendix B.

Atterberg limits testing was carried out on seven selected samples of the cohesive fill, and measured plastic limits ranging from 13 per cent to 16 per cent, liquid limits ranging from 18 per cent to 26 per cent, and plasticity indices ranging from 5 per cent to 11 per cent. These results, which are plotted on Figure B2 in Appendix B, confirm that the cohesive fill consists of clayey silt of low plasticity. The natural water content measured on selected samples of the cohesive fill ranges from about 10 to 26 per cent.

The measured Standard Penetration Test (SPT) "N"-values within the non-cohesive fill range from 4 blows to 34 blows per 0.3 m of penetration, indicating a loose to dense relative density. The measured SPT "N"-values within the cohesive fill range from 4 blows to 47 blows per 0.3 m of penetration, suggesting a firm to hard consistency.

4.2.3 Peat/Organic Sandy Silt

An approximately 0.1 m to 1.5 m thick layer of peat or organic sandy silt was encountered below the fill in Boreholes SC-4, SC-5, SC-7, SC-11, OHS-7 and F8-6, and below the clayey silt deposit in Boreholes BO-9, SC-1, SC-2, SC-8, SC-10 and SC-14. The base of the peat/organic layer was encountered between Elevation 220.3 m and 218.2 m.

The water content and organic content of one tested sample of the organic sandy silt is about 32 percent and 7 percent respectively.

The measured SPT "N"-values within the peat/organic deposit range from 2 blows to 12 blows per 0.3 m of penetration, suggesting a soft to stiff consistency.

4.2.4 Clayey Silt (Upper Deposit)

An approximately 0.4 m to 12.2 m thick deposit of clayey silt was encountered underlying the topsoil, fill, peat/organics or granular interlayers in all boreholes, except Borehole F8-6. Boreholes SC-8 and OHS7 terminated within this deposit, penetrating the clayey silt deposit for a thickness of 9.1 m and 1.1 m, respectively. The base of the deposit was encountered between Elevation 222.0 m and 206.2 m.

The deposit consists of clayey silt with sand to trace sand, containing trace to some gravel. Organic matter, wood fragments and rootlets were encountered in the upper portions of the deposit in Boreholes F8-2, SC-1, SC-4, SC-7, SC-9, SC-10 and SC-14. Silty sand and sand lenses and seams were also encountered in Boreholes SC-2, SC-4 and SC-5. The results of grain size distribution testing completed on nineteen selected samples of the deposit are shown on Figure B3A to B3C in Appendix B.



Atterberg limits testing was carried out on twenty-six selected samples of the deposit and measured plastic limits of 9 per cent to 18 per cent, liquid limits of 15 per cent to 31 per cent, and plasticity indices that are generally over 5 per cent to 15 per cent. These results, which are plotted a plasticity chart on Figures B4A to B4D in Appendix B, confirm that the deposit consists of clayey silt of low plasticity. However, two of the tested samples have plasticity indices of approximately 3 per cent, and these results indicate that portions of the deposit grade to a slightly plastic silt. The natural water content measured on selected soil samples ranges from about 14 to 27 per cent.

The measured SPT “N”-values within the clayey silt deposit range from 0 blows (weight of hammer) to 44 blows per 0.3 m of penetration. Field vane tests measured undrained shear strengths ranging from about 30 kPa (but generally greater than 40 kPa) to greater than 120 kPa, and sensitivities between about 1.5 and 6. The SPT “N”-values together with the vane undrained shear strength results indicate that the deposit is firm to very stiff in consistency.

Laboratory consolidation tests were carried out on three thin-walled Shelby tube samples of the clayey silt deposit. The consolidation test results are presented on Figures B5 to B7 in Appendix B, and are summarized below.

Borehole/ Sample No.	Sample Depth/Elev. (m)	Unit Weight (kN/m ³)	σ_{vo}' (kPa)	σ_p' (kPa)	$\sigma_p' - \sigma_{vo}'$ (kPa)	OCR	e_o	C_c	C_r	C_v^* (cm ² /s)
SC-3 / S1	5.6 / 214.5	20.7	50	280	230	5.6	0.64	0.12	0.025	3.5×10^{-3}
SC-5 / T1	12.4 / 208.7	20.1	112	135	23	1.2	0.64	0.16	0.022	2.1×10^{-3}
SC-7 / 11	11.0 / 209.7	20.6	99	150	51	1.5	0.63	0.16	0.026	1.1×10^{-3}

where	σ_p'	Estimated preconsolidation stress	σ_{vo}'	Computed existing vertical effective stress
	C_c	Compression index	C_r	Recompression index
	e_o	Initial void ratio	OCR	Overconsolidation ratio
			C_v	Coefficient of consolidations in the normally consolidated range, for approximate stress range $20 \text{ kPa} \leq \sigma_v' \leq 150 \text{ kPa}$

4.2.5 Silty Sand to Sandy Silt Interlayers

A number of silty sand to sandy silt interlayers, approximately 0.1 m to 3.0 m thick were encountered within the clayey silt deposit in all boreholes.

The interlayers consist of sandy silt to silty sand to sand and silt to sand, in places containing trace gravel and trace clay. The results of grain size distribution testing completed on six selected samples of the sandy silt to silty sand interlayers are shown on Figure B8 in Appendix B.

The measured SPT “N”-values within the sandy silt to silty sand interlayers range from 2 blows to 35 blows per 0.3 m of penetration, but are generally between 10 and 30 blows per 0.3 m of penetration, indicating a very loose to dense relative density.



4.2.6 Clayey Silt Till to Sandy Silt/Silty Sand Till

A till deposit was encountered underlying the clayey silt deposit in all boreholes, except Boreholes BO-9 and F8-6. Boreholes SC-2, SC-5, SC-10, SC-11, SC-13 and SC-14 terminated within this deposit, penetrating it for a thickness of 1.0 m to 11.4 m. The thickness of the till deposit is 1.3 m to 10.9 m in the remaining boreholes. Where the deposit was fully penetrated, the base of the deposit was encountered between Elevation 208.4 m and 200.6 m, but it extended to at least Elevation 198.1m where it was not fully penetrated.

The till deposit generally consists of clayey silt with sand to trace sand, containing trace gravel. In Boreholes SC-2, SC-4 and F8-6, it grades into or is comprised of sandy silt to silty sand containing trace to some clay and trace gravel. Cobbles and boulders were also encountered within the till deposit, as inferred from grinding augers and/or the split-spoon sampler bouncing during sampling operations; these instances are noted on the borehole records contained in Appendix A. The results of grain size distribution testing completed on sixteen selected samples of the clayey silt till to sandy silt to silty sand till are shown on Figures B9A to B9C in Appendix B.

Atterberg limits testing was carried out on twenty-one selected samples of the clayey silt portion of the till and two samples of the sandy silt portion of the till deposit, and measured plastic limits ranging from 9 per cent to 12 per cent, liquid limits ranging from 15 per cent to 21 per cent, and plasticity indices ranging from 3 per cent to 11 per cent. These results, which are plotted on plasticity charts on Figures B10A to B10C in Appendix B, confirm that the cohesive portion of the till deposit consists of clayey silt of low plasticity and the fine portion of the “non-cohesive” till consists of silty sand to sandy silt of slight plasticity. The natural water content measured on selected samples of the clayey silt portion of the till ranges from 7 to 25 per cent, but is typically in the range of 7 to 13 per cent; the natural water content measured on selected samples of the sandy silt to silty sand portion of the till ranges from 4 to 15 per cent.

The measured SPT “N”-values within the clayey silt till deposit range from 6 blows per 0.3 m of penetration to 121 blows per 0.3 m of penetration, but are generally over 25 blows per 0.3 m of penetration, with one “N”-value of 133 blows per 0.23 m of penetrations. These SPT “N”-values suggest that the consistency of the clayey silt till deposit varies from firm to hard, but is generally very stiff to hard. The measured SPT “N”-values within the sandy silt portion of the till deposit range from 55 blows to 108 blows per 0.3 m penetration, with one “N” value of 23 blows per 0.3 m of penetration at the interface with the overlying organic sandy silt deposit, indicating that this portion of the till deposit generally has a very dense relative density.

4.2.7 Sand and Silt to Sand and Gravel

A non-cohesive soil deposit varying in composition from sand and silt to sand and gravel was encountered underlying the till deposit and/or interlayered within the till deposit in Boreholes BO-9, SC-3, SC-4, SC-7, SC-9, and SC-13. The thickness of the granular deposit and interlayers ranges from 1.2 m to at least 18.8 m. Boreholes SC-3, SC-4, SC-7, SC-9 and BO-9 terminated within this deposit. The base of the granular deposit/interlayers was encountered between Elevation 202.9 m and 180.6 m.

The deposit varies in composition from sand and silt to silty sand containing trace to some clay and trace to some gravel, to sand and gravel containing some silt and trace clay. The results of grain size distribution testing completed on twelve selected samples of the silty sand to sand and silt to sand and gravel deposit and interlayers are shown on Figures B11A and B11B in Appendix B.



Atterberg limits testing was carried out on two selected samples of the sand and silt portion of the deposit, to check whether these finer soils would behave as plastic materials. This testing measured plastic limits of 16 per cent and 17 per cent, liquid limits of 20 per cent, and plasticity indices of 3 per cent and 4 per cent. These results, which are plotted on Figure B12 in Appendix B, indicate that some of the fine portions of the sand and silt deposit consists of silt of slight plasticity; however, overall this deposit is expected to behave as non-plastic.

The measured SPT "N"-values within this deposit range from 11 blows (but generally over 60 blows) to 112 blows per 0.3 m of penetration, with three SPT "N"-values greater than 100 blows per 0.08 m of penetration. These SPT "N"-values indicate that the deposit has a compact to very dense, but generally very dense, relative density.

4.2.8 Clayey Silt Interlayers (Lower Deposit)

Approximately 0.9 m to 6.1 m thick clayey silt interlayers were encountered within the sand and silt to sand and gravel deposit in Boreholes BO-9, SC-4 and SC-7. The base of these interlayers was encountered between Elevation 196.2 m and 182.3 m.

The interlayers consist of clayey silt with sand to trace sand, containing trace to some gravel. Silt and silty sand seams were observed within these interlayers in Boreholes SC-4 and SC-7. The results of grain size distribution testing completed on two selected samples of the clayey silt interlayers are shown on Figure B13 in Appendix B.

Atterberg limits testing was carried out on two selected samples of the clayey silt interlayers and measured plastic limits of 11 per cent and 15 per cent, liquid limits of 19 per cent and 30 per cent and corresponding plasticity indices of 8 per cent and 15 per cent. These results, which are plotted on a plasticity chart on Figure B14 in Appendix B, confirm that the interlayers consist of clayey silt of low plasticity. The natural water content measured on selected samples of this lower clayey silt deposit ranges from about 13 to 22 per cent.

The measured SPT "N"-values within the clayey silt interlayers range from 52 blows to 100 blows per 0.3 m of penetration, suggesting a hard consistency.

4.3 Groundwater Conditions

The observed/recorded water levels in the open boreholes following completion of drilling and in the standpipe piezometers installed in Borehole SC-1 are shown on the borehole records and are summarized as follows:

Borehole No.	Approximate Depth/Elevation at which Artesian Groundwater Pressures Encountered (m)	Approximate Depth to Water Level* (m)	Approximate Groundwater Elevation (m)	Date
SC-1	-	2.8 0.3	222.7	Jun 11, 2012 (Completion of drilling) Jun 12, 2012 (Piezometer)
SC-2	13.7/208.3	+2.0 ags*	224.0	Jun 8, 2012 (Completion of drilling)
SC-3	11.7/208.4	+3.6 ags*	223.7	May 25, 2012 (Completion of drilling)
SC-4	22.9/197.9	Not Recorded	Not Recorded	-



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Borehole No.	Approximate Depth/Elevation at which Artesian Groundwater Pressures Encountered (m)	Approximate Depth to Water Level* (m)	Approximate Groundwater Elevation (m)	Date
SC-5	15.2/205.9	4.2	216.9	Nov 15, 2012 (Completion of drilling)
SC-7	15.8/205.0	+1.5 ags*	222.2	Nov 9, 2012 (During casing removal)
SC-8	-	5.5	215.0	Nov 7, 2012 (Completion of drilling)
SC-9	18.3/202.7	+4.1 ags*	225.1	May 16, 2012 (Completion of drilling)
SC-10	-	2.1	220.0	May 14, 2012 (Completion of drilling)
SC-11	-	Dry	-	May 11, 2012 (Completion of drilling)
SC-13	-	1.0	228.0	Jun 7, 2012 (Completion of drilling)
SC-14	-	3.7	218.3	May 22, 2012 (Completion of drilling)
BO-9	25.9/195.1	1.6	222.6	Nov 15, 2011
OHS7	-	1.1	219.3	Apr 6, 2012 (Completion of drilling)
F8-2	-	15.2	214.0	Apr 1, 2011 (Completion of drilling)
F8-3	-	3.2	217.8	Jan 18, 2011 (Completion of drilling)
F8-6	-	14.9	214.2	Mar 31, 2011 (Completion of drilling)
29-1	-	3.7	223.7	Nov 17, 1970
29-2	-	1.5	222.2	Nov 17, 1970
29-3	-	0.0	220.7	Nov 10, 1970
29-4	-	1.9	219.2	Nov 17, 1970
29-5	-	1.3	219.5	Oct 20, 1970
29-6	-	3.7	222.2	Nov 19, 1970
29-8	-	1.6	219.8	Nov 17, 1970
29-9	-	1.2	219.9	Nov 19, 1970

NOTES: * ags = above ground surface

The water levels observed in the open boreholes on completion of drilling may not represent long-term stabilized groundwater levels. The water level at the site is expected to fluctuate seasonally in response to changes in precipitation and snow melt, and is expected to be higher during the spring and periods of precipitation.

Artesian groundwater conditions (i.e., groundwater levels above the ground surface at the site) were encountered within the lower non-cohesive deposit primarily in boreholes on the east side of the bridge structures on both sides of the canal. The artesian conditions were encountered at the time of borehole drilling at depths between 11.7 m and 25.9 m below ground surface, corresponding to approximately Elevation 205.9 m to 195.1 m in the northeast quadrant, approximately Elevation 208.5 m to 208.0 m in the southeast quadrant, and approximately Elevation 205.0 m to 202.5 m on the west side of the bridge structures. The groundwater level in the casing rose to between 1.5 m and 4.1 m above ground surface, to between about Elevation 225 m and 222 m. In boreholes where artesian groundwater conditions were not encountered associated with the lower non-cohesive deposit, the observed water level varied from approximately Elevation 228 m to 218 m. The approximate depth to and elevation of the surface of the artesian groundwater stratum is summarized below:



FOUNDATION REPORT - SOUTH CANAL BRIDGES GWP 2025-13-00

Foundation Element	Approximate Depth to Surface of Stratum Where Artesian Pressures Encountered (m)	Approximate Elevation of Surface of Stratum Where Artesian Pressures Encountered (m)
North abutment – NBL	22.9 to 25.9	195 to 198
North abutment – SBL	15.8	205
Centre pier	11.7 to 18.3	208 to 203
South abutment – NBL	13.7	208
South abutment – SBL	-	-

5.0 CLOSURE

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

GOLDER ASSOCIATES LTD.



Lisa C. Coyne, P.Eng.
Senior Geotechnical Engineer, Principal



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

NK/LCC/JMAC/sm

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APPENDIX A

Borehole Records from Current Investigation



LIST OF SYMBOLS

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

I. GENERAL

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

II. STRESS AND STRAIN

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

III. SOIL PROPERTIES

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

(a) Index Properties (continued)

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

(b) Hydraulic Properties

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

(c) Consolidation (one-dimensional)

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

(d) Shear Strength

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

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

Notes: 1
2

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



LIST OF ABBREVIATIONS

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

I. SAMPLE TYPE

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

II. PENETRATION RESISTANCE

Standard Penetration Resistance (SPT), N:

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

Dynamic Cone Penetration Resistance; N_d :

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

PH: Sampler advanced by hydraulic pressure

PM: Sampler advanced by manual pressure

WH: Sampler advanced by static weight of hammer

WR: Sampler advanced by weight of sampler and rod

Piezo-Cone Penetration Test (CPT)

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

III. SOIL DESCRIPTION

(a) Non-Cohesive (Cohesionless) Soils

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

(b) Cohesive Soils Consistency

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

IV. SOIL TESTS

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

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

V. MINOR SOIL CONSTITUENTS

Per cent by Weight	Modifier	Example
0 to 5	Trace	Trace sand
5 to 12	Trace to Some (or Little)	Trace to some sand
12 to 20	Some	Some sand
20 to 30	(ey) or (y)	Sandy
over 30	And (non-cohesive (cohesionless)) or With (cohesive)	Sand and Gravel Silty Clay with sand / Clayey Silt with sand

PROJECT 09-1111-0018		RECORD OF BOREHOLE No B0-9		SHEET 1 OF 2	METRIC
G.W.P. 2835-02-00		LOCATION N 4877161.8; E 297169.1		ORIGINATED BY TZ	
DIST Central HWY 400		BOREHOLE TYPE 108 mm Inside Diameter Hollow Stem Augers		COMPILED BY NK	
DATUM Geodetic		DATE November 14-15, 2011		CHECKED BY LCC	

SOIL PROFILE			SAMPLES			GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT		PLASTIC LIMIT W _p	NATURAL MOISTURE CONTENT W	LIQUID LIMIT W _L	UNIT WEIGHT γ kN/m ³	REMARKS & GRAIN SIZE DISTRIBUTION (%) GR SA SI CL		
ELEV DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE	"N" VALUES			SHEAR STRENGTH kPa							WATER CONTENT (%)	
								○ UNCONFINED ● QUICK TRIAXIAL	+ FIELD VANE × REMOULDED							
221.0	GROUND SURFACE															
0.0	TOPSOIL															
0.1	CLAYEY SILT, trace gravel, trace sand, containing organics Firm Brown Moist		1	SS	5											
219.5																
1.5	PEAT (Amorphous), containing rootlets and decomposed wood fragments, containing clayey silt seams Firm Black Moist		2	SS	4											
218.4																
2.6	CLAYEY SILT, trace to some sand Firm to stiff Grey Moist		3	SS	7											
			4	SS	9											
			5	SS	2											
215.5																
5.5	Silty SAND, some gravel, trace clay Compact Grey Wet		6	SS	19											
214.7			7A													
6.3	CLAYEY SILT, trace sand Stiff to very stiff Grey Wet		7B	SS	19											
			8	SS	17											
			9	SS	13											
			10	SS	12											
			11	SS	11											
			12	SS	8											
206.2																
14.8																

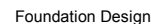
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+ 3, × 3: Numbers refer to Sensitivity ○ 3% STRAIN AT FAILURE

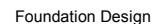
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PROJECT 09-1111-0018			RECORD OF BOREHOLE No B0-9			SHEET 2 OF 2			METRIC																						
G.W.P. 2835-02-00			LOCATION N 4877161.8 ; E 297169.1			ORIGINATED BY TZ																									
DIST Central HWY 400			BOREHOLE TYPE 108 mm Inside Diameter Hollow Stem Augers			COMPILED BY NK																									
DATUM Geodetic			DATE November 14-15, 2011			CHECKED BY LCC																									
SOIL PROFILE			SAMPLES			GROUND WATER CONDITIONS			ELEVATION SCALE			DYNAMIC CONE PENETRATION RESISTANCE PLOT			PLASTIC LIMIT NATURAL MOISTURE CONTENT LIQUID LIMIT			SHEAR STRENGTH kPa			WATER CONTENT (%)			UNIT WEIGHT			REMARKS & GRAIN SIZE DISTRIBUTION (%)				
ELEV DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE	"N" VALUES																										
--- CONTINUED FROM PREVIOUS PAGE ---																															
203.2	SILT, some clay Very dense Grey Moist		13	SS	16/0.28																										
			14	SS	286																										
17.8	SAND and SILT, trace to some clay Compact to very dense Grey Wet		15	SS	69																										
			16	SS	83																										
			17	SS	21																										
			18	SS	102																										
197.1	CLAYEY SILT with sand, some gravel Hard Grey Wet		19A	SS	100																										
196.2	SAND, trace gravel, trace silt Very dense Grey Wet		19B																												
195.5	SAND and GRAVEL Very dense Grey Wet		20	SS	101																										
194.5	END OF BOREHOLE																														
26.5	NOTES: 1. Artesian conditions encountered below a depth of 25.9 m (Elev. 195.1 m). 2. Water level measured inside casing at 1.6 m above ground surface (Elev. 222.6 m) on completion of drilling. 3. Borehole abandoned using cement grout with 3 m of bentonite placed above grout immediately below ground surface.																														

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

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PROJECT 09-1111-0018			RECORD OF BOREHOLE No F8-3			SHEET 1 OF 1			METRIC								
G.W.P. 2835-02-00			LOCATION N 4877098.8 ; E 297187.5			ORIGINATED BY AM											
DIST Central HWY 400			BOREHOLE TYPE D-25 Track Mount, 108 mm Inside Diameter Hollow Stem Augers			COMPILED BY TT											
DATUM Geodetic			DATE January 18, 2011			CHECKED BY SMM											
SOIL PROFILE			SAMPLES			GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT					PLASTIC LIMIT W _p	NATURAL MOISTURE CONTENT W	LIQUID LIMIT W _L	UNIT WEIGHT γ	REMARKS & GRAIN SIZE DISTRIBUTION (%)
ELEV DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE	"N" VALUES			SHEAR STRENGTH kPa									
221.0	GROUND SURFACE							20	40	60	80	100					
0.0	TOPSOIL																
0.2	Clayey silt, trace to some sand, trace gravel, slightly organic, rootlets and wood fragments (FILL) Firm Brown Moist		1	SS	6												
			2	SS	4												
			3	SS	4												
218.8																	
2.2	Clayey silt, trace sand (FILL) Stiff Brown Wet Grey clayey silt seams between depths of 2.7 m and 2.8 m		4	SS	12												
217.7			5	SS	8												
217.3	CLAYEY SILT, trace sand, containing rootlets Stiff Grey Moist		6	SS	16												
3.7	CLAYEY SILT with sand (TILL) Very stiff to hard Grey Moist		7	SS	18												
			8	SS	57												
214.3	END OF BOREHOLE																
6.7	NOTE: 1. Water level in open borehole at a depth of 3.2 m below ground surface (Elev. 217.8 m) upon completion of drilling.																


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PROJECT 09-1111-0018		RECORD OF BOREHOLE No F8-6		SHEET 1 OF 2		METRIC														
G.W.P. 2835-02-00		LOCATION N 4877028.4 ; E 297140.7		ORIGINATED BY AM																
DIST Central HWY 400		BOREHOLE TYPE D-90 Truck Mount, 108 mm Inside Diameter Hollow Stem Auger		COMPILED BY CS																
DATUM Geodetic		DATE March 31, 2011		CHECKED BY SMM																
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	20 40 60 80 100	20 40 60 80 100	W _p	W	W _L	γ	GR	SA	SI	CL			
229.1	GROUND SURFACE																			
0.0	ASPHALT						229													
0.1	Silty sand and gravel (FILL)																			
228.3																				
0.8	Clayey silt, some sand, trace gravel (FILL)		1	SS	10		228													
227.6	Stiff Brown Moist																			
1.5	Sand and gravel, some silt, trace clay (FILL)		2	SS	18		227													
	Compact Brown Moist		3	SS	22															
226.1							226													
3.0	Clayey silt, trace sand, trace gravel (FILL)		4	SS	6															
	Firm to very stiff Brown to grey Moist						225													
	Augers grinding and spoon bouncing at a depth of 3.3 m		5	SS	8															
			6	SS	15		224													
							223													
			7	SS	27															
							222													
							221													
	Silt and sand interlayers at a depth of 7.9 m		8	SS	13															
220.4							220													
8.7	Organic Sandy SILT, some clay, trace gravel																			
	Stiff Brown to black Moist		9A	SS	23															
219.6							219													
9.5	Sandy SILT to Silty SAND, trace to some clay, trace gravel (TILL)		9B																	
	Compact to very dense Grey Moist						218													
	Augers grinding and spoon bouncing at a depth of 10.7 m		10	SS																
							217													
			11	SS	80															
							216													
			12	SS	104		215													

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PROJECT		2835-02-00		LOCATION		N 4877028.4 ; E 297140.7		ORIGINATED BY		AM								
DIST		Central HWY 400		BOREHOLE TYPE		D-90 Truck Mount, 108 mm Inside Diameter Hollow Stem Auger		COMPILED BY		CS								
DATUM		Geodetic		DATE		March 31, 2011		CHECKED BY		SMM								
SOIL PROFILE				SAMPLES			GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT					PLASTIC LIMIT W _p	NATURAL MOISTURE CONTENT W	LIQUID LIMIT W _L	UNIT WEIGHT γ kN/m ³	REMARKS & GRAIN SIZE DISTRIBUTION (%) GR SA SI CL
ELEV DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE	"N" VALUES	20			40	60	80	100	20					
211.9	Sandy SILT to Silty SAND, trace to some clay, trace gravel (TILL) Compact to very dense Grey Moist		13	SS	104													
17.2	END OF BOREHOLE NOTE: 1. Water level in open borehole at a depth of 14.9 m below ground surface (Elev. 214.2 m) upon completion of drilling.		14	SS	103													

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PROJECT		RECORD OF BOREHOLE		No OHS7		SHEET 1 OF 1		METRIC						
G.W.P. 2835-02-00		LOCATION		N 4877043.3; E 297113.2		ORIGINATED BY		TT						
DIST Central HWY 400		BOREHOLE TYPE		Geoprobe, 108 mm Outside Diameter Solid Stem Augers		COMPILED BY		CS						
DATUM Geodetic		DATE		April 6, 2011		CHECKED BY								
SOIL PROFILE			SAMPLES			GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT		PLASTIC LIMIT W _p	NATURAL MOISTURE CONTENT W	LIQUID LIMIT W _L	UNIT WEIGHT γ	REMARKS & GRAIN SIZE DISTRIBUTION (%)
ELEV DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE	"N" VALUES			SHEAR STRENGTH kPa						
220.4	GROUND SURFACE							20 40 60 80 100	20 40 60 80 100	10 20 30				
0.0	Clayey silt, trace sand, trace gravel, containing rootlets and wood fragments (FILL) Soft		1	SS	2		220						61	
219.6	Grey and black Moist		2	SS	10		219							
0.9	PEAT/TOPSOIL													
	Sandy SILT, trace clay Compact		3A	SS	10									
218.4	Grey Wet		3B											
2.0	CLAYEY SILT, trace sand, containing zones of oxidation to a depth of 5.6 m Stiff Grey Moist, becoming wet below 5.6 m		4	SS	16		218							0 0 63 37
			5	SS	14		217							
			6	SS	17									
			7	SS	16		216							
			8	SS	20									
							215							
	becoming wet at a depth of 5.6 m													
			9	SS	12		214							0 2 63 35
213.7	END OF BOREHOLE													
6.7	NOTES: 1. Water level in open borehole at a depth of 1.1 m below ground surface (Elev. 219.3 m) upon completion of drilling. 2. Borehole caved at a depth of 2.4 m below ground surface (Elev. 218.0 m) upon completion of drilling.													

