

FOUNDATION INVESTIGATION  
AND DESIGN REPORT  
PROPOSED RECONSTRUCTION OF  
NON-STRUCTURAL CULVERTS C1 TO C24  
RECONSTRUCTION OF HIGHWAY 21 FROM KINCARDINE TO TIVERTON  
G.W.P. 408-94-00  
Agreement # 3005-E-0038



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## PART A – FOUNDATION INVESTIGATION

### 1.0 INTRODUCTION

This report presents the results of a foundation investigation carried out by Infrastructure Engineering Group Inc. on behalf of SNC-Lavalin Engineers & Contractors Inc.

The assignment involves the reconstruction/rehabilitation of the pavement structure on Highway 21 from 0.63 m north of the intersection with Highway 9 (north of Kincardine) northerly to 1.2 km east of the intersection with Bruce County Road 15 (west junction in the Village of Tiverton) for 12.4 km; including pavement rehabilitation/reconstruction throughout, snow drifting/storage treatments, structural culvert replacement/rehabilitation, non-structural culvert replacement, minor intersection improvements, drainage improvements and minor electrical work.

Foundation investigation and recommendations are required for the design and construction of culvert replacements as part of the improvement of Highway 21. Five (5) structural culverts and twenty-four (24) non-structural culverts are to be investigated. This report covers the sites of the 24 non-structural culverts (<3 m span).

The twenty-four (24) non-structural culverts are listed in the following table as per the information supplied by SNC-Lavalin Engineers & Contractors Inc. The locations of these structures are shown in Appendix A, Borehole Location Plan, Drawings 1 to 5.

**Table 1**  
**Summary of location, structure type, dimensions as recommended by SNC**

Culvert #	Chainage (m)	Existing Culvert Type and Size	Recommended Replacement Culvert Type and Size	Length (m)	U/S Culvert Invert (m)	D/S Culvert Invert (m)	Cover Depth (m)
C1	15+411	Concrete Open 910 X 610	Precast Concrete Box 910x610	33.03	219.00	218.51	4.37
C2	15+514	C.S.P 450	Precast Concrete Pipe 800 diameter	30.21	221.99	219.47	1.93
C3	15+634	C.S.P 450	Precast Concrete Box 910x610	19.85	223.81	223.26	1.20
C4	16+968	Concrete Open with CSP Ext. 600	Precast Concrete Box 1220x610	20.40	233.39	233.26	1.20
C5	18+349	C.S.P 450	Precast Concrete Box 910x610	19.01	238.26	238.11	1.20
C6	18+864	C.S.P 450	Precast Concrete Box 910x610	20.52	233.35	233.08	1.20

Culvert #	Chainage (m)	Existing Culvert Type and Size	Recommended Replacement Culvert Type and Size	Length (m)	U/S Culvert Invert (m)	D/S Culvert Invert (m)	Cover Depth (m)
C7	19+102	C.S.P 600	Precast Concrete Box 1220 X 610	16.56	233.05	232.86	1.20
C8	19+329	Concrete Open 910 X 610	Precast Concrete Box 2730 X 610	19.53	233.14	233.01	1.20
C9	19+491	C.S.P 600	Precast Concrete Box 910 X 610	34.46	233.59	233.54	1.19
C10	19+972	C.S.P 600	Precast Concrete Box 910 X 610	19.22	233.61	233.59	1.20
C11	21+004	C.S.P 600	Precast Concrete Box 2730 X 610	18.07	225.25	225.18	1.20
C12	21+489	C.S.P 450	Precast Concrete Box 910 X 610	22.82	225.34	225.06	1.20
C13	21+587	Concrete Open 1200 X 1200	Precast Concrete Box 1200 X 1200	21.03	223.74	223.63	1.77
C14	21+777	C.S.P 450	Precast Concrete Box 910 X 610	19.47	224.26	223.99	1.20
C15	22+176	Concrete Open 1830 X 1520	Precast Concrete Box 1830 X 1520	25.98	225.23	225.15	3.76
C16	22+618	C.S.P 600	Precast Concrete Box 910 X 610	22.15	231.58	231.28	1.20
C17	23+062	S.P.C.S.P 2750	Precast Concrete Box 2750 X 2100	40.06	223.56	223.23	5.19
C18	23+984	C.S.P 450	Precast Concrete Box 910 X 610	20.31	232.10	231.85	1.20
C19	24+103	C.S.P 450	Precast Concrete Box 910 X 610	20.84	233.25	232.80	1.24
C20	24+214	C.S.P 600	Precast Concrete Box 910 X 610	18.86	234.43	234.19	1.20
C21	24+519	Concrete Open 910 X 610	Precast Concrete Box 910 X 610	28.56	233.04	232.92	3.09
C22	25+512	C.S.P.A. 1630 X 1120	Precast Concrete Box 1220 X 910	33.72	235.42	235.25	1.38
C23	25+924	Concrete Open 2740 X 910	Precast Concrete Box 2740 X 910	19.06	238.70	238.63	0.71
C24	26+793	C.S.P 600	Precast Concrete Pipe 800 diameter	20.45	240.46	240.16	1.20

The purpose of the investigation was to obtain information about the subsurface conditions at the site by means of boreholes and, based on the findings, to provide geotechnical recommendations for the foundation elements. The existing culverts are to be replaced with new culverts.

The work presented herein was undertaken under MTO G.W.P. 408-94-00, Agreement No. 3005-E-0038.

Authorization to complete this assignment was given by Mr. Bing Wong, Project Manager, SNC-Lavalin Engineers and Constructors Inc., the TPM Consultant who is completing this assignment for MTO under Agreement # 3005-E-0038.

## **2.0 SITE DESCRIPTION**

### **2.1 Site Location**

The twenty-four (24) non-structural culverts are located on Highway 21, approximately between 1.8 km and 13.2 km north of the intersection of Highway 9 and Highway 21 (STA 13+613). Table 1 summarizes the locations, structure types and dimensions of the replacement culverts as recommended by SNC-Lavalin Engineers & Contractors Inc. Locations of the individual non-structural culverts are illustrated in the Borehole Location Plans, Drawings 1 to 5, inclusive, presented in Appendix A.

The existing structures consist of either cast-in-place concrete culverts with open bottom (with CSP extensions where indicated), CSPs, SPCSP or CSPA, as indicated on page 58 of the RFP.

Scouring with the footings exposed is common at most open bottom concrete culverts. Generally, a brown silty clay deposit was noted at the streambed.

These non-structural culvert sites are generally located within drainage valleys or surface water flow paths. Several larger non-structural culverts, such as C01, C03, C05, C06, C08, C12, C13, C15, C17, C21 and C22 have high cover fills with approach embankments built on both north and south sides of the culverts. The fill heights range approximately between 0.7 m and 7.3 m, being the highest at C17. The embankment slopes are typically 2.5H to 3H:1V and are grass covered. No signs of embankment slope instability were observed at the time of this foundation investigation. Site photographs taken during a site visit in April 2006 and obtained from SNC are provided in Appendix C.

### **2.2 Physiography and Topography**

The site is located within the Physiographic Region known as the "Huron-slope" (Chapman and Putnam, 1984) which occupies the area east of Lake Huron between Sarnia and Tobermory. The area is characterized by a flat topography, heavy textured soil and poor drainage. The surficial

deposits consist of brown, calcareous clayey tills, which contain very few cobbles and boulders. The tills are known to be underlain by grey stratified clays of lacustrine origin.

### **3.0 INVESTIGATION PROCEDURES**

#### **3.1 Field Investigation**

Between September 6 and 26, 2006, a Bombardier-mounted Ditriech drill rig, supplied and operated by London Soil Test Ltd. of London, was used on site for drilling and Standard Penetration Testing (SPT, following the procedures of ASTM D 1586). Three (3) boreholes at each site were drilled and sampled to obtain data for foundation and bedding design of the proposed replacement culverts. The boreholes were drilled to a minimum depth of 1.5 m (or deeper if required) below the culvert inverts to provide sufficient subsurface information for the evaluation of bearing resistances or support of bedding material for the proposed culvert replacements.

The boreholes were advanced using continuous flight solid stem augers, with hollow stem augers used where required. Soil samples were retrieved at selected intervals throughout the depths of the boreholes in conjunction with Standard Penetration Tests (SPT). Samples were generally taken at intervals of depth of 0.75 m to the maximum depth of exploration.

Field pocket penetrometer was used on the retrieved SPT samples to determine the undrained shear strength of the cohesive soil deposits. These undrained shear strengths are used to supplement the properties of the cohesive soils. It is noted that the measured shear strength value would be slightly lower than the actual value due to sampling disturbance.

Seepage and water levels were noted in each borehole during and at the completion of drilling and sampling. All boreholes were grouted with a bentonite/cement mix at completion of sampling in accordance with Ontario Regulation 903.

Our field engineer, Mr. Ralph Billings, P. Eng., working under the direction of the project engineer, Mr. Eric Chung, P. Eng., supervised the fieldwork. Our field staff cleared the location of buried utilities and logged the boreholes. The soil samples obtained were placed in labeled containers and transported to our London Office for further examination and laboratory testing.

The stations, offsets and ground surface elevations at the as drilled borehole locations were surveyed by AGM London and provided to Infrastructure Engineering Group Inc. for the purpose of this report.

The results of the drilling, sampling, in-situ testing and groundwater observations are summarized on the Record of Borehole sheets and enclosed in Appendix B.

### **3.2 Laboratory Analysis**

Geotechnical laboratory testing consisted of natural moisture content determinations and visual classifications of all retrieved soil samples. In addition, grain size analyses, Atterberg Limit tests and unit weight tests were performed on selected samples.

The results of the laboratory testing are presented on the Record of Borehole sheets and in the respective figures presented in Appendix B.

The culvert locations are described as C1 to C24. For the purpose of proper management of the Borehole Logs within gINT, the borehole logging software, a preceding 0 was added to Culverts 1 to 9 with the last number being the borehole at the culvert site, i.e., "C01-1" refers to Borehole 1 at the location of Culvert C1, etc.

### **4.0 SUBSURFACE CONDITIONS**

Reference is made to the respective appendix of each culvert site for the Record of Borehole sheets and Laboratory Test Results (Appendix B) for detailed subsurface soil and groundwater conditions encountered in the boreholes. The stratigraphic boundaries shown on the Record of Borehole sheets are inferred from non-continuous sampling and, consequently, represent transitions between soil types rather than exact planes of geological change. The soil profiles depicting the subsurface conditions on the respective Borehole Locations will vary between and beyond the borehole locations.

In general, the subsurface deposits encountered in the boreholes put down on the shoulder area at the twenty-four (24) culvert sites consist of loose to compact embankment fill placed on very stiff to hard silty clay till, with localized zones of clayey silt, sand, and sand and silt deposits. The boreholes put down at each end of the culverts generally encountered a layer of topsoil and/or topsoil fill of between 150 and 610 mm thick, which is generally underlain by a stiff to hard silty clay till, with localized near surface loose to compact, sand to silt layers as well as embedded sand and silt layers within the silty clay till. Exceptions to the generalized subsurface conditions are also noted in the following sections.

Where "N"-values exceeds 100 blows per 0.3 m and the undrained shear strength inferred from pocket penetrometer reading exceeds 225 kPa, the values of 100 blows per 0.3 m and 225 kPa were used in performing the statistical analyses.

#### **4.1 Fill**

The boreholes at the shoulders generally encountered a 0.2 to 2.44 m thick layer of granular fill (shoulder gravel). The shoulder gravel is generally between 0.2 to 0.76 m thick with localized thicker zones, which likely reflect granular backfill for the culverts. The shoulder gravel and

granular fills are underlain by silty clay fill with localized zones of sand, silt and organic inclusions, and extended to or slightly below the bottom of the culverts. Borehole C22-2 was put down on the partially paved shoulder and encountered a 50 mm thick layer of asphalt above a 1.32 m thick layer of granular fill.

The boreholes near the ends of the existing culverts generally encountered a 0.1 to 1.37 m thick layer of topsoil to topsoil fill with an average thickness of 0.53 m. Little topsoil (<0.1 m thick) was encountered in Boreholes C17-1 and C17-3. A 0.7 to 2.13 m thick layer of fill was encountered beneath the topsoil in Boreholes C17-1, C17-3 and C23-3. A 300 to 600 mm thick layer of buried topsoil was present in Boreholes C19-2 and C22-2.

Standard penetration tests taken in the embankment fill, topsoil, topsoil fill, and mixed fill yielded "N"-values from 4 to over 100 blows per 0.3 m, with an average of 13.8 blows per 0.3 m and a standard deviation of 13.4 blows per 0.3 m.

The unit weights of these layers were measured to be in the range of 17.6 to 23.5 kN/m<sup>3</sup>, with an average of 21.2 kN/m<sup>3</sup> and a standard deviation of 1.7 kN/m<sup>3</sup>.

The measured natural moisture contents of the granular fill ranged from 2 to 21% with an average of 7.1% and a standard deviation of 3.8%. The measured natural moisture contents of the topsoil and topsoil fill ranged from 10 to 61%, with an average of 25.2% and a standard deviation of 10.0%. The measured natural moisture contents of the remaining mixed fill ranged from 6 to 52% with an average of 18.1% and a standard deviation of 7.9%. The higher natural moisture contents (>25%) generally reflected the presence of topsoil.

Grain size distributions of these fill materials are shown on the first figure of the corresponding culvert site in Appendix B, e.g. Figure C01-1 refers to the first figure of culvert C01 etc.

An Atterberg Limits determination was conducted on the silty clay (CL) fill encountered in Borehole C17-1 and the results are presented on Figure C17-2 in Appendix B.

#### **4.2 Silty Clay to Clayey Silt Till (CL to CL-ML)**

A major stratum of brown to grey silty clay to clayey silt till was contacted below the embankment fill, topsoil, topsoil fill, mixed fill and buried topsoil. Within the silty clay till, embedded sand and gravel particles were found, as well as wet sand and silt partings, seams and layers. The silty clay till layer was not encountered in Boreholes C06-1 to 3, C13-1 to 3, C14-1, C18-1 and C20-1.

Grain size analyses and Atterberg Limits determinations were performed and the results are plotted on the following figures of Appendix B.

**Table of Figures of Laboratory Test Results**

<b>Culvert Number</b>	<b>Grain Size Figure</b>	<b>Atterberg Limits Figure</b>
C01	C01-2 and 3	C01-4
C02	C02-2	C02-3
C03	C03-2	C03-3
C04	C04-2	C04-3
C05	C05-2	C05-3
C07	C07-2	C07-3
C08	C08-2	C08-3
C09	C09-2	C09-3
C10	C10-2	C10-3
C11	C11-2	C11-3
C12	C12-2	C12-3
C14	C14-3	C14-4
C15	C15-2	C15-3
C16	C16-2	C16-3
C17	C17-3	C17-4
C18	C18-2 and 6	C18-3 and 7
C19	C19-2	C19-3
C20	C20-3	C20-4
C22	C22-3	C22-4
C23	C23-2	C23-3
C24	C24-2	C24-3

**4.2.1 Silty Clay Till (CL)**

Atterberg Limits determinations on the silty clay (CL) yielded the following results:

<b>Atterberg Limits</b>	<b>Minimum</b>	<b>Maximum</b>	<b>Average</b>	<b>Standard Deviation</b>
<b>Liquid Limit (<math>W_L</math>)</b>	19	46	25.8	5.38
<b>Plastic Limit (<math>W_P</math>)</b>	12	28	14.4	3.09
<b>Plasticity Index (<math>I_p</math>)</b>	7	19	11.3	2.69

Standard penetration tests taken within the silty clay till yielded “N”-values of between 6 and over 100 blows per 0.3 m, with an average of 30.9 blows per 0.3 m and a standard deviation of 18.8 blows per 0.3 m. The measured natural moisture contents of the silty clay till ranged from 8 to 42% with an average of 15.4% and a standard deviation of 4.1%. Undrained shear strength of the silty clay till as determined from field pocket penetrometer ranged from 50 to over 225 kPa,

which generally increased with increasing depths. The unit weight of the silty clay till was measured to be between 21.3 and 24.9 kN/m<sup>3</sup>, with an average of 23.2 kN/m<sup>3</sup> and a standard deviation of 0.8 kN/m<sup>3</sup>.

#### 4.2.2 Clayey Silt to Silty Clay Till (CL-ML to CL)

Atterberg Limits determinations on the clayey silt (CL-ML to CL) yielded the following results:

Atterberg Limits	Minimum	Maximum	Average	Standard Deviation
Liquid Limit (W <sub>L</sub> )	18	32	23.1	5.60
Plastic Limit (W <sub>P</sub> )	12	17	14.0	1.87
Plasticity Index (I <sub>p</sub> )	4	16	9.1	4.14

Standard penetration tests taken in the clayey silt to silty clay till yielded “N”-values from 6 to over 100 blows per 0.3 m, with an average of 44.2 blows per 0.3 m and a standard deviation of 26.19 blows per 0.3 m. The measured natural moisture contents of the clayey silt to silty clay till range from 10 to 22% with an average of 14.4% and a standard deviation of 3.52%. Undrained shear strength of the clayey silt to silty clay till as determined from field pocket penetrometer ranged from 100 to over 225 kPa, that generally increased with increasing depths. The unit weight of the clayey silt to silty clay till was measured to be between 21.9 and 25.3 kN/m<sup>3</sup> with an average of 23.7 kN/m<sup>3</sup> and a standard deviation of 1.4 kN/m<sup>3</sup>.

Standard penetration tests taken in the thin layers of sand and silt within the till deposits yielded “N”-values from 5 to 18 blows per 0.3 m, with an average of 12.0 blows per 0.3 m and a standard deviation of 3.5 blows per 0.3 m. The measured natural moisture contents of the thin layers of sand to silt ranged from 12 to 36% with an average of 19.7% and a standard deviation of 7.5%. The unit weight of the thin layers of sand and silt was measured to be between 19.9 and 23.3 kN/m<sup>3</sup>, with an average of 21.9 kN/m<sup>3</sup> and a standard deviation of 1.8 kN/m<sup>3</sup>.

Based on the above field and laboratory test results, together with visual and tactile examination, the silty clay to clayey silt till deposit generally exhibited very stiff to hard consistency with localized firm to stiff conditions, and is generally moist with localized wet zones. The thin layers of sand and silt are generally wet to saturated, with a loose to compact compactness condition.

#### 4.3 Sand, Silt and Sandy Silt

Sand, sandy silt and silt layers are present at the locations of Culverts C13, C14, C18, C19, C20, C21 and C22. Silty clay partings, seams and layers were also present within the silt to sandy silt layers.

Grain size analyses and Atterberg Limits determinations were performed and the results are plotted on the following figures of Appendix B.

**Table of Figures of Laboratory Test Results**

<b>Culvert Number</b>	<b>Grain Size Figure</b>	<b>Atterberg Limits Figure</b>
C13	C13-2	
C14	C14-2	
C18	C18-4	C18-5
C19	C19-4	
C20	C20-2	
C21	C21-2	
C22	C22-2	

Standard penetration tests taken in the layers of sand and silt yielded “N”-values from 7 to over 100 blows per 0.3 m, with an average of 23.9 blows per 0.3 m and a standard deviation of 17.0 blows per 0.3 m. The measured natural moisture contents of the layers of sand to silt ranged from 8 to 27% with an average of 16.1% and a standard deviation of 3.9%. The unit weight of the layers of sand and silt was measured to be between 19.7 and 23.6 kN/m<sup>3</sup> with an average of 22.1 kN/m<sup>3</sup> and a standard deviation of 1.5 kN/m<sup>3</sup>.

Based on the above field and laboratory test results, together with visual and tactile examination, the sand to silt layers generally exhibited compact compactness condition with localized loose to dense and very dense zones. The natural moisture contents of the soil samples revealed that the sand to silt layers are generally wet to saturated with localized moist zones.

**4.4 Silty Clay with Intermediate to High Plasticity (CI to CH)**

Silty Clay with intermediate to high plasticity is encountered in Boreholes C09-1, C11-1 and 3, C14-3, C20-3 and C21-3.

Based on the field and laboratory test results described below, together with visual and tactile examination, the silty clay with intermediate to high plasticity generally exhibited a stiff consistency, and existed in moist to wet condition.

**4.4.1 Silty Clay with Intermediate Plasticity (CI)**

The silty clay with intermediate plasticity (CI) is found at the following boreholes and depths:

<b>Borehole</b>	<b>Depth (m)</b>	<b>Inferred Elevation (m)</b>	<b>Remarks</b>
C09-1	0.8 to 1.4	234.0 to 233.4	Beneath Topsoil
C11-3	3 to 3.5	222.8 to 222.2	Below CL

Borehole	Depth (m)	Inferred Elevation (m)	Remarks
C14-3	0.6 to 1.2	224.8 to 223.6	Beneath Topsoil
C20-3	2.85 to 3.5	232.4 to 231.7	Below CL

Grain size analyses and Atterberg Limits determinations were performed and the results are plotted on the following figures of Appendix B.

#### Table of Figures of Laboratory Test Results

Borehole Number	Grain Size Figure	Atterberg Limits Figure
C09-1	C09-2	C09-3
C11-3	C11-2	C11-3
C14-3	C14-3	C14-4
C20-3	C20-3	C20-4

Atterberg Limits determinations on the silty clay with intermediate plasticity (CI) yielded the following results:

Atterberg Limits	Minimum	Maximum	Average	Standard Deviation
Liquid Limit ( $W_L$ )	36	41	38.8	2.63
Plastic Limit ( $W_P$ )	16	20	18.0	2.06
Plasticity Index ( $I_p$ )	18	23	20.8	1.63

Standard penetration tests taken in the silty clay with intermediate plasticity yielded “N”-values from 8 to 12 blows per 0.3 m, with an average of 9.8 blows per 0.3 m and a standard deviation of 1.7 blows per 0.3 m. The measured natural moisture contents of the silty clay with intermediate plasticity ranged from 19 to 29% with an average of 23.6% and a standard deviation of 4.2%. Undrained shear strength of the silty clay with intermediate plasticity as determined from field pocket penetrometer taken on slightly disturbed samples ranged from 25 to 100 kPa. The unit weight of a single soil sample was measured at 21.8 kN/m<sup>3</sup>.

#### 4.4.2 Silty Clay with High Plasticity (CH)

The silty clay with high plasticity (CH) is found at the following boreholes:

Borehole	Depth (m)	Inferred Elevation (m)	Remarks
C11-1	0.6 to 1.4	225.9 to 225.1	Beneath Topsoil
C21-3	0.6 to 1.4	232.7 to 231.9	Beneath Topsoil

Grain size analyses and Atterberg Limits determinations were performed and the results are plotted on the following figures of Appendix B.

#### Table of Figures of Laboratory Test Results

Borehole Number	Grain Size Figure	Atterberg Limits Figure
C11-1	C11-2	C11-3
C21-3	C21-3	C21-4

Atterberg Limits determinations on the silty clay with high plasticity (CH) yielded the following results:

Atterberg Limits	Minimum	Maximum	Average	Standard Deviation
Liquid Limit ( $W_L$ )	52	53	52.5	0.71
Plastic Limit ( $W_P$ )	24	24	24.0	0.00
Plasticity Index ( $I_p$ )	28	29	28.5	0.71

Standard penetration tests taken in the silty clay with high plasticity yielded “N”-values from 9 to 24 blows per 0.3 m, with an average of 16.5 blows per 0.3 m. The measured natural moisture contents of the silty clay with high plasticity ranged from 16 to 17% with an average of 16.5%. Undrained shear strength of the silty clay with high plasticity as determined from field pocket penetrometer on a single slightly disturbed sample was 112.5 kPa. The unit weights of two soil samples were measured at 20.8 and 20.9 kN/m<sup>3</sup>.

#### 4.5 Sandy Silt to Clayey Silt

A deposit of silt bordering between sandy silt and clayey silt was present at the location of Culvert C06.

Grain size analyses were performed and the results are plotted on Figure C06-2 of Appendix B.

Standard penetration tests taken on the sandy silt to clayey silt yielded “N”-values from 7 to 61 blows per 0.3 m, with an average of 27.8 blows per 0.3 m with a standard deviation of 15.4 blows per 0.3 m. The measured natural moisture contents of the sandy silt to clayey silt ranged from 11 to 22% with an average of 14.3% and a standard deviation of 3.7%. Undrained shear strength could not be determined from pocket penetrometer due to the non-cohesive nature of the material. The unit weights of four soil samples were measured between 22.1 and 24.0 kN/m<sup>3</sup> with an average of 23.1 kN/m<sup>3</sup>.

#### 4.6 Groundwater

The groundwater condition was monitored during and upon completion of sampling. On completion of drilling, groundwater levels noted in the boreholes are summarized in the following table.

Culvert Number	Groundwater Levels - Depth/Elevation (m)		
	Borehole 1	Borehole 2	Borehole 3
C01	BD&O	BD&O	6.20/217.86
C02	BD&O	5.80/218.97	2.50/219.80
C03	3.65/222.07	BD&O	BD&O
C04	BD&O	1.80/231.75	BD&O
C05	BD&O	BD&O	BD&O
C06	BD&O	BD&O	BD&O
C07	BD&O	BD&O	BD&O
C08	BD&O	BD&O	BD&O
C09	BD&O	BD&O	BD&O
C10	BD&O	BD&O	BD&O
C11	2.90/223.59	BD&O	BD&O
C12	BD&O	BD&O	2.75/224.32
C13	4.00/222.86	BD&O	2.40/222.14
C14	2.10/224.11	2.70/221.93	2.10/223.28
C15	5.55/225.01	1.20/225.02	BD&O
C16	BD&O	BD&O	BD&O
C17	1.50/223.49	6.70/224.24	2.70/222.27
C18	3.20/230.53	BD&O	2.10/230.38
C19	2.00/231.64	3.20/231.72	BD&O
C20	BD&O	BD&O	BD&O
C21	2.10/231.00	5.95/230.80	1.90/231.32
C22	0.85/235.81	3.50/232.17	BD&O
C23	0.90/238.46	0.90/239.42	BD&O
C24	BD&O	BD&O	BD&O

**Note:** BD&O means borehole dry and open at completion

In general, the groundwater was encountered as perched condition within the upper fill materials and in the wet to saturated sand to silt layers within the till deposits.

Locally at Culverts C12, C13, C14, C18, C19, C21 and C22, thicker wet to saturated deposits of sand, silty sand, silt and sandy silt were encountered, and the observed groundwater table represented the shallow groundwater condition at these culvert sites.

The groundwater condition will fluctuate seasonally and in response to weather events.

## **PART B – FOUNDATION DESIGN**

### **5.0 DISCUSSION AND RECOMMENDATIONS**

#### **5.1 General**

This section of the report provides our recommendations on the geotechnical aspects of foundation design of the proposed reconstruction of Culverts C1 to C24, inclusive, based on our interpretation of the factual information obtained during this investigation. It should be noted that the interpretation and recommendations are intended for use only by the design engineer. Where comments are made on construction, they are provided only to highlight those aspects which could affect the design of the project. Those requiring information on aspects of construction should make their own interpretation of the factual information provided as it may affect equipment selection, proposed construction method and scheduling.

The twenty-four (24) non-structural culverts are located on Highway 21, approximately between 1.8 km and 13.2 km north of the intersection of Highway 9 and Highway 21 (STA 13+613). Table 1 summarizes the locations, structure types and dimensions as recommended by SNC-Lavalin Engineers & Contractors Inc. Locations of the individual non-structural culverts are illustrated in the Borehole Location Plans, Drawings 1 to 5, inclusive, presented in Appendix A.

The existing structures consist of either cast-in-place concrete culverts with open bottom (with CSP extensions where indicated), CSPs, SPCSP or CSPA, as indicated in the RFP.

Scouring with the footings exposed is common at most open bottom concrete culverts. Generally, a brown silty clay deposit was noted at the streambed.

These non-structural culvert sites are generally located within drainage valleys or surface water flow paths. Several larger non-structural culverts, such as C01, C03, C05, C06, C08, C12, C13, C15, C17, C21 and C22 have high cover fills with approach embankments built on both north and south sides of the culverts. The fill heights range approximately between 2.0 and 7.3 m, being the highest at C17. The embankment slopes are typically 2.5H to 3H:1V and are grass covered. No signs of embankment slope instability were observed at the time of this foundation investigation.

The following culvert replacement recommendations were provided by SNC. With the exception of Culverts C2 and C24, the remaining culverts will be replaced with precast concrete box culverts. Culverts C2 and C24 will be replaced with 800 mm diameter precast concrete pipe culverts.

Culvert #	Chainage (m)	Existing Culvert Type and Size	Recommended Replacement Culvert Type and Size	Length (m)	U/S Culvert Invert (m)	D/S Culvert Invert (m)	Cover Depth (m)
C1	15+411	Concrete Open 910 X 610	Precast Concrete Box 910x610	33.03	219.00	218.51	4.37
C2	15+514	C.S.P 450	Precast Concrete Pipe 800 diameter	30.21	221.99	219.47	1.93
C3	15+634	C.S.P 450	Precast Concrete Box 910x610	19.85	223.81	223.26	1.20
C4	16+968	Concrete Open with CSP Ext. 600	Precast Concrete Box 1220x610	20.40	233.39	233.26	1.20
C5	18+349	C.S.P 450	Precast Concrete Box 910x610	19.01	238.26	238.11	1.20
C6	18+864	C.S.P 450	Precast Concrete Box 910x610	20.52	233.35	233.08	1.20
C7	19+102	C.S.P 600	Precast Concrete Box 1220 X 610	16.56	233.05	232.86	1.20
C8	19+329	Concrete Open 910 X 610	Precast Concrete Box 2730 X 610	19.53	233.14	233.01	1.20
C9	19+491	C.S.P 600	Precast Concrete Box 910 X 610	34.46	233.59	233.54	1.19
C10	19+972	C.S.P 600	Precast Concrete Box 910 X 610	19.22	233.61	233.59	1.20
C11	21+004	C.S.P 600	Precast Concrete Box 2730 X 610	18.07	225.25	225.18	1.20
C12	21+489	C.S.P 450	Precast Concrete Box 910 X 610	22.82	225.34	225.06	1.20
C13	21+587	Concrete Open 1200 X 1200	Precast Concrete Box 1200 X 1200	21.03	223.74	223.63	1.77
C14	21+777	C.S.P 450	Precast Concrete Box 910 X 610	19.47	224.26	223.99	1.20
C15	22+176	Concrete Open 1830 X 1520	Precast Concrete Box 1830 X 1520	25.98	225.23	225.15	3.76
C16	22+618	C.S.P 600	Precast Concrete Box 910 X 610	22.15	231.58	231.28	1.20
C17	23+062	S.P.C.S.P 2750	Precast Concrete Box 2750 X 2100	40.06	223.56	223.23	5.19
C18	23+984	C.S.P 450	Precast Concrete Box 910 X 610	20.31	232.10	231.85	1.20

Culvert #	Chainage (m)	Existing Culvert Type and Size	Recommended Replacement Culvert Type and Size	Length (m)	U/S Culvert Invert (m)	D/S Culvert Invert (m)	Cover Depth (m)
C19	24+103	C.S.P 450	Precast Concrete Box 910 X 610	20.84	233.25	232.80	1.24
C20	24+214	C.S.P 600	Precast Concrete Box 910 X 610	18.86	234.43	234.19	1.20
C21	24+519	Concrete Open 910 X 610	Precast Concrete Box 910 X 610	28.56	233.04	232.92	3.09
C22	25+512	C.S.P.A. 1630 X 1120	Precast Concrete Box 1220 X 910	33.72	235.42	235.25	1.38
C23	25+924	Concrete Open 2740 X 910	Precast Concrete Box 2740 X 910	19.06	238.70	238.63	0.71
C24	26+793	C.S.P 600	Precast Concrete Pipe 800 diameter	20.45	240.46	240.16	1.20

The recommended replacement culvert types and sizes were obtained from the Drainage and Hydrological design, but may require adjustment during detail design in order to accommodate the pavement widening and geometric improvements.

Based on the anticipated invert elevations, the culverts will be placed on mostly silty clay till to clayey silt till subgrade, with localized zones of wet to saturated sand, silty sand, silt and sandy silt deposits.

## 5.2 Summarized Construction Conditions

The following table summarizes the anticipated founding subgrade conditions for the replacement culverts, bedding and backfill requirements and the excavation/cut slope methodology, along with the applicable OPSD's for construction of the proposed replacement culverts. The anticipated foundation subgrade was established based on the invert elevations provided by SNC-LAVALIN, with anticipation of the bedding subgrade to be approximately 0.5 m below the box culvert invert (0.2 m concrete slab over 0.3 m of bedding material). Classification of the soil types for excavation in accordance with OHSA and O. Reg. 213/91 are also provided in the following table.

Culvert #	ANTICIPATED FOUNDING SUBGRADE	BEDDING, BACKFILL	OHSA & O.Reg. 213/91 EXCAVATION SOIL TYPE*
C1	compact sandy silt to hard silty clay till	OPSD 803.010	TYPES 3 AND 4
C2	0.3 m compact fill on firm to hard silty clay till with near surface	OPSD 802.031 OPSD 802.032	TYPES 3 AND 4

<b>Culvert #</b>	<b>ANTICIPATED FOUNDING SUBGRADE</b>	<b>BEDDING, BACKFILL</b>	<b>OHS &amp; O.Reg. 213/91 EXCAVATION SOIL TYPE*</b>
	sandy silt		
C3	0.8 m compact fill with stiff to hard silty clay till below	OPSD 803.010	TYPE 3
C4	stiff to very stiff silty clay till	OPSD 803.010	TYPE 3
C5	stiff to very stiff silty clay till with near surface wet silty sand	OPSD 803.010	TYPES 3 AND 4
C6	moist to wet compact to dense silt till to very stiff to hard clayey silt till	OPSD 803.010	TYPE 3
C7	very stiff to hard silty clay till	OPSD 803.010	TYPE 3
C8	0.1 m fill on stiff to hard silty clay till	OPSD 803.010	TYPE 3
C9	0.15 m of fill to stiff to hard silty clay till	OPSD 803.010	TYPE 3
C10	very stiff to hard silty clay till	OPSD 803.010	TYPE 3
C11	stiff to hard silty clay till	OPSD 803.010	TYPE 3
C12	wet loose silt to firm to hard silty clay/clayey silt till	OPSD 803.010	TYPES 3 AND 4
C13	compact sandy silt, possibly wet	OPSD 803.010	TYPES 3 AND 4
C14	compact wet sand or silt, or very stiff silty clay till	OPSD 803.010	TYPES 3 AND 4
C15	very stiff to hard silty clay/clayey silt till with near surface sand/silt	OPSD 803.010	TYPES 3 AND 4
C16	stiff to hard silty clay till	OPSD 803.010	TYPE 3
C17	saturated sand and very stiff to hard silty clay till	OPSD 803.010	TYPES 3 AND 4
C18	compact to dense silt to sandy silt	OPSD 803.010	TYPE 3
C19	firm to stiff silty clay till on top of sandy silt	OPSD 803.010	TYPE 3
C20	compact sandy silt to stiff silty clay till	OPSD 803.010	TYPE 3
C21	0.1 m of fill on top of thin layer of silty clay over compact silt to sandy silt	OPSD 803.010	TYPE 3
C22	saturated compact sandy silt to silt or very stiff silty clay till	OPSD 803.010	TYPES 3 AND 4
C23	very stiff to hard silty clay till with near surface silt	OPSD 803.010	TYPES 3 AND 4
C24	0.45 m compact fill on top of stiff to hard silty clay till	OPSD802.031	TYPE 3

\*Note: Field verification is required to confirm soil type.

### 5.3 Closed Box Culvert

The closed box culverts should be designed to OPSS 1821 and CAN/CSA-S6-06 and to withstand the appropriate weight of overfill, traffic loadings (CL-625-ONT), temporary construction loads and critical loading effects during construction. If the base slab does not have adequate frost cover/protection, it should be designed for frost pressures.

As there was no hydrostatic pressure observed during borehole sampling (within the clayey silt or silty clay till), piping is not considered likely to occur at the founding subgrade of the culvert.

As per CAN/CSA-S6-06, Clause 1.9.5.6, a cut-off wall of sufficient depth and strength shall be provided at the ends of the culvert to prevent undermining. The depth of the cut-off wall should be designed cognizant of the hydraulic condition (CAN/CSA-S6-06, Section 1.9) and the frost depth of 1.2 m (OPSD 3090.101).

With the exception of Culvert C23, it is understood that the top or obvert of the culverts will be placed at or below the frost depth based on information provided by the preliminary hydraulic analyses and that frost treatment will not be required. The top of Culvert C23 will be placed at a depth of about 0.7m below the finished grade and above the frost depth, adequate frost treatment (taper) should be provided in accordance with OPSD803.010, OPSD 803.030 and OPSD 803.031. The excavation for the installation of the box culverts shall follow OPSS 902 and SSP902S01.

The bedding material, cover and backfill for non-structural precast concrete box culverts (<3m span) shall conform to OPSS 422 and SSP422S01. The bedding should be Granular "A" and should be 0.15 times of the width of the culvert, and should not be less than 150 mm and more than 300 mm. The placement and compaction of the bedding layer should conform to OPSS 422.07.07. A 75 mm thick uncompacted Granular "A" or fine aggregates (OPSS 1002) shall be placed on the bedding layer as leveling course.

Fill materials of between 0.1 and 0.8 m could be encountered below the design invert of the culverts at the location of Culverts C03, C08, C09 and C21. The fill materials could be variable and unpredictable and considered unsuitable for providing indirect support of the culverts, and should be removed to expose the native undisturbed subgrade, and replaced with additional compacted bedding material.

Saturated sand and silt will also be encountered at the bedding subgrade in the area of Culverts C01, C06, C12, C13, C14, C15, C17 and C22. The subgrade may become unstable shortly after completion of excavation. The thickness of the bedding material on wet sand to silt subgrade will have to be increased to 600 mm where saturated sand to silt subgrade is encountered.

The granular backfill shall meet the gradation requirements of OPSS 1010 for Granular "B" Type III, placed in lifts not exceeding 200 mm and compacted to at least 95% SPMDD in accordance with OPSS 501 and OPSS 422.07.11.

#### **5.4 Pipe Culvert**

Replacement Culverts C02 and C24 are to be 800 mm diameter precast concrete pipe culverts. The pipe culverts should be designed to OPSS 1820 and CAN/CSA-S6-06 and to withstand the appropriate weight of overfill, traffic loadings (CL-625-ONT), temporary construction loads and critical loading effects during construction. If the base slab does not have adequate frost cover/protection, it should be designed for frost pressures.

It is understood that the bedding subgrade for both Culvert C02 and C24 will be placed below the design frost depth and the frost taper treatment should be carried out in accordance with OPSD 803.031. Excavation for the installation of the pipe culverts shall follow OPSS 514.

The bedding material, cover and backfill for concrete pipe culverts shall conform to OPSS 421, SSP421S01 and OPSS 514. The bedding should be Granular "A" and should be 0.15 times of the diameter of the culvert, and should not be less than 150 mm and more than 300 mm. The placement and compaction of the bedding layer should conform to OPSS 514.07.10.

Fill materials, 0.3 m at Culvert C2 and 0.45 m at Culvert C24, could be encountered below the design invert. The fill materials could be variable and unpredictable and considered unsuitable for providing indirect support of the culverts, and should be removed to expose the native undisturbed subgrade, and replaced with additional compacted bedding material.

The granular backfill shall meet the gradation requirements of OPSS 1010 for Granular "B" Type III, placed in lifts not exceeding 300 mm and compacted to at least 95% SPMDD in accordance with OPSS 514.07.10.05.

#### **5.5 Lateral Earth Pressures**

Standard pipe culvert headwalls could be specified as per OPSD 804.030 and 804.040. Design of the headwalls (wing walls) and retaining walls for the box culverts is recommended below.

The lateral earth pressures acting on the culvert walls, headwalls (wing walls) and retaining walls will depend on the type and method of placement of the backfill materials and on the subsequent lateral movement of the structure whether it is restrained or unrestrained. The lateral earth pressures to be used in the design should be computed in accordance with Section 6.9 of the CAN/CSA-S6-06.

Granular backfill should be constructed behind the culvert walls, headwalls (wing walls) and retaining walls as per OPSD 3121.150, with particular attention to the frost taper requirement.

The granular backfill should conform to OPSS 1010 for either Granular “A” or Granular “B” Type III. To maintain free draining characteristics in granular fill materials, the maximum percentage passing the No. 200 sieve (75 µm) should be limited to 5%.

The backfill should be constructed as per OPSS 902 and OPSS 501, and SSP 902S01. A perforated subdrain should be installed behind the walls with a positive outlet or wall drains as per OPSD 3190.100 to drain the granular fill above the stream water level. Alternatively, the culvert walls could be designed to resist hydrostatic pressure.

The lateral earth pressure,  $P_h$ , may be computed using the equivalent fluid pressures presented in Clause 6.9.2.3 of the CAN/CSA-S6-06, or employing the following equation based on unfactored earth pressure distributions:

$$P_h = K (\gamma h + q)$$

Where:

- K = earth pressure coefficient, use value from table below
- $\gamma$  = unit weight of soil, = 21.2 kN/m<sup>3</sup> for Granular “B”  
 = 22.8 kN/m<sup>3</sup> for Granular “A”
- h = depth below top of wall, m
- q = live load surcharge, of 0.8 m of fill as per Clause 6.9.5, CAN/CSA-S6-06

Wall Type	Earth Pressure Coefficient (K)	
	Granular “A” $\phi = 35^\circ$	Granular “B” $\phi = 30 \text{ to } 35^\circ$
Restrained Wall ( $K_o$ )	0.43	0.50 to 0.43
Unrestrained Wall ( $K_a$ )	0.27	0.33 to 0.27

The submerged unit weight of the backfill should be used for any submerged portion of the granular backfill when calculating the lateral earth pressure.

The above parameters are based on a horizontal back slope (not exceeding 5 degrees) behind the headwalls. A compaction surcharge equal to 12 kPa should be included in the lateral earth pressures for the structural design of the headwalls and retaining walls in accordance with Clause 6.9.3 of the CAN/CSA-S6-06.

Vibratory equipment for use behind abutments and retaining walls should be restricted in size as per current MTO practices.

## 5.6 Embankment Widening

The existing approach embankments are up to 2 to 7.3 m high adjacent to the proposed culvert. For the widening of the embankment, the surficial topsoil and any deleterious materials should

be stripped or excavated prior to placing fill materials. The embankment widening should then be constructed as per OPSD 202.010, 202.030 and 208.010, with emphasis on adequate benching of the subgrade for receiving the embankment fill. The fill to be used for embankment construction can either be imported silty clay or granular materials. Backfill adjacent to the structure should be carried out in conformance with OPSS 902, SSP902S01 and OPSD 3101.150, and the fill should be placed and compacted in accordance with OPSS 501.

Based on the findings of the field investigation, no foundation stability or settlement problems due to widening the approach embankments on the inorganic native soils are anticipated for embankment slope of 2.5H:1V and up to 7.3 m high. The fill placement should begin at the toe of the embankment, in leveled lifts and each lift compacted to at least 98% SPMDD. Benching into the existing embankment slope at 1 m high steps is recommended as per OPSD 208.010.

After stripping, the exposed subgrade should be inspected and approved by the geotechnical engineer. The approved subgrade should then be proof-rolled using a heavy compactor, as directed by the engineer. Unless the excavation is carried out in wet weather conditions, no unusual dewatering is anticipated during stripping and preparation of the subgrade to receive the embankment fills. Where necessary, dewatering using gravity drainage and pumping from open filtered sumps in accordance with OPSS 517 and 902, and SSP902S01, with emphasis on the requirements of OPSS 518.

Measures should be incorporated into the design and staging to ensure that the slope surfaces are protected from surface erosion in accordance with the requirements of OPSS 577. Proper erosion control measures should be implemented both during construction of the embankment fills and permanently. Erosion control during construction should be carried out by installing silt fences. Properly designed erosion control blankets could also be placed on any new embankments and adjacent disturbed embankments after completion of fill placement. A vegetative cover should be established as soon as practical upon completion of fill placement to minimize the chances of surface erosion.

Revetments such as rip-rap blanket should be provided at the toe of the slope and the ends of the culvert to prevent erosion/scour by stream action in accordance with OPSS 511, SSP511S01, and OPSD 810.010. The design of the rip-rap blanket should be carried out cognizant of the stream hydraulics.

## **5.7 Excavation, Groundwater Control and Temporary Support**

Excavation for this project will involve the construction of the box and pipe culverts. Depending on the design that is finally selected, the anticipated maximum depth of excavation below the existing grade of Highway 21 is between 2.5 and 7.5 m.

Excavation to depths of up to 7.5 m should not present any special difficulties using heavy excavation equipment, provided it is constructed in accordance with OPSS 501, 514, 517, 518,

539, 577 and, 902, SSP421S01, SSP422S01, SSP902S01 and OPSD 803.010 and 3121.150. However, the buried utilities along the west side of the embankment will likely be in conflict with the excavation. Excavation and protection procedures shall conform to SSP 105S19 and should be reviewed with the utility companies or authorities prior to construction.

Disturbance of the subgrade due to excavation below the streambed in non-cohesive soil could occur, in particular, at Culverts C01, C06, C12, C13, C14, C15, C17 and C22. Fill materials could be encountered at the subgrade of Culverts C02, C03, C08, C09, C21 and C24. The thickness of the bedding material will have to be increased where loose fill or unsuitable soil is encountered at the bedding subgrade level. The procedures for additional excavation and bedding material are covered in OPSS 421, 422 514 and 902, SSP421S01, SSP422S01 and SSP902S01.

The water in the stream can be controlled by temporary diversion or dam and pump method. Saturated fine granular soils (sand, silty sand, silt and sandy silt) will be encountered during excavation, and groundwater control will be required to handle surface runoff and minor seepage. The minor groundwater ingress can be controlled using intercept ditches and pumping from filtered sump pits.

It is noted that a "Permit To Take Water" (PTTW, Regulation 387/04) will be required from the MOE (Ministry of Environment) when the total quantity of water to be handled exceeds 50,000 litres/day while employing temporary pumping of water, flow passages through culverts, stream diversion or dam and pump method as groundwater control measures (unwatering). It may take up to 90 days for MOE to review an application and issue a permit. It is understood that the amount of water to be handled will be based on a two-year storm event.

It should be pointed out that if the founding soil is disturbed, excessive settlements could occur after structural loads are applied. The founding level will be located below the stream bed and, therefore, a minimum 50 mm thick lean concrete working mat should be placed immediately after excavation and subgrade preparation for footings to protect the integrity of the bearing surface and to facilitate placement of reinforcing steel. All foundation excavations, bearing surfaces, and placement of lean concrete mat should be inspected and approved by the geotechnical engineer.

All excavation must be carried out in compliance with the requirements of the Occupational Health and Safety Act (OHSA). For this purpose, the unsaturated upper fill and loose to compact sandy soils encountered at this site are classified as Type 3 soils and the very stiff to hard clayey silt to silty clay soils are classified as Type 2 soils. Saturated cohesionless soils are classified as Type 4 soils.

For the Type 2 soils, the excavation shall be cut to near vertical in the bottom 1.2 m and then trimmed back to 1H:1V. Within the Type 3 soils and above the water table, the excavation shall

be cut to no steeper than 1H : 1V throughout. Side slopes of 3H:1V or flatter shall be used for excavation within Type 4 soils.

Temporary support within the overfill of the existing and new culverts may be required to facilitate culvert construction and to maintain access for construction and local traffic, and emergency vehicles. The staging of different phases of this work should be examined to determine if roadway protection is required. Roadway protection is generally a contractor design/build item in accordance with SSP 105S19 and current MTO practices.

### **5.8 Frost Protection**

This project is located in the Owen Sound Operations District. The design frost penetration depth for this project is 1.2 m in accordance with OPSD 3090.101. All foundations and spread footings should be provided with at least 1.2 m of soil cover for adequate frost protection.

### **5.9 Scour Depth**

The footings should be founded below the anticipated local and general scour depths as per CAN/CSA-S6-06, Clause 1.9, Hydraulic Design. The permissible velocities of the various soil types which will be exposed at the streambeds (based on American Society of Civil Engineers publication, 1926, reprinted as Design Chart 2.17, MTO Drainage Management Manual 1997) are provided in the following table:

<b>Soil Type</b>	<b>Permissible Velocity (m/sec)</b>
Sand	0.6
Silty Sand	0.7
Sandy Silt	0.8
Silt	0.8
Sandy Silt Till	1.2
Clayey Silt	1.5
Silty Clay	1.5

## 6.0 STATEMENT OF LIMITATION

We recommend that once the details of the proposed structure are finalized, our recommendations should be reviewed for their specific applicability.

The Limitations of Report, as quoted in Appendix D, is an integral part of this report.

We trust that we have completed the assignment within the Terms of Reference for this project. If there are any questions concerning this report, please do not hesitate to contact our office.

Yours truly,

**Infrastructure Engineering Group Inc.**

Eric Y. Chung, M.Eng., P.Eng.  
Designated MTO Contact



Joseph Law, P.Eng.  
Project Manager



Tom O'Dwyer, P. Eng.  
Quality Review Engineer



Ministry of Transportation/SNC-LAVALIN  
G.W.P. 408-94-00  
Reconstruction of Highway 21 from Kincardine northerly to Tiverton  
Agreement # 3005-E-0038

06-8-IEG2-C1 to 24  
Final Report  
Appendix A  
September 28, 2007

Appendix A

Drawings 1 to 5

Borehole Location Plan

# METRIC

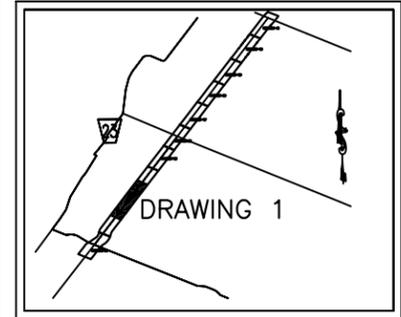
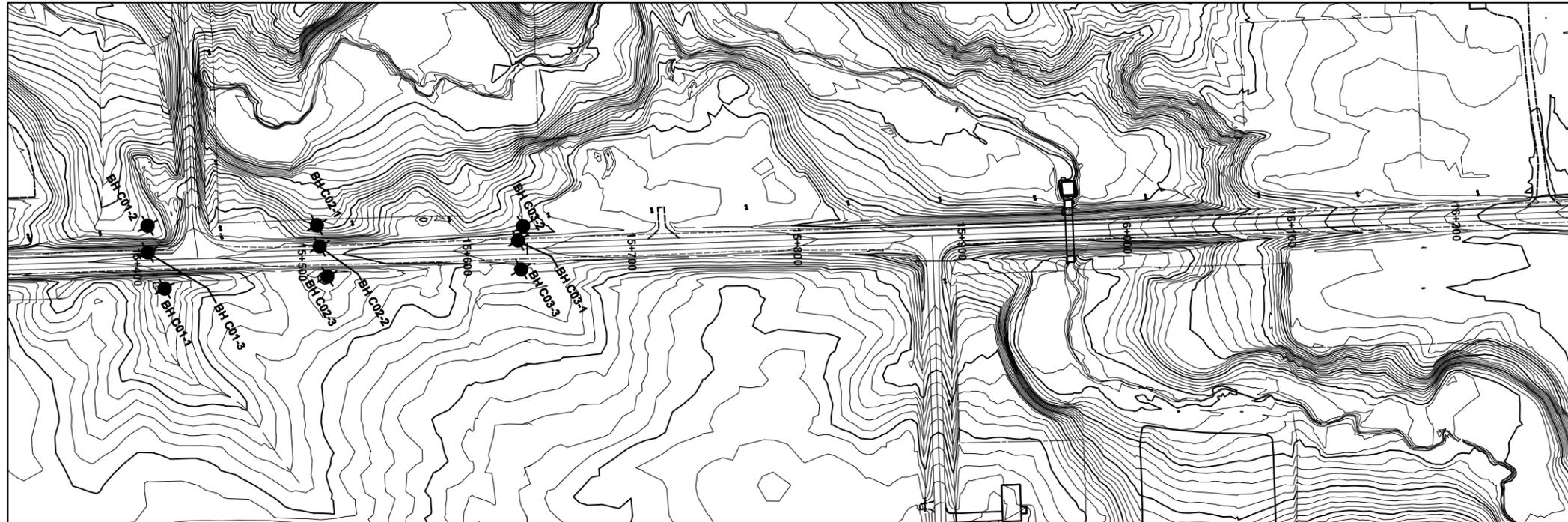
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AND/OR MILLIMETRES  
UNLESS OTHERWISE SHOWN

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WP No GWP 408-94-00



Culvert # C01 TO C04  
Highway 21  
BOREHOLE LOCATION PLAN

**SHEET**  
1

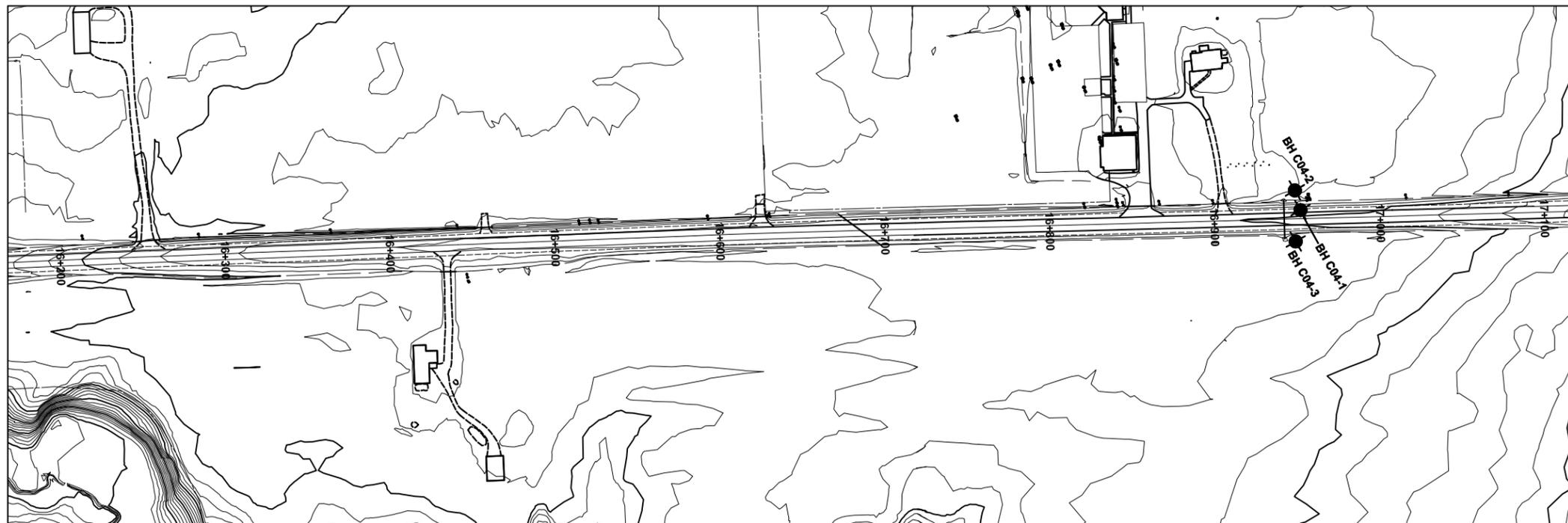


KEYPLAN

NTS

## LEGEND

- Bore Hole
- Dynamic Cone Penetration Test (Cone)
- Bore Hole & Cone
- Blows/0.3m (Std Pen Test, 475 J/blow)
- Blows/0.3m (60° Cone, 475 J/blow)
- W L at time of investigation
- Standpipe



### NOTES

1. THE COMPLETE FOUNDATION INVESTIGATION AND DESIGN REPORT FOR THIS PROJECT AND OTHER RELATED DOCUMENTS MAY BE EXAMINED AT THE ENGINEERING MATERIALS OFFICE, DOWNSVIEW. INFORMATION CONTAINED IN THIS REPORT AND RELATED DOCUMENTS ARE SPECIFICALLY EXCLUDED IN ACCORDANCE WITH THE CONDITIONS OF SECTION GC2.01 OF OPS GEN. COND.



