



Terraprobe

*Consulting Geotechnical & Environmental Engineering
Construction Materials Inspection & Testing*

**FOUNDATION INVESTIGATION REPORT
CROW CREEK BRIDGE REPLACEMENT
HIGHWAY 11, 3.7 KM WEST OF LOWTHER
G.W.P. No. 5233-06-00, W.P. 5147-05-01, SITE 39W-055
GEOCRES No. 42G-35
MINISTRY OF TRANSPORTATION, ONTARIO
NORTHEASTERN REGION**

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File No. 11-10-5076
May 22, 2012

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Appendix B	Laboratory Test Results
Appendix C	Drawings titled “Borehole Locations and Soil Strata”



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PART 1: FACTUAL INFORMATION**

1 INTRODUCTION

This report presents the factual findings obtained from foundation investigations conducted at the Crow Creek Bridge site where a bridge replacement and a detour structure are proposed. The site is located on Highway 11, 3.7 km west of Lowther in the Township of McCrea; District of Cochrane, Ontario.

The purpose of this investigation was to explore the subsurface conditions at this site and, based on the data obtained, to provide borehole location plans, records of boreholes, stratigraphic profiles, laboratory test results and descriptions of the subsurface conditions. Models of the subsurface conditions were developed from the data obtained.

Terraprobe conducted the investigation as a sub-consultant to McCormick Rankin, a Member of MMM Group Ltd., (MRC) under the Ministry of Transportation Ontario (MTO) Northeastern Region Assignment Number 5009-E-0020.

The results of a preliminary foundation investigation carried out at the site were presented in the following report:

- Preliminary Foundation Investigation & Design Report, Crow Creek Bridge Replacement, Highway 11, 3.7 km West of Lowther, G.W.P. No. 5233-06-00, W.P. 5147-05-01, Site 39W-055, Geocres No. 42G-33, dated March 02, 2011.

This report contains information from the above referenced report as well as additional subsurface information that has been subsequently obtained.

A Pavement Design Report which addressed pavement widening and the detour pavement requirements at this site are reported under separate cover.

2 SITE DESCRIPTION & PHYSIOGRAPHY

Highway 11 crosses Crow Creek via an 11.7 m wide five span timber bridge measuring about 23 m in length. At this site Highway 11 is a two-lane highway with fully paved shoulders carrying east



and west bound traffic. A CN Railway track runs parallel to Highway 11 and is located approximately 45 m south of Highway 11 centre line.

Crow Creek flows from north to south meandering gently within a well-defined flood plain. The terrain is generally flat and within the flood plain area vegetation consists primarily of grass, shrubs and occasional small trees. Beyond the flood plain the area is vegetated with mature stands of deciduous and coniferous trees.

The study area is located in northeastern Ontario. Recent deposits consist of peat, gravel, sand, clay and till soils. The area is underlain by supracrustal rocks composed of metavolcanics, their intrusive equivalents and metasediments of Precambrian age.

3 SITE INVESTIGATION AND FIELD TESTING

The site investigation and field testing for this project was carried out in two phases. Four boreholes, designated as C1 to C4 inclusive were drilled at the preliminary design stage between July 27 and August 6, 2010. Boreholes C1 and C2 were drilled at the existing bridge site and Boreholes C3 and C4 were drilled at the site of the proposed detour structure. The second phase of the investigation was carried out between October 6 and November 8, 2011 and consisted of drilling and sampling six additional boreholes, designated CD1 to CD6 inclusive. Boreholes CD1 and CD2 were drilled at the existing bridge and boreholes CD3 and CD4 were drilled in the approaches to the existing bridge. Boreholes CD5 and CD6 were drilled in the approaches to the temporary bridge. The locations of the boreholes are shown on the attached Borehole Locations and Soil Strata Drawing in Appendix C.

Samples of the overburden soils were obtained at selected intervals using a split spoon sampler in conjunction with Standard Penetration Testing (SPT), as specified in ASTM Method D1586. In the cohesive deposits the undrained shear strength of the soil was measured in-situ by means of field vane tests using an MTO type field vane. Relatively undisturbed soil samples were also collected with thin-walled Shelby Tube samplers. The boreholes at the abutments were also advanced into bedrock using NQ size diamond coring techniques.

The ground water conditions in the open boreholes were observed throughout the drilling operations. The boreholes were also instrumented with standpipe piezometers consisting of 25 mm diameter PVC pipe with a slotted screen enclosed in sand to permit longer term ground water level monitoring. The locations and completion details of the piezometers are summarized in Table 3.1. The piezometers were decommissioned between April 26 and 30, 2012.

The drilling, sampling and coring operations were observed on a full time basis by a member of Terraprobe's technical staff who logged the boreholes and rock cores and prepared the recovered soil and rock samples for transport to Terraprobe's Brampton laboratory for further examination and testing.



Table 3.1 – Piezometer Installation Details

Piezometer Location	Piezometer Details	
	Tip Depth/ Elevation (m)	Completion Details
C1	27.4/214.2	Piezometer with 1.5 m slotted screen installed with filter sand to 25.6 m, bentonite seal from 25.6 m to 0.6 m and a concrete encased flush mount cover from 0.6 m to ground surface.
C2	21.0/220.6	Piezometer with 1.5 m slotted screen installed with filter sand to 18.9 m, bentonite seal from 18.9 m to 6.1 m, drill cuttings from 6.1 m to 0.6 m and a concrete encased flush mount cover from 0.6 m to ground surface.
C3	25.8/214.0	Piezometer with 1.5 m slotted screen installed with filter sand to 24.0 m and bentonite seal from 24.0 m to ground surface.
C4	22.9/217.1	Piezometer with 1.5 m slotted screen installed with filter sand to 21.1 m, bentonite seal from 21.1 m to 7.7 m and drill cuttings from 7.7 m to ground surface.
CD1	18.3/223.4	Piezometer with 3.0 m slotted screen installed with filter sand to 14.6 m, bentonite seal from 14.6 m to 14.0 m, drill cuttings from 14.0 m to 0.6 m and a concrete encased flush mount cover from 0.6 m to ground surface.
CD2	20.7/220.9	Piezometer with 3.0 m slotted screen installed with filter sand to 17.1 m, bentonite seal from 17.1 m to 16.5 m, drill cuttings from 16.5 m to 0.6 m and a concrete encased flush mount cover from 0.6 m to ground surface.
CD3	9.1/232.5	Piezometer with 3.0 m slotted screen installed with filter sand to 5.5 m, bentonite seal from 5.5 m to 4.9 m, drill cuttings from 4.9 m to 0.6 m and a concrete encased flush mount cover from 0.6 m to ground surface.
CD4	11.3/230.3	Piezometer with 3.0 m slotted screen installed with filter sand to 7.6 m, bentonite seal from 7.6 m to 0.3 m and a concrete encased flush mount cover from 0.3 m to ground surface.
CD5	7.9/230.7	Piezometer with 3.0 m slotted screen installed with filter sand to 4.3 m, bentonite seal from 4.3 m to 3.7 m, drill cuttings from 3.7 m to 0.6 m and bentonite seal from 0.6 m to ground surface.
CD6	9.4/229.3	Piezometer with 3.0 m slotted screen installed with filter sand to 5.8 m, bentonite seal from 5.8 m to 5.2 m, drill cuttings from 5.2 m to 0.6 m and bentonite seal from 0.6 m to ground surface.

4 LABORATORY TESTING

The recovered soil samples were subjected to Visual Identification (VI) and water content determination. Selected samples were also subjected to a laboratory testing programme consisting of gradation analysis, Atterberg Limits tests, consolidation tests, unit weight and undrained shear strength testing with a laboratory vane. The results of this testing program are shown on the Record of Borehole sheets in Appendix A and on the figures in Appendix B.

5 DESCRIPTION OF SUBSURFACE CONDITIONS

Reference is made to the Record of Borehole sheets in Appendix A. Details of the encountered soil and rock stratigraphy are presented in Appendix A on the “Borehole Locations and Soil Strata” drawings in Appendix C. The stratigraphic boundaries shown have been inferred from non-continuous samples and observations of drilling resistance and typically represent a transition from one soil or rock type to another. These boundaries should not be interpreted to represent exact



planes of geological change. The subsurface conditions are confirmed at the borehole locations only, and will vary between and beyond the locations investigated. The following discussion has been simplified in terms of the major soil strata.

5.1 Existing Bridge Site (Boreholes C1, C2, CD1, CD2, CD3 & CD4)

In general, the site was underlain by flexible pavement (asphalt and sand and gravel), sand fill and deposits of sand and silt to silt, clayey silt to silty clay, and glacial till. The overburden was underlain by bedrock consisting of metamorphic phyllite and igneous granitoid.

5.1.1 Flexible Pavement/Gravel Shoulder

A flexible pavement comprising of 150 mm to 200 mm thick of asphalt underlain by a layer of sand and gravel ranging in thickness from 130 mm to 250 mm was encountered in Boreholes C1, C2, CD1, CD2 and CD3. Borehole CD4 was drilled through the road shoulder and encountered a layer of sand and gravel fill approximately 450 mm thick. The granular fill extended to elevations ranging from 241.1 m to 241.3 m and was inferred to be in a compact state.

5.1.2 Fill – Sand

Fill consisting of sand, trace silt, trace gravel was encountered beneath the pavement and to depths of 1.4 m (Elev. 240.2 m) and 2.1 m (Elev. 239.5 m) below the existing ground surface.

The grain size distribution plots of samples of the sand fill recovered from the boreholes are presented in Figure B1-1. These results show a grain size distribution consisting about of 0-5% gravel, 87-95% sand and 5-8% silt and clay size particles.

‘N’ values in the range of 6 to 29 blows for 0.3 m were determined in the standard penetration testing carried out in the sand fill, inferring a loose to compact relative density. The water content of samples of the sand fill ranged from 2% to 14% by weight.

5.1.3 Sand and Silt to Silt

A near surface deposit ranging in composition from sand and silt to silt was encountered in all of the boreholes extending to depths ranging from 2.9 m (Elev. 238.8 m) to 3.7 m (Elev. 237.9 m) below ground surface.

The results of grain size distribution analysis of samples recovered from this deposit are shown in Figure B1-2. These results show a grain size distribution consisting of 11-44% sand, 44-71% silt and 10-18% clay size particles.

The N values determined in this deposit ranged from 4 to 13 blows per 0.3 m indicating a loose to compact relative density. The moisture content of samples from this stratum ranged from 14% to 19%.

5.1.4 Clayey Silt to Silty Clay

A clayey silt to silty clay deposit was encountered beneath the fill and surficial sands and silts and to depths ranging from 8.2 m (Elev. 233.4 m) to 9.8 m (Elev. 231.8 m) below ground surface.



The grain size distribution curves of samples of the clayey silt to silty clay are presented in Figures B1-3 and B1-4. These results show a grain size distribution consisting of 0-3% gravel, 1-17% sand, 44-75% silt and 21-53% clay size particles.

Samples were also subjected to Atterberg Limits tests and the results are shown on the plasticity chart, Figures B1-5 and B1-6. The index values from these tests are summarized below:

Liquid Limit:	21-30%
Plastic Limit:	12-21%
Plasticity Index:	4-12%
Natural Moisture Content:	12-38%

These values indicate low plasticity clayey silt to silty clay soils.

The N values determined in the clayey silt to silty clay ranged from 2 to 14 blows for 0.3 m penetration. Field vane shear tests indicated undrained shear strengths ranging from 20 kPa to 88 kPa. These values indicate that the consistency of the clayey silt to silty clay was generally firm to stiff with infrequent soft zones. The natural moisture content of samples of the clayey silt to silty clay ranged from 12% to 43%.

5.1.5 Sand and Silt Till

A deposit of sand and silt till was encountered beneath the clayey silt to silty clay. These till strata were fully penetrated in some of the boreholes at depths ranging from 14.6 m to 17.6 m below ground surface or at elevations ranging from 227.1 m to 224.0 m. The approach boreholes were terminated in this deposit at depths of 10.5 m (Elev. 231.1 m) and 12.4 m (Elev. 229.2 m).

The results of grain size distribution tests carried out on samples obtained from the sand and silt till are shown in Figure B1-7. These results show grain size distributions consisting of 0-17% gravel, 37-50% sand, 35-55% silt and 4-12% clay size particles. The high penetration resistance and the resistance to auger advance observed in the boreholes were indications of the presence of cobbles and boulders in this soil matrix.

The N values in the sand and silt till ranged from 19 to more than 100 blows per 0.3 m, indicating a compact to very dense relative density. The natural water content of samples of the till ranged from 1% to 16% by weight.

5.1.6 Clayey Silt Till

A clayey silt till deposit was encountered beneath the sand and silt till and overlying the bedrock surface in boreholes C1, C2 and CD1 and CD2. The clayey silt till extended to depths ranging from 22.5 m (Elev. 219.1 m) to 28.0 m (Elev. 213.6 m) below ground surface.

The grain size distribution plots of samples of the clayey silt till deposit are presented in Figure B1-8. These results show a grain size distribution consisting of 1-9% gravel, 20-36% sand, 44-64% silt and 11-23% clay size particles. Cobbles and boulders were also thought to have been encountered in the clayey silt till.



The results of Atterberg Limits determinations on samples of the clayey silt till are presented in Figure B1-9 and summarized below:

Liquid Limit:	15-22%
Plastic Limit:	11-17%
Plasticity Index:	3-10%
Natural Moisture Content:	8-12%

These values indicate that the clayey silt till was of relatively low plasticity.

The N values in the clayey silt till ranged from 60 to more than 100 blows for 0.3 m penetration indicating a hard consistency. The natural water content of samples of the clayey silt till was in the range of 7% to 12%.

5.1.7 Bedrock

The overburden described above was underlain by metamorphic phyllite and igneous granitoid bedrock. Bedrock was proved by coring at the abutment locations and the bedrock depth and elevations to the top of bedrock are summarized in Table 5.1.

Table 5.1 – Depth to Bedrock

BH No.	Depth to Bedrock (m)	Top of Bedrock Elevation (m)
C1	28.0	213.6
C2	22.5	219.1
CD1	23.5	218.2
CD2	26.4	215.2

In Borehole CD1 the phyllite bedrock has been described as moderately to highly weathered and unweathered in the Boreholes C1, C2 and CD2. The phyllite bedrock had sub-vertical foliations and was generally grey to dark grey in colour. Total core recovery in this bedrock ranged from 72% to 100% and the RQD values ranged from 0% to 100% however the RQD values were typically above 50%. Based on these results the rock quality is considered to be fair to good with occasional zones of very poor to poor quality rock.

5.2 Detour Structure (Boreholes C3, C4, CD5 & CD6)

In general, the site was underlain by topsoil, peat, silty clay fill and native deposits of clayey silt to silty clay, sandy silt till and clayey silt till. The overburden soils were underlain by bedrock consisting of phyllite.

5.2.1 Topsoil and Peat

A surface topsoil layer about 0.2 to 0.3m thick was encountered in Boreholes C3 and C4. Amorphous peat was encountered to depths of 0.7 to 1.1 m below ground surface in Boreholes CD5 and CD6. The samples of peat recovered from the penetration testing had natural water contents in the range of about 172 to 194%.



Peat was also encountered in several of the boreholes drilled along the detour alignment as part of the pavement design investigation. The natural water content of the peat recovered from these boreholes ranged from about 60 to 700 %. The consolidation characteristics inferred from the results of a one dimensional consolidation test carried out on a sample of the peat are summarized below. The results of the consolidation testing are shown on Figures B2-12 B2-13.

Table 5.2 – Consolidation Characteristics of Peat

Parameter	
Natural water content	586 %
Bulk Unit weight	9.8 kN/m ³
Dry Unit weight	5.4 kN/m ³
Compression index	1.67
Recompression index	0.426
Void ratio	2.8
Preconsolidation Pressure	20 kPa
Consolidation Coefficient	0.146 m ² /yr

5.2.2 Fill – Silty Clay

Fill material consisting of silty clay mixed with peat was encountered in Boreholes C3 and C4 extending to depths ranging from 1.4 m (Elev. 238.6 m) to 2.1 m (Elev. 237.7 m) below ground surface. It is thought that the fill may have been surplus excavated soil from the construction of HWY 11 which could account for the mixture of peat and silty clay.

The grain size distribution curve of a sample of this fill is shown in Figure B2-1. These results show a grain size distribution consisting of 5% gravel, 8% sand, 41% silt and 46% clay size particles.

A sample of the silty clay fill was also subjected to an Atterberg Limits test and the results are presented in Figure B2-2. The index values from these tests are summarized below:

Liquid Limit:	64%
Plastic Limit:	33%
Plasticity Index:	31%
Moisture Content:	31%

N values in the range of 5 to 8 blows for 0.3 m were determined in the fill, indicating a firm consistency. The moisture content of samples of this fill ranged from about 28 to 76%.

5.2.3 Clayey Silt to Silty Clay

Native clayey silt to silty clay deposits were encountered in all of the boreholes. These deposits extended to depths ranging from 5.5 m to 7.1 m below ground surface or to elevations ranging from 233.1 m to 232.7 m.

The grain size distribution plots of samples of the clayey silt to silty clay are presented in Figures B2-3 and B2-4. These results show a grain size distribution consisting of 0-1% gravel, 1-14% sand, 27-76% silt and 23-71% clay size particles.



Samples were also subjected to Atterberg Limits tests and the results are illustrated on the plasticity chart, Figures B2-5 and B2-6. The index values from these tests are summarized below:

Liquid Limit:	21-43%
Plastic Limit:	14-22%
Plasticity Index:	5-21%
Natural Moisture Content:	17-36%

These values indicate that the deposit can be characterized as low plasticity clayey silt to silty clay.

Standard Penetration tests in these strata gave 'N' values that ranged from 1 to 10 blows for 0.3 m penetration and field vane tests gave in-situ undrained shear strengths ranging from 8 kPa to greater than 100 kPa. A laboratory vane test on a relatively undisturbed Shelby tube sample gave undrained shear strength of 24 kPa. Based on these results the clayey silt to silty clay was generally firm to stiff with some soft to very soft zones. The moisture content of samples of the clayey silt to silty clay ranged from 16% to 40% and the unit weight of a tested sample was 17.4 kN/m³.

A one dimensional consolidation test was carried out on a tube sample of the clayey silt to silty clay deposit from Borehole CD5 and the results are presented on Figures B2-7 and B2-8. The consolidation characteristics listed in Table 5.3 were determined from the results of the consolidation testing.

Table 5.3 - Summary of Consolidation Testing on Silty Clay

Parameter	
Natural water content	33 %
Bulk Unit weight	17.4 kN/m ³
Dry Unit weight	13.2 kN/m ³
Compression index	0.341
Recompression index	0.042
Void ratio	1.04
Preconsolidation Pressure	60 kPa
Consolidation Coefficient	0.041 m ² /yr

5.2.4 Sandy Silt Till

Sandy silt till was encountered across this site extending to depths ranging from 14.6 m to 14.7 m below ground surface or to elevations ranging from 225.2 m to 225.3 m. The approach boreholes were terminated in this deposit at depths of 8.1 m (Elev. 230.5 m) and 9.6 m (Elev. 229.1 m).

The results of grain size distribution tests conducted on samples of this till are illustrated in Figure B2-9. These results show grain size distributions of 5-16% gravel, 31-33% sand, 41-55% silt and 7-11% clay size particles. The high penetration resistance and the resistance to auger advance observed in the boreholes were indications of the presence of cobbles and boulders in this soil matrix.



The N values determined in the sandy silt till ranged from 31 to more than 100 blows per 0.3 m penetration indicating a dense to very dense relative density. The moisture content of samples from this stratum ranged from about 8 to 17%.

5.2.5 Clayey Silt Till

Clayey silt till was encountered beneath the sand and silt till and to depths ranging from 25.4 m (Elev. 214.6 m) to 28.2 m (Elev. 211.6 m) below ground surface.

The grain size distribution plots of samples of the clayey silt till deposit are presented in Figure B2-10. These results show a grain size distribution consisting of 2-19% gravel, 16-35% sand, 40-62% silt and 13-24% clay size particles. The high penetration resistance and the resistance to auger advance observed in the boreholes were indications of the presence of cobbles and boulders in this soil matrix.

Samples of the clayey silt till were also subjected to Atterberg Limits tests and the results are presented in Figure B2-11. The index values from these tests are summarized below:

Liquid Limit:	18-22%
Plastic Limit:	12-14%
Plasticity Index:	5-10%
Natural Moisture Content:	8-15%

These values indicate low plasticity clayey silt soils.

The N values in the clayey silt till were typically greater than 100 blows for 0.3 m penetration indicating a hard consistency. The natural water content of the clayey silt till ranged from about 7 to 15 per cent.

5.2.6 Bedrock

The overburden was underlain by metamorphic phyllite bedrock. Bedrock was proved by coring in both abutment boreholes and the bedrock depth and top of bedrock elevations are summarized in Table 5.4.

Table 5.4 – Depth to Bedrock

BH No.	Depth to Bedrock (m)	Top of Bedrock Elevation (m)
C3	28.2	211.6
C4	25.4	214.6

The bedrock has been described as weathered at depths extending to between 28.9 m (Elev. 210.9 m) and 29.0 m (Elev. 211.0 m). Below these depths the bedrock was described as unweathered and was colour is grey. Total core recovery in the bedrock ranged from 33% to 98%. The RQD values ranged widely from 0% to 74% but generally, most of the RQD values were below 50%. Based on these results the rock quality is considered to be very poor to poor with occasional zones of fair quality rock.



5.3 Water Levels

Standpipe piezometers were installed in the boreholes and the water level readings were measured on separate visits made after the completion of drilling. The water level records are presented in Table 5.5.

Table 5.5 – Water Level Measurements

Borehole	Date	Water Levels	
		Depth (m)	Elevation (m)
Existing Bridge Site			
C1	August 06, 2010	0.2	241.4
	August 10, 2010	0.9	240.7
	September 03, 2010	0.9	240.7
	April 26, 2012	1.0	240.6
C2	August 06, 2010	0.7	240.9
	August 10, 2010	0.7	240.9
	September 03, 2010	0.7	240.9
	April 26, 2012	0.8	240.8
CD1	December 06, 2011	1.2	240.5
	December 12, 2011	1.3	240.4
	April 26, 2012	1.1	240.6
CD2	December 06, 2011	0.8	240.8
	December 12, 2011	0.8	240.8
CD3	November 07, 2011	1.4	240.2
	November 08, 2011	1.1	240.5
	December 12, 2011	1.0	240.6
	April 26, 2012	1.2	240.4
CD4	November 07, 2011	1.1	240.5
	November 08, 2011	1.2	240.4
	December 12, 2011	0.7	240.9
	April 26, 2012	1.0	240.6
Detour Structure			
C3	August 06, 2010	0.8(*ag)	240.6
	August 10, 2010	1.0(*ag)	240.8
	September 03, 2010	1.2(*ag)	241.0
	April 26, 2012	1.2	238.6
C4	August 10, 2010	1.1(*ag)	241.1
	September 03, 2010	1.6(*ag)	241.6
CD5	November 07, 2011	0.1	238.5
	November 08, 2011	0.0	238.6
	December 12, 2011	0.8(*ag)	239.4
	April 26, 2012	0.0	238.6
CD6	November 07, 2011	0.1	238.6
	November 08, 2011	0.2	238.5
	December 12, 2011	0.0	238.7
	April 26, 2012	0.0	238.7

*ag: recorded water level above the ground.

The free water level in the creek was recorded at Elev. 239.18 m in August, 2010 indicating that the ground water table exists just below the ground surface in the flood plain area.

The recorded water levels in the standpipe piezometers indicated the presence of excess hydrostatic pressure at depth in the underlying till since the piezometric water levels were at or slightly higher than the ground surface of the flood plain.

At the existing bridge the piezometric head was estimated to range between Elev. ± 240.4 m and Elev. ± 240.9 m. Along the Detour Structure the recorded water levels are at the surface to 1.6 m



higher than ground surface and the piezometric head ranged between Elev. ± 238.7 and Elev. ± 241.6 m.

All groundwater observations at this site are short term and the levels are expected to fluctuate seasonally and with precipitation conditions. The ground water level may also be affected by the free water level in the creek.