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PROJECT 09-1111-0018		RECORD OF BOREHOLE No SC-1		SHEET 1 OF 2		METRIC						
G.W.P. 2835-02-00		LOCATION N 4877070.0; E 297189.1		ORIGINATED BY OS								
DIST Central HWY 400		BOREHOLE TYPE D-25 Track Mount, 76 mm Wash Rotary Boring, NW Casing		COMPILED BY NK								
DATUM Geodetic		DATE June 8 and 11, 2012		CHECKED BY LCC								
SOIL PROFILE			SAMPLES			DYNAMIC CONE PENETRATION RESISTANCE PLOT			PLASTIC NATURAL LIQUID UNIT REMARKS			
ELEV	DESCRIPTION	STRAT PLOT	NUMBER	TYPE	"N" VALUES	GROUND WATER CONDITIONS	ELEVATION SCALE	20 40 60 80 100	W _p W W _L	WATER CONTENT (%)	γ	GRAIN SIZE DISTRIBUTION (%)
223.0	GROUND SURFACE											
0.0	TOPSOIL											
0.2	Silty sand, some gravel, trace clay, containing organic matter and rootlets (FILL) Loose to compact Brown with oxidation staining Moist		1	SS	12		222					
			2	SS	4							
221.5	CLAYEY SILT with sand, trace gravel, containing organic matter Firm Grey and black Moist		3	SS	6		221					
220.7	PEAT, containing silt Loose Dark brown to black Moist		4	SS	8		220					
220.3	SILTY SAND, trace clay, trace gravel, containing wood fragments and organic matter Loose Grey and black Moist		5	SS	6		219					
	CLAYEY SILT with sand, trace to some gravel (TILL) Firm to hard Grey Moist		6	SS	21		218					
			7	SS	18							7 25 47 21
			8	SS	27		217					
			9	SS	56		216					
	Cobbles inferred from split spoon bouncing at 7.6 m and 8.4 m		10	SS	66		215					
			11	SS	55		214					
			12	SS	79		213					
			13	SS	43		212					
210.2							211					1 27 49 23
12.8												

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PROJECT 09-1111-0018		RECORD OF BOREHOLE No SC-1				SHEET 2 OF 2		METRIC													
G.W.P. 2835-02-00		LOCATION N 4877070.0 ; E 297189.1				ORIGINATED BY OS															
DIST Central HWY 400		BOREHOLE TYPE D-25 Track Mount, 76 mm Wash Rotary Boring, NW Casing				COMPILED BY NK															
DATUM Geodetic		DATE June 8 and 11, 2012				CHECKED BY LCC															
SOIL PROFILE		SAMPLES			GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT					PLASTIC LIMIT W _p	NATURAL MOISTURE CONTENT W	LIQUID LIMIT W _L	UNIT WEIGHT γ kN/m ³	REMARKS & GRAIN SIZE DISTRIBUTION (%) GR SA SI CL					
ELEV DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE			"N" VALUES	SHEAR STRENGTH kPa													
--- CONTINUED FROM PREVIOUS PAGE ---							<div style="display: flex; justify-content: space-between;"> 20 40 60 80 100 20 40 60 80 100 </div> <div style="display: flex; justify-content: space-between;"> ○ UNCONFINED + FIELD VANE </div> <div style="display: flex; justify-content: space-between;"> ● QUICK TRIAXIAL × REMOULDED </div>					<div style="display: flex; justify-content: space-between;"> 20 40 60 80 100 10 20 30 </div>									
	END OF BOREHOLE NOTES: 1. Water level in open borehole measured at a depth of 2.8 m (Elev. 220.2 m) on completion of drilling. 2. Water level in piezometer measured at a depth of 0.3 m (Elev. 222.7 m) on June 12, 2012.																				

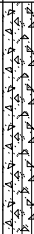
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PROJECT		09-1111-0018		RECORD OF BOREHOLE No SC-2		SHEET 1 OF 2		METRIC								
G.W.P.		2835-02-00		LOCATION		N 4877082.3 ; E 297188.1		ORIGINATED BY OS								
DIST		Central HWY 400		BOREHOLE TYPE		D-25 Track Mount, 76 mm Wash Rotary Boring, NW Casing		COMPILED BY NK								
DATUM		Geodetic		DATE		June 6-8, 2012		CHECKED BY LCC								
SOIL PROFILE			SAMPLES			GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT			PLASTIC LIMIT W _p	NATURAL MOISTURE CONTENT W	LIQUID LIMIT W _L	UNIT WEIGHT γ	REMARKS & GRAIN SIZE DISTRIBUTION (%)	
ELEV DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE	"N" VALUES			SHEAR STRENGTH kPa								WATER CONTENT (%)
222.0	GROUND SURFACE							20	40	60	80	100				
0.0	TOPSOIL															
0.1	CLAYEY SILT with sand, trace to some gravel, containing wet silty sand lenses Soft to firm Brown to grey below 0.7 m Moist		1	SS	7											
			2	SS	3											
220.3	PEAT, containing silt Loose Dark brown to black Moist		3	SS	2											
1.9	Sandy SILT, some clay, containing wood fragments and organic matter Very loose to compact Grey Moist to wet		4	SS	15											0 25 60 15
218.9	CLAYEY SILT with sand, trace to some gravel (TILL) Firm to hard Grey Moist		5	SS	6											
3.1			6	SS	19											9 25 46 20
			7	SS	34											
			8	SS	29											
			9	SS	25											
			10	SS	31											
			11	SS	36											
			12	SS	34											
			13	SS	71											
208.1	SAND and SILT, trace clay, trace gravel (TILL) Very dense Grey Wet		14	SS	66											
13.9																

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

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PROJECT		RECORD OF BOREHOLE		No SC-2		SHEET 2 OF 2		METRIC									
G.W.P. 09-1111-0018		LOCATION		N 4877082.3 ; E 297188.1		ORIGINATED BY		OS									
DIST Central HWY 400		BOREHOLE TYPE		D-25 Track Mount, 76 mm Wash Rotary Boring, NW Casing		COMPILED BY		NK									
DATUM Geodetic		DATE		June 6-8, 2012		CHECKED BY		LCC									
SOIL PROFILE			SAMPLES			GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT					PLASTIC LIMIT W _p	NATURAL MOISTURE CONTENT W	LIQUID LIMIT W _L	UNIT WEIGHT γ kN/m ³	REMARKS & GRAIN SIZE DISTRIBUTION (%) GR SA SI CL
ELEV DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE	"N" VALUES			SHEAR STRENGTH kPa									
	--- CONTINUED FROM PREVIOUS PAGE ---																
	SAND and SILT, trace clay, trace gravel (TILL) Very dense Grey Wet		15	SS	55												2 61 30 7
204.6																	
17.4	END OF BOREHOLE																
	NOTES: 1. Artesian conditions observed at a depth of 13.7 m (Elev. 208.3 m) during drilling operations. 2. Water level measured inside casing at 2.0 m above ground surface (Elev. 224.0 m) on completion of drilling. 3. Borehole abandoned using cement grout.																

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PROJECT 09-1111-0018		RECORD OF BOREHOLE No SC-3		SHEET 1 OF 2	METRIC
G.W.P. 2835-02-00		LOCATION N 4877124.8 ; E 297177.2		ORIGINATED BY OS	
DIST Central HWY 400		BOREHOLE TYPE D-25 Track Mount, 76 mm Wash Rotary Boring, NW Casing		COMPILED BY NK	
DATUM Geodetic		DATE May 23-25, 2012		CHECKED BY LCC	

SOIL PROFILE			SAMPLES			GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT		PLASTIC LIMIT w _p	NATURAL MOISTURE CONTENT w	LIQUID LIMIT w _L	UNIT WEIGHT γ kN/m ³	REMARKS & GRAIN SIZE DISTRIBUTION (%) GR SA SI CL		
ELEV DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE	"N" VALUES			SHEAR STRENGTH kPa							WATER CONTENT (%)	
								○ UNCONFINED + FIELD VANE								
						● QUICK TRIAXIAL × REMOULDED										
220.1	GROUND SURFACE															
0.0	TOPSOIL															
0.2	Clayey silt with sand to some sand, trace to some gravel, containing rootlets, wood fragments and organics (FILL) Firm to stiff Brown to grey Moist to wet		1	SS	7											
			2A	SS	10											
218.8			2B													
1.3	Silty sand, containing wood fragments and organics (FILL) Compact Grey to black Moist		3	SS	23											
217.4			4	SS	14											
2.7	CLAYEY SILT, trace to some sand, trace gravel Soft to stiff Grey Moist to wet															
			5	SS	5											
			6	SS	10											
			S1	TO	PH											
			7	SS	10											
			8	SS	3											
			9	SS	20											
210.4	Silty SAND Grey Moist															
209.7																
10.4	CLAYEY SILT with sand, some gravel (TILL) Hard Grey Moist		10	SS	96											
208.4	SAND and SILT, trace clay Very dense Grey Moist															
11.7			11	SS	74											
			12	SS	100/0.08											

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PROJECT 09-1111-0018				RECORD OF BOREHOLE No SC-3				SHEET 2 OF 2				METRIC					
G.W.P. 2835-02-00				LOCATION N 4877124.8 ; E 297177.2				ORIGINATED BY OS									
DIST Central HWY 400				BOREHOLE TYPE D-25 Track Mount, 76 mm Wash Rotary Boring, NW Casing				COMPILED BY NK									
DATUM Geodetic				DATE May 23-25, 2012				CHECKED BY LCC									
SOIL PROFILE			SAMPLES			GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT					PLASTIC LIMIT NATURAL MOISTURE CONTENT			UNIT WEIGHT γ kN/m ³	REMARKS & GRAIN SIZE DISTRIBUTION (%) GR SA SI CL
ELEV DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE	"N" VALUES			SHEAR STRENGTH kPa					W _p	W	W _L		
	--- CONTINUED FROM PREVIOUS PAGE ---																
203.8	SAND and SILT, trace clay Very dense Grey Moist		13	SS	172		205										
16.3	Silty SAND, containing silt seams Very dense Grey Moist						204										
202.9			14	SS	212/0.25		203										
17.2	END OF BOREHOLE NOTES: 1. Artesian groundwater conditions were encountered within the cohesionless soil below a depth of 11.7 m (Elev. 208.4 m). 2. Artesian groundwater level was measured at 3.6 m above ground surface (Elev. 223.7 m) on May 25, 2012, after completion of drilling. 3. Borehole abandoned using cement grout.																

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PROJECT <u>09-1111-0018</u>		RECORD OF BOREHOLE No SC-4		SHEET 1 OF 2		METRIC	
G.W.P. <u>2835-02-00</u>		LOCATION <u>N 4877151.8;E 297171.4</u>		ORIGINATED BY <u>TT</u>			
DIST <u>Central</u> HWY <u>400</u>		BOREHOLE TYPE <u>108 mm Inside Diameter Hollow Stem Augers</u>		COMPILED BY <u>NK</u>			
DATUM <u>Geodetic</u>		DATE <u>November 17, 18 and 21, 2011</u>		CHECKED BY <u>LCC</u>			

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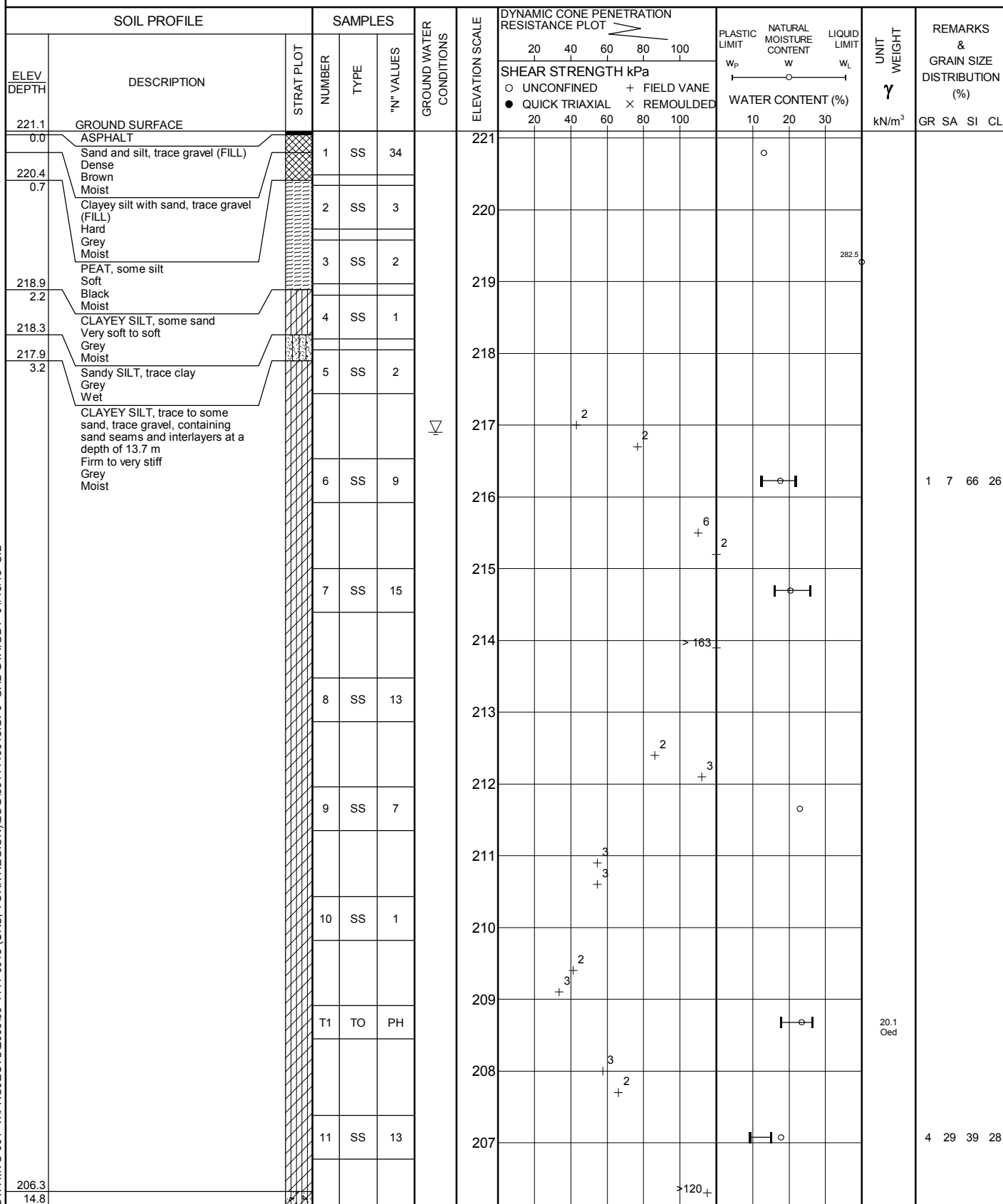
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○ 3% STRAIN AT FAILURE






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

PROJECT <u>09-1111-0018</u>		RECORD OF BOREHOLE No SC-5		SHEET 1 OF 2		METRIC	
G.W.P. <u>2835-02-00</u>		LOCATION <u>N 4877176.1 ;E 297165.0</u>		ORIGINATED BY <u>TT</u>			
DIST <u>Central</u> HWY <u>400</u>		BOREHOLE TYPE <u>108 mm Inside Diameter Hollow Stem Augers</u>		COMPILED BY <u>NK</u>			
DATUM <u>Geodetic</u>		DATE <u>November 15, 2011</u>		CHECKED BY <u>LCC</u>			



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PROJECT		RECORD OF BOREHOLE		No SC-5		SHEET 2 OF 2		METRIC									
G.W.P. 09-1111-0018		LOCATION		N 4877176.1 ; E 297165.0		ORIGINATED BY		TT									
DIST Central HWY 400		BOREHOLE TYPE		108 mm Inside Diameter Hollow Stem Augers		COMPILED BY		NK									
DATUM Geodetic		DATE		November 15, 2011		CHECKED BY		LCC									
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	 20 40 60 80 100 SHEAR STRENGTH kPa ○ UNCONFINED + FIELD VANE ● QUICK TRIAXIAL × REMOULDED					 W _p W W _L WATER CONTENT (%)			γ kN/m ³	GR SA SI CL
							20 40 60 80 100	10 20 30									
205.3 15.9	--- CONTINUED FROM PREVIOUS PAGE --- CLAYEY SILT, some sand, trace gravel (TILL) Hard Grey Moist END OF BOREHOLE NOTES: 1. Blowing sands encountered at a depth of 15.2 m (Elev. 205.9 m) 2. Water level in open borehole at a depth of 4.2 m (Elev. 216.9 m) on completion of drilling.		12	SS	66		206										

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PROJECT <u>09-1111-0018</u>		RECORD OF BOREHOLE No SC-7		SHEET 1 OF 3		METRIC	
G.W.P. <u>2835-02-00</u>		LOCATION <u>N 4877117.8;E 297113.1</u>		ORIGINATED BY <u>SB/TT</u>			
DIST <u>Central</u> HWY <u>400</u>		BOREHOLE TYPE <u>108 mm Inside Diameter Hollow Stem Augers</u>		COMPILED BY <u>NK</u>			
DATUM <u>Geodetic</u>		DATE <u>November 7, 2011</u>		CHECKED BY <u>LCC</u>			

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○ 3% STRAIN AT FAILURE

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PROJECT 09-1111-0018			RECORD OF BOREHOLE No SC-7			SHEET 2 OF 3			METRIC											
G.W.P. 2835-02-00			LOCATION N 4877117.8; E 297113.1			ORIGINATED BY SB/TT														
DIST Central HWY 400			BOREHOLE TYPE 108 mm Inside Diameter Hollow Stem Augers			COMPILED BY NK														
DATUM Geodetic			DATE November 7, 2011			CHECKED BY LCC														
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 ³	GR SA SI CL			
								20 40 60 80 100	20 40 60 80 100	20 40 60 80 100	10 20 30									
205.5	--- CONTINUED FROM PREVIOUS PAGE ---																			
15.2	SAND and SILT, trace to some gravel, trace clay Very dense Grey Moist to wet Blowing sand encountered at a depth of 15.8 m		14	SS	146		205												1 38 52 9	
			15	SS	93		204													
							203													
			16	SS	63		202													
201.4							201													
19.3	SAND and GRAVEL, trace silt and clay Very dense Grey Wet		17	SS	69														33 59 6 2	
199.9							200													
20.8	SAND and SILT to SAND, trace to some silt, trace gravel and clay Very dense Grey Wet		18	SS	106		199													
							198													
			19	SS	76		197													
							196													
			20	SS	64		195													
							194													
			21	SS	72		193												0 85 10 5	
							192													
			22	SS	61		191													
			23	SS	71															

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PROJECT 09-1111-0018		RECORD OF BOREHOLE No SC-7		SHEET 3 OF 3		METRIC						
G.W.P. 2835-02-00		LOCATION N 4877117.8; E 297113.1		ORIGINATED BY SB/TT								
DIST Central HWY 400		BOREHOLE TYPE 108 mm Inside Diameter Hollow Stem Augers		COMPILED BY NK								
DATUM Geodetic		DATE November 7, 2011		CHECKED BY LCC								
SOIL PROFILE		SAMPLES		GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT		PLASTIC LIMIT W _p	NATURAL MOISTURE CONTENT W	LIQUID LIMIT W _L	UNIT WEIGHT γ	REMARKS & GRAIN SIZE DISTRIBUTION (%)
ELEV DEPTH	DESCRIPTION	STRAT PLOT	NUMBER			TYPE	"N" VALUES					
	--- CONTINUED FROM PREVIOUS PAGE ---											
188.4	SAND and SILT to SAND, trace to some silt, trace gravel and clay Very dense Grey Wet		24	SS	61							
32.3	CLAYEY SILT, trace sand, trace gravel, containing silt seams Hard Grey Moist		25	SS	52							
			26	SS	67							
182.3	SAND and GRAVEL, some silt, trace clay Very dense Grey Wet		27	SS	87							
38.4												
180.6	END OF BOREHOLE											
40.1	NOTES: 1. Blowing sands and artesian conditions encountered below a depth of 15.7 m (Elev. 205.0m). 2. Tricone and wash boring used below a depth of 15.2 m (Elev. 205.5 m) due to artesian conditions in the sand layer. 3. Artesian pressure up to 1.5 m above ground surface (Elev. 222.2 m) noted during removal of hollow stem augers. 4. Borehole caved at a depth of 36.6 m (Elev. 184.1 m) on completion of drilling. 5. Borehole abandoned using cement grout, with 3 m of bentonite placed above the grout immediately below ground surface.											

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PROJECT 09-1111-0018		RECORD OF BOREHOLE No SC-8		SHEET 1 OF 1		METRIC															
G.W.P. 2835-02-00		LOCATION N 4877130.1 ; E 297103.5		ORIGINATED BY SB																	
DIST Central HWY 400		BOREHOLE TYPE 108 mm Inside Diameter Hollow Stem Augers		COMPILED BY NK																	
DATUM Geodetic		DATE November 7, 2011		CHECKED BY LCC																	
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		
220.5	GROUND SURFACE							20 40 60 80 100 ○ UNCONFINED + FIELD VANE ● QUICK TRIAXIAL × REMOULDED					10 20 30 W _p W W _L			kN/m ³					
0.0	TOPSOIL																				
0.2	CLAYEY SILT, trace sand, trace gravel, containing organic matter Stiff Brown and grey Moist		1	SS	13		220														
			2	SS	11		219														
218.7	PEAT (Fibrous)		3	SS	5		218														
1.8	Firm																				
218.2	Black																				
2.3	Moist		4	SS	2		217														
	CLAYEY SILT, trace sand																				
	Very soft		5	SS	WH		216														
	Grey		6	SS	7		215														
	Moist		7	SS	6		214														
217.0	Silty SAND																				
	Very loose																				
	Grey																				
	Moist																				
	CLAYEY SILT to SILT, some clay, trace to some sand																				
	Soft to very stiff																				
	Grey																				
	Moist																				
			8	SS	24		213														
			9	SS	18		212														
			10	SS	WH		211														
			11	SS	WH		210														
			12	SS	WH		209														
207.7	END OF BOREHOLE						208														
12.8	NOTE: 1. Water level in open borehole at a depth of 5.5 m (Elev. 215.0 m) on completion of drilling.																				

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PROJECT <u>09-1111-0018</u>		RECORD OF BOREHOLE No SC-9		SHEET 1 OF 2		METRIC	
G.W.P. <u>2835-02-00</u>		LOCATION <u>N 4877070.2; E 297116.5</u>		ORIGINATED BY <u>OS</u>			
DIST <u>Central</u> HWY <u>400</u>		BOREHOLE TYPE <u>D-25 Track Mount, 76 mm Wash Rotary Boring, NW Casing</u>		COMPILED BY <u>NK</u>			
DATUM <u>Geodetic</u>		DATE <u>May 15 and 16, 2012</u>		CHECKED BY <u>LCC</u>			

SOIL PROFILE			SAMPLES			GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT		PLASTIC NATURAL LIQUID LIMIT MOISTURE LIMIT CONTENT			UNIT WEIGHT γ kN/m ³	REMARKS & GRAIN SIZE DISTRIBUTION (%)
ELEV DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE	"N" VALUES			SHEAR STRENGTH kPa		W _p	W	W _L		
							20 40 60 80 100							
221.0	GROUND SURFACE													
0.0	TOPSOIL													
0.2	Silty SAND, some gravel, trace clay, containing rootlets and organic matter		1	SS	12									
220.4	Compact Brown Moist		2	SS	11									
0.6	CLAYEY SILT, some sand, some gravel, contains rootlets and organic matter, containing peat at a depth of 1.0 m		3	SS	2									
218.9	Soft to stiff													
2.1	Grey Moist		4	SS	25									
	SILT, some sand, trace to some clay		5	SS	17									0 14 74 12
	Compact Grey Wet													
217.3	CLAYEY SILT, trace sand, trace gravel		6	SS	11									
3.7	Stiff to very stiff		7	SS	12									
	Grey Moist to wet													
			8	SS	16									0 0 57 43
			9	SS	23									
			10	SS	15									
210.8	CLAYEY SILT with to some sand, trace gravel (TILL)		11	SS	68									
10.2	Hard Grey Moist		12	SS	78									
			13	SS	68									2 25 48 25

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PROJECT 09-1111-0018			RECORD OF BOREHOLE No SC-9			SHEET 2 OF 2			METRIC					
G.W.P. 2835-02-00			LOCATION N 4877070.2; E 297116.5			ORIGINATED BY OS								
DIST Central HWY 400			BOREHOLE TYPE D-25 Track Mount, 76 mm Wash Rotary Boring, NW Casing			COMPILED BY NK								
DATUM Geodetic			DATE May 15 and 16, 2012			CHECKED BY LCC								
SOIL PROFILE			SAMPLES			GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT					UNIT WEIGHT γ kN/m ³	REMARKS & GRAIN SIZE DISTRIBUTION (%) GR SA SI CL
ELEV DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE	"N" VALUES			SHEAR STRENGTH kPa						
	--- CONTINUED FROM PREVIOUS PAGE ---						20 40 60 80 100 ○ UNCONFINED + FIELD VANE ● QUICK TRIAXIAL × REMOULDED							
							PLASTIC LIMIT W _p NATURAL MOISTURE CONTENT W LIQUID LIMIT W _L WATER CONTENT (%)							
							20 40 60 80 100							
							10 20 30							
202.7	CLAYEY SILT with to some sand, trace gravel (TILL) Hard Grey Moist		14	SS	104		205							
			15	SS	96		204							
							203							
18.5	Silty SAND Grey Wet		16	SS	99		202							
201.6	CLAYEY SILT with sand, some gravel (TILL) Hard Grey Wet													
19.4	SAND, some silt, trace gravel, trace clay Very dense Grey Wet		17	SS	113		201							
200.6	END OF BOREHOLE													
20.4	NOTES: 1. Artesian groundwater conditions were encountered within the cohesionless soil below a depth of 18.3 m (Elev. 202.7 m) during drilling operations 2. Artesian groundwater level was measured at 4.1 m above ground surface (Elev. 225.1 m) on May 16, 2012. 3. Borehole abandoned using cement grout.													