BOREHOLE NO.	ELEV.	UTM CO-ORDINATES		BOREHOLE NO.	ELEV.	UTM CO-ORDINATES		BOREHOLE NO.	ELEV.	UTM CO-ORDINATES		BOREHOLE NO.	ELEV.	UTM CO-ORDINATES	
		NORTH	EAST												
C01-1	219.68	4894542	376341	C02-1	219.58	4894641	376354	C03-1	225.72	4894742	376423	C04-1	234.86	4895908	377044
C01-2	218.96	4894552	376303	C02-2	224.77	4894636	376366	C03-2	223.82	4894749	376417	C04-2	233.55	4895911	377032
C01-3	224.06	4894544	376317	C02-3	222.30	4894631	376384	C03-3	224.99	4894735	376439	C04-3	233.78	4895896	377059

REVISIONS	DATE	BY	DISCRPTION
	25/09/07	J.L.	Final Report
	30/01/07	J.L.	Draft

MTO GEOCRIS No. 41A-192

HWY No.	HWY 21	DIST	Owen Sound
SUBM'D	J.L.	CHECKED E.C.	DATE 28/01/07
DRAWN	J.L.	CHECKED J.L.	APPROVED E.C.
			SITE C01 TO C04
			DWG 1



# METRIC

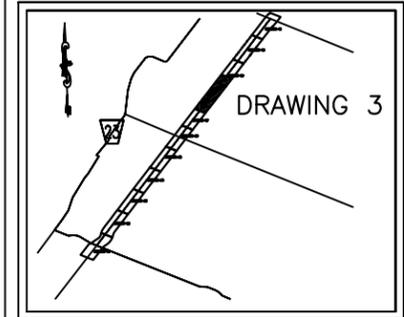
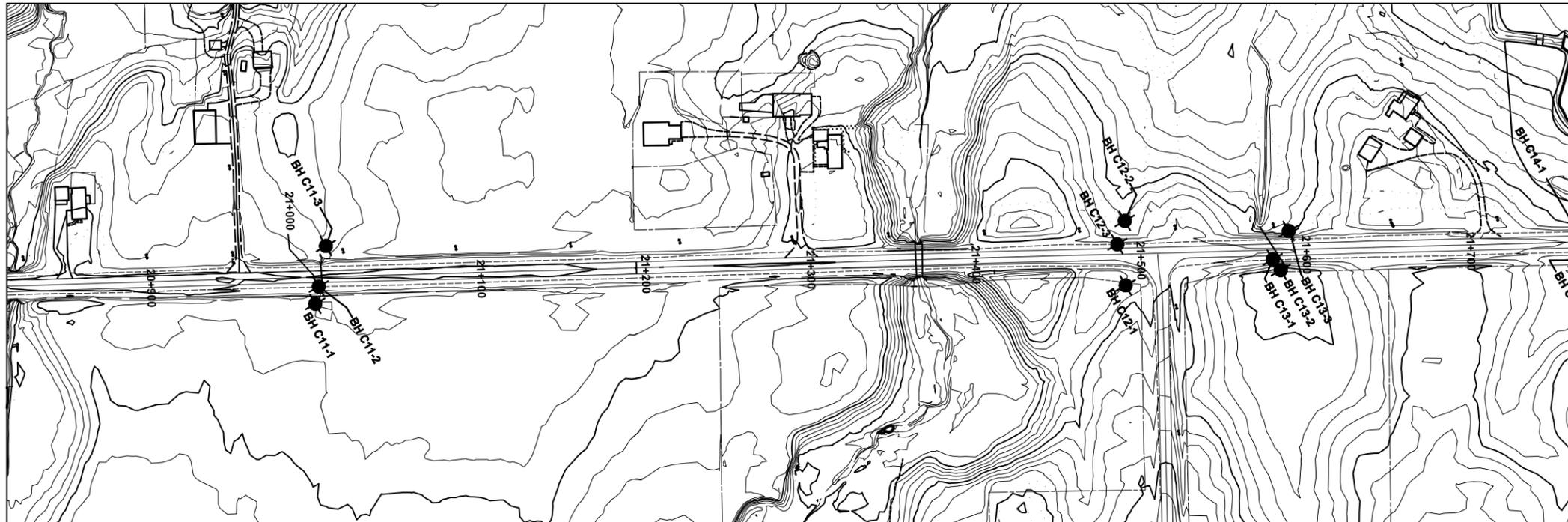
DIMENSIONS ARE IN METRES  
AND/OR MILLIMETRES  
UNLESS OTHERWISE SHOWN

CONT No xxxx-xxxx  
WP No GWP 408-94-00



Culvert # C11 TO C16  
Highway 21  
BOREHOLE LOCATION PLAN

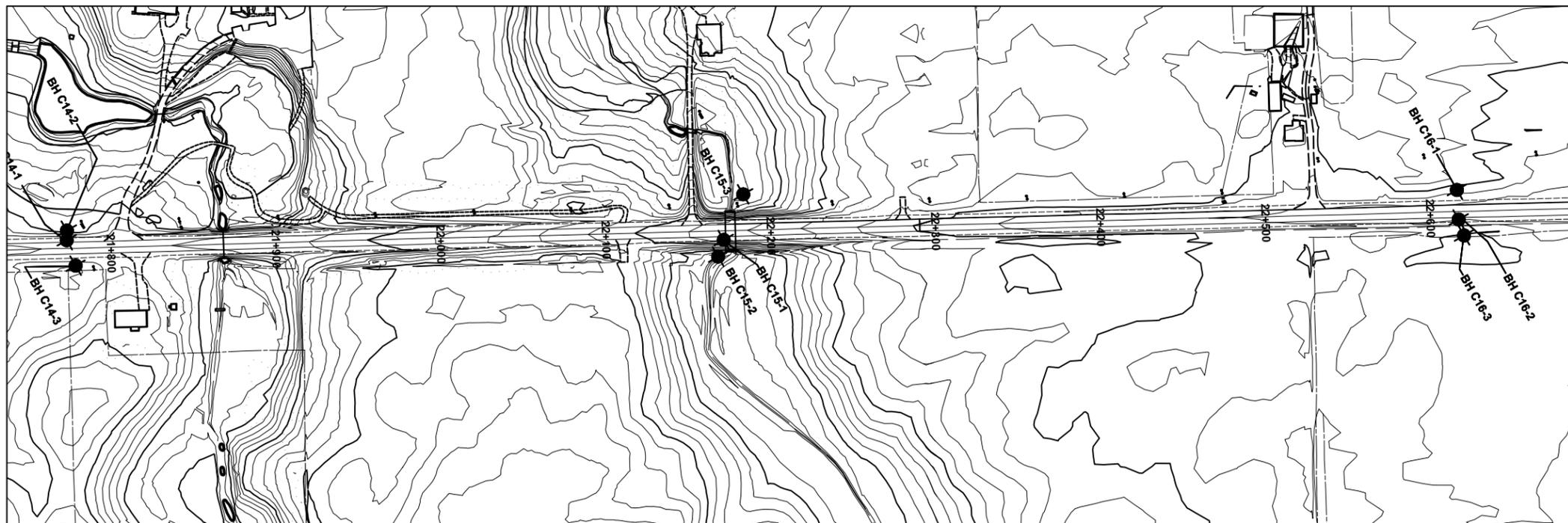
**SHEET**  
3



KEYPLAN NTS

## LEGEND

- Bore Hole
- Dynamic Cone Penetration Test (Cone)
- Bore Hole & Cone
- Blows/0.3m (Std Pen Test, 475 J/blow)
- Blows/0.3m (60° Cone, 475 J/blow)
- W L at time of investigation
- Standpipe



### NOTES

1. THE COMPLETE FOUNDATION INVESTIGATION AND DESIGN REPORT FOR THIS PROJECT AND OTHER RELATED DOCUMENTS MAY BE EXAMINED AT THE ENGINEERING MATERIALS OFFICE, DOWNSVIEW.  
INFORMATION CONTAINED IN THIS REPORT AND RELATED DOCUMENTS ARE SPECIFICALLY EXCLUDED IN ACCORDANCE WITH THE CONDITIONS OF SECTION GC2.01 OF OPS GEN. COND.



REVISIONS	DATE	BY	DISCRPTION
	25/09/07	J.L.	Final Report
	30/01/07	J.L.	Draft

MTO GEOCREs No. 41A-192

HWY No.	HWY 21	DIST	Owen Sound
SUBM'D	J.L.	CHECKED	E.C.
DATE	26/01/07	SITE	C11 TO C16
DRAWN	J.L.	CHECKED	J.L.
APPROVED	E.C.	DWG	3

BOREHOLE NO.	ELEV.	UTM CO-ORDINATES		BOREHOLE NO.	ELEV.	UTM CO-ORDINATES		BOREHOLE NO.	ELEV.	UTM CO-ORDINATES		BOREHOLE NO.	ELEV.	UTM CO-ORDINATES		BOREHOLE NO.	ELEV.	UTM CO-ORDINATES					
		NORTH	EAST	NORTH	EAST																		
C11-1	226.49	4899459	378985	C12-1	226.51	4899890	379221	C13-1	226.86	4899975	379252	C14-1	226.21	4900150	379335	C15-1	230.56	4900495	379534	C16-1	232.08	4900895	379730
C11-2	227.37	4899466	378977	C12-2	225.54	4899909	379187	C13-2	224.71	4899976	379260	C14-2	224.63	4900153	379330	C15-2	226.22	4900478	379541	C16-2	233.46	4900887	379746
C11-3	225.72	4899482	378958	C12-3	227.07	4899898	379197	C13-3	224.54	4899992	379242	C14-3	225.38	4900147	379351	C15-3	225.70	4900519	379516	C16-3	232.26	4900885	379756



**METRIC**

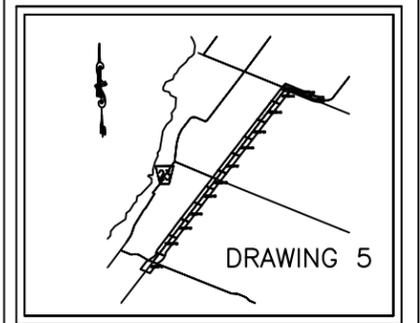
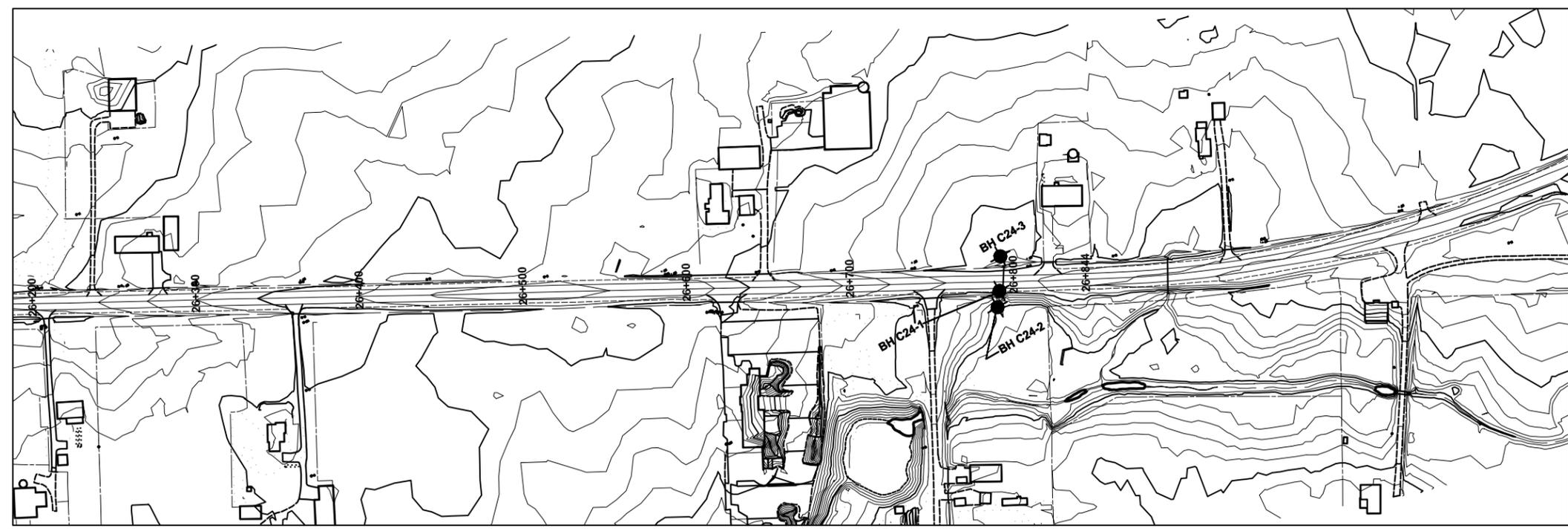
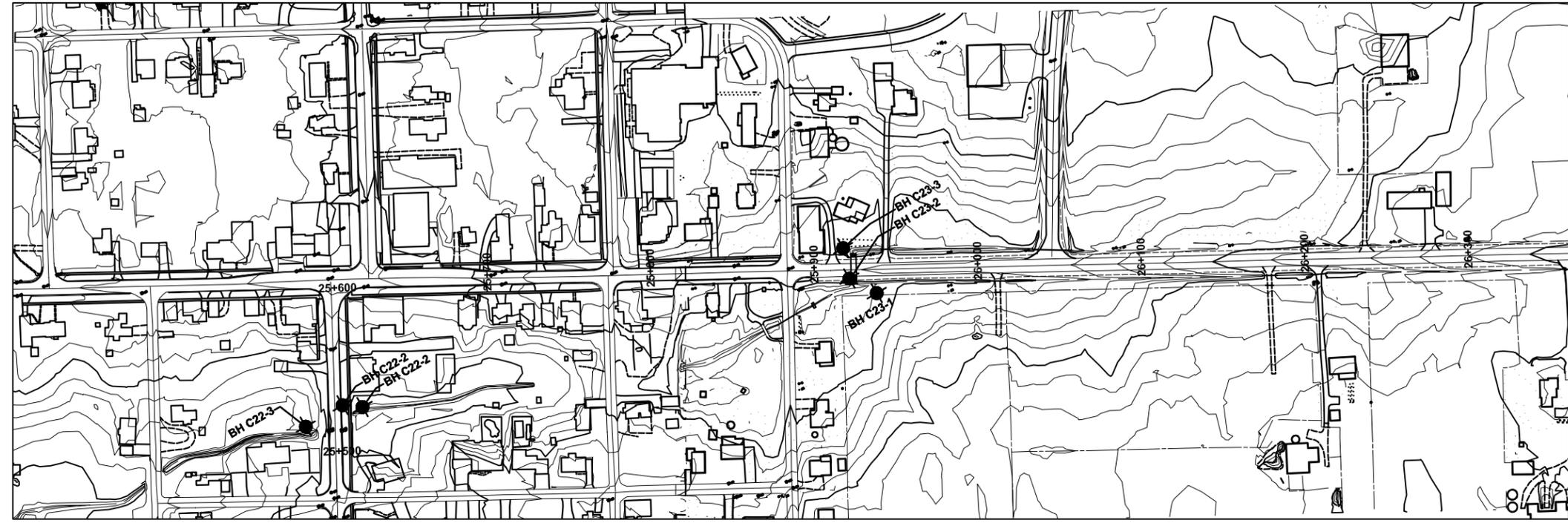
DIMENSIONS ARE IN METRES  
AND/OR MILLIMETRES  
UNLESS OTHERWISE SHOWN

CONT No xxxx-xxxx  
WP No GWP 408-94-00



Culvert # C22 TO C24  
Highway 21  
BOREHOLE LOCATION PLAN

**SHEET**  
5

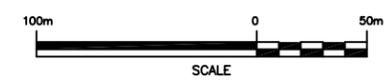


KEYPLAN NTS

**LEGEND**

- Bore Hole
- Dynamic Cone Penetration Test (Cone)
- Bore Hole & Cone
- Blows/0.3m (Std Pen Test, 475 J/blow)
- Blows/0.3m (60° Cone, 475 J/blow)
- W L at time of investigation
- Standpipe

**NOTES**  
1. THE COMPLETE FOUNDATION INVESTIGATION AND DESIGN REPORT FOR THIS PROJECT AND OTHER RELATED DOCUMENTS MAY BE EXAMINED AT THE ENGINEERING MATERIALS OFFICE, DOWNSVIEW. INFORMATION CONTAINED IN THIS REPORT AND RELATED DOCUMENTS ARE SPECIFICALLY EXCLUDED IN ACCORDANCE WITH THE CONDITIONS OF SECTION GC2.01 OF OPS GEN. COND.



BOREHOLE NO.	ELEV.	UTM CO-ORDINATES		BOREHOLE NO.	ELEV.	UTM CO-ORDINATES		BOREHOLE NO.	ELEV.	UTM CO-ORDINATES	
		NORTH	EAST			NORTH	EAST			NORTH	EAST
C22-1	236.66	4903440	381142	C23-1	239.36	4903343	381449	C24-1	242.59	4902941	382202
C22-2	237.67	4903447	381132	C23-2	240.32	4903359	381439	C24-2	239.98	4902933	382196
C22-3	236.35	4903447	381106	C23-3	239.69	4903377	381445	C24-3	241.88	4902959	382213

REVISIONS	DATE	BY	DISCRPTION
	25/09/07	J.L.	Final Report
	30/01/07	J.L.	Draft

MTO GEORES No. 41A-192

HWY No.	HWY 21	DIST	Owen Sound
SUBM'D	J.L. CHECKED E.C.	DATE 26/01/07	SITE C22 TO C24
DRAWN	J.L. CHECKED J.L.	APPROVED E.C.	DWG 5

Appendix B

Explanation of Terms Used in Report  
 Record of Borehole Sheet  
 Laboratory Test Results

<b>Culvert Site</b>	<b>Borehole Logs</b>	<b>Grain Size</b>	<b>Atterberg Limits</b>
C01	C01-1 to 3	Figures C01-1 to 3	Figure C01-4
C02	C02-1 to 3	Figures C02-1 to 2	Figure C02-3
C03	C03-1 to 3	Figures C03-1 to 2	Figure C03-3
C04	C04-1 to 3	Figures C04-1 to 2	Figure C04-3
C05	C05-1 to 3	Figures C05-1 to 2	Figure C05-3
C06	C06-1 to 3	Figures C06-1 to 2	
C07	C07-1 to 3	Figures C07-1 to 2	Figure C07-3
C08	C08-1 to 3	Figures C08-1 to 2	Figure C08-3
C09	C09-1 to 3	Figures C09-1 to 2	Figure C09-3
C10	C10-1 to 3	Figures C10-1 to 2	Figure C10-3
C11	C11-1 to 3	Figures C11-1 to 2	Figure C11-3
C12	C12-1 to 3	Figures C12-1 to 2	Figure C12-3
C13	C13-1 to 3	Figures C13-1 to 2	
C14	C14-1 to 3	Figures C14-1 to 3	Figure C14-4
C15	C15-1 to 3	Figures C15-1 to 2	Figure C15-3
C16	C16-1 to 3	Figures C16-1 to 2	Figure C16-3
C17	C17-1 to 3	Figures C17-1 & 3	Figures C17-2 & 4
C18	C18-1 to 3	Figures C18-1, 2, 4 & 6	Figures C18-3, 5 & 7
C19	C19-1 to 3	Figures C19-1, 2 & 4	Figure C19-3
C20	C20-1 to 3	Figures C20-1 to 3	Figure C20-4
C21	C21-1 to 3	Figures C21-1 to 3	Figure C21-4
C22	C22-1 to 3	Figures C22-1 to 3	Figure C22-4
C23	C23-1 to 3	Figures C23-1 to 2	Figure C23-3
C24	C24-1 to 3	Figures C24-1 to 2	Figure C24-3

## 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 475 J 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 UNDRAINED 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 (R Q D), FOR MODIFIED RECOVERY, IS:

R Q D (%)	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

S S	SPLIT SPOON	T P	THINWALL PISTON
W S	WASH SAMPLE	O S	OSTERBERG SAMPLE
S T	SLOTTED TUBE SAMPLE	R C	ROCK CORE
B S	BLOCK SAMPLE	P H	T W ADVANCED HYDRAULICALLY
C S	CHUNK SAMPLE	P M	T W ADVANCED MANUALLY
T W	THINWALL OPEN	F S	FOIL SAMPLE

### MECHANICAL PROPERTIES OF SOIL

$m_v$	$kPa^{-1}$	COEFFICIENT OF VOLUME CHANGE
$C_c$	1	COMPRESSION INDEX
$C_s$	1	SWELLING INDEX
$C_\alpha$	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
$\sigma'_{v0}$	kPa	EFFECTIVE OVERBURDEN PRESSURE
$\sigma'_p$	kPa	PRECONSOLIDATION PRESSURE
$\tau_f$	kPa	SHEAR STRENGTH
$c'$	kPa	EFFECTIVE COHESION INTERCEPT
$\phi'$	-°	EFFECTIVE ANGLE OF INTERNAL FRICTION
$c_u$	kPa	APPARENT COHESION INTERCEPT
$\phi_u$	-°	APPARENT ANGLE OF INTERNAL FRICTION
$\tau_r$	kPa	RESIDUAL SHEAR STRENGTH
$\tau_c$	kPa	REMOULDED SHEAR STRENGTH
$S_t$	1	SENSITIVITY = $\frac{c_u}{\tau_c}$

### STRESS AND STRAIN

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

### PHYSICAL PROPERTIES OF SOIL

$\rho_s$	$kg/m^3$	DENSITY OF SOLID PARTICLES	e	1. %	VOID RATIO	$e_{min}$	1. %	VOID RATIO IN DENSEST STATE
$\gamma_s$	$kn/m^3$	UNIT WEIGHT OF SOLID PARTICLES	n	1. %	POROSITY	$I_D$	1	DENSITY INDEX = $\frac{e_{max} - e}{e_{max} - e_{min}}$
$\rho_w$	$kg/m^3$	DENSITY OF WATER	w	1. %	WATER CONTENT	D	mm	GRAIN DIAMETER
$\gamma_w$	$kn/m^3$	UNIT WEIGHT OF WATER	$S_r$	%	DEGREE OF SATURATION	$D_n$	mm	n PERCENT - DIAMETER
$\rho$	$kg/m^3$	DENSITY OF SOIL	$w_L$	%	LIQUID LIMIT	$C_u$	1	UNIFORMITY COEFFICIENT
$\gamma$	$kn/m^3$	UNIT WEIGHT OF SOIL	$w_p$	%	PLASTIC LIMIT	h	m	HYDRAULIC HEAD OR POTENTIAL
$\rho_d$	$kg/m^3$	DENSITY OF DRY SOIL	$w_s$	%	SHRINKAGE LIMIT	q	$m^3/s$	RATE OF DISCHARGE
$\gamma_d$	$kn/m^3$	UNIT WEIGHT OF DRY SOIL	$i_p$	%	PLASTICITY INDEX = $w_L - w_p$	v	m/s	DISCHARGE VELOCITY
$\rho_{sat}$	$kg/m^3$	DENSITY OF SATURATED SOIL	$I_L$	1	LIQUIDITY INDEX = $\frac{w - w_p}{i_p}$	i	1	HYDRAULIC GRADIENT
$\gamma_{sat}$	$kn/m^3$	UNIT WEIGHT OF SATURATED SOIL	$I_C$	1	CONSISTENCY INDEX = $\frac{w_L - w}{i_p}$	k	m/s	HYDRAULIC CONDUCTIVITY
$\rho'$	$kg/m^3$	DENSITY OF SUBMERGED SOIL	$e_{max}$	1. %	VOID RATIO IN LOOSEST STATE	j	$kn/m^3$	SEEPAGE FORCE
$\gamma'$	$kn/m^3$	UNIT WEIGHT OF SUBMERGED SOIL						

**RECORD OF BOREHOLE No C01-1**

1 OF 1

**METRIC**

W.P. GWP 408-94-00 LOCATION Culvert No. 1 Northing - 4894542, Easting - 376341 ORIGINATED BY RB  
 DIST Owen Sound HWY 21 BOREHOLE TYPE 100mm SST Auger COMPILED BY JL  
 DATUM Geodetic DATE 9.5.06 - 9.5.06 CHECKED BY EC

SOIL PROFILE		SAMPLES			GROUND WATER CONDITIONS	ELEVATION SCALE	PENETR. RESISTANCE					PLASTIC NATURAL LIQUID			UNIT WEIGHT	REMARKS & GRAIN SIZE DISTRIBUTION (%)
ELEV. DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE			"N" VALUES	STANDARD	DYN. CONE	UNCONFINED	FIELD VANE	W <sub>p</sub>	MOISTURE CONTENT	W <sub>L</sub>		
219.68 0.00	Ground Surface															
	FILL - 610mm topsoil fill.		1	SS	7											
219.07 0.61	Sandy SILT TILL (ML) Brown, moist, compact, some gravel and clay.		2	SS	14										23 26 40 11 (51)	
218.16 1.52	Silty CLAY TILL (CL) Brown, moist, hard, with embedded sand and gravel.		3	SS	39										0 14 57 29 (86)	
			4	SS	55											
			5	SS	53											
216.17 3.51	End of Borehole.															Borehole dry and open @ completion.

JOE MTO 06-8-IEG2.GPJ ONTARIO.MOT.GDT 4/17/07

+ 3, X 3: Numbers refer to Sensitivity

○ 150 UNCONFINED SHEAR STRENGTH INFERRED FROM POCKET PENETROMETER READINGS

**RECORD OF BOREHOLE No C01-2**

1 OF 1

**METRIC**

W.P. GWP 408-94-00 LOCATION Culvert No. 1 Northing - 4894552, Easting - 376303 ORIGINATED BY RB  
 DIST Owen Sound HWY 21 BOREHOLE TYPE 100mm SST Auger COMPILED BY JL  
 DATUM Geodetic DATE 09.05.06 - 09.05.06 CHECKED BY EC

SOIL PROFILE		SAMPLES			GROUND WATER CONDITIONS	ELEVATION SCALE	PENETR. RESISTANCE		PLASTIC LIMIT w <sub>p</sub>	NATURAL MOISTURE CONTENT w	LIQUID LIMIT w <sub>L</sub>	UNIT WEIGHT γ	REMARKS & GRAIN SIZE DISTRIBUTION (%)	
ELEV DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE			"N" VALUES	STANDARD ●						DYN. CONE ○
218.96	Ground Surface													
0.00	FILL - Moist, loose, topsoil.  Sandy SILT (ML) Brown, moist, compact, trace gravel.  Brown Silty CLAY TILL (CL) Moist, hard, with embedded sand and gravel.  Grey		1	SS	4									
217.89			2	SS	12								22.6	
1.07														
217.59														
1.37														
215.45														
3.51													Borehole dry and open @ completion.	

JOE MTO 06-8-IEG2.GPJ ONTARIO.MOT.GDT 09/26/07

+ 3, X 3: Numbers refer to Sensitivity

○ 150 UNCONFINED SHEAR STRENGTH INFERRED FROM POCKET PENETROMETER READINGS

**RECORD OF BOREHOLE No C01-3**

1 OF 1

**METRIC**

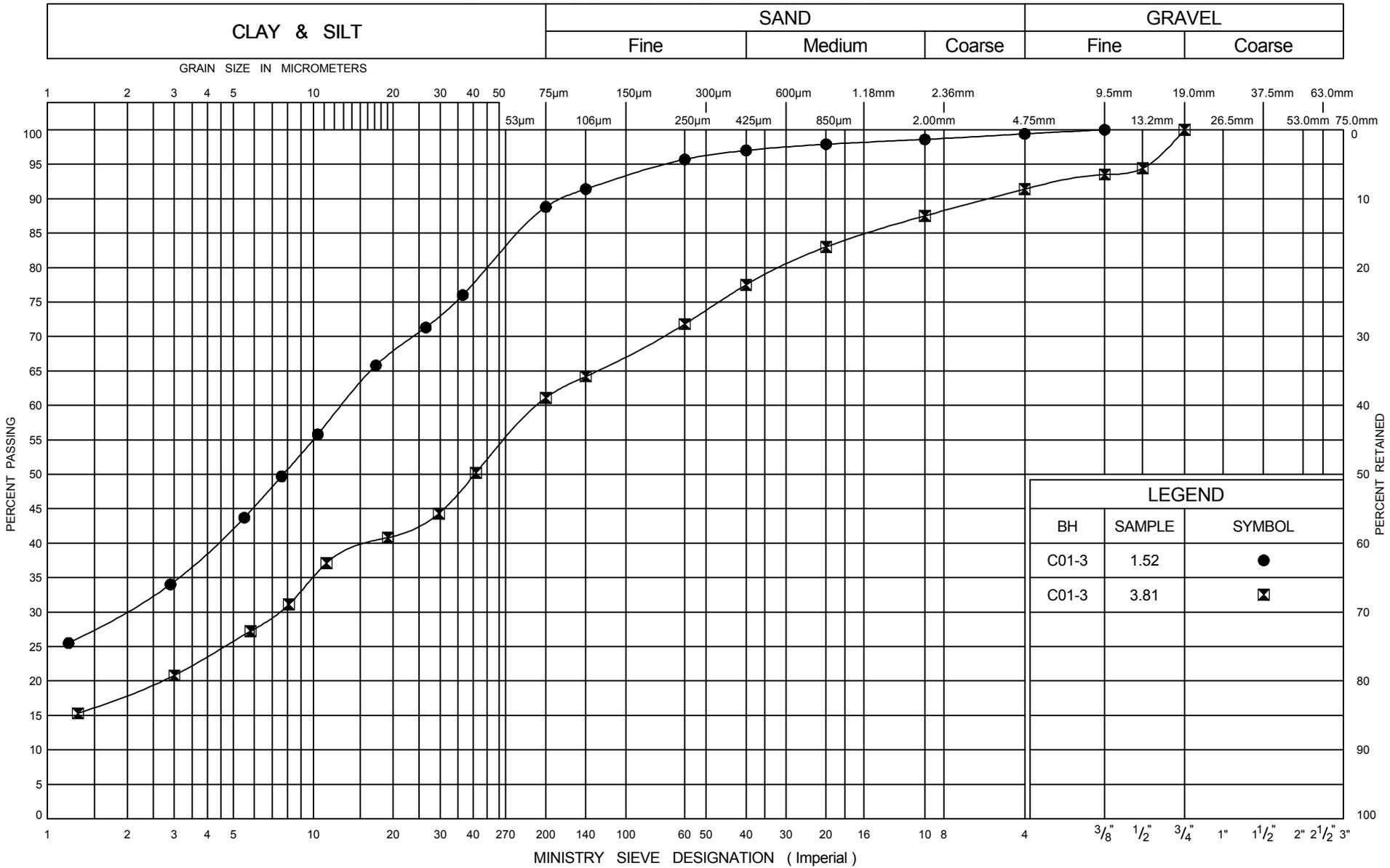
W.P. GWP 408-94-00 LOCATION Culvert No. 1 Northing - 4894544, Easting - 376317 ORIGINATED BY RB  
 DIST Owen Sound HWY 21 BOREHOLE TYPE 100mm SST Auger COMPILED BY JL  
 DATUM Geodetic DATE 9.5.06 - 9.5.06 CHECKED BY EC

SOIL PROFILE		SAMPLES			GROUND WATER CONDITIONS	ELEVATION SCALE	PENETR. RESISTANCE					PLASTIC NATURAL LIQUID			UNIT WEIGHT $\gamma$	REMARKS & GRAIN SIZE DISTRIBUTION (%)			
ELEV. DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE			"N" VALUES	STANDARD	DYN. CONE	W <sub>p</sub>	W	W <sub>L</sub>	W <sub>p</sub>	W			W <sub>L</sub>	GR	SA
224.06	Ground Surface																		
0.00	FILL - brown, moist, sand and gravel (shoulder gravel).  FILL Brown to grey, moist to wet, compact to loose, consisting of silty clay, with occasional sandy silt pockets with some gravel and wood pieces.	[Hatched Pattern]	1	AUGER															
223.60			2	SS	16														
0.46			3	SS	19														
			4	SS	18														
			5	SS	8														
			6	SS	10														
			7	SS	7														
218.57	Silty CLAY TILL (CL)	[Diagonal Pattern]	8	SS	12														
5.49	Grey, moist, stiff, with embedded sand and gravel.																		
218.12	Sandy SILT (ML)		9	SS	12														
5.94	Grey, saturated, compact.																		
217.35	Silty CLAY TILL (CL)	[Diagonal Pattern]	10	SS	51														
6.71	Grey, moist, hard, with embedded sand and gravel.																		
216.74	End of Borehole.																		
7.32																		Water level measured @ 6.2m.	

JOE MTO 06-8-IEG2.GPJ ONTARIO.MOT.GDT 4/17/07

+ 3, X 3: Numbers refer to Sensitivity      ○ 150 UNCONFINED SHEAR STRENGTH INFERRED FROM POCKET PENETROMETER READINGS

### UNIFIED SOIL CLASSIFICATION SYSTEM



LEGEND		
BH	SAMPLE	SYMBOL
C01-3	1.52	●
C01-3	3.81	⊠

ONTARIO MOT GRAIN SIZE 06-8-1EG2.GPJ ONTARIO MOT.GDT 4/17/07

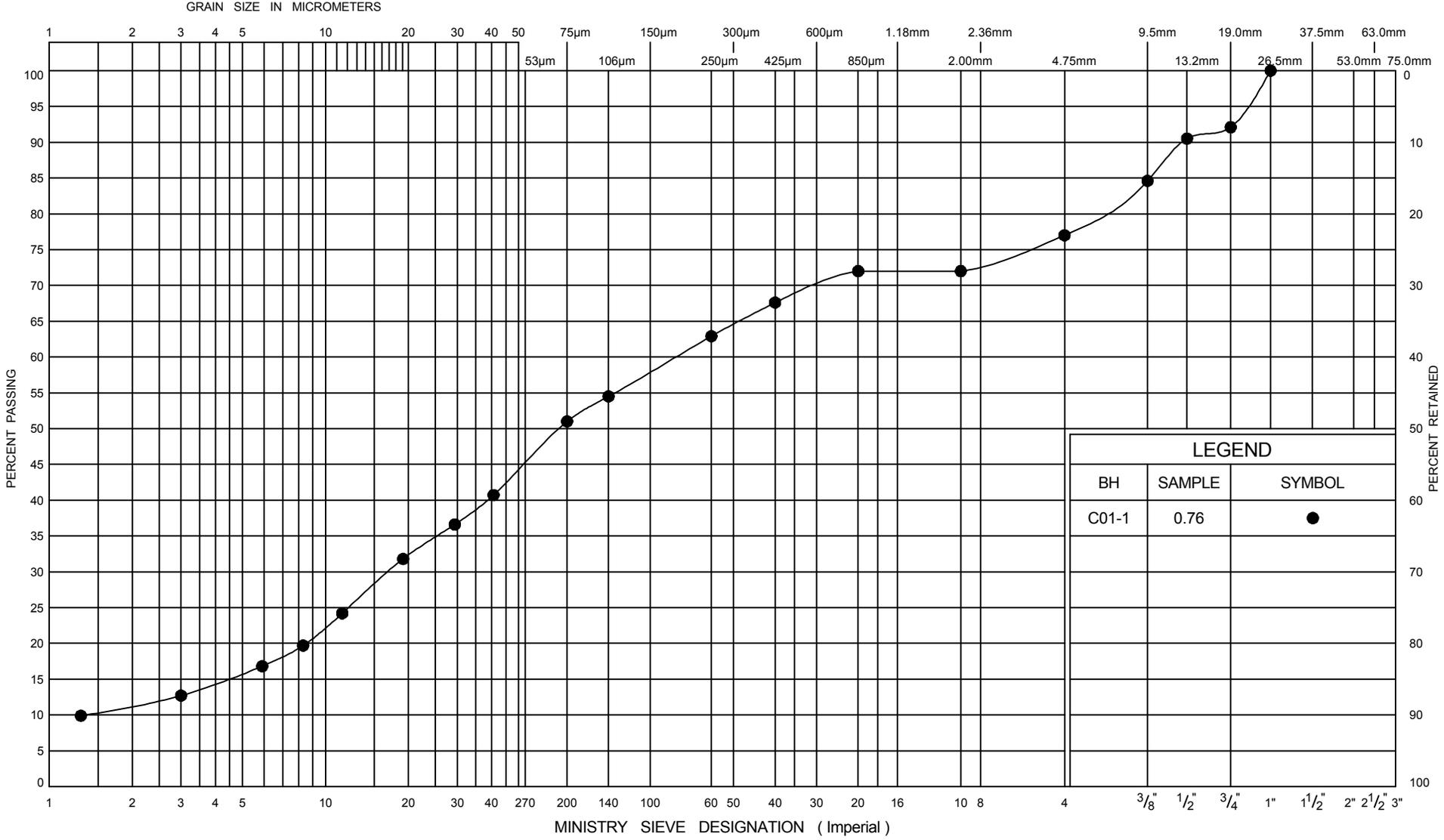


## GRAIN SIZE DISTRIBUTION FILL

FIG NoC01-1  
GWP 408-94-00  
Highway 21-Kincardine to Tiverton

### UNIFIED SOIL CLASSIFICATION SYSTEM

CLAY & SILT	SAND			GRAVEL	
	Fine	Medium	Coarse	Fine	Coarse



LEGEND		
BH	SAMPLE	SYMBOL
C01-1	0.76	●

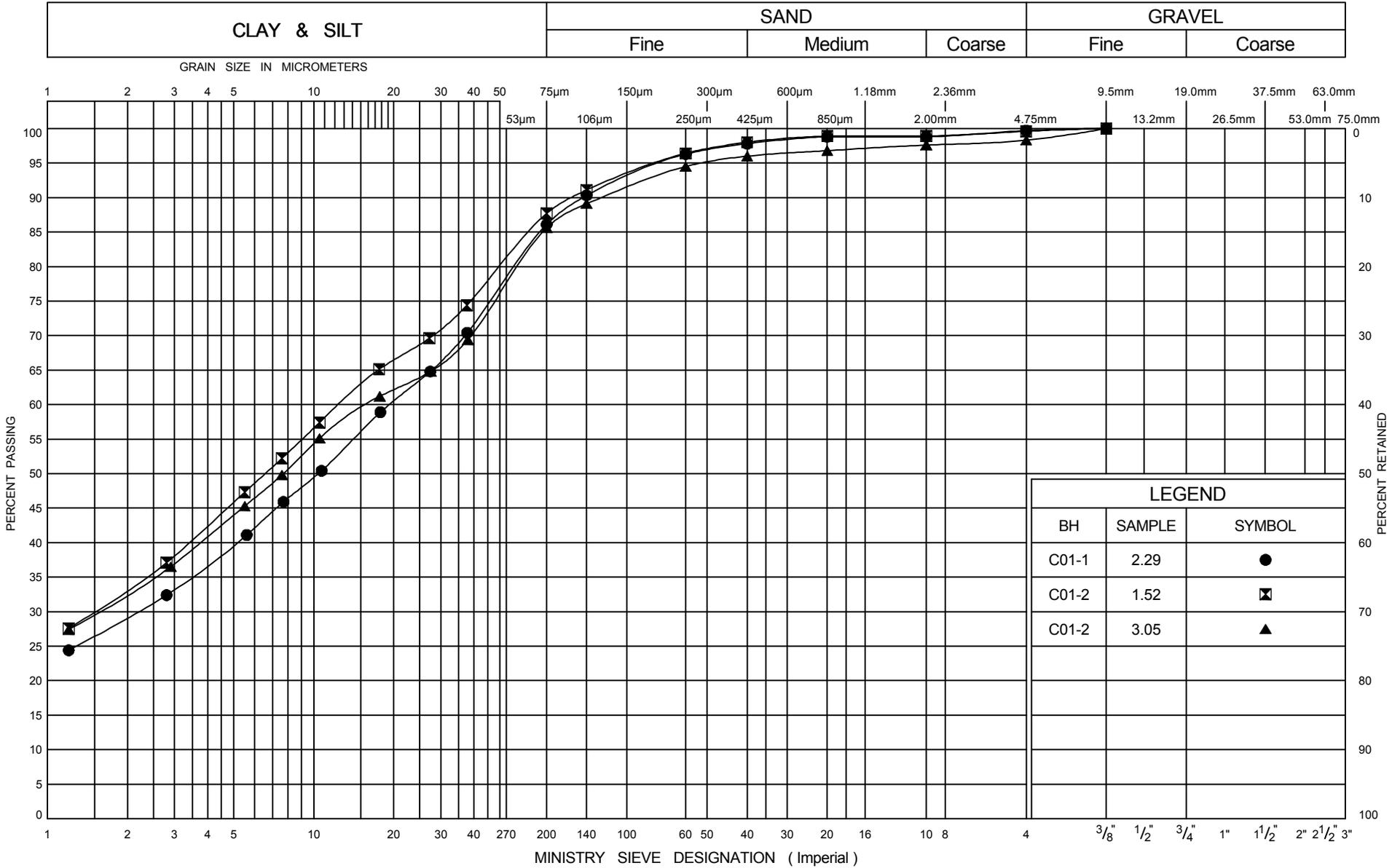
ONTARIO MOT GRAIN SIZE 06-8-1EG2.GPJ ONTARIO MOT.GDT 4/17/07



## GRAIN SIZE DISTRIBUTION SANDY SILT TILL (ML)

FIG NoC01-2  
GWP 408-94-00  
Highway 21-Kincardine to Tiverton

UNIFIED SOIL CLASSIFICATION SYSTEM



ONTARIO MOT GRAIN SIZE 06-8-1EG2.GPJ ONTARIO MOT.GDT 4/17/07

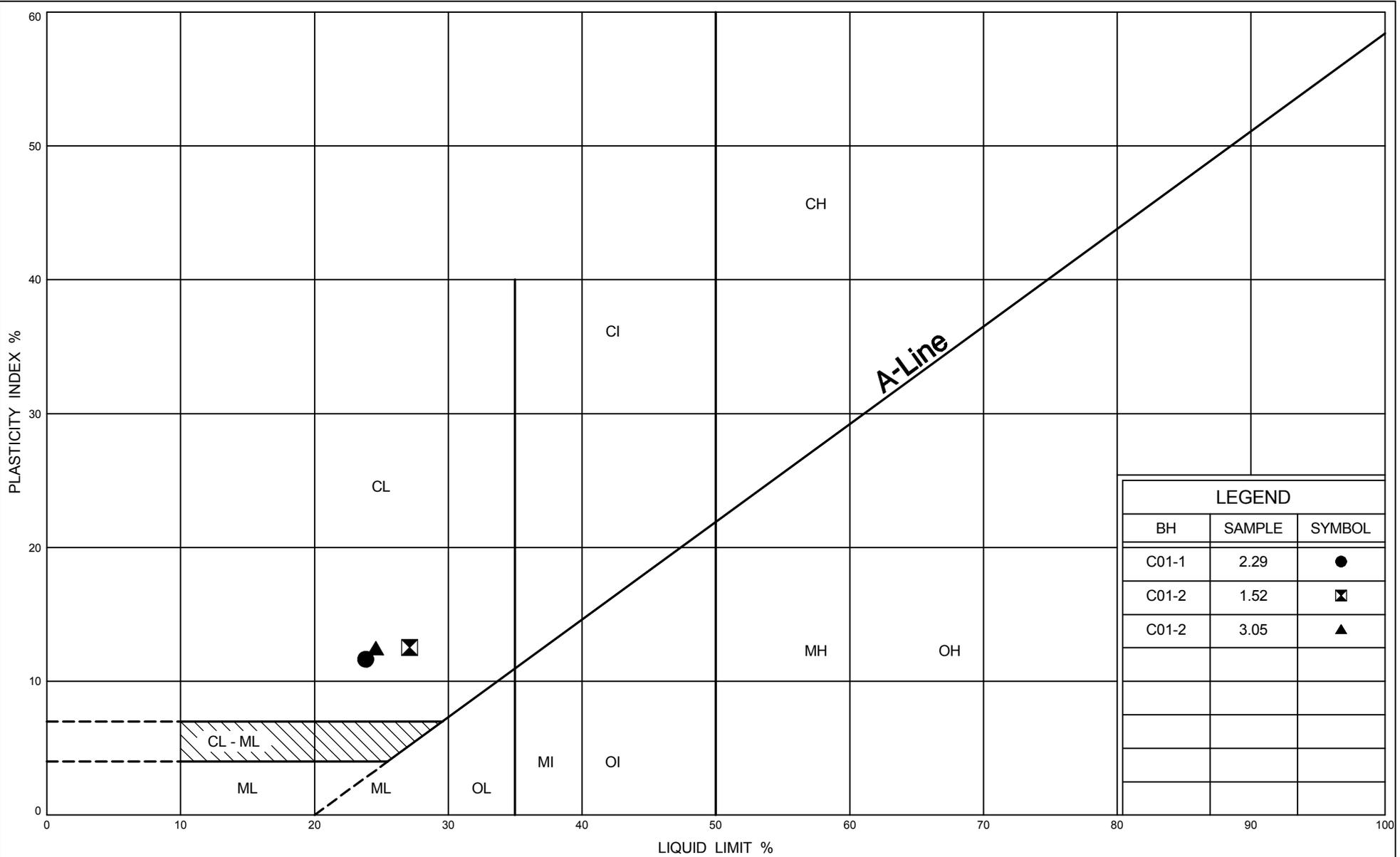


GRAIN SIZE DISTRIBUTION  
SILTY CLAY TILL (CL)

FIG NoC01-3

GWP 408-94-00

Highway 21-Kincardine to Tiverton



LEGEND		
BH	SAMPLE	SYMBOL
C01-1	2.29	●
C01-2	1.52	⊠
C01-2	3.05	▲

ONTARIO MOT PLASTICITY CHART\_06-8-1EG2.GPJ\_ONTARIO MOT.GDT\_4/17/07



PLASTICITY CHART  
SILTY CLAY TILL (CL)

FIG No C01-4  
GWP 408-94-00  
Highway 21-Kincardine to Tiverton

**RECORD OF BOREHOLE No C02-1**

1 OF 1

**METRIC**

W.P. GWP 408-94-00 LOCATION Culvert No. 2 Northing - 4894641, Easting - 376354 ORIGINATED BY RB  
 DIST Owen Sound HWY 21 BOREHOLE TYPE 100mm SST Auger COMPILED BY JL  
 DATUM Geodetic DATE 09.05.06 - 09.05.06 CHECKED BY EC

SOIL PROFILE		SAMPLES			GROUND WATER CONDITIONS	ELEVATION SCALE	PENETR. RESISTANCE STANDARD ● DYN. CONE ○		PLASTIC LIMIT NATURAL MOISTURE CONTENT LIQUID LIMIT			UNIT WEIGHT $\gamma$ kN/m <sup>3</sup>	REMARKS & GRAIN SIZE DISTRIBUTION (%)
ELEV DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE			"N" VALUES	SHEAR STRENGTH kPa		W <sub>p</sub>	W		
						20 40 60 80 100	20 40 60 80 100						
219.58	Ground Surface												
0.00	FILL Brown/black, topsoil.		1	SS	7								
218.97													
0.61													
218.67	Sandy silt		2	SS	6								
0.91													
	Brown		3	SS	100+								
	Silty CLAY TILL (CL) Moist, firm to hard, with embedded sand and gravel.		4	SS	39								
	Grey		5	SS	35								
216.07													
3.51	End of Borehole.												

JOE.MTO\_06-8-IEG2.GPJ ONTARIO.MOT.GDT 09/26/07

+ 3, X 3: Numbers refer to Sensitivity

○ 150 UNCONFINED SHEAR STRENGTH INFERRED FROM POCKET PENETROMETER READINGS

**RECORD OF BOREHOLE No C02-2**

1 OF 1

**METRIC**

W.P. GWP 408-94-00 LOCATION Culvert No. 2 Northing - 4894636, Easting - 376366 ORIGINATED BY RB  
 DIST Owen Sound HWY 21 BOREHOLE TYPE 100mm SST Auger COMPILED BY JL  
 DATUM Geodetic DATE 9.5.06 - 9.5.06 CHECKED BY EC

SOIL PROFILE		SAMPLES			GROUND WATER CONDITIONS	ELEVATION SCALE	PENETR. RESISTANCE STANDARD ● DYN. CONE ○					PLASTIC LIMIT NATURAL MOISTURE CONTENT LIQUID LIMIT			UNIT WEIGHT $\gamma$	REMARKS & GRAIN SIZE DISTRIBUTION (%)				
ELEV. DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE			"N" VALUES	SHEAR STRENGTH kPa					W <sub>p</sub>	W			W <sub>L</sub>	GR	SA	SI
						20	40	60	80	100										
224.77 0.00	Ground Surface		1	AUGER																
224.01 0.76	FILL Brown, damp, consisting of sand and gravel (shoulder gravel).  FILL Grey to greenish grey, moist, loose to compact, consisting of mixed silty clay to clayey silt, trace to some sand and gravel.	[Hatched Pattern]	2	SS	21															
			3	SS	15															
			4	SS	11															
			5	SS	5															
			6	SS	9															
			7	SS	21															
219.44 5.33			Silty CLAY TILL (CL) Moist, brown changing to grey, hard, with embedded sand and gravel.	[Hatched Pattern]	8	SS	50/75													
218.22 6.55	9	SS			68															
	End of Borehole.																		Water level measured @ 5.8m @ completion.	