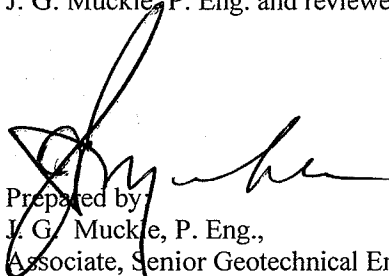
5.4 Miscellaneous

The borehole locations were marked in the field by surveyors from MRC who also provided Terraprobe with their coordinates and geodetic elevations. Terraprobe obtained utility clearances and permits prior to drilling.


The drilling, sampling and in-situ testing operations and the installation and decommissioning of piezometers was conducted with a track mounted drill rig owned and operated by Landcore Drilling of Chelmsford, Ontario.

The boreholes were advanced using hollow-stem augers and casing and washboring methods. Rock cores were retrieved by NQ size diamond coring techniques.

Ms. Pari Boreshnavand, E.I.T., and Mr. Phil Khuu, B.A.T., carried out the field work and the laboratory testing was performed at Terraprobe's Brampton laboratory. The report was written by J. G. Muckle, P. Eng. and reviewed by Michael Tanos, P. Eng.


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J. G. Muckle, P. Eng.,
Associate, Senior Geotechnical Engineer

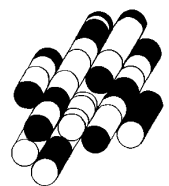



Report Reviewed by:
Michael Tanos, P. Eng.,
Review Principal



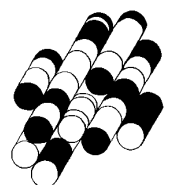
APPENDICES

TERRAPROBE INC.



APPENDIX A

TERRAPROBE INC.



LIMITATIONS AND RISK

Procedures

The soil conditions were confirmed at the borehole locations only and conditions may vary between and beyond the boreholes. The boundaries between the various strata as shown on the logs are based on non-continuous sampling. These boundaries represent an inferred transition between the various strata, rather than a precise plane of stratigraphic change.

This investigation has been carried out using investigation techniques and engineering analysis methods consistent with those ordinarily exercised by Terraprobe and other engineering practitioners, working under similar conditions and subject to the time, financial and physical constraints applicable to this project. The discussions and recommendations that have been presented are based on the factual data obtained.

It must be recognized that there are special risks whenever engineering or related disciplines are applied to identify subsurface conditions. Even a comprehensive sampling and testing programme implemented in accordance with the most stringent level of care may fail to detect certain conditions. Terraprobe has assumed for the purposes of providing design parameters and advice, that the conditions that exist between sampling points are similar to those found at the sample locations. The conditions that Terraprobe has interpreted to exist between sampling points can differ from those that actually exist.

It may not be possible to drill a sufficient number of boreholes or sample and report them in a way that would provide all the subsurface information that could affect construction costs, techniques, equipment and scheduling. Contractors bidding on or undertaking work on the project should be directed to draw their own conclusions as to how the subsurface conditions may affect them, based on their own investigations and their own interpretations of the factual investigation results, cognizant of the risks implicit in the subsurface investigation activities.

Changes In Site And Scope

It must be recognized that the passage of time, natural occurrences, and direct or indirect human intervention at or near the site have the potential to alter subsurface conditions. Groundwater levels are particularly susceptible to seasonal fluctuations.

The design advice is based on the factual data obtained from this investigation made at the site by Terraprobe and are intended for use by the owner and its retained designers in the design phase of the project. If there are changes to the project scope and development features, or there is any additional information relevant to the interpretations made of the subsurface information, the geotechnical design parameters and comments relating to constructibility issues and quality control may not be relevant or complete for the revised project. Terraprobe should be retained to review the implications of such changes with respect to the contents of this report.

This report was prepared for the express use of the Ministry of Transportation, its retained design consultants and McCormick Rankin, a Member of MMM Group Ltd. It is not for use by others. This report is copyright of Terraprobe Inc. and no part of this report may be reproduced by any means, in any form, without the prior written permission of Terraprobe Inc. The Ministry of Transportation, its retained design consultants and McCormick Rankin, a Member of MMM Group Ltd., are authorized users.

EXPLANATION OF TERMS USED IN REPORT

N VALUE: THE STANDARD PENETRATION TEST (SPT) N VALUE IS THE NUMBER OF BLOWS REQUIRED TO CAUSE A STANDARD 51mm O.D. SPLIT BARREL SAMPLER TO PENETRATE 0.3m INTO UNDISTURBED GROUND IN A BOREHOLE WHEN DRIVEN BY A HAMMER WITH A MASS OF 63.5kg. FALLING FREELY A DISTANCE OF 0.76m. FOR PENETRATIONS OF LESS THAN 0.3m N VALUES ARE INDICATED AS THE NUMBER OF BLOWS FOR THE PENETRATION ACHIEVED. AVERAGE N VALUE IS DENOTED THUS \bar{N} .

DYNAMIC CONE PENETRATION TEST: CONTINUOUS PENETRATION OF A CONICAL STEEL POINT (51mm O.D. 60° CONE ANGLE) DRIVEN BY 475J IMPACT ENERGY ON 'A' SIZE DRILL RODS. THE RESISTANCE TO CONE PENETRATION IS MEASURED AS THE NUMBER OF BLOWS FOR EACH 0.3m ADVANCE OF THE CONICAL POINT INTO THE UNDISTURBED GROUND.

SOILS ARE DESCRIBED BY THEIR COMPOSITION AND CONSISTENCY OR DENSENESS.

CONSISTENCY: COHESIVE SOILS ARE DESCRIBED ON THE BASIS OF THEIR UNRAINED SHEAR STRENGTH (c_u) AS FOLLOWS:

c_u (kPa)	0-12	12-25	25-50	50-100	100-200	>200
	VERY SOFT	SOFT	FIRM	STIFF	VERY STIFF	HARD

DENSENESS: COHESIONLESS SOILS ARE DESCRIBED ON THE BASIS OF DENSENESS AS INDICATED BY SPT N VALUES AS FOLLOWS:

N (BLOWS/0.3m)	0-5	5-10	10-30	30-50	>50
	VERY LOOSE	LOOSE	COMPACT	DENSE	VERY DENSE

ROCKS ARE DESCRIBED BY THEIR COMPOSITION AND STRUCTURAL FEATURES AND/OR STRENGTH.

RECOVERY: SUM OF ALL RECOVERED ROCK CORE PIECES FROM A CORING RUN EXPRESSED AS A PERCENT OF THE TOTAL LENGTH OF THE CORING RUN.

MODIFIED RECOVERY: SUM OF THOSE INTACT CORE PIECES, 100mm+ IN LENGTH EXPRESSED AS A PERCENT OF THE LENGTH OF THE CORING RUN. THE ROCK QUALITY DESIGNATION (RQD), FOR MODIFIED RECOVERY IS:

RQD (%)	0-25	25-50	50-75	75-90	90-100
	VERY POOR	POOR	FAIR	GOOD	EXCELLENT

JOINTING AND BEDDING:

SPACING	50mm	50-300mm	0.3m-1m	1m-3m	>3m
JOINTING	VERY CLOSE	CLOSE	MOD. CLOSE	WIDE	VERY WIDE
BEDDING	VERY THIN	THIN	MEDIUM	THICK	VERY THICK

ABBREVIATIONS AND SYMBOLS

FIELD SAMPLING

SS	SPLIT SPOON	TP	THINWALL PISTON
WS	WASH SAMPLE	OS	OSTERBERG SAMPLE
ST	SLOTTED TUBE SAMPLE	RC	ROCK CORE
BS	BLOCK SAMPLE	PH	TW ADVANCED HYDRAULICALLY
CS	CHUNK SAMPLE	PM	TW ADVANCED MANUALLY
TW	THINWALL OPEN	FS	FOIL SAMPLE

STRESS AND STRAIN

u_w	kPa	PORE WATER PRESSURE
r_u	1	PORE PRESSURE RATIO
σ	kPa	TOTAL NORMAL STRESS
σ'	kPa	EFFECTIVE NORMAL STRESS
τ	kPa	SHEAR STRESS
$\sigma_1, \sigma_2, \sigma_3$	kPa	PRINCIPAL STRESSES
ϵ	%	LINEAR STRAIN
$\epsilon_1, \epsilon_2, \epsilon_3$	%	PRINCIPAL STRAINS
E	kPa	MODULUS OF LINEAR DEFORMATION
G	kPa	MODULUS OF SHEAR DEFORMATION
μ	1	COEFFICIENT OF FRICTION

MECHANICAL PROPERTIES OF SOIL

m_v	kPa ⁻¹	COEFFICIENT OF VOLUME CHANGE
C_c	1	COMPRESSION INDEX
C_s	1	SWELLING INDEX
C_α	1	RATE OF SECONDARY CONSOLIDATION
C_v	m ² /s	COEFFICIENT OF CONSOLIDATION
H	m	DRAINAGE PATH
T_v	1	TIME FACTOR
U	%	DEGREE OF CONSOLIDATION
σ'_{vm}	kPa	EFFECTIVE OVERBURDEN PRESSURE
σ'_p	kPa	PRECONSOLIDATION PRESSURE
τ_c	kPa	SHEAR STRENGTH
c'	kPa	EFFECTIVE COHESION INTERCEPT
ϕ'	-°	EFFECTIVE ANGLE OF INTERNAL FRICTION
c_u	kPa	APPARENT COHESION INTERCEPT
ϕ_u	-°	APPARENT ANGLE OF INTERNAL FRICTION
τ_R	kPa	RESIDUAL SHEAR STRENGTH
τ_s	kPa	REMOULDED SHEAR STRENGTH
S_i	1	SENSITIVITY = c_u / τ_s

PHYSICAL PROPERTIES OF SOIL

ρ_s	kg/m ³	DENSITY OF SOLID PARTICLES	e	1%	VOID RATIO	e_{max}	1%	VOID RATIO IN DENSEST STATE
γ_s	kN/m ³	UNIT WEIGHT OF SOLID PARTICLES	n	1%	POROSITY	I_D	1	DENSITY INDEX = $\frac{e_{max} - e}{e_{max} - e_{min}}$
ρ_w	kg/m ³	DENSITY OF WATER	w	1%	WATER CONTENT	D	mm	GRAIN DIAMETER
γ_w	kN/m ³	UNIT WEIGHT OF WATER	S_r	%	DEGREE OF SATURATION	D_n	mm	n PERCENT - DIAMETER
ρ	kg/m ³	DENSITY OF SOIL	w_L	%	LIQUID LIMIT	C_u	1	UNIFORMITY COEFFICIENT
γ	kN/m ³	UNIT WEIGHT OF SOIL	w_p	%	PLASTIC LIMIT	h	m	HYDRAULIC HEAD OR POTENTIAL
ρ_d	kg/m ³	DENSITY OF DRY SOIL	w_s	%	SHRINKAGE LIMIT	q	m ³ /s	RATE OF DISCHARGE
γ_d	kN/m ³	UNIT WEIGHT OF DRY SOIL	I_p	%	PLASTICITY INDEX = $(w_L - w_p)$	v	m/s	DISCHARGE VELOCITY
ρ_{sat}	kg/m ³	DENSITY OF SATURATED SOIL	L	1	LIQUIDITY INDEX = $(w - w_p) / I_p$	i	1	HYDRAULIC GRADIENT
γ_{sat}	kN/m ³	UNIT WEIGHT OF SATURATED SOIL	I_c	1	CONSISTENCY INDEX = $(w - w_p) / I_p$	k	m/s	HYDRAULIC CONDUCTIVITY
ρ'	kg/m ³	DENSITY OF SUBMERGED SOIL	e_{max}	1%	VOID RATIO IN LOOSEST STATE	j	kN/m ²	SEEPAGE FORCE
γ'	kN/m ³	UNIT WEIGHT OF SUBMERGED SOIL						

EXPLANATORY SHEET FOR CORE LOG

Column Number

1. Elevation of borehole collar.
2. Depth of geotechnical boundary in borehole
3. Geologic symbol for rock or soil material
4. General description of geotechnical unit - qualitative description, including rock type(s), percentage rock types, frequency and sizes of interbeds, colour, texture.

Joint (discontinuity) Characteristics

5. Number of joint sets: a rock mass can be intersected by a number of joint sets of varying orientations.
6. Joint type: B = Bedding joint C = Cross joint
7. Orientation: only variations in dip can be identified in core; dip direction is from field mapping or oriented core:
F = Flat = 0 - 20° D = Dipping = 20 - 50° V = Vertical = 50 - 90°
8. Joint spacing: this is an approximate measure of spacing between joints in specific joint sets.

SPACING	> 3 m	1 m - 3 m	0.3 m - 1 m	50 mm - 300 mm	< 50 mm
	VERY WIDE	WIDE	MODERATE	CLOSE	VERY CLOSE

9. Roughness:

RU = Rough Undulating
SU = Smooth Undulating
LU = Slickensided Undulating

RP = Rough Planar
SP = Smooth Planar
LP = Slickensided Planar

10. Filling:

T = Tight, hard, non-softened
O = Oxidation surface staining only
SA = Slightly altered; clay-free
S = Sandy particles; clay-free
Si = Sandy and silty, minor clay
NC = Non-softening Clays; 5mm
SC = Swelling Clay fillings; 5mm

Approximate ϕ

25 - 35
25 - 30
25 - 30
20 - 25
16 - 24
6 - 12

11. Aperture: estimated size of joint opening.

12. Degree of weathered rock material:

DEGREE	DESCRIPTION	
UNWEATHERED	NO SIGNS OF DISCOLOURATION OR OXIDIZATION	
SLIGHTLY WEATHERED	PARTIAL DISCOLOURATION; FRACTURES (JOINTS), TYPICALLY OXIDIZED	
MODERATELY WEATHERED	TOTAL DISCOLOURATION	
HIGHLY WEATHERED	TOTAL DISCOLOURATION; TYPICALLY FRIABLE AND PITTED	
COMPLETELY WEATHERED	RESEMBLE A SOIL; ROCK STRUCTURE - USUALLY PRESERVED	

13. Strength of rock material:

VERY HIGH STRENGTH	SPECIMEN CAN ONLY BE CHIPPED BY GEOLOGICAL HAMMER	MPa	
HIGH STRENGTH	SPECIMEN REQUIRES A NUMBER OF BLOWS OF A GEOLOGICAL HAMMER TO FRACTURE IT; CANNOT BE SCRAPPED WITH POCKET KNIFE	> 200	
MEDIUM STRENGTH	SPECIMEN CANNOT BE FRACTURED BY A SINGLE, FIRM BLOW OF GEOLOGICAL HAMMER; CAN BE SCRAPPED WITH POCKET KNIFE, NOT PEELED	50 - 200	
LOW STRENGTH	SHALLOW INDENTATIONS MADE BY FIRM BLOW WITH POINT OF GEOLOGICAL HAMMER; CAN BE PEELED WITH POCKET KNIFE WITH DIFFICULTY	15 - 50	
VERY LOW STRENGTH	CRUMBLES UNDER FIRM BLOW WITH POINT OF GEOLOGICAL HAMMER; CAN BE PEELED	4 - 15	
		1 - 4	

14. Fracture frequency: number of natural joints occurring over a meter length of core. All natural joints are counted irrespective of the number of joint sets.

FRACTURE FREQUENCY	JOINT SPACING	LENGTH	
0.3 m	VERY WIDE	> 3 m	
0.3 - 1 m	WIDE	1 m - 3 m	
1 - 3 m	MODERATE	0.03 m - 1 m	
3 - 20 m	CLOSE	0.005 m - 0.03 m	
20 m	VERY CLOSE	< 0.005 m	

15. Run number and Core Recovery

- (i) Drill run number
- (ii) Total Core Recovery is the total length of core pieces, irrespective of their individual lengths obtained in a core run, and expressed as a percentage of the length of that core run.
16. Rock Quantity Designation (RQD): The total length of those pieces of sound core which are 0.01 metres or greater in length in a core run, expressed as a percentage of the total length of that core run. Sound pieces of rock are those pieces separated by natural breaks and not machine breaks or subsequent artificial breaks.

Rock Mass Classification (after Deare)					
RQD (%)	0 - 25	25 - 50	50 - 75	75 - 90	90 - 100
DESCRIPTION	VERY POOR	POOR	FAIR	GOOD	EXCELLENT

17. Core and Casing sizes: changes of core and casing sizes are indicated.
18. Water recovery, level and tests:
 - (i) percentage drill water recovery
 - (ii) water level depth
 - (iii) positions and results of tests, e.g., permeability and packer tests

RECORD OF BOREHOLE No CD1

1 of 2

METRIC

G.W.P.	5233-06-00	LOCATION	Coords: E:372347.7 N:5492810.1	ORIGINATED BY	PB
DIST	-	HWY	Hwy 11	BOREHOLE TYPE	HOLLOW STEM AUGERS / WASH BORING
DATUM	GEODETIC	DATE	11.7.11	CHECKED BY	HA
				COMPILED BY	DB

[illegible]

Continued Next Page



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

RECORD OF BOREHOLE No CD1

2 of 2

METRIC

G.W.P. 5233-06-00 LOCATION Coords: E:372347.7 N:5492810.1 ORIGINATED BY PB
DIST - HWY Hwy 11 BOREHOLE TYPE HOLLOW STEM AUGERS / WASH BORING COMPILED BY DB
DATUM GEODETIC DATE 11.7.11 CHECKED BY HA

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 (m)	DESCRIPTION	STRAT PLOT	NUMBER	TYPE	SPT 'N' VALUE			SHEAR STRENGTH (kPa)							WATER CONTENT (%)		
								○ UNCONFINED	● QUICK TRIAXIAL							+ FIELD VANE	× LAB VANE
								20	40							60	80
	(continued)																
218.2 23.5	CLAYEY SILT, sandy, trace gravel, hard, grey, moist (GLACIAL TILL) (continued)		18	SS	60												
			1	RUN													
			2	RUN													
			3	RUN													
			4	RUN													
			5	RUN													
			6	RUN													
			7	RUN													
			8	RUN													
			9	RUN													
			10	RUN													
212.3	For details see rock core log cd1 (BEDROCK)																

END OF BOREHOLE

Borehole was filled with drill water
upon completion of drilling.

25mm piezometer installed.

WATER LEVEL READINGS

Date	Water Depth (m)	Elevation (m)
December 6, 2011	1.2	240.5
December 12, 2011	1.3	240.4
April 26, 2012	1.1	240.6

Project	Crow Creek Bridge Replacement	Orientation Vertical	Ground Elevation 241.7m	Datum Geodetic	Borehole No. CD1
Location	Hwy 11, Township of McCrea, Ontario	Date Started November 8, 2011	Completed November 8, 2011	Logged By B.R.	Sheet 1 of 1
Client	MTO	Drilling Agency Landcore Drilling	Drill Type CME55	Core Barrel & Bit Design NQ	Project No. 11-10-5076

[illegible]

Remarks:

LEGEND:

Bedrock

RECORD OF BOREHOLE No CD2

1 of 3

METRIC

G.W.P. 5233-06-00 LOCATION Coords: E:372322.4 N:5492831.1 ORIGINATED BY PB
DIST - HWY Hwy 11 BOREHOLE TYPE HOLLOW STEM AUGERS / WASH BORING COMPILED BY DB
DATUM GEODETIC DATE 11.5.11 CHECKED BY HA

SOIL PROFILE			SAMPLES			GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT		PLASTIC LIMIT	NATURAL MOISTURE CONTENT	LIQUID LIMIT	UNIT WEIGHT γ	REMARKS & GRAIN SIZE DISTRIBUTION (%)			
ELEV DEPTH (m)	DESCRIPTION	STRAT PLOT	NUMBER	TYPE	SPT 'N' VALUE			SHEAR STRENGTH (kPa)							WATER CONTENT (%)		
								<div><div><div>○ UNCONFINED</div><div>● QUICK TRIAXIAL</div></div><div><div>+ FIELD VANE</div><div>✕ LAB VANE</div></div></div>							<div><div>W_P</div><div>W</div><div>W_L</div></div>		
					20	40	60	80	100	10	20	30	kN/m ³	GR SA SI CL			
241.6	GROUND SURFACE																
241.5	150mm ASPHALTIC CONCRETE		1A	AS													
241.2	250mm FILL, sand and gravel, trace silt, brown, damp		1B	AS													
241.2	FILL, sand, trace silt, trace gravel; loose to compact, brown, damp to moist		2	SS	18												
239.5			3	SS	8												
239.5	SILT, some clay, some sand, loose, brown, wet		4	SS	6												
237.9			5	SS	6												
237.9	CLAYEY SILT to SILTY CLAY, trace to some sand, trace gravel, firm to stiff, grey, moist		6	SS	6									0 19 69 12			
237.9			7	ST										0 3 44 53			
237.9			8	AS													
237.9			9	AS										0 6 64 30			
237.9			10	SS	3												
237.9			11	AS										0 15 61 24			
233.1	SAND and SILT, trace clay, trace gravel, occasional cobbles, dense to very dense, grey, damp to moist (GLACIAL TILL)		12A	AS													
233.1			12B	AS													
233.1			13	SS	30									8 39 45 8			

Continued Next Page

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

RECORD OF BOREHOLE No CD2

2 of 3

METRIC

G.W.P. 5233-06-00 LOCATION Coords: E:372322.4 N:5492831.1 ORIGINATED BY PB
DIST - HWY Hwy 11 BOREHOLE TYPE HOLLOW STEM AUGERS / WASH BORING COMPILED BY DB
DATUM GEODETIC DATE 11.5.11 CHECKED BY HA

SOIL PROFILE			SAMPLES			GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT					UNIT WEIGHT γ kN/m ³	REMARKS & GRAIN SIZE DISTRIBUTION (%)	
ELEV DEPTH (m)	DESCRIPTION	STRAT PLOT	NUMBER	TYPE	SPT 'N' VALUE			20 40 60 80 100							
								SHEAR STRENGTH (kPa)							
								○ UNCONFINED	● QUICK TRIAXIAL	+ FIELD VANE	× LAB VANE	WATER CONTENT (%)			
	(continued)														
225.4 16.2	SAND and SILT , trace clay, trace gravel, occasional cobbles, dense to very dense, grey, damp to moist (GLACIAL TILL) (continued)		17	SS	198 / 200mm								○		
	CLAYEY SILT , sandy, trace gravel, occasional cobbles, hard, grey, moist (GLACIAL TILL)		18	SS	81								○ H		6 31 47 16
			19	SS	196								○		
			20	SS	124								○		
			21	SS	115								○ H		1 28 54 17
			22	SS	100 / 125mm								○		
		1	RUN												
215.2 26.4	For details see rock core log cd2 (BEDROCK)	2	RUN												
		3	RUN												
		4	RUN												
		5	RUN												
		6	RUN												

Continued Next Page

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


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RECORD OF BOREHOLE No CD2

3 of 3

METRIC

G.W.P. 5233-06-00 LOCATION Coords: E:372322.4 N:5492831.1 ORIGINATED BY PB
 DIST - HWY Hwy 11 BOREHOLE TYPE HOLLOW STEM AUGERS / WASH BORING COMPILED BY DB
 DATUM GEODETIC DATE 11.5.11 CHECKED BY HA

SOIL PROFILE			SAMPLES			GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT			<div>PLASTIC LIMIT W_p</div> <div>NATURAL MOISTURE CONTENT W</div> <div>LIQUID LIMIT W_L</div>	UNIT WEIGHT γ kN/m ³	REMARKS & GRAIN SIZE DISTRIBUTION (%)
ELEV DEPTH (m)	DESCRIPTION	STRAT PLOT	NUMBER	TYPE	SPT 'N' VALUE			20 40 60 80 100					
								SHEAR STRENGTH (kPa)					
								<div>○ UNCONFINED + FIELD VANE</div> <div>● QUICK TRIAXIAL X LAB VANE</div>					
								WATER CONTENT (%)					
10 20 30													
	(continued)												
210.7	For details see rock core log cd2 (BEDROCK) (continued)		7	RUN			211						

END OF BOREHOLE


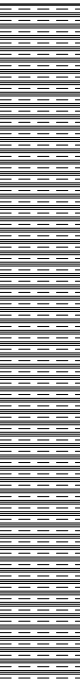
Borehole was filled with drill water
upon completion of drilling.

25mm piezometer installed.