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PROJECT <u>09-1111-0018</u>		RECORD OF BOREHOLE No SC-10		SHEET 1 OF 2		METRIC	
G.W.P. <u>2835-02-00</u>		LOCATION <u>N 4877033.5 ; E 297122.5</u>		ORIGINATED BY <u>OS</u>			
DIST <u>Central</u> HWY <u>400</u>		BOREHOLE TYPE <u>D-25 Track Mount, 76 mm Wash Rotary Boring, NW Casing</u>		COMPILED BY <u>NK</u>			
DATUM <u>Geodetic</u>		DATE <u>May 14, 2012</u>		CHECKED BY <u>LCC</u>			

SOIL PROFILE			SAMPLES			GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT		PLASTIC LIMIT NATURAL MOISTURE CONTENT LIQUID LIMIT			UNIT WEIGHT γ kN/m ³	REMARKS & GRAIN SIZE DISTRIBUTION (%)
ELEV DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE	"N" VALUES			SHEAR STRENGTH kPa		W _p	W	W _L		
222.1	GROUND SURFACE													
0.0	TOPSOIL													
0.1	CLAYEY SILT with to some sand, some gravel, containing rootlets and organic matter/wood fragments Firm to very stiff Brown to grey Moist		1	SS	7									
			2	SS	14									
			3	SS	27									
219.9	PEAT (Fibrous) Stiff Black Moist		4	SS	11									
219.4	Gravelly SAND and SILT, trace clay, containing clayey silt seams Compact to dense Grey Moist		5	SS	35									25 40 30 5
218.4	CLAYEY SILT, trace to some gravel, trace to some sand Stiff to very stiff Grey Moist		6	SS	26									
3.7			7	SS	19									0 2 64 34
			8	SS	14									
214.9	CLAYEY SILT with to some sand, trace gravel (TILL) Hard Grey Moist		9	SS	40									
7.2			10	SS	52									
			11	SS	74									1 25 47 27
			12	SS	110									
			13	SS	105									

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

GTA-MTO 001 T:\PROJECTS\2009\09-1111-0018 (URS, YORK REGION)\LOG\0911110018.GPJ GAL-GTA.GDT 01/13/15 SIB

PROJECT		RECORD OF BOREHOLE				No SC-10		SHEET 2 OF 2		METRIC								
G.W.P. 2835-02-00		LOCATION				N 4877033.5 ; E 297122.5		ORIGINATED BY OS										
DIST Central HWY 400		BOREHOLE TYPE				D-25 Track Mount, 76 mm Wash Rotary Boring, NW Casing		COMPILED BY NK										
DATUM Geodetic		DATE				May 14, 2012		CHECKED BY LCC										
SOIL PROFILE		SAMPLES			GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT					PLASTIC LIMIT W _p	NATURAL MOISTURE CONTENT W	LIQUID LIMIT W _L	UNIT WEIGHT γ kN/m ³	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					20 40 60 80 100 WATER CONTENT (%) 10 20 30						
206.2	CLAYEY SILT with to some sand, trace gravel (TILL) Hard Grey Moist		14	SS	121		207											
15.9	END OF BOREHOLE NOTE: 1. Water level in open borehole at a depth of 2.1 m (Elev. 220.0 m) on completion of drilling.																	

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PROJECT 09-1111-0018		RECORD OF BOREHOLE No SC-11		SHEET 1 OF 2		METRIC																
G.W.P. 2835-02-00		LOCATION N 4877019.1 ; E 297122.9		ORIGINATED BY OS																		
DIST Central HWY 400		BOREHOLE TYPE D-25 Track Mount, 76 mm Wash Rotary Boring, NW Casing		COMPILED BY NK																		
DATUM Geodetic		DATE May 11, 2012		CHECKED BY LCC																		
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			
221.8	GROUND SURFACE							20 40 60 80 100 ○ UNCONFINED + FIELD VANE ● QUICK TRIAXIAL × REMOULDED					10 20 30 W _p W W _L			kN/m ³						
0.0	TOPSOIL		1	SS	9		221															
0.1	Sand and gravel, trace clay, some silt, containing rootlets and organic matter (FILL) Loose to compact Dark brown to brown Moist, becoming wet at a depth of 0.3 m		2	SS	15																	49 33 13 5
220.4	Clayey silt with sand (FILL) Firm Brown Moist		3	SS	7		220															
1.4	PEAT																					
219.7	SAND and GRAVEL, containing wood fragments Dense Grey Moist		4	SS	44		219															
219.2	CLAYEY SILT, trace sand, trace gravel Very stiff Grey Moist		5	SS	20																	
2.6	CLAYEY SILT some to with sand, trace to some gravel (TILL) Very stiff to hard Grey Moist		6	SS	46		218															
218.1			7	SS	33		217															
3.7							216															
			8	SS	29		215															19 21 43 17
							214															
			9	SS	29		213															
							212															
			10	SS	29		211															
							210															
			11	SS	43		209															
							208															
			12	SS	80																	
			13	SS	106																	0 28 47 25
207.5																						
14.3																						

GTA-MTO 001 T:\PROJECTS\2009\09-1111-0018 (URS, YORK REGION)\LOG\0911110018.GPJ GAL-GTA.GDT 01/13/15 SIB

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

PROJECT <u>09-1111-0018</u>		RECORD OF BOREHOLE No SC-11				SHEET 2 OF 2		METRIC																
G.W.P. <u>2835-02-00</u>		LOCATION <u>N 4877019.1 ; E 297122.9</u>				ORIGINATED BY <u>OS</u>																		
DIST <u>Central</u> HWY <u>400</u>		BOREHOLE TYPE <u>D-25 Track Mount, 76 mm Wash Rotary Boring, NW Casing</u>				COMPILED BY <u>NK</u>																		
DATUM <u>Geodetic</u>		DATE <u>May 11, 2012</u>				CHECKED BY <u>LCC</u>																		
SOIL PROFILE		SAMPLES			GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT					PLASTIC LIMIT W _p	NATURAL MOISTURE CONTENT W	LIQUID LIMIT W _L	UNIT WEIGHT γ kN/m ³	REMARKS & GRAIN SIZE DISTRIBUTION (%) GR SA SI CL								
ELEV DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE			"N" VALUES	SHEAR STRENGTH kPa																
	--- CONTINUED FROM PREVIOUS PAGE ---						<div style="display: flex; justify-content: space-between;"> 20 40 60 80 100 20 40 60 80 100 </div> <div style="display: flex; justify-content: space-between;"> ○ UNCONFINED + FIELD VANE </div> <div style="display: flex; justify-content: space-between;"> ● QUICK TRIAXIAL × REMOULDED </div>																	
	END OF BOREHOLE NOTE: 1. Borehole dry on completion of drilling.																							

GTA-MTO 001 T:\PROJECTS\2009\09-1111-0018 (URS, YORK REGION)\LOG\0911110018.GPJ GAL-GTA.GDT 01/13/15 SIB

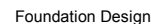
PROJECT <u>09-1111-0018</u>		RECORD OF BOREHOLE No SC-13		SHEET 2 OF 3	METRIC
G.W.P. <u>2835-02-00</u>		LOCATION <u>N 4877052.4 ; E 297161.4</u>		ORIGINATED BY <u>TWB</u>	
DIST <u>Central</u> HWY <u>400</u>		BOREHOLE TYPE <u>D-90 Track Mount, 89 mm Outside Diameter Tricone Wash Boring, N Casing</u>		COMPILED BY <u>NK</u>	
DATUM <u>Geodetic</u>		DATE <u>June 5 and 6, 2012</u>		CHECKED BY <u>LCC</u>	

SOIL PROFILE			SAMPLES			GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT		PLASTIC LIMIT w _p	NATURAL MOISTURE CONTENT w	LIQUID LIMIT w _L	UNIT WEIGHT γ kN/m ³	REMARKS & GRAIN SIZE DISTRIBUTION (%) GR SA SI CL		
ELEV DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE	"N" VALUES			SHEAR STRENGTH kPa							WATER CONTENT (%)	
								○ UNCONFINED + FIELD VANE								
							● QUICK TRIAXIAL × REMOULDED									
							20 40 60 80 100									
	--- CONTINUED FROM PREVIOUS PAGE ---															
	CLAYEY SILT with to some sand, trace gravel (TILL) Stiff to hard Grey Moist		13	SS	14		213									
			14	SS	37		212							2 25 50 23		
			15	SS	45		211									
			16	SS	44		209									
			17	SS	50		207									
204.1			18	SS	42		204									
24.9	SAND, trace to some silt, trace gravel, trace clay Very dense Grey Wet						203									
							202									
201.1			19	SS	92		201							4 84 9 3		
27.9	CLAYEY SILT with to some sand to Sandy SILT, trace to some clay, trace gravel (TILL) Very dense Grey Moist						200									

Continued Next Page

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

GTA-MTO 001 T:\PROJECTS\2009\09-1111-0018 (URS, YORK REGION)\LOG\0911110018.GPJ GAL-GTA.GDT 01/13/15 SIB



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

GTA-MTO 001 T:\PROJECTS\2009\09-1111-0018 (URS, YORK REGION)\LOG\0911110018.GPJ GAL-GTA.GDT 01/13/15 SIB

PROJECT <u>09-1111-0018</u>		RECORD OF BOREHOLE No SC-14		SHEET 1 OF 2		METRIC	
G.W.P. <u>2835-02-00</u>		LOCATION <u>N 4877041.9; E 297120.6</u>		ORIGINATED BY <u>OS</u>			
DIST <u>Central</u> HWY <u>400</u>		BOREHOLE TYPE <u>D-25 Track Mount, 76 mm Wash Rotary Boring, NW Casing</u>		COMPILED BY <u>NK</u>			
DATUM <u>Geodetic</u>		DATE <u>May 22, 2012</u>		CHECKED BY <u>LCC</u>			

SOIL PROFILE			SAMPLES			GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT		PLASTIC LIMIT w _p	NATURAL MOISTURE CONTENT w	LIQUID LIMIT w _L	UNIT WEIGHT γ kN/m ³	REMARKS & GRAIN SIZE DISTRIBUTION (%) GR SA SI CL	
ELEV DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE	"N" VALUES			SHEAR STRENGTH kPa							WATER CONTENT (%)
								○ UNCONFINED + FIELD VANE							
						● QUICK TRIAXIAL × REMOULDED									
222.0	GROUND SURFACE														
0.0	TOPSOIL														
0.2	Silty SAND, some gravel, trace clay, containing rootlets, and organic matter		1	SS	9										
221.2	Loose Brown to light brown Moist														
0.8	CLAYEY SILT with sand, some gravel, containing organic matter Very stiff Grey Moist		2	SS	19									10 41 37 12	
			3	SS	17										
219.5	PEAT, containing wood fragments Stiff Black Moist		4	SS	12								143.8		
2.7															
218.5	SAND and SILT, trace clay, trace gravel Compact Brown Moist		5	SS	27									5 32 57 6	
3.5	CLAYEY SILT, trace sand Stiff to very stiff Light grey to grey, containing oxidized stains Moist to wet														
			6	SS	15										
			7	SS	19										
			8	SS	8										
215.3	CLAYEY SILT with to some sand, trace gravel (TILL) Hard Firm Moist														
6.7															
			9	SS	53										
			10	SS	48										
			11	SS	50										
			12	SS	86										
			13	SS	63									1 26 47 26	

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

GTA-MTO 001 T:\PROJECTS\2009\09-1111-0018 (URS, YORK REGION)\LOG\0911110018.GPJ GAL-GTA.GDT 01/13/15 SIB

PROJECT		RECORD OF BOREHOLE		No SC-14		SHEET 2 OF 2		METRIC								
G.W.P. 09-1111-0018		LOCATION		N 4877041.9; E 297120.6		ORIGINATED BY		OS								
DIST Central HWY 400		BOREHOLE TYPE		D-25 Track Mount, 76 mm Wash Rotary Boring, NW Casing		COMPILED BY		NK								
DATUM Geodetic		DATE		May 22, 2012		CHECKED BY		LCC								
SOIL PROFILE		SAMPLES			GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT					PLASTIC LIMIT W _p	NATURAL MOISTURE CONTENT W	LIQUID LIMIT W _L	UNIT WEIGHT γ	REMARKS & GRAIN SIZE DISTRIBUTION (%)
ELEV DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE			"N" VALUES	SHEAR STRENGTH kPa								
	--- CONTINUED FROM PREVIOUS PAGE ---															
	CLAYEY SILT with to some sand, trace gravel (TILL) Hard Firm Moist		14	SS	65											
						206										
			15	SS	72											
						205										
			16	SS	71											
203.9						204										
18.1	END OF BOREHOLE															
	NOTE: 1. Water level in open borehole at a depth of 3.7 m (Elev. 218.3 m) on completion of drilling.															

GTA-MTO 001 T:\PROJECTS\2009\09-1111-0018 (URS, YORK REGION)\LOG\0911110018.GPJ GAL-GTA.GDT 01/13/15 SIB



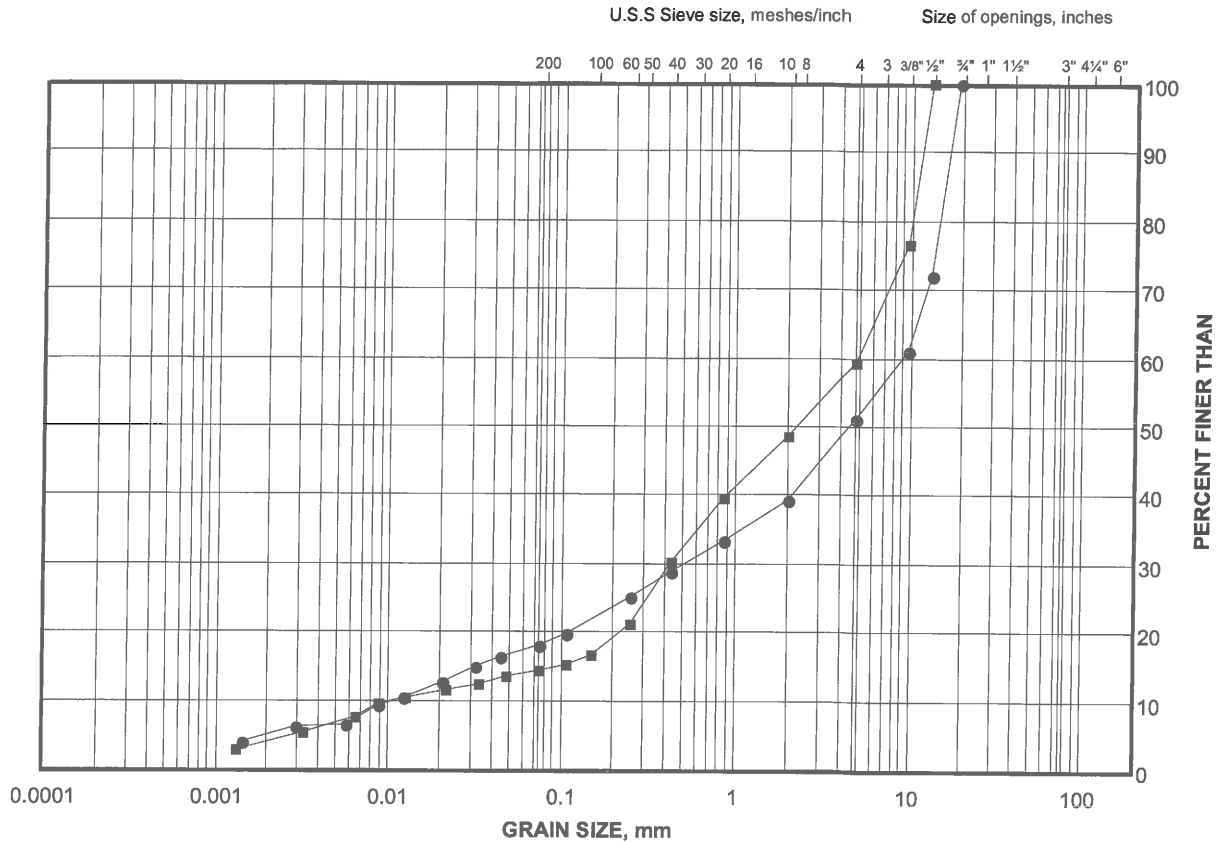
APPENDIX B

Laboratory Test Results

GRAIN SIZE DISTRIBUTION TEST RESULTS

Sand and Gravel Fill

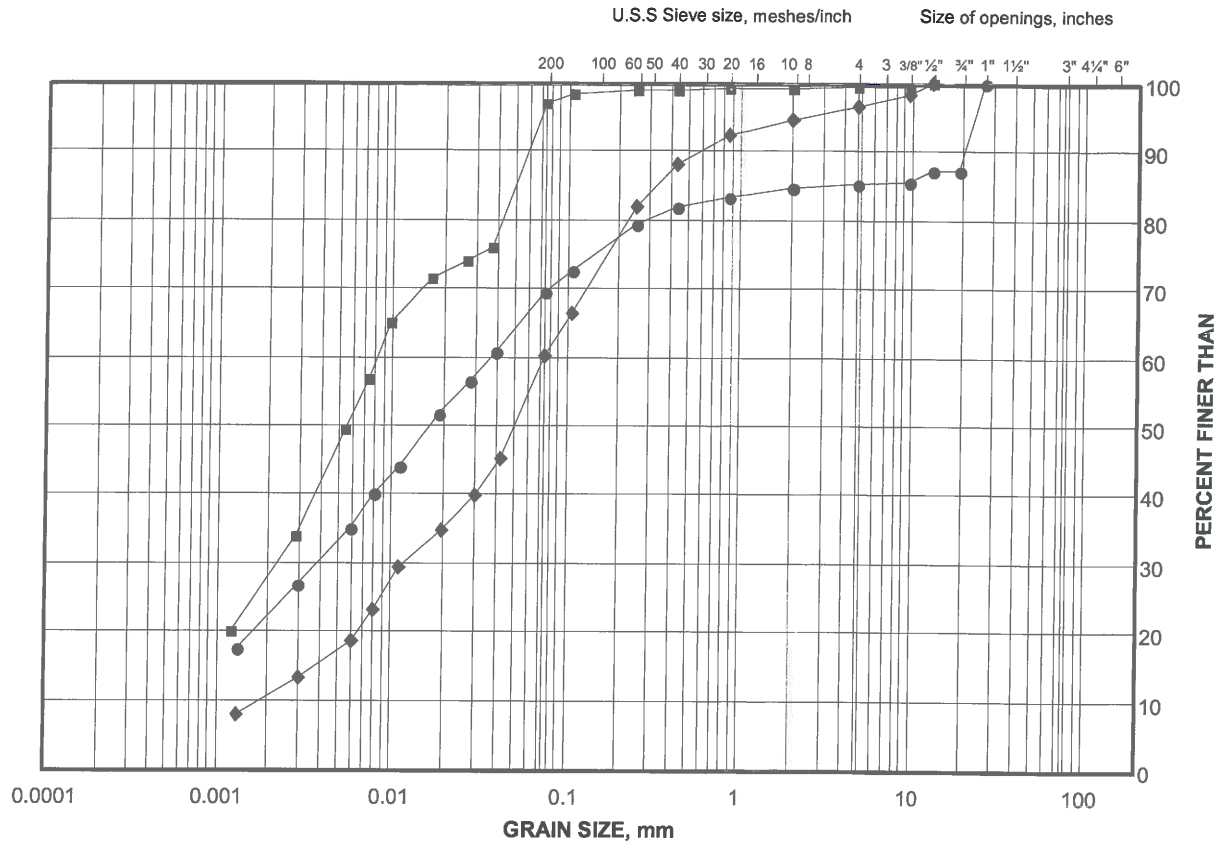
FIGURE B1A



GRAIN SIZE DISTRIBUTION TEST RESULTS

Clayey Silt Fill

FIGURE B1B



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

LEGEND

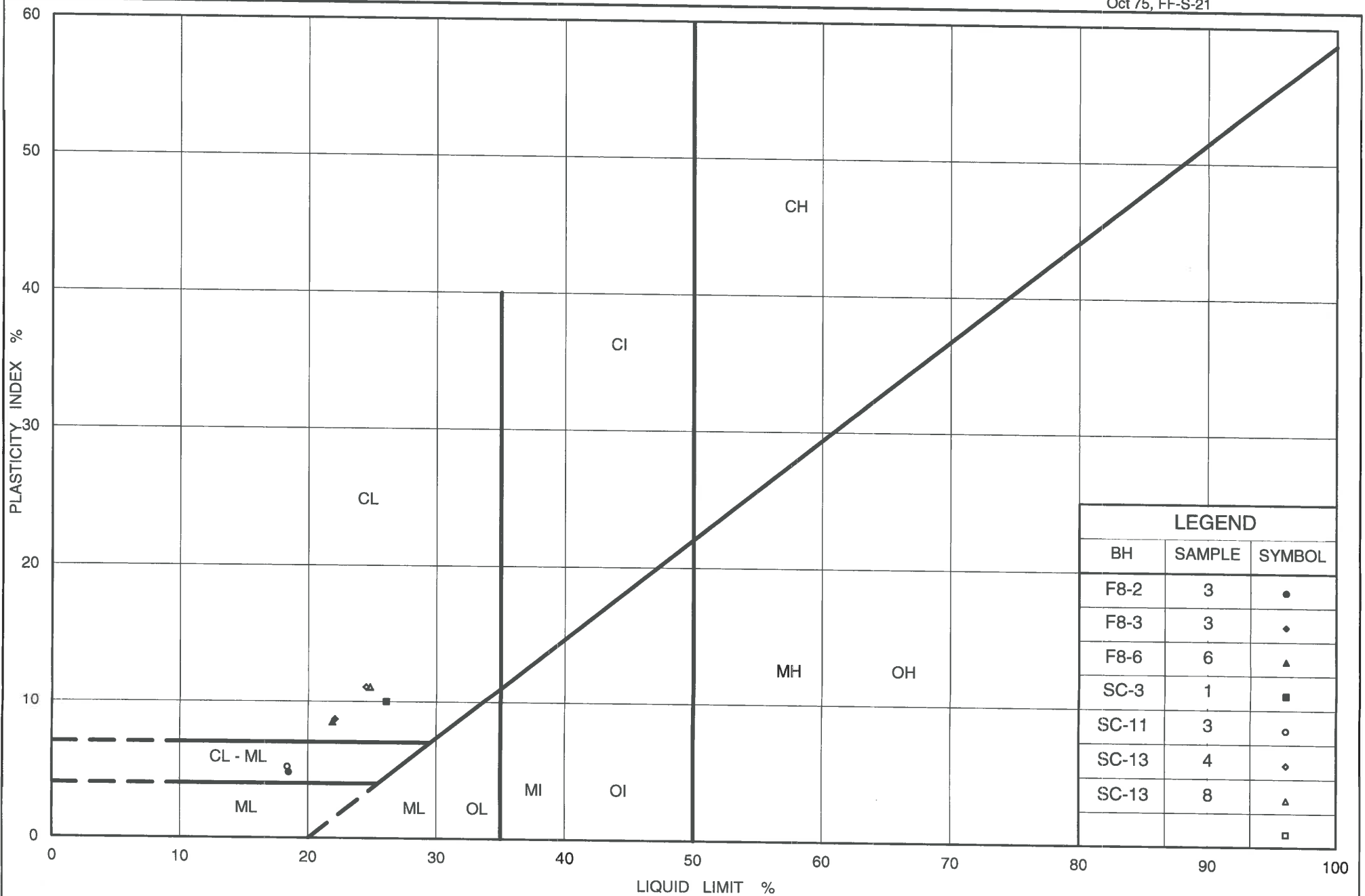
SYMBOL	BOREHOLE	SAMPLE	ELEVATION(m)
●	SC-13	4	222.6
■	F8-3	4	218.4
◆	F8-2	5	225.1

Project Number: 09-1111-0018

Checked By: *Moyle*

Golder Associates

Date: 15-Mar-13



Ministry of Transportation

Ontario

PLASTICITY CHART

Clayey Silt Fill

Figure No. B2

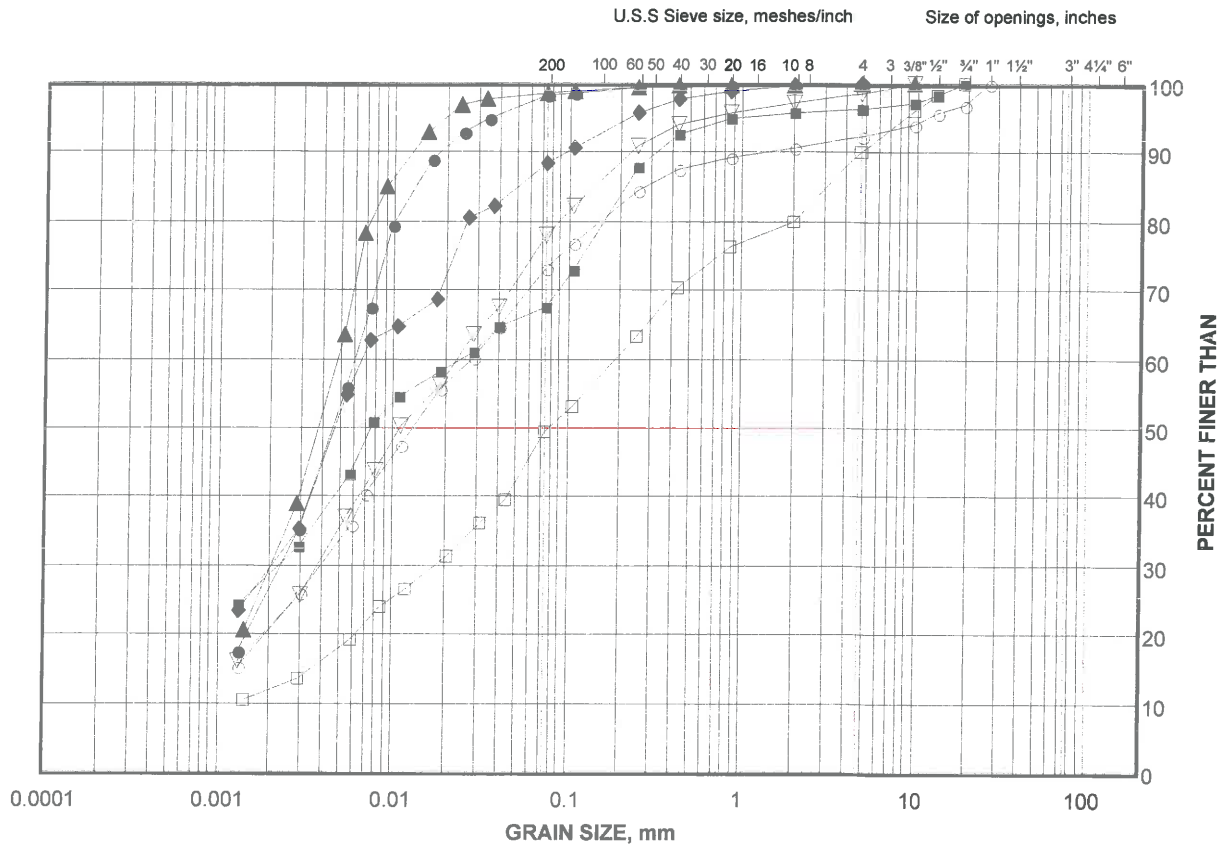
Project No. 09-1111-0018

Checked By: *Wayne*

GRAIN SIZE DISTRIBUTION TEST RESULTS

Clayey Silt (Upper Deposit)

FIGURE B3A



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

LEGEND

SYMBOL	BOREHOLE	SAMPLE	ELEVATION(m)
●	BO-9	10	210.0
■	SC-5	11	207.1
◆	SC-13	11	216.5
▲	SC-8	12	208.0
▽	SC-7	12	208.2
○	SC-4	12	208.3
□	SC-14	2	220.9