JOE MTO 06-8-IEG2.GPJ ONTARIO.MOT.GDT 4/17/07

+ 3, X 3: Numbers refer to Sensitivity

○ 150 UNCONFINED SHEAR STRENGTH INFERRED FROM POCKET PENETROMETER READINGS

**RECORD OF BOREHOLE No C02-3**

1 OF 1

**METRIC**

W.P. GWP 408-94-00 LOCATION Culvert No. 2 Northing - 4894631, Easting - 376384 ORIGINATED BY RB  
 DIST Owen Sound HWY 21 BOREHOLE TYPE 100mm SST Auger COMPILED BY JL  
 DATUM Geodetic DATE 9.5.06 - 9.5.06 CHECKED BY EC

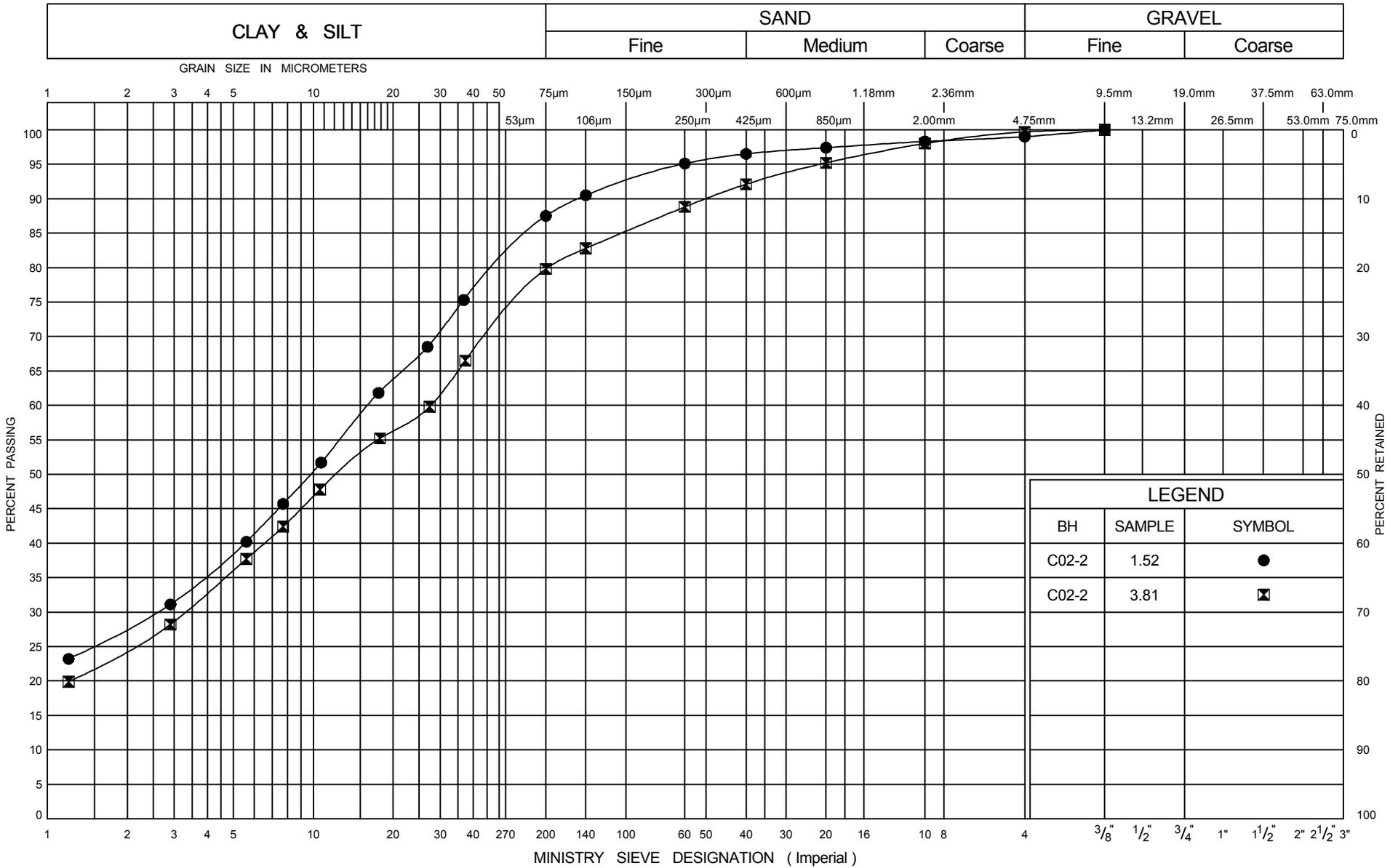
SOIL PROFILE		SAMPLES			GROUND WATER CONDITIONS	ELEVATION SCALE	PENETR. RESISTANCE		PLASTIC LIMIT W <sub>p</sub>	NATURAL MOISTURE CONTENT W	LIQUID LIMIT W <sub>L</sub>	UNIT WEIGHT γ	REMARKS & GRAIN SIZE DISTRIBUTION (%)
ELEV. DEPTH	DESCRIPTION	STRAT. PLOT	NUMBER	TYPE			"N" VALUES	STANDARD ●					
222.30 0.00	Ground Surface												
221.69 0.61	FILL Brown/Black, topsoil.		1	SS	5								
			2	SS	8						21.5	0 17 54 29 (83)	
	Brown Silty CLAY TILL (CL) Moist, firm to hard, with embedded sand and gravel.		3	SS	9							Wet seam between samples.	
			4	SS	34							0 17 55 27 (83)	
	Grey		5	SS	67								
218.79 3.51	End of Borehole.											Minor water ingress from 2.1m @ completion. Water level measured @ 2.5m @ completion.	

JOE MTO 06-8-IEG2.GPJ ONTARIO.MOT.GDT 4/17/07

+ 3, X 3: Numbers refer to Sensitivity

○ 150 UNCONFINED SHEAR STRENGTH INFERRED FROM POCKET PENETROMETER READINGS

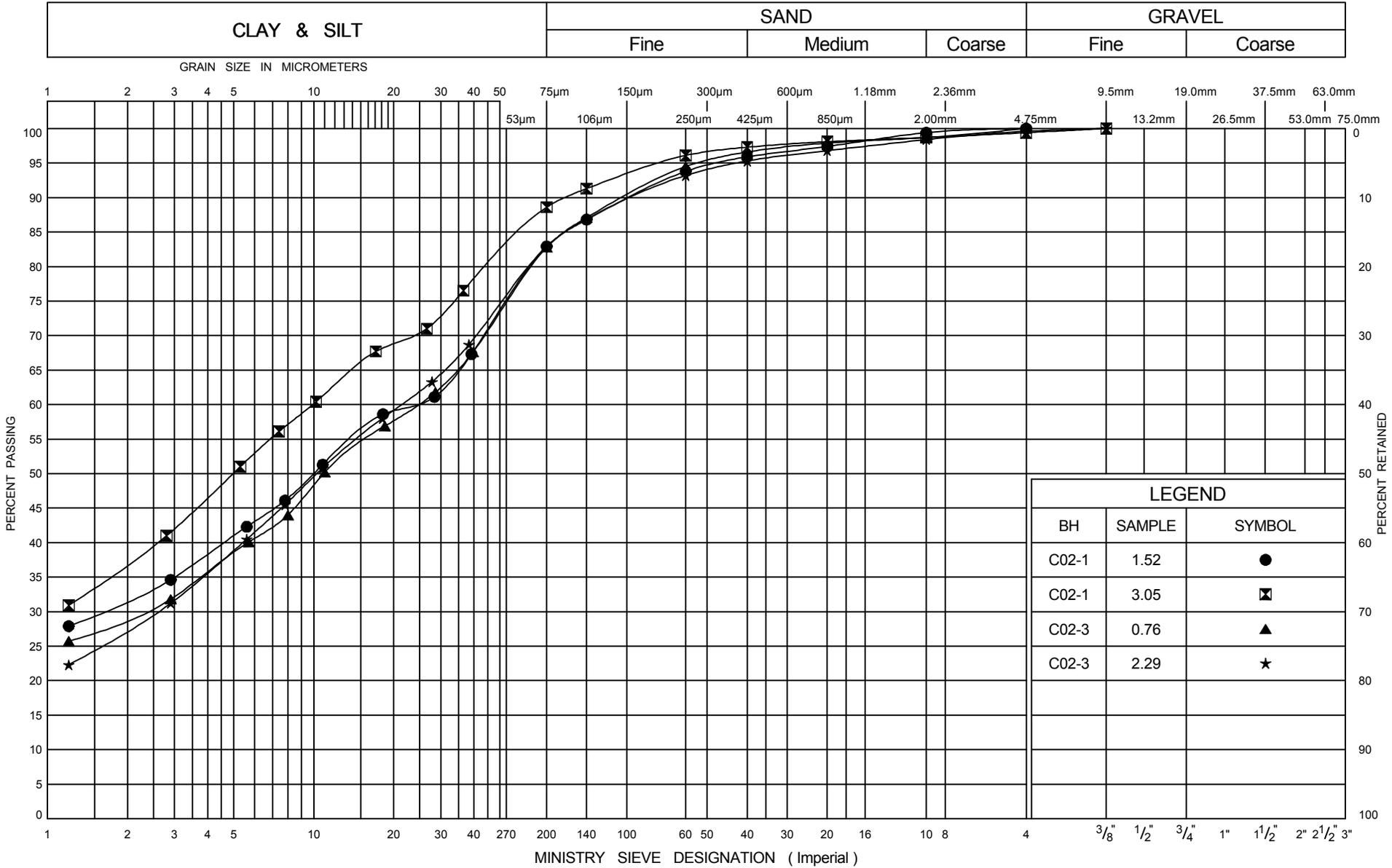
### UNIFIED SOIL CLASSIFICATION SYSTEM



## GRAIN SIZE DISTRIBUTION FILL

FIG NoC02-1  
GWP 408-94-00  
Highway 21-Kincardine to Tiverton

### UNIFIED SOIL CLASSIFICATION SYSTEM



ONTARIO MOT GRAIN SIZE 06-8-1EG2.GPJ ONTARIO MOT.GDT 4/17/07

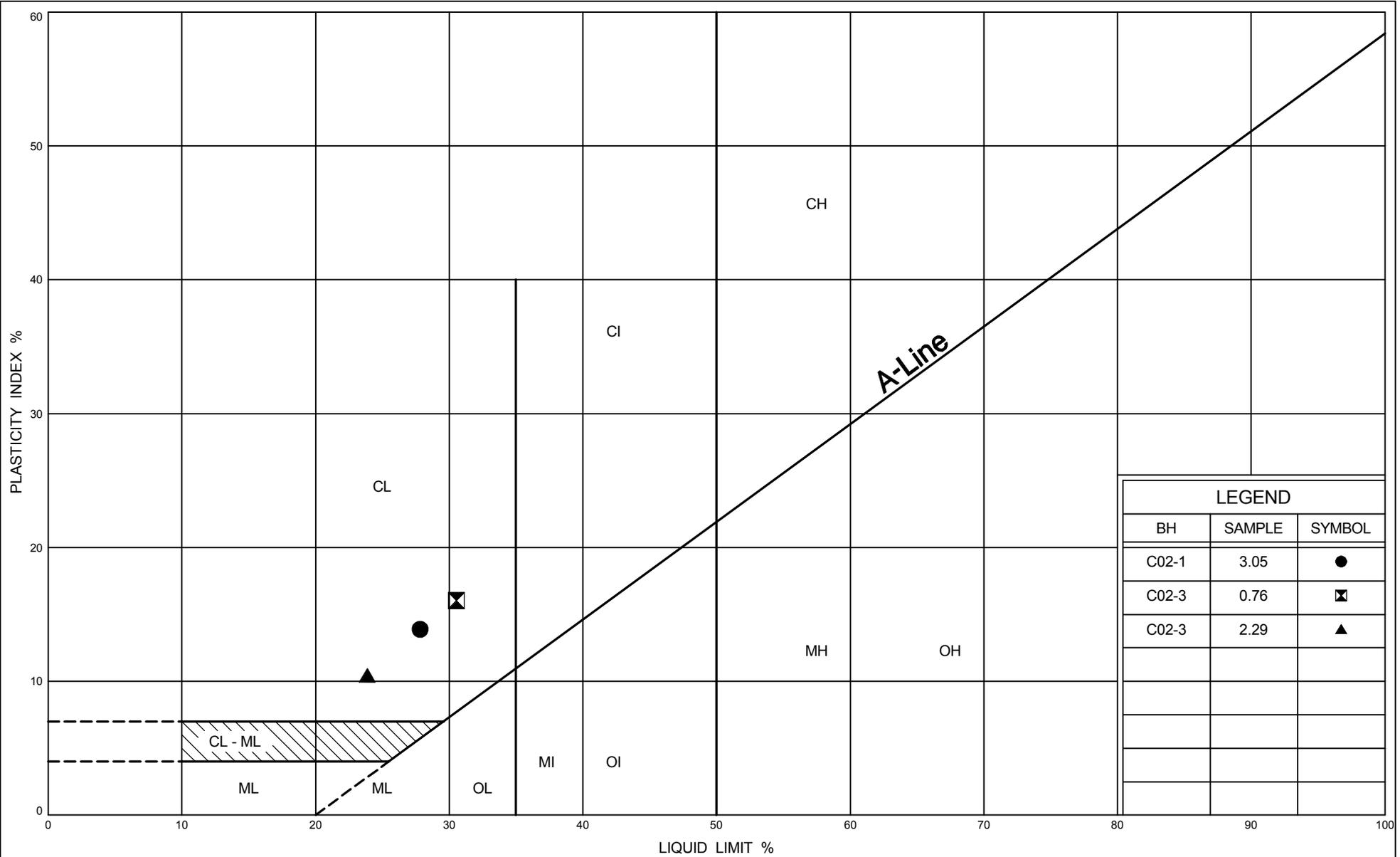


## GRAIN SIZE DISTRIBUTION SILTY CLAY TILL (CL)

FIG NoC02-2

GWP 408-94-00

Highway 21-Kincardine to Tiverton



LEGEND		
BH	SAMPLE	SYMBOL
C02-1	3.05	●
C02-3	0.76	⊠
C02-3	2.29	▲

ONTARIO MOT PLASTICITY CHART\_06-8-1EG2.GPJ\_ONTARIO MOT.GDT\_4/17/07



PLASTICITY CHART  
SILTY CLAY TILL (CL)

FIG No C02-3  
GWP 408-94-00  
Highway 21-Kincardine to Tiverton

**RECORD OF BOREHOLE No C03-1**

1 OF 1

**METRIC**

W.P. GWP 408-94-00 LOCATION Culvert No. 3 Northing - 4894742, Easting - 376423 ORIGINATED BY RB  
 DIST Owen Sound HWY 21 BOREHOLE TYPE 100mm SST Auger COMPILED BY JL  
 DATUM Geodetic DATE 9.5.06 - 9.26.06 CHECKED BY EC

SOIL PROFILE		SAMPLES			GROUND WATER CONDITIONS	ELEVATION SCALE	PENETR. RESISTANCE					PLASTIC NATURAL LIQUID			UNIT WEIGHT $\gamma$ kN/m <sup>3</sup>	REMARKS & GRAIN SIZE DISTRIBUTION (%)
ELEV. DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE			"N" VALUES	STANDARD	DYN. CONE	W <sub>p</sub>	MOISTURE CONTENT	W <sub>L</sub>	WATER CONTENT (%)	GR		
225.72 0.00	Ground Surface															
225.26 0.46	FILL Brown, damp, sand and gravel (shoulder gravel).		1	AUGER											27	47 (26)
	FILL Brown, moist, compact to loose, consisting of mixed clayey silt to silty clay and silty sand, trace organics, and buried topsoil.		2	SS	11											
			3	SS	5										3	26 50 21 (71)
			4	SS	4											
			5	SS	9										6	18 50 25 (76)
			6	SS	27											
222.06 3.66	Brown  Silty Clay TILL (CL) Moist, very stiff to hard, with embedded sand and gravel.  Grey		7	SS	60											
219.93 5.79	End of borehole.		8	SS	55											

JOE MTO 06-8-IEG2.GPJ ONTARIO.MOT.GDT 4/17/07

+ 3, X 3: Numbers refer to Sensitivity

○ 150 UNCONFINE SHEAR STRENGTH INFERRED FROM POCKET PENETROMETER READINGS

**RECORD OF BOREHOLE No C03-2**

1 OF 1

**METRIC**

W.P. GWP 408-94-00 LOCATION Culvert No. 3 Northing - 4894749, Easting - 376417 ORIGINATED BY RB  
 DIST Owen Sound HWY 21 BOREHOLE TYPE 100mm SST Auger COMPILED BY JL  
 DATUM Geodetic DATE 9.5.06 - 9.5.06 CHECKED BY EC

SOIL PROFILE		SAMPLES			GROUND WATER CONDITIONS	ELEVATION SCALE	PENETR. RESISTANCE		PLASTIC LIMIT W <sub>p</sub>	NATURAL MOISTURE CONTENT w	LIQUID LIMIT W <sub>L</sub>	UNIT WEIGHT γ	REMARKS & GRAIN SIZE DISTRIBUTION (%)
ELEV. DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE			"N" VALUES	STANDARD ●					
223.82	Ground Surface												
0.00	FILL 610mm Topsoil fill.		1	SS	12		●						
223.21			2	SS	11		●						
0.61													
	Brown Silty CLAY TILL (CL) Moist, stiff to hard, with embedded sand and gravel.		3	SS	47		●		225+	15-25		23.5	2 16 54 29 (83)
			4	SS	51		●		225+	15-25		23.8	1 15 53 31 (84)
	Grey		5	SS	40		●		225+	15-25			
220.31	End of Borehole.												Borehole dry and open @ completion.
3.51													

JOE MTO 06-8-IEG2.GPJ ONTARIO.MOT.GDT 4/17/07

**RECORD OF BOREHOLE No C03-3**

1 OF 1

**METRIC**

W.P. GWP 408-94-00 LOCATION Culvert No. 3 Northing - 4894735, Easting - 376439 ORIGINATED BY RB  
 DIST Owen Sound HWY 21 BOREHOLE TYPE 100mm SST Auger COMPILED BY JL  
 DATUM Geodetic DATE 9.5.06 - 9.5.06 CHECKED BY EC

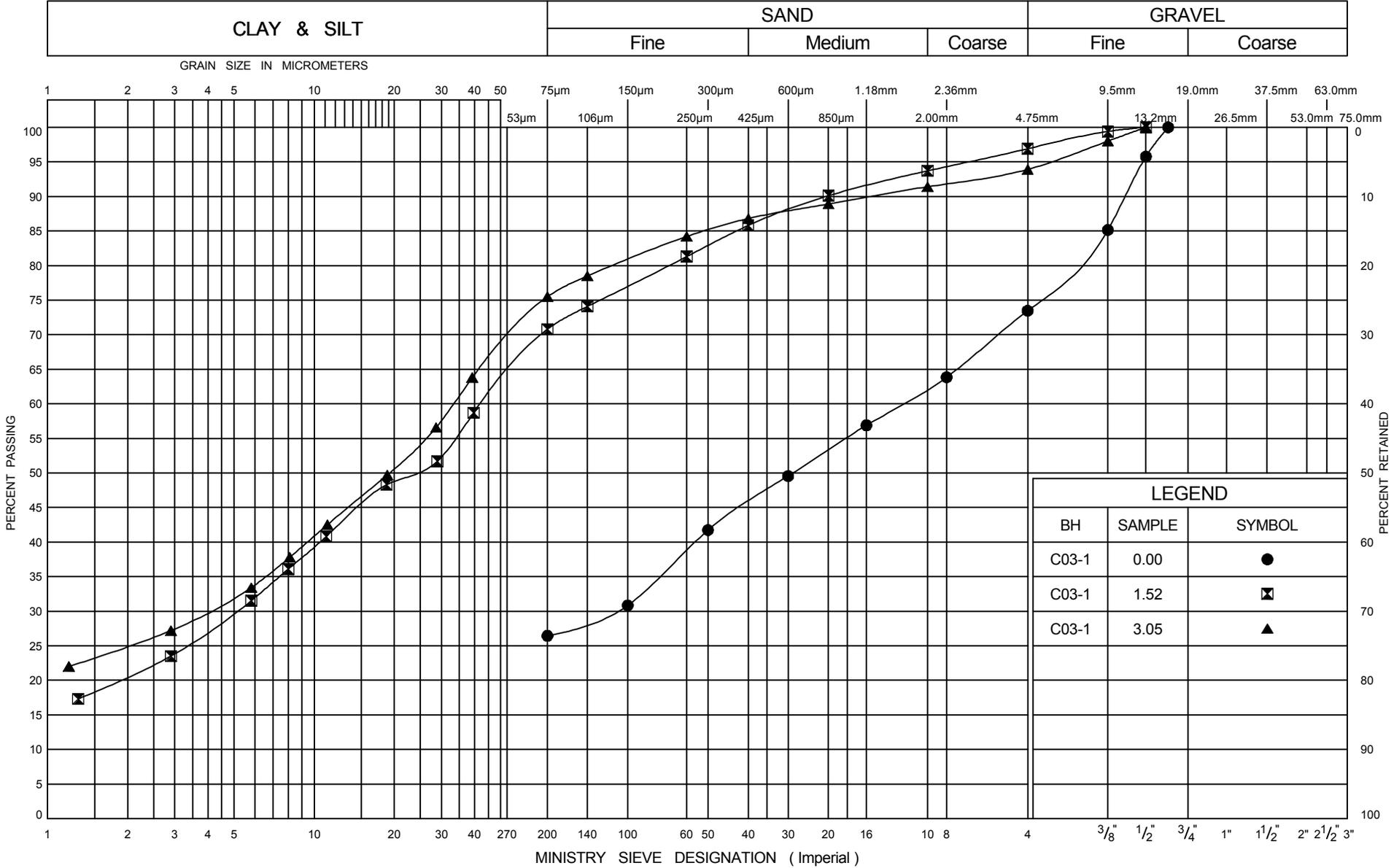
SOIL PROFILE		SAMPLES			GROUND WATER CONDITIONS	ELEVATION SCALE	PENETR. RESISTANCE		PLASTIC LIMIT W <sub>p</sub>	NATURAL MOISTURE CONTENT w	LIQUID LIMIT W <sub>L</sub>	UNIT WEIGHT γ	REMARKS & GRAIN SIZE DISTRIBUTION (%)	
ELEV. DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE			"N" VALUES	STANDARD ●						DYN. CONE ○
224.99 0.00	Ground Surface													
224.24 0.75	TOPSOIL - 750mm.		1	SS	16									
	Silty CLAY TILL (CL) Brown, moist, stiff to hard, with embedded sand and gravel.		2	SS	11									
			3	SS	23								0 12 58 30 (87)	
			4	SS	47									
			5	SS	51									
221.48 3.51	End of Borehole.												Borehole dry and open @ completion.	

JOE MTO 06-8-IEG2.GPJ ONTARIO.MOT.GDT 4/17/07

+ 3, X 3: Numbers refer to Sensitivity

○ 150 UNCONFINED SHEAR STRENGTH INFERRED FROM POCKET PENETROMETER READINGS

UNIFIED SOIL CLASSIFICATION SYSTEM



LEGEND		
BH	SAMPLE	SYMBOL
C03-1	0.00	●
C03-1	1.52	⊠
C03-1	3.05	▲

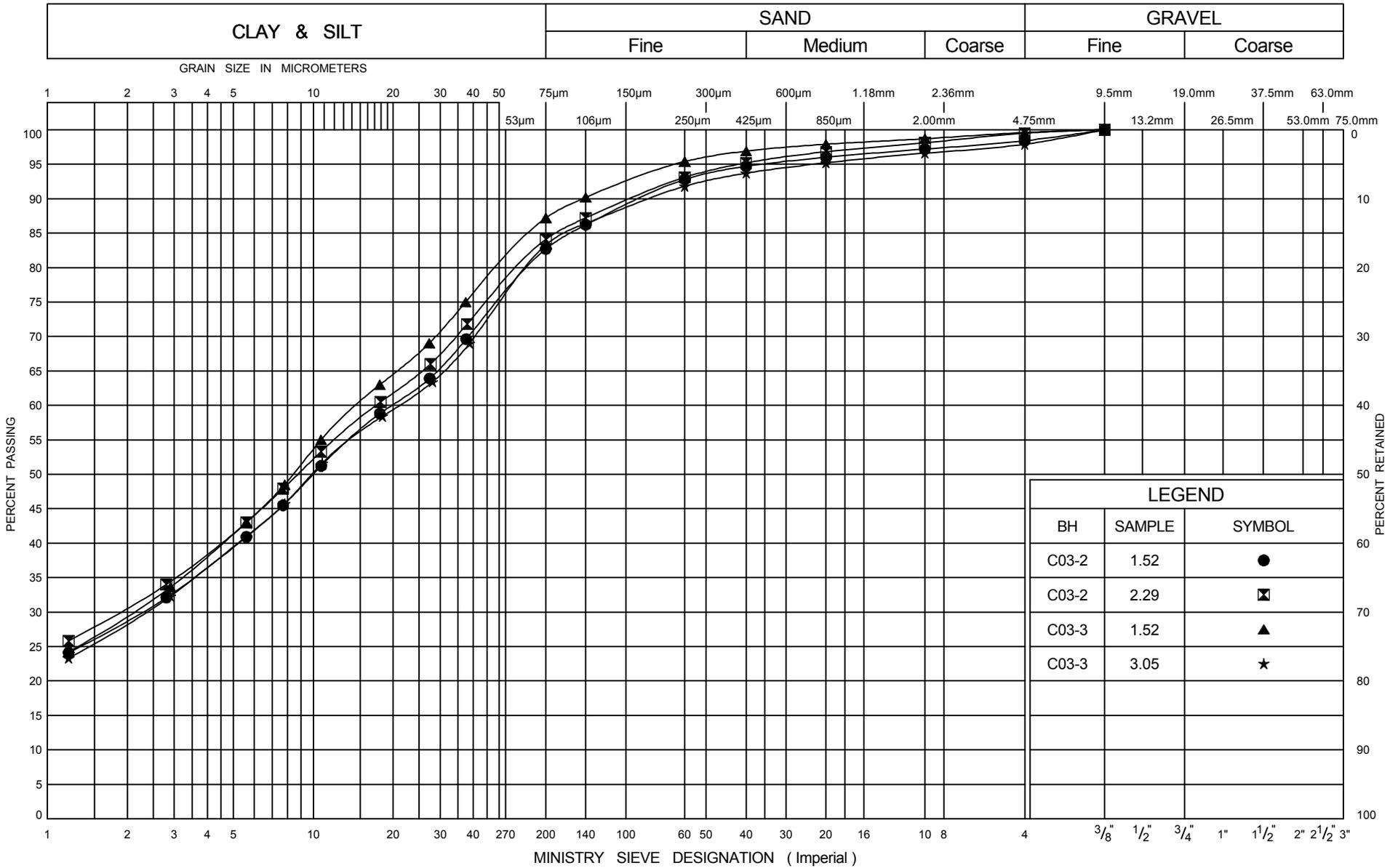
ONTARIO MOT GRAIN SIZE 06-8-1EG2.GPJ ONTARIO MOT.GDT 4/17/07



GRAIN SIZE DISTRIBUTION  
FILL

FIG NoC03-1  
GWP 408-94-00  
Highway 21-Kincardine to Tiverton

UNIFIED SOIL CLASSIFICATION SYSTEM



ONTARIO MOT GRAIN SIZE 06-8-1EG2.GPJ ONTARIO MOT.GDT 4/17/07

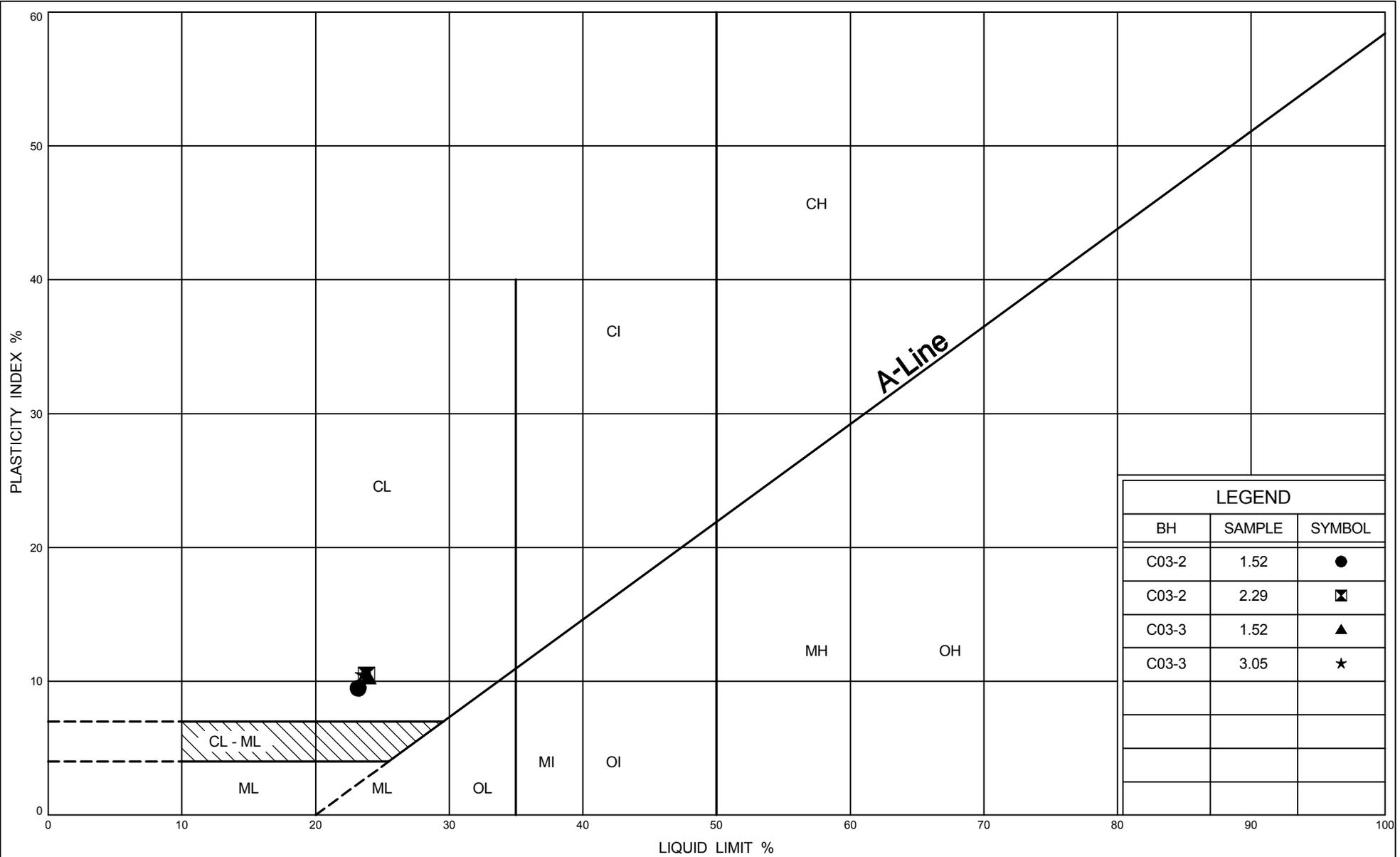


GRAIN SIZE DISTRIBUTION  
SILTY CLAY TILL (CL)

FIG NoC03-2

GWP 408-94-00

Highway 21-Kincardine to Tiverton



LEGEND		
BH	SAMPLE	SYMBOL
C03-2	1.52	●
C03-2	2.29	⊠
C03-3	1.52	▲
C03-3	3.05	★

ONTARIO MOT PLASTICITY CHART\_06-8-1EG2.GPJ\_ONTARIO MOT.GDT\_4/17/07



**PLASTICITY CHART**  
**SILTY CLAY TILL (CL)**

FIG No C03-3  
GWP 408-94-00  
Highway 21-Kincardine to Tiverton

**RECORD OF BOREHOLE No C04-1**

1 OF 1

**METRIC**

W.P. GWP 408-94-00 LOCATION Culvert No. 4 Northing - 4895908, Easting - 377044 ORIGINATED BY RB  
 DIST Owen Sound HWY 21 BOREHOLE TYPE 100mm SST Auger COMPILED BY JL  
 DATUM Geodetic DATE 9.6.06 - 9.6.06 CHECKED BY EC

SOIL PROFILE		SAMPLES			GROUND WATER CONDITIONS	ELEVATION SCALE	PENETR. RESISTANCE					PLASTIC NATURAL LIQUID			UNIT WEIGHT $\gamma$ kN/m <sup>3</sup>	REMARKS & GRAIN SIZE DISTRIBUTION (%)
ELEV. DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE			"N" VALUES	STANDARD	DYN. CONE	W <sub>p</sub>	MOISTURE CONTENT	W <sub>L</sub>	WATER CONTENT (%)	GR		
234.86 0.00	Ground Surface		1	AUGER												
	FILL Brown, damp, compact, consisting of sand and gravel (shoulder gravel).		2	SS	14											38 44 (18)
233.51 1.35	FILL Brown, damp, loose, consisting mainly of clayey silt.		3	SS	8											19.5 3 28 51 19 (69)
232.42 2.44	Silty CLAY TILL (CL) Moist, very stiff to hard, with embedded sand and gravel, occasional wet silty sand seams.		4	SS	17											
			5	SS	22											
			6	SS	37											
230.59 4.27	End of borehole.															Borehole dry and open @ completion.

JOE MTO 06-8-IEG2.GPJ ONTARIO.MOT.GDT 4/17/07

+ 3, X 3: Numbers refer to Sensitivity      ○ 150 UNCONFINE SHEAR STRENGTH INFERRED FROM POCKET PENETROMETER READINGS

**RECORD OF BOREHOLE No C04-2**

1 OF 1

**METRIC**

W.P. GWP 408-94-00 LOCATION Culvert No. 4 Northing - 4895911, Easting - 377032 ORIGINATED BY RB  
 DIST Owen Sound HWY 21 BOREHOLE TYPE 100mm SST Auger COMPILED BY JL  
 DATUM Geodetic DATE 9.7.06 - 9.7.06 CHECKED BY EC

SOIL PROFILE		SAMPLES			GROUND WATER CONDITIONS	ELEVATION SCALE	PENETR. RESISTANCE		PLASTIC LIMIT W <sub>p</sub>	NATURAL MOISTURE CONTENT W	LIQUID LIMIT W <sub>L</sub>	UNIT WEIGHT γ	REMARKS & GRAIN SIZE DISTRIBUTION (%)
ELEV. DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE			"N" VALUES	STANDARD ●					
233.55	Ground Surface												
0.00	TOPSOIL - 100mm.												
	Brown		1	SS	34								
			2	SS	11								3 23 52 22 (74)
		Silty CLAY TILL (CL) Moist, stiff to hard, with embedded sand and gravel, occasional wet sand and gravel seams.		3	SS	8	▽						
	Grey			4	SS	21			225			23.6	1 20 53 26 (79)
				5	SS	41			225+				
230.04	End of Borehole.												Water level measured @ 1.8m @ completion.
3.51													

JOE MTO 06-8-IEG2.GPJ ONTARIO.MOT.GDT 4/17/07

+ 3, X 3: Numbers refer to Sensitivity ○ 150 UNCONFINED SHEAR STRENGTH INFERRED FROM POCKET PENETROMETER READINGS

**RECORD OF BOREHOLE No C04-3**

1 OF 1

**METRIC**

W.P. GWP 408-94-00 LOCATION Culvert No. 4 Northing - 4895896, Easting - 377059 ORIGINATED BY RB  
 DIST Owen Sound HWY 21 BOREHOLE TYPE 100mm SST Auger COMPILED BY JL  
 DATUM Geodetic DATE 9.7.06 - 9.7.06 CHECKED BY EC

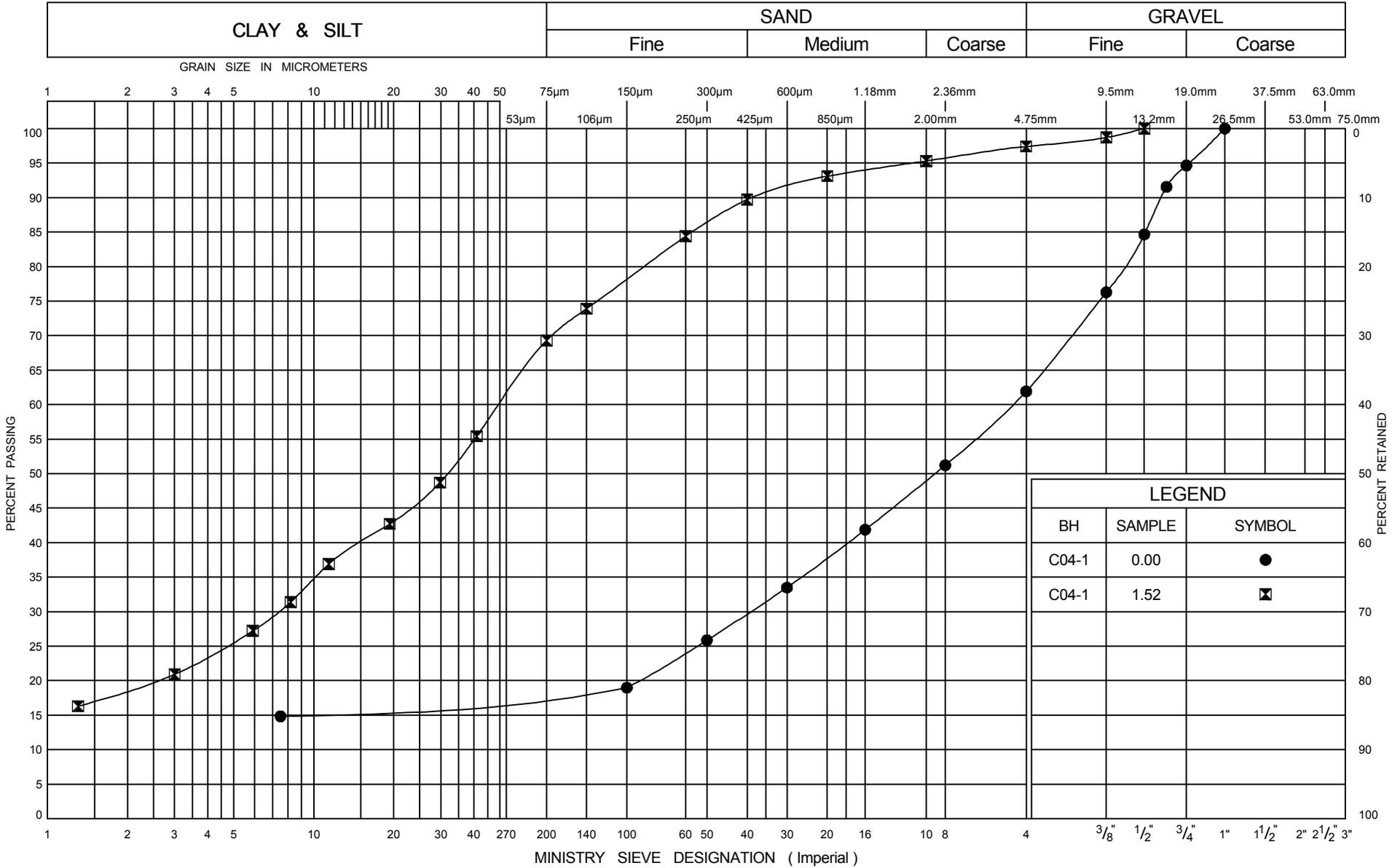
SOIL PROFILE		SAMPLES			GROUND WATER CONDITIONS	ELEVATION SCALE	PENETR. RESISTANCE					PLASTIC NATURAL LIQUID			UNIT WEIGHT $\gamma$ kN/m <sup>3</sup>	REMARKS & GRAIN SIZE DISTRIBUTION (%) GR SA SI CL	
ELEV. DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE			"N" VALUES	STANDARD	DYN. CONE	W <sub>p</sub>	W	W <sub>L</sub>	WATER CONTENT (%)				
233.78	Ground Surface																
0.00	TOPSOIL - 600mm.		1	SS	9												
233.18	Brown  Silty CLAY TILL (CL) Moist, stiff to hard, with embedded sand and gravel.  Grey		2	SS	12												
0.60																	
					3	SS	29										
					4	SS	34										
					5	SS	29										
230.27	End of Borehole.																
3.51															Borehole dry and open @ completion.		

JOE MTO 06-8-IEG2.GPJ ONTARIO.MOT.GDT 4/17/07

+ 3, X 3: Numbers refer to Sensitivity

○ 150 UNCONFINED SHEAR STRENGTH INFERRED FROM POCKET PENETROMETER READINGS

### UNIFIED SOIL CLASSIFICATION SYSTEM



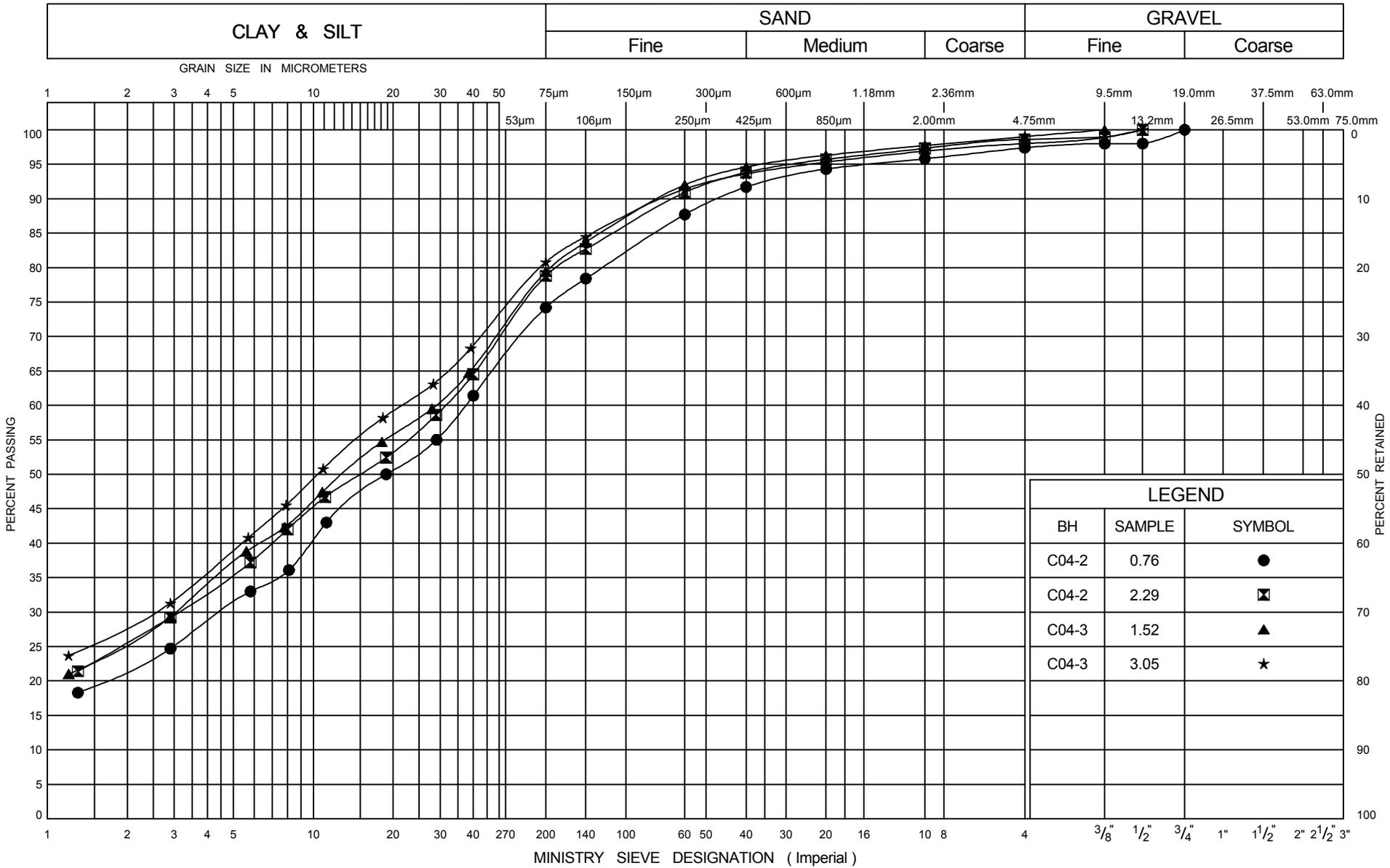
ONTARIO MOT GRAIN SIZE 06-8-1EG2.GPJ ONTARIO MOT.GDT 4/17/07



## GRAIN SIZE DISTRIBUTION FILL

FIG No C04-1  
GWP 408-94-00  
Highway 21-Kincardine to Tiverton

### UNIFIED SOIL CLASSIFICATION SYSTEM



ONTARIO MOT GRAIN SIZE 06-8-1EG2.GPJ ONTARIO MOT.GDT 4/17/07

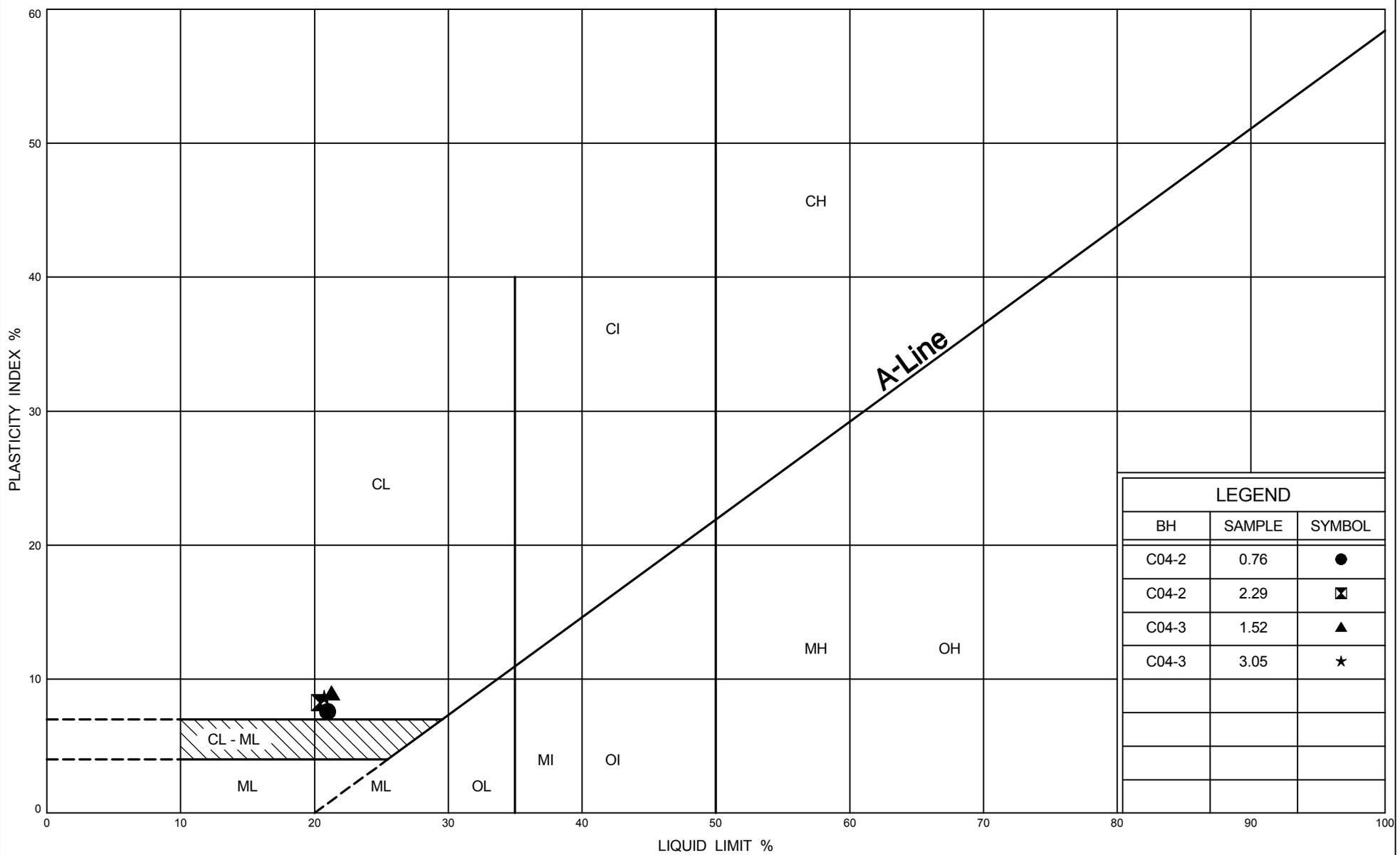


## GRAIN SIZE DISTRIBUTION SILTY CLAY TILL (CL)

FIG No C04-2

GWP 408-94-00

Highway 21-Kincardine to Tiverton



LEGEND		
BH	SAMPLE	SYMBOL
C04-2	0.76	●
C04-2	2.29	⊠
C04-3	1.52	▲
C04-3	3.05	★

ONTARIO MOT PLASTICITY CHART\_06-8-1EG2.GPJ\_ONTARIO MOT.GDT\_4/17/07



PLASTICITY CHART  
SILTY CLAY TILL (CL)

FIG No C04-3  
GWP 408-94-00  
Highway 21-Kincardine to Tiverton

**RECORD OF BOREHOLE No C05-1**

1 OF 1

**METRIC**

W.P. GWP 408-94-00 LOCATION Culvert No. 5 Northing - 4897136, Easting - 377702 ORIGINATED BY RB  
 DIST Owen Sound HWY 21 BOREHOLE TYPE 100mm SST Auger COMPILED BY JL  
 DATUM Geodetic DATE 9.7.06 - 9.7.06 CHECKED BY EC

SOIL PROFILE		SAMPLES			GROUND WATER CONDITIONS	ELEVATION SCALE	PENETR. RESISTANCE					PLASTIC LIMIT W <sub>p</sub>	NATURAL MOISTURE CONTENT W	LIQUID LIMIT W <sub>L</sub>	UNIT WEIGHT γ	REMARKS & GRAIN SIZE DISTRIBUTION (%)											
ELEV. DEPTH	DESCRIPTION	STRAT. PLOT	NUMBER	TYPE			"N" VALUES	STANDARD	DYN. CONE	SHEAR STRENGTH kPa							WATER CONTENT (%)										
						20	40	60	80	100	UNCONFINED	FIELD VANE	QUICK TRIAXIAL	LAB VANE	20	40	60	80	100	10	20	30	kN/m <sup>3</sup>	GR	SA	SI	CL
238.58	Ground Surface																										
0.00	TOPSOIL - 450mm.		1	AUGER																		51					
238.13	Silty SAND (SM) Brown, wet.					238																	22.5	5	19	52	24
0.45			2	SS	9																						
237.82	Brown					237																					
0.76			3	SS	30/0																						
	Silty CLAY TILL (CL) Moist, stiff to hard, with embedded sand and gravel.					236																					
	Grey		4	SS	27																						
						236																					
			5	SS	82																						
235.07	End of Borehole.																										
3.51																											

Borehole dry and open @ completion. Minor water ingress from silty sand layer with no significant water accumulation.

JOE MTO 06-8-IEG2.GPJ ONTARIO.MOT.GDT 4/17/07

**RECORD OF BOREHOLE No C05-2**

1 OF 1

**METRIC**

W.P. GWP 408-94-00 LOCATION Culvert No. 5 Northing - 4897139, Easting - 377709 ORIGINATED BY RB  
 DIST Owen Sound HWY 21 BOREHOLE TYPE 100mm SST Auger COMPILED BY JL  
 DATUM Geodetic DATE 9.7.06 - 9.7.06 CHECKED BY EC

SOIL PROFILE		SAMPLES			GROUND WATER CONDITIONS	ELEVATION SCALE	PENETR. RESISTANCE STANDARD ● DYN. CONE ○					PLASTIC NATURAL LIQUID LIMIT MOISTURE LIMIT CONTENT			UNIT WEIGHT $\gamma$ kN/m <sup>3</sup>	REMARKS & GRAIN SIZE DISTRIBUTION (%) GR SA SI CL			
ELEV DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE			"N" VALUES	SHEAR STRENGTH kPa					W <sub>p</sub>	W			W <sub>L</sub>		
						○ UNCONFINED	● QUICK TRIAXIAL	+ FIELD VANE	× LAB VANE										
						20	40	60	80	100	20	40	60	80	100				
240.05 0.00	Ground Surface		1	AUGER															
	FILL Brown, moist, loose, FILL consisting of sand and gravel (shoulder gravel).		2	SS	9												53 30 (17)		
			3	SS	6														
237.61 2.44			Silty CLAY TILL (CL) Brown, moist, very stiff, with embedded sand and gravel.		4	SS	18												greenish grey near top of native soil.
	5	SS			24														
	6	SS			28														
235.78 4.27	End of borehole.																		Borehole dry and open @ completion.