WATER LEVEL READINGS


Date	Water Depth (m)	Elevation (m)
December 6, 2011	0.8	240.8
December 12, 2011	0.8	240.8
April 26, 2012	0.8	240.8

Y:\1-Project Files\11-Geotechnical\2010\11-10-5001 to 5099\11-10-5076\A Dwg, Log\AutoCAD\11-10-5076 CORE.dwg, DB

CORE LOG													 Terraprobe						
Project Crow Creek Bridge Replacement				Orientation Vertical			Ground Elevation 241.6m			Datum Geodetic				Borehole No. CD2					
Location Hwy 11, Township of McCrea, Ontario				Date Started November 6, 2011			Completed November 6, 2011			Logged By B.R.				Sheet 1 of 1					
Client MTO				Drilling Agency Landcore Drilling			Drill Type CME55			Core Barrel & Bit Design NQ				Project No. 11-10-5076					
ELEVATION (m)	DEPTH (m)	SYMBOL	GENERAL DESCRIPTION	Joint Characteristics							WEATHERING	STRENGTH	FRACTURE FREQUENCY	RUN NO. CORE RECOVERY %	R Q D %	CORE SIZE/CASING	MPa UNCONFINED COMPRESSIVE STRENGTH	UNIT WEIGHT (kN/m³)	
				No. OF SETS	JOINT TYPE	ORIENTATION	SPACING	ROUGHNESS	FILLING	APERTURE									
1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	
219.6	22.0																		
218.6	23.0																		
218.4	23.2															#1			
217.6	24.0														#2				
216.6	25.0																		
															#3				
215.6	26.0			Overburden, see Borehole Log CD2															
214.6	27.0			BEDROCK – PHILLITE (Metasediments) unweathered, subvertical foliations, dark grey, high strength.	1	C	F	VC C	SP	O	0 to 1				#4	TCR 100 SCR 100	15	NQ	
213.6	28.0			Moderately to highly fractured: from 26.4m to 27.6m	2	CC	DV	M	SP	O	0 to 1				#5	TCR 100 SCR 92	74	NQ	
212.6	29.0																		
															#6	TCR 100 SCR 28	33	NQ	
211.6	30.0																		
														#7	TCR 100 SCR 47	13	NQ		
210.7	30.9		End of Core Log																
210.6	31.0																		
209.6	32.0																		
208.6	33.0																		
207.6	34.0																		

Remarks:

LEGEND:

 Bedrock

RECORD OF BOREHOLE No CD3

1 of 1

METRIC

G.W.P. 5233-06-00 LOCATION Coords: E:372293.4 N:5492832.4 ORIGINATED BY PB
DIST - HWY Hwy 11 BOREHOLE TYPE HOLLOW STEM AUGERS COMPILED BY DB
DATUM GEODETIC DATE 10.19.11 CHECKED BY HA

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 (%)				
ELEV DEPTH (m)	DESCRIPTION	STRAT PLOT	NUMBER	TYPE	SPT 'N' VALUE			SHEAR STRENGTH (kPa)							WATER CONTENT (%)			
								20	40							60	80	100
241.6	GROUND SURFACE																	
241.4	170mm ASPHALTIC CONCRETE		1A															
0.2																		
241.3	130mm FILL, sand and gravel, trace silt, brown, damp		1B	AS														
0.3																		
	FILL, sand, trace silt, trace gravel; compact, brown, moist to wet		2	SS	19													
	...at 1.5m, silty		3	SS	18													
239.5																		
2.1	SILT, some clay, some sand, trace organics, compact, brown, wet		4	SS	13													
238.4			5A															
3.2	Trace organics		5B	SS	8													
			6	SS	5													
237.2																		
4.4	CLAYEY SILT to SILTY CLAY, trace sand, trace gravel, soft to stiff, grey, moist		7	ST														
			8	AS														
			9	AS														
			10	SS	3													
			11	AS														
233.4																		
8.2	SAND and SILT, trace clay, trace gravel, occasional cobbles and boulders, dense to very dense, grey, moist (GLACIAL TILL)		12	SS	37													
			13	SS	69													
			14	SS	61													
231.1																		

END OF BOREHOLE
Auger refusal

Unstabilized water level measured at 8.5m and borehole caved to 9.1m below grade upon completion of drilling

25mm piezometer installed.

WATER LEVEL READINGS

Date	Water Depth (m)	Elevation (m)
November 7, 2011	1.4	240.2
November 8, 2011	1.1	240.5
December 12, 2011	1.0	240.6
April 26, 2012	1.2	240.4

RECORD OF BOREHOLE No CD4

1 of 1

METRIC

G.W.P. 5233-06-00 LOCATION Coords: E:372373.2 N:5492800 ORIGINATED BY PB
DIST - HWY Hwy 11 BOREHOLE TYPE HOLLOW STEM AUGERS COMPILED BY DB
DATUM GEODETIC DATE 10.6.11 CHECKED BY HA

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 (%)			
ELEV DEPTH (m)	DESCRIPTION	STRAT PLOT	NUMBER	TYPE	SPT 'N' VALUE			SHEAR STRENGTH (kPa)									
								20 40 60 80 100									
								○ UNCONFINED ● QUICK TRIAXIAL + FIELD VANE x LAB VANE									
							WATER CONTENT (%)										
							20 40 60 80 100					10 20 30					
241.6	GROUND SURFACE																
241.1	450mm FILL, sand and gravel, trace silt, compact, brown, damp		1A	SS	19												
0.5	FILL, sand, trace silt, trace gravel; compact, brown, damp		1B														
			2	SS	12												
240.2																	
1.4	SAND AND SILT, trace to some clay, trace gravel, loose, brown, wet		3	SS	7												
			4	AS													
238.7																	
2.9	Occasional peat inclusions		5	SS	10												
237.9																	
3.7	CLAYEY SILT to SILTY CLAY, trace to some sand, trace gravel, firm to stiff, grey, moist to moist		6	AS													
			7	ST													
			8	SS	2												
			9	AS													
			10	ST													
			11	AS													
			12	SS	4												
	...at 8.8m, sandy		13	AS													
231.8																	
9.8	SAND and SILT, trace clay, trace gravel, compact, grey, moist (GLACIAL TILL)		14	SS	19												
			15	SS	27												
229.0																	

END OF BOREHOLE

Borehole was dry upon completion of drilling.

25mm piezometer installed.

Dynamic cone penetration test conducted.

WATER LEVEL READINGS

Date	Water Depth (m)	Elevation (m)
November 7, 2011	1.1	240.5
November 8, 2011	1.2	240.4
December 12, 2011	0.7	240.9
April 26, 2012	1.0	240.6

RECORD OF BOREHOLE No CD5

1 of 1

METRIC

G.W.P. 5233-06-00 LOCATION Coords: E:372276.6 N:5492820.9 ORIGINATED BY PB
DIST - HWY Hwy 11 BOREHOLE TYPE HOLLOW STEM AUGERS COMPILED BY DB
DATUM GEODETIC DATE 10.24.11 CHECKED BY HA

SOIL PROFILE			SAMPLES			GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT		PLASTIC NATURAL LIQUID LIMIT MOISTURE CONTENT			UNIT WEIGHT γ	REMARKS & GRAIN SIZE DISTRIBUTION (%)
ELEV DEPTH (m)	DESCRIPTION	STRAT PLOT	NUMBER	TYPE	SPT 'N' VALUE			20 40 60 80 100	20 40 60 80 100	W _p	W	W _L		
238.6	GROUND SURFACE													
237.9	PEAT, black, wet		1	SS	3		238						172	
0.7	CLAYEY SILT to SILT AND CLAY, trace sand, very soft to firm, grey, moist		2	SS	3		237							0 2 27 71
			3	SS	7		236							
			4	AS			235							
			5	AS			234							
			6	ST			233							
			7	AS			232							
233.1	SANDY SILT, trace clay, trace gravel, occasional cobbles and boulders, very dense, grey, moist (GLACIAL TILL)		8	AS			231							
5.5			9	SS	65									
230.5			10	SS	102									
8.1														

END OF BOREHOLE

Auger refusal

Wet cave to 5.5m below grade upon
completion of drilling.

25mm piezometer installed.

WATER LEVEL READINGS



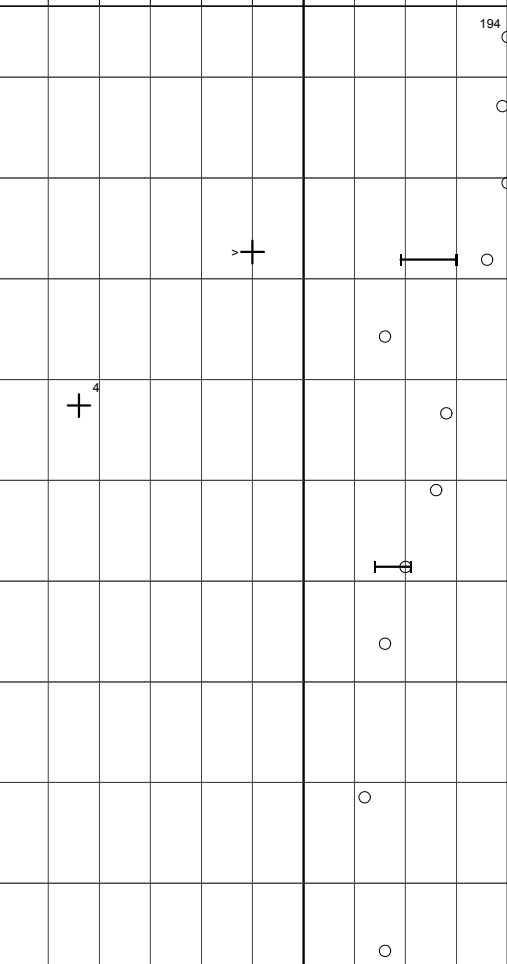
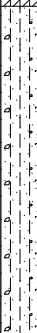
Date	Water Depth (m)	Elevation (m)
November 7, 2011	0.1	238.5
November 8, 2011	0.0	238.6
December 12, 2011	-0.8	239.4
April 26, 2012	0.0	238.6

RECORD OF BOREHOLE No CD6

1 of 1

METRIC

G.W.P. 5233-06-00 LOCATION Coords: E:372367.8 N:5492786.3 ORIGINATED BY PB
DIST - HWY Hwy 11 BOREHOLE TYPE HOLLOW STEM AUGERS COMPILED BY DB
DATUM GEODETIC DATE 10.24.11 CHECKED BY HA

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 (%)			
ELEV DEPTH (m)	DESCRIPTION	STRAT PLOT	NUMBER	TYPE	SPT 'N' VALUE			SHEAR STRENGTH (kPa)										
								20 40 60 80 100										
								○ UNCONFINED ● QUICK TRIAXIAL										
238.7	GROUND SURFACE																	
	PEAT, black, wet		1	SS	1		238							194		0 2 30 68		
237.6			2	SS	2		238											
1.1	Trace rootlets						237											
237.3			3	SS	3		237											
1.4	CLAYEY SILT to SILTY CLAY, trace to some sand, trace gravel, firm, grey, moist		4	AS			236											
			5	SS	5		236											
			6	AS			235											
			7	SS	4		235											
		8	SS	0	234													
232.8							233											1 12 60 27
5.9	SANDY SILT, trace to some clay, trace to some gravel, dense to very dense, grey, moist to wet (GLACIAL TILL)		9	SS	40													
						232												
			10	SS	31	231										6 31 53 10		
						230												
	...at 9.1m, frequent sand interlayers		11	SS	74													
229.1																		

END OF BOREHOLE

Auger refusal

Unstabilized water level measured at 2.7m and borehole caved to 6.7m below grade upon completion of drilling

25mm piezometer installed.

WATER LEVEL READINGS

Date	Water Depth (m)	Elevation (m)
November 7, 2011	0.1	238.6
November 8, 2011	0.2	238.5
December 12, 2011	0.0	238.7
April 26, 2012	0.0	238.7

RECORD OF BOREHOLE No C-1

1 OF 3

METRIC

W.P. 5233-06-00 LOCATION Coords: N:5492821.8 E:372318.7 ORIGINATED BY PK
DIST HWY Hwy 11 BOREHOLE TYPE Hollow Stem Augers / Casing and Washboring / NQ Coring COMPILED BY DB
DATUM Geodetic DATE 7.28.10 - 7.29.10 CHECKED BY RA

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		
241.6	Ground Surface						20 40 60 80 100							
241.5	150mm ASPHALT													
241.3	170mm FILL - Sand and Gravel, trace silt, inferred compact, brown, damp		1	SS	16									5 87 (8)
0.3			2	SS	8									
	FILL - Sand, trace silt, trace gravel, loose to compact, brown, damp to moist		3	SS	7									
239.5														
2.1	SANDY SILT some clay, loose, brown, wet		4	SS	6									
			5	SS	4									0 23 67 10
237.9														
3.7	SILTY CLAY trace to some sand, trace gravel, occasional silt seams, soft to firm, grey, moist		6	SS	7									
			7	SS	3									0 4 56 40
			8	TW	PH									
			9	SS	2									1 15 58 26
232.6														
9.0	SAND AND SILT trace clay, trace gravel, occasional cobbles and boulders, very dense, grey, damp to moist (GLACIAL TILL)		10	SS	70									commence casing and washboring
			11	SS	100/ 13cm									
			12	SS	100/ 8cm									
			13	SS	100/ 10cm									6 42 45 7

Continued Next Page

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

ON_MOT_OLD 1-10-5076 CROW MONTCALM BRIDGE RPL - ORIGINAL.GPJ ON MOT.GDT 5/22/12

RECORD OF BOREHOLE No C-1

2 OF 3

METRIC

W.P. 5233-06-00 LOCATION Coords: N:5492821.8 E:372318.7 ORIGINATED BY PK
 DIST HWY Hwy 11 BOREHOLE TYPE Hollow Stem Augers / Casing and Washboring / NQ Coring COMPILED BY DB
 DATUM Geodetic DATE 7.28.10 - 7.29.10 CHECKED BY RA

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 (%)
ELEV DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE	"N" VALUES			SHEAR STRENGTH kPa									
								○ UNCONFINED	+ FIELD VANE	● QUICK TRIAXIAL	× LAB VANE						
			14	SS	100/ 15cm											○	Jul.28
																	Jul.29
			15	SS	100/ 15cm											○	
224.0																	
17.6	CLAYEY SILT some sand to sandy, trace gravel, frequent cobbles and boulders below 21.8m, hard, grey, damp (GLACIAL TILL)		16	SS	100/ 13cm											⊕	1 20 64 15
			17	SS	100											⊕	7 36 46 11

Continued Next Page

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

ONL_MOT_OLD 1-10-5076 CROW MONTCALM BRIDGE RPL - ORIGINAL.GPJ ON_MOT.GDT 5/22/12

RECORD OF BOREHOLE No C-1

3 OF 3

METRIC

W.P. 5233-06-00 LOCATION Coords: N:5492821.8 E:372318.7 ORIGINATED BY PK
 DIST HWY Hwy 11 BOREHOLE TYPE Hollow Stem Augers / Casing and Washboring / NQ Coring COMPILED BY DB
 DATUM Geodetic DATE 7.28.10 - 7.29.10 CHECKED BY RA

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								
								○ UNCONFINED + FIELD VANE ● QUICK TRIAXIAL × LAB VANE								
								20 40 60 80 100								
210.3							211									
31.3	End of Borehole		3	RUN	NQ											RUN#3 TCR=91% SCR=80% RQD=80%
	<p>Piezometer installation consists of a 25mm diameter, Schedule 40 PVC pipe with a 1.52m slotted screen.</p> <p>Water Level Readings: Date Depth(m) Elevation(m) Aug.06.10 0.2 241.4 Aug.10.10 0.9 240.7 Sep.03.10 0.9 240.7 Apr. 26, 12 1.0 240.6</p> <p>Borehole was open to 30.2m and filled with drill water on completion of drilling.</p> <p>Continous soil core sample collected from 25.4m to 28.0m.</p>															

METRIC

SOIL PROFILE					
ELEV DEPTH	DESCRIPTION	STRAT PLOT	SAMPLES	N° VALUES	GROUND WATER CONDITIONS
			NUMBER	TYPE	
241.6	Ground Surface				
241.5	150mm ASPHALT				
241.3	150mm FILL - Sand and Gravel, inferred compact, brown, damp		1	SS	29
0.3	FILL - Sand, trace silt, loose to compact, brown, dry		2	SS	9
	wet		3	SS	8
239.5					
2.1	SAND AND SILT some clay, loose, brown, wet		4	SS	4
238.7					
2.9	SILTY CLAY trace sand, occasional gravel inclusions, firm to stiff, grey, damp to moist		5	SS	14
			6	SS	11
			7	SS	12
			8	SS	5
			9	TW	PH
			10	SS	6
232.9					
8.7	SAND AND SILT trace to some gravel, trace clay, occasional cobbles, compact to very dense, grey, damp to moist (GLACIAL TILL)		11	SS	24
			12	SS	117
			13	SS	44
			14	SS	156
226.9					
14.7					

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

ON_MOT OLD 1-10-5076 CROW MONTCALM BRIDGE RPL - ORIGINAL.GPJ ON_MOT.GDT 5/22/12

RECORD OF BOREHOLE No C-2

2 OF 2

METRIC

W.P. 5233-06-00 LOCATION Coords: N:5492819.4 E:372351.3 ORIGINATED BY PK
 DIST HWY Hwy 11 BOREHOLE TYPE Hollow Stem Augers / Casing and Washboring / NQ Coring COMPILED BY DB
 DATUM Geodetic DATE 7.27.10 CHECKED BY RA

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 (%)			
ELEV DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE	"N" VALUES			SHEAR STRENGTH kPa										WATER CONTENT (%)		
								○ UNCONFINED	+ FIELD VANE	● QUICK TRIAXIAL	× LAB VANE									
	CLAYEY SILT sandy, trace gravel, some cobbles, hard, grey, damp (GLACIAL TILL) (continued)		15	SS	85												9 32 44 15 commence casing and washboring			
				16	SS	100/ 13cm														

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

ONL_MOT_OLD 1-10-5076 CROW MONTCALM BRIDGE RPL - ORIGINAL.GPJ ONL_MOT_GDT 5/22/12

RECORD OF BOREHOLE No C-3

1 OF 3

METRIC

W.P. 5233-06-00 LOCATION Coords: N:5492806.5 E:372316.7 ORIGINATED BY PK
 DIST HWY Hwy 11 BOREHOLE TYPE Hollow Stem Augers / Casing and Washboring / NQ Coring COMPILED BY DB
 DATUM Geodetic DATE 8.4.10 - 8.5.10 CHECKED BY RA

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 (%)	
ELEV DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE	"N" VALUES			SHEAR STRENGTH kPa ○ UNCONFINED + FIELD VANE ● QUICK TRIAXIAL × LAB VANE								WATER CONTENT (%)
239.8 0.0	Ground Surface						20	40	60	80	100					
239.5 0.3	300mm TOPSOIL		1	SS	8									64	5 8 41 46	
237.7 2.1	FILL - Silty Clay and Peat, trace sand, trace gravel, firm, dark brown / black, moist		2	SS	6											
			3	SS	5									76		
			4	SS	10											
			5	SS	5											1 7 64 28
			6	SS	5											
			7	TW	PH											
			8	SS	1											1 14 62 23
232.7 7.1	SANDY SILT trace clay, trace gravel, occasional cobbles and boulders, very dense, brown, damp to moist (GLACIAL TILL)		9	SS	51										5 33 55 7	
			10	SS	78											commence casing and washboring
			11	SS	100/ 13cm											
			12	SS	100/ 13cm											
			13	SS	100/ 10cm											
225.2 14.6																

Continued Next Page

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

ONL MOT OLD 1-10-5076 CROW MONTCALM BRIDGE RPL - ORIGINAL.GPJ ONL MOT.GDT 5/22/12

METRIC

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

ON MOT OLD 1-10-5076 CROW MONTCALM BRIDGE RPL - ORIGINAL.GPJ ON MOT.GDT 5/22/12

RECORD OF BOREHOLE No C-3

3 OF 3

METRIC

W.P. 5233-06-00 LOCATION Coords: N:5492806.5 E:372316.7 ORIGINATED BY PK
 DIST HWY Hwy 11 BOREHOLE TYPE Hollow Stem Augers / Casing and Washboring / NQ Coring COMPILED BY DB
 DATUM Geodetic DATE 8.4.10 - 8.5.10 CHECKED BY RA

SOIL PROFILE		SAMPLES			GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT					PLASTIC NATURAL LIQUID LIMIT MOISTURE LIMIT CONTENT CONTENT 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 ○ UNCONFINED + FIELD VANE ● QUICK TRIAXIAL × LAB VANE					WATER CONTENT (%)				
							20 40 60 80 100					10 20 30				
208.0			3	RUN	NQ	209										RUN#3 TCR=97% SCR=84% RQD=74%
31.8	End of Borehole Piezometer installation consists of a 25mm diameter, Schedule 40 PVC pipe with a 1.52m slotted screen. Water Level Readings: Date Depth(m) Elevation(m) Aug.06.10 0.8(ag)* 240.6 Aug.10.10 1.0(ag)* 240.8 Sep.03.10 1.2(ag)* 241.0 Apr. 26, 12 1.2 238.6 *(ag) - above ground Borehole filled with drill water on completion of drilling. **Enough sample not available to perform Atterberg Limits Test.					208										

CORE LOG



Terraprobe

Project	Crow Creek Bridge Replacement	Orientation	Vertical	Ground Elevation	239.8m	Datum	Geodetic	Borehole No.	C-3
Location	Hwy 11, Township of McCrea, Ontario	Date Started	August 5, 2010	Completed	August 5, 2010	Logged By	A.W.	Sheet	1 of 1
Client	MTO	Drilling Agency	Landcore Drilling	Drill Type	CME55	Core Barrel & Bit Design	NQ	Project No.	1-10-5076

ELEVATION (m)	DEPTH (m)	SYMBOL	GENERAL DESCRIPTION	Joint Characteristics							WEATHERING	STRENGTH	FRACTURE FREQUENCY	RUN NO. CORE RECOVERY %	R Q D %	CORE SIZE/CASING	MPa UNCONFINED COMPRESSIVE STRENGTH	UNIT WEIGHT (kN/m³)
				No. OF SETS	JOINT TYPE	ORIENTATION	SPACING	ROUGHNESS	FILLING	APERTURE								
1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19
212.1	27.7		Overburden, see Borehole Log C-3															
211.8	28.0																	
211.6	28.2		BEDROCK - PHYLLITE	1	C	F	C	SP	SA	0 to 1				#1 TCR 46 SCR 23	0	NQ		
210.8	29.0		Unweathered below 28.9m, sub-vertical foliations, grey, medium to high strength.		CCC	FDV	VC	SP	SA									
			Slightly to moderately weathered from 28.2m to 28.9m.	3	CCC	FDV	C	SP	T	0 to 1				#2 TCR 90 SCR 79	29	NQ		
209.8	30.0		Highly fractured from 28.7m to 28.9m.															
208.8	31.0			2	CC	DV	C	SP	T	0 to 1				#3 TCR 97 SCR 84	74	NQ		
208.0	31.8		End of Core Log															

Remarks:

LEGEND:

Bedrock

RECORD OF BOREHOLE No C-4

1 OF 3

METRIC

W.P. 5233-06-00 LOCATION Coords: N:5492800.2 E:372339.6 ORIGINATED BY PK
 DIST HWY Hwy 11 BOREHOLE TYPE Hollow Stem Augers / Casing and Washboring / NQ Coring COMPILED BY DB
 DATUM Geodetic DATE 8.6.10 CHECKED BY RA

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	GR	SA	SI
240.0	Ground Surface							20 40 60 80 100									
239.8	200mm TOPSOIL							20 40 60 80 100									
0.2	FILL - Silty Clay and Peat, trace sand, trace gravel, firm, dark brown, moist		1	SS	7												
			2	SS	5		239										
238.6																	
1.4	SILTY CLAY trace to some sand, trace gravel, firm to stiff, brown, moist		3	SS	8		238										
			4	SS	9		237							1	2	66	31
			5	TW	PH												
							236										
			6	SS	5		235										
			7	SS	4		234										
			8	SS	4												
232.9							233										
7.1	SANDY SILT trace to some clay, trace to some gravel, occasional cobbles and boulders, dense to very dense, brown, damp to moist (GLACIAL TILL)		9	SS	42		232										
							231										
			10	SS	100/ 15cm		230										
			11	SS	100/ 15cm		229										
			12	SS	100/ 15cm		228										
							227										
			13	SS	99		226										
225.3																	
14.7																	

Continued Next Page

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

ONL MOT OLD 1-10-5076 CROW MONTCALM BRIDGE RPL - ORIGINAL.GPJ ON MOT.GDT 5/22/12

2 OF 3

METRIC

[illegible]

Continued Next Page

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


ON MOT OLD 1-10-5076 CROW MONTCALM BRIDGE RPL - ORIGINAL.GPJ ON MOT.GDT 5/22/12

RECORD OF BOREHOLE No C-4

3 OF 3

METRIC

W.P. 5233-06-00 LOCATION Coords: N:5492800.2 E:372339.6 ORIGINATED BY PK
 DIST HWY Hwy 11 BOREHOLE TYPE Hollow Stem Augers / Casing and Washboring / NQ Coring COMPILED BY DB
 DATUM Geodetic DATE 8.6.10 CHECKED BY RA

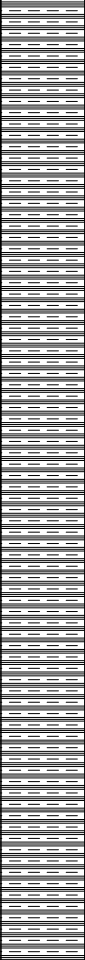
SOIL PROFILE		SAMPLES			GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT					PLASTIC LIMIT NATURAL MOISTURE CONTENT LIQUID LIMIT			UNIT WEIGHT γ kN/m ³	REMARKS & GRAIN SIZE DISTRIBUTION (%)
ELEV DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE			"N" VALUES	SHEAR STRENGTH kPa					WATER CONTENT (%)			
						20	40	60	80	100	W _p	W	W _L			
209.5 30.5	End of Borehole Piezometer installation consists of a 25mm diameter, Schedule 40 PVC pipe with a 1.52m slotted screen. Water Level Readings: Date Depth(m) Elevation(m) Aug.10.10 1.1(ag)* 241.1 Sep.03.10 1.6(ag)* 241.6 *(ag) - above ground Borehole filled with drill water on completion of drilling. Unable to push vane beyond 7.5m.															