Project Number: 09-1111-0018

Checked By: *Mazze*

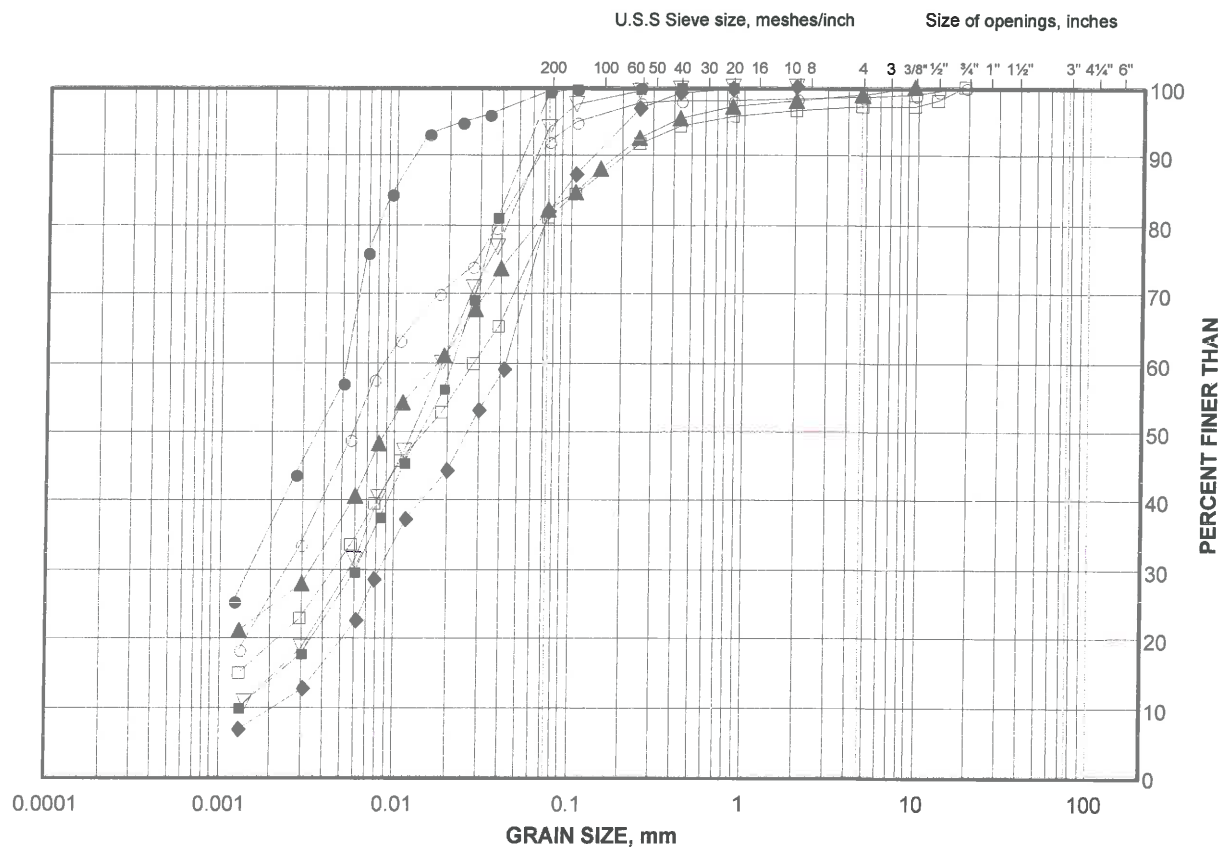
Golder Associates

Date: 08-Mar-13

GRAIN SIZE DISTRIBUTION TEST RESULTS

Clayey Silt (Upper Deposit)

FIGURE B3B



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

LEGEND

SYMBOL	BOREHOLE	SAMPLE	ELEVATION(m)
●	OHS-7	4	217.8
■	SC-8	4	217.9
◆	BO-9	5	216.9
▲	F8-6	6	224.2
▽	SC-7	6	216.6
○	SC-5	6	216.2
□	F8-2	7	222.8

Project Number: 09-1111-0018

Checked By: *Maye*

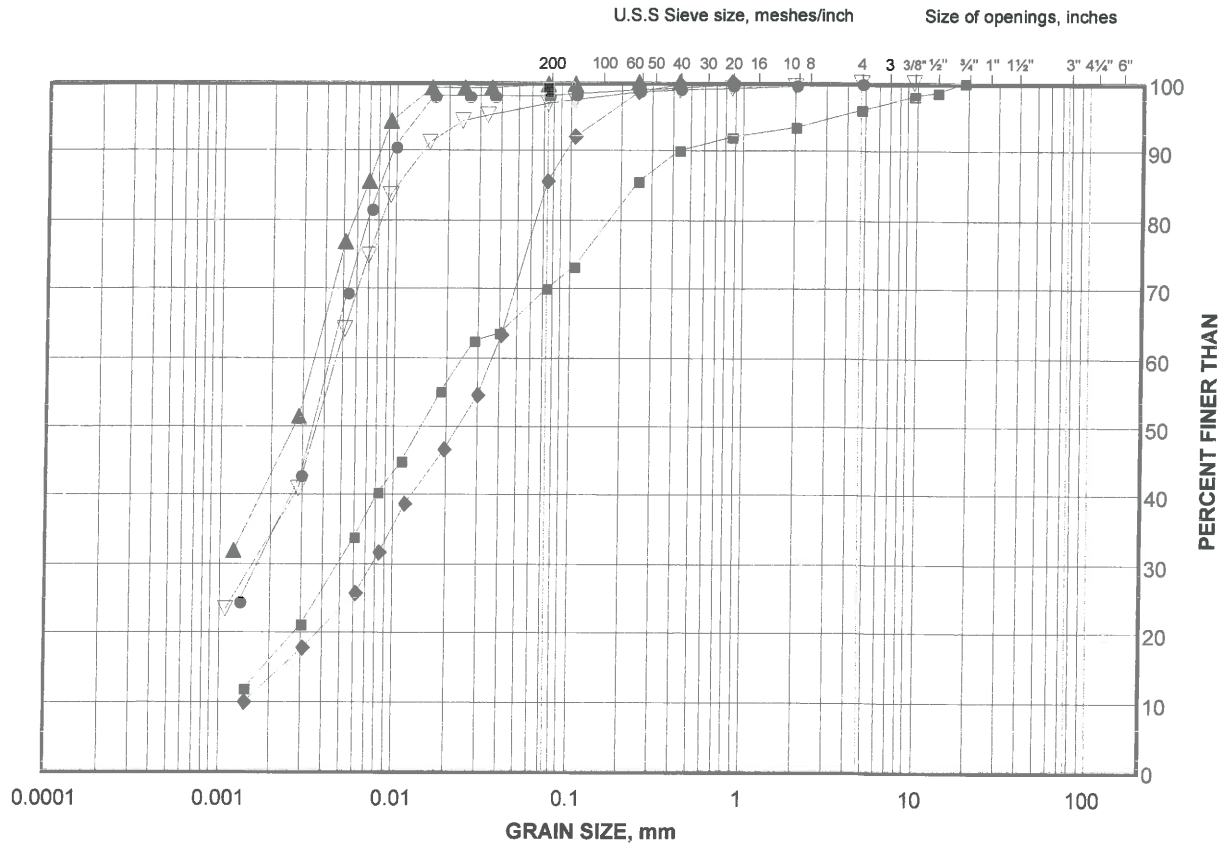
Golder Associates

Date: 08-Mar-13

GRAIN SIZE DISTRIBUTION TEST RESULTS

Clayey Silt (Upper Deposit)

FIGURE B3C



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

LEGEND

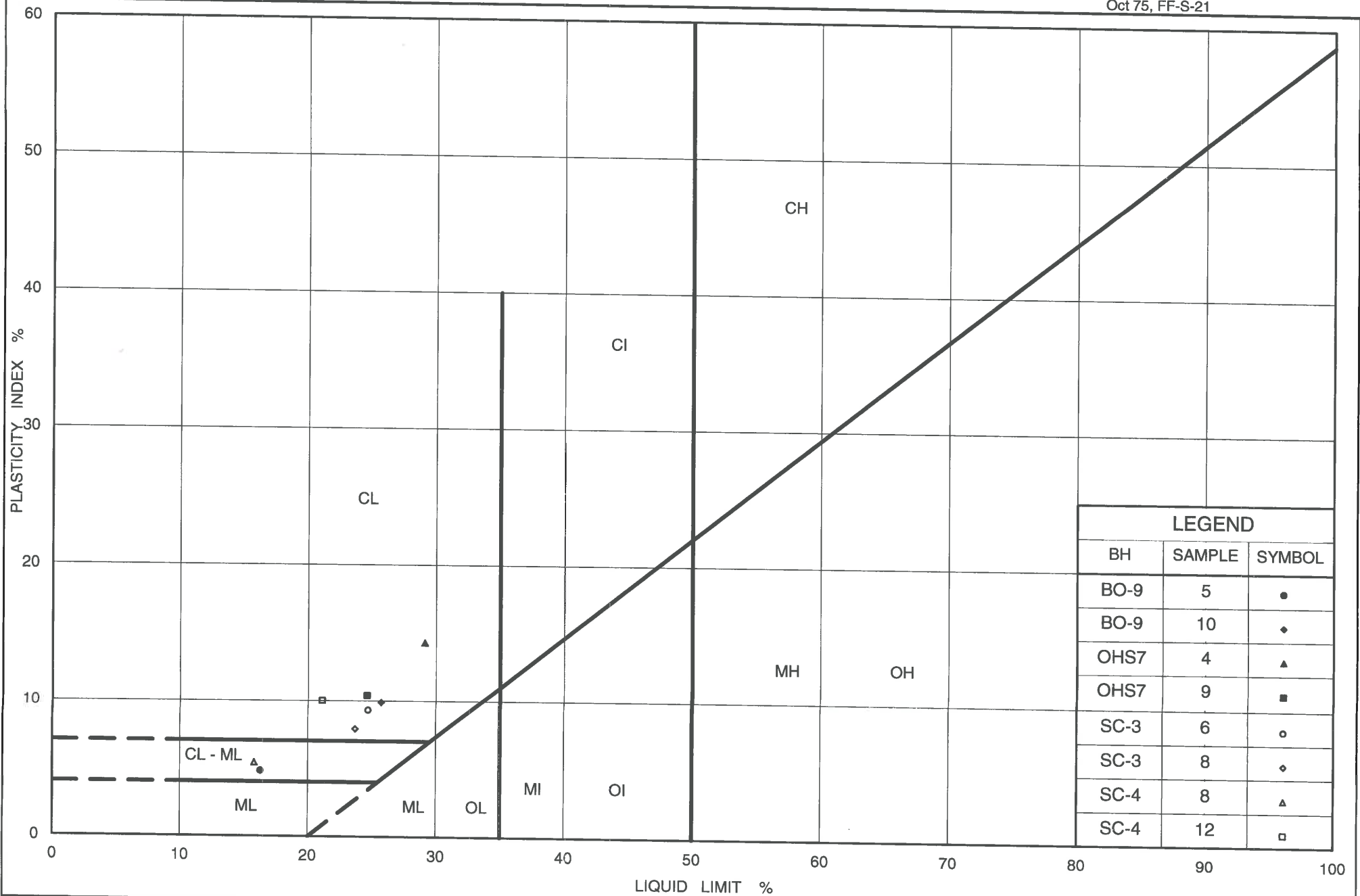
SYMBOL	BOREHOLE	SAMPLE	ELEVATION(m)
●	SC-10	7	217.2
■	SC-4	8	214.4
◆	SC-8	8	214.1
▲	SC-9	8	214.6
▽	OHS-7	9	214.0

Project Number: 10-1111-0120

Checked By: *Maye*

Golder Associates

Date: 08-Mar-13



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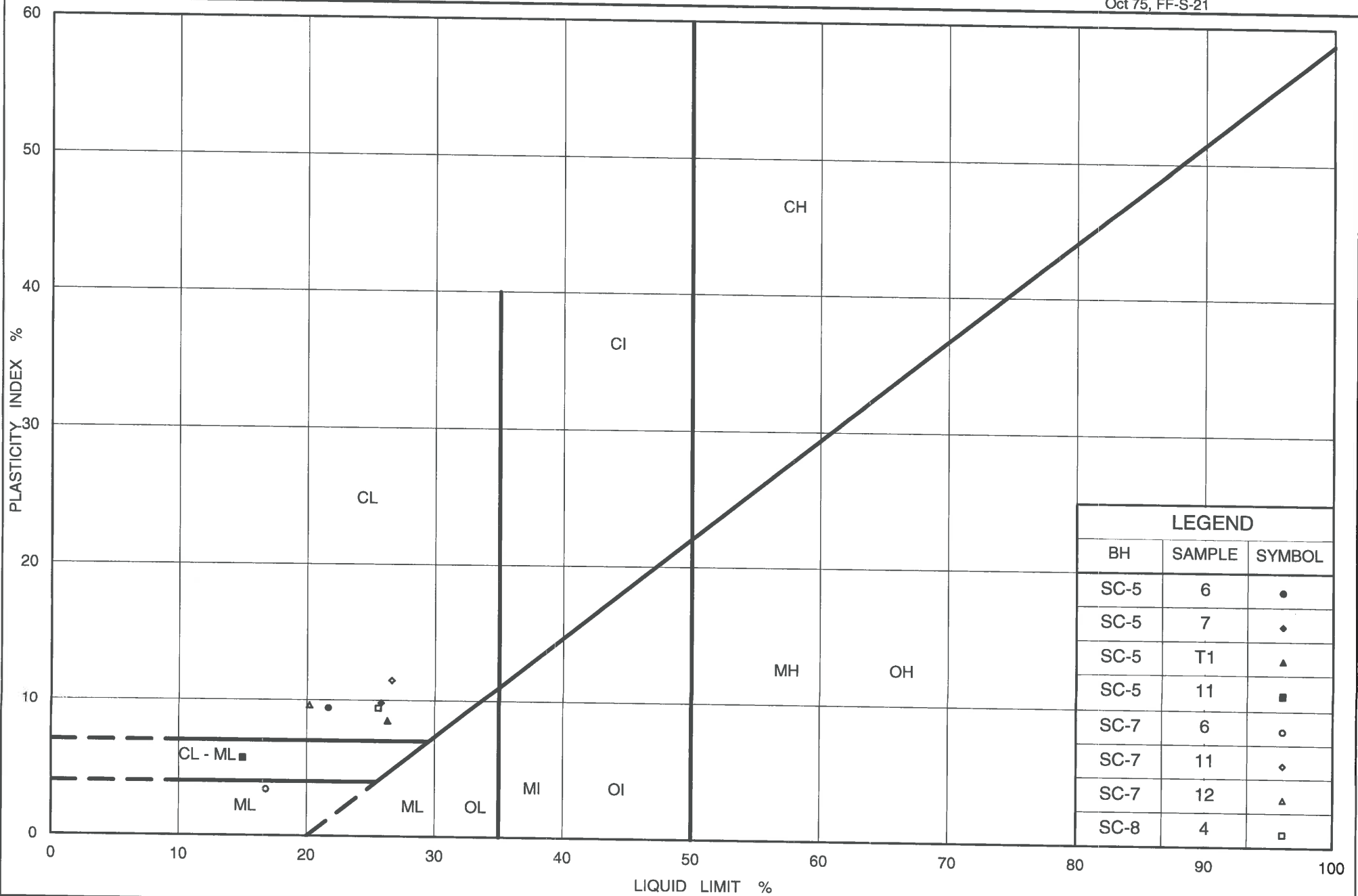
Ontario

PLASTICITY CHART Clayey Silt (Upper Deposit)

Figure No. B4A

Project No. 09-1111-0018

Checked By: *Wojciech*



Ministry of Transportation

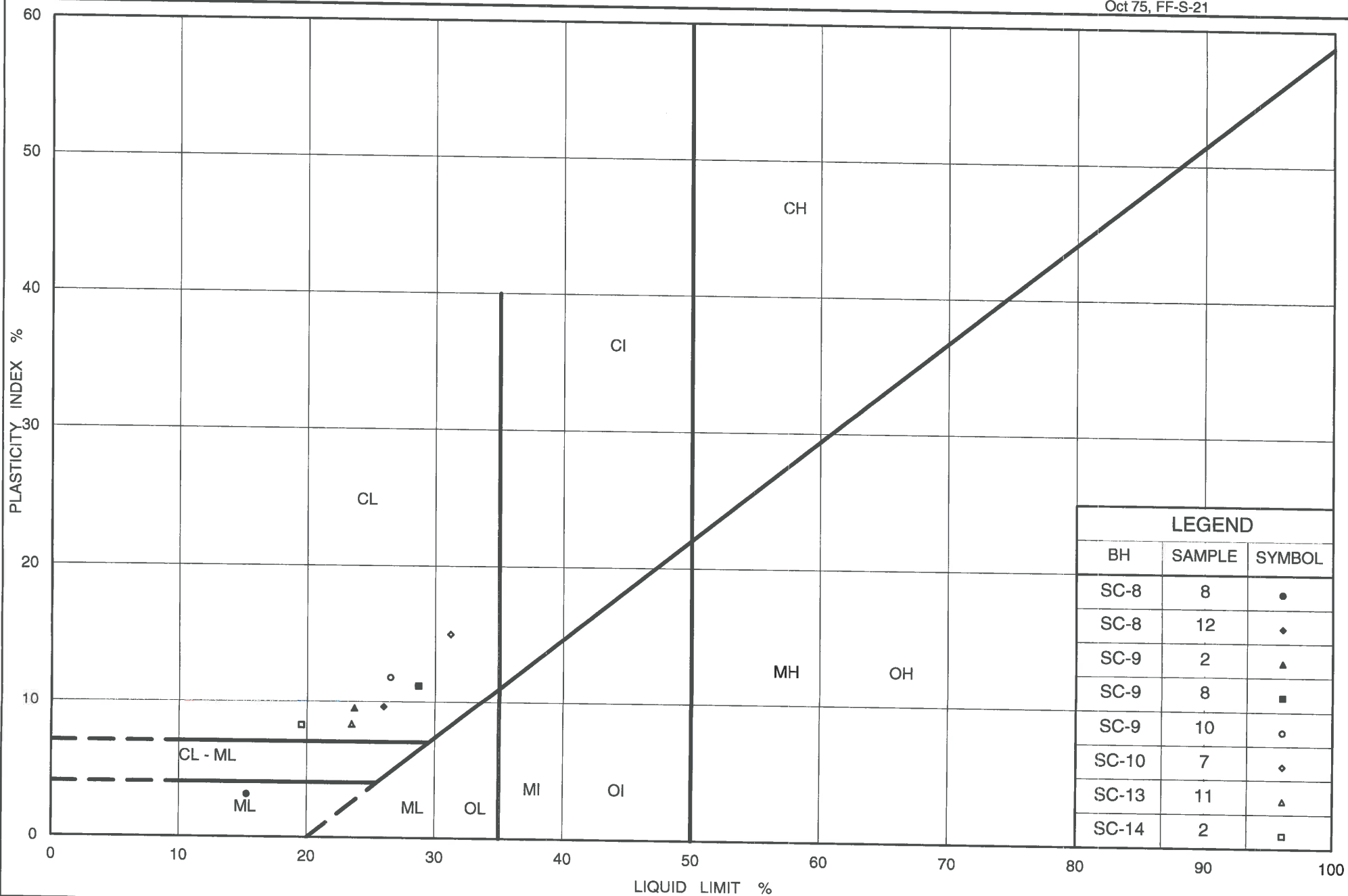
Ontario

PLASTICITY CHART Clayey Silt (Upper Deposit)

Figure No. B4B

Project No. 09-1111-0018

Checked By: *Wojciech*



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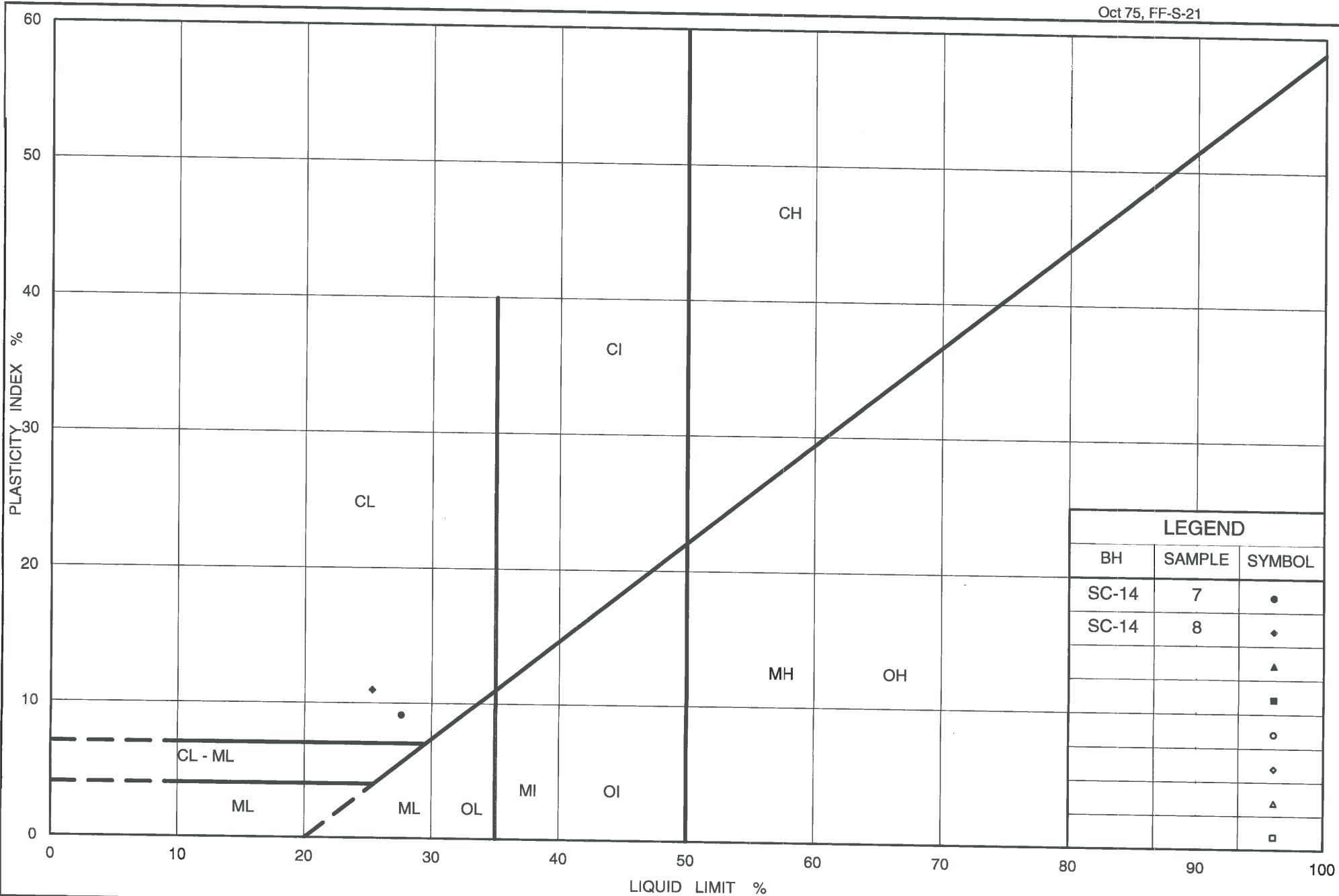
Ontario

PLASTICITY CHART Clayey Silt (Upper Deposit)

Figure No. B4C

Project No. 09-1111-0018

Checked By: *Wang*



Ministry of Transportation

Ontario

PLASTICITY CHART Clayey Silt (Upper Deposit)

Figure No. B4D

Project No. 09-1111-0018

Checked By: *Woye*

CONSOLIDATION TEST RESULTS

Clayey Silt (Upper Deposit)

FIGURE B5A**SAMPLE IDENTIFICATION**

Project Number	09-1111-0018	Sample Number	S1
Borehole Number	SC-3	Sample Depth, m	5.34-5.79

TEST CONDITIONS

Test Type	Standard	Load Duration, hr	24
Oedometer Number	12		
Date Started	06/20/2012		
Date Completed	07/05/2012		

SAMPLE DIMENSIONS AND PROPERTIES - INITIAL

Sample Height, cm	2.55	Unit Weight, kN/m ³	20.74
Sample Diameter, cm	6.34	Dry Unit Weight, kN/m ³	16.56
Area, cm ²	31.58	Specific Gravity, measured	2.77
Volume, cm ³	80.46	Solids Height, cm	1.553
Water Content, %	25.28	Volume of Solids, cm ³	49.04
Wet Mass, g	170.18	Volume of Voids, cm ³	31.42
Dry Mass, g	135.84	Degree of Saturation, %	109.3

TEST COMPUTATIONS

Stress kPa	Corr. Height cm	Void Ratio	Average Height cm	t ₉₀ sec	cv. cm ² /s	mv m ² /kN	k cm/s
0.00	2.548	0.641	2.548				
5.97	2.524	0.625	2.536	1411	9.66E-04	1.60E-03	1.52E-07
10.77	2.516	0.620	2.520	1782	7.55E-04	6.46E-04	4.78E-08
20.51	2.502	0.611	2.509	1156	1.15E-03	5.40E-04	6.11E-08
39.99	2.486	0.601	2.494	454	2.90E-03	3.30E-04	9.41E-08
78.32	2.463	0.586	2.474	265	4.90E-03	2.38E-04	1.14E-07
156.28	2.436	0.569	2.449	252	5.05E-03	1.35E-04	6.67E-08
311.94	2.400	0.545	2.418	217	5.71E-03	9.18E-05	5.14E-08
622.06	2.356	0.517	2.378	228	5.26E-03	5.49E-05	2.83E-08
1241.34	2.306	0.485	2.331	240	4.80E-03	3.18E-05	1.50E-08
2481.97	2.249	0.448	2.277	104	1.06E-02	1.81E-05	1.87E-08
1241.34	2.253	0.451	2.251				
311.94	2.275	0.465	2.264				
78.32	2.301	0.482	2.288				
20.51	2.324	0.496	2.313				
6.04	2.343	0.509	2.334				

Note:

k calculated using cv based on t₉₀ values.**SAMPLE DIMENSIONS AND PROPERTIES - FINAL**

Sample Height, cm	2.34	Unit Weight, kN/m ³	21.73
Sample Diameter, cm	6.34	Dry Unit Weight, kN/m ³	18.00
Area, cm ²	31.58	Specific Gravity, measured	2.77
Volume, cm ³	74.00	Solids Height, cm	1.553
Water Content, %	20.69	Volume of Solids, cm ³	49.04
Wet Mass, g	163.94	Volume of Voids, cm ³	24.96
Dry Mass, g	135.84		

Prepared By: LH

Golder AssociatesChecked By: 