JOE MTO 06-8-IEG2.GPJ ONTARIO.MOT.GDT 4/17/07

**RECORD OF BOREHOLE No C05-3**

1 OF 1

**METRIC**

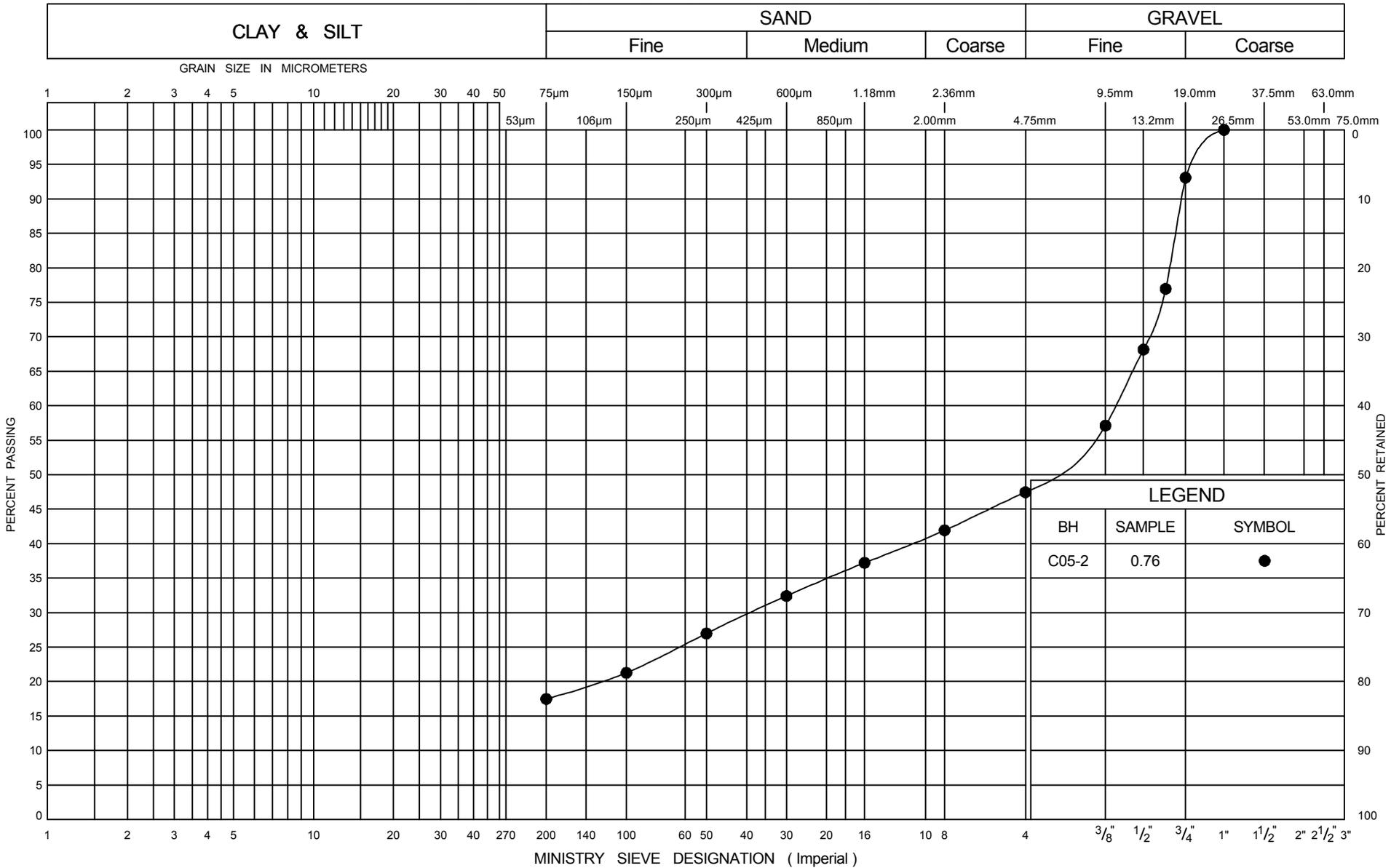
W.P. GWP 408-94-00 LOCATION Culvert No. 5 Northing - 4897128, Easting - 377731 ORIGINATED BY RB  
 DIST Owen Sound HWY 21 BOREHOLE TYPE 100mm SST Auger COMPILED BY JL  
 DATUM Geodetic DATE 9.27.06 - 9.27.06 CHECKED BY EC

SOIL PROFILE		SAMPLES			GROUND WATER CONDITIONS	ELEVATION SCALE	PENETR. RESISTANCE					PLASTIC NATURAL LIQUID			UNIT WEIGHT	REMARKS & GRAIN SIZE DISTRIBUTION (%)	
ELEV. DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE			"N" VALUES	STANDARD	DYN. CONE	PLASTIC LIMIT	NATURAL MOISTURE CONTENT	LIQUID LIMIT	W <sub>p</sub>	w			W <sub>L</sub>
						20 40 60 80 100	20 40 60 80 100										
239.58	Ground Surface																
0.00	TOPSOIL - 450mm.		1	SS	6												
239.13	Silty SAND (SM)																
0.45	Brown, moist, trace gravel.																
238.82	Brown		2	SS	19												
0.76																	
	Grey		3	SS	25												
236.68	clayey silt		4	SS	36												
2.90																	
236.07	End of Borehole.		5	SS	31												
3.51																	

JOE MTO 06-8-IEG2.GPJ ONTARIO.MOT.GDT 4/17/07

+ 3, X 3: Numbers refer to Sensitivity ○ 150 UNCONFINED SHEAR STRENGTH INFERRED FROM POCKET PENETROMETER READINGS

### UNIFIED SOIL CLASSIFICATION SYSTEM



ONTARIO MOT GRAIN SIZE 06-8-1EG2.GPJ ONTARIO MOT.GDT 4/17/07

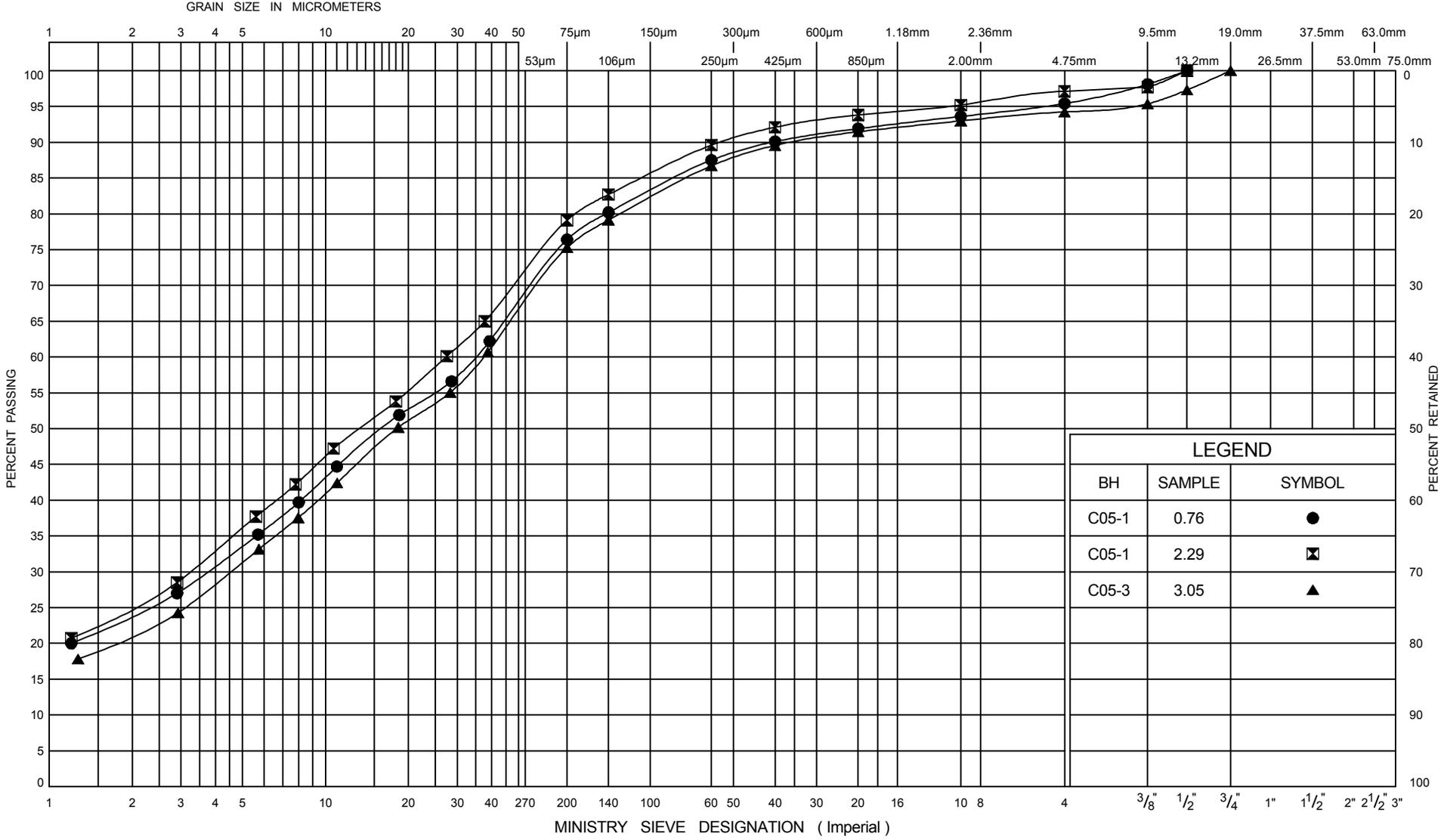


## GRAIN SIZE DISTRIBUTION FILL

FIG No C05-1  
GWP 408-94-00  
Highway 21-Kincardine to Tiverton

### UNIFIED SOIL CLASSIFICATION SYSTEM

CLAY & SILT	SAND			GRAVEL	
	Fine	Medium	Coarse	Fine	Coarse



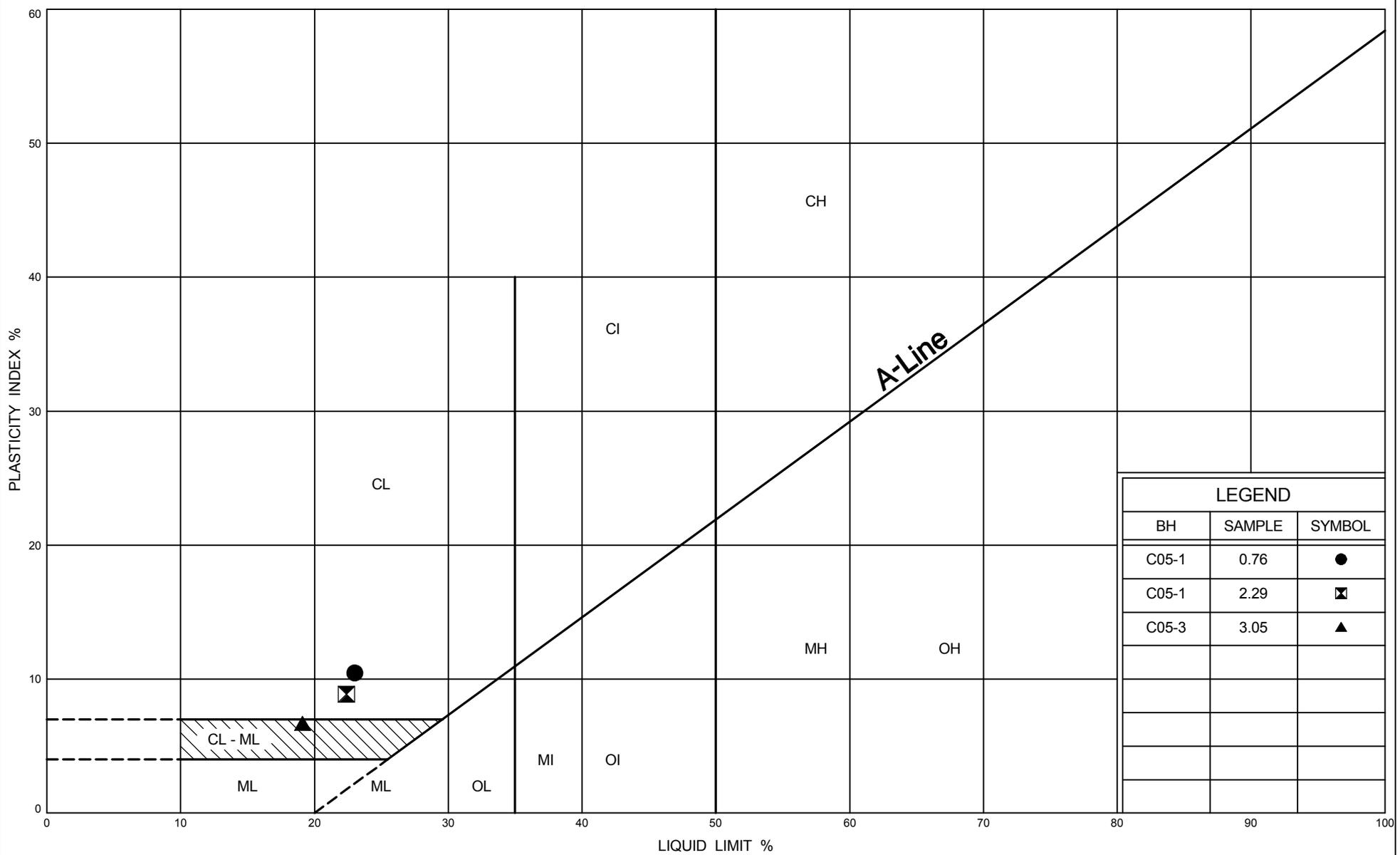
LEGEND		
BH	SAMPLE	SYMBOL
C05-1	0.76	●
C05-1	2.29	⊠
C05-3	3.05	▲

ONTARIO MOT GRAIN SIZE 06-8-1EG2.GPJ ONTARIO MOT.GDT 4/17/07



## GRAIN SIZE DISTRIBUTION SILTY CLAY TILL (CL)

FIG No C05-2  
GWP 408-94-00  
Highway 21-Kincardine to Tiverton



LEGEND		
BH	SAMPLE	SYMBOL
C05-1	0.76	●
C05-1	2.29	⊠
C05-3	3.05	▲

ONTARIO MOT PLASTICITY CHART\_06-8-1EG2.GPJ\_ONTARIO MOT.GDT\_4/17/07



**PLASTICITY CHART**  
**SILTY CLAY TILL (CL)**

FIG No C05-3  
GWP 408-94-00  
Highway 21-Kincardine to Tiverton

**RECORD OF BOREHOLE No C06-1**

1 OF 1

**METRIC**

W.P. GWP 408-94-00 LOCATION Culvert No. 6 Northing - 4897593, Easting - 377955 ORIGINATED BY RB  
 DIST Owen Sound HWY 21 BOREHOLE TYPE 100mm SST Auger COMPILED BY JL  
 DATUM Geodetic DATE 9.7.06 - 9.7.06 CHECKED BY EC

SOIL PROFILE		SAMPLES			GROUND WATER CONDITIONS	ELEVATION SCALE	PENETR. RESISTANCE					PLASTIC NATURAL LIQUID			UNIT WEIGHT	REMARKS & GRAIN SIZE DISTRIBUTION (%)				
ELEV. DEPTH	DESCRIPTION	STRAT. PLOT	NUMBER	TYPE			"N" VALUES	STANDARD	DYN. CONE	W <sub>p</sub>	MOISTURE CONTENT	W <sub>L</sub>	WATER CONTENT (%)	W <sub>p</sub>			W	W <sub>L</sub>	γ	GR
234.97	Ground Surface																			
0.00	FILL Brown, damp, compact, consisting of sand and gravel (shoulder gravel).		1	AUGER																50 42 (8)
234.06	FILL Brown to dark brown, moist, loose, consisting of sand and gravel mixed with topsoil.		2	SS	7															40
0.91																				
233.29	Brown  SILT to Clayey SILT TILL (ML to CL-ML) Moist, compact to very dense or stiff to hard, with embedded sand and gravel.		3	SS	10															22.3
1.68																				0 15 64 20 (84)
	Grey		4	SS	50															
			5	SS	61															
			6	SS	60															
230.70	End of borehole.																			Borehole dry and open @ completion.
4.27																				

JOE MTO 06-8-IEG2.GPJ ONTARIO.MOT.GDT 4/17/07

+ 3, X 3: Numbers refer to Sensitivity

○ 150 UNCONFINED SHEAR STRENGTH INFERRED FROM POCKET PENETROMETER READINGS



**RECORD OF BOREHOLE No C06-3**

1 OF 1

**METRIC**

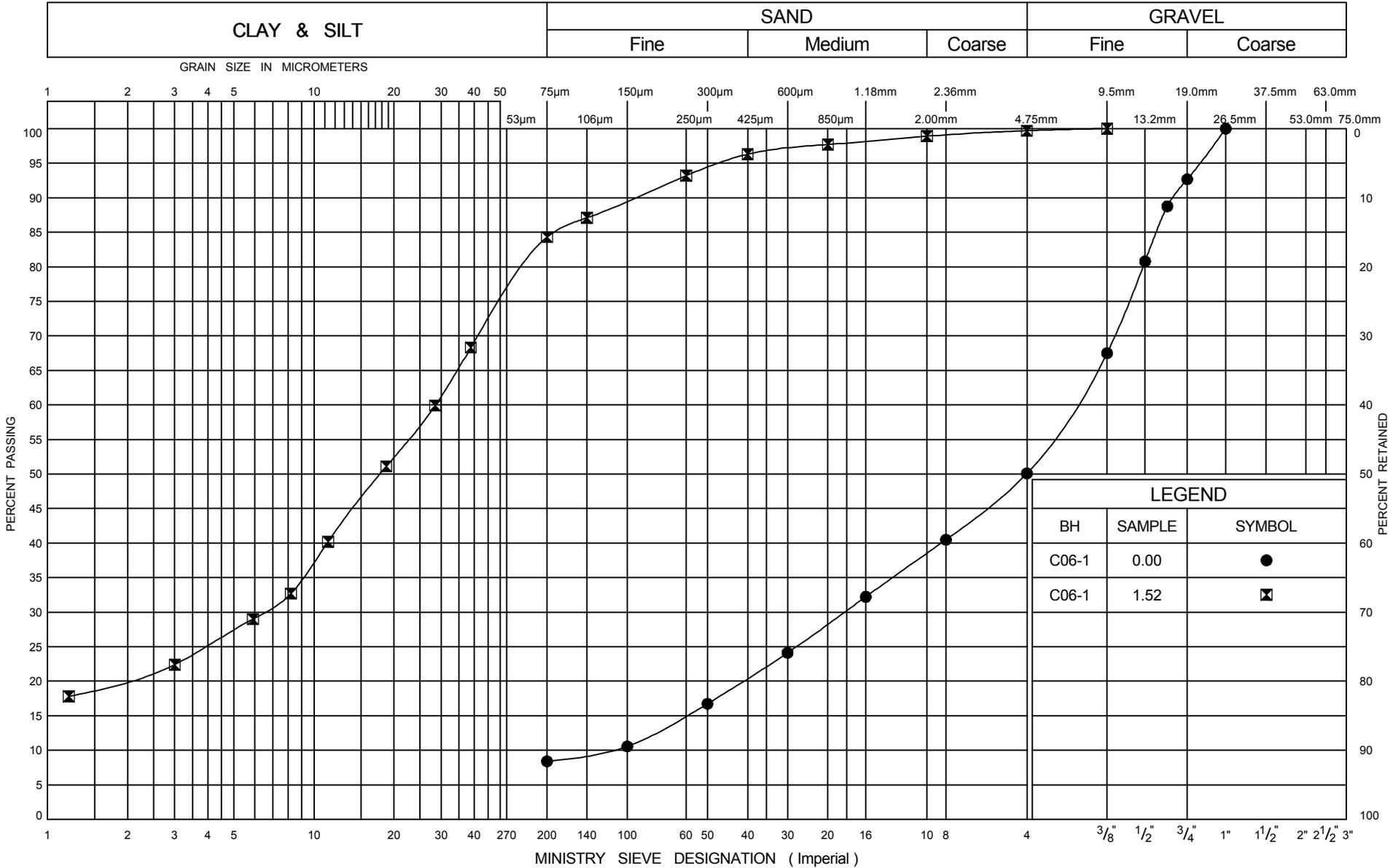
W.P. GWP 408-94-00 LOCATION Culvert No. 6 Northing - 4897589, Easting - 377973 ORIGINATED BY RB  
 DIST Owen Sound HWY 21 BOREHOLE TYPE 100mm SST Auger COMPILED BY JL  
 DATUM Geodetic DATE 9.7.06 - 9.7.06 CHECKED BY EC

SOIL PROFILE		SAMPLES			GROUND WATER CONDITIONS	ELEVATION SCALE	PENETR. RESISTANCE					PLASTIC NATURAL LIQUID			UNIT WEIGHT	REMARKS & GRAIN SIZE DISTRIBUTION (%)
ELEV. DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE			"N" VALUES	STANDARD	DYN. CONE	W <sub>p</sub>	MOISTURE CONTENT	W <sub>L</sub>	WATER CONTENT (%)	W		
234.44	Ground Surface															
0.00	TOPSOIL - 300mm.															
234.14			1	SS	9											
0.30			2	SS	7											
	SILT to Clayey SILT TILL (ML to CL-ML) Brown, moist, loose to dense or firm to hard, with embedded sand and gravel.		3	SS	29									23.8	2 25 54 19 (73)	
			4	SS	32											
			5	SS	22											
230.93	End of Borehole.															3 25 52 20 (72)
3.51																Borehole dry and open @ completion.

JOE MTO 06-8-IEG2.GPJ ONTARIO.MOT.GDT 4/17/07

+ 3, X 3: Numbers refer to Sensitivity      ○ 150 UNCONFINED SHEAR STRENGTH INFERRED FROM POCKET PENETROMETER READINGS

### UNIFIED SOIL CLASSIFICATION SYSTEM



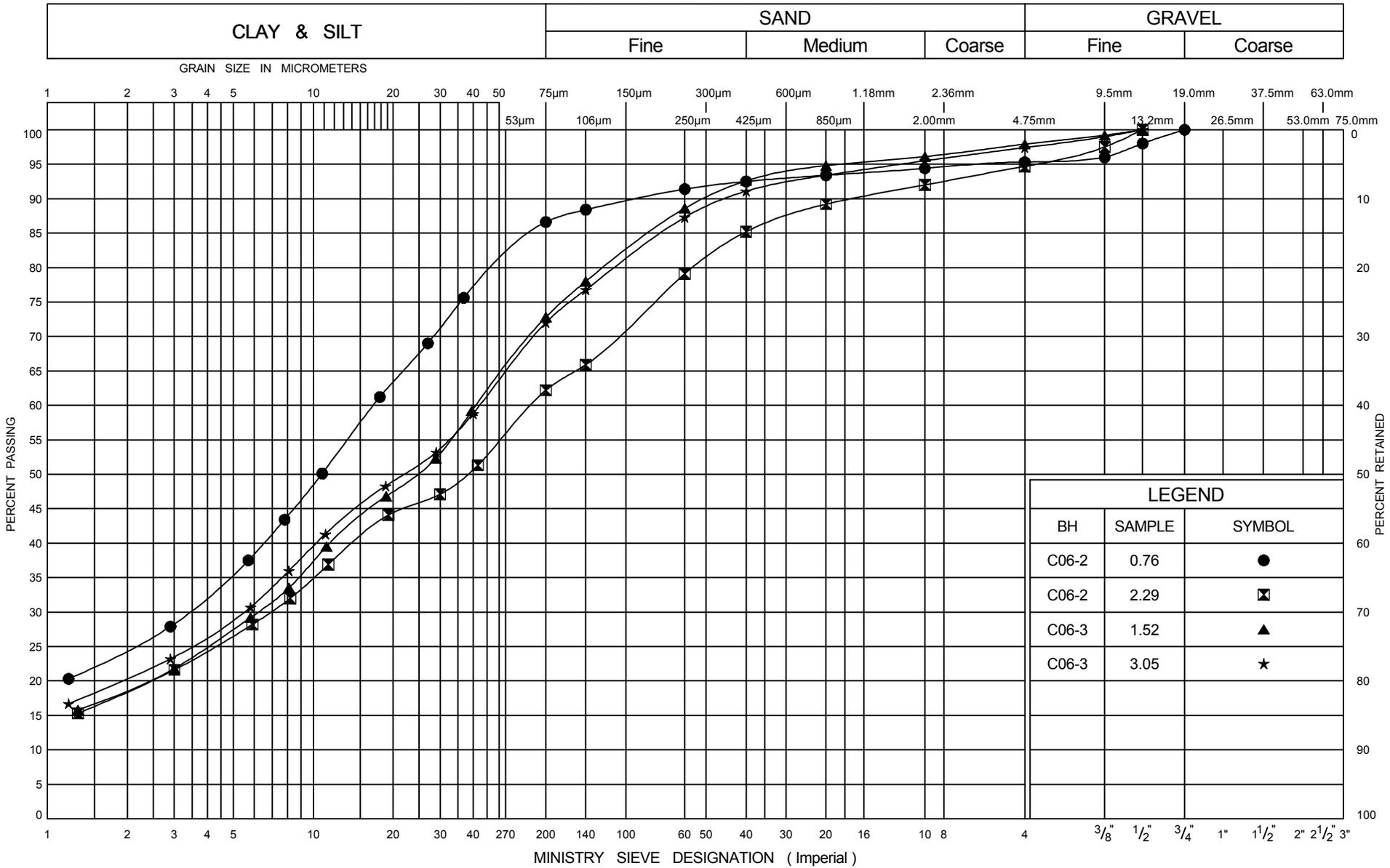
ONTARIO MOT GRAIN SIZE 06-8-1EG2.GPJ ONTARIO MOT.GDT 4/17/07



## GRAIN SIZE DISTRIBUTION FILL

FIG No C06-1  
GWP 408-94-00  
Highway 21-Kincardine to Tiverton

### UNIFIED SOIL CLASSIFICATION SYSTEM



LEGEND		
BH	SAMPLE	SYMBOL
C06-2	0.76	●
C06-2	2.29	◻
C06-3	1.52	▲
C06-3	3.05	★

ONTARIO MOT GRAIN SIZE 06-8-1EG2.GPJ ONTARIO MOT.GDT 4/17/07



## GRAIN SIZE DISTRIBUTION SILTY CLAY TILL (CL)

FIG No C06-2  
GWP 408-94-00  
Highway 21-Kincardine to Tiverton

**RECORD OF BOREHOLE No C07-1**

1 OF 1

**METRIC**

W.P. GWP 408-94-00 LOCATION Culvert No. 7 Northing - 4897792, Easting - 378074 ORIGINATED BY RB  
 DIST Owen Sound HWY 21 BOREHOLE TYPE 100mm SST Auger COMPILED BY JL  
 DATUM Geodetic DATE 9.7.06 - 9.7.06 CHECKED BY EC

SOIL PROFILE		STRAT PLOT	SAMPLES			GROUND WATER CONDITIONS	ELEVATION SCALE	PENETR. RESISTANCE					PLASTIC LIMIT W <sub>p</sub>	NATURAL MOISTURE CONTENT w	LIQUID LIMIT W <sub>L</sub>	UNIT WEIGHT γ	REMARKS & GRAIN SIZE DISTRIBUTION (%)									
ELEV DEPTH	DESCRIPTION		NUMBER	TYPE	"N" VALUES			STANDARD ●	DYN. CONE ○	SHEAR STRENGTH kPa								WATER CONTENT (%)								
							20	40	60	80	100	20	40	60	80	100	10	20	30	GR	SA	SI	CL			
234.90	Ground Surface		1	AUGER																	60	31		(10)		
0.00	FILL 200mm - sand and gravel (shoulder gravel).		2	SS	7																	16	39	30	15	(45)
233.22	FILL Brown to dark brown, moist, loose, consisting of clayey sand and silt mixed with topsoil.		3	SS	17																					
1.68	Brown		4	SS	31																					
	- Silty CLAY TILL (CL) Moist, very stiff to hard, with embedded sand and gravel.		5	SS	41																					
	Grey		6	SS	41																					
230.63	End of borehole.																									
4.27																										

JOE MTO 06-8-IEG2.GPJ ONTARIO.MOT.GDT 4/17/07

+ 3, X 3: Numbers refer to Sensitivity      ○ 150 UNCONFINED SHEAR STRENGTH INFERRED FROM POCKET PENETROMETER READINGS

**RECORD OF BOREHOLE No C07-2**

1 OF 1

**METRIC**

W.P. GWP 408-94-00 LOCATION Culvert No. 7 Northing - 4897789, Easting - 378082 ORIGINATED BY RB  
 DIST Owen Sound HWY 21 BOREHOLE TYPE 100mm SST Auger COMPILED BY JL  
 DATUM Geodetic DATE 9.7.06 - 9.7.06 CHECKED BY EC

SOIL PROFILE		SAMPLES			GROUND WATER CONDITIONS	ELEVATION SCALE	PENETR. RESISTANCE		PLASTIC LIMIT W <sub>p</sub>	NATURAL MOISTURE CONTENT W	LIQUID LIMIT W <sub>L</sub>	UNIT WEIGHT γ	REMARKS & GRAIN SIZE DISTRIBUTION (%)
ELEV. DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE			"N" VALUES	STANDARD ●					
234.24	Ground Surface												
0.00	TOPSOIL - 300mm.												
233.94			1	SS	11								
0.30	Brown		2	SS	12						21.6	4 13 47 36 (83)	
	Silty CLAY TILL (CL) Moist, stiff to hard, with embedded sand and gravel.		3	SS	36								
	Grey		4	SS	54						24.9	0 11 59 30 (89)	
			5	SS	32								
230.73	End of Borehole.												Borehole dry and open @ completion.
3.51													

JOE MTO 06-8-IEG2.GPJ ONTARIO.MOT.GDT 4/17/07

+ 3, X 3: Numbers refer to Sensitivity

○ 150 UNCONFINED SHEAR STRENGTH INFERRED FROM POCKET PENETROMETER READINGS

**RECORD OF BOREHOLE No C07-3**

1 OF 1

**METRIC**

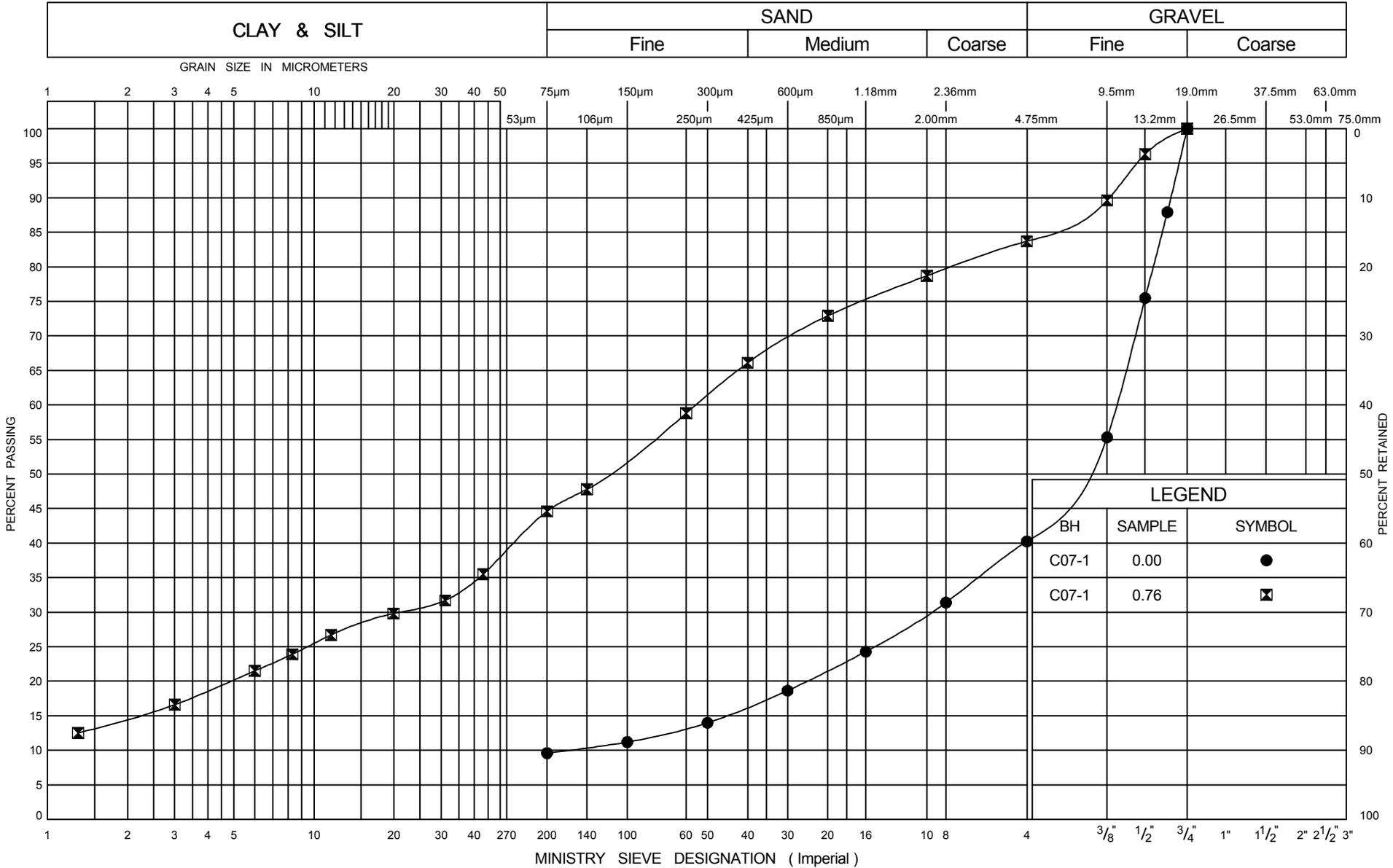
W.P. GWP 408-94-00 LOCATION Culvert No. 7 Northing - 4897800, Easting - 378061 ORIGINATED BY RB  
 DIST Owen Sound HWY 21 BOREHOLE TYPE 100mm SST Auger COMPILED BY JL  
 DATUM Geodetic DATE 9.7.06 - 9.7.06 CHECKED BY EC

SOIL PROFILE		SAMPLES			GROUND WATER CONDITIONS	ELEVATION SCALE	PENETR. RESISTANCE		PLASTIC LIMIT W <sub>p</sub>	NATURAL MOISTURE CONTENT w	LIQUID LIMIT W <sub>L</sub>	UNIT WEIGHT γ	REMARKS & GRAIN SIZE DISTRIBUTION (%)
ELEV. DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE			"N" VALUES	STANDARD ●					
233.70	Ground Surface												
0.00	TOPSOIL - 150mm.		1	SS	7								
	Brown		2	SS	21				175				
	Silty CLAY TILL (CL) Moist, firm to hard, with embedded sand and gravel, occasional wet sand and gravel seams.		3	SS	32				175			21.7	1 15 55 29 (84)
	Grey		4	SS	34				225				
230.19			5	SS	23				225+			22.8	4 17 54 25 (79)
3.51	End of Borehole.												Borehole dry and open @ completion.

JOE MTO 06-8-IEG2.GPJ ONTARIO.MOT.GDT 4/17/07

+ 3, X 3: Numbers refer to Sensitivity ○ 150 UNCONFINED SHEAR STRENGTH INFERRED FROM POCKET PENETROMETER READINGS

### UNIFIED SOIL CLASSIFICATION SYSTEM



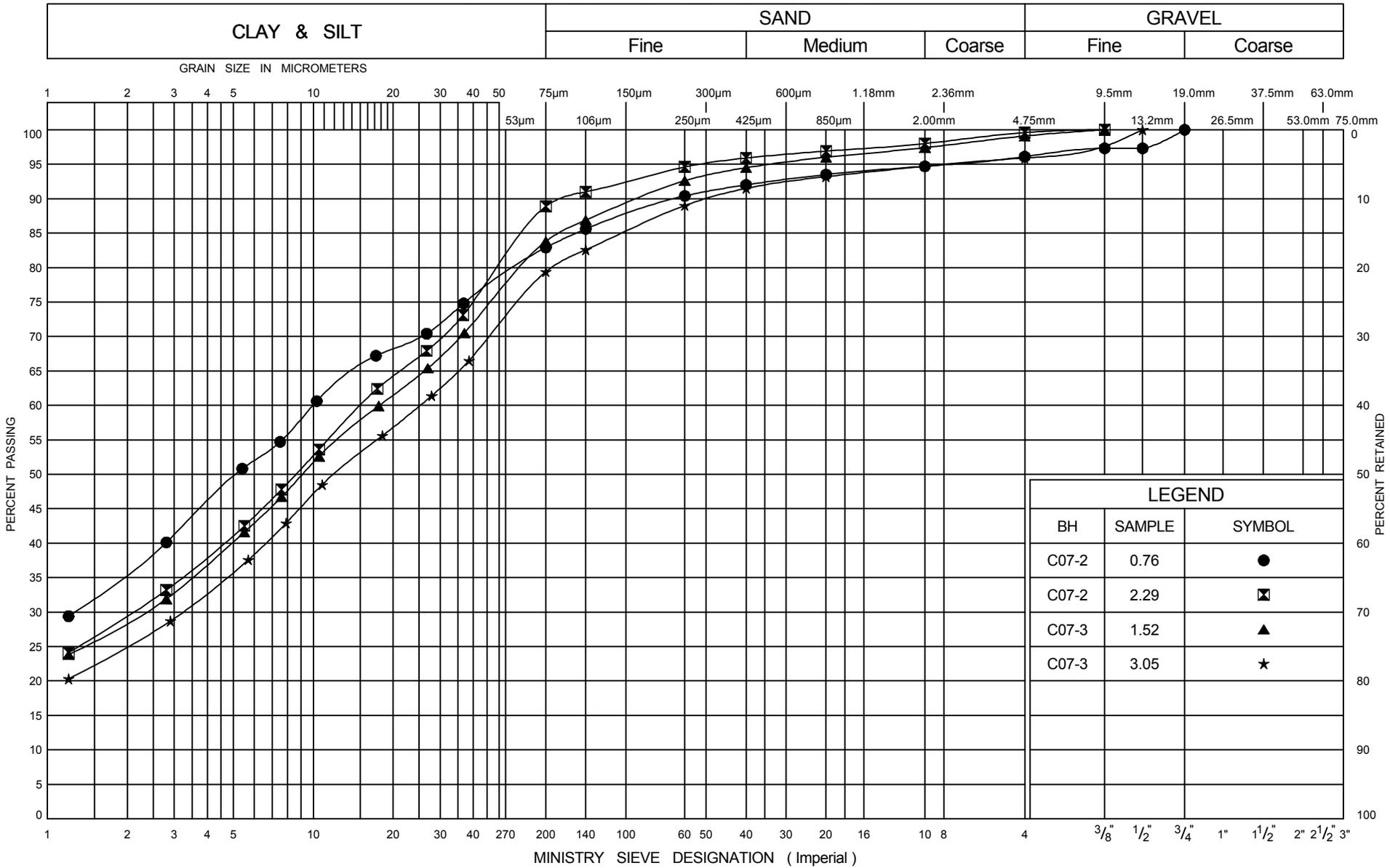
ONTARIO MOT GRAIN SIZE 06-8-1EG2.GPJ ONTARIO MOT.GDT 4/17/07



## GRAIN SIZE DISTRIBUTION FILL

FIG No C07-1  
GWP 408-94-00  
Highway 21-Kincardine to Tiverton

UNIFIED SOIL CLASSIFICATION SYSTEM



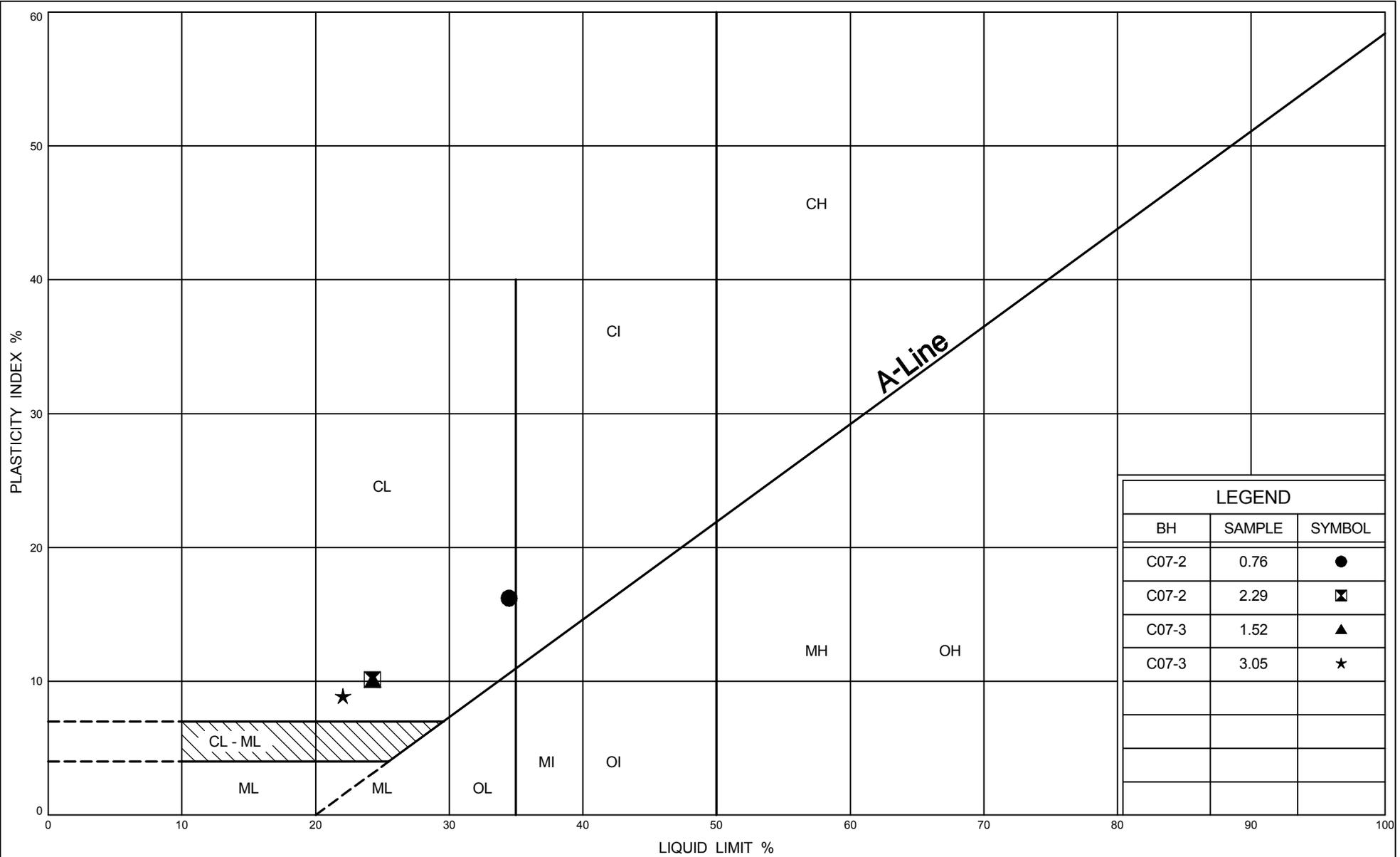
LEGEND		
BH	SAMPLE	SYMBOL
C07-2	0.76	●
C07-2	2.29	⊠
C07-3	1.52	▲
C07-3	3.05	★

ONTARIO MOT GRAIN SIZE 06-8-1EG2.GPJ ONTARIO MOT.GDT 4/17/07



GRAIN SIZE DISTRIBUTION  
SILTY CLAY TILL (CL)

FIG No C07-2  
GWP 408-94-00  
Highway 21-Kincardine to Tiverton



LEGEND		
BH	SAMPLE	SYMBOL
C07-2	0.76	●
C07-2	2.29	⊠
C07-3	1.52	▲
C07-3	3.05	★

ONTARIO MOT PLASTICITY CHART\_06-8-1EG2.GPJ\_ONTARIO MOT.GDT\_4/17/07



**PLASTICITY CHART**  
**SILTY CLAY TILL (CL)**

FIG No C07-3  
GWP 408-94-00  
Highway 21-Kincardine to Tiverton

**RECORD OF BOREHOLE No C08-1**

1 OF 1

**METRIC**

W.P. GWP 408-94-00 LOCATION Culvert No. 8 Northing - 4898007, Easting - 378172 ORIGINATED BY RB  
 DIST Owen Sound HWY 21 BOREHOLE TYPE 100mm SST Auger COMPILED BY JL  
 DATUM Geodetic DATE 9.7.06 - 9.7.06 CHECKED BY EC

SOIL PROFILE		SAMPLES			GROUND WATER CONDITIONS	ELEVATION SCALE	PENETR. RESISTANCE		PLASTIC LIMIT W <sub>p</sub>	NATURAL MOISTURE CONTENT W	LIQUID LIMIT W <sub>L</sub>	UNIT WEIGHT γ	REMARKS & GRAIN SIZE DISTRIBUTION (%)
ELEV. DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE			"N" VALUES	STANDARD ●					
233.47	Ground Surface												
0.00													
232.97	TOPSOIL - 500mm.		1	SS	8								
0.50													
	Brown		2	SS	14				125			23.7	2 11 53 34 (87)
	Silty CLAY TILL (CL) Moist, stiff to hard, with embedded sand and gravel.		3	SS	30				225				
	Grey		4	SS	28				225+			23.3	1 9 59 31 (91)
			5	SS	25				225+				
229.96	End of Borehole.												Borehole dry and open @ completion.
3.51													

JOE MTO 06-8-IEG2.GPJ ONTARIO.MOT.GDT 4/17/07

+ 3, X 3: Numbers refer to Sensitivity

○ 150 UNCONFINED SHEAR STRENGTH INFERRED FROM POCKET PENETROMETER READINGS

**RECORD OF BOREHOLE No C08-2**

1 OF 1

**METRIC**

W.P. GWP 408-94-00 LOCATION Culvert No. 8 Northing - 4897989, Easting - 378192 ORIGINATED BY RB  
 DIST Owen Sound HWY 21 BOREHOLE TYPE 100mm SST Auger COMPILED BY JL  
 DATUM Geodetic DATE 9.11.06 - 9.11.06 CHECKED BY EC

SOIL PROFILE		SAMPLES			GROUND WATER CONDITIONS	ELEVATION SCALE	PENETR. RESISTANCE		PLASTIC LIMIT W <sub>p</sub>	NATURAL MOISTURE CONTENT W	LIQUID LIMIT W <sub>L</sub>	UNIT WEIGHT γ	REMARKS & GRAIN SIZE DISTRIBUTION (%)
ELEV DEPTH	DESCRIPTION	NUMBER	TYPE	"N" VALUES			STANDARD ● DYN. CONE ○	SHEAR STRENGTH kPa					
234.23	Ground Surface												
0.00	FILL - 900mm Topsoil.	1	SS	9		234	●						
233.33		2	SS	13		233	●	200					
0.90	Brown	3	SS	30		232	●	200	18	28	23.8	1 10 53 36 (89)	
	Silty CLAY TILL (CL) Moist to wet, stiff to hard, with embedded sand and gravel.	4	SS	30		231	●	225					
	Grey	5	SS	29		231	●	137.5	18	28	23.5	0 10 57 33 (89)	
230.72	End of Borehole.												Borehole dry and open @ completion.
3.51													

JOE MTO 06-8-IEG2.GPJ ONTARIO.MOT.GDT 4/17/07

+ 3, X 3: Numbers refer to Sensitivity

○ 150 UNCONFINED SHEAR STRENGTH INFERRED FROM POCKET PENETROMETER READINGS

**RECORD OF BOREHOLE No C08-3**

1 OF 1

**METRIC**

W.P. GWP 408-94-00 LOCATION Culvert No. 8 Northing - 4897996, Easting - 378184 ORIGINATED BY RB  
 DIST Owen Sound HWY 21 BOREHOLE TYPE 100mm SST Auger COMPILED BY JL  
 DATUM Geodetic DATE 9.11.06 - 9.11.06 CHECKED BY EC

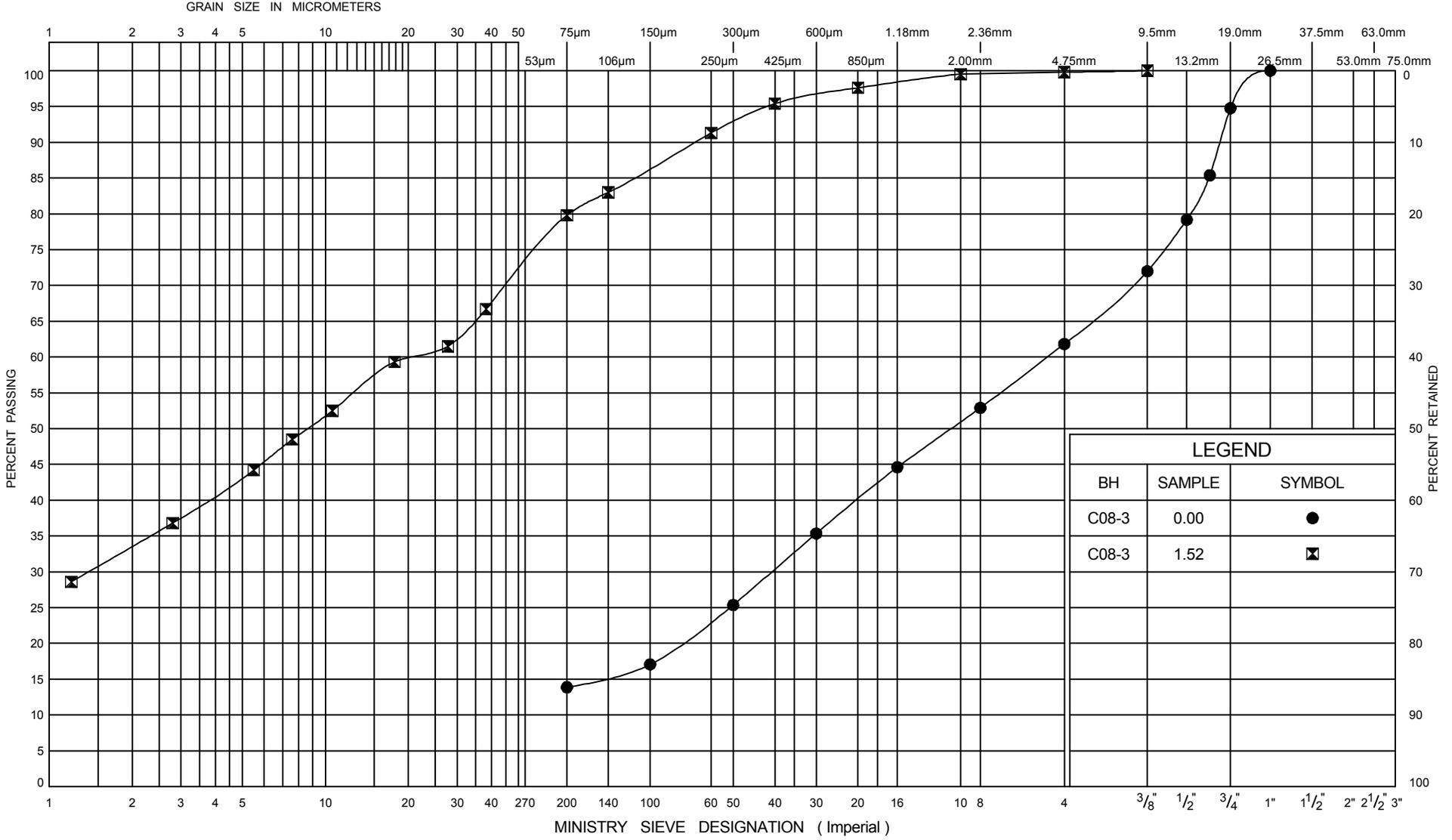
SOIL PROFILE		SAMPLES			GROUND WATER CONDITIONS	ELEVATION SCALE	PENETR. RESISTANCE					PLASTIC NATURAL LIQUID			UNIT WEIGHT $\gamma$ kN/m <sup>3</sup>	REMARKS & GRAIN SIZE DISTRIBUTION (%)
ELEV. DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE			"N" VALUES	STANDARD	DYN. CONE	W <sub>p</sub>	MOISTURE CONTENT	W <sub>L</sub>	WATER CONTENT (%)	GR		
234.93	Ground Surface															
0.00	FILL - 300mm sand and gravel (shoulder gravel)		1	AUGER											38	48
234.63	FILL Brown, moist, loose to compact, consisting of silty clay mixed with organics and topsoil, some sand.		2	SS	7											
0.30			3	SS	21										19.2	0 20 46 34 (80)
				4	SS	24										
232.49	Silty CLAY TILL (CL) Grey, moist to wet, very stiff to hard, with embedded sand and gravel.		5	SS	35											
2.44			6	SS	37											
230.66	End of borehole.															
4.27																Borehole dry and open @ completion.