CORE LOG



Terraprobe

Project	Crow Creek Bridge Replacement	Orientation	Vertical	Ground Elevation	240.0m	Datum	Geodetic	Borehole No.	C-4
Location	Hwy 11, Township of McCrea, Ontario	Date Started	August 6, 2010	Completed	August 6, 2010	Logged By	A.W.	Sheet	1 of 1
Client	MTO	Drilling Agency	Landcore Drilling	Drill Type	CME55	Core Barrel & Bit Design	NQ	Project No.	1-10-5076

ELEVATION (m)	DEPTH (m)	SYMBOL	GENERAL DESCRIPTION	Joint Characteristics							WEATHERING	STRENGTH	FRACTURE FREQUENCY	RUN NO. CORE RECOVERY %	R Q D %	CORE SIZE/CASING	MPa UNCONFINED COMPRESSIVE STRENGTH	UNIT WEIGHT (KN/m³)	
				No. OF SETS	JOINT TYPE	ORIENTATION	SPACING	ROUGHNESS	FILLING	APERTURE									
1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	
216.0	24.0		Overburden, see Borehole Log C-4																
215.6	24.4																		
215.0	25.0																		
214.6	25.4					2	CC	FV	VC	SP	SA	0 to 1				#2 TCR 33 SCR 7	7	NQ	
214.0	26.0						CC	FV	VC	SU	SI								
						2	CC	FV	C	SU	SI	0 to 3				#3 TCR 59 SCR 28	9	NQ	
213.0	27.0																		
212.0	28.0					2	CC	FV	C	SU	SI	0 to 1				#4 TCR 63 SCR 34	23	NQ	
							CC	FV	M	SU	SI								
211.0	29.0																		
				2	CC	FV	M	SP	T	0 to 1				#5 TCR 98 SCR 92	65	NQ			
210.0	30.0																		
209.5	30.5																		
			End of Core Log																

Remarks:	<div>LEGEND: Bedrock</div>
----------	---------------------------------

Foundation Investigation Report
Crow Creek Bridge Replacement
G.W.P. No.: 5233-06-00; W.P. 5147-05-01



Bedrock Core Sample
Borehole: C1
Runs: 1, 2 & 3
Depth: 28.0m – 31.3m



Foundation Investigation Report
Crow Creek Bridge Replacement
G.W.P. No.: 5233-06-00; W.P. 5147-05-01



Bedrock Core Sample

Borehole: C2

Runs: 1, 2 & 3

Depth: 22.2m – 25.9m



Foundation Investigation Report
Crow Creek Bridge Replacement
G.W.P. No.: 5233-06-00; W.P. 5147-05-01



Soil/Bedrock Core Sample

Borehole: CD1; Runs: 1 to 6; Depth: 19.2m – 24.9m



Bedrock Core Sample

Borehole: CD1; Runs: 7 to 11; Depth: 24.9m – 29.4m



Foundation Investigation Report
Crow Creek Bridge Replacement
G.W.P. No.: 5233-06-00; W.P. 5147-05-01



Soil/Bedrock Core Sample

Borehole: CD2; Runs: 1 to 4; Depth: 23.2m – 27.6m



Bedrock Core Sample

Borehole: CD2; Runs: 5 to 7; Depth: 27.6m – 30.9m



Foundation Investigation Report
Crow Creek Bridge Replacement
G.W.P. No.: 5233-06-00; W.P. 5147-05-01



Bedrock Core Sample
Borehole: C3
Runs: 1, 2 & 3
Depth: 27.7m – 31.8m



Foundation Investigation Report
Crow Creek Bridge Replacement
G.W.P. No.: 5233-06-00; W.P. 5147-05-01



Bedrock Core Sample

Borehole: C4

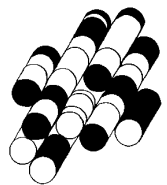
Runs: 1, 2, 3, 4 & 5

Depth: 23.9m – 30.5m

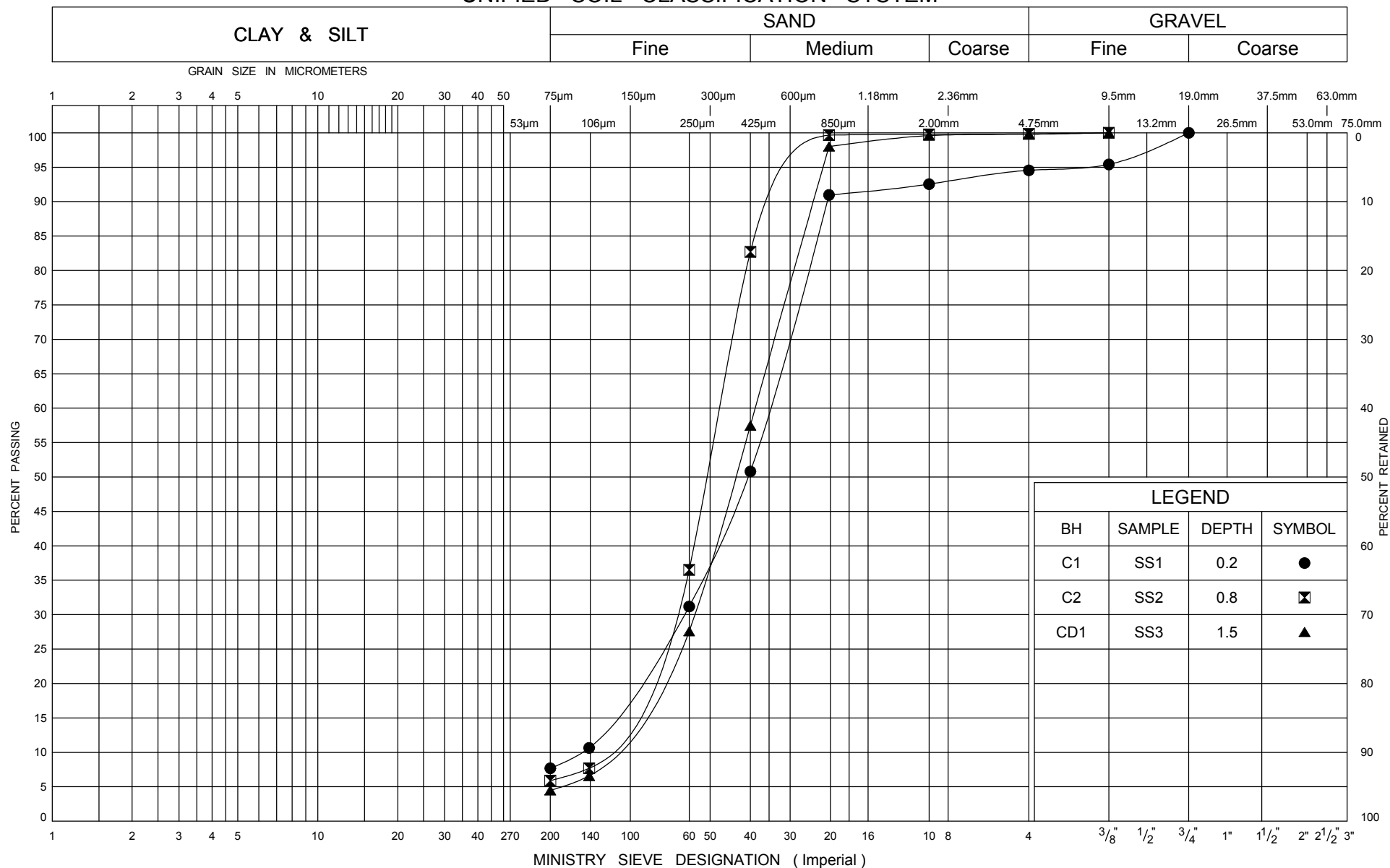


APPENDIX B

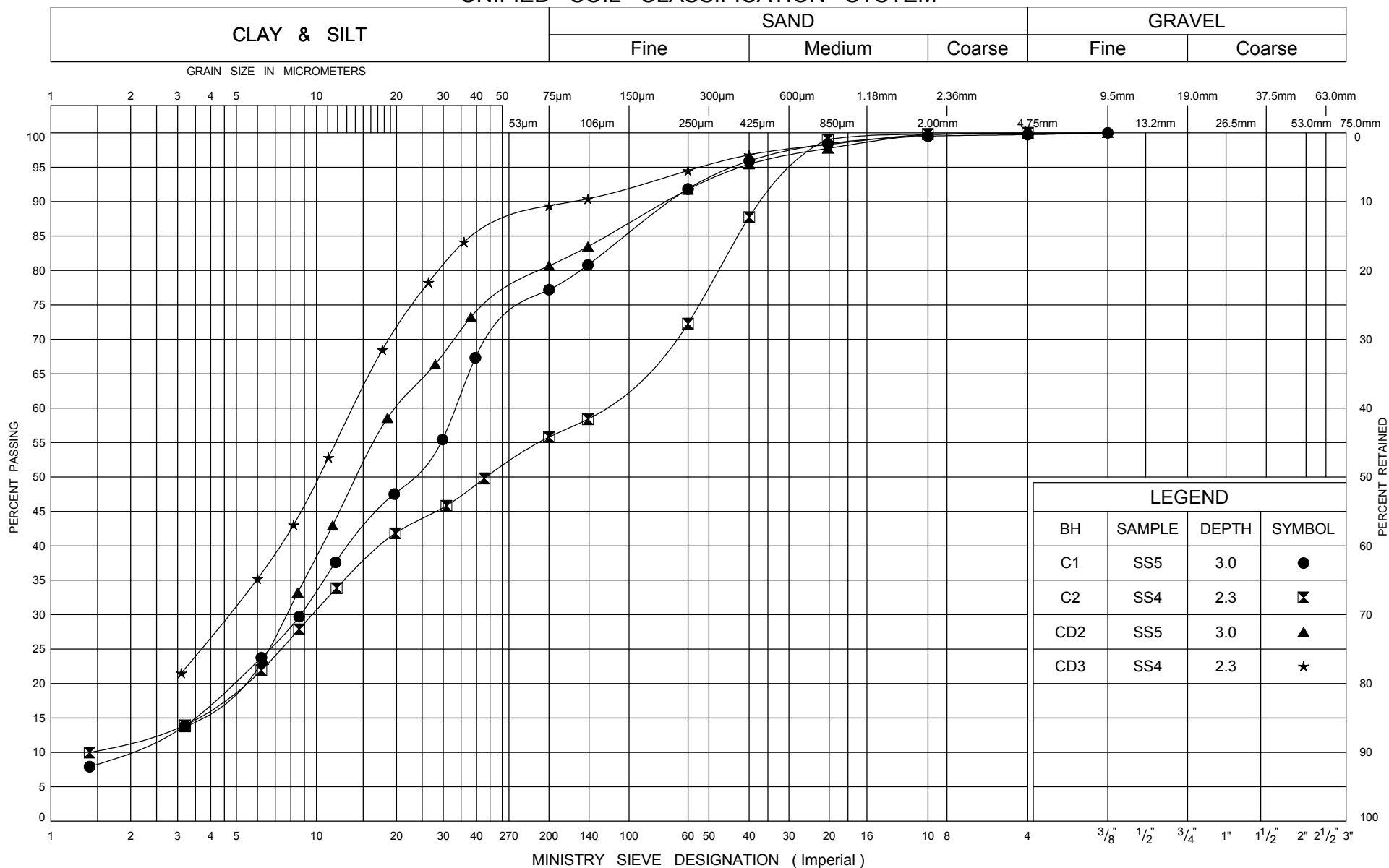
TERRAPROBE INC.



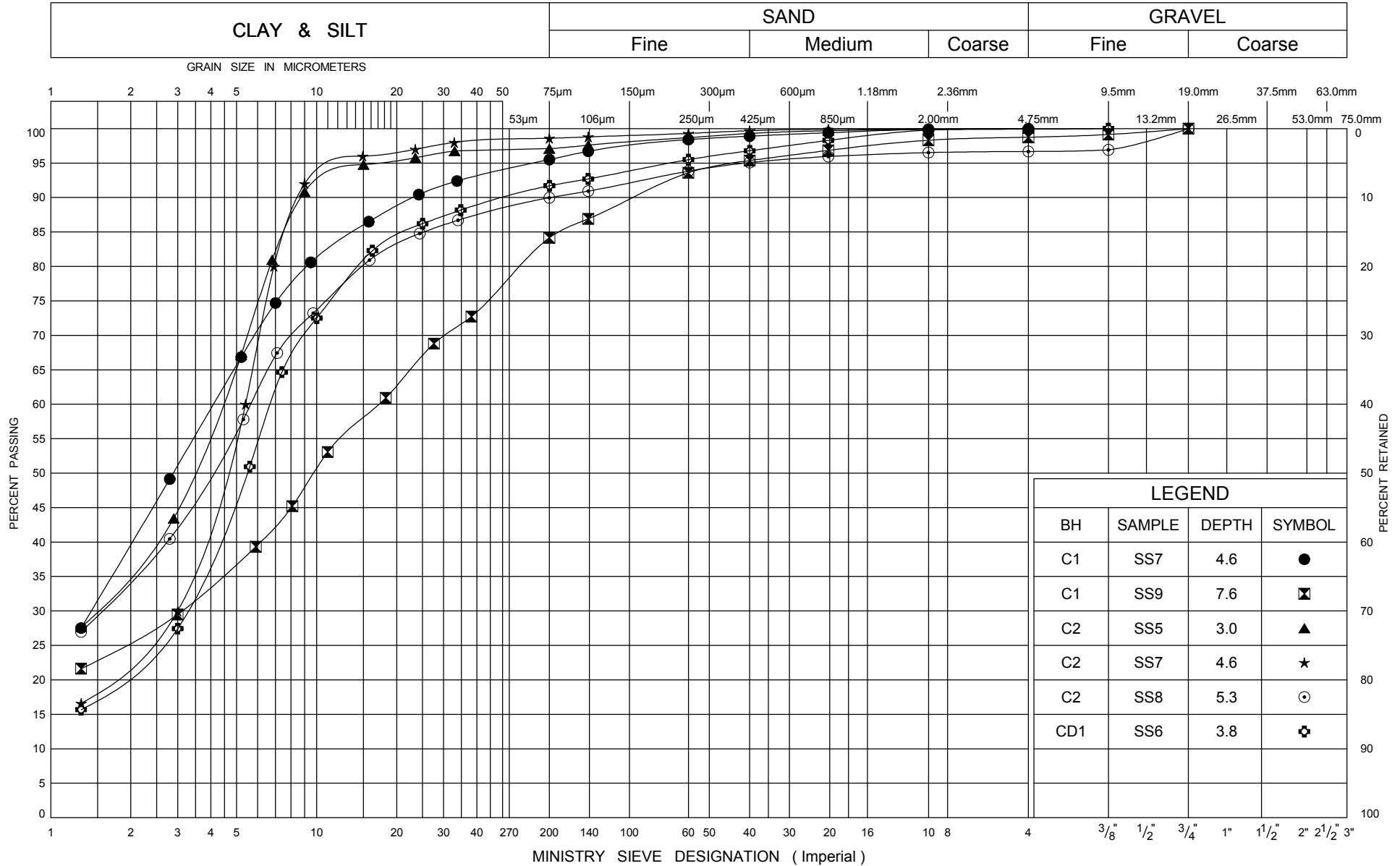
UNIFIED SOIL CLASSIFICATION SYSTEM



UNIFIED SOIL CLASSIFICATION SYSTEM



UNIFIED SOIL CLASSIFICATION SYSTEM



Ministry of
Transportation

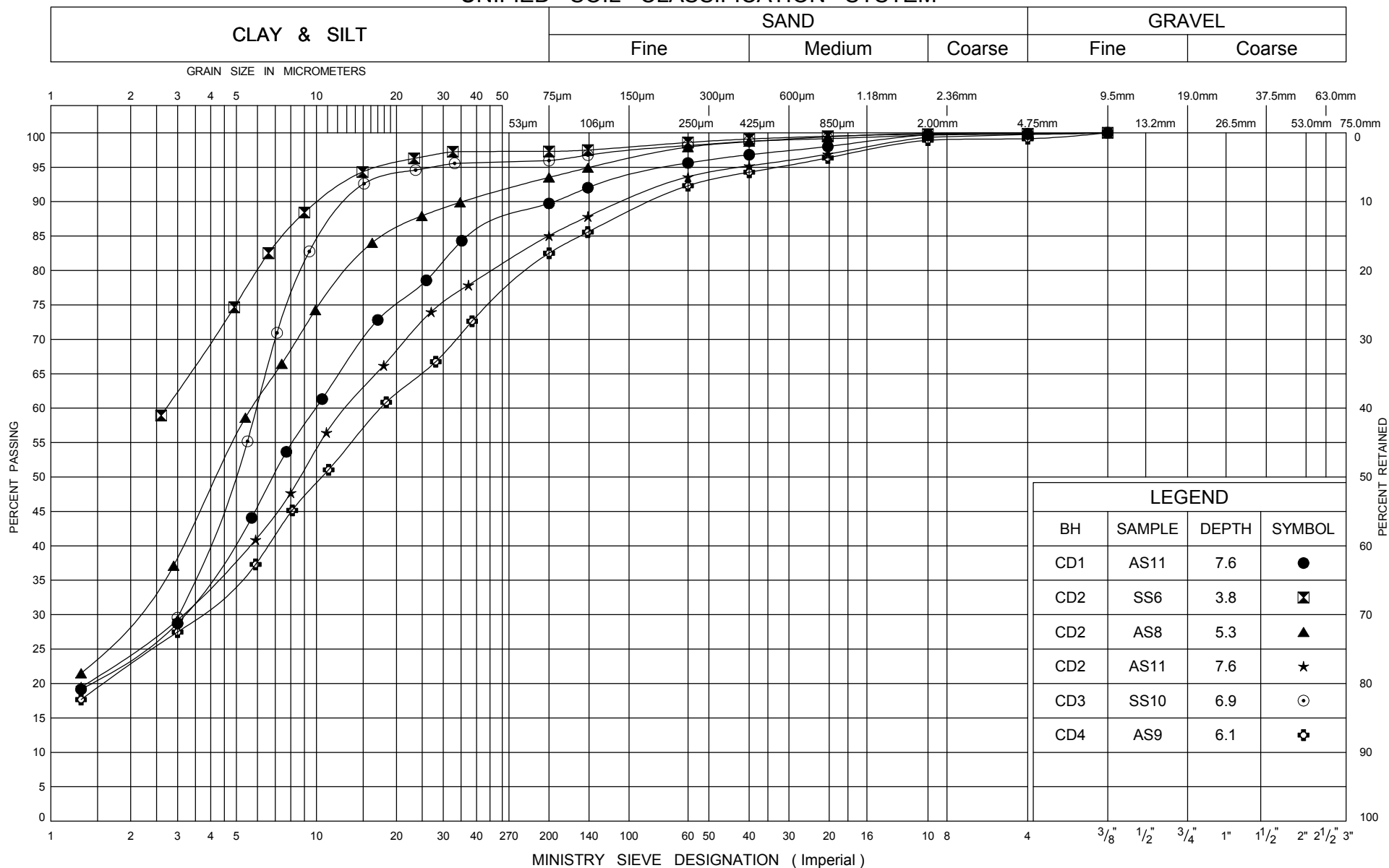
GRAIN SIZE DISTRIBUTION
CLAYEY SILT TO SILTY CLAY