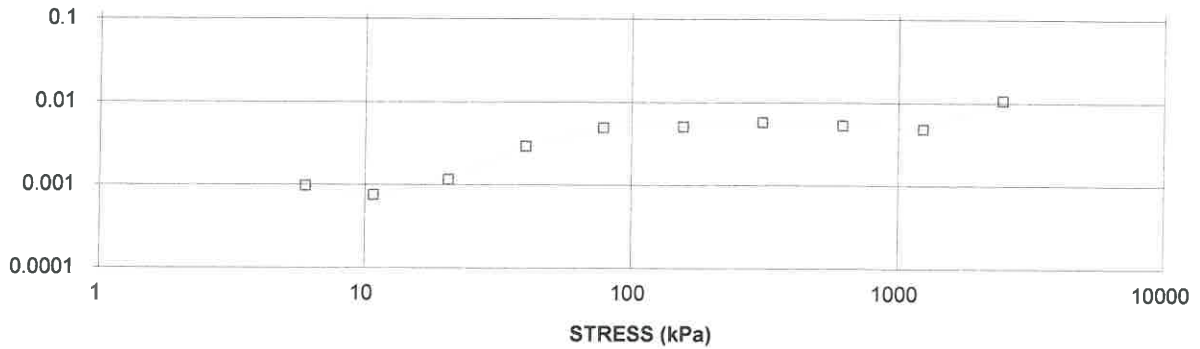
CONSOLIDATION TEST RESULTS

Clayey Silt (Upper Deposit)

FIGURE B5B

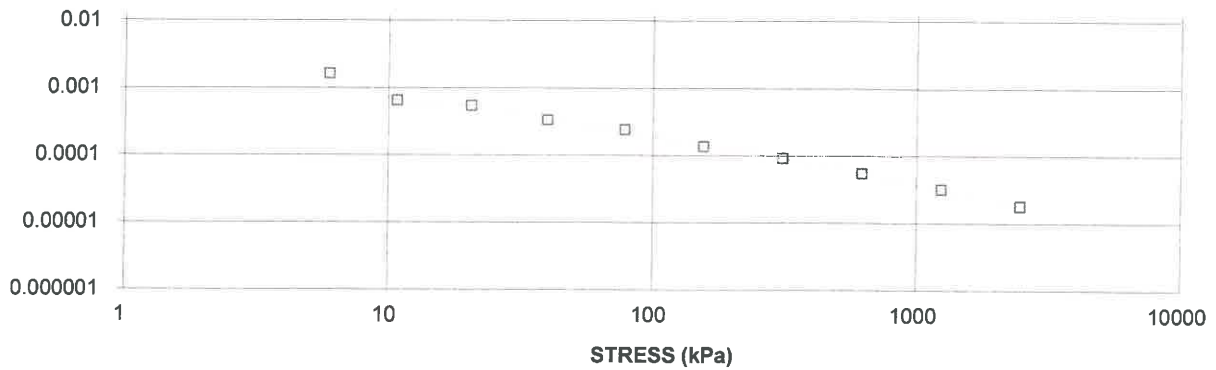
COEFFICIENT OF CONSOLIDATION,
cm²/s

CONSOLIDATION TEST
CV cm²/s VS STRESS (kPa)
BH SC-3 SA S1



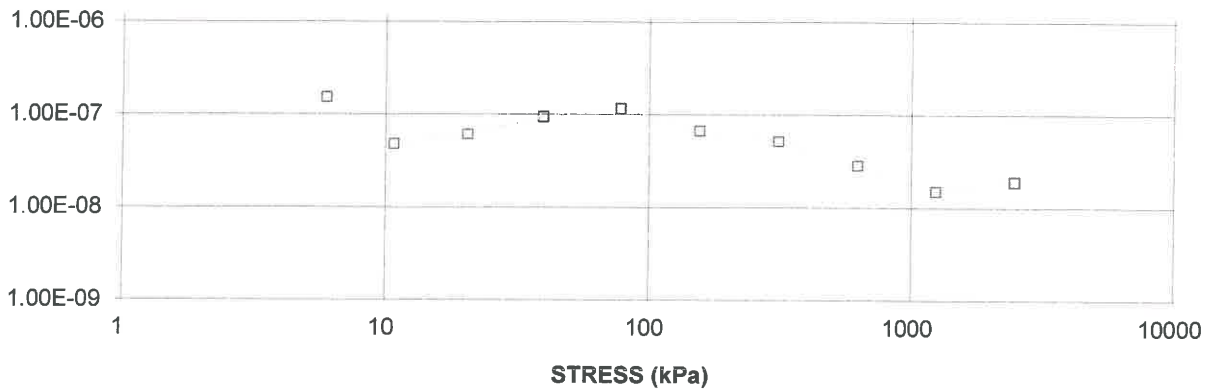
VOLUME COMPRESSIBILITY, m²/kN

CONSOLIDATION TEST
MV m²/kN vs STRESS (kPa)
BH SC-3 SA S1



HYDRAULIC CONDUCTIVITY,
cm/s

CONSOLIDATION TEST
HYDRAULIC CONDUCTIVITY vs STRESS
BH SC-3 SA S1



Project No. 09-1111-0018

Prepared By: LH

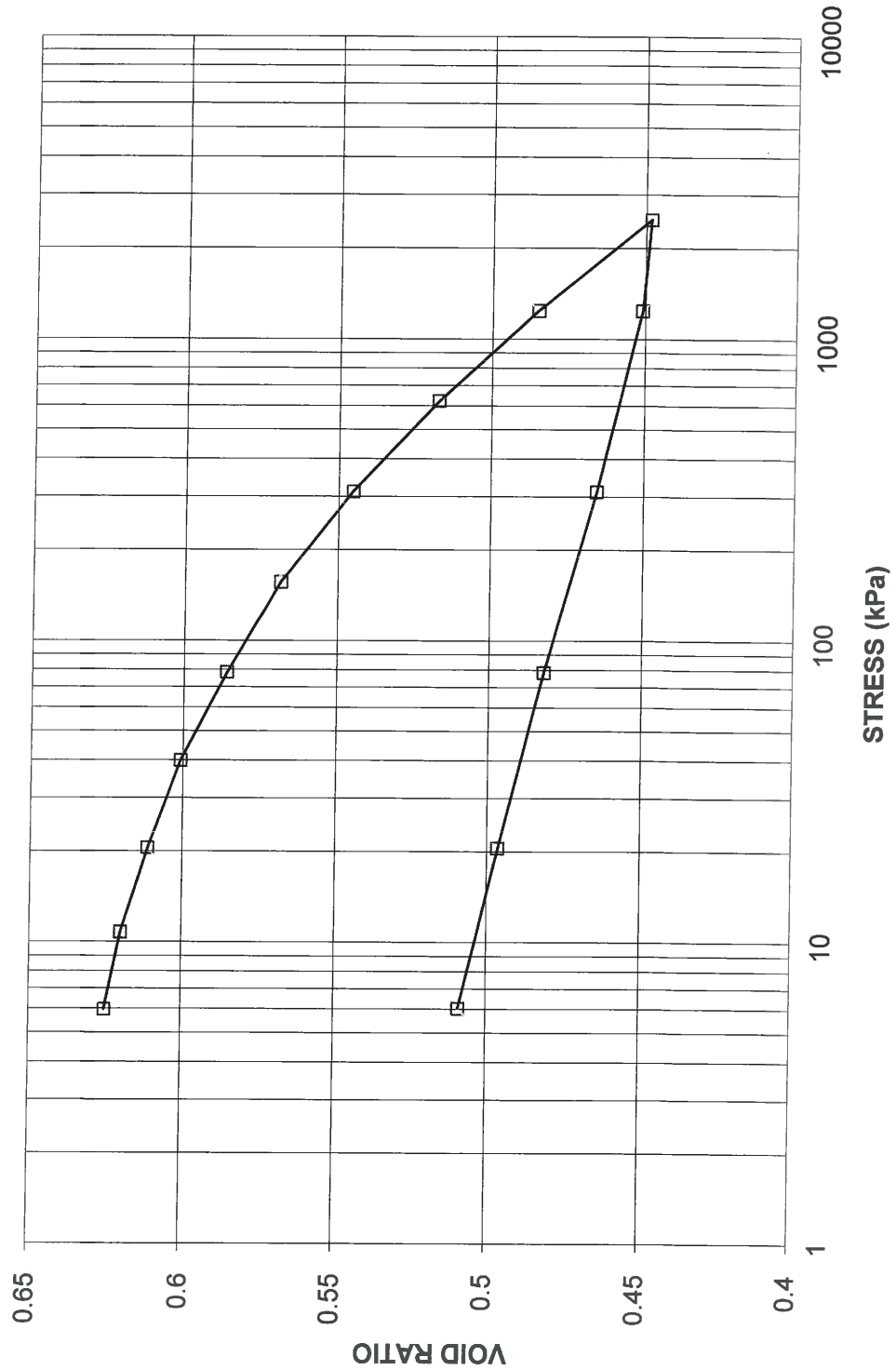
Golder Associates

Checked By: *[Signature]*

**CONSOLIDATION TEST RESULTS
VOID RATIO VS LOG STRESS**

FIGURE B5C

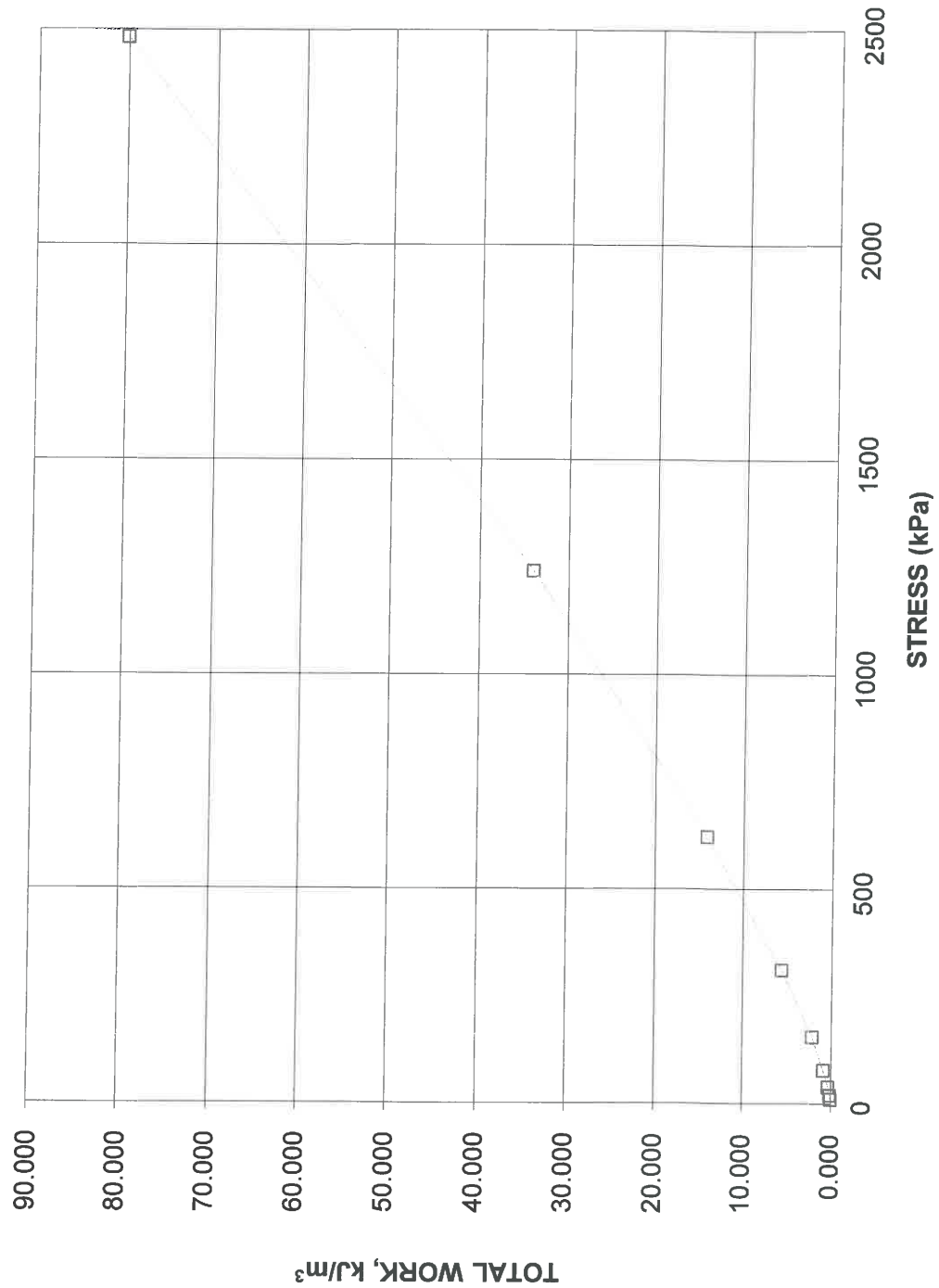
**CONSOLIDATION TEST
VOID RATIO vs STRESS
BH SC-3 SA S1**



**CONSOLIDATION TEST RESULTS
TOTAL WORK VS STRESS**

FIGURE B5D

**CONSOLIDATION TEST
TOTAL WORK, kJ/m^3 vs STRESS
BH SC-3 SA S1**



CONSOLIDATION TEST RESULTS

Clayey Silt (Upper Deposit)

FIGURE B6A**SAMPLE IDENTIFICATION**

Project Number	09-1111-0018	Sample Number	T1
Borehole Number	SC-5	Sample Depth, m	12.20-12.65

TEST CONDITIONS

Test Type	Standard	Load Duration, hr	24
Oedometer Number	2		
Date Started	06/26/2012		
Date Completed	07/10/2012		

SAMPLE DIMENSIONS AND PROPERTIES - INITIAL

Sample Height, cm	2.54	Unit Weight, kN/m ³	20.11
Sample Diameter, cm	6.34	Dry Unit Weight, kN/m ³	16.29
Area, cm ²	31.58	Specific Gravity, measured	2.72
Volume, cm ³	80.09	Solids Height, cm	1.548
Water Content, %	23.49	Volume of Solids, cm ³	48.90
Wet Mass, g	164.26	Volume of Voids, cm ³	31.18
Dry Mass, g	133.01	Degree of Saturation, %	100.2

TEST COMPUTATIONS

Stress kPa	Corr. Height cm	Void Ratio	Average Height cm	t ₉₀ sec	cv. cm ² /s	mv m ² /kN	k cm/s
0.00	2.536	0.638	2.536				
5.95	2.513	0.623	2.525	1417	9.54E-04	1.52E-03	1.42E-07
10.66	2.501	0.615	2.507	1009	1.32E-03	9.80E-04	1.27E-07
20.63	2.487	0.606	2.494	1058	1.25E-03	5.70E-04	6.96E-08
39.97	2.466	0.592	2.476	540	2.41E-03	4.30E-04	1.02E-07
78.79	2.439	0.575	2.452	614	2.08E-03	2.77E-04	5.64E-08
156.24	2.404	0.552	2.421	457	2.72E-03	1.78E-04	4.74E-08
312.03	2.352	0.519	2.378	520	2.31E-03	1.31E-04	2.96E-08
622.07	2.276	0.470	2.314	427	2.66E-03	9.64E-05	2.51E-08
1242.57	2.209	0.427	2.243	240	4.44E-03	4.25E-05	1.85E-08
2482.49	2.150	0.388	2.179	265	3.80E-03	1.90E-05	7.07E-09
1242.57	2.150	0.389	2.150				
312.03	2.170	0.401	2.160				
78.79	2.191	0.415	2.180				
20.63	2.220	0.434	2.205				
5.95	2.235	0.443	2.228				

Note:

k calculated using cv based on t₉₀ values.**SAMPLE DIMENSIONS AND PROPERTIES - FINAL**

Sample Height, cm	2.24	Unit Weight, kN/m ³	22.06
Sample Diameter, cm	6.34	Dry Unit Weight, kN/m ³	18.48
Area, cm ²	31.58	Specific Gravity, measured	2.72
Volume, cm ³	70.59	Solids Height, cm	1.548
Water Content, %	19.39	Volume of Solids, cm ³	48.90
Wet Mass, g	158.80	Volume of Voids, cm ³	21.69
Dry Mass, g	133.01		

Prepared By: LH

Golder AssociatesChecked By: 

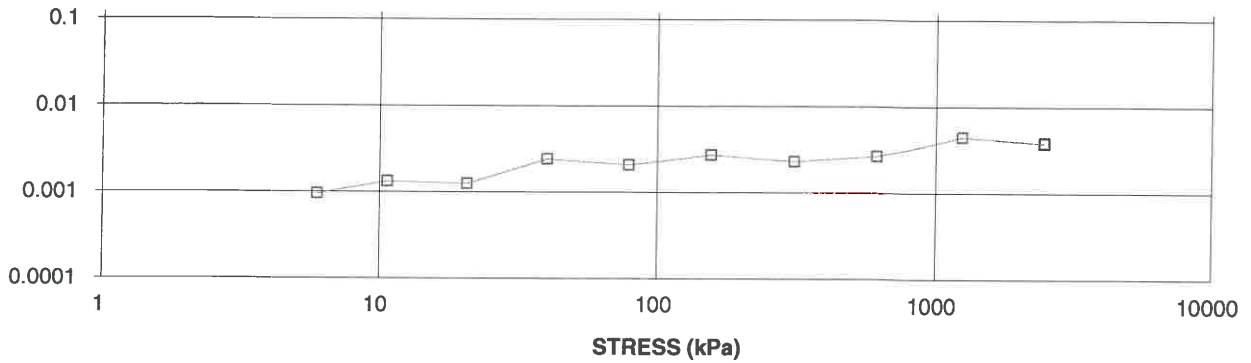
CONSOLIDATION TEST RESULTS

Clayey Silt (Upper Deposit)

FIGURE B6B

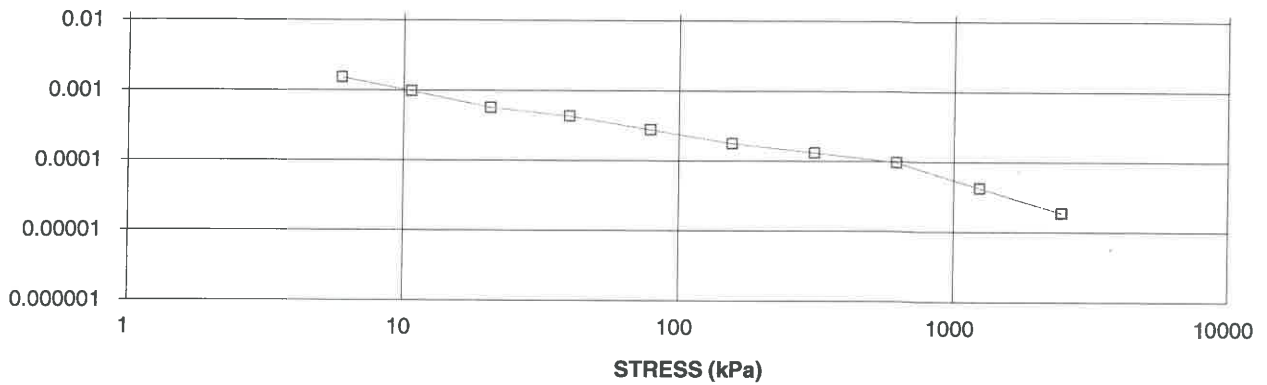
COEFFICIENT OF CONSOLIDATION,
cm²/s

CONSOLIDATION TEST
CV cm²/s VS STRESS (kPa)
BH SC-5 SA T1



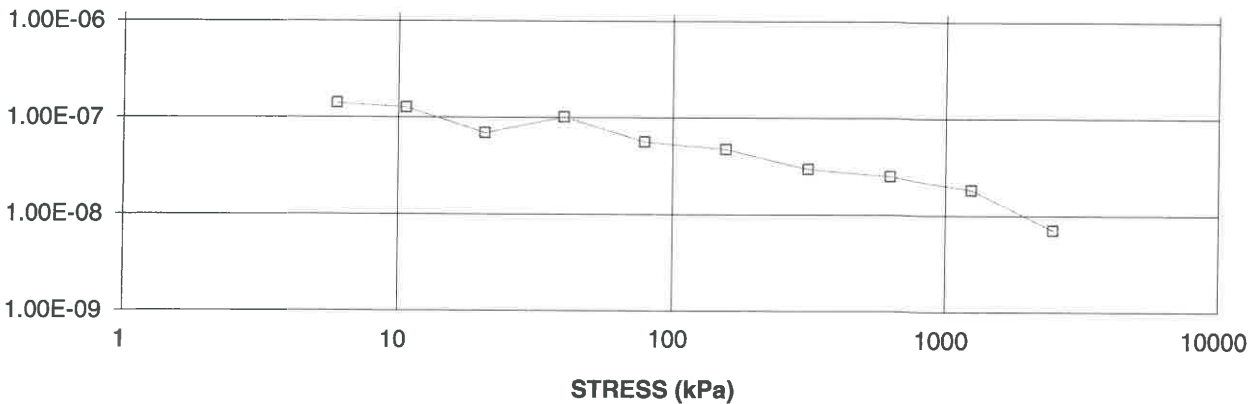
VOLUME COMPRESSIBILITY, m²/kN

CONSOLIDATION TEST
MV m²/kN vs STRESS (kPa)
BH SC-5 SA T1



HYDRAULIC CONDUCTIVITY,
cm/s

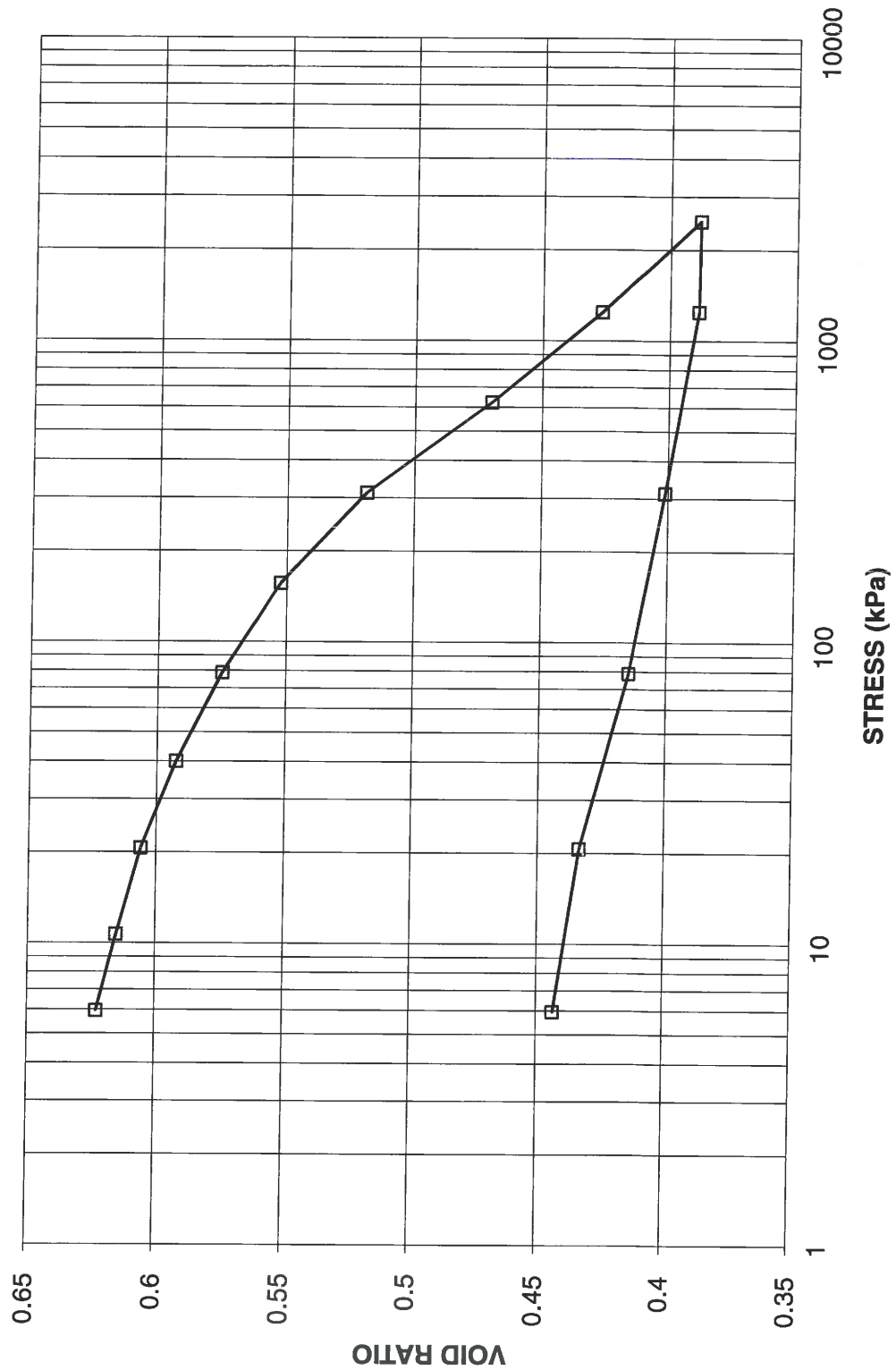
CONSOLIDATION TEST
HYDRAULIC CONDUCTIVITY vs STRESS
BH SC-5 SA T1