JOE MTO 06-8-IEG2.GPJ ONTARIO.MOT.GDT 4/17/07

+ 3, X 3: Numbers refer to Sensitivity      ○ 150 UNCONFINED SHEAR STRENGTH INFERRED FROM POCKET PENETROMETER READINGS

UNIFIED SOIL CLASSIFICATION SYSTEM

CLAY & SILT	SAND			GRAVEL	
	Fine	Medium	Coarse	Fine	Coarse



LEGEND		
BH	SAMPLE	SYMBOL
C08-3	0.00	●
C08-3	1.52	⊠

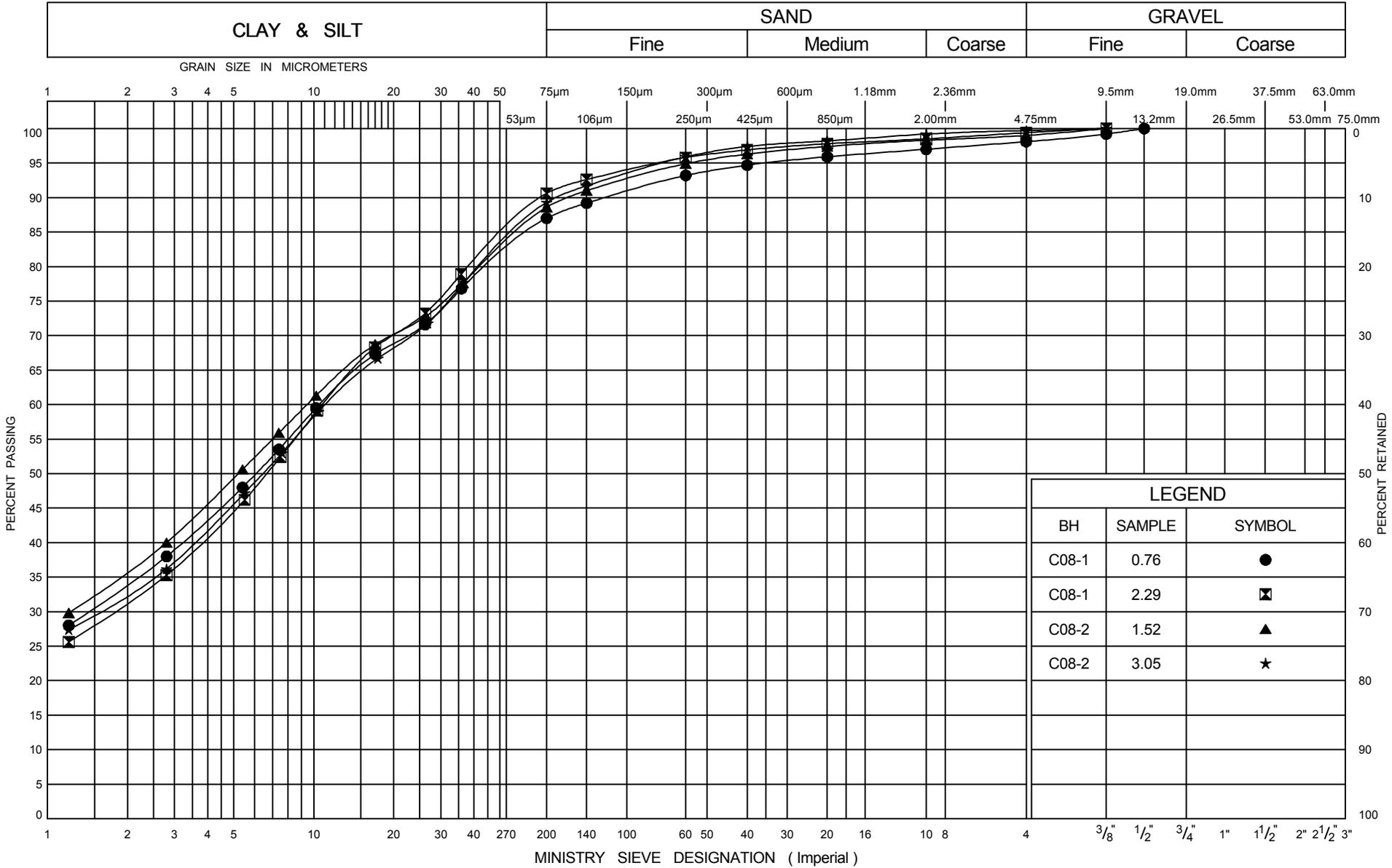
ONTARIO MOT GRAIN SIZE 06-8-1EG2.GPJ ONTARIO MOT.GDT 4/17/07



GRAIN SIZE DISTRIBUTION  
FILL

FIG No C08-1  
GWP 408-94-00  
Highway 21-Kincardine to Tiverton

### UNIFIED SOIL CLASSIFICATION SYSTEM



ONTARIO MOT GRAIN SIZE 06-8-1EG2.GPJ ONTARIO MOT.GDT 4/17/07

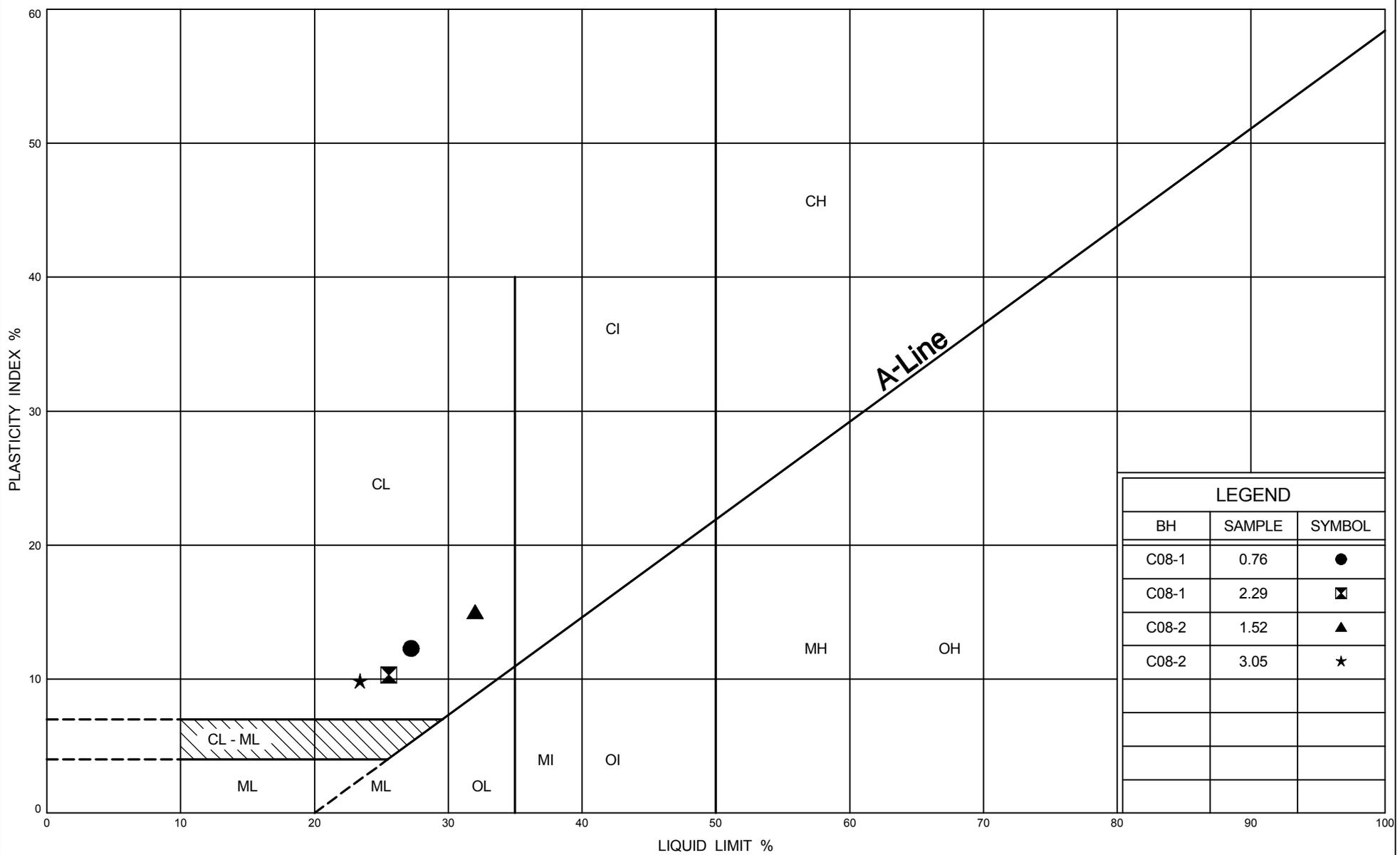


## GRAIN SIZE DISTRIBUTION SILTY CLAY TILL (CL)

FIG No C08-2

GWP 408-94-00

Highway 21-Kincardine to Tiverton



LEGEND		
BH	SAMPLE	SYMBOL
C08-1	0.76	●
C08-1	2.29	⊠
C08-2	1.52	▲
C08-2	3.05	★

ONTARIO MOT PLASTICITY CHART\_06-8-1EG2.GPJ\_ONTARIO MOT.GDT\_4/17/07



PLASTICITY CHART  
SILTY CLAY TILL (CL)

FIG No C08-3  
GWP 408-94-00  
Highway 21-Kincardine to Tiverton

**RECORD OF BOREHOLE No C09-1**

1 OF 1

**METRIC**

W.P. GWP 408-94-00 LOCATION Culvert No. 9 Northing - 4898135, Easting - 378272 ORIGINATED BY RB  
 DIST Owen Sound HWY 21 BOREHOLE TYPE 100mm SST Auger COMPILED BY JL  
 DATUM Geodetic DATE 09.11.06 - 09.11.06 CHECKED BY EC

SOIL PROFILE		SAMPLES			GROUND WATER CONDITIONS	ELEVATION SCALE	PENETR. RESISTANCE STANDARD ● DYN. CONE ○		PLASTIC LIMIT NATURAL MOISTURE CONTENT LIQUID LIMIT			UNIT WEIGHT $\gamma$	REMARKS & GRAIN SIZE DISTRIBUTION (%)	
ELEV DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE			"N" VALUES	20	40	60	80			100
234.76	Ground Surface													
0.00	TOPSOIL - 750mm.		1	SS	8									
234.01			2	SS	12									
0.75		Cl												
233.39	Brown		3	SS	19									
1.37	Silty CLAY TILL (Cl to CL) Moist to wet, stiff to hard, with embedded sand and gravel, occasional silt partings.	CL												
	Grey		4	SS	28									
231.25			5	SS	41									
3.51	End of Borehole.													Borehole dry and open @ completion.

JOE.MTO\_06-8-EG2.GPJ\_ONTARIO.MOT.GDT\_09/26/07

+ 3, X 3: Numbers refer to Sensitivity

○ 150 UNCONFINED SHEAR STRENGTH INFERRED FROM POCKET PENETROMETER READINGS

**RECORD OF BOREHOLE No C09-2**

1 OF 1

**METRIC**

W.P. GWP 408-94-00 LOCATION Culvert No. 9 Northing - 4898140, Easting - 378265 ORIGINATED BY RB  
 DIST Owen Sound HWY 21 BOREHOLE TYPE 100mm SST Auger COMPILED BY JL  
 DATUM Geodetic DATE 9.11.06 - 9.11.06 CHECKED BY EC

SOIL PROFILE		SAMPLES			GROUND WATER CONDITIONS	ELEVATION SCALE	PENETR. RESISTANCE					PLASTIC NATURAL LIQUID			UNIT WEIGHT $\gamma$ kN/m <sup>3</sup>	REMARKS & GRAIN SIZE DISTRIBUTION (%)
ELEV. DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE			"N" VALUES	STANDARD	DYN. CONE	W <sub>p</sub>	W	W <sub>L</sub>	WATER CONTENT (%)	GR		
235.36	Ground Surface															
0.00	FILL - 300mm sand and gravel (shoulder gravel)		1	AUGER											38	50
235.06			2	SS	8											
0.30	FILL Brown, moist, loose to compact, consisting of sand and gravel, mixed with silty clay, occasional organics.		3	SS	13										4	22 43 31 (74)
232.92			4	SS	25											
2.44	Brown Silty CLAY TILL (CL) Moist, very stiff to hard, with embedded sand and gravel, occasional silt partings.		5	SS	39											
	Grey		6	SS	32											
231.09	End of borehole.															
4.27																Borehole dry and open @ completion.

JOE MTO 06-8-IEG2.GPJ ONTARIO.MOT.GDT 4/17/07

+ 3, X 3: Numbers refer to Sensitivity

○ 150 UNCONFINED SHEAR STRENGTH INFERRED FROM POCKET PENETROMETER READINGS

**RECORD OF BOREHOLE No C09-3**

1 OF 1

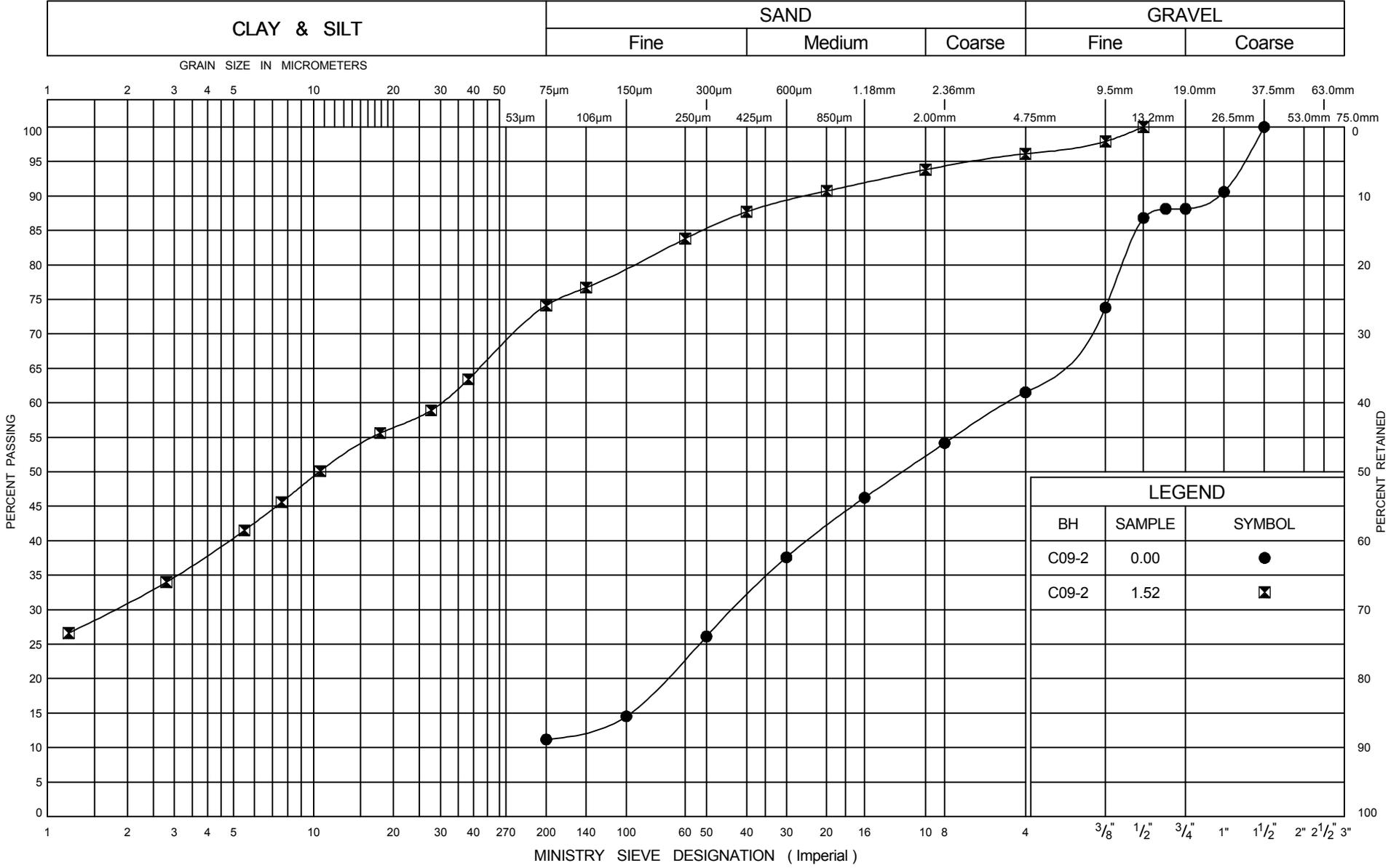
**METRIC**

W.P. GWP 408-94-00 LOCATION Culvert No. 9 Northing - 4898155, Easting - 378237 ORIGINATED BY RB  
 DIST Owen Sound HWY 21 BOREHOLE TYPE 100mm SST Auger COMPILED BY JL  
 DATUM Geodetic DATE 9.11.06 - 9.11.06 CHECKED BY EC

SOIL PROFILE		SAMPLES			GROUND WATER CONDITIONS	ELEVATION SCALE	PENETR. RESISTANCE		PLASTIC LIMIT W <sub>p</sub>	NATURAL MOISTURE CONTENT w	LIQUID LIMIT W <sub>L</sub>	UNIT WEIGHT γ	REMARKS & GRAIN SIZE DISTRIBUTION (%)
ELEV. DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE			"N" VALUES	STANDARD ●					
234.40	Ground Surface												
0.00													
233.88	TOPSOIL - 520mm.		1	SS	10								
0.52													
	Brown		2	SS	15			100					
	Silty CLAY TILL (CL) Moist, very stiff to hard, with embedded sand and gravel.		3	SS	34				225			23.1	0 12 49 38 (87)
	Grey		4	SS	36				225+				
230.89			5	SS	37				225+			23.5	0 8 59 32 (92)
3.51	End of borehole.												Borehole dry and open @ completion.

JOE MTO 06-8-IEG2.GPJ ONTARIO.MOT.GDT 4/17/07

UNIFIED SOIL CLASSIFICATION SYSTEM



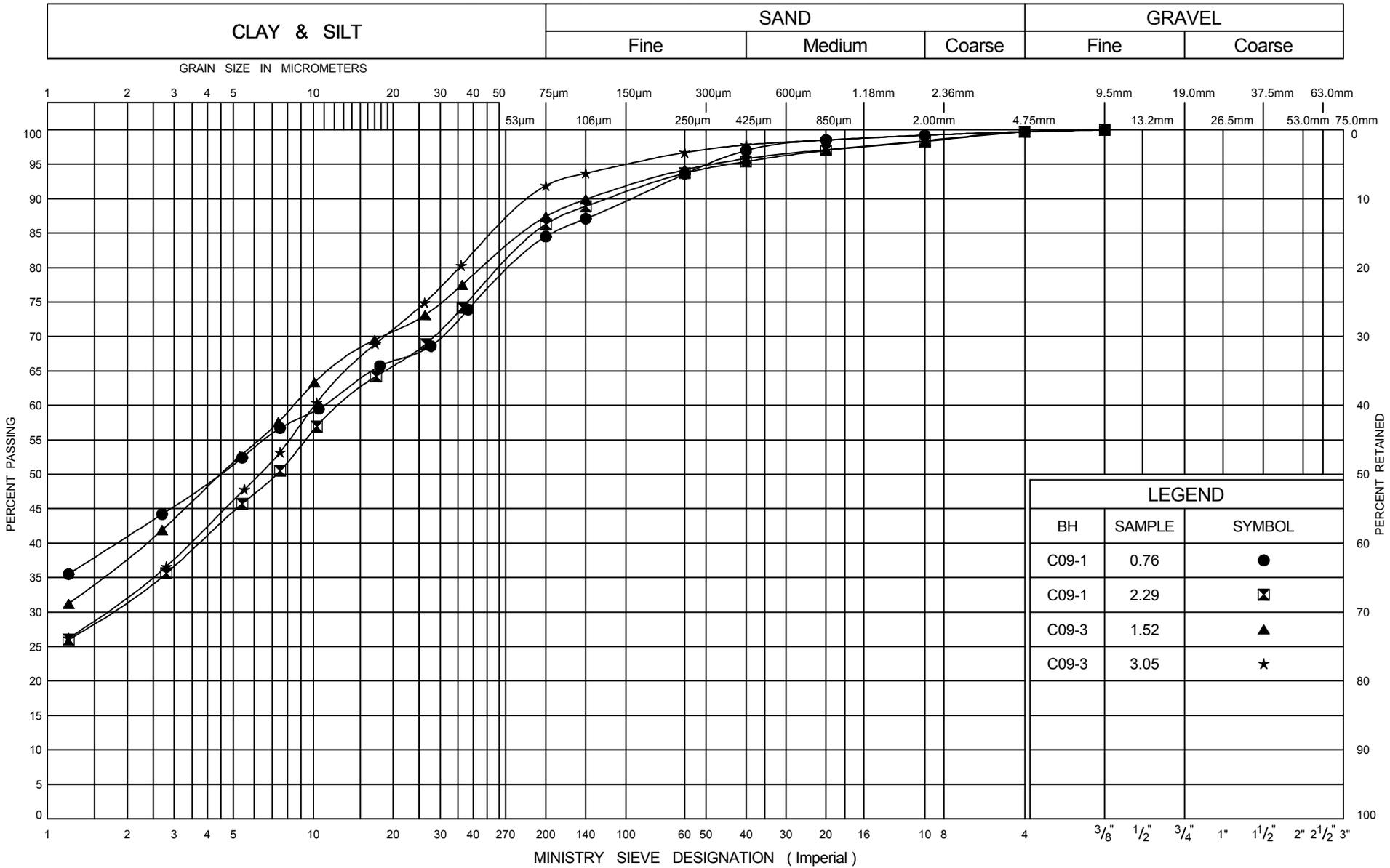
ONTARIO MOT GRAIN SIZE 06-8-1EG2.GPJ ONTARIO MOT.GDT 4/17/07



GRAIN SIZE DISTRIBUTION  
FILL

FIG No C09-1  
GWP 408-94-00  
Highway 21-Kincardine to Tiverton

### UNIFIED SOIL CLASSIFICATION SYSTEM



ONTARIO MOT GRAIN SIZE 06-8-1EG2.GPJ ONTARIO MOT.GDT 4/17/07

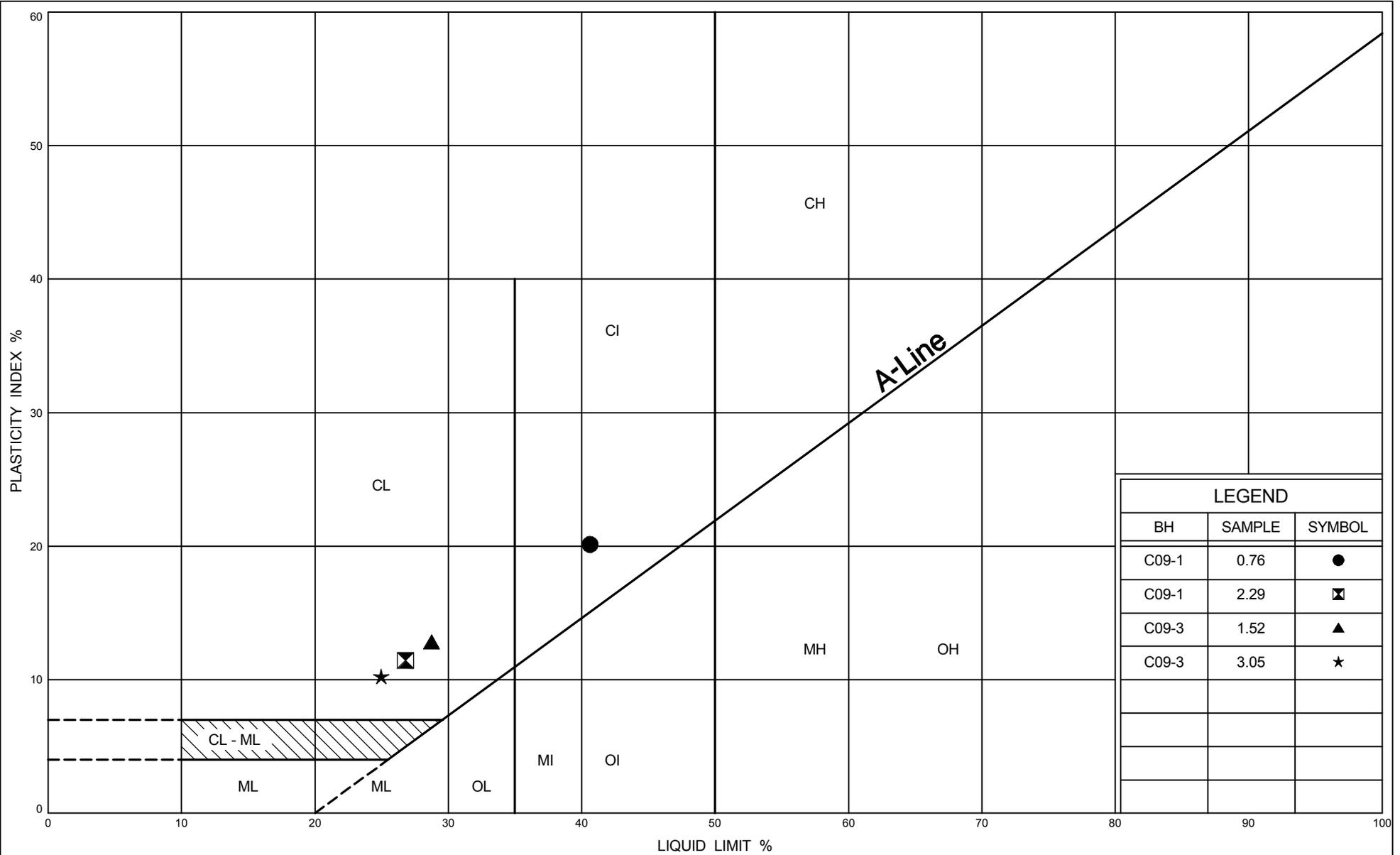


**GRAIN SIZE DISTRIBUTION**  
**SILTY CLAY TILL (CL TO CI)**

FIG No C09-2

GWP 408-94-00

Highway 21-Kincardine to Tiverton



ONTARIO MOT PLASTICITY CHART\_06-8-1EG2.GPJ\_ONTARIO MOT.GDT\_4/17/07



**PLASTICITY CHART**  
**SILTY CLAY TILL (CL TO CI)**

FIG No C09-3  
GWP 408-94-00  
Highway 21-Kincardine to Tiverton

**RECORD OF BOREHOLE No C10-1**

1 OF 1

**METRIC**

W.P. GWP 408-94-00 LOCATION Culvert No. 10 Northing - 4898569, Easting - 378475 ORIGINATED BY RB  
 DIST Owen Sound HWY 21 BOREHOLE TYPE 100mm SST Auger COMPILED BY JL  
 DATUM Geodetic DATE 9.11.06 - 9.11.06 CHECKED BY EC

SOIL PROFILE		SAMPLES			GROUND WATER CONDITIONS	ELEVATION SCALE	PENETR. RESISTANCE		PLASTIC LIMIT W <sub>p</sub>	NATURAL MOISTURE CONTENT w	LIQUID LIMIT W <sub>L</sub>	UNIT WEIGHT γ	REMARKS & GRAIN SIZE DISTRIBUTION (%)
ELEV. DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE			"N" VALUES	STANDARD ●					
234.54	Ground Surface												
0.00													
234.09	TOPSOIL - 450mm.		1	SS	5								
0.45													
	Brown		2	SS	9			75				1 13 55 30 (86)	
	Silty CLAY TILL (CL) Moist, stiff to hard, with embedded sand and gravel.		3	SS	23				225+				
	Grey		4	SS	40				225+		24.8	2 12 54 31 (86)	
			5	SS	42				225+				
231.03	End of Borehole.												Borehole dry and open @ completion.
3.51													

JOE MTO 06-8-IEG2.GPJ ONTARIO.MOT.GDT 4/17/07

+ 3, X 3: Numbers refer to Sensitivity

○ 150 UNCONFINED SHEAR STRENGTH INFERRED FROM POCKET PENETROMETER READINGS

**RECORD OF BOREHOLE No C10-2**

1 OF 1

**METRIC**

W.P. GWP 408-94-00 LOCATION Culvert No. 10 Northing - 4898564, Easting - 378478 ORIGINATED BY RB  
 DIST Owen Sound HWY 21 BOREHOLE TYPE 100mm SST Auger COMPILED BY JL  
 DATUM Geodetic DATE 9.11.06 - 9.28.06 CHECKED BY EC

SOIL PROFILE		SAMPLES			GROUND WATER CONDITIONS	ELEVATION SCALE	PENETR. RESISTANCE					PLASTIC LIMIT W <sub>p</sub>	NATURAL MOISTURE CONTENT w	LIQUID LIMIT W <sub>L</sub>	UNIT WEIGHT γ	REMARKS & GRAIN SIZE DISTRIBUTION (%)													
ELEV. DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE			"N" VALUES	STANDARD ●	DYN. CONE ○	SHEAR STRENGTH kPa							WATER CONTENT (%)												
						20	40	60	80	100	UNCONFINED ○	FIELD VANE +	QUICK TRIAXIAL ●	LAB VANE ×	20	40	60	80	100	10	20	30	GR	SA	SI	CL			
235.60 0.00	Ground Surface																												
	FILL Damp to moist, compact sand and gravel to gravelly sand FILL (shoulder gravel).  sand and gravel mixed with silty clay	[Cross-hatched pattern]	1	AUGER																				69	26	(6)			
234.23 1.37			1A	SS	18																								
233.77 1.83			1B	SS	13																								
233.47 2.13			silt layer																										
	Silty CLAY TILL (CL) Grey, moist, hard, with embedded sand and gravel.	[Diagonal hatched pattern]	2	SS	30																								
			3	SS	32																								
			4	SS	62																								
231.33 4.27			End of borehole.																										

Borehole dry and open @ completion. Redrilled top 2m with H/S augers on Sept. 28, 2006

JOE MTO 06-8-IEG2.GPJ ONTARIO.MOT.GDT 4/17/07

+ 3, × 3: Numbers refer to Sensitivity

○ 150 UNCONFINED SHEAR STRENGTH INFERRED FROM POCKET PENETROMETER READINGS

**RECORD OF BOREHOLE No C10-3**

1 OF 1

**METRIC**

W.P. GWP 408-94-00 LOCATION Culvert No. 10 Northing - 4898557, Easting - 378492 ORIGINATED BY RB  
 DIST Owen Sound HWY 21 BOREHOLE TYPE 100mm SST Auger COMPILED BY JL  
 DATUM Geodetic DATE 9.11.06 - 9.11.06 CHECKED BY EC

SOIL PROFILE		SAMPLES			GROUND WATER CONDITIONS	ELEVATION SCALE	PENETR. RESISTANCE		PLASTIC LIMIT W <sub>p</sub>	NATURAL MOISTURE CONTENT w	LIQUID LIMIT W <sub>L</sub>	UNIT WEIGHT γ	REMARKS & GRAIN SIZE DISTRIBUTION (%)
ELEV. DEPTH	DESCRIPTION	NUMBER	TYPE	"N" VALUES			STANDARD ● DYN. CONE ○	UNCONFINED ○ + FIELD VANE					
234.78 0.00	Ground Surface												
233.88 0.90	FILL - 900mm topsoil and topsoil fill.	1	SS	6									
	Brown	2	SS	8		234		125					
	— Silty CLAY TILL (CL) Moist, stiff to hard, with embedded sand and gravel.	3	SS	36		233		225+			23.8	1 15 54 30 (85)	
	Grey	4	SS	40				225+					
231.27 3.51	End of Borehole.	5	SS	55		232		225+			24.7	1 14 53 32 (85)	

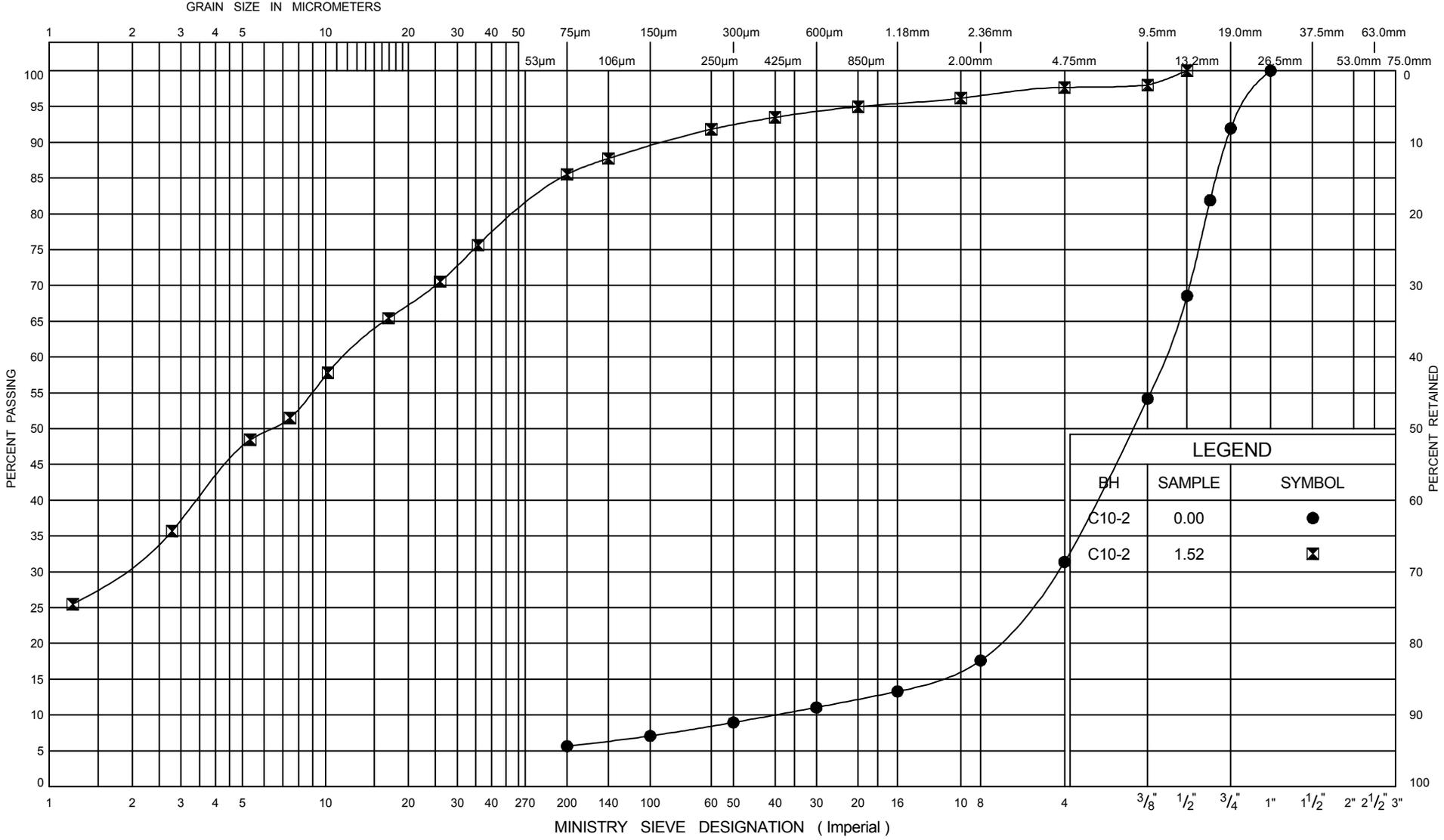
JOE MTO 06-8-IEG2.GPJ ONTARIO.MOT.GDT 4/17/07

+ 3, × 3: Numbers refer to Sensitivity

○ 150 UNCONFINED SHEAR STRENGTH INFERRED FROM POCKET PENETROMETER READINGS

### UNIFIED SOIL CLASSIFICATION SYSTEM

CLAY & SILT	SAND			GRAVEL	
	Fine	Medium	Coarse	Fine	Coarse



LEGEND		
BH	SAMPLE	SYMBOL
C10-2	0.00	●
C10-2	1.52	⊠

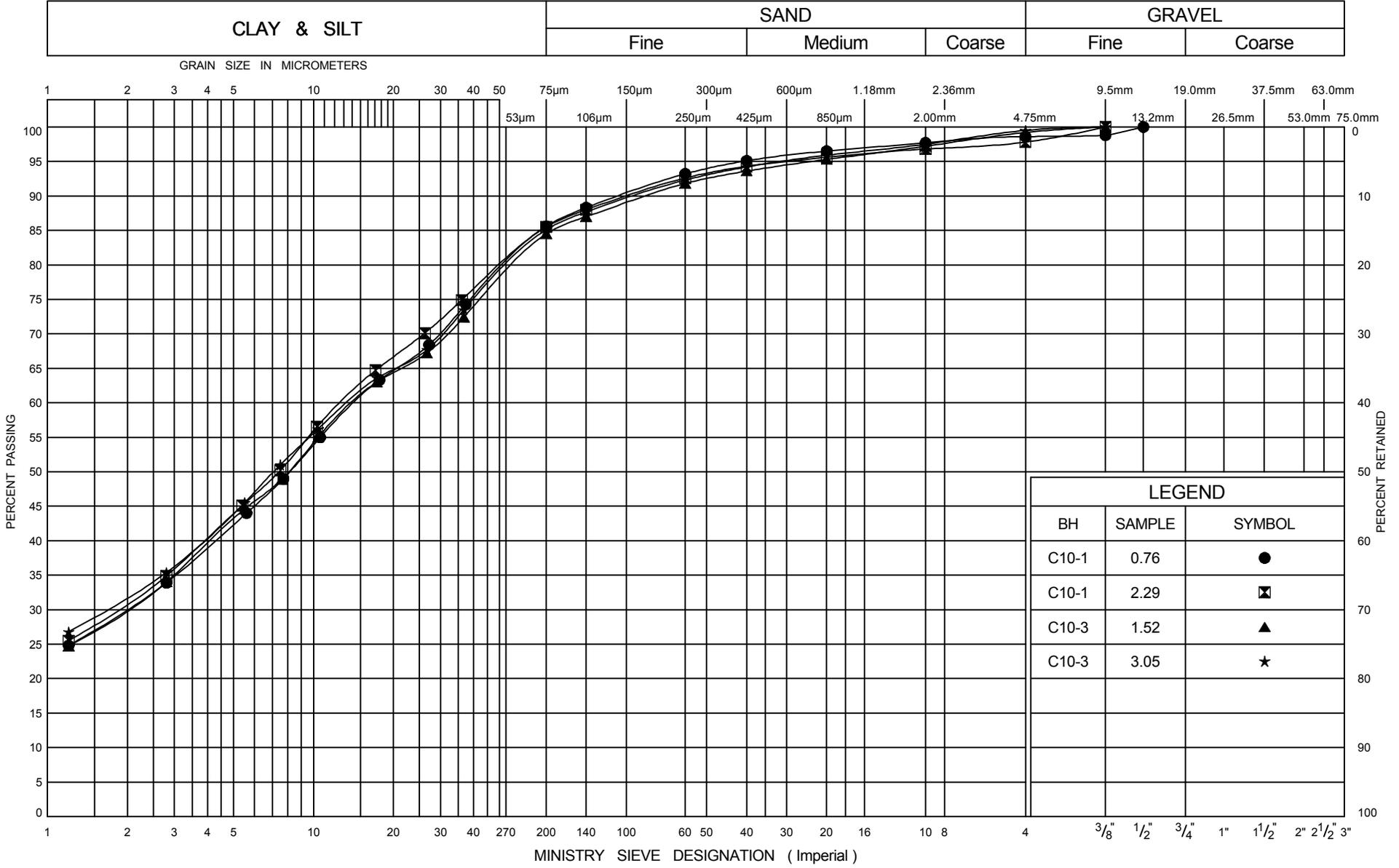
ONTARIO MOT GRAIN SIZE 06-8-1EG2.GPJ ONTARIO MOT.GDT 4/17/07



## GRAIN SIZE DISTRIBUTION FILL

FIG No C10-1  
GWP 408-94-00  
Highway 21-Kincardine to Tiverton

UNIFIED SOIL CLASSIFICATION SYSTEM



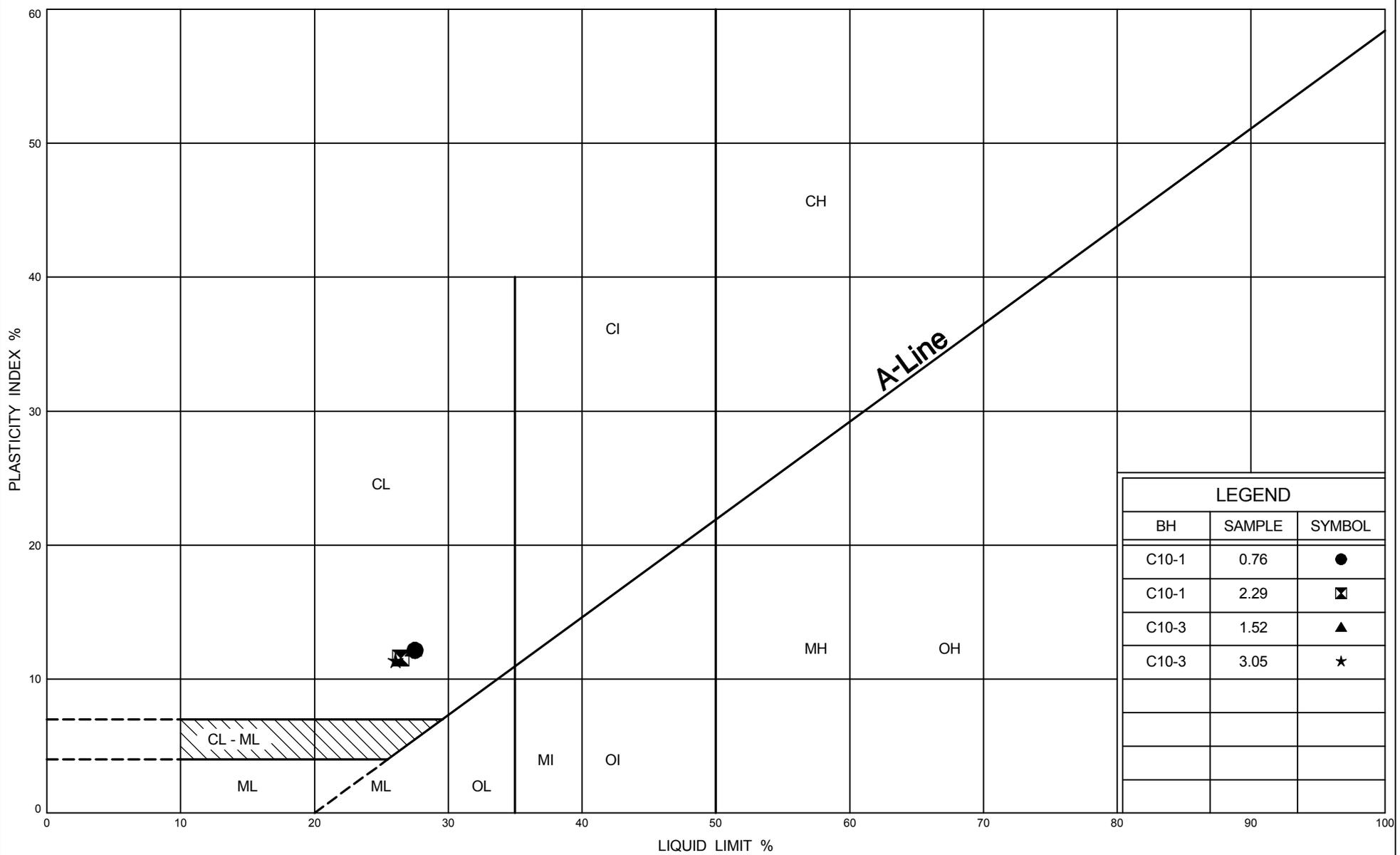
LEGEND		
BH	SAMPLE	SYMBOL
C10-1	0.76	●
C10-1	2.29	⊠
C10-3	1.52	▲
C10-3	3.05	★

ONTARIO MOT GRAIN SIZE 06-8-1EG2.GPJ ONTARIO MOT.GDT 4/17/07



GRAIN SIZE DISTRIBUTION  
SILTY CLAY TILL (CL)

FIG No C10-2  
GWP 408-94-00  
Highway 21-Kincardine to Tiverton



ONTARIO MOT PLASTICITY CHART\_06-8-1EG2.GPJ\_ONTARIO MOT.GDT\_4/17/07



**PLASTICITY CHART**  
**SILTY CLAY TILL (CL)**

FIG No C10-3  
GWP 408-94-00  
Highway 21-Kincardine to Tiverton

**RECORD OF BOREHOLE No C11-1**

1 OF 1

**METRIC**

W.P. GWP 408-94-00 LOCATION Culvert No. 11 Northing - 4899459, Easting - 378985 ORIGINATED BY RB  
 DIST Owen Sound HWY 21 BOREHOLE TYPE 100mm SST Auger COMPILED BY JL  
 DATUM Geodetic DATE 09.12.06 - 09.12.06 CHECKED BY EC

SOIL PROFILE		SAMPLES			GROUND WATER CONDITIONS	ELEVATION SCALE	PENETR. RESISTANCE STANDARD ● DYN. CONE ○		PLASTIC LIMIT $w_p$	NATURAL MOISTURE CONTENT $w$	LIQUID LIMIT $w_L$	UNIT WEIGHT $\gamma$	REMARKS & GRAIN SIZE DISTRIBUTION (%)
ELEV DEPTH	DESCRIPTION	STRAT. PLOT	NUMBER	TYPE			"N" VALUES	SHEAR STRENGTH kPa					
						○ UNCONFINED	+ FIELD VANE						
						● QUICK TRIAXIAL	× LAB VANE						
						20 40 60 80 100	20 40 60 80 100	10 20 30				GR SA SI CL	
226.49	Ground Surface												
0.00													
225.89	TOPSOIL - 600mm.		1	SS	17								
0.60													
	Silty CLAY TILL (CH to CL) Moist to wet, stiff to very stiff, with embedded sand and gravel, occasional wet silt partings.  Brown  Grey	CH	2	SS	9			112.5		53	20.9	0 2 48 51 (98)	
			3	SS	14			137.5					
				4	SS	16			87.5			23.9	0 16 55 28 (83)
			CL	5	SS	11			100				
222.98													
3.51	End of Borehole											Water level measured @ 2.9m @ completion.	

JOE.MTO 06-8-IEG2.GPJ ONTARIO.MOT.GDT 09/26/07

+ 3, × 3: Numbers refer to Sensitivity

○ 150 UNCONFINED SHEAR STRENGTH INFERRED FROM POCKET PENETROMETER READINGS

**RECORD OF BOREHOLE No C11-3**

1 OF 1

**METRIC**

W.P. GWP 408-94-00 LOCATION Culvert No. 11 Northing - 4899482, Easting - 378958 ORIGINATED BY RB  
 DIST Owen Sound HWY 21 BOREHOLE TYPE 100mm SST Auger COMPILED BY JL  
 DATUM Geodetic DATE 09.12.06 - 09.12.06 CHECKED BY EC

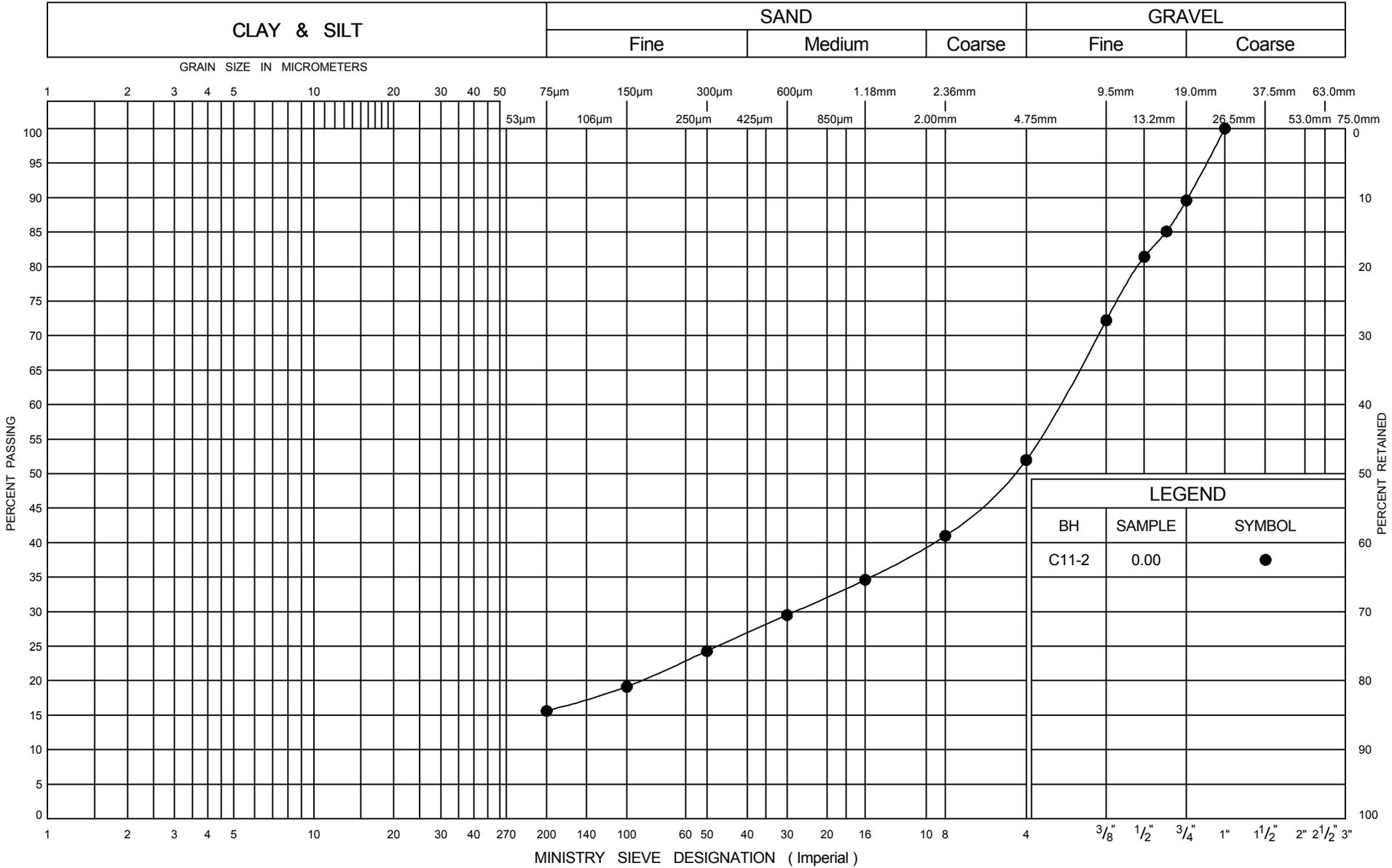
SOIL PROFILE		SAMPLES			GROUND WATER CONDITIONS	ELEVATION SCALE	PENETR. RESISTANCE		PLASTIC LIMIT w <sub>p</sub>	NATURAL MOISTURE CONTENT w	LIQUID LIMIT w <sub>L</sub>	UNIT WEIGHT γ	REMARKS & GRAIN SIZE DISTRIBUTION (%)
ELEV DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE			"N" VALUES	STANDARD ●					
225.72	Ground Surface												
0.00	TOPSOIL - 100mm.		1	SS	15								
	Brown		2	SS	26								
	Silty CLAY TILL (CL to CI) Moist to wet, stiff to hard, with embedded sand and gravel.	CL	3	SS	40								
			4	SS	19								
			5	SS	9								
222.82 2.90	Grey	CI											
222.21 3.51	End of Borehole.												

JOE.MTO\_06-8-IEG2.GPJ ONTARIO.MOT.GDT 09/26/07

+ 3 . X 3 : Numbers refer to Sensitivity ○ 150 UNCONFINED SHEAR STRENGTH INFERRED FROM POCKET PENETROMETER READINGS



### UNIFIED SOIL CLASSIFICATION SYSTEM



LEGEND		
BH	SAMPLE	SYMBOL
C11-2	0.00	●

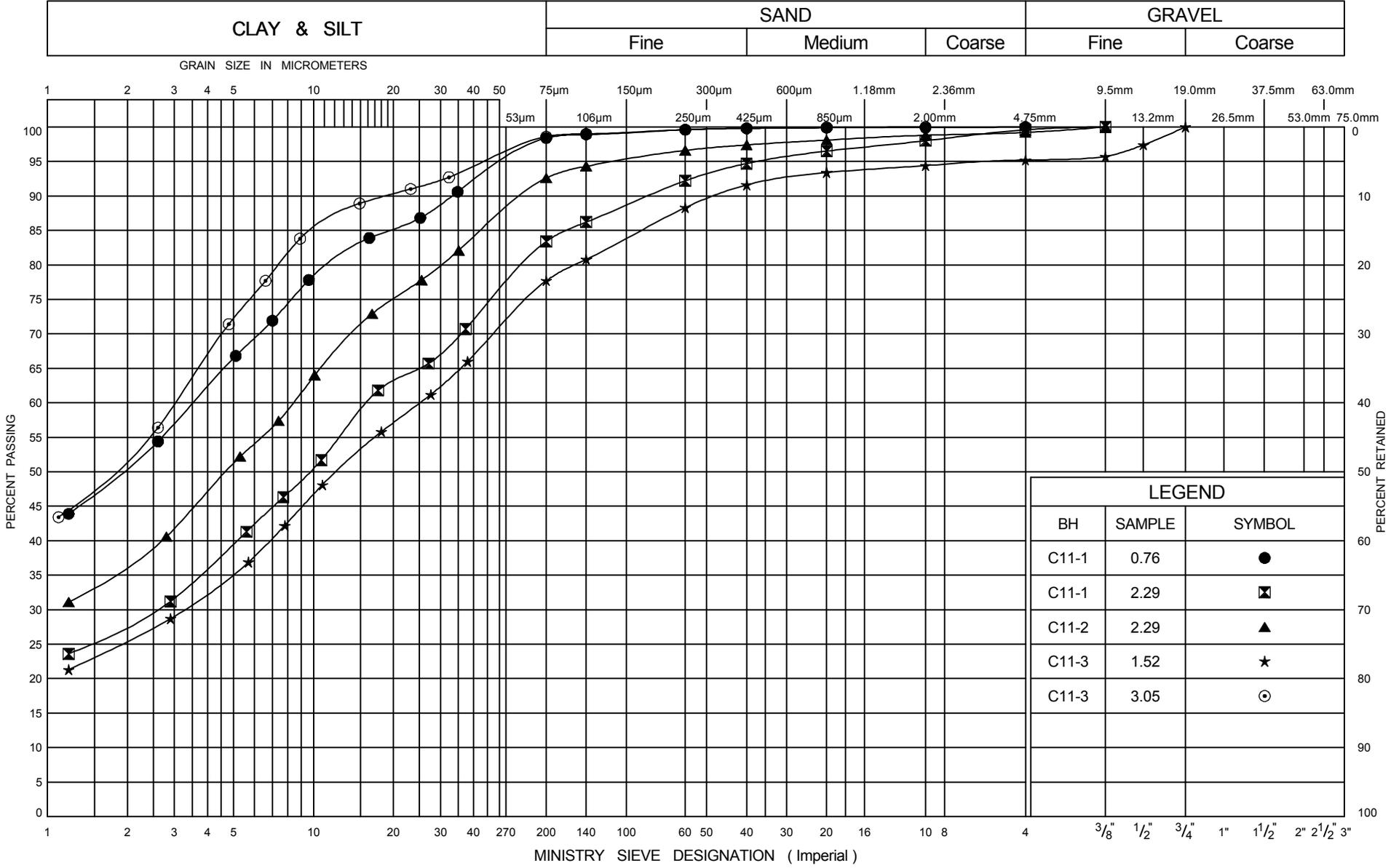
ONTARIO MOT GRAIN SIZE 06-8-1EG2.GPJ ONTARIO MOT.GDT 4/17/07



## GRAIN SIZE DISTRIBUTION FILL

FIG No C11-1  
GWP 408-94-00  
Highway 21-Kincardine to Tiverton

UNIFIED SOIL CLASSIFICATION SYSTEM

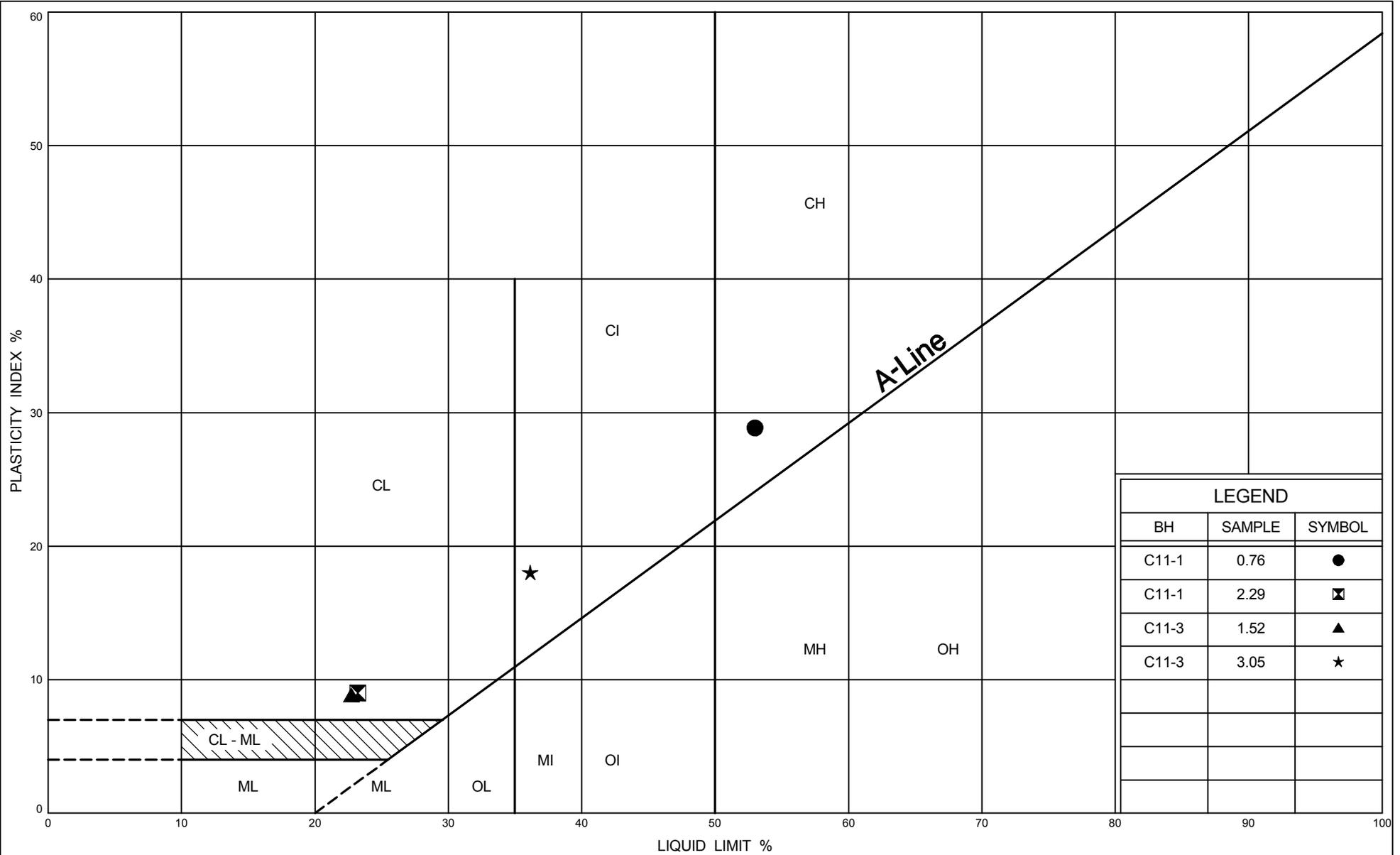


ONTARIO MOT GRAIN SIZE 06-8-1EG2.GPJ ONTARIO MOT.GDT 4/17/07



GRAIN SIZE DISTRIBUTION  
SILTY CLAY TILL (CLTO CH)

FIG No C11-2  
GWP 408-94-00  
Highway 21-Kincardine to Tiverton



ONTARIO MOT PLASTICITY CHART\_06-8-1EG2.GPJ\_ONTARIO MOT.GDT\_4/17/07



**PLASTICITY CHART**  
**SILTY CLAY TILL (CL TO CH)**

**FIG No C11-3**  
**GWP 408-94-00**  
 Highway 21-Kincardine to Tiverton

**RECORD OF BOREHOLE No C12-1**

1 OF 1

**METRIC**

W.P. GWP 408-94-00 LOCATION Culvert No. 12 Northing - 4899890, Easting - 379221 ORIGINATED BY RB  
 DIST Owen Sound HWY 21 BOREHOLE TYPE 100mm SST Auger COMPILED BY JL  
 DATUM Geodetic DATE 09.12.06 - 09.12.06 CHECKED BY EC

SOIL PROFILE		SAMPLES			GROUND WATER CONDITIONS	ELEVATION SCALE	PENETR. RESISTANCE STANDARD ● DYN. CONE ○		PLASTIC LIMIT W <sub>p</sub>	NATURAL MOISTURE CONTENT W	LIQUID LIMIT W <sub>L</sub>	UNIT WEIGHT γ	REMARKS & GRAIN SIZE DISTRIBUTION (%)	
ELEV DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE			"N" VALUES	SHEAR STRENGTH kPa						WATER CONTENT (%)
226.51 0.00	Ground Surface													
225.98 0.53	TOPSOIL - 530mm.		1	SS	11		●							
	Clayey SILT to Silty CLAY TILL (CL to CL-ML) Moist, hard, with embedded sand and gravel.  Brown		2	SS	100+		●						9 26 49 17 (66)	
			3	SS	45		●		○	○				
			4	SS	48		●		○	○	○			0 13 52 34 (86)
			5	SS	31		●		○	○	○			
223.00 3.51	Grey End of Borehole.												Borehole dry and open @ completion.	