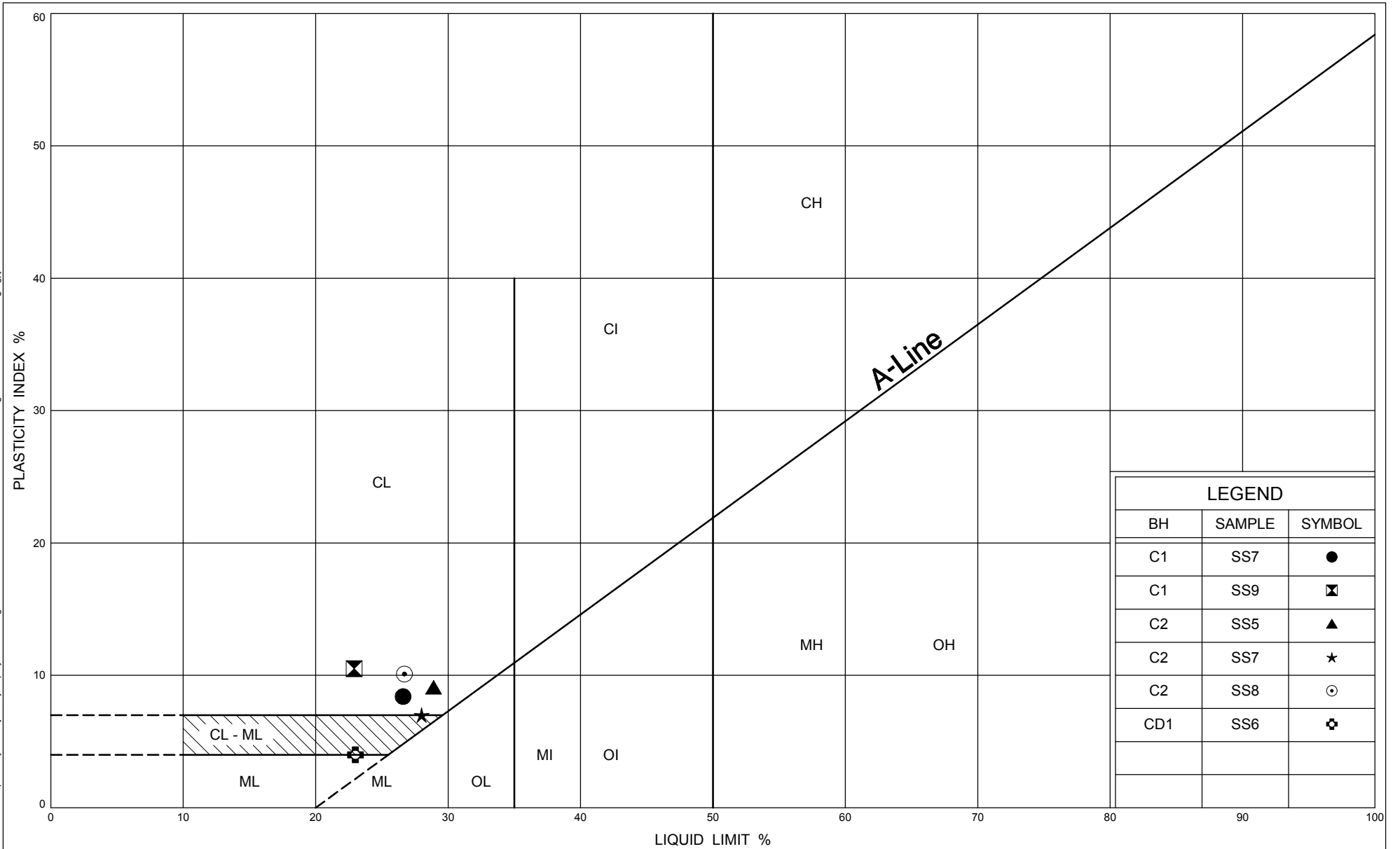
FIG No B1-3

G W P 5233-06-00

Crow Bridge Replacement

UNIFIED SOIL CLASSIFICATION SYSTEM





Ministry of
Transportation

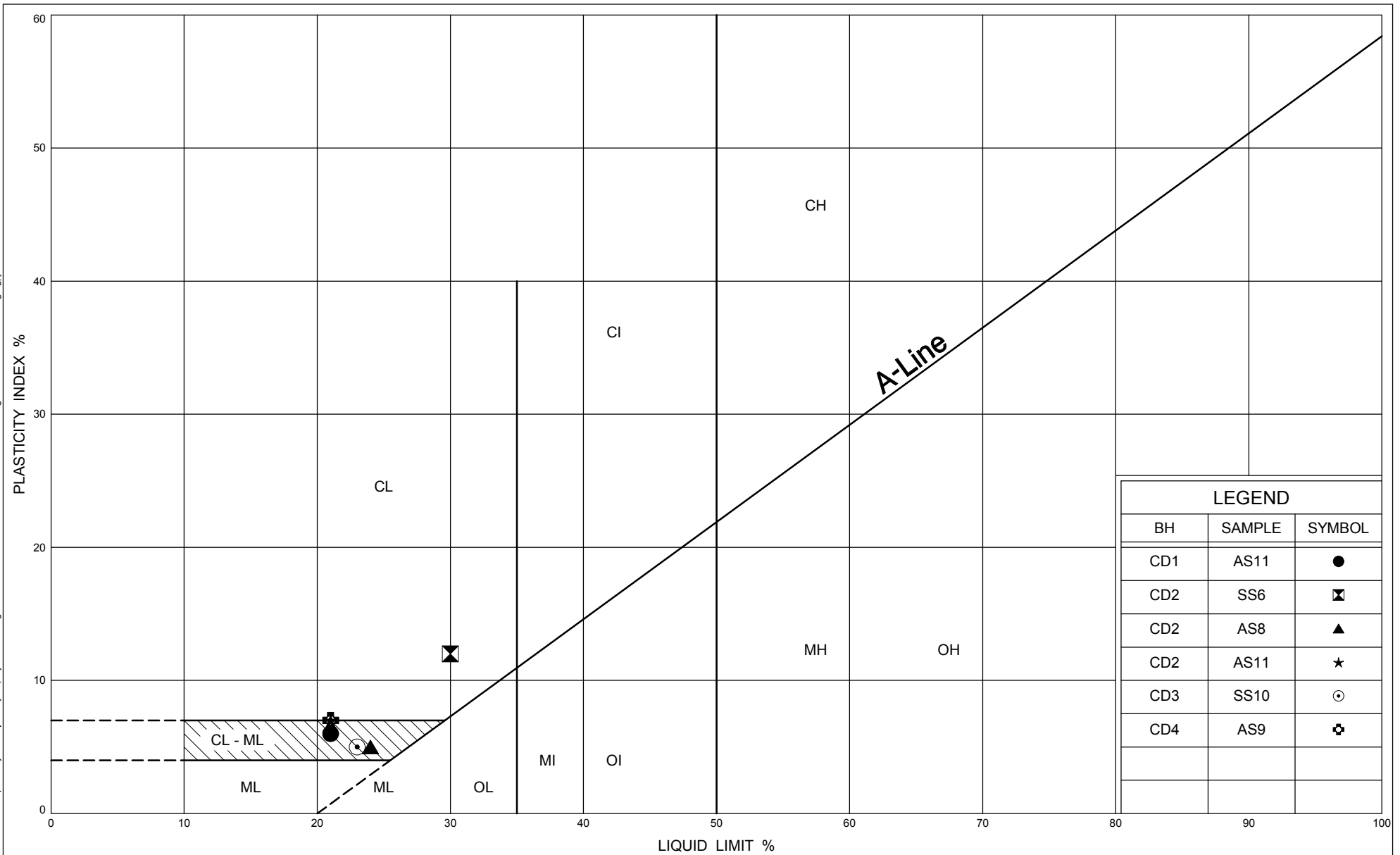
PLASTICITY CHART

CLAYEY SILT TO SILTY CLAY

FIG No B1-5

G W P 5233-06-00

Crow Bridge Replacement



Ministry of
Transportation

PLASTICITY CHART

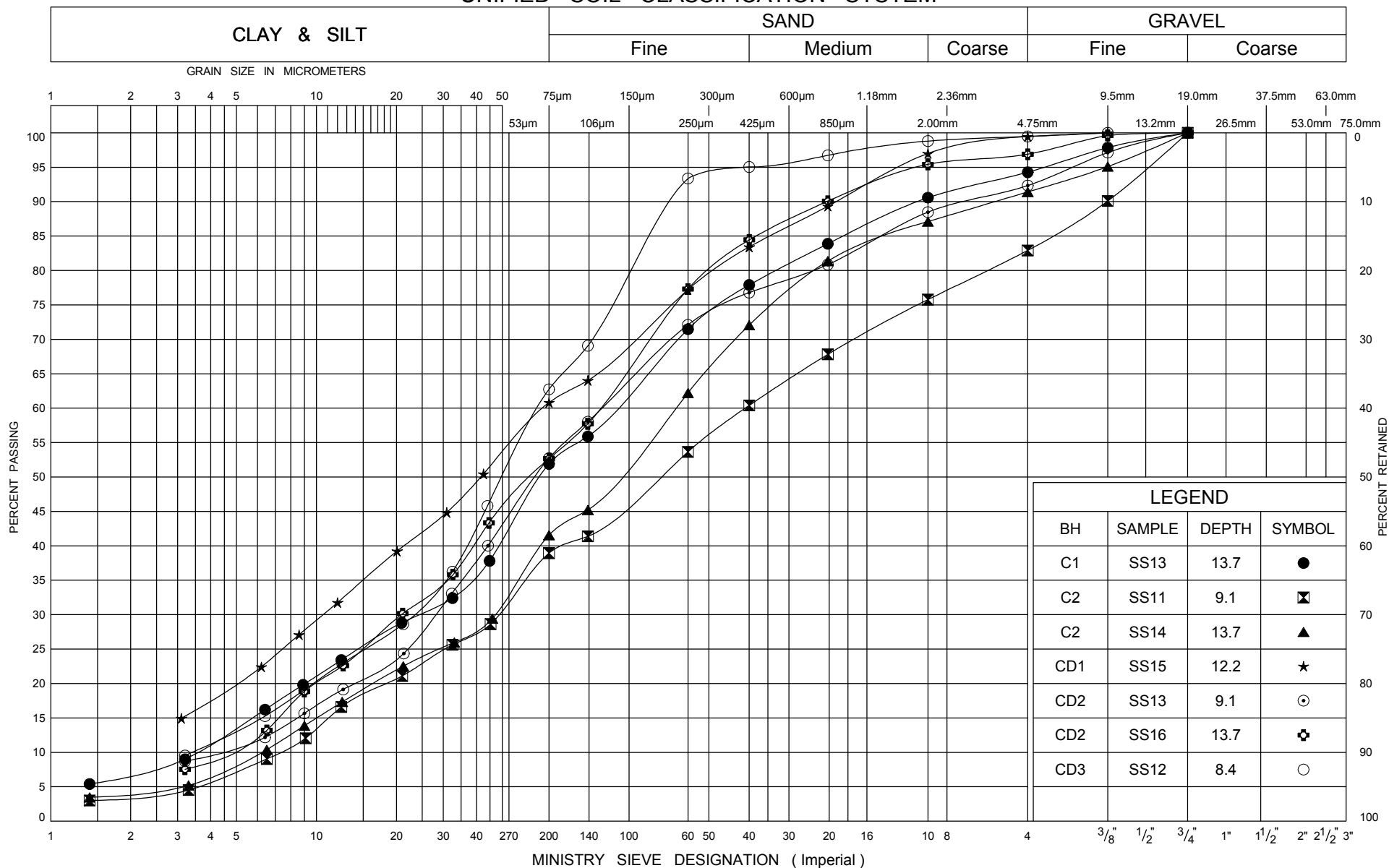
CLAYEY SILT TO SILTY CLAY

FIG No B1-6

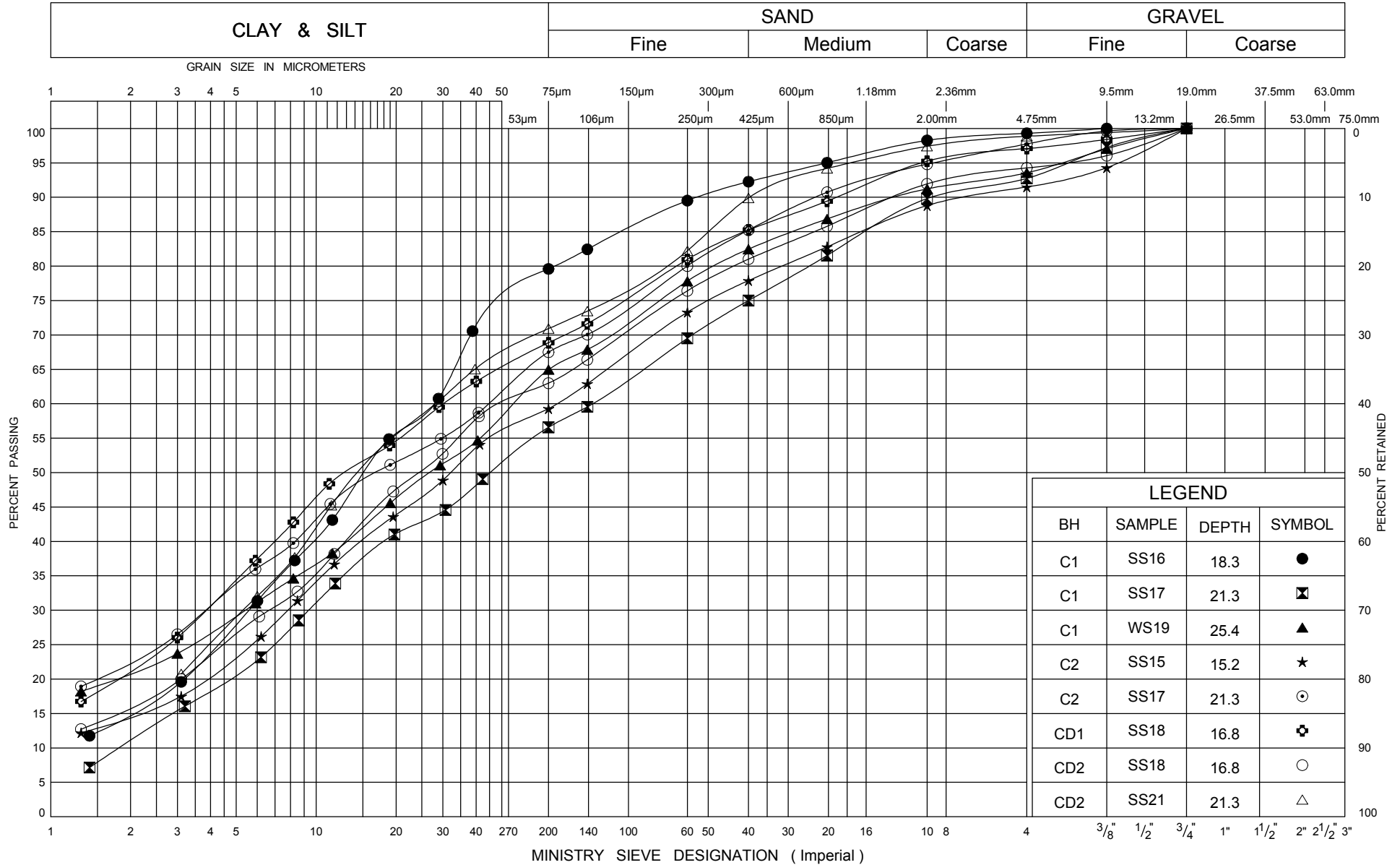
G W P 5233-06-00

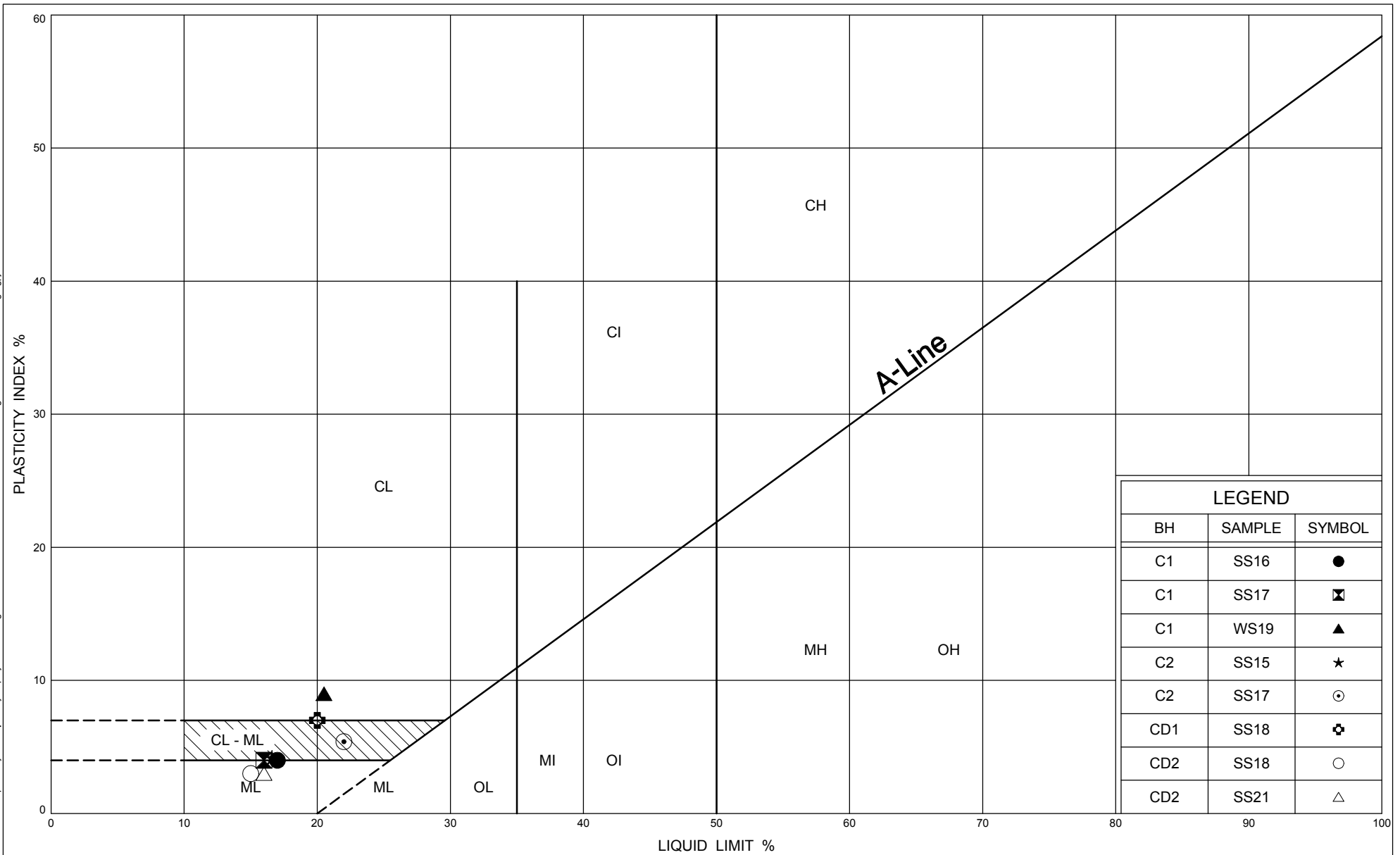
Crow Bridge Replacement

UNIFIED SOIL CLASSIFICATION SYSTEM



UNIFIED SOIL CLASSIFICATION SYSTEM





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Transportation

PLASTICITY CHART

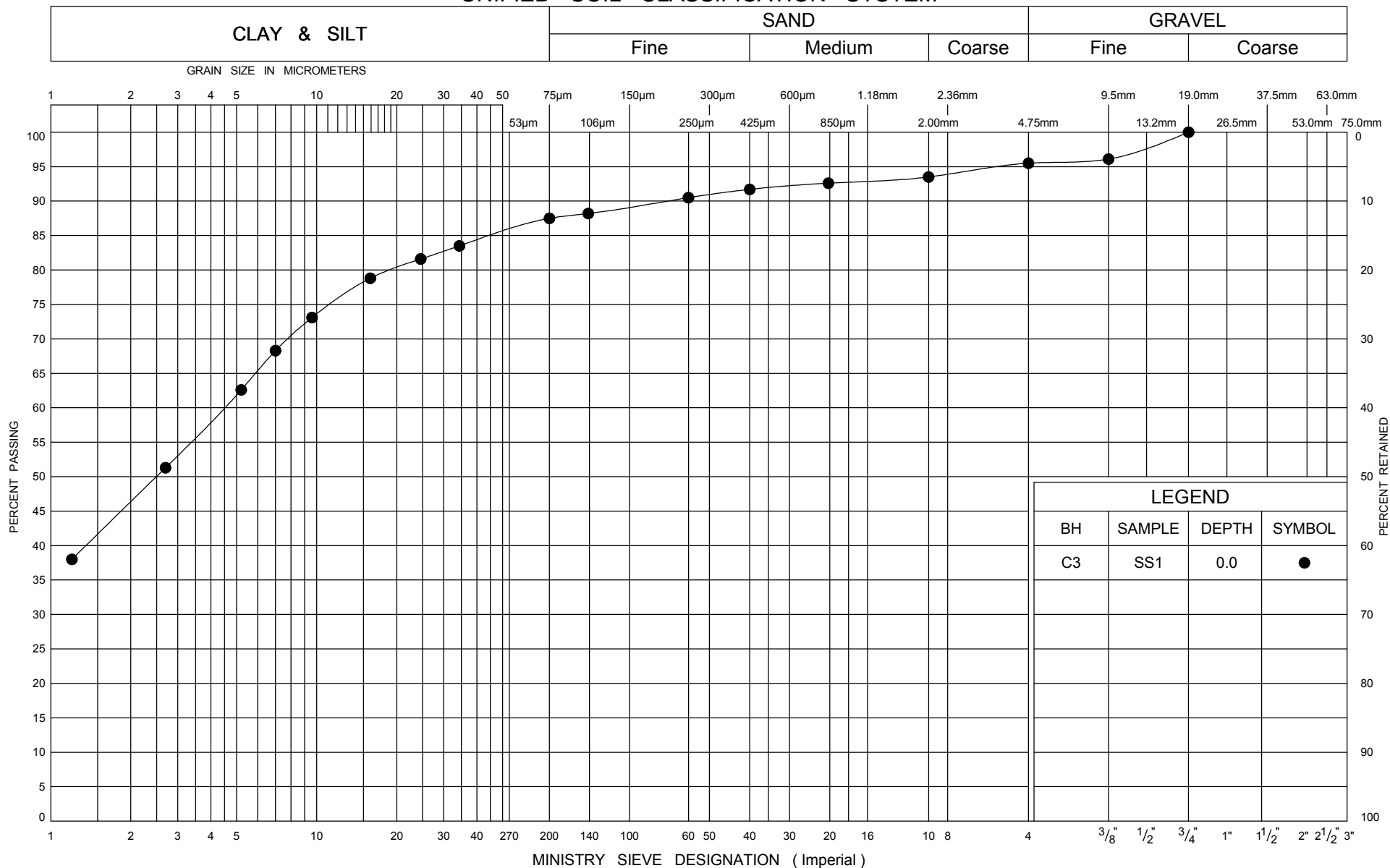
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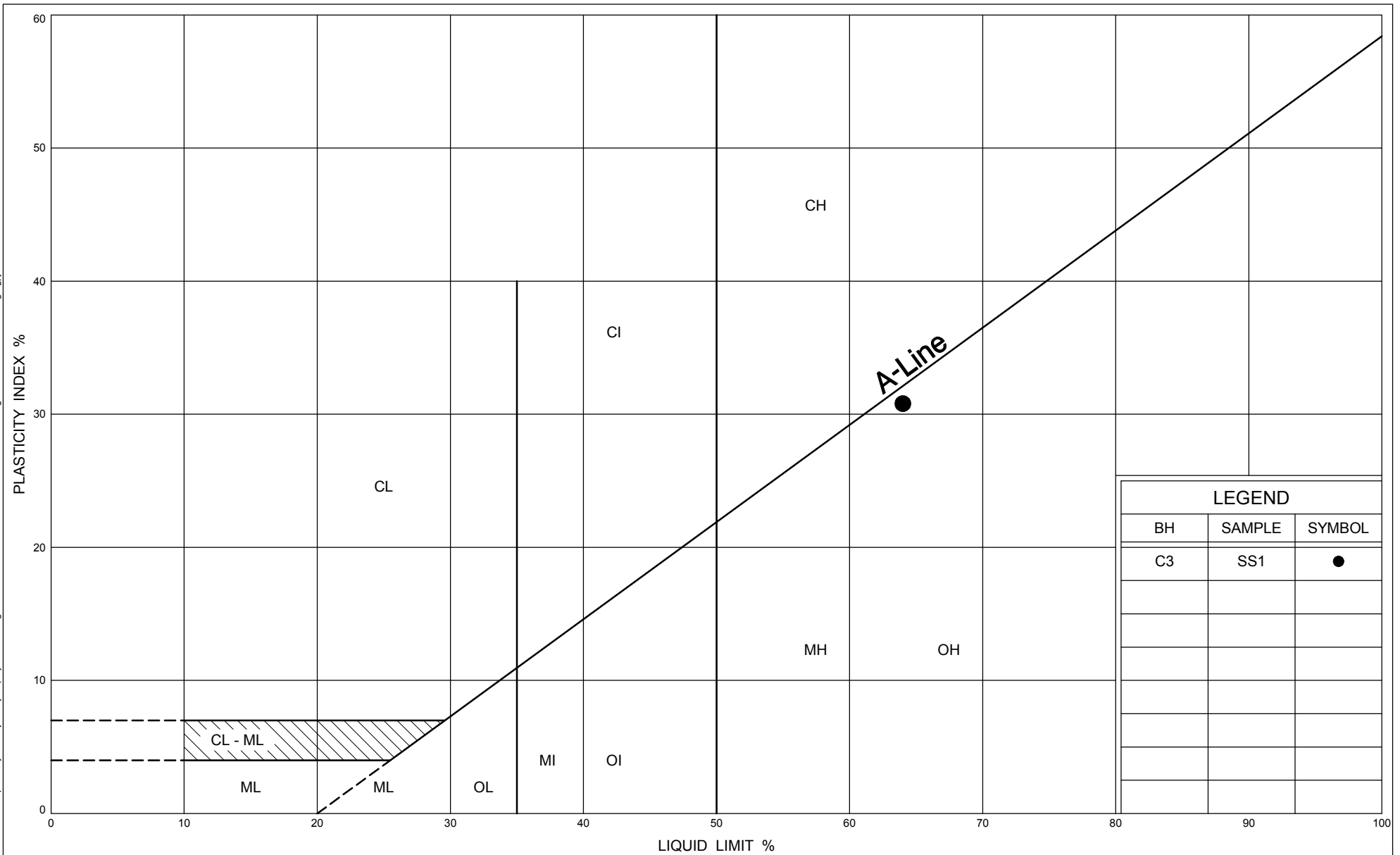
FIG No B1-9