**CONSOLIDATION TEST RESULTS
VOID RATIO VS LOG STRESS**

FIGURE B6C

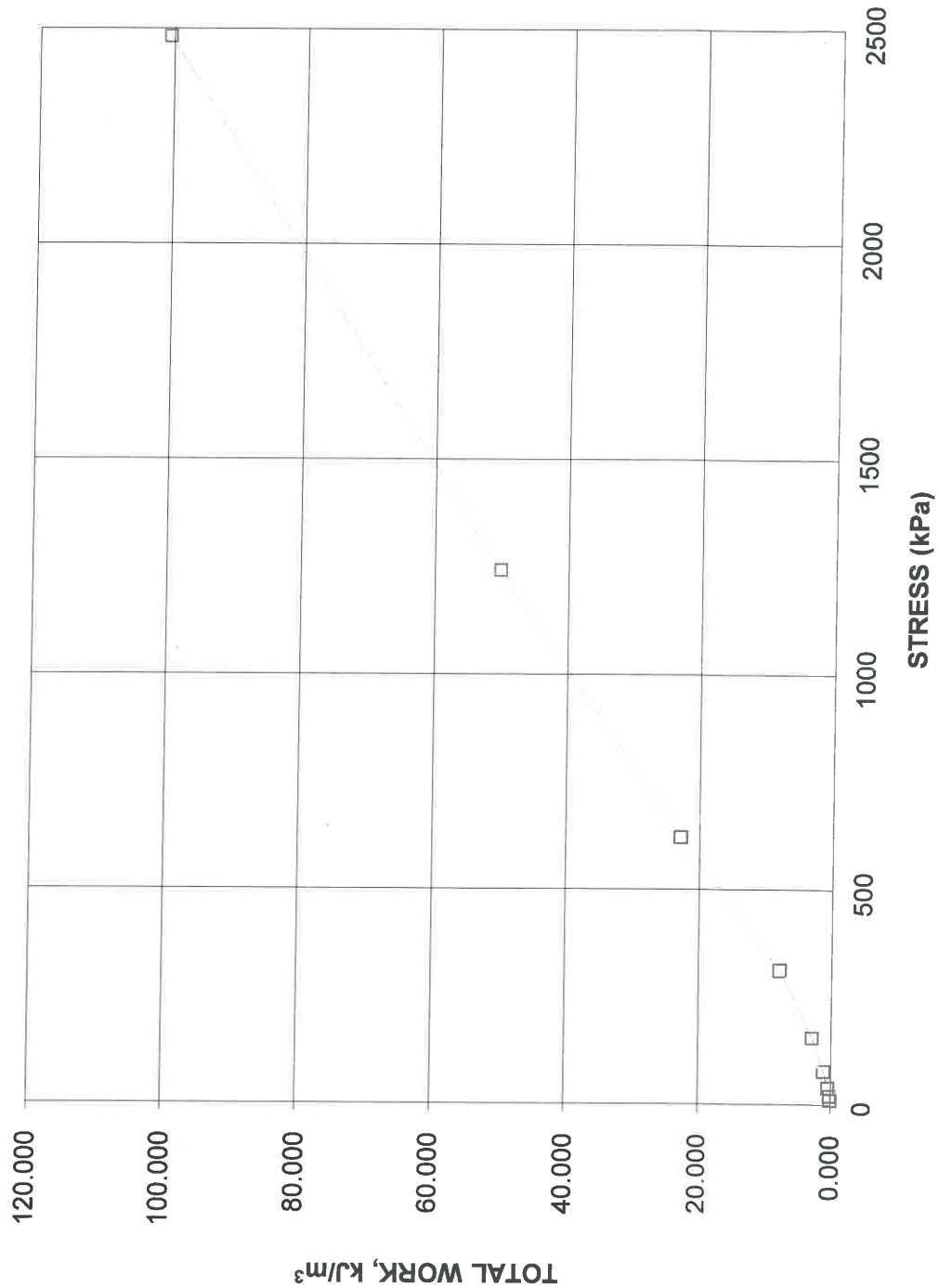
CONSOLIDATION TEST
VOID RATIO vs STRESS
BH SC-5 SA T1



**CONSOLIDATION TEST RESULTS
TOTAL WORK VS STRESS**

FIGURE B6D

**CONSOLIDATION TEST
TOTAL WORK, kJ/m^3 vs STRESS
BH SC-5 SA T1**



CONSOLIDATION TEST RESULTS

Clayey Silt (Upper Deposit)

FIGURE B7A**SAMPLE IDENTIFICATION**

Project Number	09-1111-0018	Sample Number	11
Borehole Number	SC-7	Sample Depth, m	10.67-11.28

TEST CONDITIONS

Test Type	Standard	Load Duration, hr	24
Oedometer Number	9		
Date Started	06/20/2012		
Date Completed	07/05/2012		

SAMPLE DIMENSIONS AND PROPERTIES - INITIAL

Sample Height, cm	1.90	Unit Weight, kN/m ³	20.59
Sample Diameter, cm	6.33	Dry Unit Weight, kN/m ³	16.64
Area, cm ²	31.43	Specific Gravity, measured	2.76
Volume, cm ³	59.65	Solids Height, cm	1.167
Water Content, %	23.75	Volume of Solids, cm ³	36.67
Wet Mass, g	125.26	Volume of Voids, cm ³	22.98
Dry Mass, g	101.22	Degree of Saturation, %	104.6

TEST COMPUTATIONS

Stress kPa	Corr. Height cm	Void Ratio	Average Height cm	t ₉₀ sec	cv. cm ² /s	mv m ² /kN	k cm/s
0.00	1.898	0.627	1.898				
6.55	1.863	0.596	1.880	1848	4.06E-04	2.85E-03	1.13E-07
11.23	1.851	0.586	1.857	4133	1.77E-04	1.33E-03	2.30E-08
21.21	1.835	0.573	1.843	1370	5.26E-04	8.39E-04	4.32E-08
40.58	1.808	0.550	1.822	470	1.50E-03	7.26E-04	1.07E-07
79.64	1.783	0.528	1.796	622	1.10E-03	3.39E-04	3.65E-08
160.90	1.750	0.500	1.766	454	1.46E-03	2.16E-04	3.08E-08
313.19	1.706	0.462	1.728	406	1.56E-03	1.52E-04	2.32E-08
624.68	1.662	0.425	1.684	228	2.64E-03	7.41E-05	1.91E-08
1247.80	1.616	0.385	1.639	265	2.15E-03	3.91E-05	8.25E-09
2494.02	1.570	0.345	1.593	217	2.48E-03	1.95E-05	4.73E-09
1247.80	1.574	0.349	1.572				
313.19	1.592	0.365	1.583				
79.64	1.616	0.385	1.604				
21.21	1.631	0.398	1.624				
6.55	1.646	0.411	1.639				

Note:

k calculated using cv based on t₉₀ values.**SAMPLE DIMENSIONS AND PROPERTIES - FINAL**

Sample Height, cm	1.65	Unit Weight, kN/m ³	22.67
Sample Diameter, cm	6.33	Dry Unit Weight, kN/m ³	19.19
Area, cm ²	31.43	Specific Gravity, measured	2.76
Volume, cm ³	51.73	Solids Height, cm	1.167
Water Content, %	18.14	Volume of Solids, cm ³	36.67
Wet Mass, g	119.58	Volume of Voids, cm ³	15.06
Dry Mass, g	101.22		

Prepared By: LH

Golder AssociatesChecked By: 

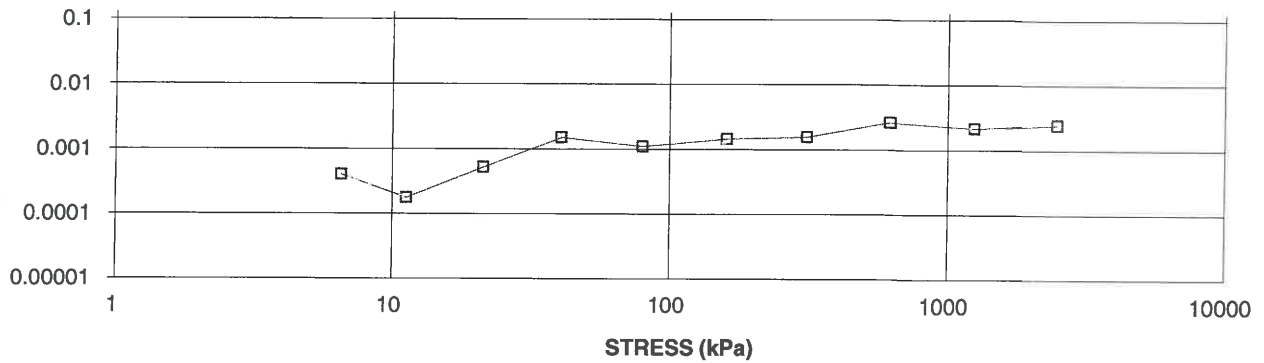
CONSOLIDATION TEST RESULTS

Clayey Silt (Upper Deposit)

FIGURE B7B

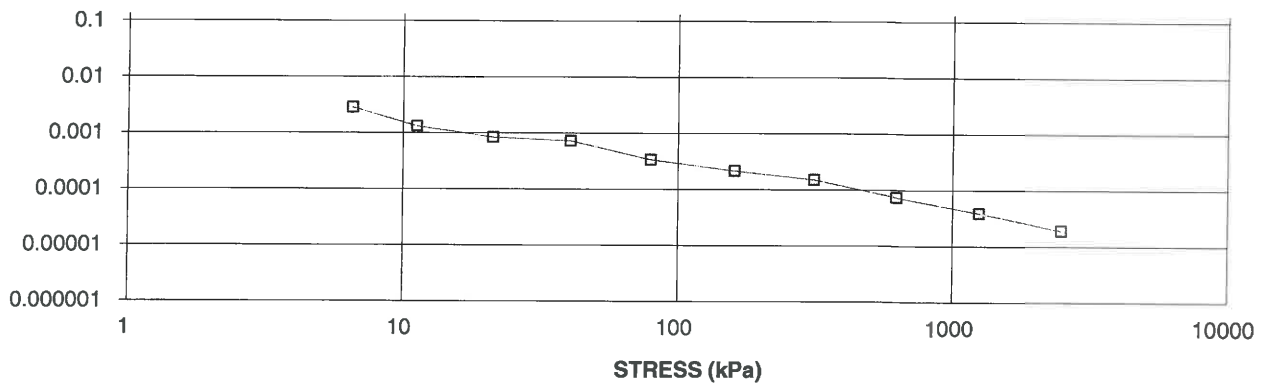
CONSOLIDATION TEST
CV cm²/s VS STRESS (kPa)
BH SC-7 SA 11

COEFFICIENT OF CONSOLIDATION,
cm²/s



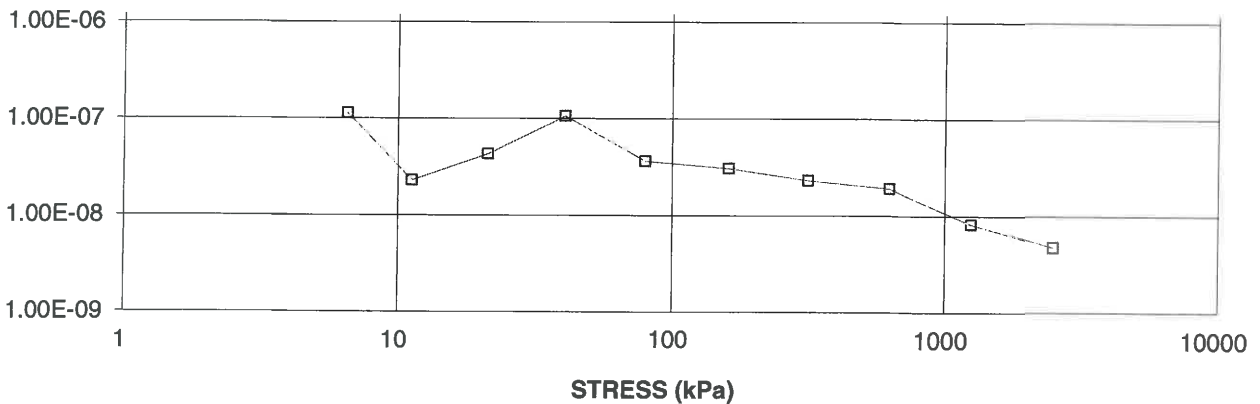
CONSOLIDATION TEST
MV m²/kN vs STRESS (kPa)
BH SC-7 SA 11

VOLUME COMPRESSIBILITY, m²/kN



CONSOLIDATION TEST
HYDRAULIC CONDUCTIVITY vs STRESS
BH SC-7 SA 11

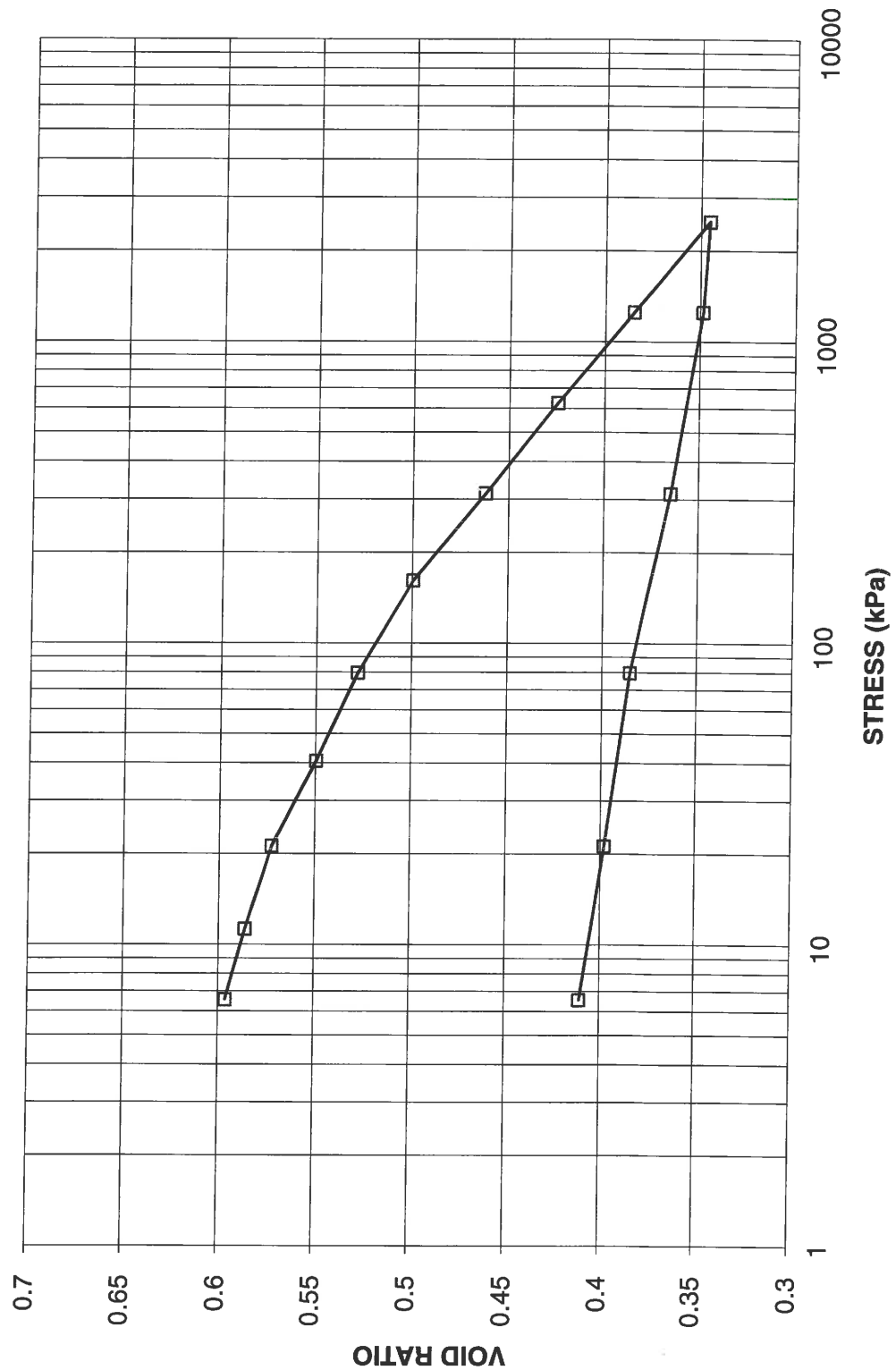
HYDRAULIC CONDUCTIVITY,
cm/s



**CONSOLIDATION TEST RESULTS
VOID RATIO VS LOG STRESS**

FIGURE B7C

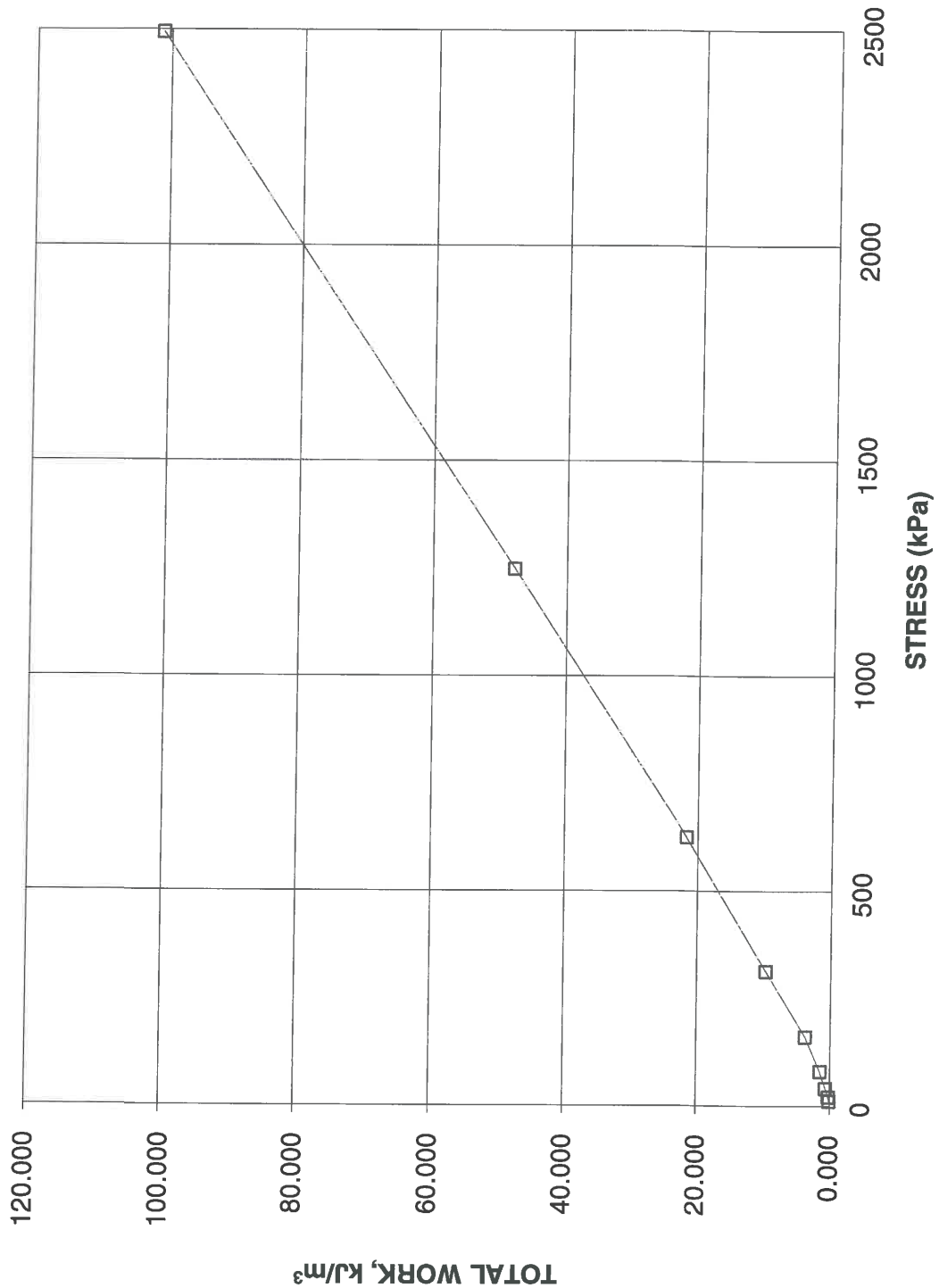
**CONSOLIDATION TEST
VOID RATIO vs STRESS
BH SC-7 SA 11**



**CONSOLIDATION TEST RESULTS
TOTAL WORK VS STRESS**

FIGURE B7D

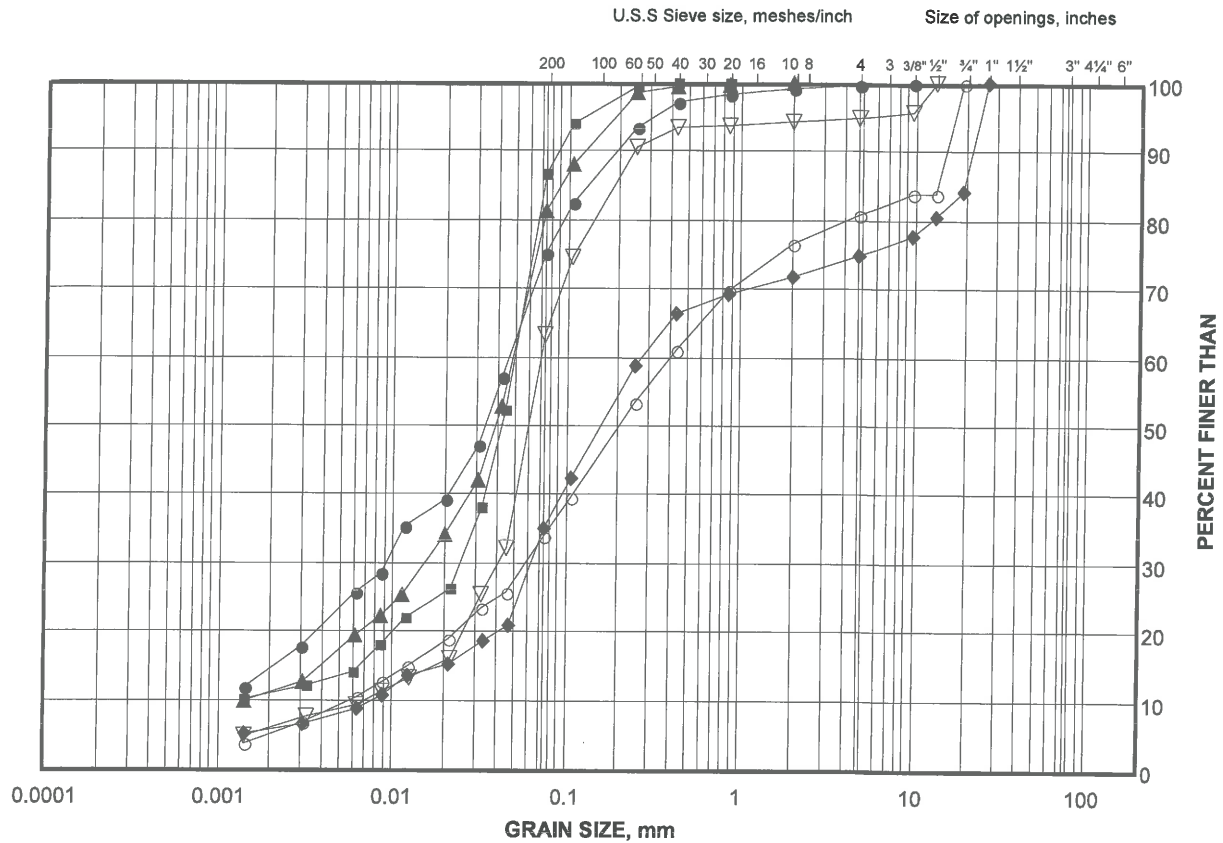
**CONSOLIDATION TEST
TOTAL WORK, kJ/m³ vs STRESS
BH SC-7 SA 11**



GRAIN SIZE DISTRIBUTION TEST RESULTS

Silty Sand to Sandy Silt Interlayers

FIGURE B8



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

LEGEND

SYMBOL	BOREHOLE	SAMPLE	ELEVATION(m)
●	SC-2	4	219.4
■	SC-9	4	218.4
◆	SC-10	5	218.8
▲	SC-4	5	217.5
▽	SC-14	5A	218.7
○	BO-9	7A	214.8

Project Number: 09-1111-0018

Checked By: *Woyce*

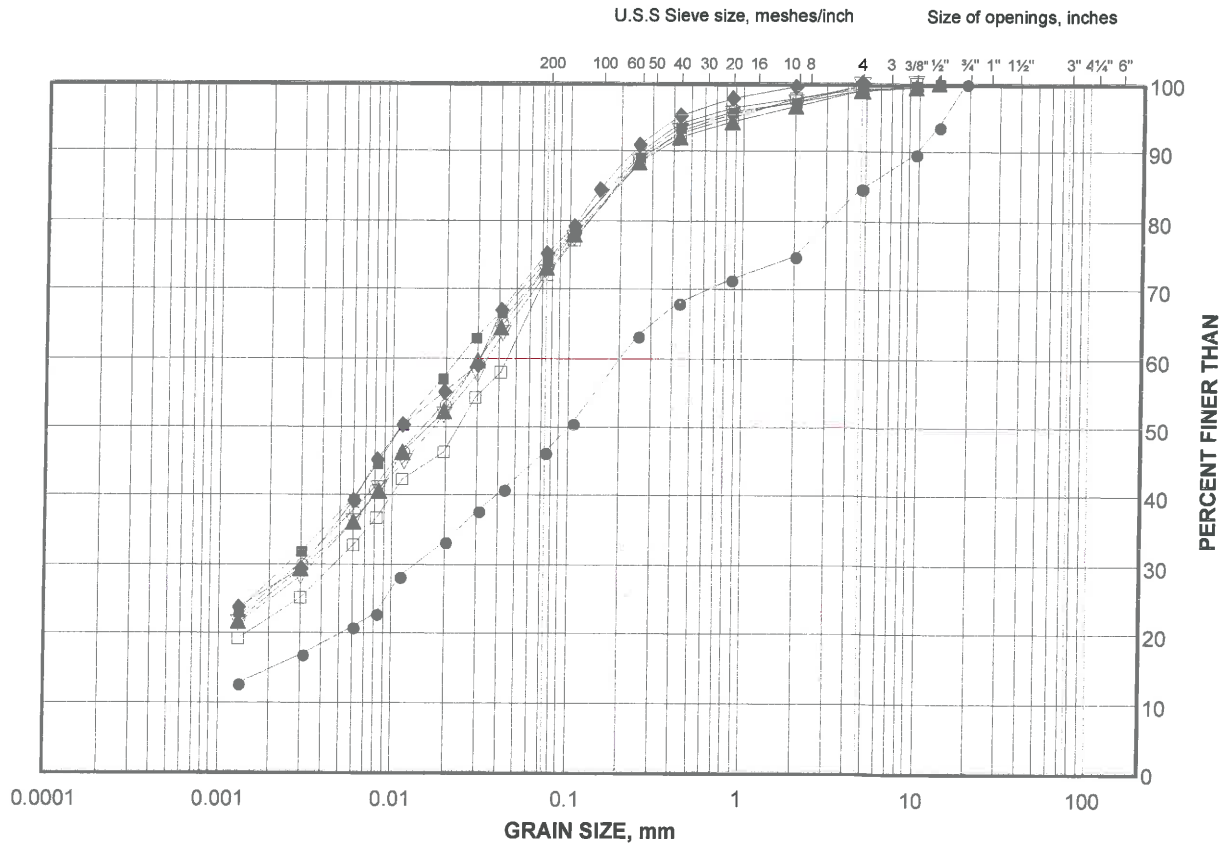
Golder Associates

Date: 08-Mar-13

GRAIN SIZE DISTRIBUTION TEST RESULTS

Clayey Silt Till to Sandy Silt to Silty Sand

FIGURE B9A



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

LEGEND

SYMBOL	BOREHOLE	SAMPLE	ELEVATION(m)
●	SC-3	10	209.2
■	SC-10	11	211.1
◆	F8-6	11	216.7
▲	SC-9	13	207.0
▽	SC-11	13	207.8
○	SC-14	13	208.0
□	SC-1	13	210.5