JOE MTO 06-8-IEG2.GPJ ONTARIO.MOT.GDT 09/26/07

+ 3 . X 3 : Numbers refer to Sensitivity

○ 150 UNCONFINED SHEAR STRENGTH INFERRED FROM POCKET PENETROMETER READINGS

**RECORD OF BOREHOLE No C12-2**

1 OF 1

**METRIC**

W.P. GWP 408-94-00 LOCATION Culvert No. 12 Northing - 4899909, Easting - 379187 ORIGINATED BY RB  
 DIST Owen Sound HWY 21 BOREHOLE TYPE 100mm SST Auger COMPILED BY JL  
 DATUM Geodetic DATE 09.13.06 - 09.13.06 CHECKED BY EC

SOIL PROFILE		SAMPLES			GROUND WATER CONDITIONS	ELEVATION SCALE	PENETR. RESISTANCE		PLASTIC LIMIT w <sub>p</sub>	NATURAL MOISTURE CONTENT w	LIQUID LIMIT w <sub>L</sub>	UNIT WEIGHT γ	REMARKS & GRAIN SIZE DISTRIBUTION (%)
ELEV DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE			"N" VALUES	STANDARD ●					
225.54	Ground Surface												
0.00													
224.96	TOPSOIL - 580mm.		1	SS	7								
0.58			2	SS	6								
	Brown		3	SS	36								
	Clayey SILT to Silty CLAY TILL (CL to CL-ML) Moist, firm to hard, with embedded sand and gravel.		4	SS	40								
	Grey		5	SS	36								
222.03	End of Borehole.												
3.51													Borehole dry and open @ completion.

JOE.MTO 06-8-IEG2.GPJ ONTARIO.MOT.GDT 09/26/07

+ 3, X 3: Numbers refer to Sensitivity

○ 150 UNCONFINED SHEAR STRENGTH INFERRED FROM POCKET PENETROMETER READINGS

**RECORD OF BOREHOLE No C12-3**

1 OF 1

**METRIC**

W.P. GWP 408-94-00 LOCATION Culvert No. 12 Northing - 4899898, Easting - 379197 ORIGINATED BY RB  
 DIST Owen Sound HWY 21 BOREHOLE TYPE 100mm SST Auger COMPILED BY JL  
 DATUM Geodetic DATE 09.14.06 - 09.14.06 CHECKED BY EC

SOIL PROFILE		SAMPLES			GROUND WATER CONDITIONS	ELEVATION SCALE	PENETR. RESISTANCE STANDARD ● DYN. CONE ○		PLASTIC LIMIT W <sub>p</sub>	NATURAL MOISTURE CONTENT W	LIQUID LIMIT W <sub>L</sub>	UNIT WEIGHT γ	REMARKS & GRAIN SIZE DISTRIBUTION (%)
ELEV DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE			"N" VALUES	SHEAR STRENGTH kPa					
							20 40 60 80 100						GR SA SI CL
227.07	Ground Surface												
0.00	FILL - 230mm sand and gravel (shoulder gravel).	[Cross-hatched pattern]	1	AUGER									35 54 (11)
	FILL Brown, moist, loose to compact, Mixed FILL consisting of silty clay with organic inclusions.		2	SS	10							22.0	7 32 41 20 (61)
			3	SS	9								52
224.63 2.44	SILT (ML) Brown, wet, loose, trace clay, with embedded sand and gravel.	[Dotted pattern]	4	SS	9								
224.02 3.05	Clayey SILT to Silty CLAY TILL (CL to CL-ML) Moist, hard, with embedded sand and gravel.		5	SS	36								
222.80 4.27	End of borehole.		6	SS	69								Water level measured @ 2.75m @ completion.

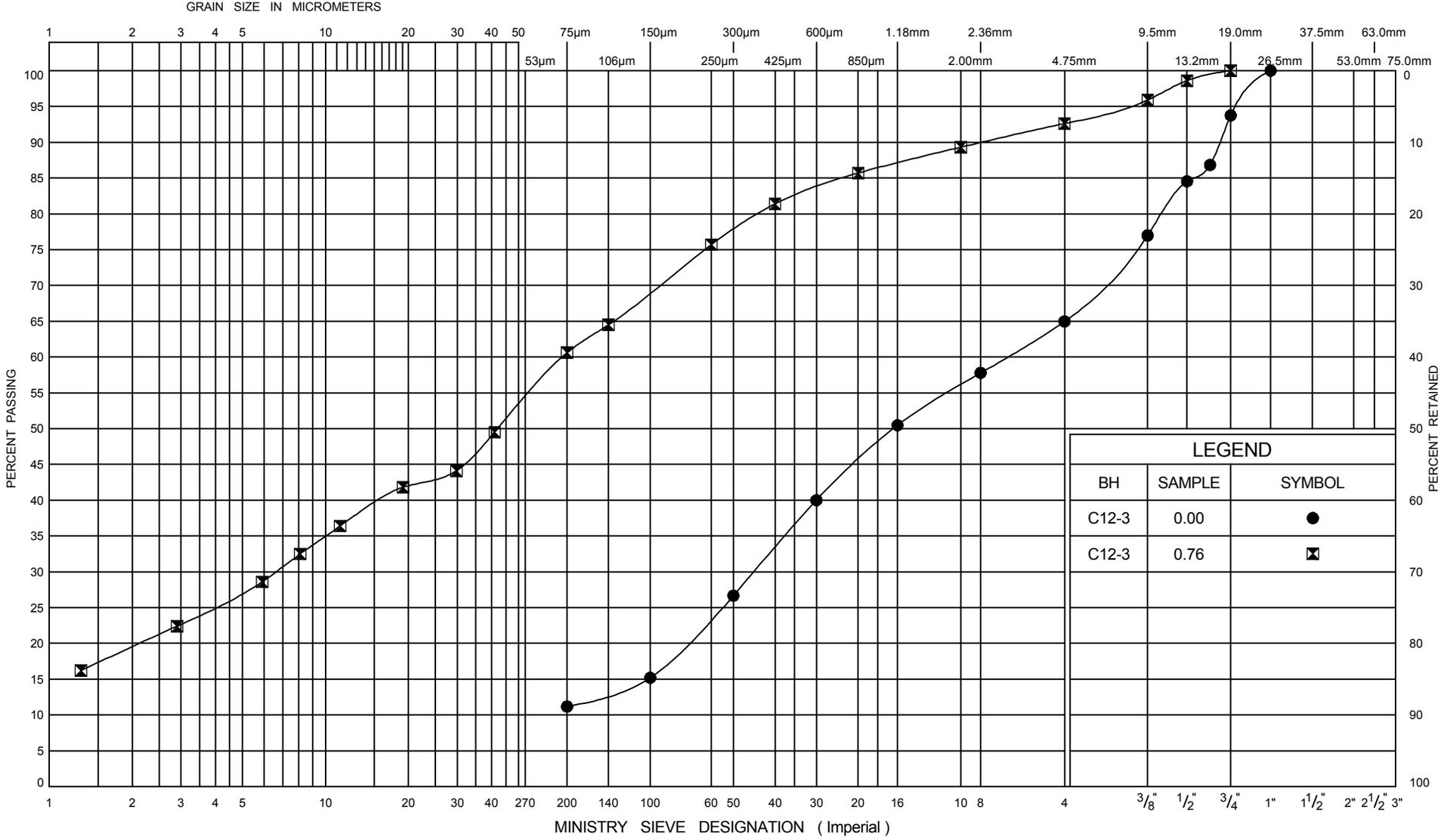
JOE MTO 06-8-IEG2.GPJ ONTARIO MOT.GDT 09/26/07

+ 3, X 3: Numbers refer to Sensitivity

○ 150 UNCONFINED SHEAR STRENGTH INFERRED FROM POCKET PENETROMETER READINGS

UNIFIED SOIL CLASSIFICATION SYSTEM

CLAY & SILT	SAND			GRAVEL	
	Fine	Medium	Coarse	Fine	Coarse



LEGEND		
BH	SAMPLE	SYMBOL
C12-3	0.00	●
C12-3	0.76	⊠

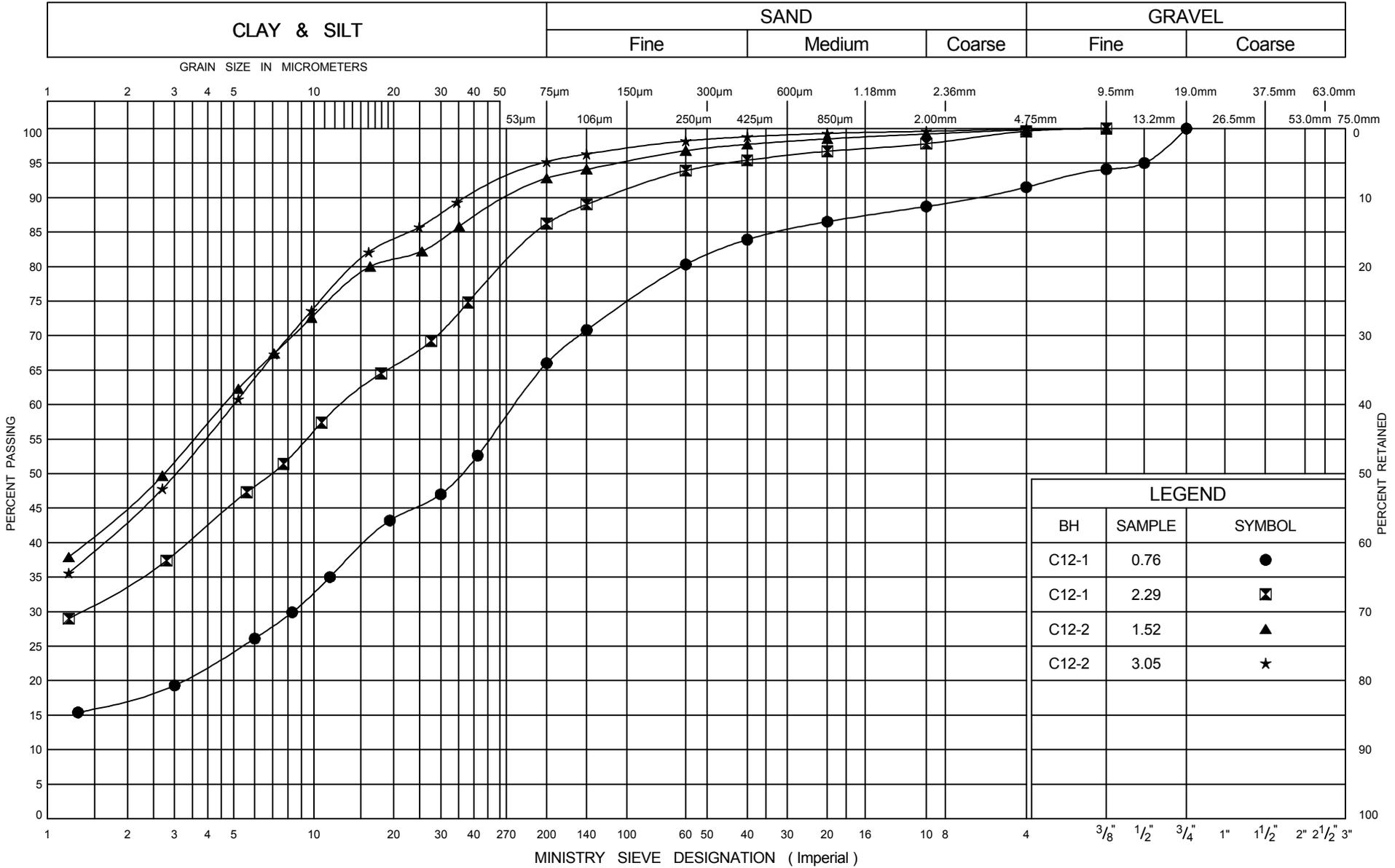
ONTARIO MOT GRAIN SIZE 06-8-1EG2.GPJ ONTARIO MOT.GDT 4/17/07



GRAIN SIZE DISTRIBUTION  
FILL

FIG No C12-1  
GWP 408-94-00  
Highway 21-Kincardine to Tiverton

UNIFIED SOIL CLASSIFICATION SYSTEM



ONTARIO MOT GRAIN SIZE 06-8-1EG2.GPJ ONTARIO MOT.GDT 4/17/07

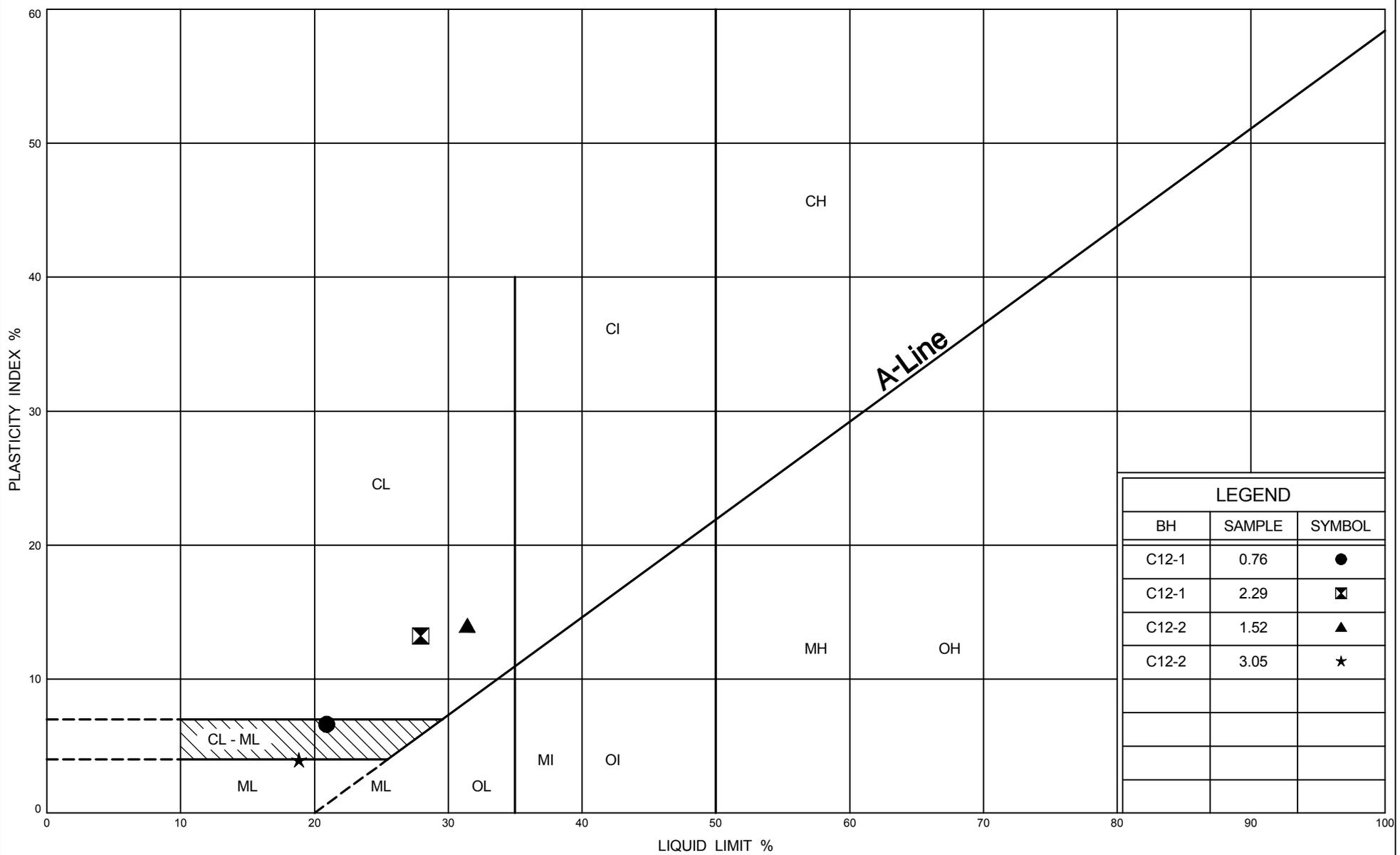


GRAIN SIZE DISTRIBUTION  
CLAYEY SILT TO SILTY CLAY TILL (CL-ML TO CL)

FIG No C12-2

GWP 408-94-00

Highway 21-Kincardine to Tiverton



LEGEND		
BH	SAMPLE	SYMBOL
C12-1	0.76	●
C12-1	2.29	⊠
C12-2	1.52	▲
C12-2	3.05	★

ONTARIO MOT PLASTICITY CHART\_06-8-1EG2.GPJ\_ONTARIO MOT.GDT\_4/17/07



**PLASTICITY CHART**  
**CLAYEY SILT TO SILTY CLAY TILL (CL-ML TO CL)**

FIG No C12-3  
 GWP 408-94-00  
 Highway 21-Kincardine to Tiverton

**RECORD OF BOREHOLE No C13-1**

1 OF 1

**METRIC**

W.P. GWP 408-94-00 LOCATION Culvert No. 13 Northing - 4899975, Easting - 379252 ORIGINATED BY RB  
 DIST Owen Sound HWY 21 BOREHOLE TYPE 100mm SST Auger COMPILED BY JL  
 DATUM Geodetic DATE 9.14.06 - 9.14.06 CHECKED BY EC

SOIL PROFILE		SAMPLES			GROUND WATER CONDITIONS	ELEVATION SCALE	PENETR. RESISTANCE STANDARD ● DYN. CONE ○					PLASTIC NATURAL LIQUID LIMIT MOISTURE CONTENT LIMIT			UNIT WEIGHT $\gamma$ kN/m <sup>3</sup>	REMARKS & GRAIN SIZE DISTRIBUTION (%) GR SA SI CL
ELEV DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE			"N" VALUES	SHEAR STRENGTH kPa					WATER CONTENT (%)			
						20	40	60	80	100	W <sub>p</sub>	W	W <sub>L</sub>			
226.86 0.00	Ground Surface		1	AUGER							○					
226.17 0.69	FILL - 690mm sand and gravel (shoulder gravel).	[Cross-hatched pattern]	2	SS	10							○			22.5	
			3	SS	4								○			
			4	SS	7									○		
			5	SS	15									○		
223.66 3.20	Sandy SILT (ML) Brown, moist to wet, loose to compact, consisting of silty clay mixed with some organics.	[Dotted pattern]	6	SS	28								○			
			7	SS	56									○		
221.83 5.03	End of borehole.															

JOE MTO 06-8-IEG2.GPJ ONTARIO.MOT.GDT 4/17/07

+ 3, X 3: Numbers refer to Sensitivity ○ 150 UNCONFINED SHEAR STRENGTH INFERRED FROM POCKET PENETROMETER READINGS

**RECORD OF BOREHOLE No C13-2**

1 OF 1

**METRIC**

W.P. GWP 408-94-00 LOCATION Culvert No. 13 Northing - 4899976, Easting - 379260 ORIGINATED BY RB  
 DIST Owen Sound HWY 21 BOREHOLE TYPE 100mm SST Auger COMPILED BY JL  
 DATUM Geodetic DATE 9.14.06 - 9.14.06 CHECKED BY EC

SOIL PROFILE		SAMPLES			GROUND WATER CONDITIONS	ELEVATION SCALE	PENETR. RESISTANCE STANDARD ● DYN. CONE ○					PLASTIC NATURAL LIQUID LIMIT MOISTURE CONTENT LIMIT			UNIT WEIGHT $\gamma$ kN/m <sup>3</sup>	REMARKS & GRAIN SIZE DISTRIBUTION (%) GR SA SI CL
ELEV DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE			"N" VALUES	SHEAR STRENGTH kPa					WATER CONTENT (%)			
						20	40	60	80	100	W <sub>p</sub>	W	W <sub>L</sub>			
224.71	Ground Surface		1	AUGER												
0.00	TOPSOIL - 900mm topsoil fill.															
223.64			2	SS	13										3 26 49 22 (71)	
1.07			3	SS	20											
	Sandy SILT to SAND and SILT (ML to SM) Brown, moist to wet, compact to very dense, trace to some gravel, with wet sand and silty clay layers.		4	SS	32										2 50 44 4 (48)	
			5	SS	66											
221.20	End of Borehole.														Borehole dry and open at completion.	
3.51																

JOE MTO 06-8-IEG2.GPJ ONTARIO.MOT.GDT 4/17/07

**RECORD OF BOREHOLE No C13-3**

1 OF 1

**METRIC**

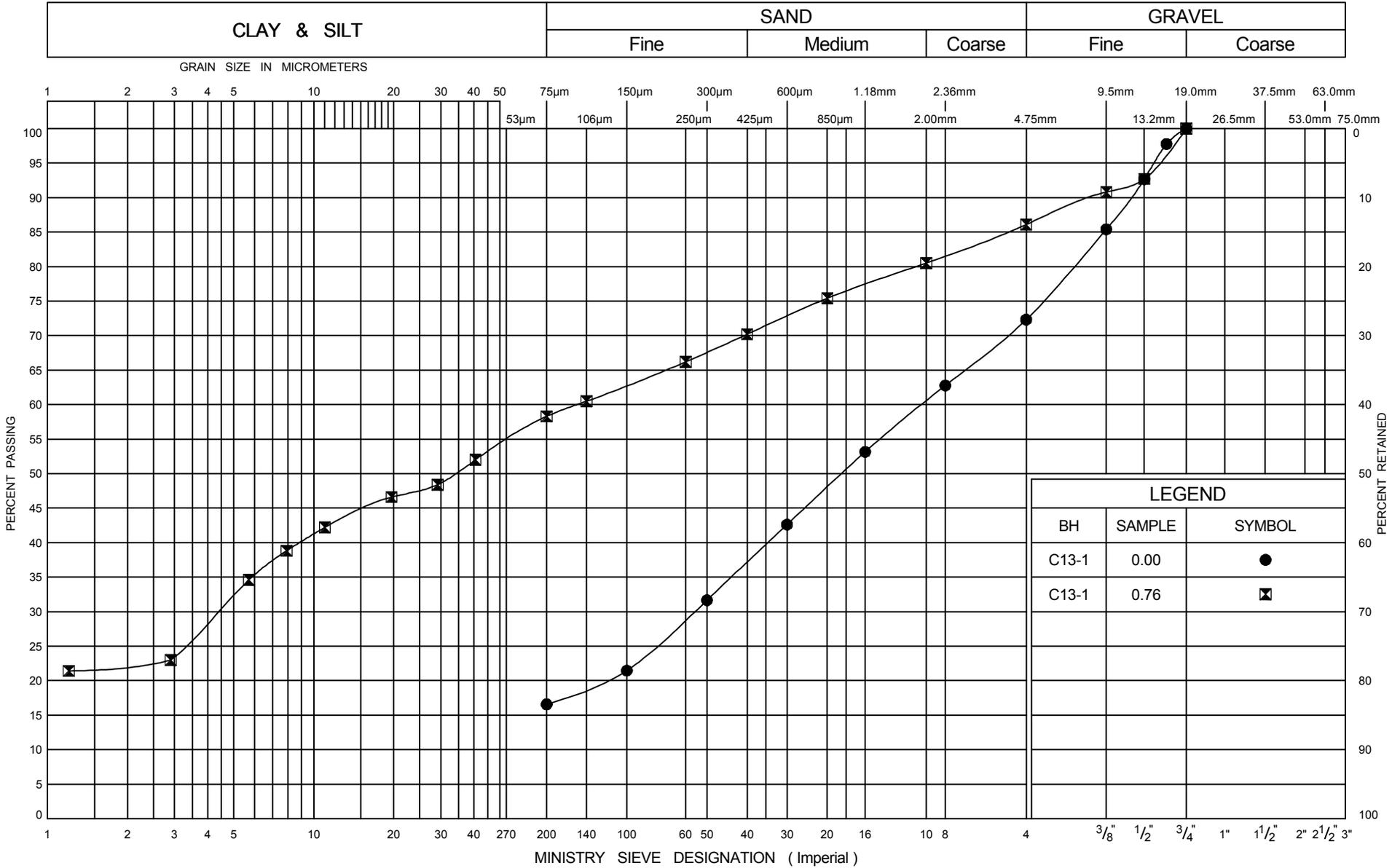
W.P. GWP 408-94-00 LOCATION Culvert No. 13 Northing - 4899992, Easting - 379242 ORIGINATED BY RB  
 DIST Owen Sound HWY 21 BOREHOLE TYPE 100mm SST Auger COMPILED BY JL  
 DATUM Geodetic DATE 9.14.06 - 9.14.06 CHECKED BY EC

SOIL PROFILE		SAMPLES			GROUND WATER CONDITIONS	ELEVATION SCALE	PENETR. RESISTANCE					PLASTIC NATURAL LIQUID			UNIT WEIGHT $\gamma$ kN/m <sup>3</sup>	REMARKS & GRAIN SIZE DISTRIBUTION (%) GR SA SI CL
ELEV. DEPTH	DESCRIPTION	NUMBER	TYPE	"N" VALUES			STANDARD 20 40 60 80 100	DYN. CONE 20 40 60 80 100	W <sub>p</sub>	MOISTURE CONTENT W	LIMIT W <sub>L</sub>	WATER CONTENT (%)	WATER CONTENT (%)	WATER CONTENT (%)		
224.54 0.00	Ground Surface TOPSOIL - 130mm.															
	Sandy SILT (ML) Brown, moist, compact to dense, Sandy SILT, some gravel, occasional sand and silty clay seams and layers.	1	SS	9		●								23.6	2 29 51 17 (68)	
		2	SS	9		●										
		3	SS	21		●										
		4	SS	23		●										
221.49 3.05	saturated silty sand layer	5	SS	49		●								3 76 20 2 (22)		
221.03 3.51	End of Borehole.														Water level measured at 2.4m at completion.	

JOE MTO 06-8-IEG2.GPJ ONTARIO.MOT.GDT 4/17/07

+ 3, X 3: Numbers refer to Sensitivity ○ 150 UNCONFINED SHEAR STRENGTH INFERRED FROM POCKET PENETROMETER READINGS

### UNIFIED SOIL CLASSIFICATION SYSTEM



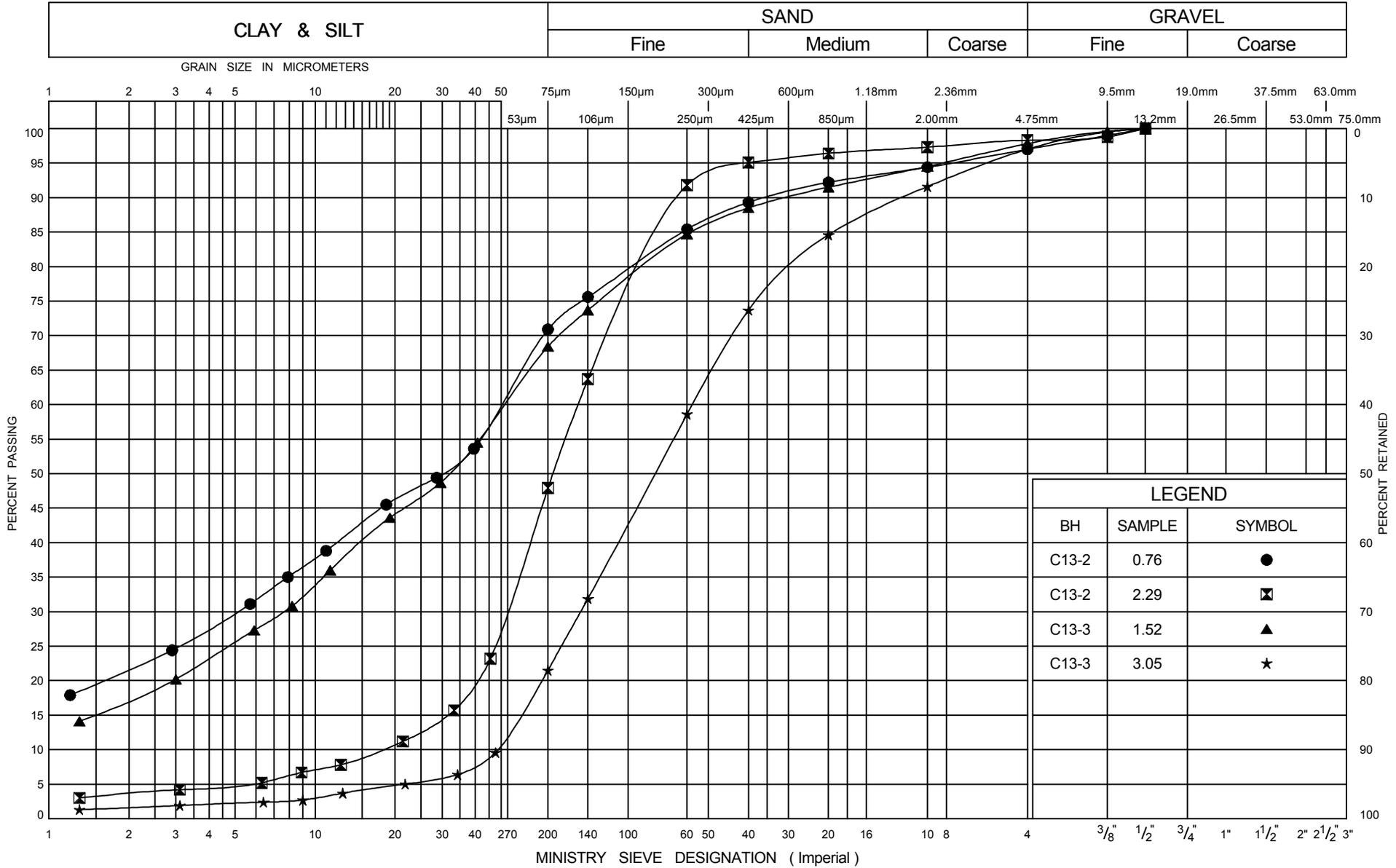
ONTARIO MOT GRAIN SIZE 06-8-1EG2.GPJ ONTARIO MOT.GDT 4/17/07



## GRAIN SIZE DISTRIBUTION FILL

FIG No C13-1  
GWP 408-94-00  
Highway 21-Kincardine to Tiverton

### UNIFIED SOIL CLASSIFICATION SYSTEM



ONTARIO MOT GRAIN SIZE 06-8-1EG2.GPJ ONTARIO MOT.GDT 4/17/07



## GRAIN SIZE DISTRIBUTION

### SANDY SILT TO SILTY SAND (ML TO SM)

FIG No C13-2

GWP 408-94-00

Highway 21-Kincardine to Tiverton

**RECORD OF BOREHOLE No C14-1**

1 OF 1

**METRIC**

W.P. GWP 408-94-00 LOCATION Culvert No. 14 Northing - 4900150, Easting - 379335 ORIGINATED BY RB  
 DIST Owen Sound HWY 21 BOREHOLE TYPE 100mm SST Auger COMPILED BY JL  
 DATUM Geodetic DATE 9.14.06 - 9.14.06 CHECKED BY EC

SOIL PROFILE		SAMPLES			GROUND WATER CONDITIONS	ELEVATION SCALE	PENETR. RESISTANCE					NATURAL MOISTURE CONTENT			UNIT WEIGHT $\gamma$ kN/m <sup>3</sup>	REMARKS & GRAIN SIZE DISTRIBUTION (%)
ELEV. DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE			"N" VALUES	STANDARD	DYN. CONE	PLASTIC LIMIT	WATER CONTENT (%)	LIQUID LIMIT	GR	SA		
226.21	Ground Surface															
0.00	FILL - 300mm sand and gravel (shoulder gravel).		1	AUGER											32 56 (13)	
225.91			2	SS	10											
0.30	FILL Brown to black, moist to wet, compact, consisting of topsoil mixed with silty clay, some sand and gravel.		3	SS	10										5 21 46 28 (74)	
224.08			4	SS	21											
2.13	SAND (SP) Brown, saturated, compact.		5	SS	25											
223.31			6	SS	100+											
2.90	SILT (ML) Grey, wet, compact.															
222.40	changing to hard clayey silt															
3.81																
	End of borehole.														Water level measured @ 2.1m @ completion.	

JOE MTO 06-8-IEG2.GPJ ONTARIO.MOT.GDT 4/17/07

**RECORD OF BOREHOLE No C14-2**

1 OF 1

**METRIC**

W.P. GWP 408-94-00 LOCATION Culvert No. 14 Northing - 4900153, Easting - 379330 ORIGINATED BY RB  
 DIST Owen Sound HWY 21 BOREHOLE TYPE 100mm SST Auger COMPILED BY JL  
 DATUM Geodetic DATE 9.18.06 - 9.18.06 CHECKED BY EC

SOIL PROFILE		SAMPLES			GROUND WATER CONDITIONS	ELEVATION SCALE	PENETR. RESISTANCE					PLASTIC NATURAL LIQUID			UNIT WEIGHT $\gamma$ kN/m <sup>3</sup>	REMARKS & GRAIN SIZE DISTRIBUTION (%) GR SA SI CL
ELEV. DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE			"N" VALUES	STANDARD	DYN. CONE	W <sub>p</sub>	W	W <sub>L</sub>	WATER CONTENT (%)	WATER CONTENT (%)		
224.63 0.00	Ground Surface															
223.87 0.76	FILL - 760mm topsoil and topsoil fill.		1	SS	5											
	Brown SILT to Sandy SILT (ML) Moist to wet, loose to compact, trace gravel.		2	SS	8										8	30 51 11 (62)
	Grey		3	SS	17											
222.50 2.13	Silty CLAY TILL (CL) Grey, damp, hard, with embedded sand and gravel.		4	SS	54							225+			1	11 56 31 (87)
			5	SS	100+											
221.12 3.51	End of borehole.															Water level measured at 2.7m at completion.

JOE MTO 06-8-IEG2.GPJ ONTARIO.MOT.GDT 4/17/07

+ 3, X 3: Numbers refer to Sensitivity      ○ 150 UNCONFINED SHEAR STRENGTH INFERRED FROM POCKET PENETROMETER READINGS

**RECORD OF BOREHOLE No C14-3**

1 OF 1

**METRIC**

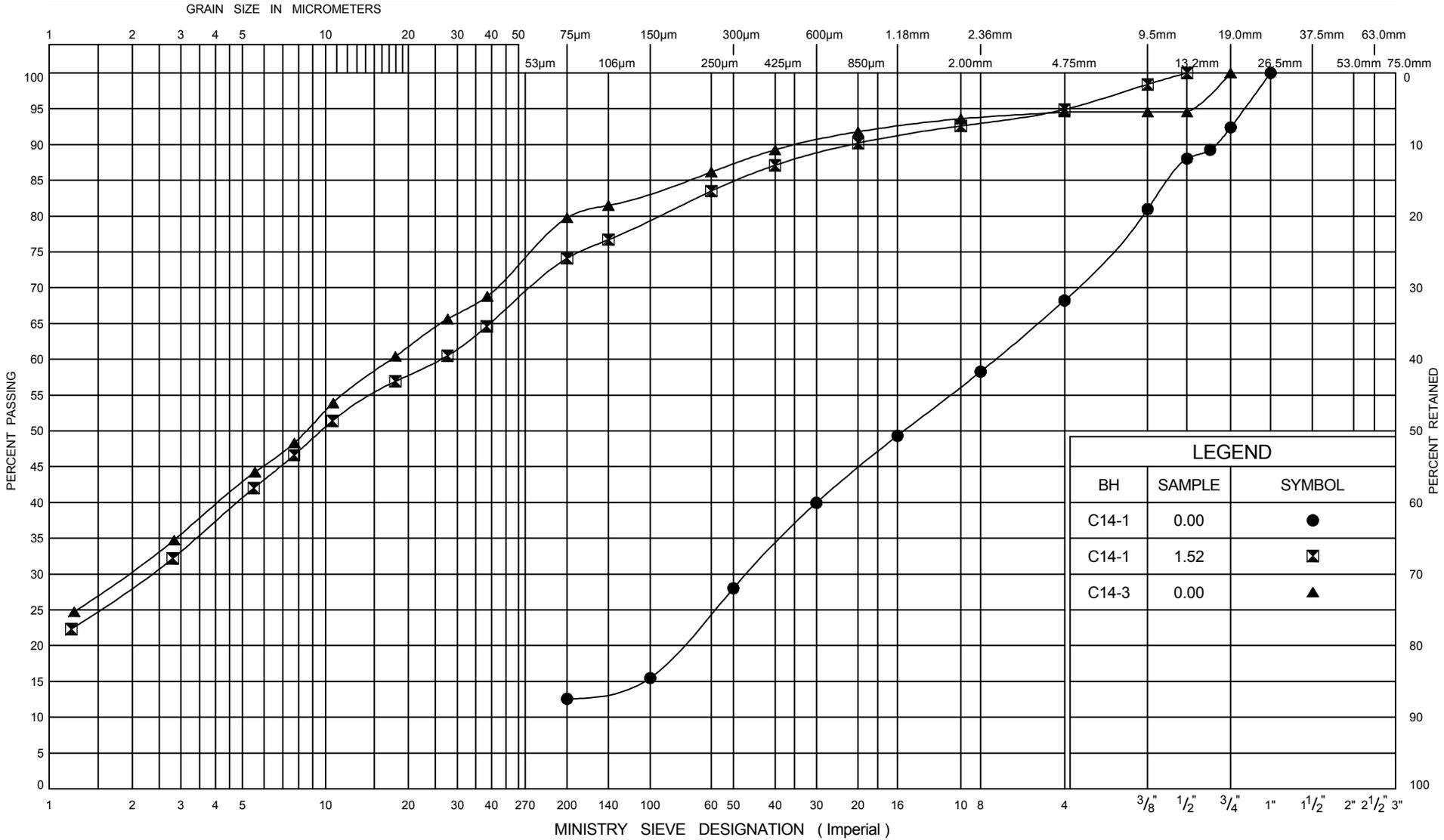
W.P. GWP 408-94-00 LOCATION Culvert No. 14 Northing - 4900147, Easting - 379351 ORIGINATED BY RB  
 DIST Owen Sound HWY 21 BOREHOLE TYPE 100mm SST Auger COMPILED BY JL  
 DATUM Geodetic DATE 9.18.06 - 9.18.06 CHECKED BY EC

SOIL PROFILE		SAMPLES			GROUND WATER CONDITIONS	ELEVATION SCALE	PENETR. RESISTANCE		PLASTIC LIMIT W <sub>p</sub>	NATURAL MOISTURE CONTENT w	LIQUID LIMIT W <sub>L</sub>	UNIT WEIGHT γ	REMARKS & GRAIN SIZE DISTRIBUTION (%)
ELEV. DEPTH	DESCRIPTION	STRAT. PLOT	NUMBER	TYPE			"N" VALUES	STANDARD ●					
225.38 0.00	Ground Surface												
224.77 0.61	FILL - 610mm topsoil and topsoil fill.		1	SS	6							5 15 49 31 (80)	
	Brown	CL	2	SS	8						41	0 17 45 38 (83)	
		Silty CLAY TILL (CI to CL) Damp to moist, firm to hard, with embedded sand and gravel.		3	SS	15						22.9	1 6 61 32 (93)
	Grey	CL	4	SS	59								
				5	SS	100+							
221.87 3.51	End of borehole.												Wet cave-in at 2.1m at completion.

JOE MTO 06-8-IEG2.GPJ ONTARIO.MOT.GDT 4/17/07

### UNIFIED SOIL CLASSIFICATION SYSTEM

CLAY & SILT	SAND			GRAVEL	
	Fine	Medium	Coarse	Fine	Coarse



ONTARIO MOT GRAIN SIZE 06-8-1EG2.GPJ ONTARIO MOT.GDT 4/17/07



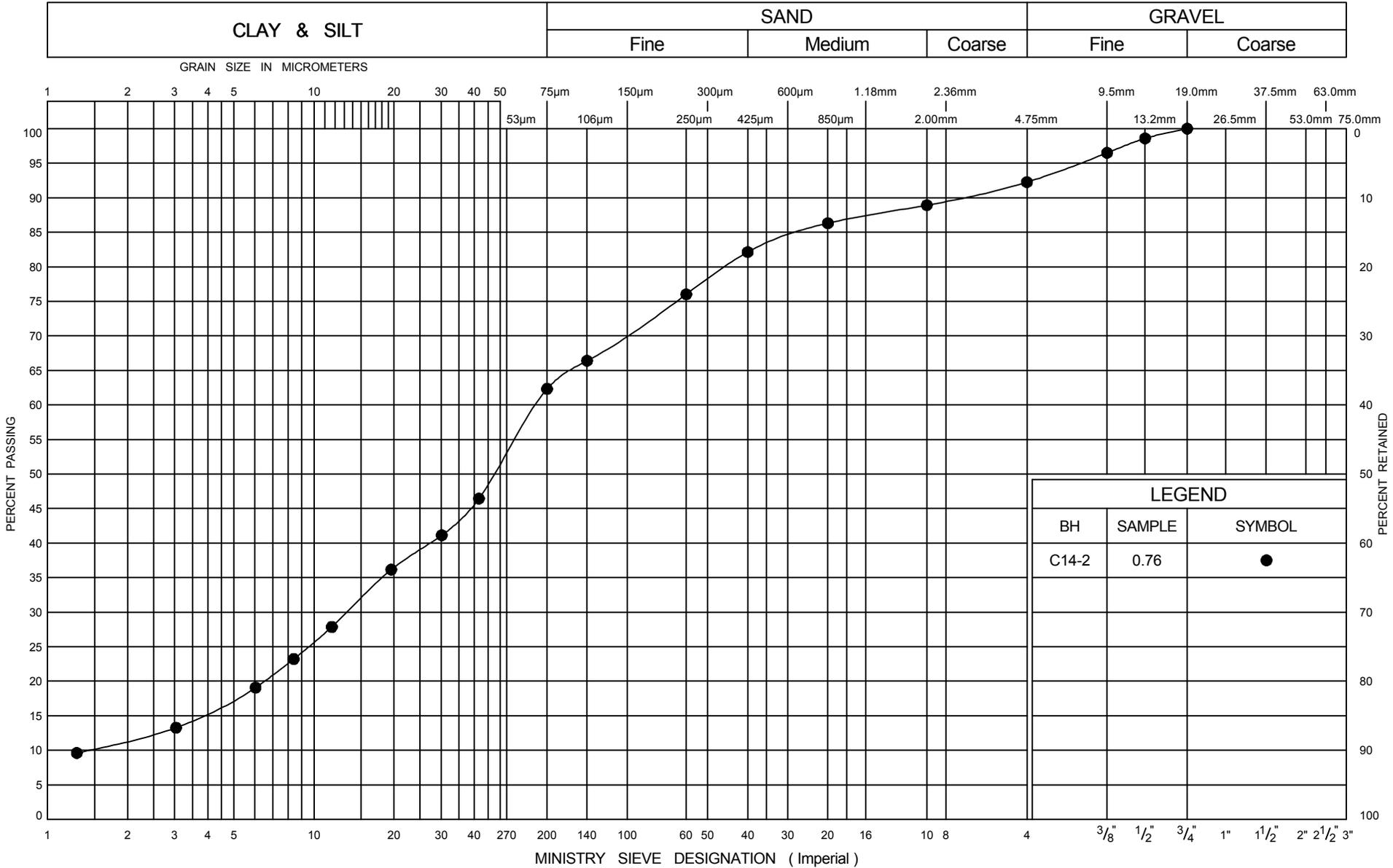
## GRAIN SIZE DISTRIBUTION FILL

FIG No C14-1

GWP 408-94-00

Highway 21-Kincardine to Tiverton

### UNIFIED SOIL CLASSIFICATION SYSTEM



ONTARIO MOT GRAIN SIZE 06-8-1EG2.GPJ ONTARIO MOT.GDT 4/17/07



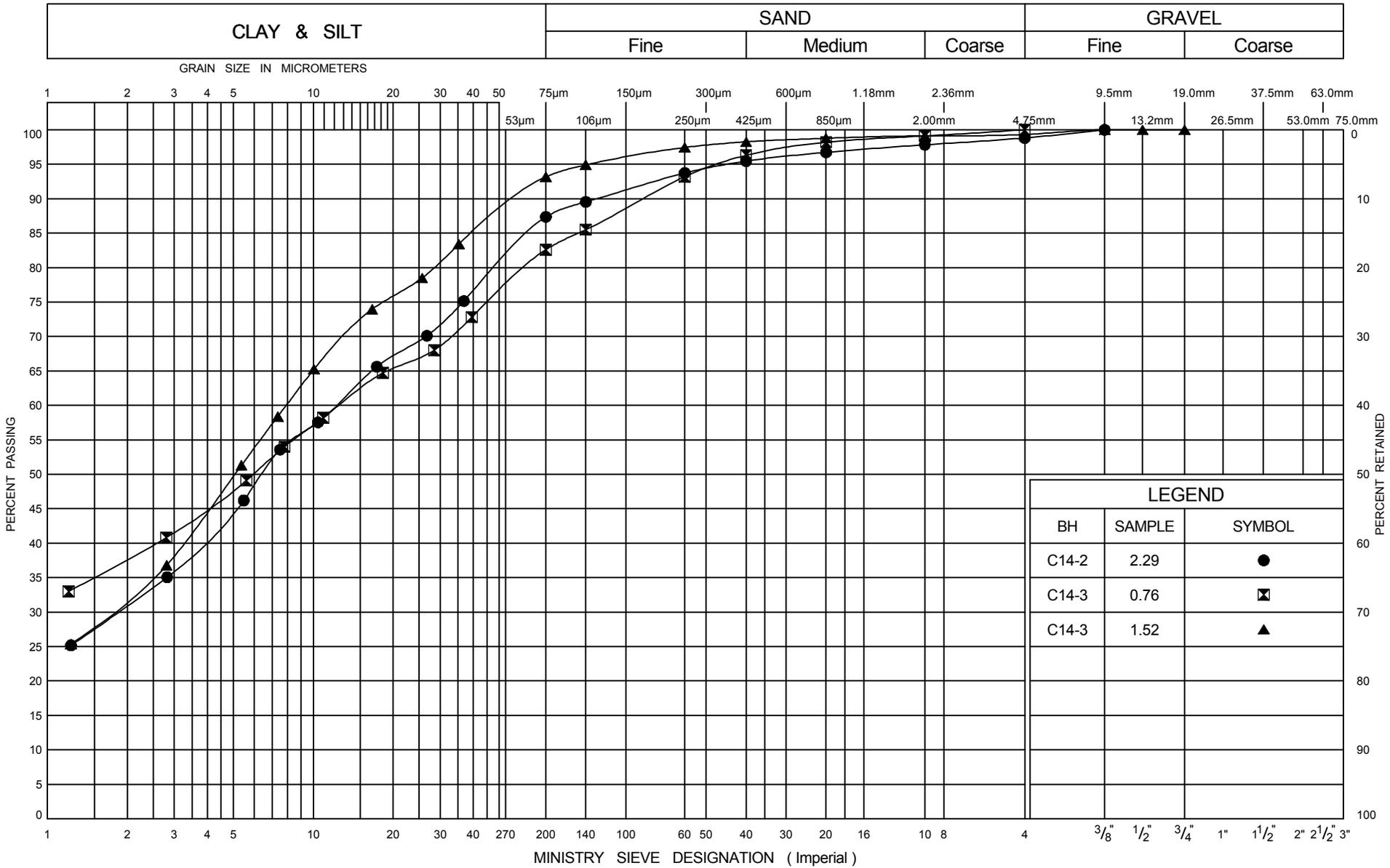
## GRAIN SIZE DISTRIBUTION SILT TO SANDY SILT (ML)

FIG No C14-2

GWP 408-94-00

Highway 21-Kincardine to Tiverton

### UNIFIED SOIL CLASSIFICATION SYSTEM



ONTARIO MOT GRAIN SIZE 06-8-1EG2.GPJ ONTARIO MOT.GDT 4/17/07

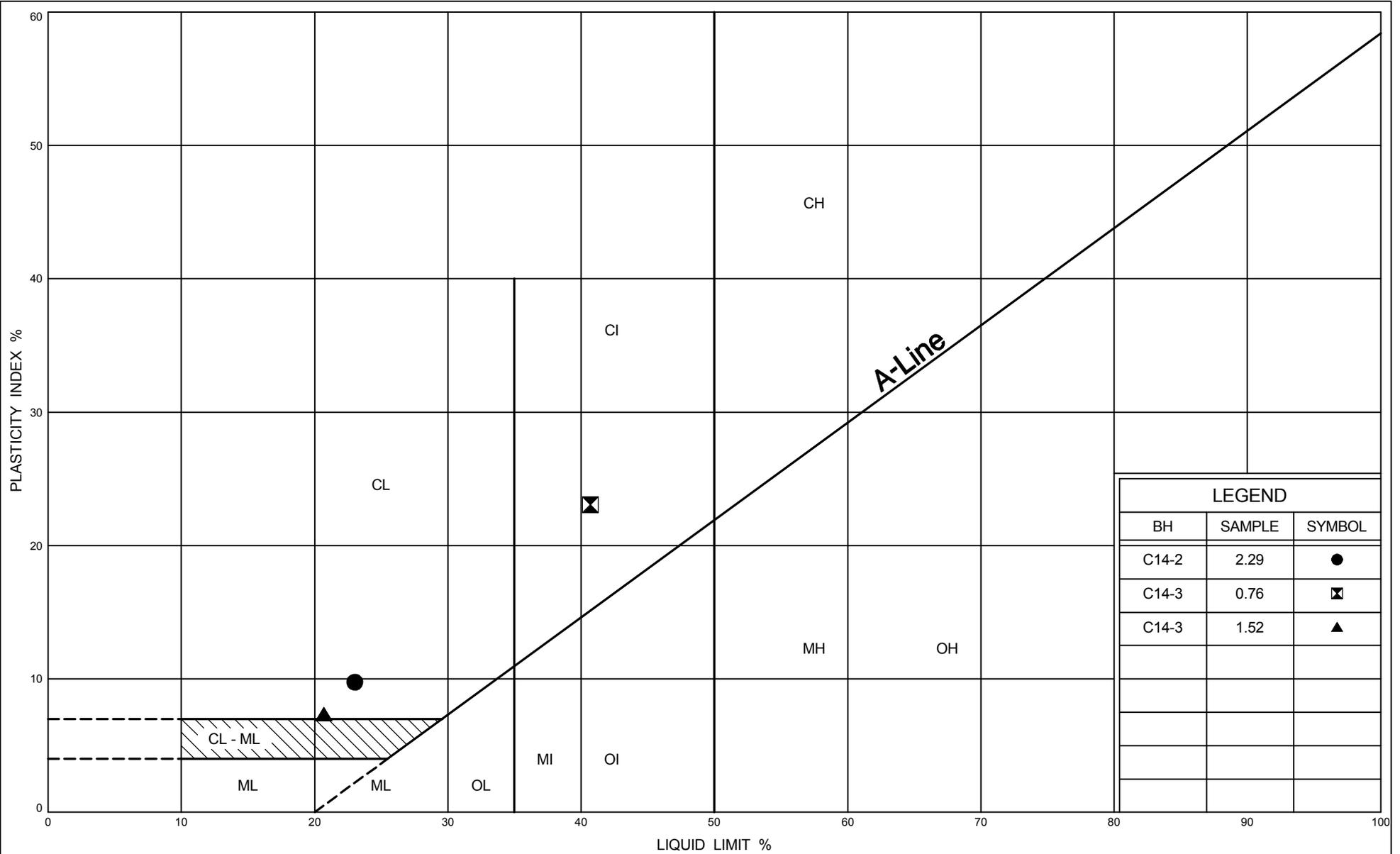


**GRAIN SIZE DISTRIBUTION**  
**SILTY CLAY TILL (CL TO CI)**

FIG No C14-3

GWP 408-94-00

Highway 21-Kincardine to Tiverton



LEGEND		
BH	SAMPLE	SYMBOL
C14-2	2.29	●
C14-3	0.76	⊠
C14-3	1.52	▲

ONTARIO MOT PLASTICITY CHART\_06-8-1EG2.GPJ\_ONTARIO MOT.GDT\_4/17/07



**PLASTICITY CHART**  
**SILTY CLAY TILL (CL TO CI)**

FIG No C14-4  
GWP 408-94-00  
Highway 21-Kincardine to Tiverton

RECORD OF BOREHOLE No C15-1

1 OF 1

METRIC

W.P. GWP 408-94-00 LOCATION Culvert No. 15 Northing - 4900495, Easting - 379534 ORIGINATED BY RB  
 DIST Owen Sound HWY 21 BOREHOLE TYPE 100mm SST Auger COMPILED BY JL  
 DATUM Geodetic DATE 09.19.06 - 09.19.06 CHECKED BY EC

SOIL PROFILE		SAMPLES			GROUND WATER CONDITIONS	ELEVATION SCALE	PENETR. RESISTANCE STANDARD ● DYN. CONE ○		PLASTIC LIMIT $w_p$	NATURAL MOISTURE CONTENT $w$	LIQUID LIMIT $w_L$	UNIT WEIGHT $\gamma$	REMARKS & GRAIN SIZE DISTRIBUTION (%)			
ELEV DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE			"N" VALUES	20						40	60	80
230.56	Ground Surface															
0.00	FILL - 300mm sand and gravel (shoulder gravel)		1	AUGER												
230.28			2	SS	12							21.9	2 12 51 35 (86)			
0.30			3	SS	7											
	FILL Brown, moist, loose to compact, consisting of sand and gravel mixed with silty clay, some organics.		4	SS	11											
			5	SS	12							20.7	1 16 47 36 (83)			
			6	SS	11											
			7	SS	11											
224.92			8	SS	19											
5.64	wet sand and gravel		9	SS	32											
224.62	wet silt		10	SS	66											
5.94	Brown Clayey SILT to Silty CLAY TILL (CL to CL-ML)															
	Grey Moist, very stiff to hard, with embedded sand and gravel.															
223.24	End of borehole.												Water level measured at 5.55m at completion.			
7.32																

JOE.MTO\_06-8-IEG2.GPJ ONTARIO.MOT.GDT 09/26/07

+<sup>3</sup>, X<sup>3</sup>: Numbers refer to Sensitivity ○ 150 UNCONFINED SHEAR STRENGTH INFERRED FROM POCKET PENETROMETER READINGS

**RECORD OF BOREHOLE No C15-2**

1 OF 1

**METRIC**

W.P. GWP 408-94-00 LOCATION Culvert No. 15 Northing - 4900478, Easting - 379541 ORIGINATED BY RB  
 DIST Owen Sound HWY 21 BOREHOLE TYPE 100mm SST Auger COMPILED BY JL  
 DATUM Geodetic DATE 09.19.06 - 09.19.06 CHECKED BY EC

SOIL PROFILE		SAMPLES			GROUND WATER CONDITIONS	ELEVATION SCALE	PENETR. RESISTANCE		PLASTIC LIMIT w <sub>p</sub>	NATURAL MOISTURE CONTENT w	LIQUID LIMIT w <sub>L</sub>	UNIT WEIGHT γ	REMARKS & GRAIN SIZE DISTRIBUTION (%)
ELEV DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE			"N" VALUES	STANDARD ●					
226.22	Ground Surface												
0.00	FILL - 1.37m topsoil and topsoil fill.	[Cross-hatched pattern]	1	SS	5	▽	●					17.6	1 29 45 24 (70)
224.85			2	SS	7		●						
1.37	wet silty sand seam	[Dotted pattern]	3	SS	17		○	100					5 26 50 19 (69)
224.54			4	SS	26		○	125					
1.68			5	SS	26		○	125					
222.71	End of borehole.												Water level measured at 1.2m at completion.