G W P 5233-06-00

Crow Bridge Replacement

UNIFIED SOIL CLASSIFICATION SYSTEM





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PLASTICITY CHART

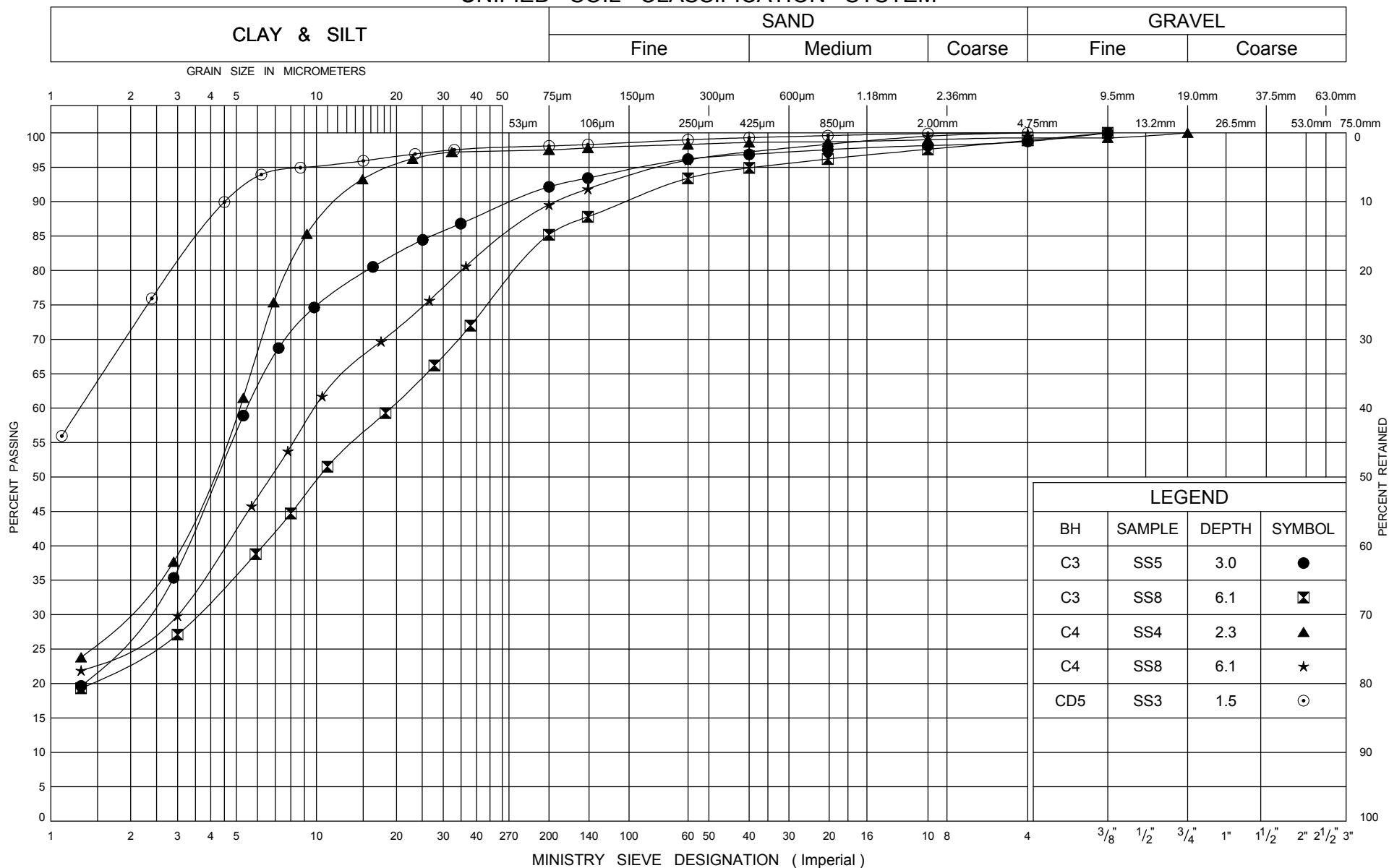
FILL - SILTY CLAY

FIG No B2-2

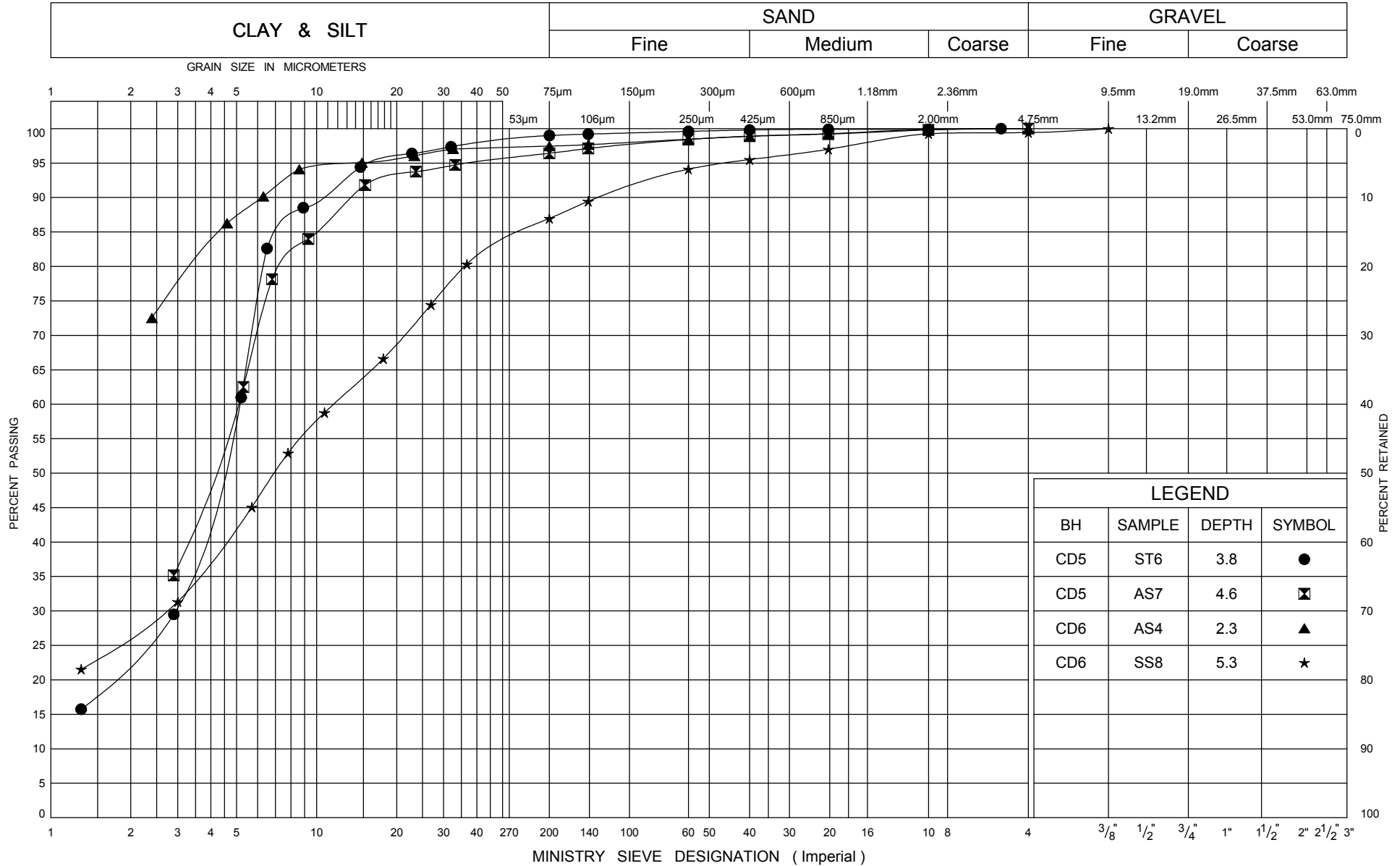
G W P 5233-06-00

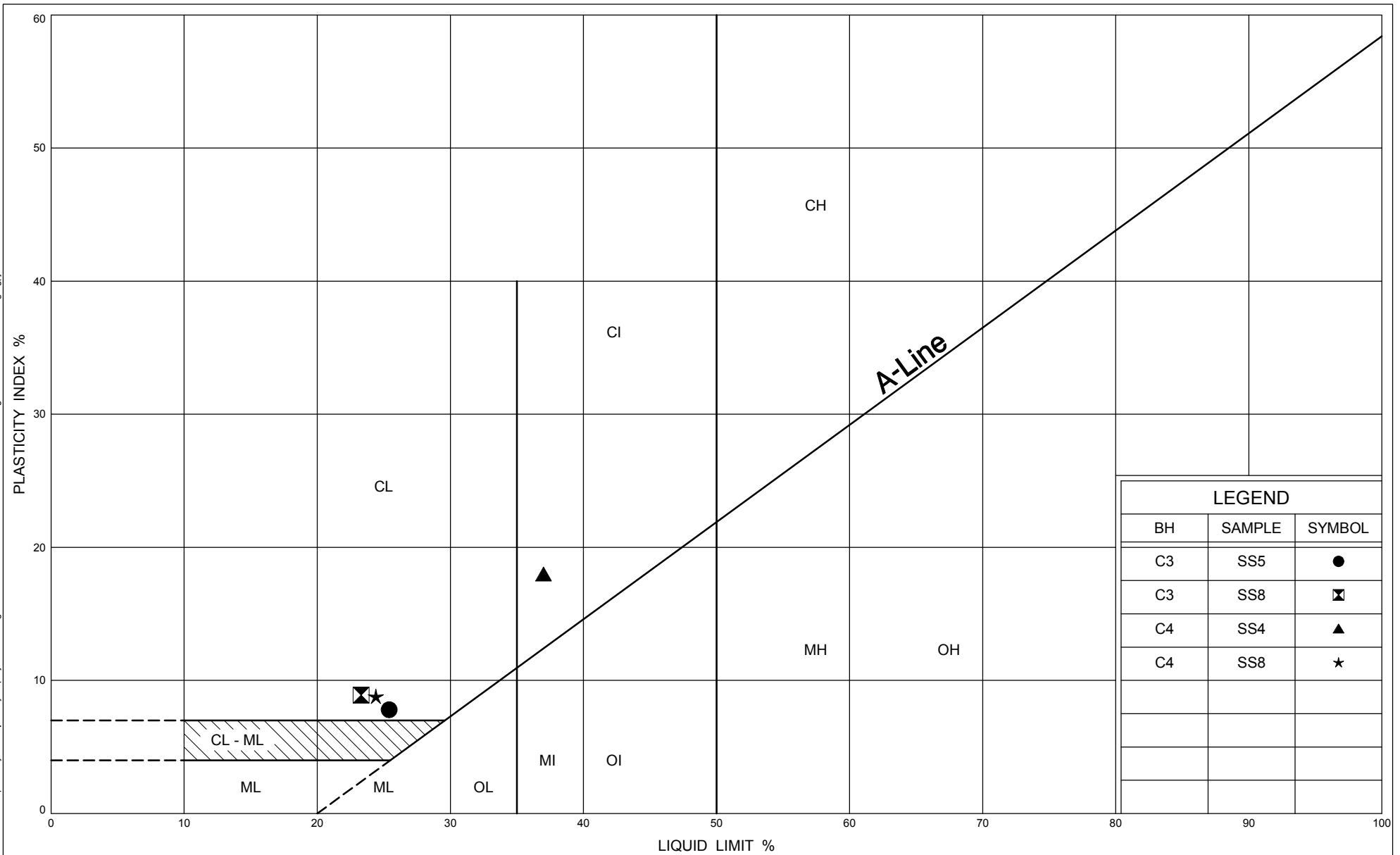
Crow Bridge Replacement

UNIFIED SOIL CLASSIFICATION SYSTEM



UNIFIED SOIL CLASSIFICATION SYSTEM





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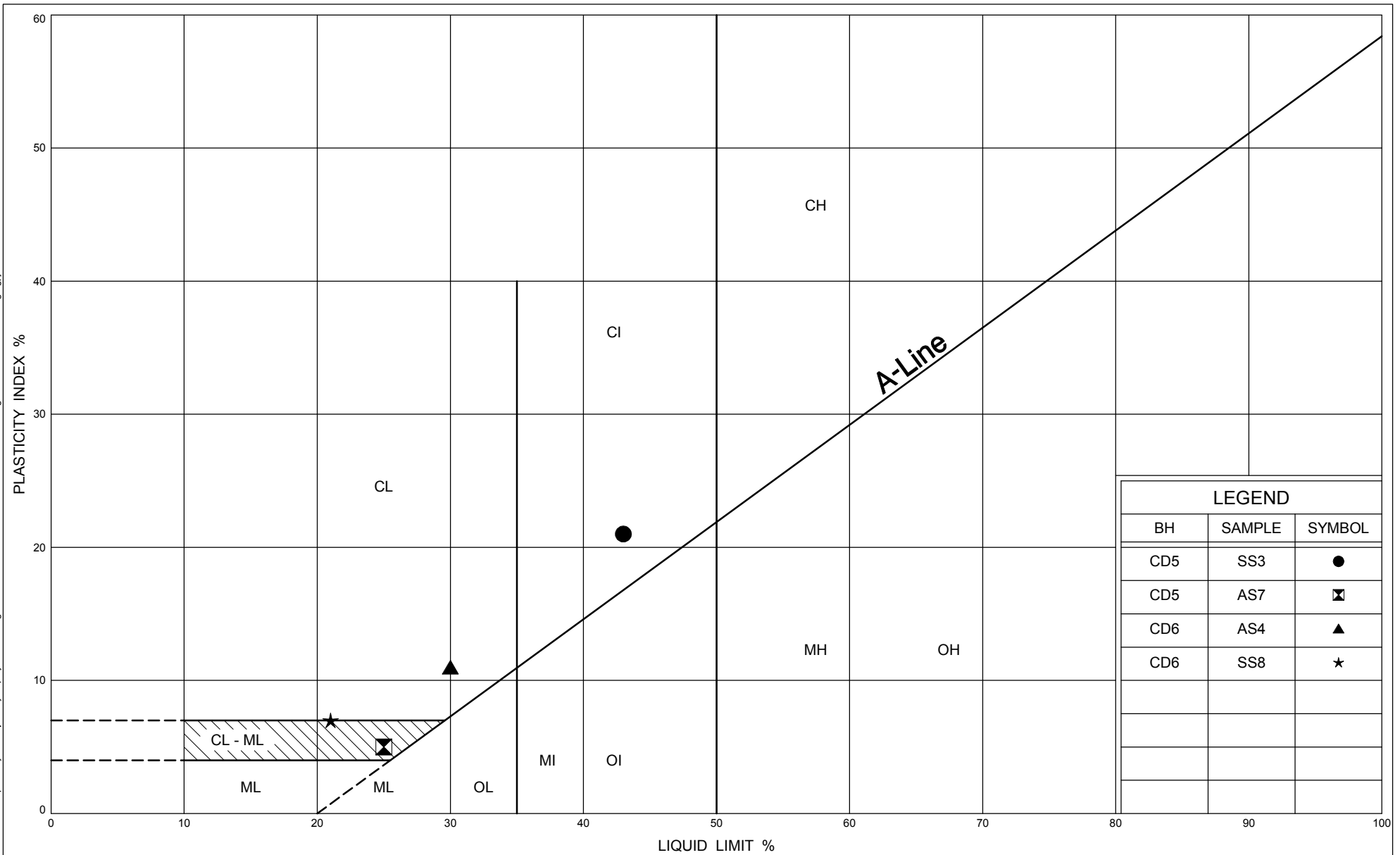
PLASTICITY CHART

SILTY CLAY

FIG No B2-5

G W P 5233-06-00

Crow Bridge Replacement



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PLASTICITY CHART

CLAYEY SILT TO SILTY CLAY

FIG No B2-6

G W P 5233-06-00

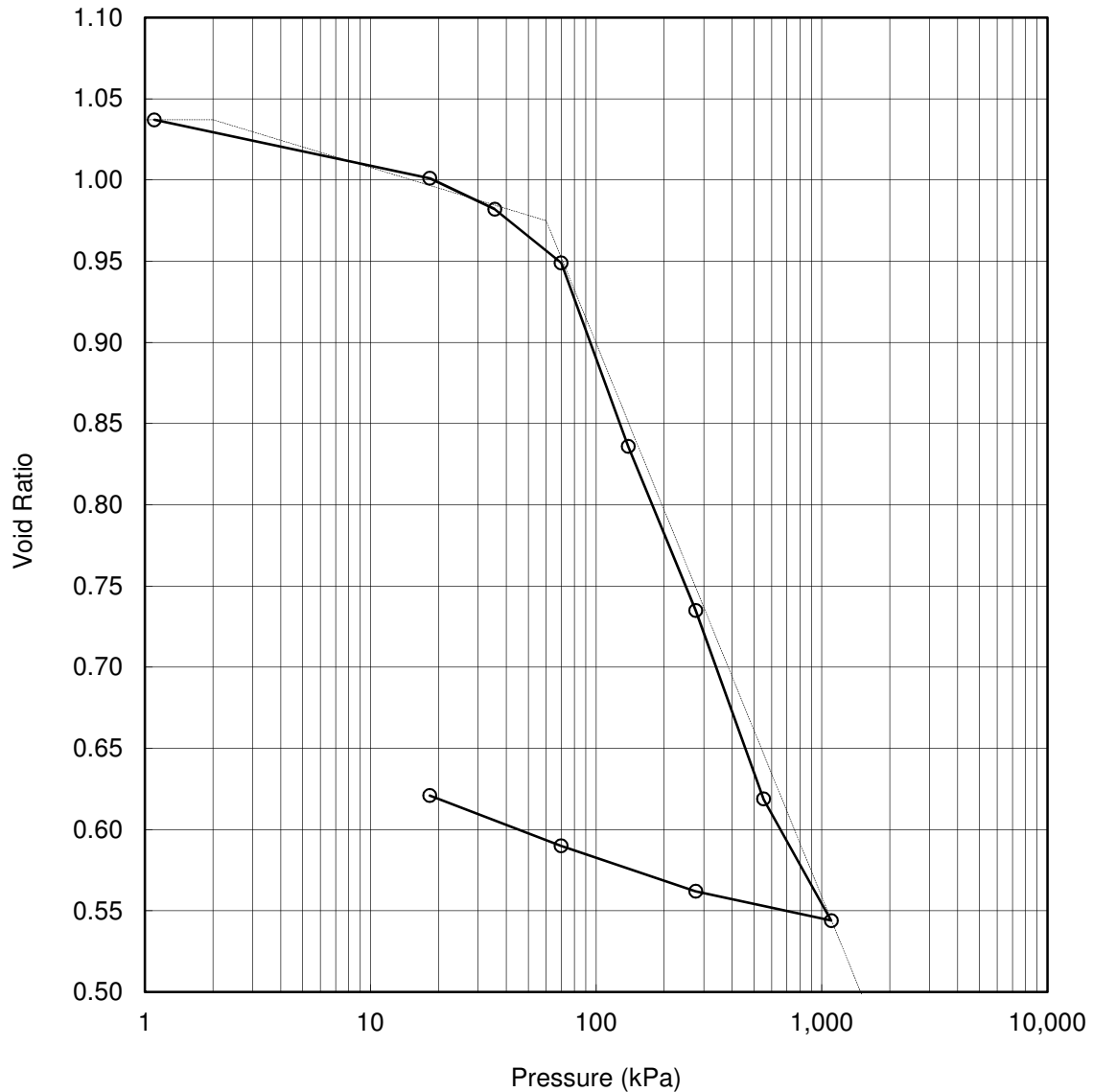
Crow Bridge Replacement

CONSOLIDATION TEST

FIG No B2-7

CROW BRIDGE, BH CD5, SAMPLE Sa6
SILTY CLAY

e vs Pressure



Soil Type : Silty Clay

$e_o =$	1.04	$\omega_L =$	-	$Po' =$	2 kPa
$\omega =$	33%	$\omega_P =$	-	$Pc' =$	60 kPa
$\gamma =$	17.4 kN/m ³	$PI =$	-	$Cc =$	0.341
$G_s =$	2.73			$Cr =$	0.042

Project No. : 11-10-5076
Date : January 2012



Terraprobe Inc.