Project Number: 09-1111-0018

Checked By: *Wayne*

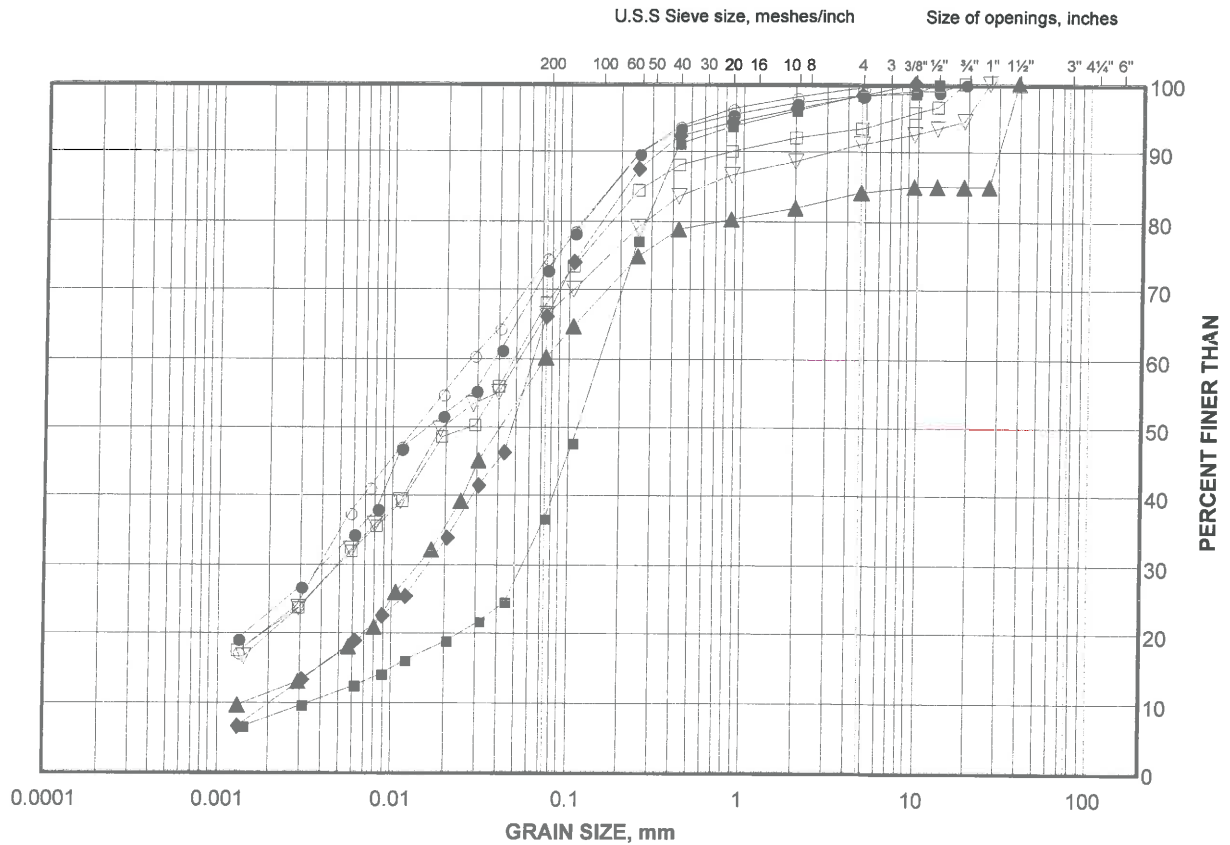
Golder Associates

Date: 08-Mar-13

GRAIN SIZE DISTRIBUTION TEST RESULTS

Clayey Silt Till to Sandy Silt to Silty Sand

FIGURE B9B



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

LEGEND

SYMBOL	BOREHOLE	SAMPLE	ELEVATION(m)
●	SC-13	14	211.9
■	SC-2	15	206.4
◆	SC-4	15	203.7
▲	SC-13	20	198.3
▽	SC-2	6	217.9
○	F8-3	7	216.1
□	SC-1	7	218.1

Project Number: 09-1111-0018

Checked By: *[Signature]*

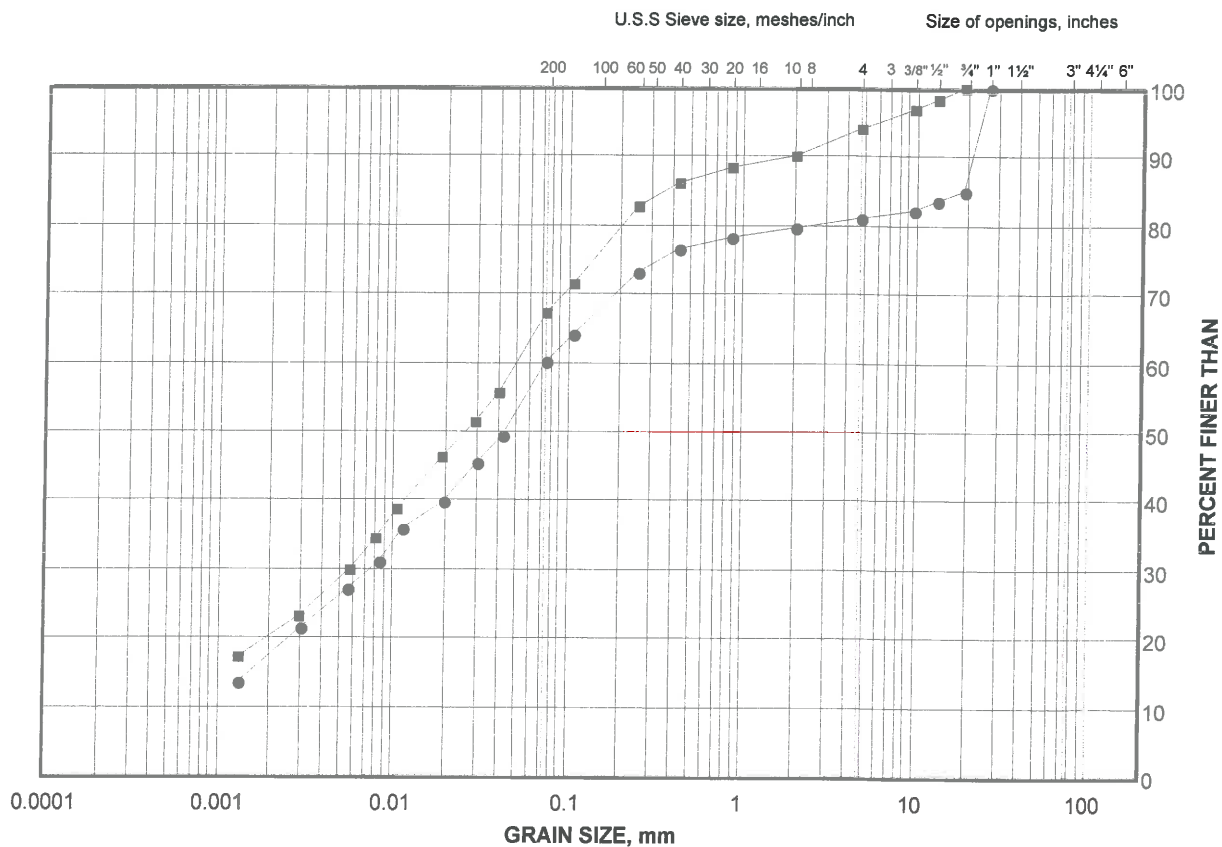
Golder Associates

Date: 08-Mar-13

GRAIN SIZE DISTRIBUTION TEST RESULTS

Clayey Silt Till to Sandy Silt to Silty Sand

FIGURE B9C



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

LEGEND

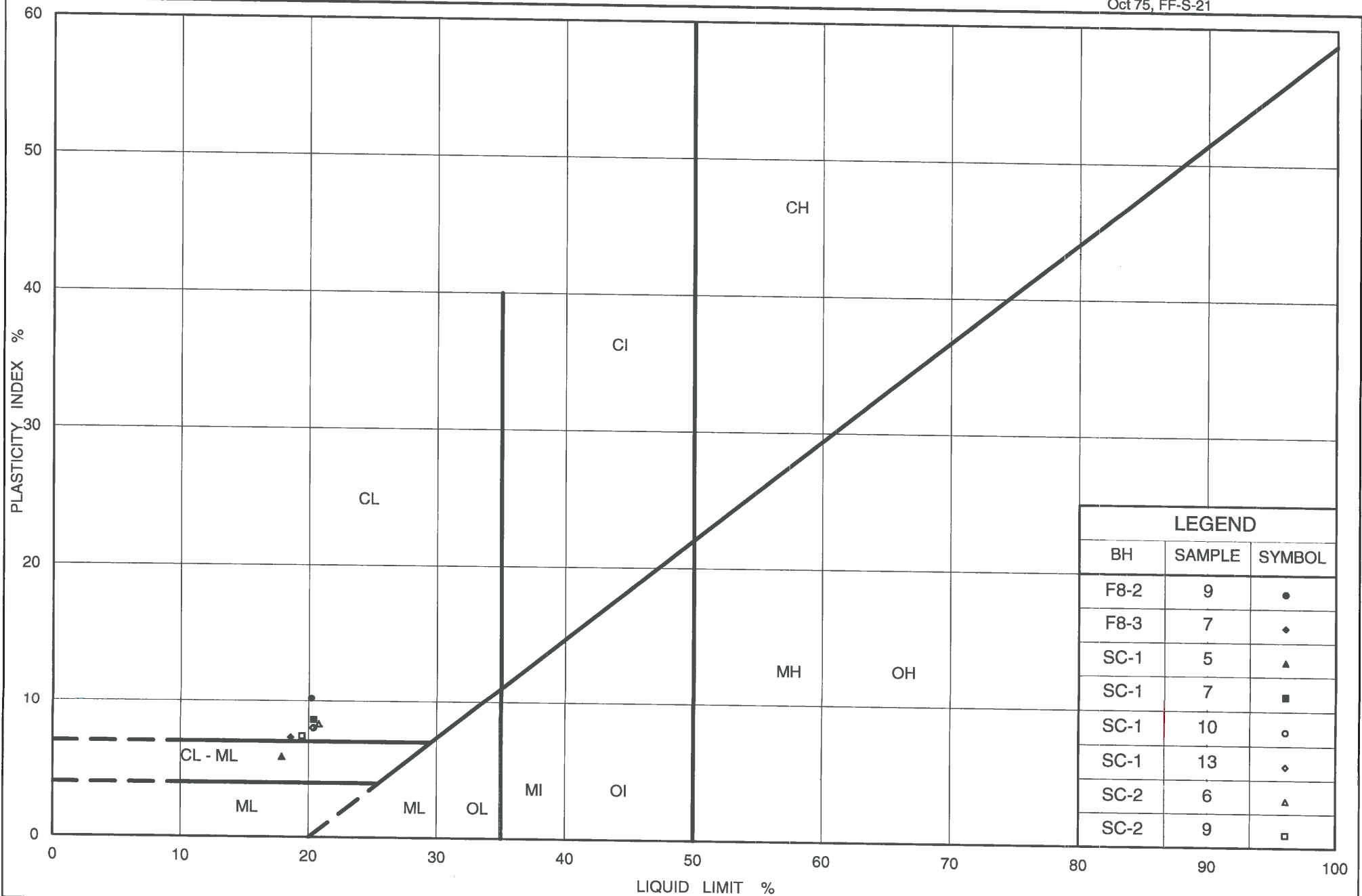
SYMBOL	BOREHOLE	SAMPLE	ELEVATION(m)
●	SC-11	8	215.4
■	F8-2	9	219.8

Project Number: 09-1111-0018

Checked By: *Wazye*

Golder Associates

Date: 08-Mar-13



Ministry of Transportation

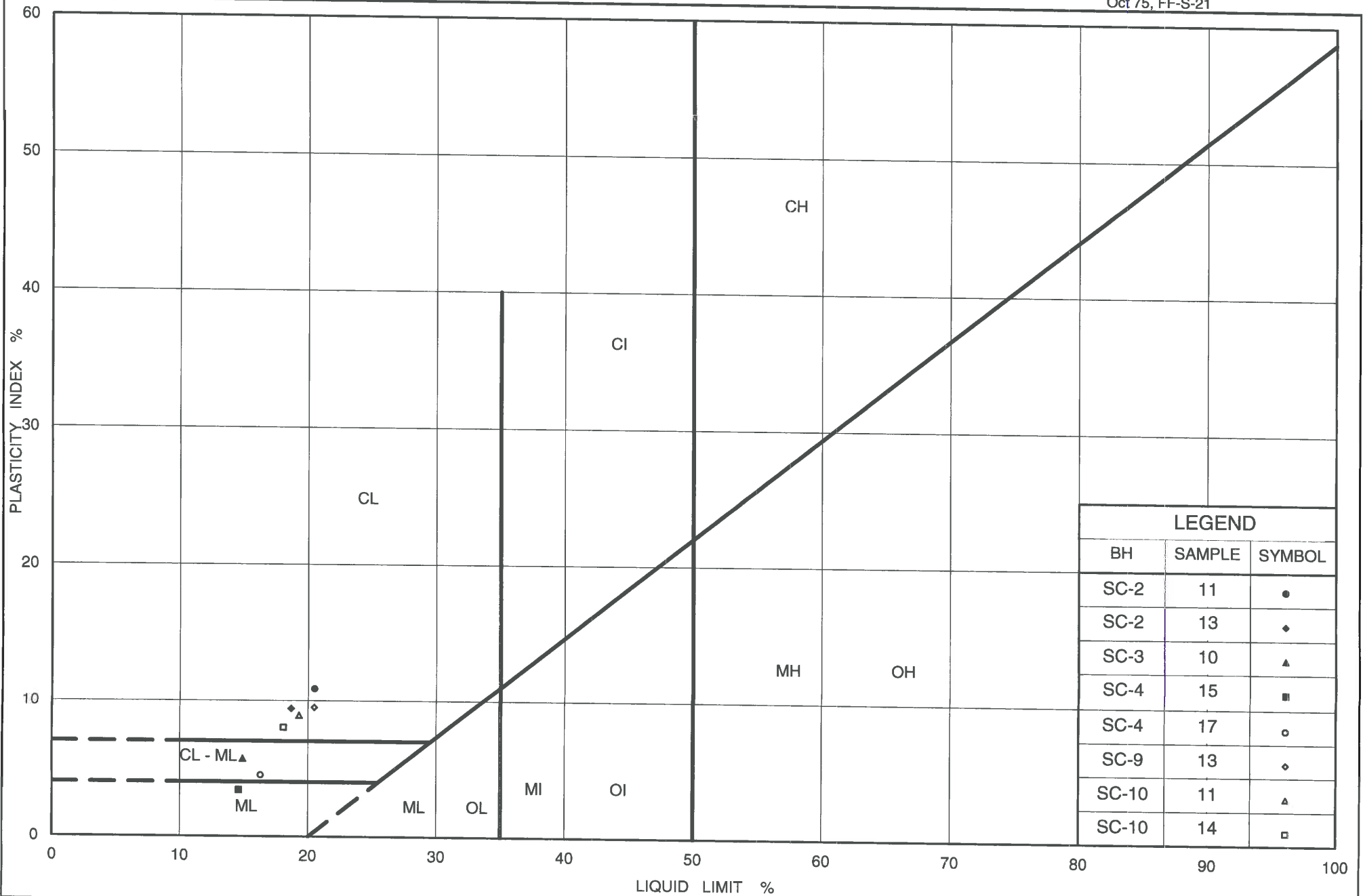
Ontario

PLASTICITY CHART Clayey Silt Till to Sandy Silt to Silty Sand Till

Figure No. B10A

Project No. 09-1111-0018

Checked By: *Wayne*



Ministry of Transportation

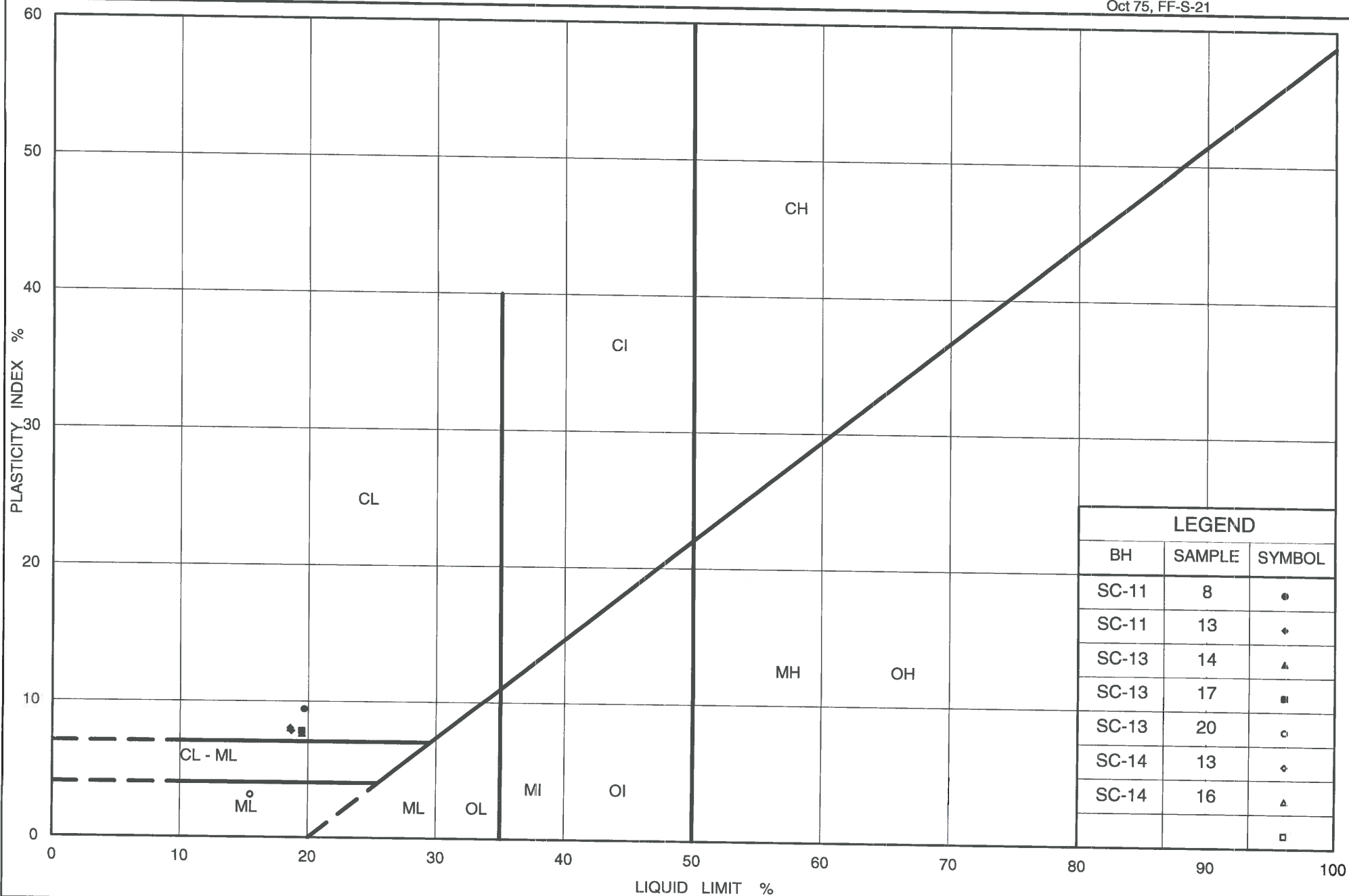
Ontario

PLASTICITY CHART Clayey Silt Till to Sandy Silt to Silty Sand Till

Figure No. B10B

Project No. 09-1111-0018

Checked By: *Wayne*



Ministry of Transportation

Ontario

PLASTICITY CHART Clayey Silt Till to Sandy Silt to Silty Sand Till

Figure No. B10C

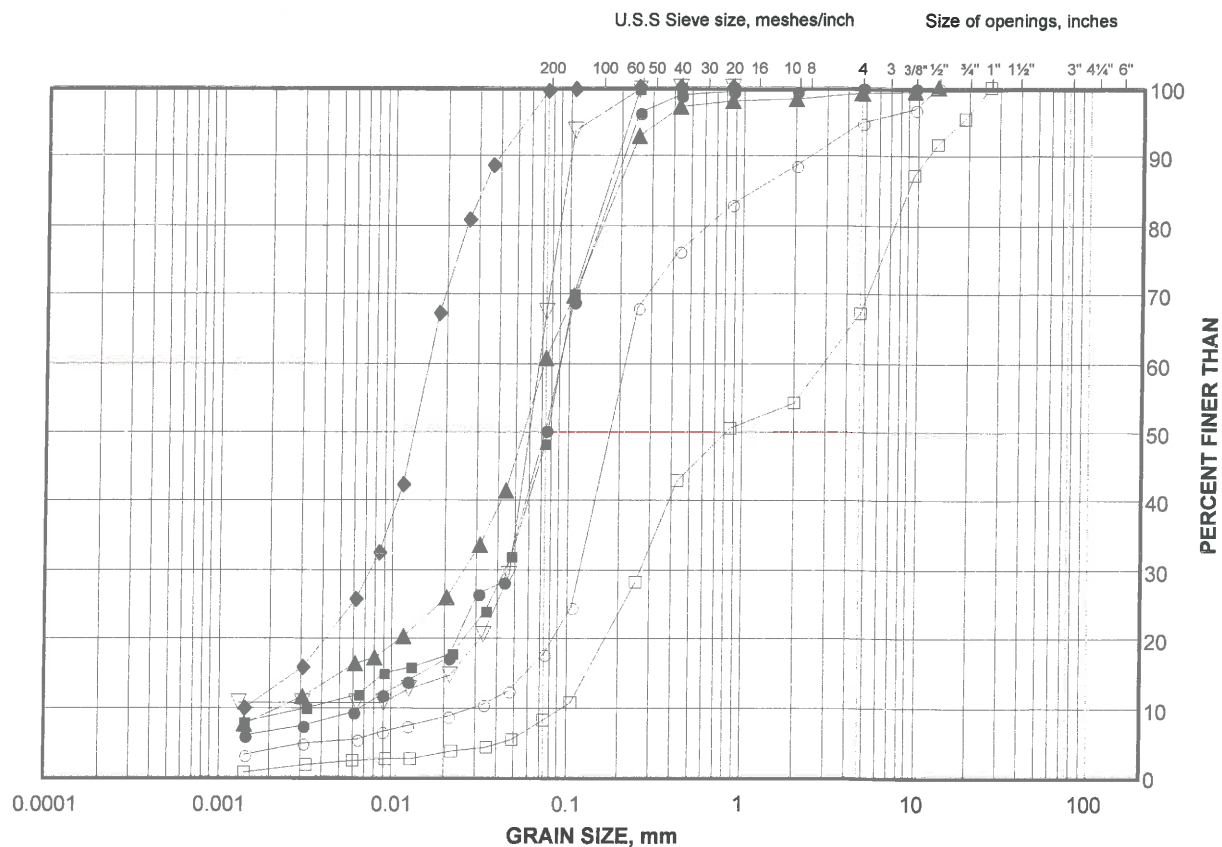
Project No. 09-1111-0018

Checked By: *Wojciech*

GRAIN SIZE DISTRIBUTION TEST RESULTS

Sand and Silt to Sand and Gravel

FIGURE B11A



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

LEGEND

SYMBOL	BOREHOLE	SAMPLE	ELEVATION(m)
●	SC-3	11	207.6
■	SC-3	13	204.6
◆	BO-9	13	204.1
▲	SC-7	14	205.3
▽	BO-9	15	202.4
○	SC-9	17	200.9
□	SC-7	17	200.7

Project Number: 09-1111-0018

Checked By: *Woye*

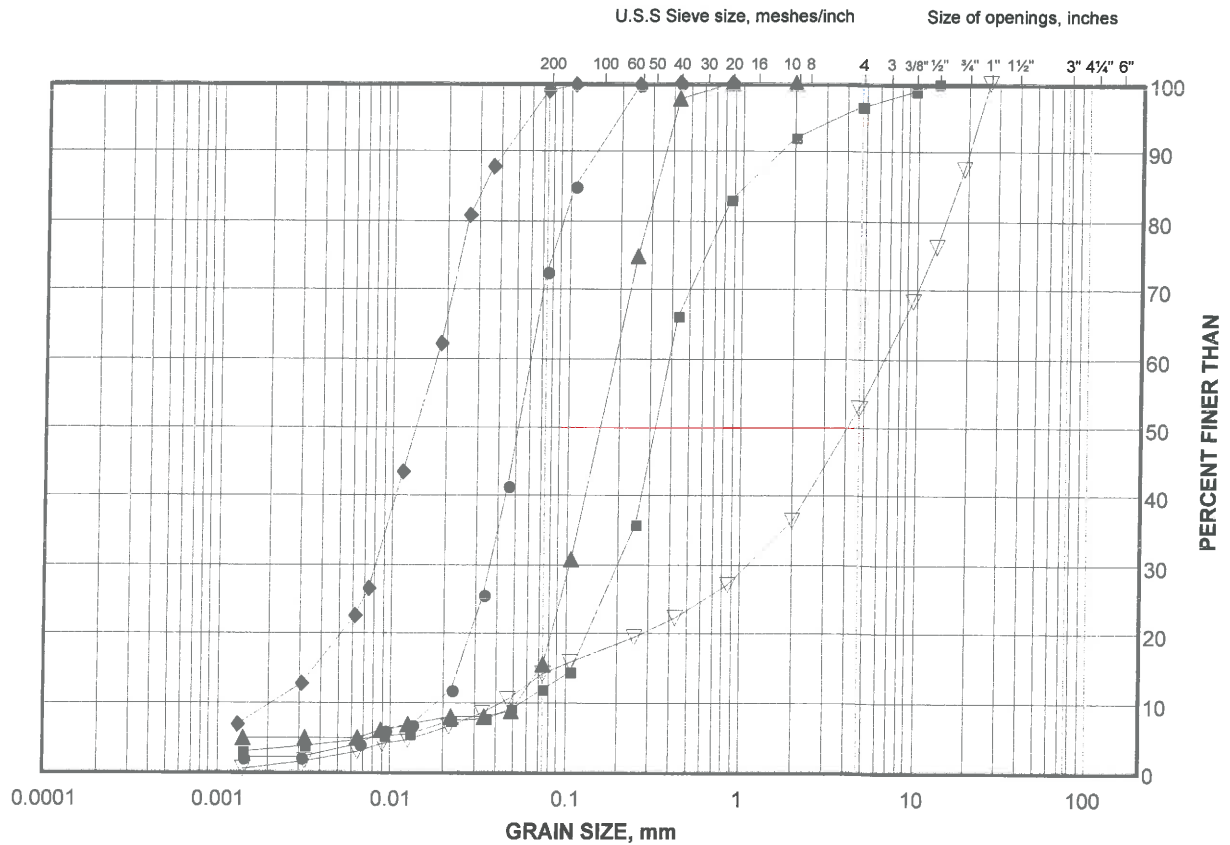
Golder Associates

Date: 08-Mar-13

GRAIN SIZE DISTRIBUTION TEST RESULTS

Sand and Silt to Sand and Gravel

FIGURE B11B



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

LEGEND

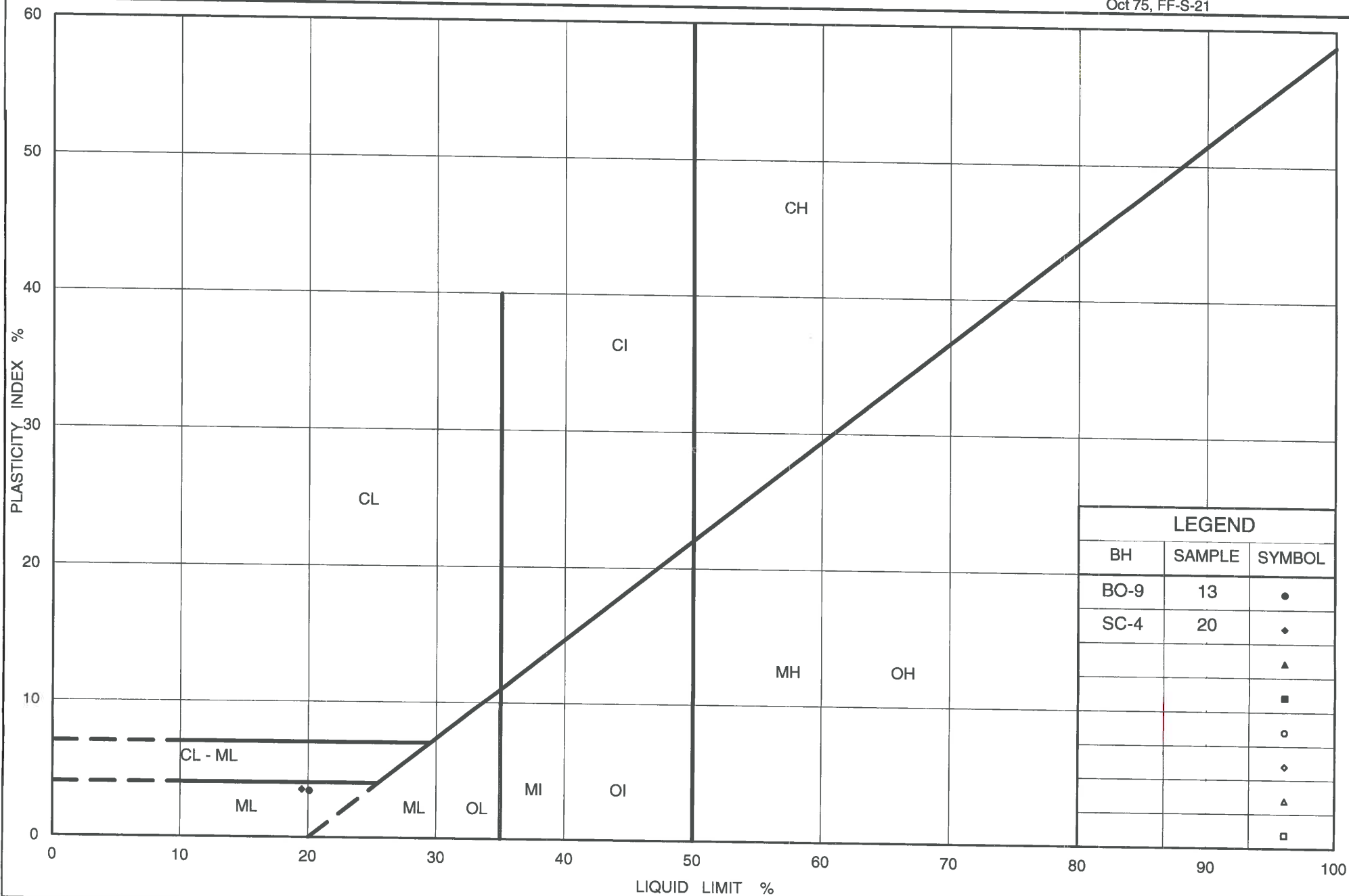
SYMBOL	BOREHOLE	SAMPLE	ELEVATION(m)
●	SC-4	18	199.2
■	SC-13	19A	201.3
◆	SC-4	20	196.1
▲	SC-7	21	194.6
▽	SC-7	27	180.9