JOE.MTO\_06-8-IEG2.GPJ ONTARIO.MOT.GDT 09/26/07

+ 3, X 3: Numbers refer to Sensitivity ○ 150 UNCONFINED SHEAR STRENGTH INFERRED FROM POCKET PENETROMETER READINGS

**RECORD OF BOREHOLE No C15-3**

1 OF 1

**METRIC**

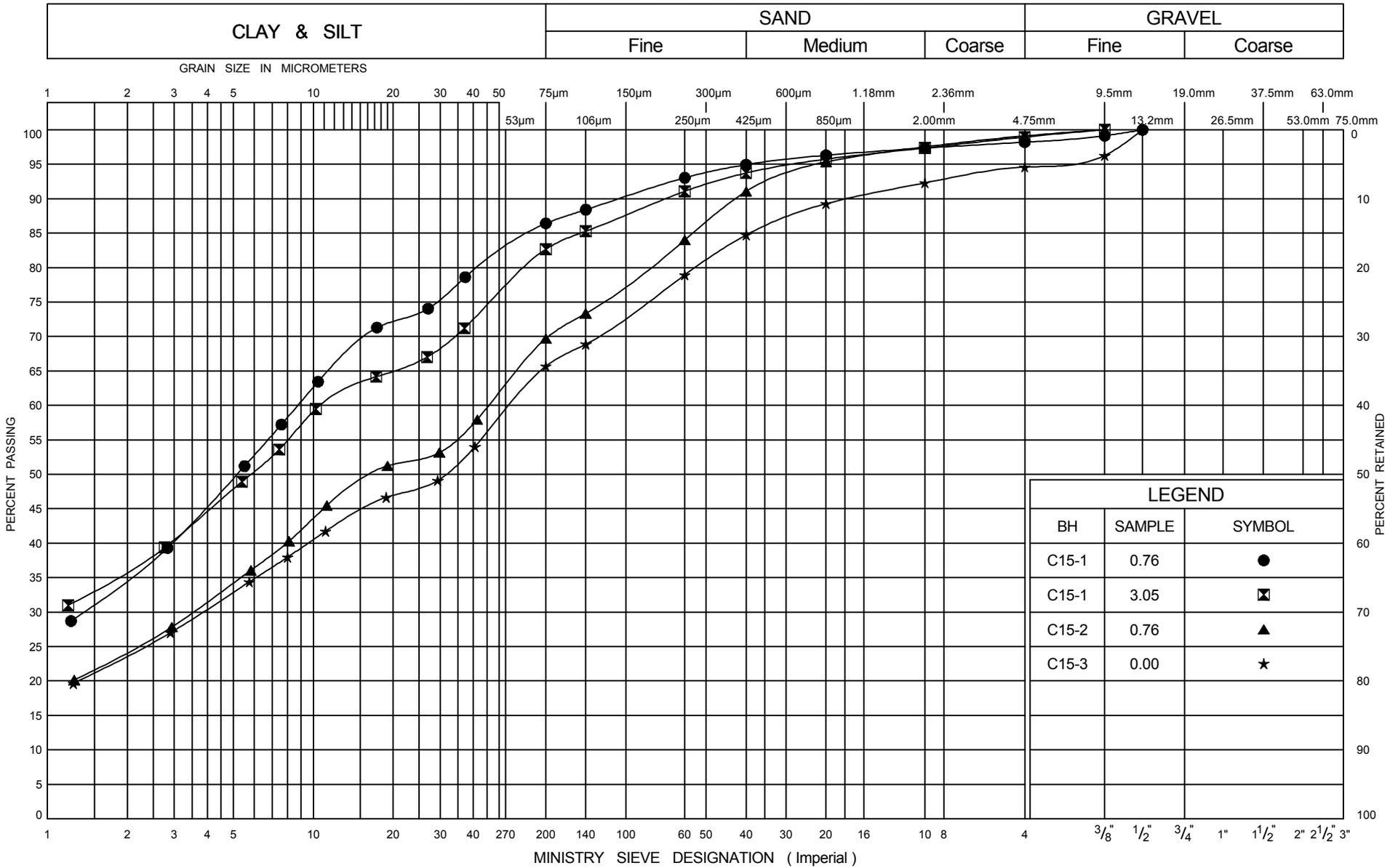
W.P. GWP 408-94-00 LOCATION Culvert No. 15 Northing - 4900519, Easting - 379516 ORIGINATED BY RB  
 DIST Owen Sound HWY 21 BOREHOLE TYPE 100mm SST Auger COMPILED BY JL  
 DATUM Geodetic DATE 9.19.06 - 9.19.06 CHECKED BY EC

SOIL PROFILE		SAMPLES			GROUND WATER CONDITIONS	ELEVATION SCALE	PENETR. RESISTANCE					PLASTIC NATURAL LIQUID			UNIT WEIGHT $\gamma$	REMARKS & GRAIN SIZE DISTRIBUTION (%)		
ELEV. DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE			"N" VALUES	STANDARD	DYN. CONE	W <sub>p</sub>	MOISTURE CONTENT	W <sub>L</sub>	W <sub>p</sub>	W			W <sub>L</sub>	GR
225.70 0.00	Ground Surface																	
225.15 0.55	550mm Topsoil and Topsoil FILL.		1	SS	7		●											5 29 42 24 (66)
224.18 1.52	SAND and SILT (SM to ML) Brown, wet, compact.		2	SS	11		●											spoon empty, auger sample
224.18 1.52	Brown		3	SS	33		●				○							
222.19 3.51	Clayey SILT to Silty CLAY TILL (CL to CL-ML) Moist, hard, with embedded sand Grey and gravel.		4	SS	57		●				○							
222.19 3.51	End of Borehole.		5	SS	52		●				○							24.3 1 11 43 45 (88)
																		Borehole dry and open at completion.

JOE MTO 06-8-IEG2.GPJ ONTARIO.MOT.GDT 4/17/07

+ 3, X 3: Numbers refer to Sensitivity ○ 150 UNCONFINED SHEAR STRENGTH INFERRED FROM POCKET PENETROMETER READINGS

UNIFIED SOIL CLASSIFICATION SYSTEM



LEGEND		
BH	SAMPLE	SYMBOL
C15-1	0.76	●
C15-1	3.05	⊠
C15-2	0.76	▲
C15-3	0.00	★

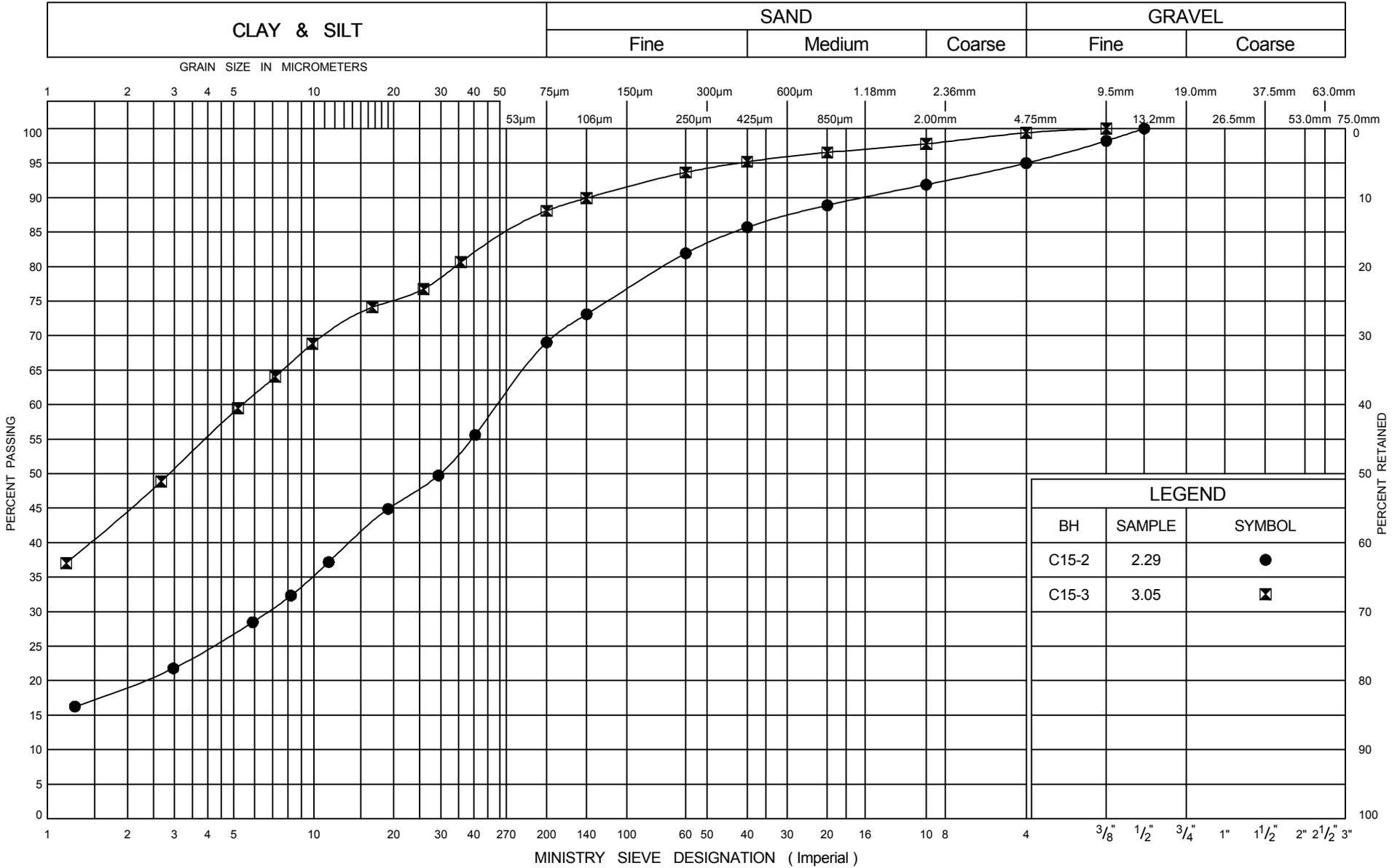
ONTARIO MOT GRAIN SIZE 06-8-1EG2.GPJ ONTARIO MOT.GDT 4/17/07



GRAIN SIZE DISTRIBUTION  
FILL

FIG No C15-1  
GWP 408-94-00  
Highway 21-Kincardine to Tiverton

### UNIFIED SOIL CLASSIFICATION SYSTEM



ONTARIO MOT GRAIN SIZE 06-8-1EG2.GPJ ONTARIO MOT.GDT 4/17/07



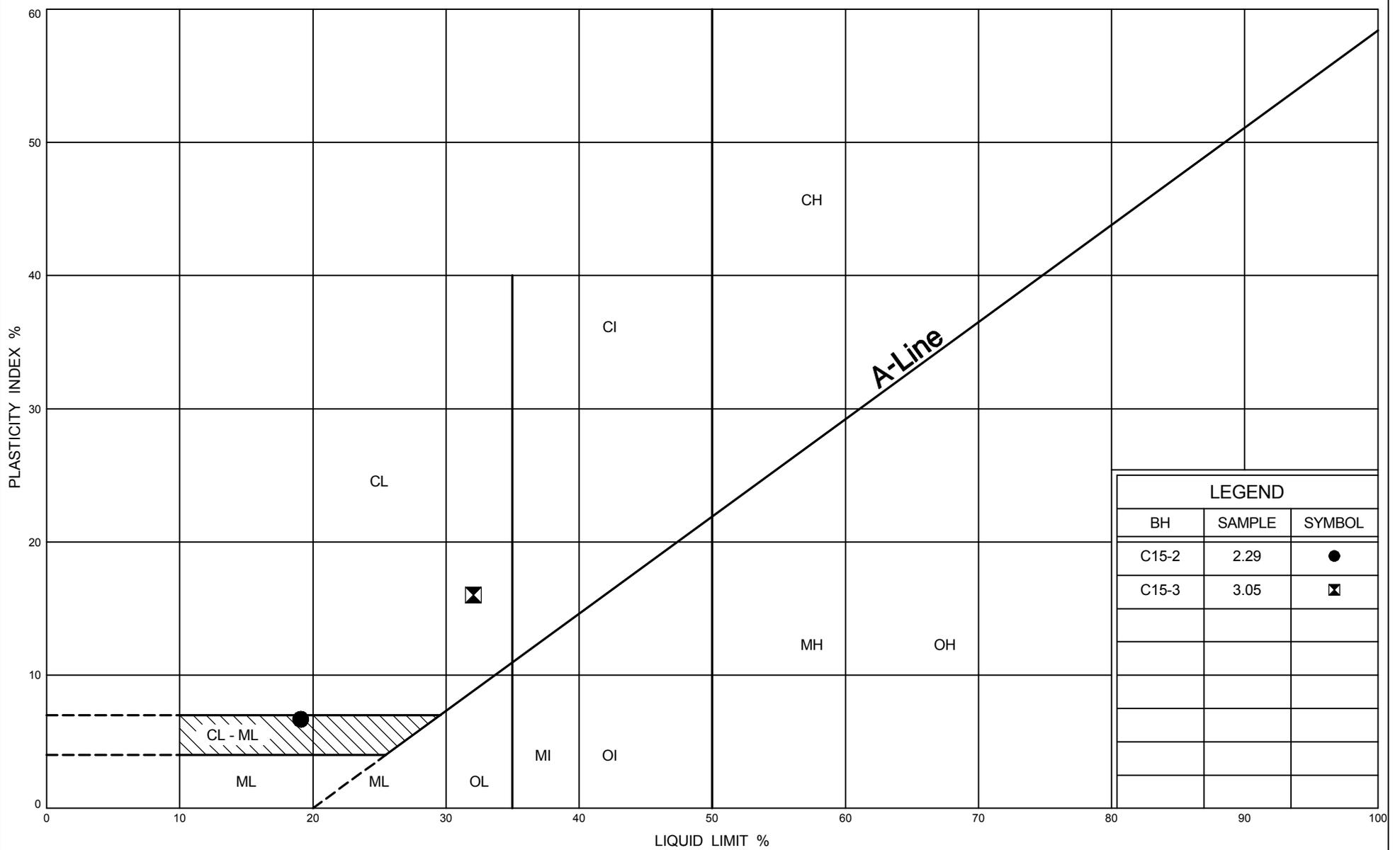
## GRAIN SIZE DISTRIBUTION

### CLAYEY SILT TO SILTY CLAY TILL (CL-ML TO CL)

FIG No C15-2

GWP 408-94-00

Highway 21-Kincardine to Tiverton



LEGEND		
BH	SAMPLE	SYMBOL
C15-2	2.29	●
C15-3	3.05	⊠

ONTARIO MOT PLASTICITY CHART\_06-8-1EG2.GPJ\_ONTARIO MOT.GDT\_4/17/07



**PLASTICITY CHART**  
**CLAYEY SILT TO SILTY CLAY TILL (CL-ML TO CL)**

FIG No C15-3  
 GWP 408-94-00  
 Highway 21-Kincardine to Tiverton

**RECORD OF BOREHOLE No C16-2**

1 OF 1

**METRIC**

W.P. GWP 408-94-00 LOCATION Culvert No. 16 Northing - 4900887, Easting - 379746 ORIGINATED BY RB  
 DIST Owen Sound HWY 21 BOREHOLE TYPE 100mm SST Auger COMPILED BY JL  
 DATUM Geodetic DATE 09.20.06 - 09.20.06 CHECKED BY EC

SOIL PROFILE		SAMPLES			GROUND WATER CONDITIONS	ELEVATION SCALE	PENETR. RESISTANCE		PLASTIC LIMIT w <sub>p</sub>	NATURAL MOISTURE CONTENT w	LIQUID LIMIT w <sub>L</sub>	UNIT WEIGHT γ	REMARKS & GRAIN SIZE DISTRIBUTION (%)
ELEV DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE			"N" VALUES	STANDARD ● DYN. CONE ○					
233.46	Ground Surface												
0.00 233.08 0.38	FILL - 380mm sand and gravel (shoulder gravel)		1	AUGER									38 39 (23)
	FILL Brown, moist, loose, consisting of silty clay with embedded sand and gravel, trace organics.		2	SS	7							21.3	16 23 39 22 (61)
			3	SS	10								
231.33 2.13			4	SS	9								
	Silty CLAY TILL (CL) Brown, moist, with embedded sand and gravel.	stiff											
			5	SS	34								
229.19 4.27		hard	6	SS	34								
	End of borehole.												Borehole dry and open at completion.

JOE.MTO\_06-8-IEG2.GPJ ONTARIO.MOT.GDT\_09/26/07

+ 3, X 3: Numbers refer to Sensitivity

○ 150 UNCONFINED SHEAR STRENGTH INFERRED FROM POCKET PENETROMETER READINGS

**RECORD OF BOREHOLE No C16-1**

1 OF 1

**METRIC**

W.P. GWP 408-94-00 LOCATION Culvert No. 16 Northing - 4900895, Easting - 379730 ORIGINATED BY RB  
 DIST Owen Sound HWY 21 BOREHOLE TYPE 100mm SST Auger COMPILED BY JL  
 DATUM Geodetic DATE 9.20.06 - 9.20.06 CHECKED BY EC

SOIL PROFILE		SAMPLES			GROUND WATER CONDITIONS	ELEVATION SCALE	PENETR. RESISTANCE		PLASTIC LIMIT W <sub>p</sub>	NATURAL MOISTURE CONTENT w	LIQUID LIMIT W <sub>L</sub>	UNIT WEIGHT γ	REMARKS & GRAIN SIZE DISTRIBUTION (%)		
ELEV. DEPTH	DESCRIPTION	STRAT. PLOT	NUMBER	TYPE			"N" VALUES	STANDARD ●						DYN. CONE ○	UNCONFINED ○
232.08	Ground Surface														
0.00	TOPSOIL - 300mm.														
231.78	Silty CLAY TILL (CL) Brown, moist, with embedded sand and gravel.		1	SS	8		●								
0.30															
					2	SS	25		●		200			22.5	0 5 55 40 (95)
					3	SS	35		●		200				
					4	SS	44		●		200			23.6	2 15 52 31 (83)
			5	SS	25		●		125						
228.57	End of borehole.												Borehol dry and open at completion.		

JOE MTO 06-8-IEG2.GPJ ONTARIO.MOT.GDT 4/17/07

+ 3, × 3: Numbers refer to Sensitivity

○ 150 UNCONFINED SHEAR STRENGTH INFERRED FROM POCKET PENETROMETER READINGS

**RECORD OF BOREHOLE No C16-3**

1 OF 1

**METRIC**

W.P. GWP 408-94-00 LOCATION Culvert No. 16 Northing - 4900885, Easting - 379756 ORIGINATED BY RB  
 DIST Owen Sound HWY 21 BOREHOLE TYPE 100mm SST Auger COMPILED BY JL  
 DATUM Geodetic DATE 9.20.06 - 9.20.06 CHECKED BY EC

SOIL PROFILE		SAMPLES			GROUND WATER CONDITIONS	ELEVATION SCALE	PENETR. RESISTANCE		PLASTIC LIMIT W <sub>p</sub>	NATURAL MOISTURE CONTENT w	LIQUID LIMIT W <sub>L</sub>	UNIT WEIGHT γ	REMARKS & GRAIN SIZE DISTRIBUTION (%)
ELEV. DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE			"N" VALUES	STANDARD ●					
232.26 0.00	Ground Surface												
	FILL - 910m topsoil and topsoil fill.		1	SS	8								
231.35 0.91	Dark Brown some organics		2	SS	13								
	Silty CLAY TILL (CL) Brown, moist, stiff to hard, with embedded sand and gravel.		3	SS	53								
			4	SS	36								
			5	SS	28								
228.75 3.51	End of borehole.												Borehole dry and open at completion.

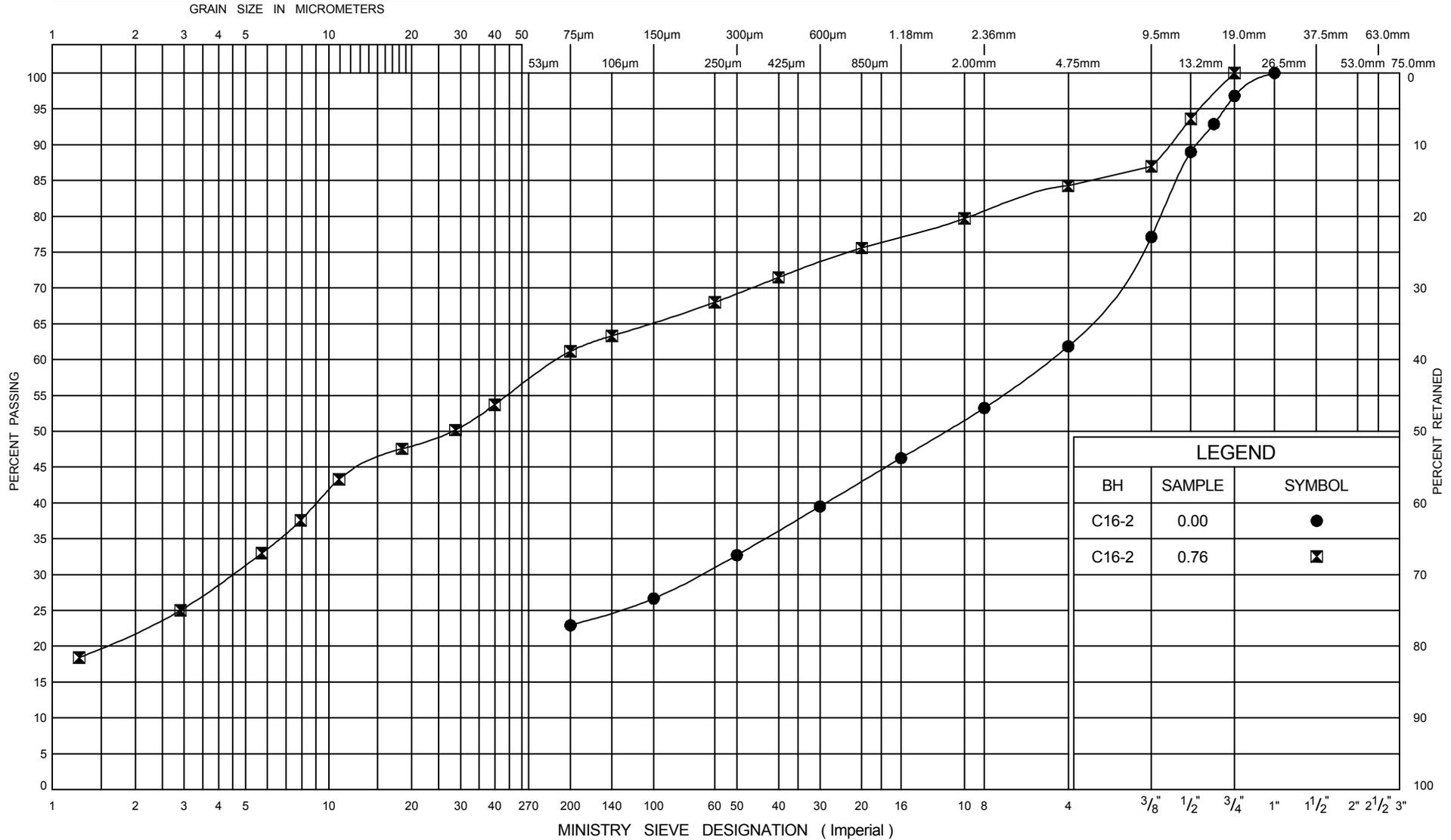
JOE MTO 06-8-IEG2.GPJ ONTARIO.MOT.GDT 4/17/07

+ 3, X 3: Numbers refer to Sensitivity

○ 150 UNCONFINED SHEAR STRENGTH INFERRED FROM POCKET PENETROMETER READINGS

### UNIFIED SOIL CLASSIFICATION SYSTEM

CLAY & SILT	SAND			GRAVEL	
	Fine	Medium	Coarse	Fine	Coarse



LEGEND		
BH	SAMPLE	SYMBOL
C16-2	0.00	●
C16-2	0.76	⊠

ONTARIO MOT GRAIN SIZE 06-8-1EG2.GPJ ONTARIO MOT.GDT 4/17/07

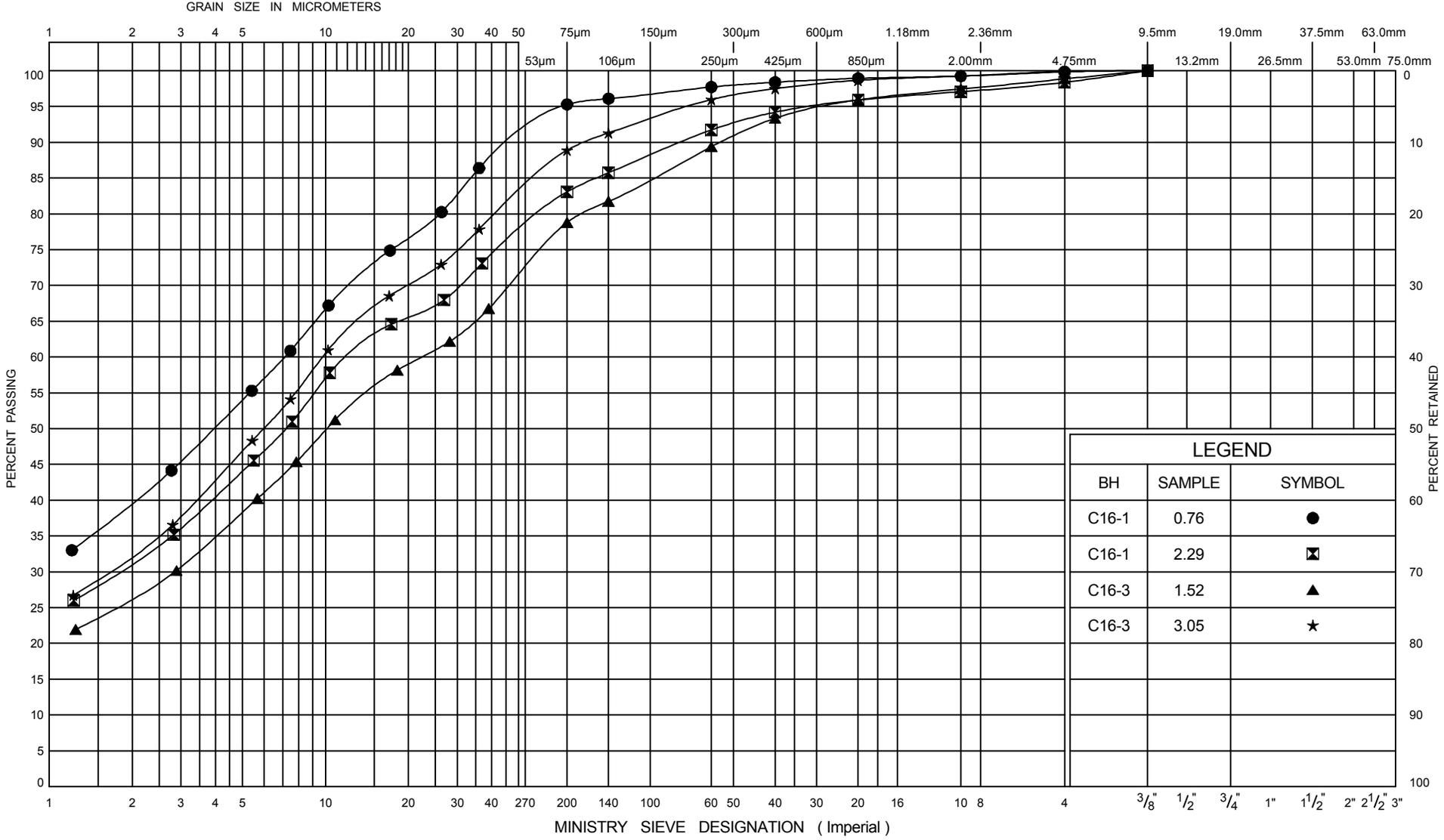


## GRAIN SIZE DISTRIBUTION FILL

FIG No C16-1  
GWP 408-94-00  
Highway 21-Kincardine to Tiverton

UNIFIED SOIL CLASSIFICATION SYSTEM

CLAY & SILT	SAND			GRAVEL	
	Fine	Medium	Coarse	Fine	Coarse



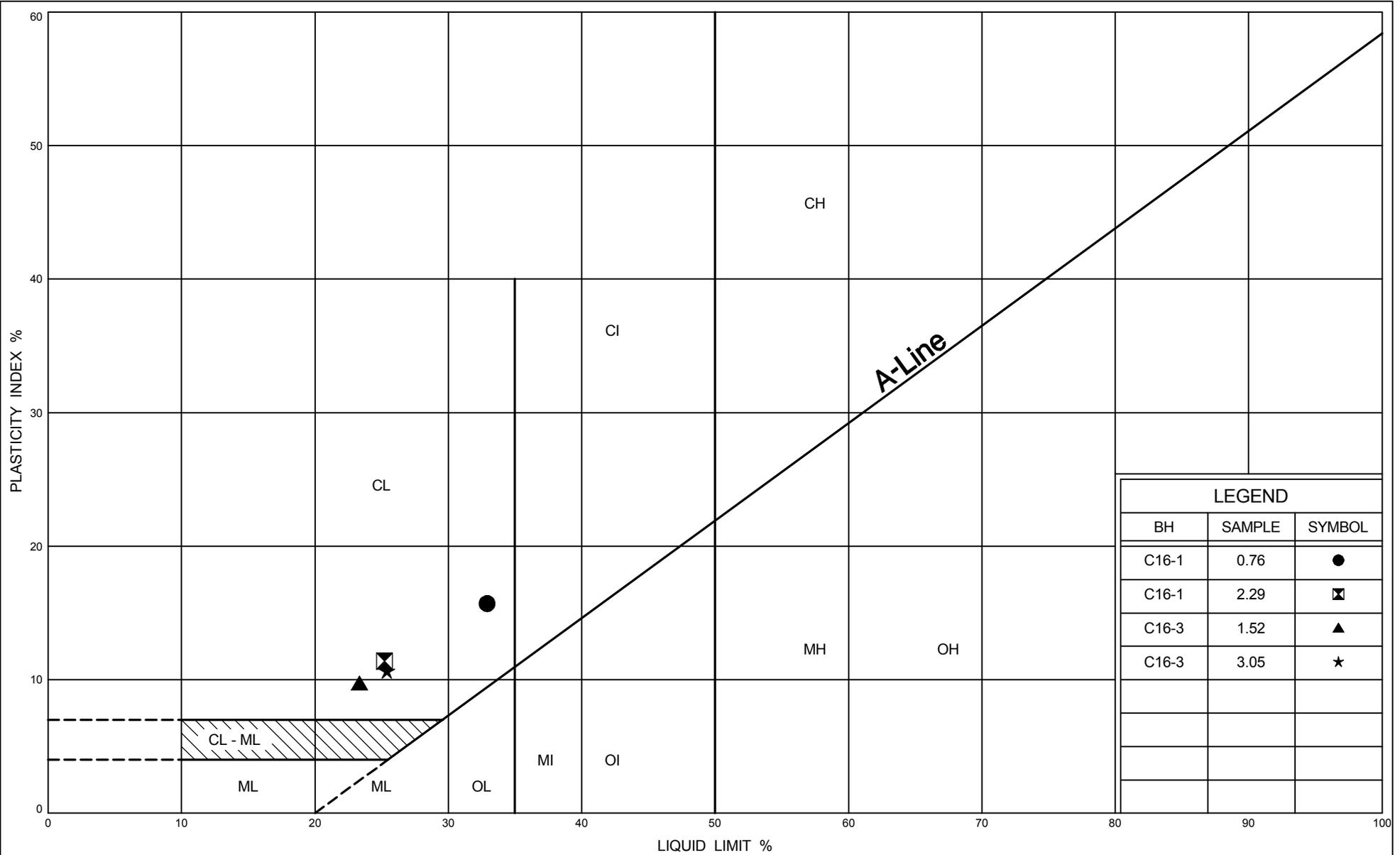
LEGEND		
BH	SAMPLE	SYMBOL
C16-1	0.76	●
C16-1	2.29	⊠
C16-3	1.52	▲
C16-3	3.05	★

ONTARIO MOT GRAIN SIZE 06-8-1EG2.GPJ ONTARIO MOT.GDT 4/17/07



GRAIN SIZE DISTRIBUTION  
SILTY CLAY TILL (CL)

FIG No C16-2  
GWP 408-94-00  
Highway 21-Kincardine to Tiverton



LEGEND		
BH	SAMPLE	SYMBOL
C16-1	0.76	●
C16-1	2.29	⊠
C16-3	1.52	▲
C16-3	3.05	★

ONTARIO MOT PLASTICITY CHART\_06-8-1EG2.GPJ\_ONTARIO MOT.GDT\_4/17/07



**PLASTICITY CHART**  
**SILTY CLAY TILL (CL)**

FIG No C16-3  
GWP 408-94-00  
Highway 21-Kincardine to Tiverton

**RECORD OF BOREHOLE No C17-1**

1 OF 1

**METRIC**

W.P. GWP 408-94-00 LOCATION Culvert No. 17 Northing - 4901268, Easting - 379971 ORIGINATED BY RB  
 DIST Owen Sound HWY 21 BOREHOLE TYPE 100mm SST Auger COMPILED BY JL  
 DATUM Geodetic DATE 9.20.06 - 9.20.06 CHECKED BY EC

SOIL PROFILE		SAMPLES			GROUND WATER CONDITIONS	ELEVATION SCALE	PENETR. RESISTANCE		PLASTIC LIMIT W <sub>p</sub>	NATURAL MOISTURE CONTENT w	LIQUID LIMIT W <sub>L</sub>	UNIT WEIGHT γ	REMARKS & GRAIN SIZE DISTRIBUTION (%)
ELEV. DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE			"N" VALUES	STANDARD ●					
224.99	Ground Surface												
0.00	FILL Brown to black, moist, compact to very dense, Mixed FILL consisting of cobbles, gravel, sand, silt, silty clay and topsoil.  cobbles	[Hatched Pattern]	1	SS	13		●						1 17 47 35 (82)
224.23 0.76			2	SS	100+			●					
223.47 1.52	SAND (SP) Grey, saturated, compact, some silt, trace gravel.	[Dotted Pattern]	3	SS	18		●						
222.78 2.21	Clayey SILT to Silty CLAY TILL (CL-ML to CL) Grey, moist, hard, with embedded sand and gravel.	[Diagonal Lines]	4	SS	33		●						
221.48 3.51			5	SS	92			●				21.9	7 24 49 20 (69)
221.48 3.51	End of borehole.												Water level measured at 1.5m at completion.

JOE MTO 06-8-IEG2.GPJ ONTARIO.MOT.GDT 4/17/07

+ 3, X 3: Numbers refer to Sensitivity

○ 150 UNCONFINED SHEAR STRENGTH INFERRED FROM POCKET PENETROMETER READINGS

**RECORD OF BOREHOLE No C17-2**

1 OF 1

**METRIC**

W.P. GWP 408-94-00 LOCATION Culvert No. 17 Northing - 4901284, Easting - 379961 ORIGINATED BY RB  
 DIST Owen Sound HWY 21 BOREHOLE TYPE 100mm SST Auger COMPILED BY JL  
 DATUM Geodetic DATE 9.20.06 - 9.20.06 CHECKED BY EC

SOIL PROFILE		SAMPLES			GROUND WATER CONDITIONS	ELEVATION SCALE	PENETR. RESISTANCE		PLASTIC LIMIT W <sub>p</sub>	NATURAL MOISTURE CONTENT w	LIQUID LIMIT W <sub>L</sub>	UNIT WEIGHT γ	REMARKS & GRAIN SIZE DISTRIBUTION (%)
ELEV. DEPTH	DESCRIPTION	NUMBER	TYPE	"N" VALUES			STANDARD ● DYN. CONE ○	SHEAR STRENGTH kPa					
230.94 0.00	Ground Surface												
	FILL Brown, moist, sand and gravel (shoulder gravel).  FILL Brown, moist, compact to very dense, consisting of silty clay, sand and gravel, asphalt pieces, trace to some organics.  saturated sand and gravel layer  Clayey SILT to Silty CLAY TILL (CL-ML to CL) Grey, moist, hard, with embedded sand and gravel.	1	AUGER									43 45 (12)	
230.03 0.91		2	SS	29		230							9 22 46 23 (69)
		3	SS	17		229							
		4	SS	20		228							
		5	SS	49		227							30 30 27 13 (40)
		6	SS	28		226							
		7	SS	35		225							
		8	SS	47		224							33 43 17 7 (24)
		9	SS	15		223							
223.02 7.92		10	SS	121/300		222							
		11	SS	43		221							
		12	SS	135/300									
		13	SS	100/300									
		14	SS	59									
220.58 10.36	End of borehole.												Water level measured at 6.7m at completion.

JOE MTO 06-8-IEG2.GPJ ONTARIO MOT.GDT 4/17/07

+<sup>3</sup>, ×<sup>3</sup>: Numbers refer to Sensitivity

○ 150 UNCONFINED SHEAR STRENGTH INFERRED FROM POCKET PENETROMETER READINGS

**RECORD OF BOREHOLE No C17-3**

1 OF 1

**METRIC**

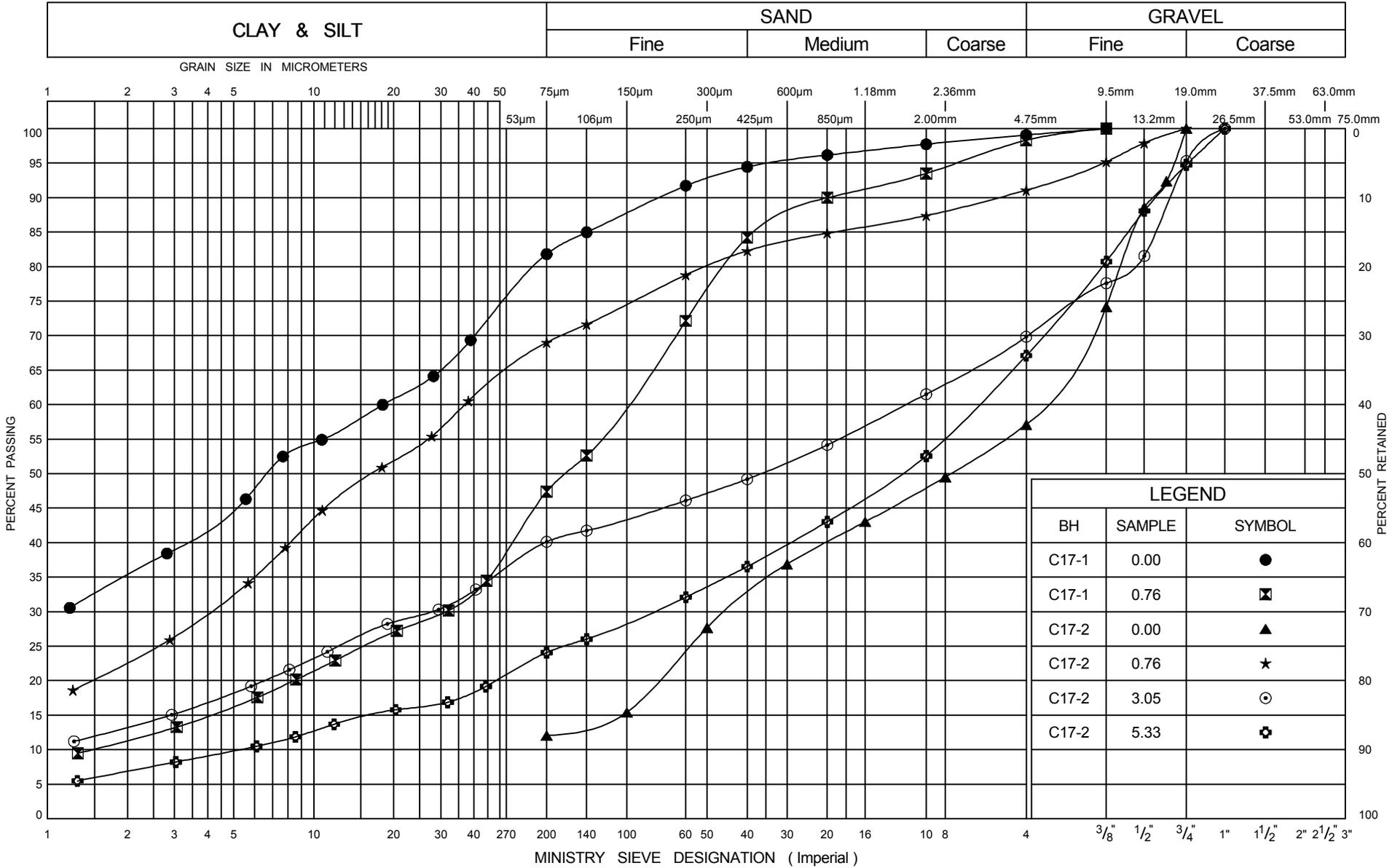
W.P. GWP 408-94-00 LOCATION Culvert No. 17 Northing - 4901293, Easting - 379936 ORIGINATED BY RB  
 DIST Owen Sound HWY 21 BOREHOLE TYPE 100mm SST Auger COMPILED BY JL  
 DATUM Geodetic DATE 9.20.06 - 9.20.06 CHECKED BY EC

SOIL PROFILE		SAMPLES			GROUND WATER CONDITIONS	ELEVATION SCALE	PENETR. RESISTANCE					PLASTIC NATURAL LIQUID			UNIT WEIGHT	REMARKS & GRAIN SIZE DISTRIBUTION (%)	
ELEV. DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE			"N" VALUES	STANDARD	DYN. CONE	PLASTIC LIMIT	NATURAL MOISTURE CONTENT	LIQUID LIMIT	W <sub>p</sub>	w			W <sub>L</sub>
							SHEAR STRENGTH kPa					WATER CONTENT (%)					
							20	40	60	80	100						
							○ UNCONFINED	+	FIELD VANE								
							● QUICK TRIAXIAL	×	LAB VANE								
							20	40	60	80	100	10	20	30			
224.97 0.00	Ground Surface																
	FILL Brown to grey, moist to wet, loose to compact, consisting of clayey silt to silty clay, trace organics.		1	SS	16												
			2	SS	7		224										
			3	SS	8		223										
222.84 2.13	Clayey SILT to Silty CLAY TILL (CL-ML to CL) Grey, moist, very stiff, with embedded sand and gravel.		4	SS	15						150						
			5	SS	26		222					150			25.4	10 25 49 17 (65)	
221.46 3.51	End of borehole.															Water level measured at 2.7m at completion.	