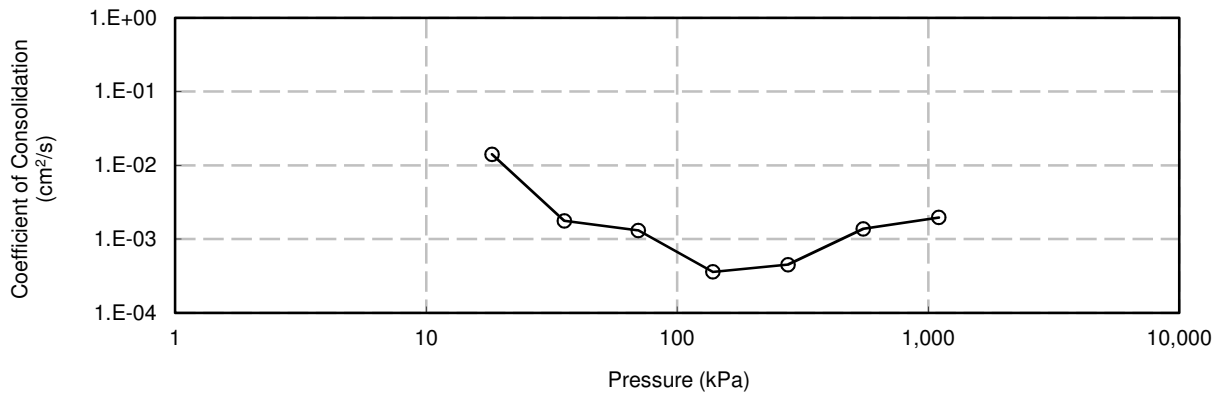
Prepared By : MD
Checked By : JC

CONSOLIDATION TEST

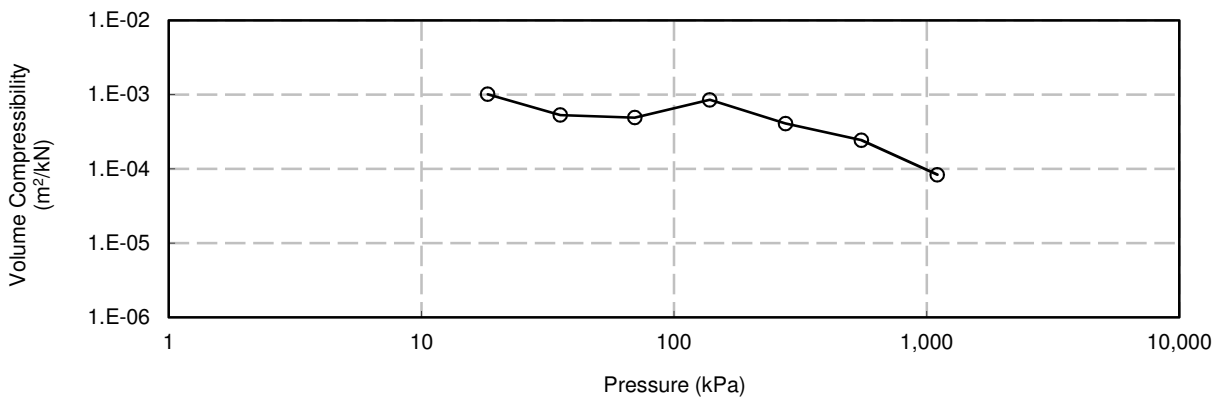
FIG No B2-8

CROW BRIDGE, BH CD5, SAMPLE Sa6
SILTY CLAY

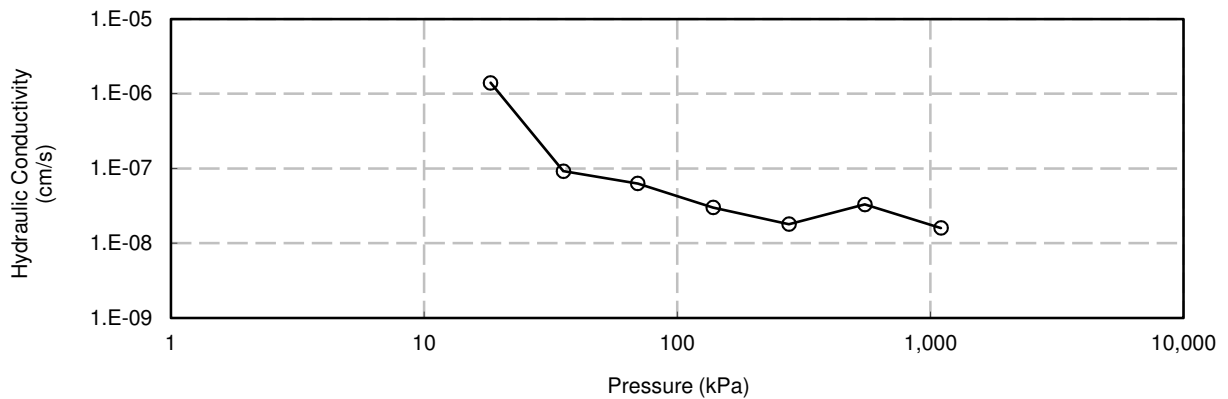
Cv vs Pressure



mv vs Pressure



k vs Pressure



Project No. : 11-10-5076
Date : January 2012

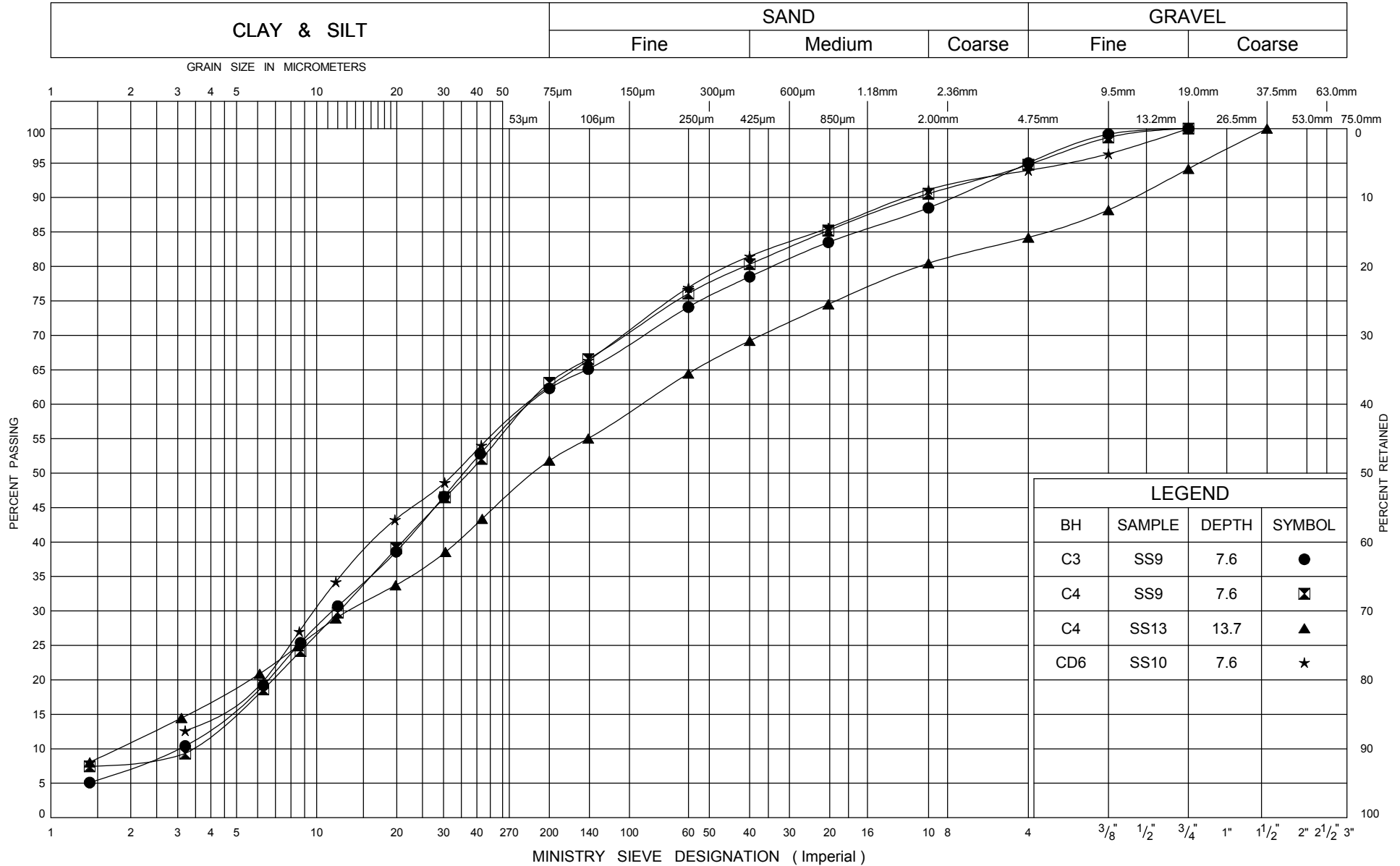


Terraprobe Inc.

Prepared By : MD
Checked By : JC

C:\Users\Toshiba\Documents\1 Projects\11-10-5076, Hwy 11, Crow and Montcalm Creeks\Reports\Crow Creek\Latest Draft\Appendix C3-4.xls

UNIFIED SOIL CLASSIFICATION SYSTEM



Ministry of
Transportation

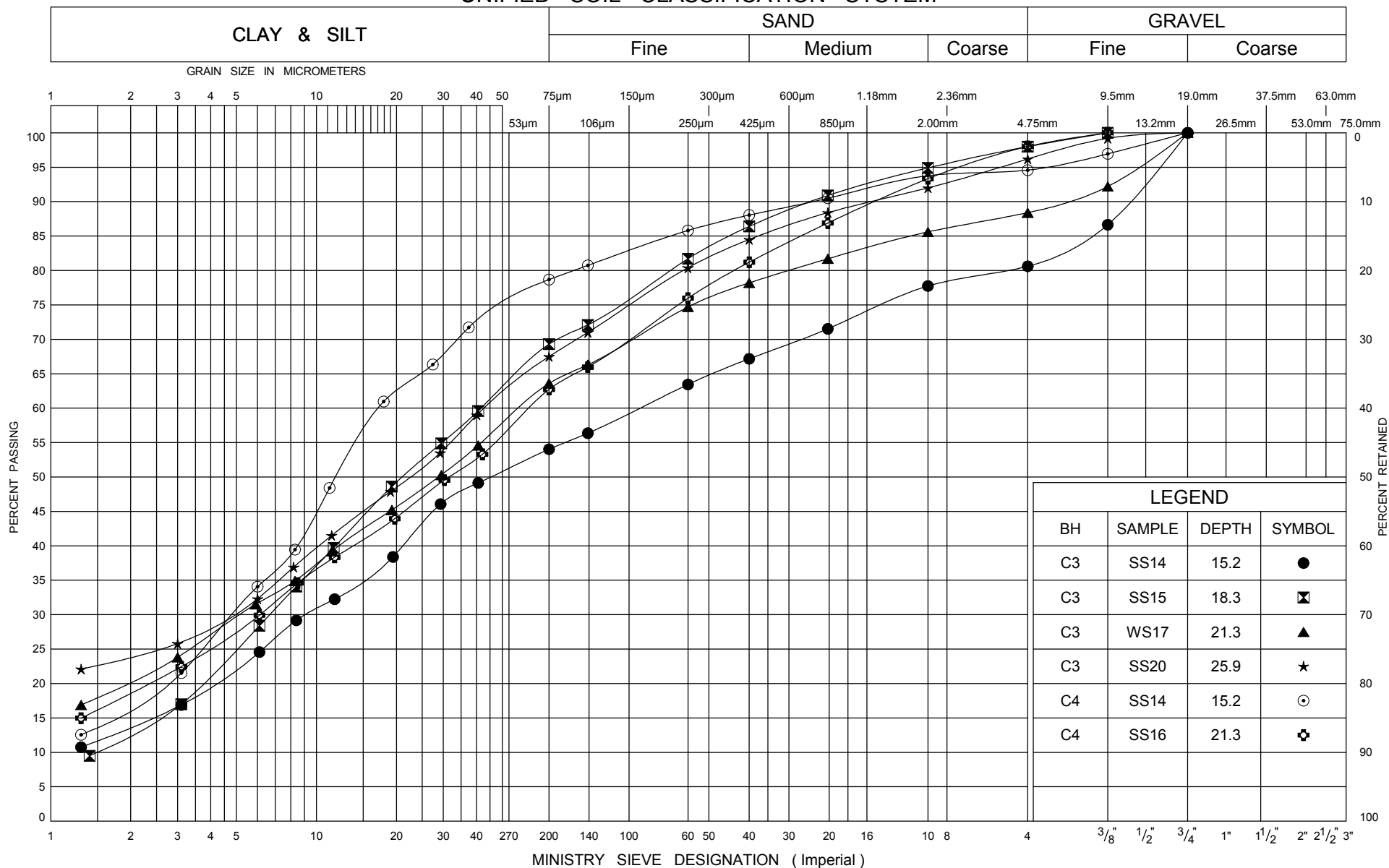
GRAIN SIZE DISTRIBUTION SANDY SILT TILL

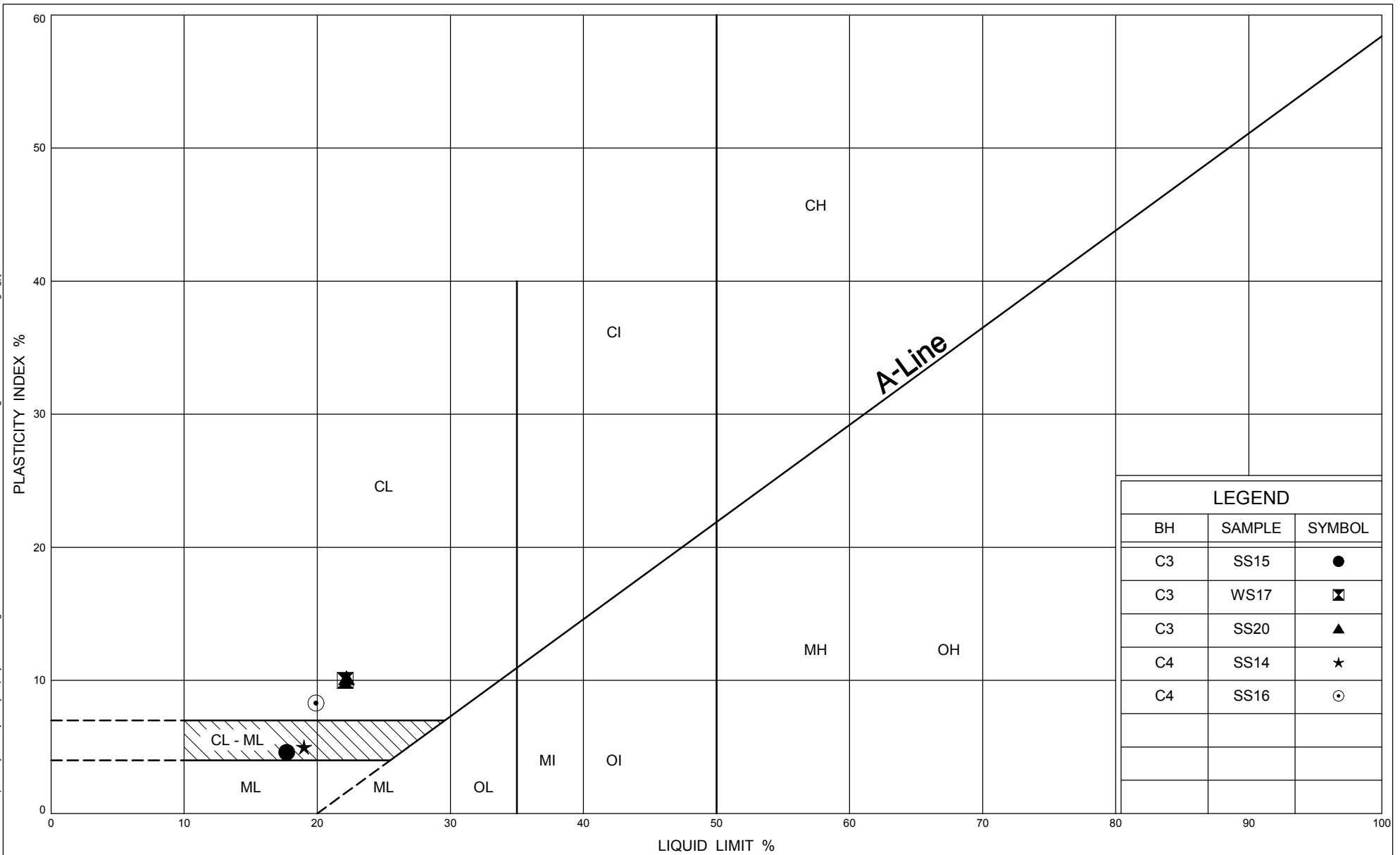
FIG No B2-9

G W P 5233-06-00

Crow Bridge Replacement

UNIFIED SOIL CLASSIFICATION SYSTEM





Ministry of
Transportation

PLASTICITY CHART

CLAYEY SILT TILL

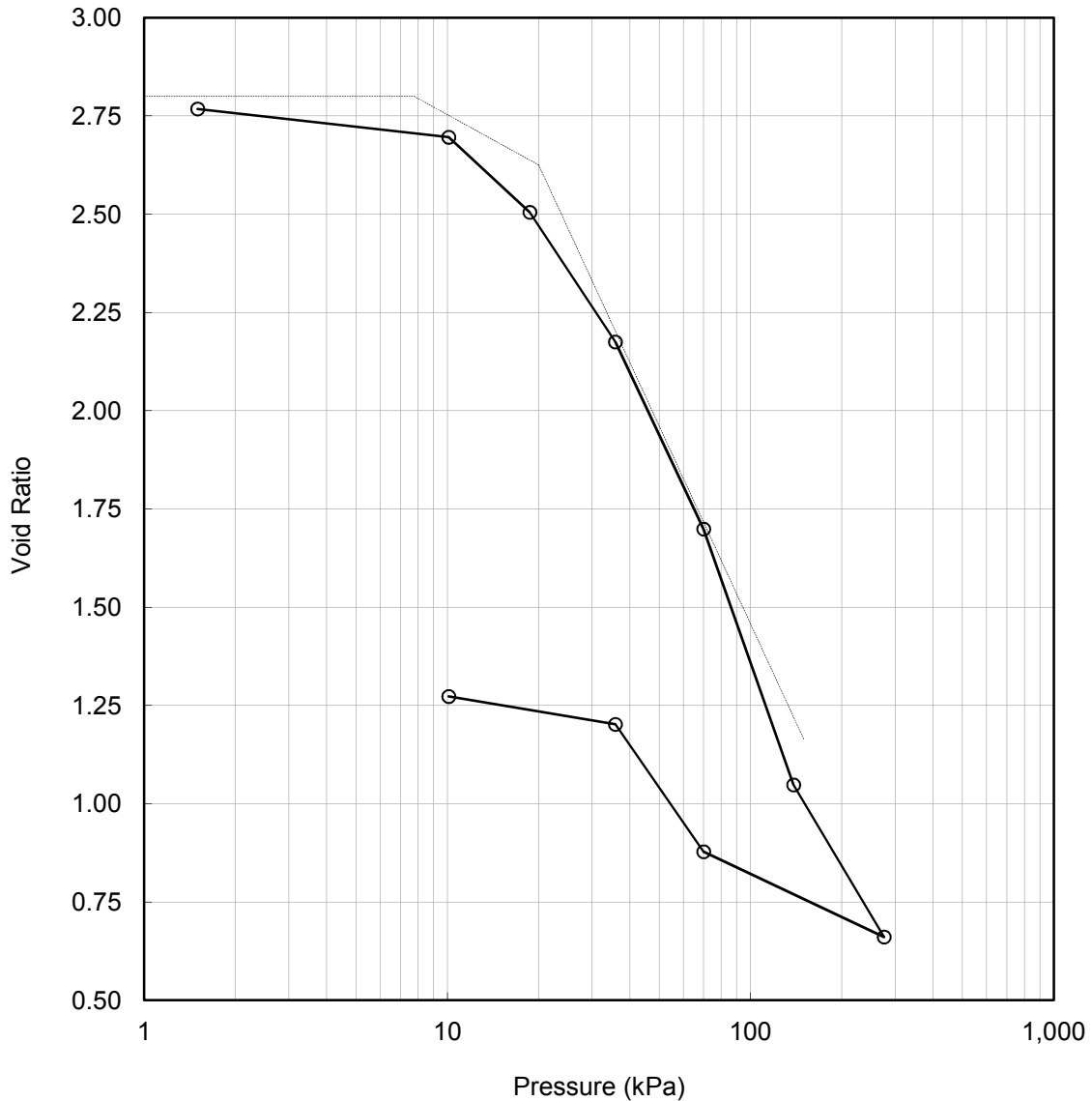
FIG No B2-11

G W P 5233-06-00

Crow Bridge Replacement

CROW CREEK DETOUR, BH 24+450
PEAT

e vs Pressure



Soil Type :	Peat		
$e_o =$	2.80	$\omega_L =$	-
$\omega =$	586%	$\omega_P =$	-
$\gamma =$	9.8 kN/m ³	PI =	-
Gs =	0.55		
		Po' =	7 kPa
		Pc' =	20 kPa
		Cc =	1.671
		Cr =	0.426

Project No. : 11-10-5076
Date : January 2012



Terraprobe Inc.

Prepared By : MD
Checked By : JC

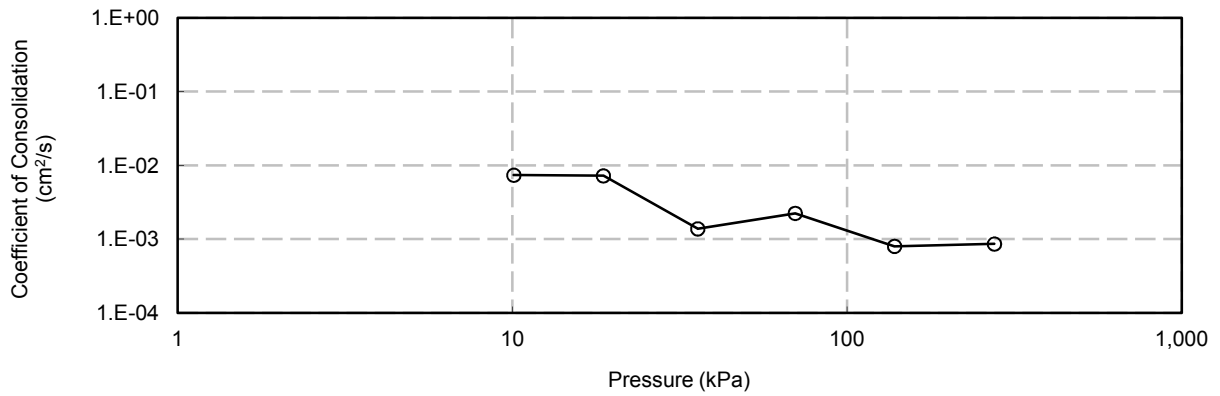
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CONSOLIDATION TEST

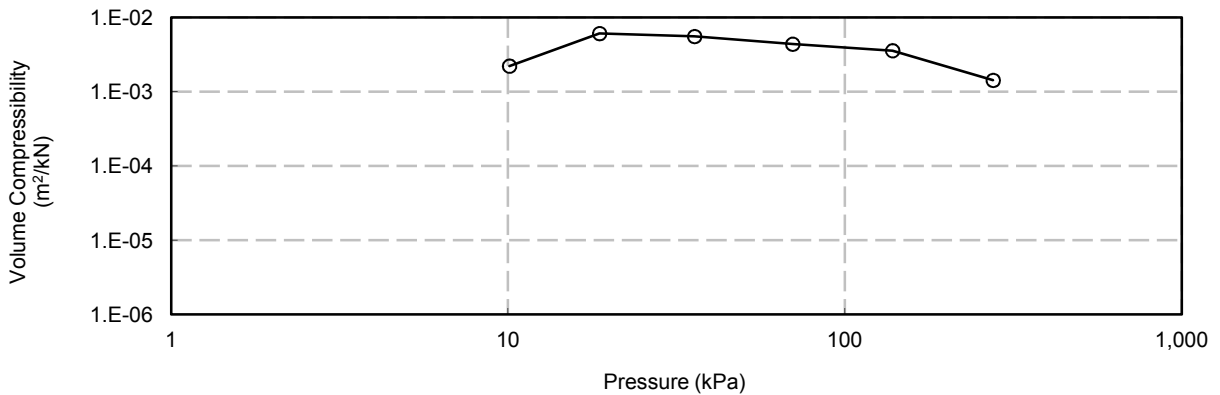
APPENDIX B2-13

CROW CREEK DETOUR, BH 24+450
PEAT

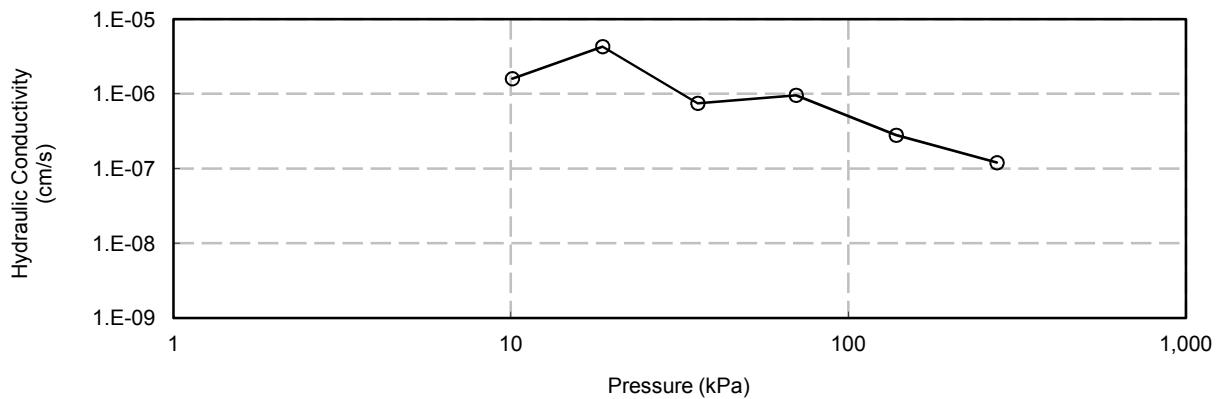
Cv vs Pressure



mv vs Pressure



k vs Pressure



Project No. : 11-10-5076
Date : January 2012



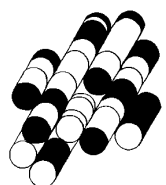
Terraprobe Inc.

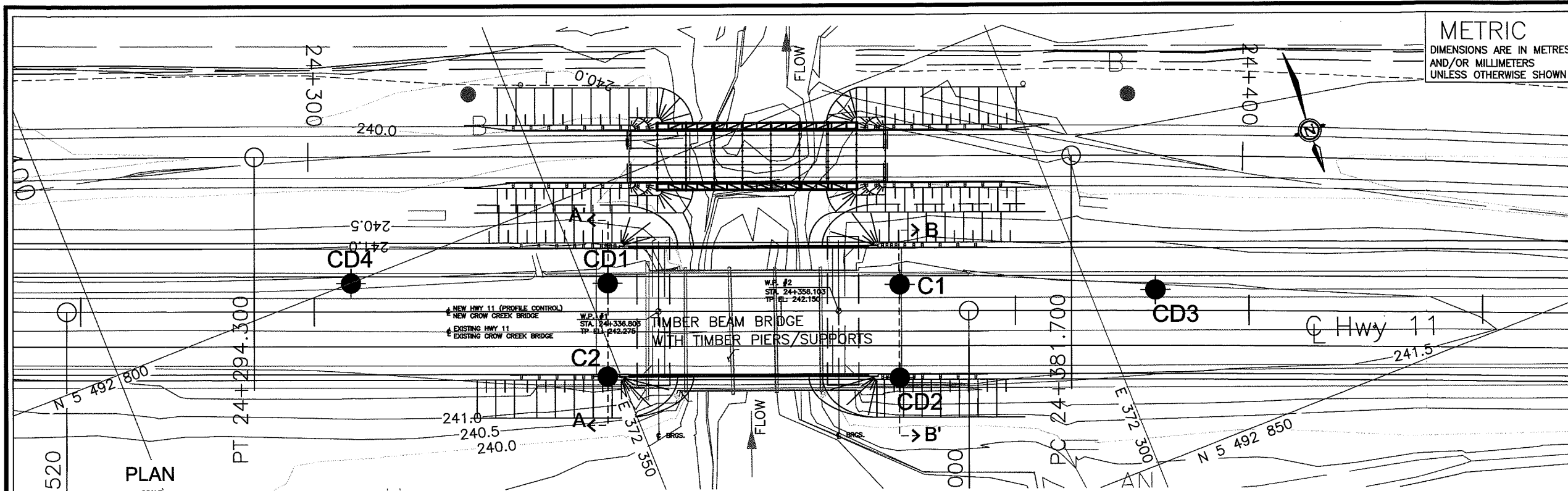
Prepared By : MD
Checked By : JC

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APPENDIX C

TERRAPROBE INC.