Project Number: 09-1111-0018

Checked By: *Moze*

Golder Associates

Date: 08-Mar-13



Ministry of Transportation

Ontario

PLASTICITY CHART Silty Sand to Sand and Silt

Figure No. B12

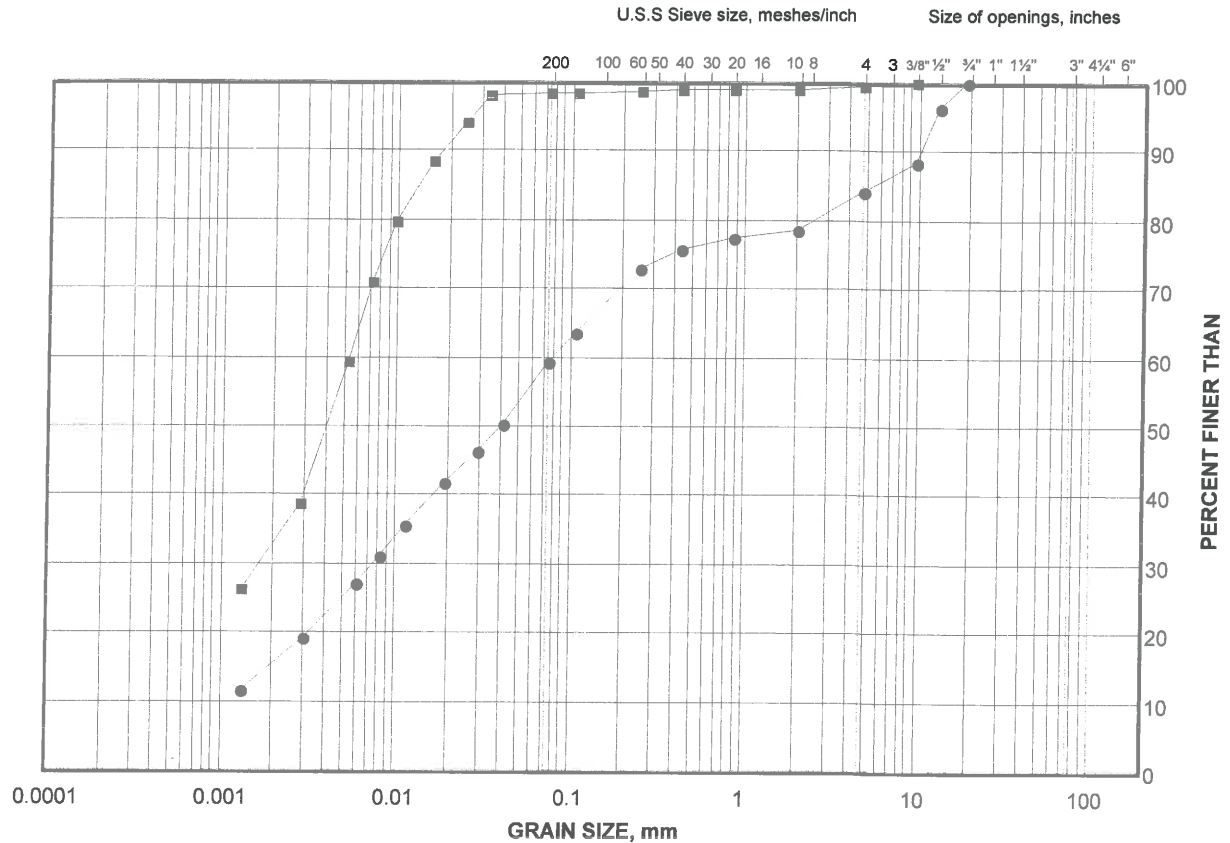
Project No. 09-1111-0018

Checked By: *Woyce*

GRAIN SIZE DISTRIBUTION TEST RESULTS

Clayey Silt Interlayers

FIGURE B13



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

LEGEND

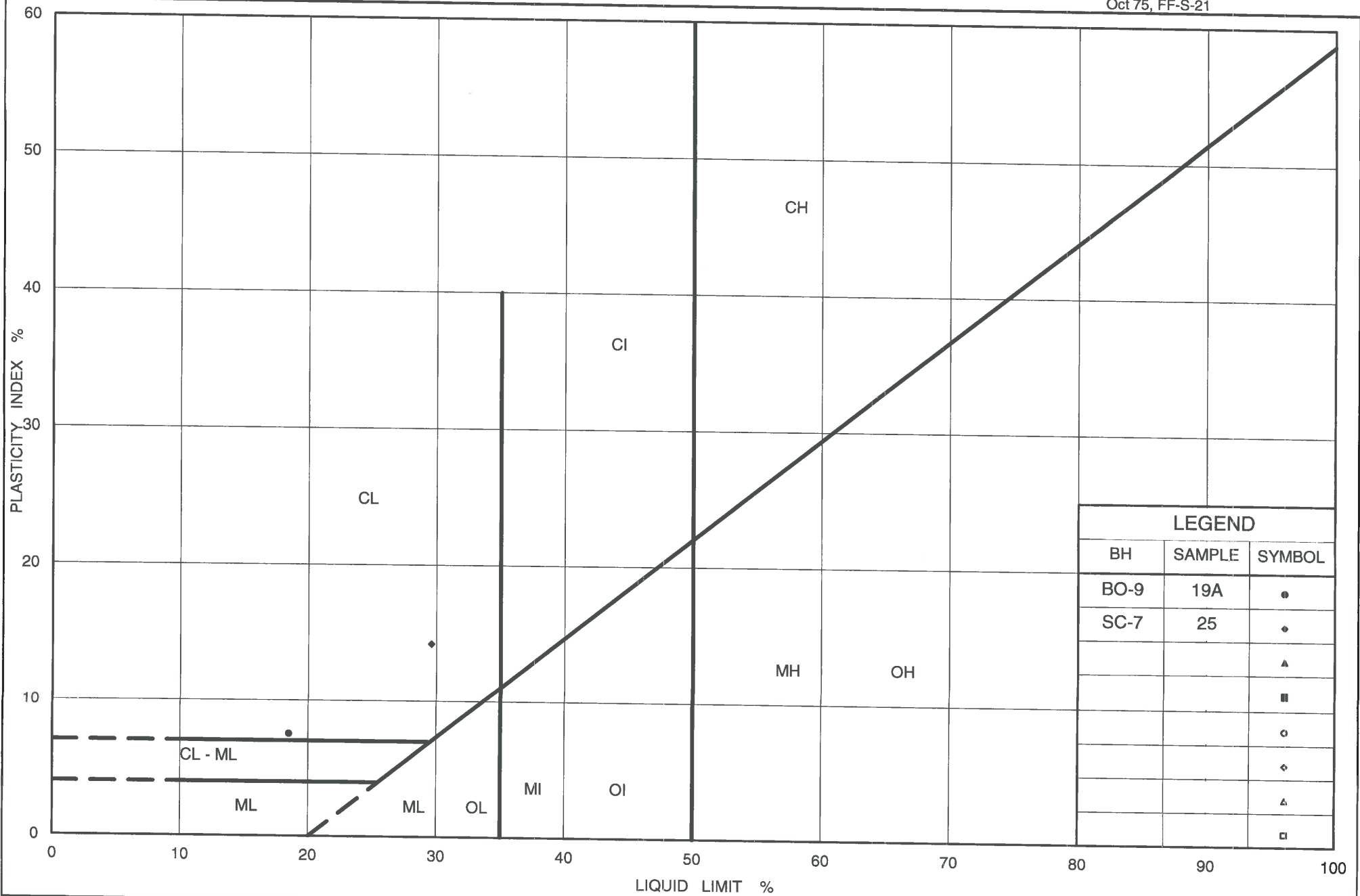
SYMBOL	BOREHOLE	SAMPLE	ELEVATION(m)
●	BO-9	19A	196.3
■	SC-7	25	186.9

Project Number: 09-1111-0018

Checked By: *Marye*

Golder Associates

Date: 08-Mar-13



Ministry of Transportation

Ontario

PLASTICITY CHART Clayey Silt Interlayers

Figure No. B14

Project No. 09-1111-0018

Checked By: *Maye*



APPENDIX C

Borehole Records from Previous Investigation

DEPARTMENT OF HIGHWAYS- ONTARIO
MATERIALS & TESTING OFFICE

RECORD OF BOREHOLE No. 1 BH 29-1

FOUNDATION SECTION

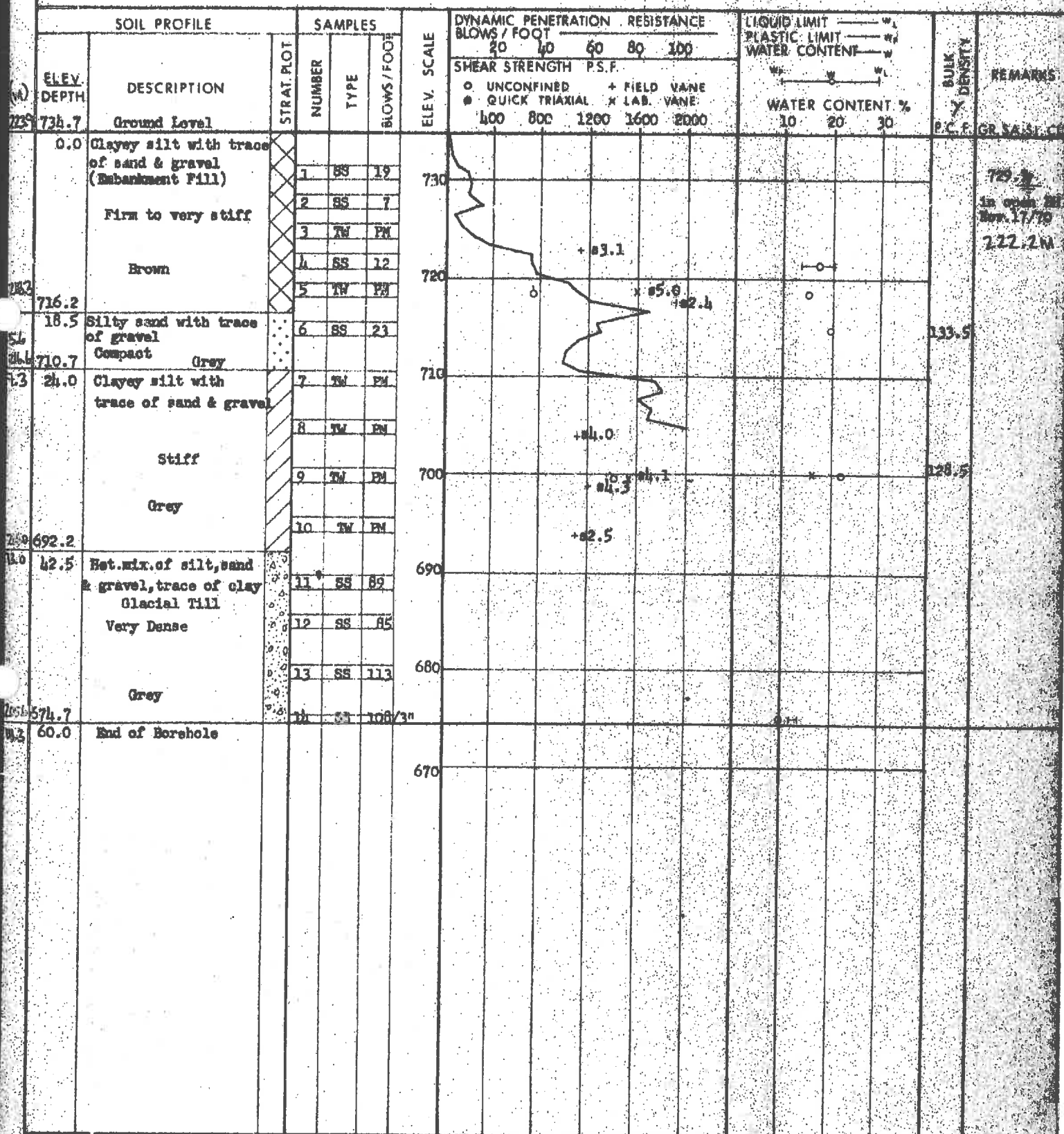
JOB 70-11089 LOCATION Sta. 587 + 10 o/s 50.5' Rt. ORIGINATED BY VK
W.P. 105-70-04 BORING DATE Nov. 12, 1970 COMPILED BY SAA
DATUM Geodetic BOREHOLE TYPE Washboring, NX Casing CHECKED BY AK

ELEV. DEPTH	SOIL PROFILE DESCRIPTION	STRAT. PLT	SAMPLES			ELEV. SCALE	DYNAMIC PENETRATION RESISTANCE BLOWS / FOOT					LIQUID LIMIT PLASTIC LIMIT WATER CONTENT			BULK DENSITY P.C.F.	REMARKS
			NUMBER	TYPE	BLOWS / FOOT		20	40	60	80	100	W _L	W _P	W		
745.9	Ground Level															
0.0	Clayey silt with trace of sand & gravel (Embankment Fill) Firm - Hard		1	SS	12	740										
			2	TV	PM											
			3	TV	PM											
			4	TV	PM											
			5	SS	32	730										
			6	SS	18											
			7	SS	31	720										
24.5 716.9	Brown															
25.3 29.0	Silty sand with trace of gravel.		8	SS	62											
24.3 712.9	Very Dense. Gray															
26.1 33.0	Clayey silt with trace of sand and gravel.		9	TV	PM	710										
			10	TV	PM											
	Stiff		11	TV	PM	700										
	Gray		12	TV	PM											
24.1 692.9																
24.1 53.0	Het. mix. of silt, sand & gravel, trace of clay (Glacial Till)		13	SS	17	690										
24.0 685.4	Dense to Very Dense Gray		14	SS	12											
24.4 60.5	End of Borehole					680										

DEPARTMENT OF HIGHWAYS - ONTARIO
MATERIALS & TESTING OFFICE

RECORD OF BOREHOLE No. 29-2

FOUNDATION SECTION

JOB 70-11089 LOCATION Sta. 587 + 07 o/s 5th Lt.
W.P. 105-70-04 BORING DATE Nov. 13, 1970
DATUM Geodetic BOREHOLE TYPE Washboring-VI CasingORIGINATED BY VK
COMPILED BY SAA
CHECKED BY725.2
in open pit
Nov. 17/70
122.2M

133.5

128.5

DEPARTMENT OF HIGHWAYS- ONTARIO
MATERIALS & TESTING OFFICE

RECORD OF BOREHOLE No. 3 BH 29-3

FOUNDATION SECTION

JOB 70-11089 LOCATION Sta. 587 + 87 O/S 59' Rt.

ORIGINATED BY VK

W.P. 105-70-04 BORING DATE Nov. 10, 1970

COMPILED BY SAA

DATUM Geodetic BOREHOLE TYPE Washboring and NX Casing

CHECKED BY

SOIL PROFILE			SAMPLES			ELEV. SCALE	DYNAMIC PENETRATION RESISTANCE					LIQUID LIMIT — w_L PLASTIC LIMIT — w_p WATER CONTENT — w			BULK DENSITY γ P.C.F.	REMARKS	
(m)	ELEV. DEPTH	DESCRIPTION	STRAT. PLOT	NUMBER	TYPE		BLOWS / FOOT					SHEAR STRENGTH P.S.F.					WATER CONTENT %
							20	40	60	80	100	UNCONFINED + FIELD VANE ● QUICK TRIAXIAL x LAB. VANE					
												400	800	1200			
210.6	727.6	Ground Level														GR SA 51 CV	
	0.0	Clayey silt with trace of sand & gravel. Stiff to Very Stiff		1	SS	11											
218.0	715.1	Brown		2	SS	19										0 10 85	
2.6	8.5	Gray		3	TV	TH									132		
				4	SS	20											
				5	SS	25											
				6	SS	25											
				7	TV	TH									129		
				8	SS	12											
210.8	691.6																
9.8	32.0	Het. mix. of silt, sand & gravel, trace of clay. Glacial Till Very Dense		9	SS	85										0 37 52 20	
				10	SS	100/4"											
104.7	678.1	Gray		11	SS	100/4"											
13.9	45.5	End of Borehole															

DEPARTMENT OF HIGHWAYS- ONTARIO
MATERIALS & TESTING OFFICE

RECORD OF BOREHOLE No. 5 BH 29-5 FOUNDATION SECTION

JOB 70-11C89 LOCATION Sta. 589 + 08 o/s 57' Rt. ORIGINATED BY TK
 W.P. 105-70-04 BORING DATE Oct. 20/70 COMPILED BY SAA
 DATUM Geodetic BOREHOLE TYPE Cont. Flight Auger CHECKED BY

(M) ELEV. DEPTH	SOIL PROFILE DESCRIPTION	STRAT. PLT	SAMPLES			ELEV. SCALE	DYNAMIC PENETRATION RESISTANCE					LIQUID LIMIT PLASTIC LIMIT WATER CONTENT			BUCK DENSITY	REMARKS
			NUMBER	TYPE	BLOWS/FOOT		20	40	60	80	100	W _L	W _P	W		
221.1 725.3	Ground Level						SHEAR STRENGTH P.S.F.					WATER CONTENT %				
							○ UNCONFINED + FIELD VANE ● QUICK TRIAXIAL x LAB. VANE					W _L ——— W _P ——— W ——— 10 20 30				
							400	800	1200	1600	2000	10	20	30	P.C.F.	GR SA SI C
0.0	Clayey silt with trace of sand & gravel & organics (Fill) Firm Brown		1	SS	1	720				x 89.8					109	0 25 65 19
219.2 719.3	Organic Clay Black Soft		2	SS	1											2.25 Org, 87.15 Org.
218.3 716.3	Clayey silt with trace of sand & gravel		2A	TW	PM											
2.7 9.0	Soft to Very Stiff Grey		3	SS	7											
			4	TW	PM	710										
			5	SS	7											
			6	SS	23											
			7	SS	17	700										
			8	TW	PM											
			9	TW	PM	690										
			10	TW	PM											
			10A	SS	8											
			11	TW	PM	680										
206.1 676.3																
14.9 49.0	Het. mix. of silt, sand & gravel, trace of clay Glacial Till Dense to Very Dense Grey		12	SS	31	670										
			13	SS	77											
			14	SS	159											
201.1 659.8																
20.0 65.5	End of Borehole		15	SS	162	660										
						650										

DEPARTMENT OF HIGHWAYS- ONTARIO
MATERIALS & TESTING OFFICE

RECORD OF BOREHOLE No. 6 BH 29-6

FOUNDATION SECTION

JOB 70-11089 LOCATION Sta. 589 + 15 o/s 54.5' Lt. ORIGINATED BY VK
 W.P. 105-70-04 BORING DATE Nov. 19/70 COMPILED BY SAA
 DATUM Geodetic BOREHOLE TYPE Washboring-MI Casing CHECKED BY *fr*

(W)	SOIL PROFILE			STRAT. PLOT	SAMPLES			ELEV. SCALE	DYNAMIC PENETRATION RESISTANCE					LIQUID LIMIT — w_L PLASTIC LIMIT — w_p WATER CONTENT — w			BULK DENSITY γ	REMARKS																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																														
	ELEV. DEPTH	DESCRIPTION	NUMBER		TYPE	BLOWS/FOOT	BLOWS / FOOT					SHEAR STRENGTH P.S.F.			WATER CONTENT %																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																	
							20		40	60	80	100	UNCONFINED			FIELD VANE			QUICK TRIAXIAL			LAB. VANE																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																										
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225.8	740.9	Ground Level																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																														</

DEPARTMENT OF HIGHWAYS- ONTARIO
MATERIALS & TESTING OFFICE

RECORD OF BOREHOLE No. 8 3H29-8

FOUNDATION SECTION

JOB 70-11089 LOCATION Sta. 588 + 48 o/s 2' Lt. ORIGINATED BY VK
 W.P. 105-70-04 BORING DATE Oct. 21/70 COMPILED BY 844
 DATUM Geodetic BOREHOLE TYPE Cont. Flight Auger CHECKED BY 844

SOIL PROFILE			SAMPLES			ELEV. SCALE	DYNAMIC PENETRATION RESISTANCE BLOWS / FOOT					LIQUID LIMIT — w_L PLASTIC LIMIT — w_p WATER CONTENT — w			BULK DENSITY Y P.C.F.	REMARKS	
ELEV. DEPTH	DESCRIPTION	STRAT. PLOT	NUMBER	TYPE	BLOWS / FOOT		20	40	60	80	100	WATER CONTENT % 10 20 30					
							SHEAR STRENGTH P.S.F.										
							○ UNCONFINED + FIELD VANE ● QUICK TRIAXIAL x LAB. VANE										
(M)							400	800	1200	1600	2000						
221.1	725.5	Ground Level															
	0.0	Sandy silt, trace of organics		1	SS	11						82.6			Nov. 17/70		
		Loose to compact		2	SS	7									720.8		
218.4	716.5	Brown		3	SS	8									0.21.69.10		
2.7	9.0	Clayey silt with trace of sand & gravel		4	TW	PH									0.1.87.12		
				5	TW	PH											
		Soft to Stiff		6	TW	PH											
		Grey		7	SS	27											
				8	TW	PH											
				9	TW	PH											
				10	TW	PH											
				11	TW	PH											
206.2	676.5			12	SS	14.5											
14.9	49.0	Het. mix. of silt, sand & gravel, trace of clay - Glacial Till		13	SS	30											
				14	SS	100/3"											
200.9	659.0	Dense to Very Dense Grey		15	SS	100/5"											
20.3	66.5	End of Borehole															

DEPARTMENT OF HIGHWAYS - ONTARIO
MATERIALS & TESTING OFFICERECORD OF BOREHOLE No. 9 *299*

FOUNDATION SECTION

JOB 70-11089 LOCATION 587 + 08 o/s 111' Rt.
W.P. 105-70-04 BORING DATE Nov. 18, 1970
DATUM Geodetic BOREHOLE TYPE Washboring-NK CasingORIGINATED BY VE
COMPILED BY SAA
CHECKED BY MR

SOIL PROFILE			SAMPLES			ELEV. SCALE	DYNAMIC PENETRATION RESISTANCE BLOWS / FOOT					LIQUID LIMIT w_L PLASTIC LIMIT w_p WATER CONTENT w			BULK DENSITY γ	REMARKS
ELEV. DEPTH	DESCRIPTION	STRAT. PLOT	NUMBER	TYPE	BLOWS / FOOT		20	40	60	80	100	w_p	w	w_L		
224.1 725.4	Ground Level															
0.0	Clayey silt with trace of sand & gravel and organic		1	TW	FM											
	Firm to very stiff		2	TW	FM											
	Brown - Grey		3	SS	17											
			4	SS	21											
			5	SS	19											
			6	SS	28											
224.1 702.4																
4.0 23.0	End of Borehole															

20
10-5 % STRAIN AT FAILURE
10

At Golder Associates we strive to be the most respected global company providing consulting, design, and construction services in earth, environment, and related areas of energy. Employee owned since our formation in 1960, our focus, unique culture and operating environment offer opportunities and the freedom to excel, which attracts the leading specialists in our fields. Golder professionals take the time to build an understanding of client needs and of the specific environments in which they operate. We continue to expand our technical capabilities and have experienced steady growth with employees who operate from offices located throughout Africa, Asia, Australasia, Europe, North America, and South America.

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