METRIC
DIMENSIONS ARE IN METRES
AND/OR MILLIMETERS
UNLESS OTHERWISE SHOWN

CONT No
GWP No 5233-06-00

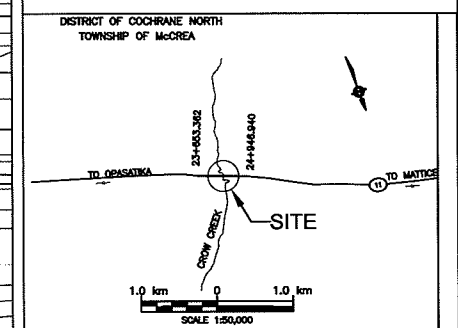
CROW CREEK BRIDGE
BOREHOLE LOCATION AND SOIL STRATA



SHEET
1 OF 4

McCORMICK RANKIN CORPORATION
MRC

Terraprobe Inc.
Consulting Geotechnical & Environmental Engineering
Construction Materials, Inspection & Testing
11 Indell Lane - Brampton Ontario L6T 3Y3 (905) 796-2650



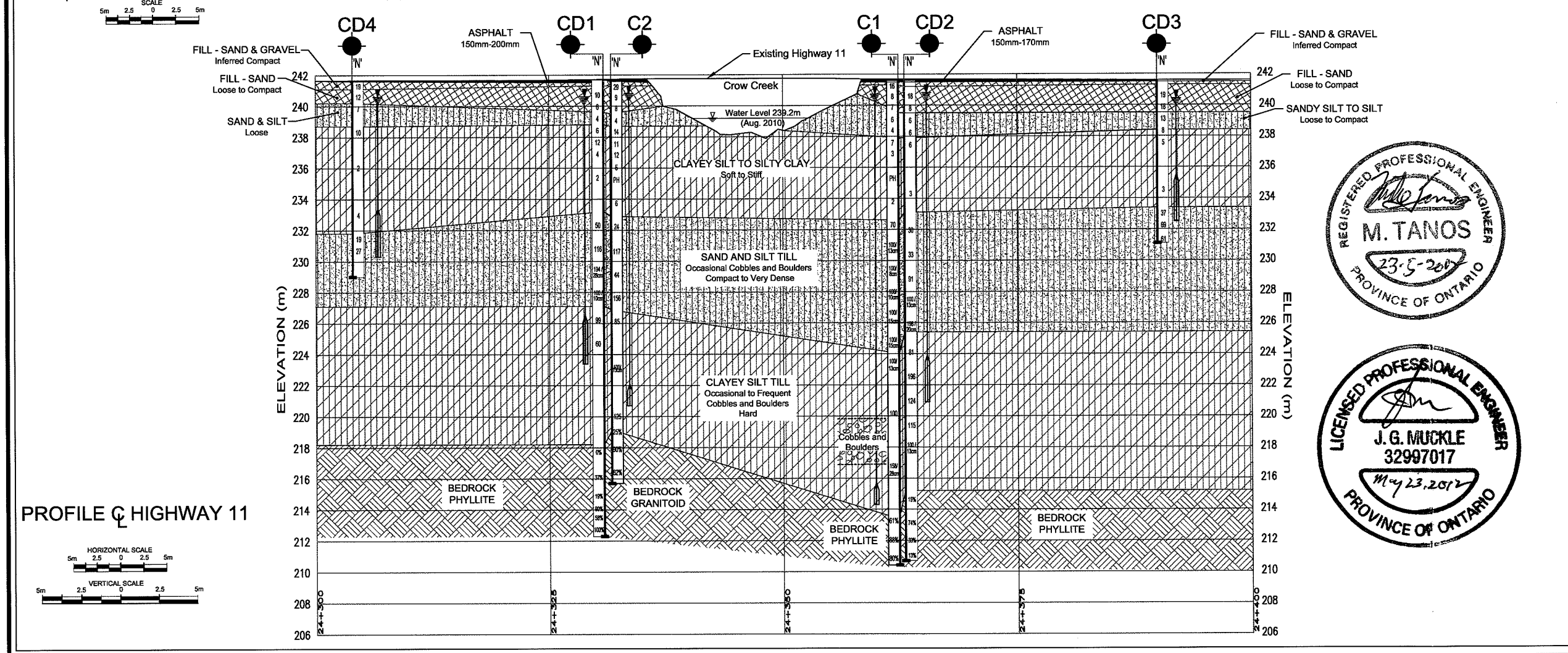
KEY PLAN

- LEGEND
- Bore Hole
 - Dynamic Cone Penetration Test
 - Bore Hole And Cone
 - 'N' Blows/0.3m (Std Pen Test, 475 J/blow)
 - CONE Blows/0.3m (60° Cone, 475 J/blow)
 - WL at Time of Investigation
 - WL in Piezometer
 - Piezometer
 - 90% Rock Quality Designation
 - A/R Auger Refusal

No	ELEV.	COORDINATES	
		NORTHING	EASTING
C1	241.6	5 492 821.8	372 318.7
C2	241.6	5 492 819.4	372 351.3
CD1	241.7	5 492 810.1	372 347.7
CD2	241.6	5 492 831.1	372 322.4
CD3	241.6	5 492 832.4	372 293.4
CD4	241.6	5 492 800.0	372 373.2

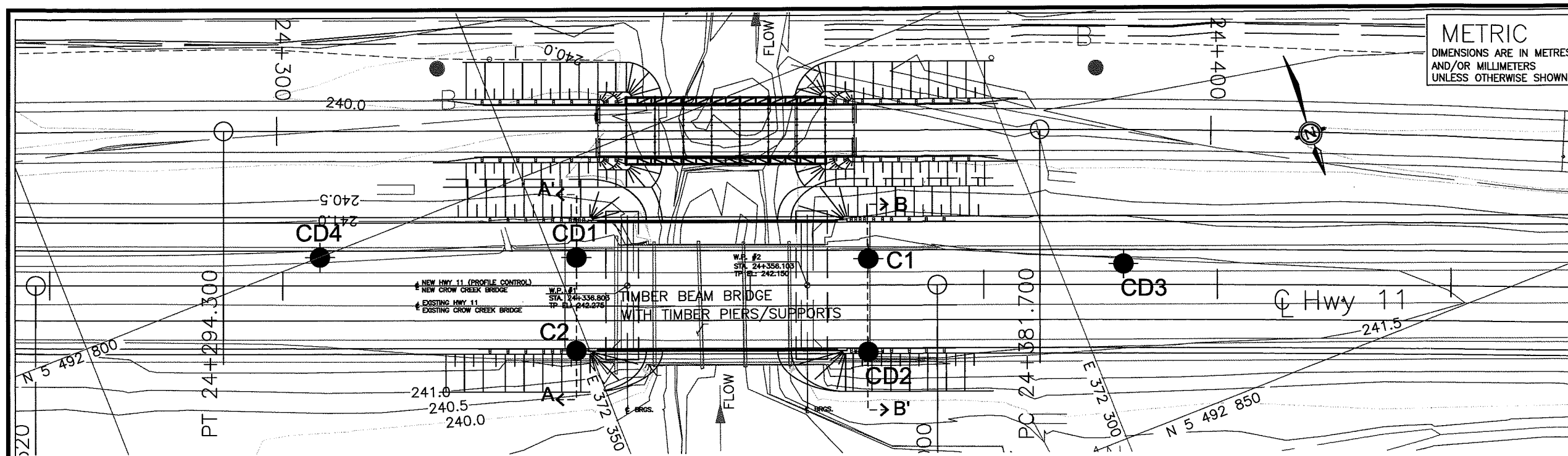
NOTE
The boundaries between soil strata have been established only at Bore Hole locations. Between Bore Holes the boundaries are assumed from geological evidence.
This drawing is for subsurface information only. Surface details and features are for conceptual illustration.

REVISIONS	DATE				DESCRIPTION
	DATE	BY	DATE	DESCRIPTION	
DESIGN	G.M.	CODE	CHBDC2008	LOAD	DATE MAY 2012
DRAWN	K.C.	CHK	G.M.	STRUCT 39W-055	GEOCRES 42G-33



PROFILE Q HIGHWAY 11





METRIC
DIMENSIONS ARE IN METRES
AND/OR MILLIMETERS
UNLESS OTHERWISE SHOWN

CONT No
GWP No 5233-06-00



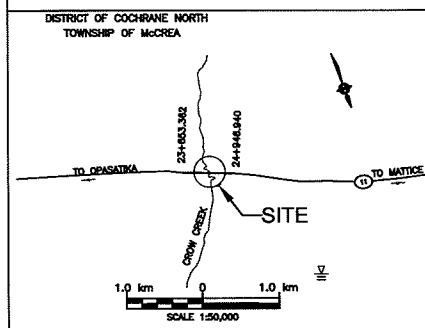
CROW CREEK BRIDGE
BOREHOLE LOCATION AND SOIL STRATA

SHEET
2 OF 4

McCORMICK RANKIN CORPORATION



Terraprobe Inc.
Consulting Geotechnical & Environmental Engineering
Construction Materials, Inspection & Testing
11 Indell Lane - Brampton Ontario L6T 3Y3 (905) 796-2650



KEY PLAN

LEGEND

- Bore Hole
- ⊕ Dynamic Cone Penetration Test
- ⊙ Bore Hole And Cone
- 'N' Blows/0.3m (Std Pen Test, 475 J/blow)
- CONE Blows/0.3m (60° Cone, 475 J/blow)
- WL at Time of Investigation
- WL in Piezometer
- 90% Rock Quality Designation
- A/R Auger Refusal

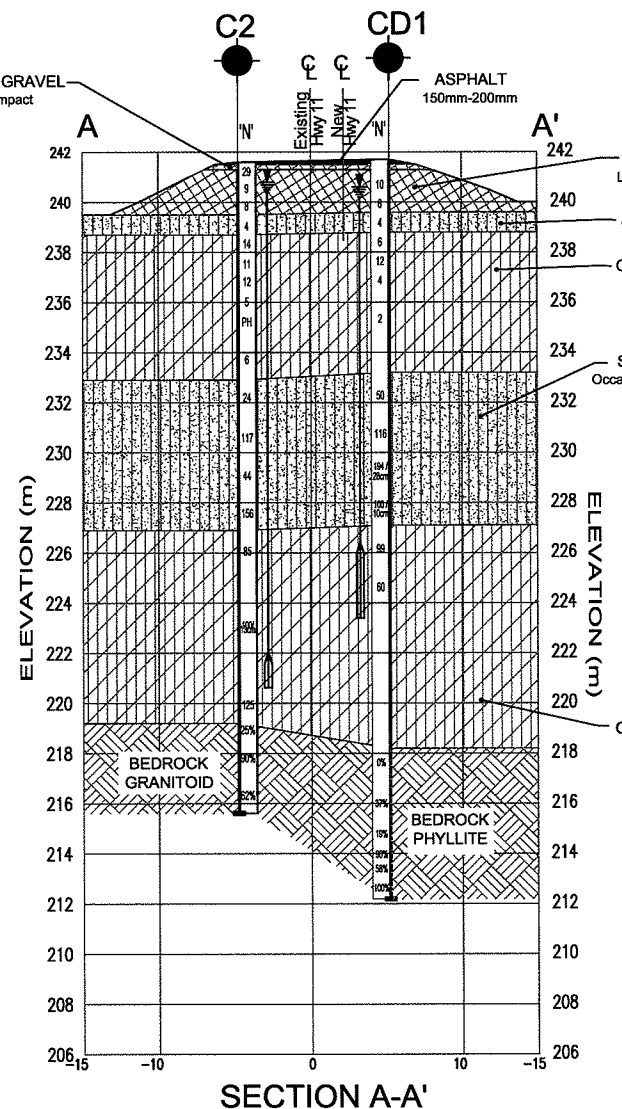
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		NORTHING	EASTING
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C2	241.6	5 492 819.4	372 351.3
CD1	241.7	5 492 810.1	372 347.7
CD2	241.6	5 492 831.1	372 322.4
CD3	241.6	5 492 832.4	372 293.4
CD4	241.6	5 492 800.0	372 373.2

NOTE

The boundaries between soil strata have been established only at Bore Hole locations. Between Bore Holes the boundaries are assumed from geological evidence.
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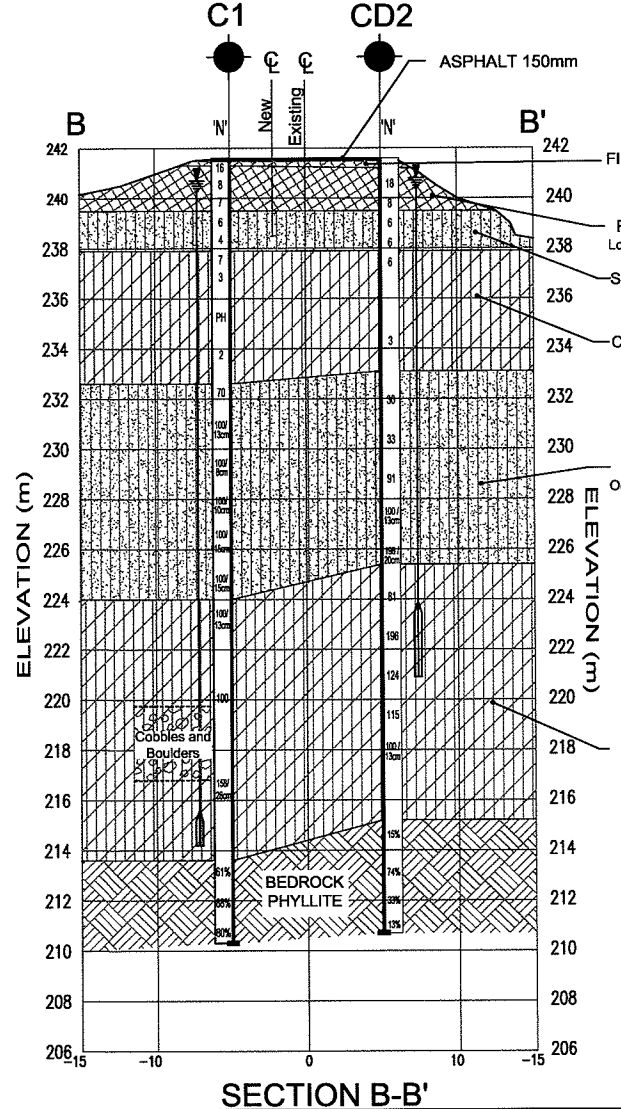
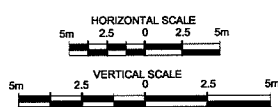
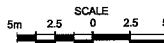
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	DATE	BY	CHK	DESIGN	DATE	BY	CHK	DESIGN

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DRAWN	K.C.	CHK	G.M.	STRUCT	39W-055	GEOCRES 42G-33

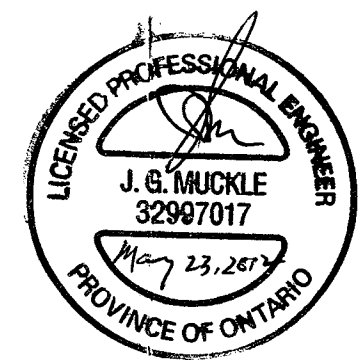


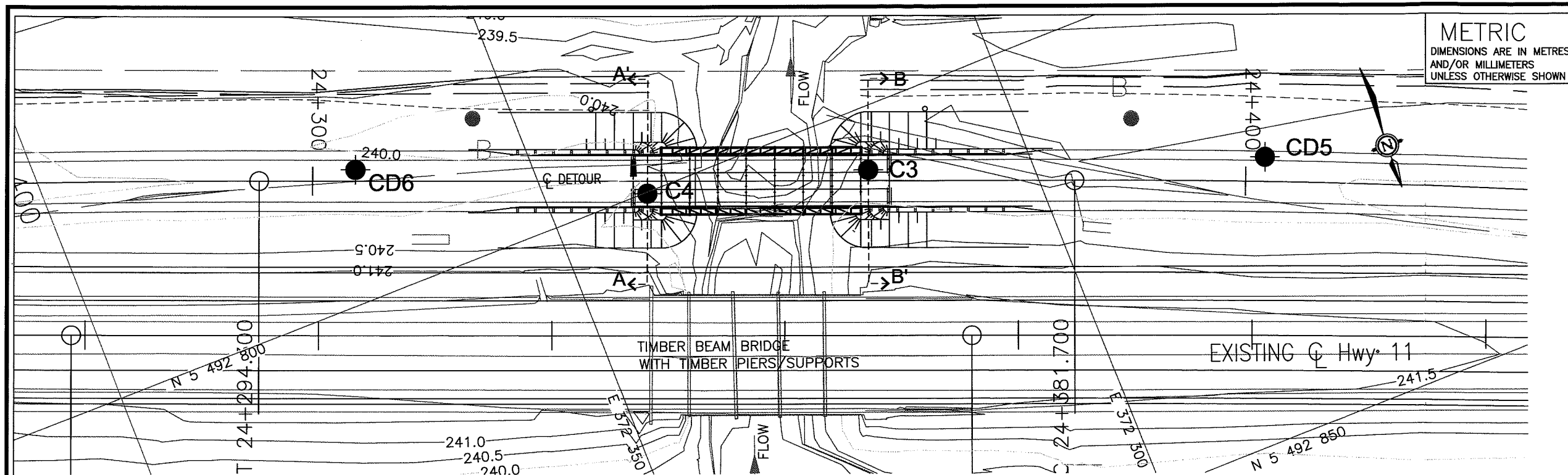
SECTION A-A'

PLAN



SECTION B-B'





METRIC
DIMENSIONS ARE IN METRES
AND/OR MILLIMETERS
UNLESS OTHERWISE SHOWN

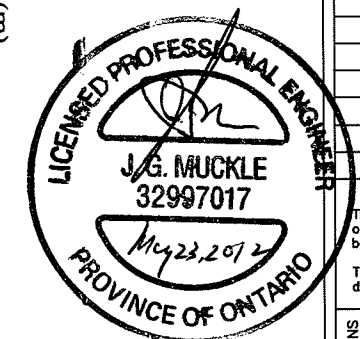
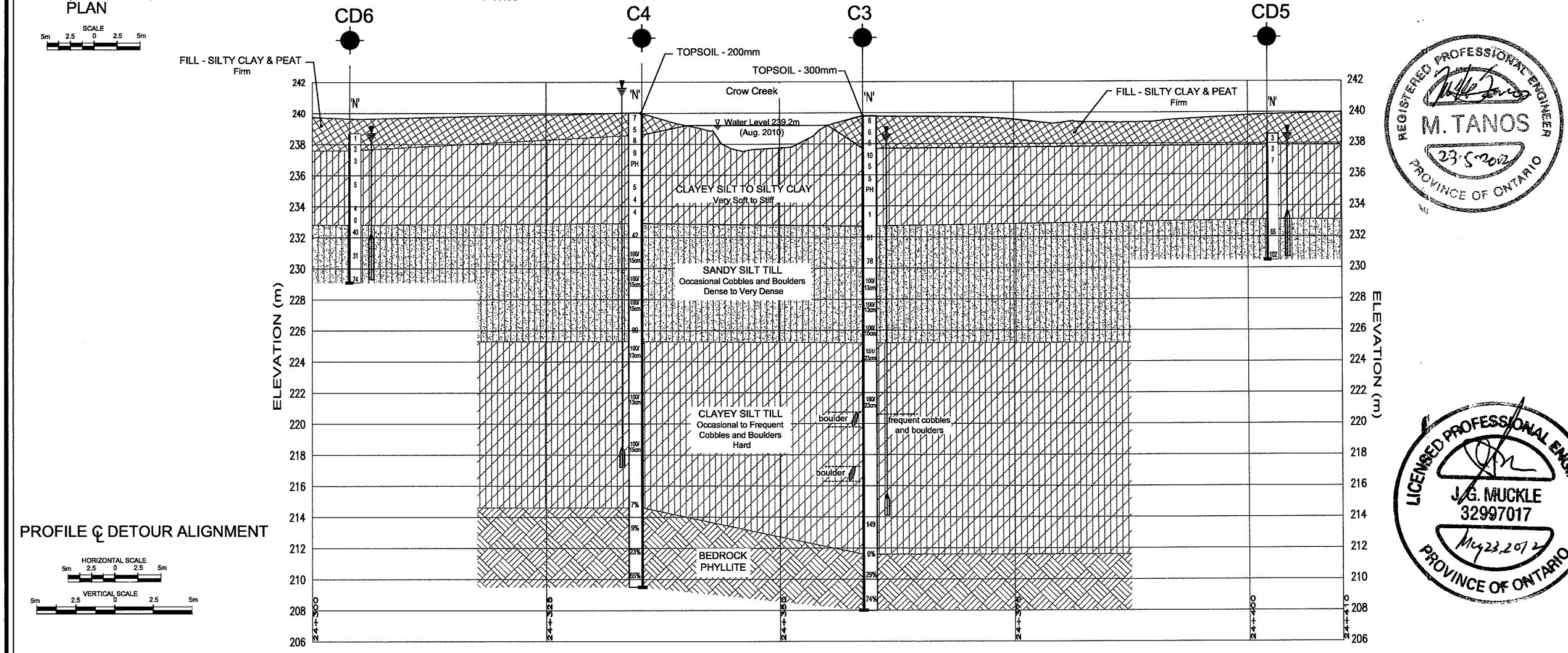
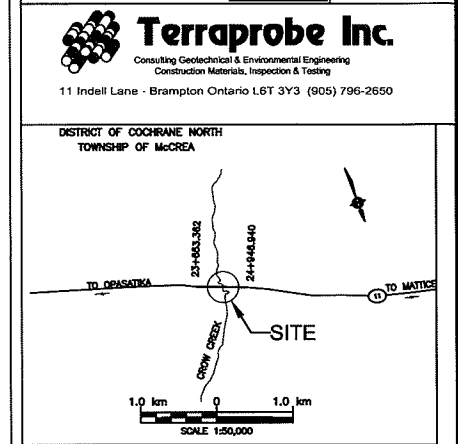
CONT No
GWP No 5233-06-00







CROW CREEK DETOUR
BOREHOLE LOCATION AND SOIL STRATA

McCORMICK RANKIN CORPORATION

MRC

SHEET
3 OF 4



KEY PLAN				
		LEGEND		
CONE 90% A/R		Bore Hole		
		Dynamic Cone Penetration Test		
		Bore Hole And Cone		
		Blows/0.3m (Std Pen Test, 475 J/blow)		
		Blows/0.3m (60° Cone, 475 J/blow)		
		WL at Time of Investigation		
		WL in Piezometer		
		Piezometer		
		90% Rock Quality Designation		
	A/R Auger Refusal			
No		ELEV.	COORDINATES	
			NORTHING	EASTING
C3		239.8	5 492 806.5	372 316.7
C4		240.0	5 492 800.2	372 339.6
CD5		238.6	5 492 820.9	372 276.6
CD6		238.7	5 492 786.3	372 367.8
NOTE				
The boundaries between soil strata have been established only at Bore Hole locations. Between Bore Holes the boundaries are assumed from geological evidence.				
This drawing is for subsurface information only. Surface details and features are for conceptual illustration.				
REVISIONS				
DATE		BY	DESCRIPTION	
DESIGN G.M		CODE CHBDC2006	LOAD	DATE MAY 2012
DRAWN K.C		CHK G.M	STRUCT 39W-055	GEOCRESS 426-33