JOE MTO 06-8-IEG2.GPJ ONTARIO.MOT.GDT 4/17/07

+ 3, X 3: Numbers refer to Sensitivity      ○ 150 UNCONFINED SHEAR STRENGTH INFERRED FROM POCKET PENETROMETER READINGS

### UNIFIED SOIL CLASSIFICATION SYSTEM



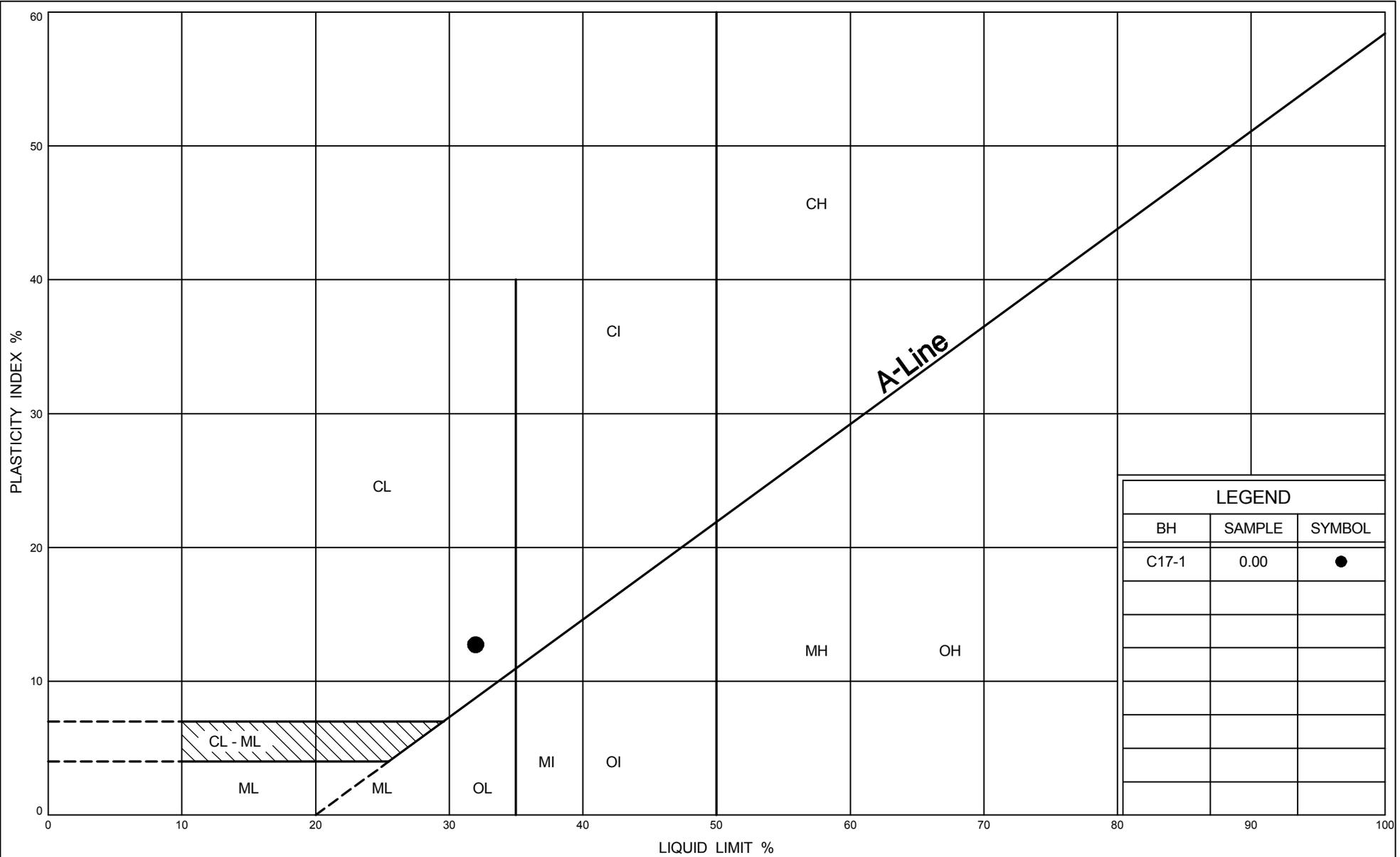
LEGEND		
BH	SAMPLE	SYMBOL
C17-1	0.00	●
C17-1	0.76	⊠
C17-2	0.00	▲
C17-2	0.76	★
C17-2	3.05	⊙
C17-2	5.33	⊕

ONTARIO MOT GRAIN SIZE 06-8-1EG2.GPJ ONTARIO MOT.GDT 4/17/07



## GRAIN SIZE DISTRIBUTION FILL

FIG No C17-1  
GWP 408-94-00  
Highway 21-Kincardine to Tiverton



LEGEND		
BH	SAMPLE	SYMBOL
C17-1	0.00	●

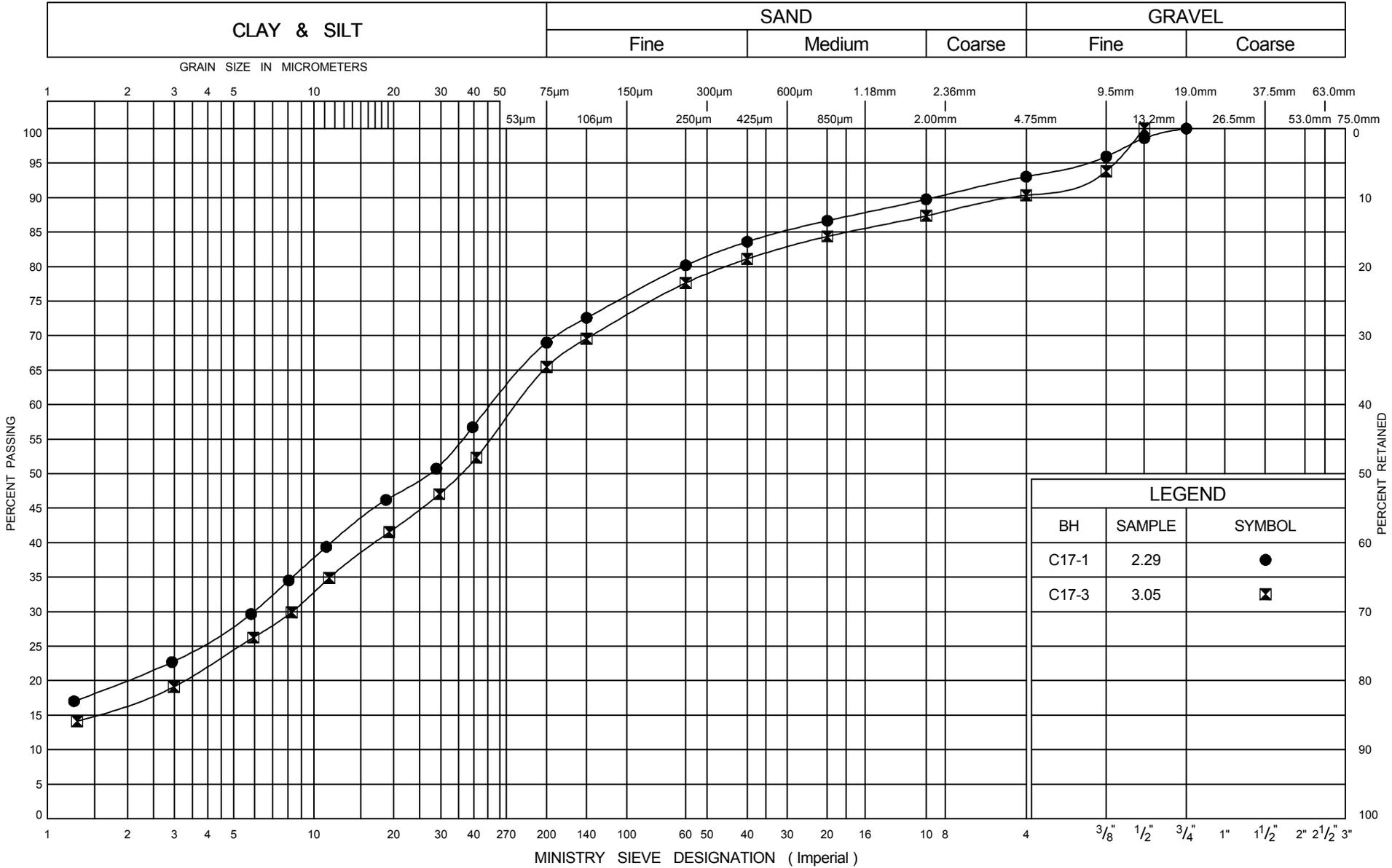
ONTARIO MOT PLASTICITY CHART\_06-8-1EG2.GPJ\_ONTARIO MOT.GDT\_4/17/07



## PLASTICITY CHART FILL

FIG No C17-2  
GWP 408-94-00  
Highway 21-Kincardine to Tiverton

### UNIFIED SOIL CLASSIFICATION SYSTEM



ONTARIO MOT GRAIN SIZE 06-8-1EG2.GPJ ONTARIO MOT.GDT 4/17/07



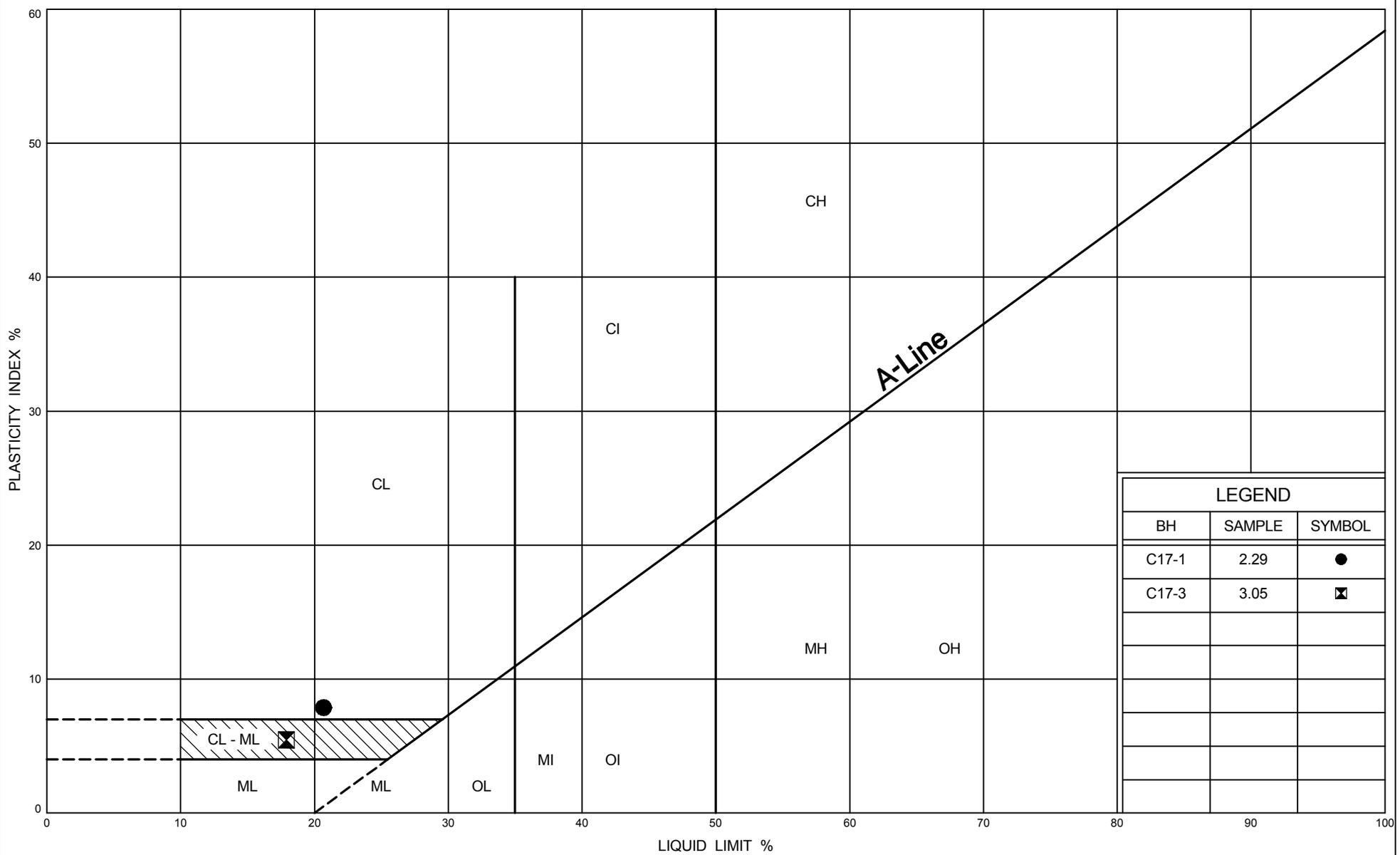
## GRAIN SIZE DISTRIBUTION

### CLAYEY SILT TO SILTY CLAY TILL (CL-ML TO CL)

FIG No C17-3

GWP 408-94-00

Highway 21-Kincardine to Tiverton



LEGEND		
BH	SAMPLE	SYMBOL
C17-1	2.29	●
C17-3	3.05	⊠

ONTARIO MOT PLASTICITY CHART\_06-8-1EG2.GPJ\_ONTARIO MOT.GDT\_4/17/07



PLASTICITY CHART  
CLAYEY SILT TO SILTY CLAY TILL (CL-ML TO CL)

FIG No C17-4  
GWP 408-94-00  
Highway 21-Kincardine to Tiverton



**RECORD OF BOREHOLE No C18-2**

1 OF 1

**METRIC**

W.P. GWP 408-94-00 LOCATION Culvert No. 18 Northing - 4902084, Easting - 380402 ORIGINATED BY RB  
 DIST Owen Sound HWY 21 BOREHOLE TYPE 100mm SST Auger COMPILED BY JL  
 DATUM Geodetic DATE 9.21.06 - 9.21.06 CHECKED BY EC

SOIL PROFILE		SAMPLES			GROUND WATER CONDITIONS	ELEVATION SCALE	PENETR. RESISTANCE					PLASTIC NATURAL LIQUID			UNIT WEIGHT $\gamma$ kN/m <sup>3</sup>	REMARKS & GRAIN SIZE DISTRIBUTION (%)
ELEV. DEPTH	DESCRIPTION	STRAT. PLOT	NUMBER	TYPE			"N" VALUES	STANDARD	DYN. CONE	W <sub>p</sub>	W	W <sub>L</sub>	WATER CONTENT (%)	GR		
232.71	Ground Surface															
0.00	TOPSOIL - 200mm.		1	SS	8											5 18 47 30 (77)
	Silty CLAY TILL (CI) Brown, moist, stiff, with embedded sand and gravel.		2	SS	11											
231.34																
1.37	Sandy SILT (ML) Brown, moist, dense.		3	SS	37											0 41 52 7 (59)
230.12																
2.59	Clayey SILT TILL (CL-ML) Grey, moist, hard, with embedded sand and gravel.		4	SS	33											
229.20																
3.51	End of borehole.		5	SS	40								25.1			2 21 55 23 (77)
																Borehole dry and open at completion.

JOE MTO 06-8-IEG2.GPJ ONTARIO.MOT.GDT 4/17/07

+ 3, X 3: Numbers refer to Sensitivity      ○ 150 UNCONFINED SHEAR STRENGTH INFERRED FROM POCKET PENETROMETER READINGS

**RECORD OF BOREHOLE No C18-3**

1 OF 1

**METRIC**

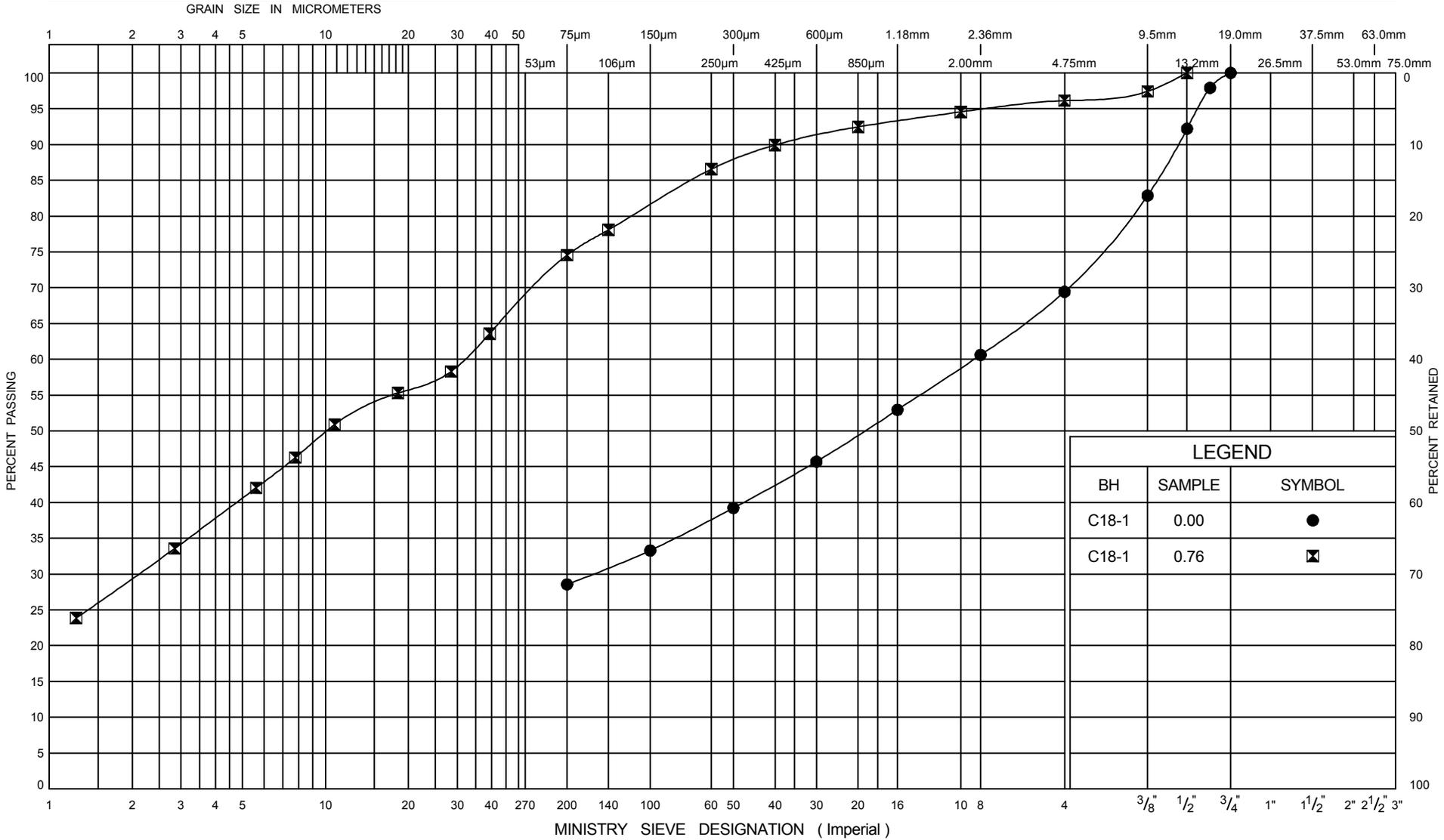
W.P. GWP 408-94-00 LOCATION Culvert No. 18 Northing - 4902096, Easting - 380383 ORIGINATED BY RB  
 DIST Owen Sound HWY 21 BOREHOLE TYPE 100mm SST Auger COMPILED BY JL  
 DATUM Geodetic DATE 9.21.06 - 9.21.06 CHECKED BY EC

SOIL PROFILE		SAMPLES			GROUND WATER CONDITIONS	ELEVATION SCALE	PENETR. RESISTANCE					PLASTIC NATURAL LIQUID			UNIT WEIGHT	REMARKS & GRAIN SIZE DISTRIBUTION (%)	
ELEV. DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE			"N" VALUES	STANDARD	DYN. CONE	W <sub>p</sub>	MOISTURE CONTENT	W <sub>L</sub>	W	W <sub>p</sub>			W
232.48	Ground Surface																
0.00																	
232.18	TOPSOIL - 300mm.																
0.30			1	SS	10												1 16 51 32 (83)
	Silty CLAY TILL (CI) Brown, moist, stiff, with embedded sand and gravel.																
231.34			2	SS	12												
1.14																	
	SILT to Sandy SILT (ML) Brown, moist to saturated, compact to dense, occasional silty clay partings.																0 14 72 14 (86)
228.97			3	SS	25												
1.14																	
			4	SS	39												
			5	SS	22												
228.97	End of borehole.																
3.51																	Water level measured at 2.1m at completion.

JOE MTO 06-8-IEG2.GPJ ONTARIO.MOT.GDT 4/17/07

### UNIFIED SOIL CLASSIFICATION SYSTEM

CLAY & SILT	SAND			GRAVEL	
	Fine	Medium	Coarse	Fine	Coarse



LEGEND		
BH	SAMPLE	SYMBOL
C18-1	0.00	●
C18-1	0.76	⊠

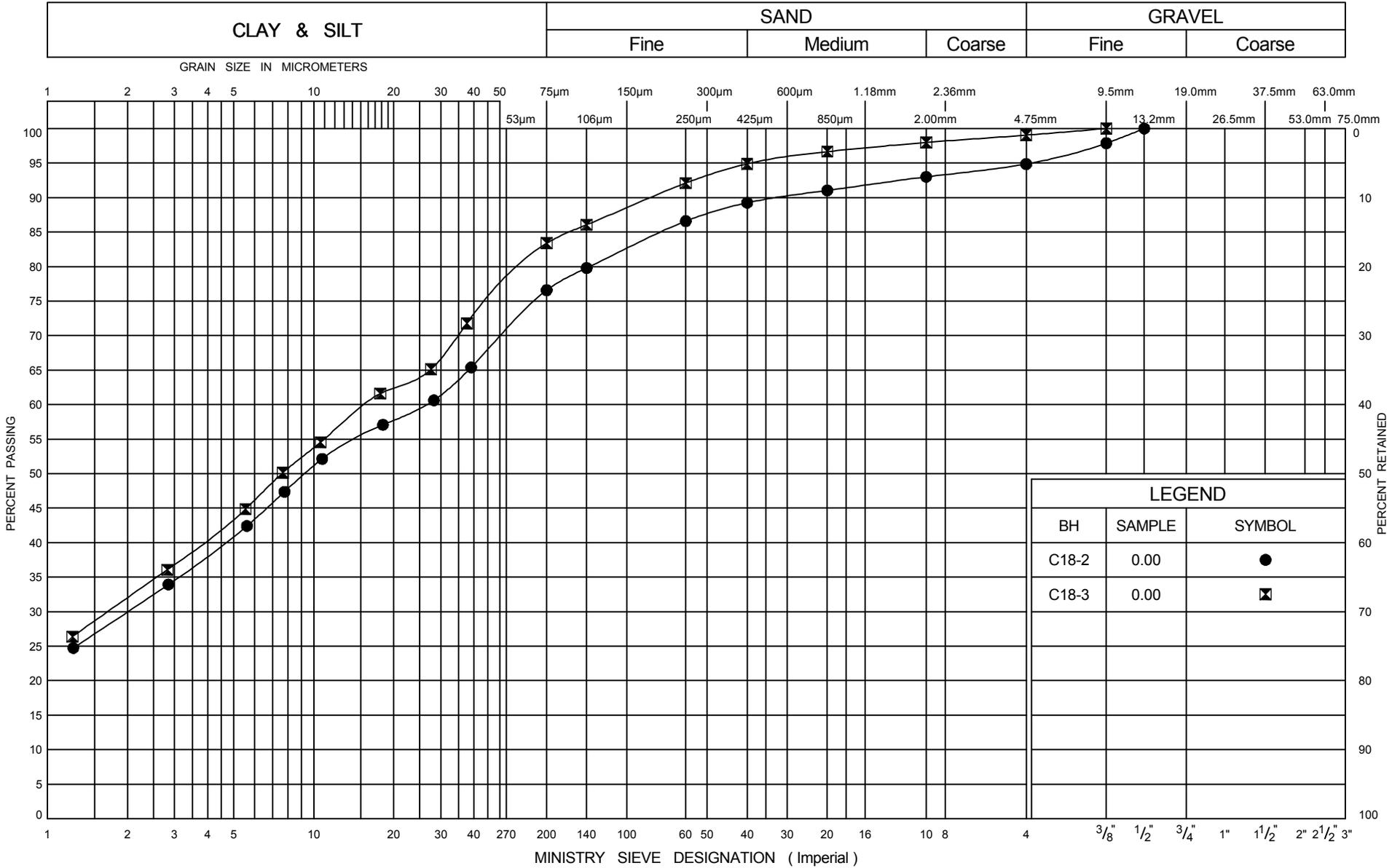
ONTARIO MOT GRAIN SIZE 06-8-1EG2.GPJ ONTARIO MOT.GDT 4/17/07



## GRAIN SIZE DISTRIBUTION FILL

FIG No C18-1  
GWP 408-94-00  
Highway 21-Kincardine to Tiverton

### UNIFIED SOIL CLASSIFICATION SYSTEM



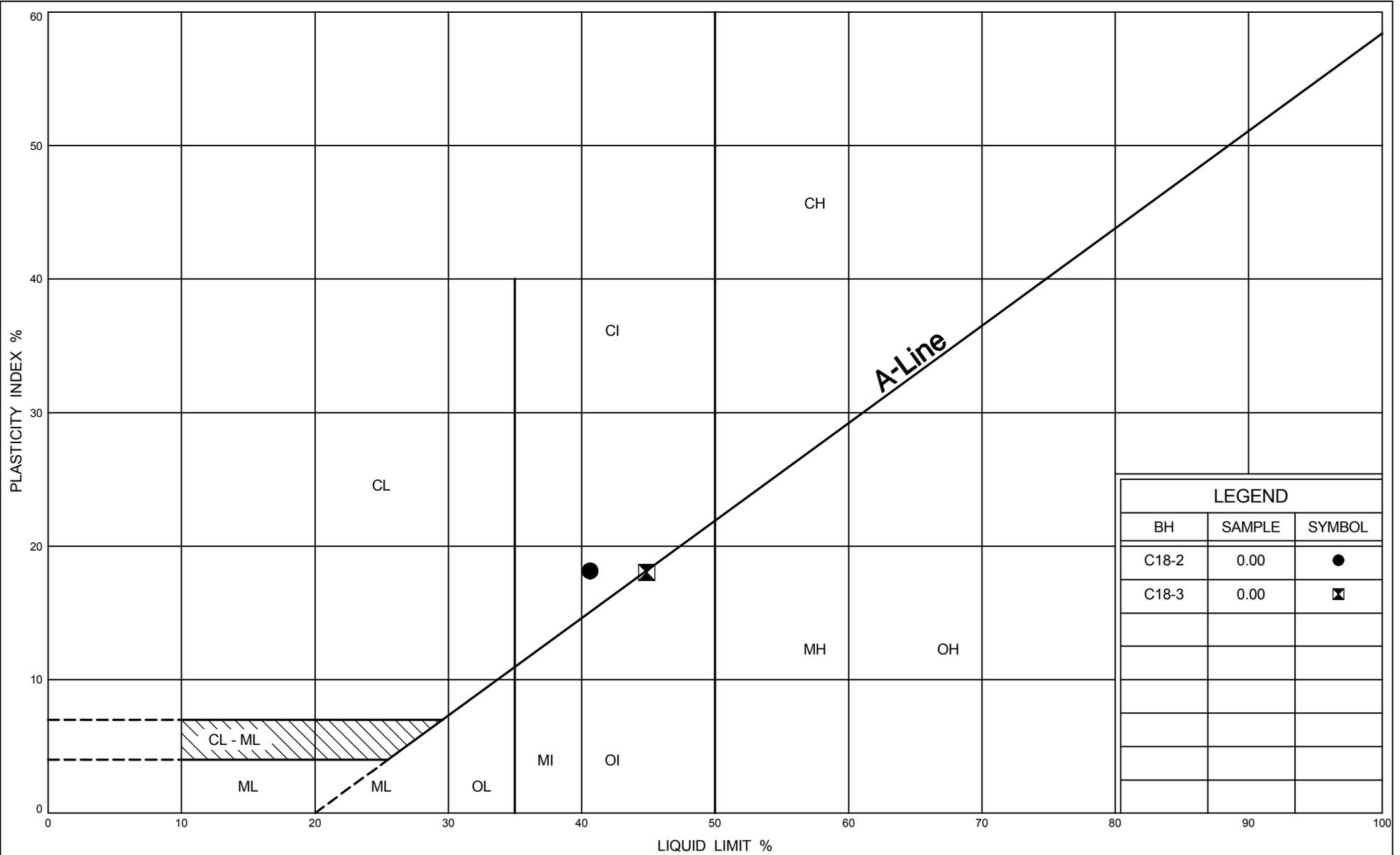
LEGEND		
BH	SAMPLE	SYMBOL
C18-2	0.00	●
C18-3	0.00	⊠

ONTARIO MOT GRAIN SIZE 06-8-1EG2.GPJ ONTARIO MOT.GDT 4/17/07



**GRAIN SIZE DISTRIBUTION**  
**SILTY CLAY TILL (CI)**

FIG No C18-2  
GWP 408-94-00  
Highway 21-Kincardine to Tiverton



LEGEND		
BH	SAMPLE	SYMBOL
C18-2	0.00	●
C18-3	0.00	⊠

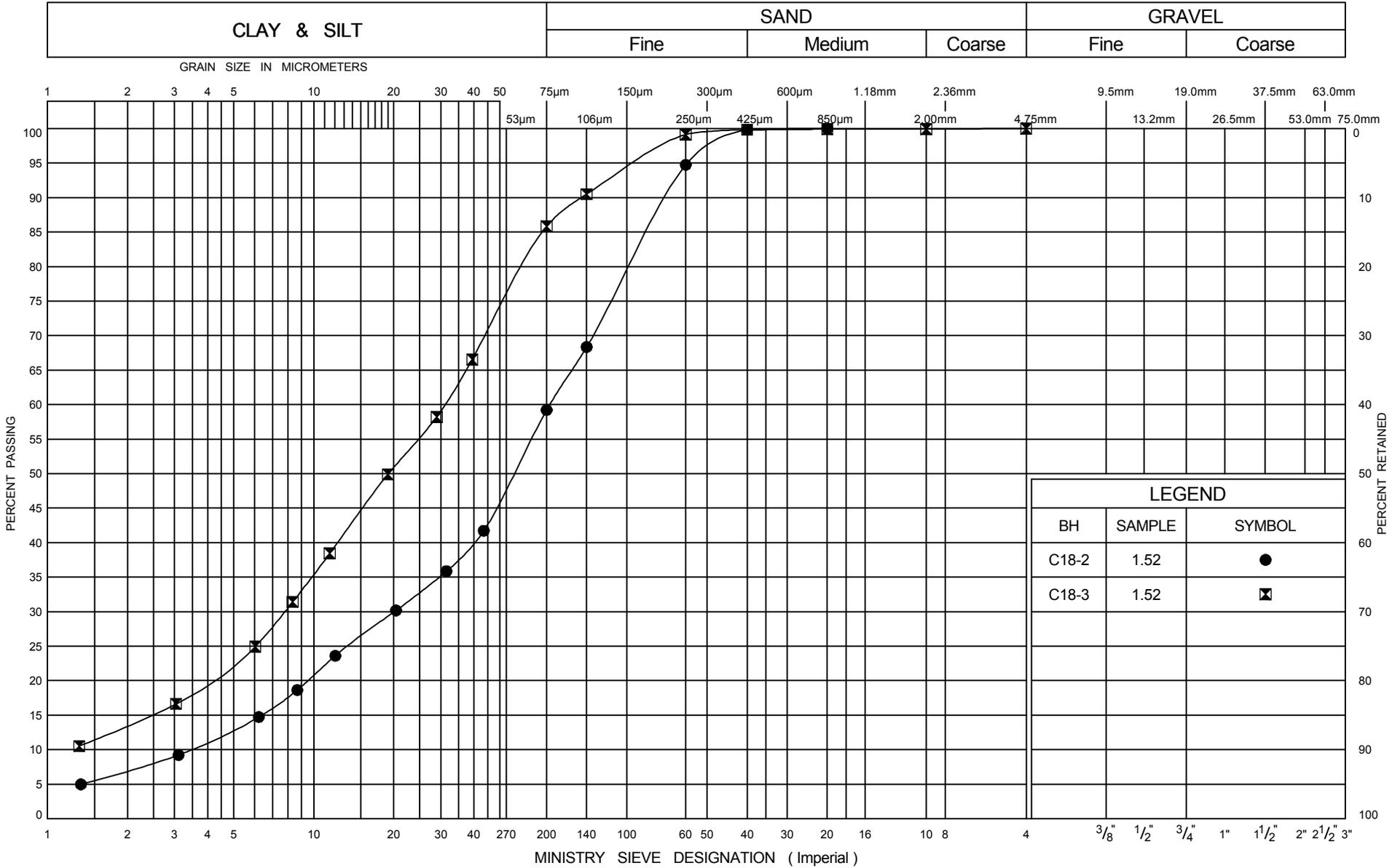
ONTARIO MOT PLASTICITY CHART\_06-8-1EG2.GPJ\_ONTARIO MOT.GDT\_4/17/07



PLASTICITY CHART  
SILTY CLAY TILL (CI)

FIG No C18-3  
GWP 408-94-00  
Highway 21-Kincardine to Tiverton

### UNIFIED SOIL CLASSIFICATION SYSTEM



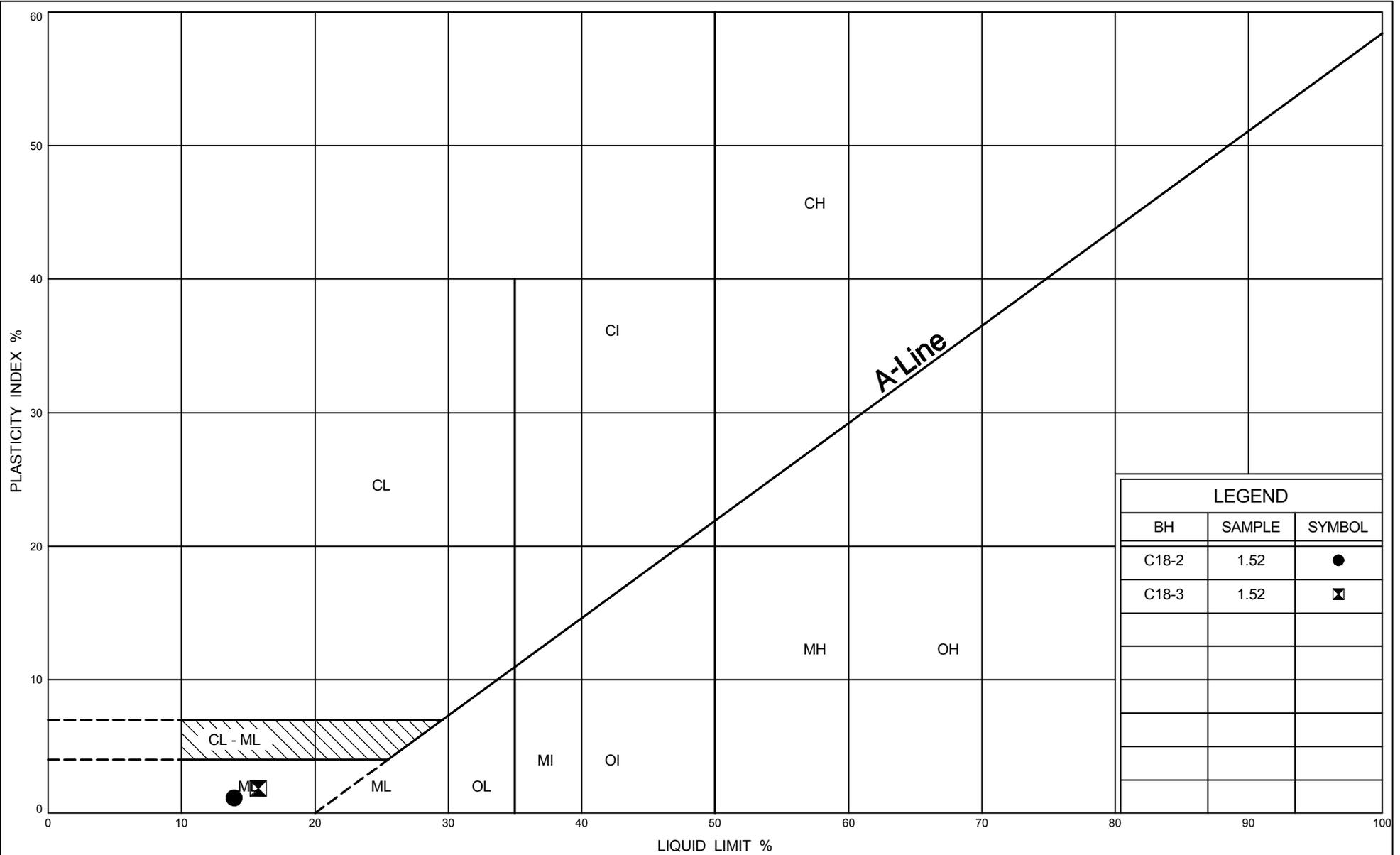
LEGEND		
BH	SAMPLE	SYMBOL
C18-2	1.52	●
C18-3	1.52	⊠

ONTARIO MOT GRAIN SIZE 06-8-1EG2.GPJ ONTARIO MOT.GDT 4/17/07



## GRAIN SIZE DISTRIBUTION SANDY SILT TO SILT (ML)

FIG No C18-4  
GWP 408-94-00  
Highway 21-Kincardine to Tiverton



LEGEND		
BH	SAMPLE	SYMBOL
C18-2	1.52	●
C18-3	1.52	⊠

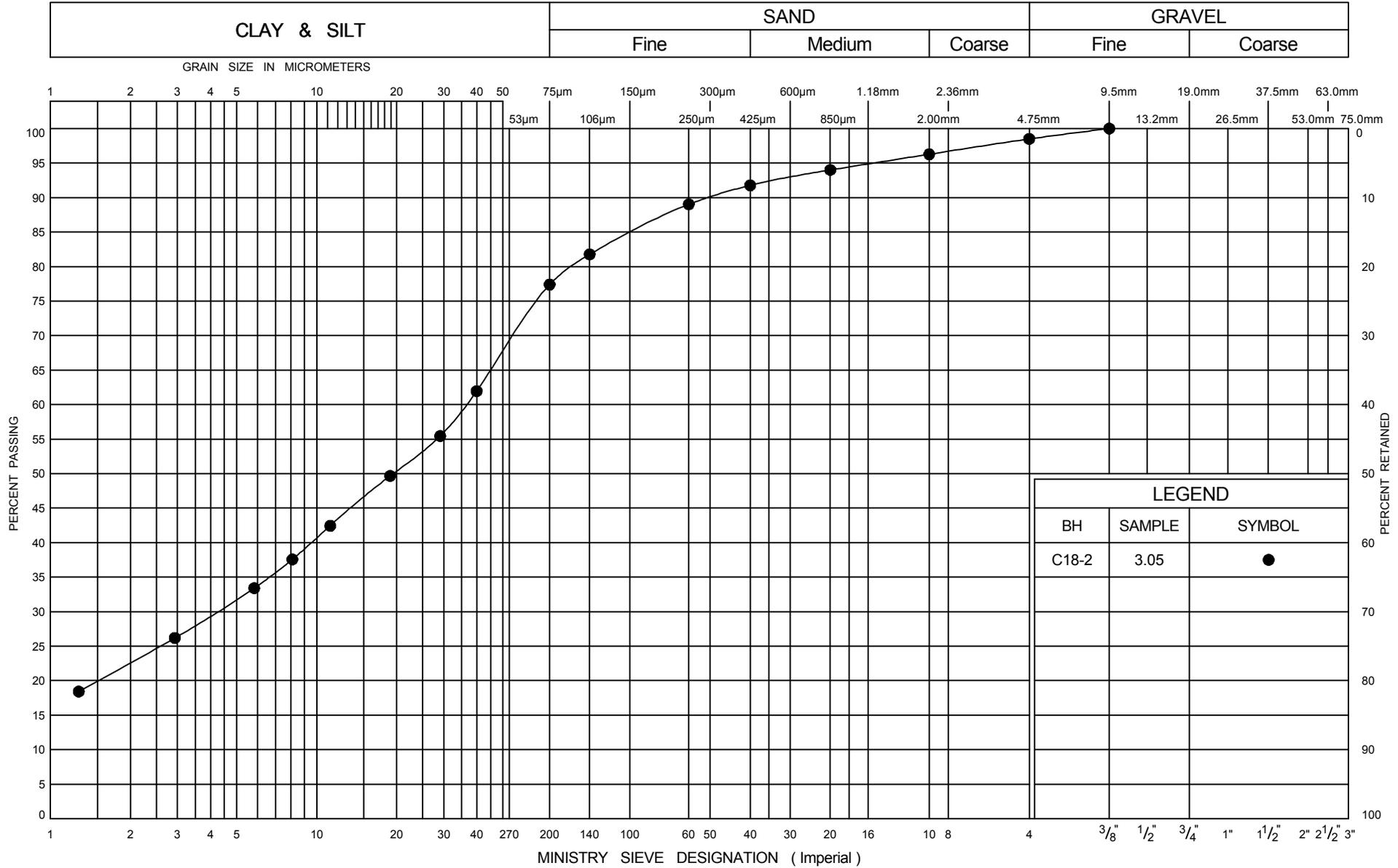
ONTARIO MOT PLASTICITY CHART\_06-8-1EG2.GPJ\_ONTARIO MOT.GDT\_4/17/07



**PLASTICITY CHART**  
**SILT TO SANDY SILT (ML)**

FIG No C18-5  
 GWP 408-94-00  
 Highway 21-Kincardine to Tiverton

### UNIFIED SOIL CLASSIFICATION SYSTEM

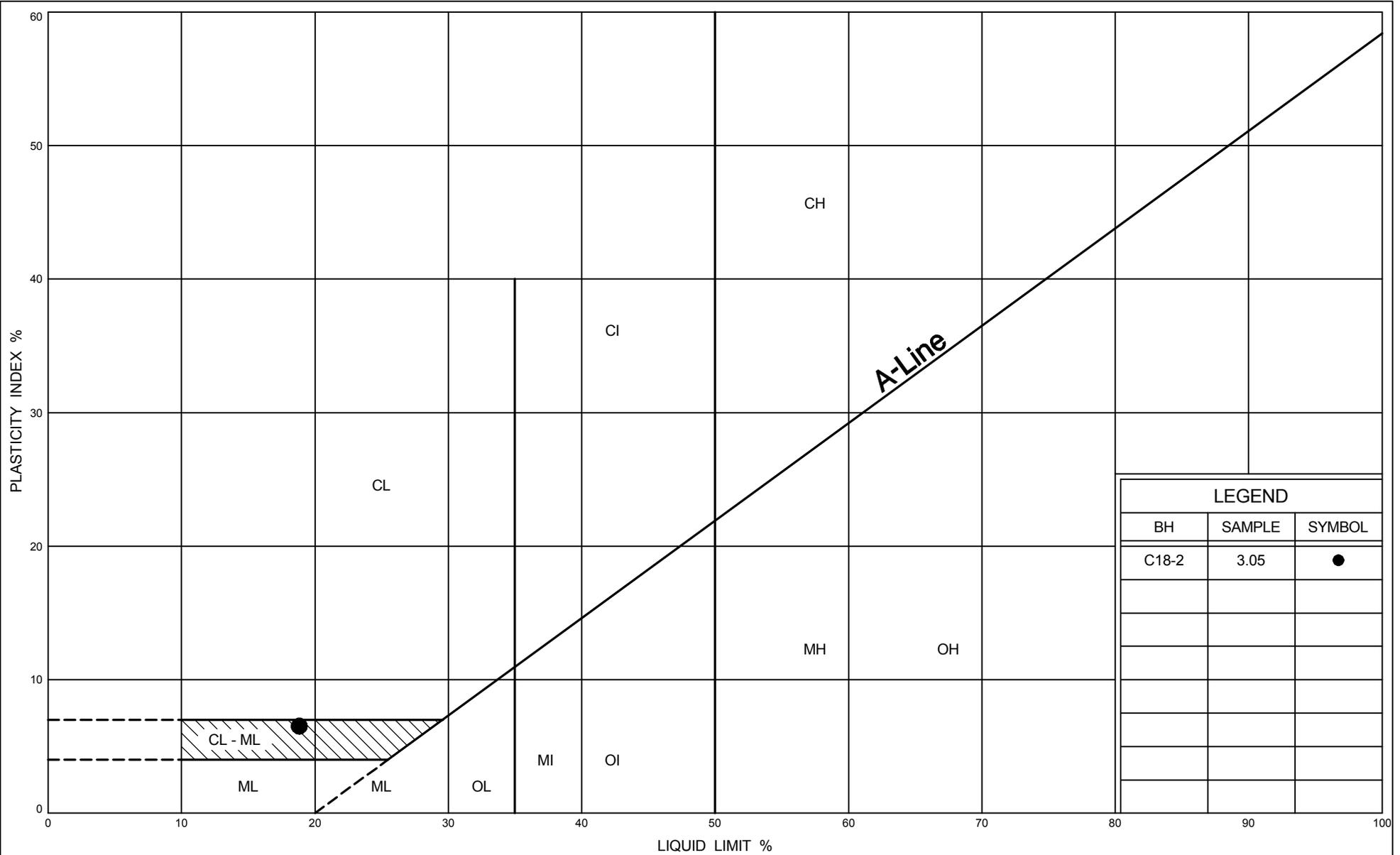


ONTARIO MOT GRAIN SIZE 06-8-1EG2.GPJ ONTARIO MOT.GDT 4/17/07



**GRAIN SIZE DISTRIBUTION**  
**CLAYEY SILT TILL (CL-ML)**

FIG No C18-6  
 GWP 408-94-00  
 Highway 21-Kincardine to Tiverton



ONTARIO MOT PLASTICITY CHART\_06-8-1EG2.GPJ\_ONTARIO MOT.GDT\_4/17/07



**PLASTICITY CHART**  
**CLAYEY SILT TILL (CL-ML)**

FIG No C18-7  
 GWP 408-94-00  
 Highway 21-Kincardine to Tiverton

**RECORD OF BOREHOLE No C19-1**

1 OF 1

**METRIC**

W.P. GWP 408-94-00 LOCATION Culvert No. 19 Northing - 4902189, Easting - 380460 ORIGINATED BY RB  
 DIST Owen Sound HWY 21 BOREHOLE TYPE 100mm SST Auger COMPILED BY JL  
 DATUM Geodetic DATE 9.21.06 - 9.21.06 CHECKED BY EC

SOIL PROFILE		SAMPLES			GROUND WATER CONDITIONS	ELEVATION SCALE	PENETR. RESISTANCE STANDARD ● DYN. CONE ○					PLASTIC NATURAL LIQUID LIMIT MOISTURE LIMIT CONTENT			UNIT WEIGHT $\gamma$ kN/m <sup>3</sup>	REMARKS & GRAIN SIZE DISTRIBUTION (%) GR SA SI CL	
ELEV DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE			"N" VALUES	SHEAR STRENGTH kPa					W <sub>p</sub>	W			W <sub>L</sub>
						○ UNCONFINED	● QUICK TRIAXIAL	+ FIELD VANE	× LAB VANE								
						20	40	60	80	100	20	40	60	80	100		
233.64	Ground Surface																
0.00	TOPSOIL - 610mm.		1	SS	8												
233.03	Silty Clay TILL (CL) Brown, moist, stiff, with embedded sand and gravel.  SILT to Sandy SILT (ML) Brown, moist to saturated, loose to dense, occasional silty clay partings.		2	SS	9												
232.50			3	SS	9												
1.14			4	SS	19												
			5	SS	37												
230.13			End of borehole.														
3.51																	

JOE MTO 06-8-IEG2.GPJ ONTARIO.MOT.GDT 4/17/07

**RECORD OF BOREHOLE No C19-2**

1 OF 1

**METRIC**

W.P. GWP 408-94-00 LOCATION Culvert No. 19 Northing - 4902191, Easting - 380453 ORIGINATED BY RB  
 DIST Owen Sound HWY 21 BOREHOLE TYPE 100mm SST Auger COMPILED BY JL  
 DATUM Geodetic DATE 9.21.06 - 9.21.06 CHECKED BY EC

SOIL PROFILE		SAMPLES			GROUND WATER CONDITIONS	ELEVATION SCALE	PENETR. RESISTANCE					PLASTIC NATURAL LIQUID			UNIT WEIGHT $\gamma$ kN/m <sup>3</sup>	REMARKS & GRAIN SIZE DISTRIBUTION (%) GR SA SI CL
ELEV. DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE			"N" VALUES	STANDARD	DYN. CONE	W <sub>p</sub>	MOISTURE CONTENT	W <sub>L</sub>	W	WATER CONTENT (%)		
234.92	Ground Surface															
0.00	FILL - 300mm sand and gravel (shoulder gravel).		1	AUGER												42 41 (17)
234.62																
0.30	FILL Brown, moist, compact, consisting of clayey silt to silty clay with embedded sand and gravel.		2	SS	20										20.4	2 15 54 29 (83)
233.24																
1.68	Buried TOPSOIL - 300mm.		3	SS	11											
232.94																
1.98	Silty Clay TILL (CL) Brown, moist, firm, with embedded sand and gravel.		4	SS	7											
231.87																
3.05	SILT to Sandy SILT (ML) Brown, moist to saturated, compact, occasional silty clay partings.		5	SS	14											
230.65																
4.27	End of borehole.		6	SS	23											Water level measured at 3.2m at completion.

JOE MTO 06-8-IEG2.GPJ ONTARIO.MOT.GDT 4/17/07

+ 3, X 3: Numbers refer to Sensitivity

○ 150 UNCONFINED SHEAR STRENGTH INFERRED FROM POCKET PENETROMETER READINGS

**RECORD OF BOREHOLE No C19-3**

1 OF 1

**METRIC**

W.P. GWP 408-94-00 LOCATION Culvert No. 19 Northing - 4902204, Easting - 380429 ORIGINATED BY RB  
 DIST Owen Sound HWY 21 BOREHOLE TYPE 100mm SST Auger COMPILED BY JL  
 DATUM Geodetic DATE 9.21.06 - 9.21.06 CHECKED BY EC

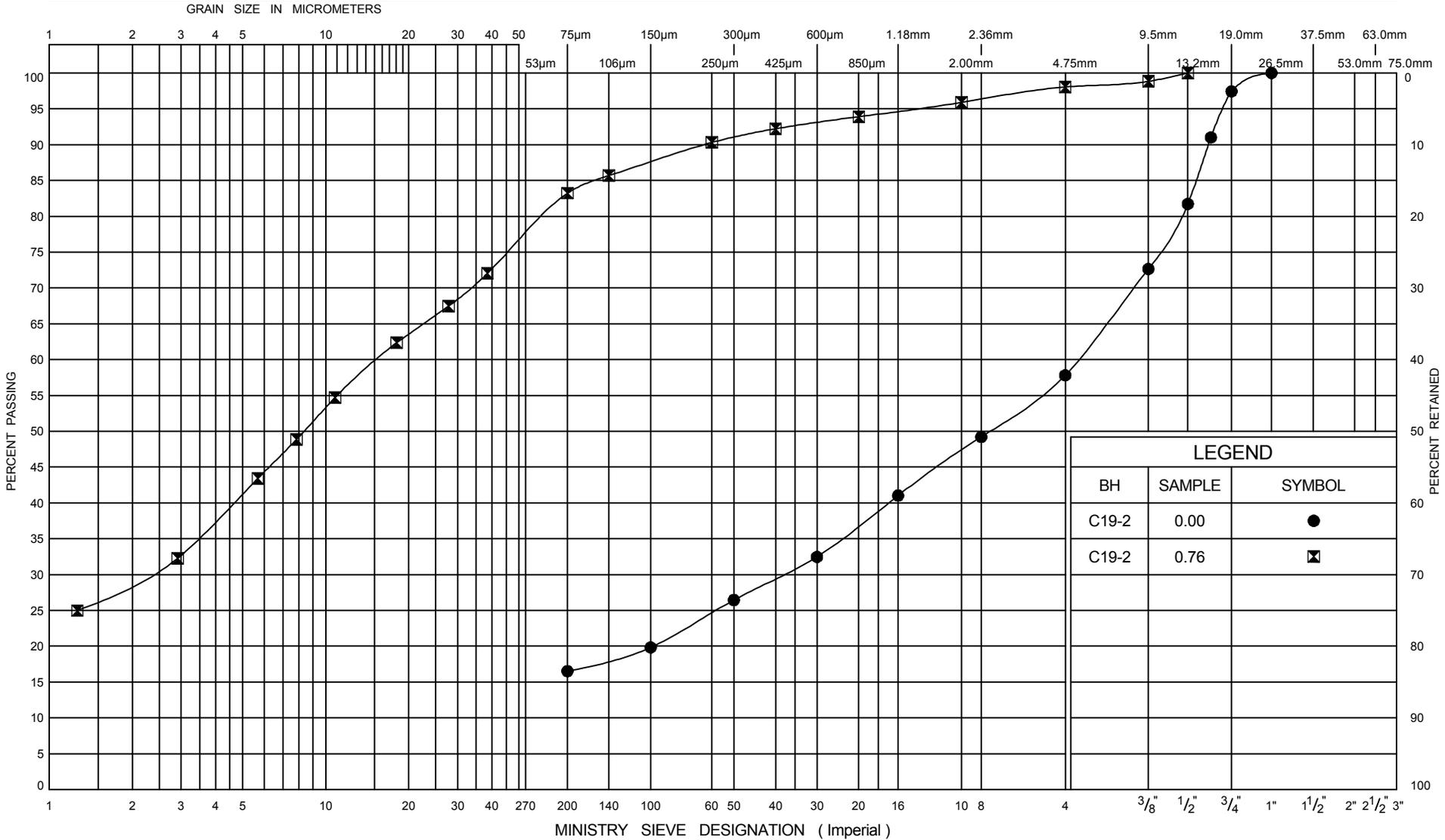
SOIL PROFILE		SAMPLES			GROUND WATER CONDITIONS	ELEVATION SCALE	PENETR. RESISTANCE		PLASTIC LIMIT W <sub>p</sub>	NATURAL MOISTURE CONTENT w	LIQUID LIMIT W <sub>L</sub>	UNIT WEIGHT γ	REMARKS & GRAIN SIZE DISTRIBUTION (%)
ELEV. DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE			"N" VALUES	STANDARD ●					
232.71	Ground Surface												
0.00													
232.41	TOPSOIL - 300mm.												
0.30													
	trace organics		1	SS	16								0 16 46 38 (84)
			2	SS	10			87.5					
	Silty Clay TILL (CL) Brown, moist, stiff to hard, with embedded sand and gravel, occasional fine sand partings.		3	SS	27				162.5			22.6	0 12 58 30 (88)
			4	SS	36				225+				
229.66													
3.05	wet silt layer		5	SS	15							23.3	0 14 64 22 (86)
229.20													
3.51	End of borehole.												Borehole dry and open at completion. spoon wet @ 3.05m.

JOE MTO 06-8-IEG2.GPJ ONTARIO.MOT.GDT 4/17/07

+ 3, X 3: Numbers refer to Sensitivity ○ 150 UNCONFINED SHEAR STRENGTH INFERRED FROM POCKET PENETROMETER READINGS

### UNIFIED SOIL CLASSIFICATION SYSTEM

CLAY & SILT	SAND			GRAVEL	
	Fine	Medium	Coarse	Fine	Coarse



LEGEND		
BH	SAMPLE	SYMBOL
C19-2	0.00	●
C19-2	0.76	⊠

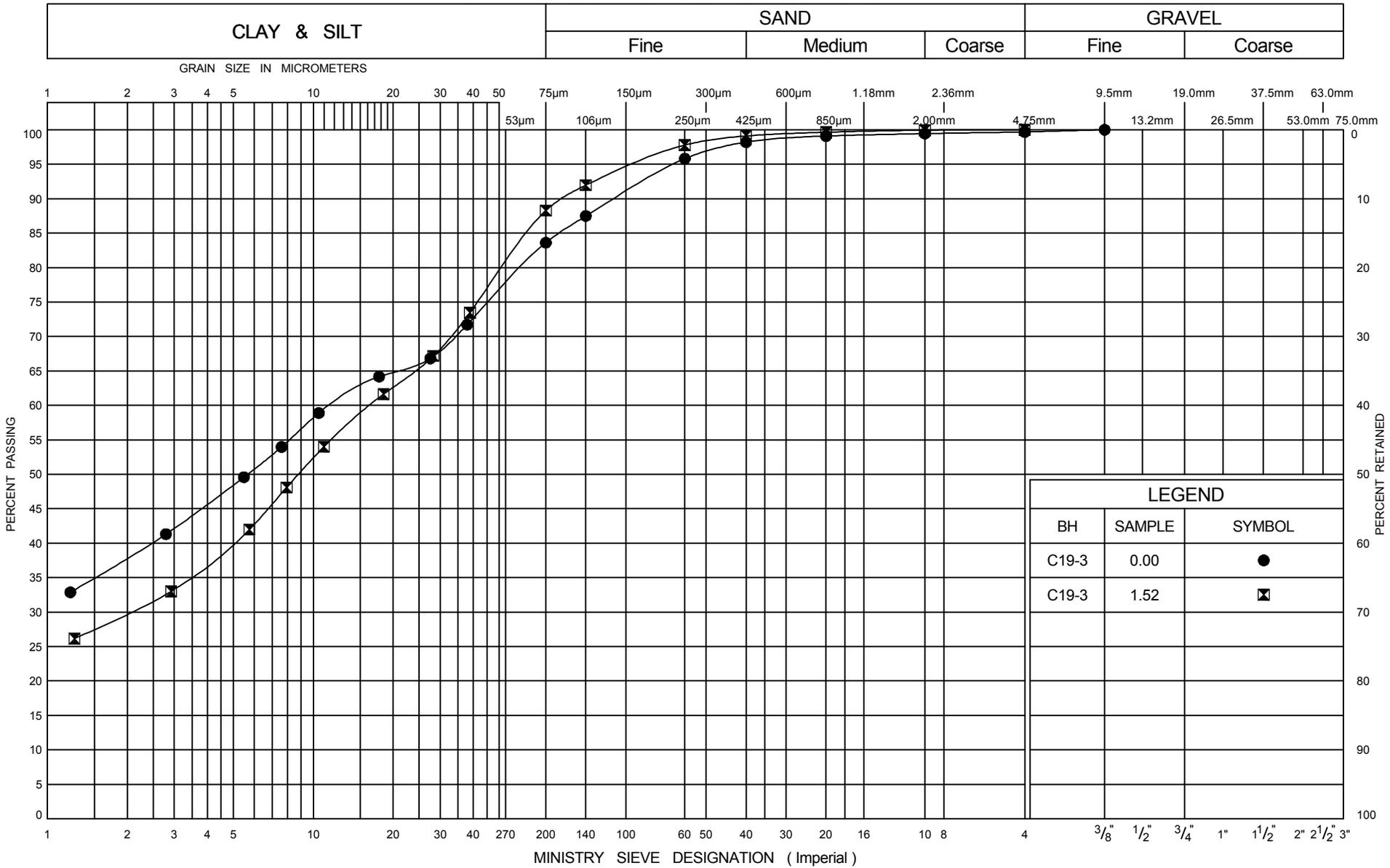
ONTARIO MOT GRAIN SIZE 06-8-1EG2.GPJ ONTARIO MOT.GDT 4/17/07



## GRAIN SIZE DISTRIBUTION

FIG No C19-1  
 GWP 408-94-00  
 Highway 21-Kincardine to Tiverton

UNIFIED SOIL CLASSIFICATION SYSTEM



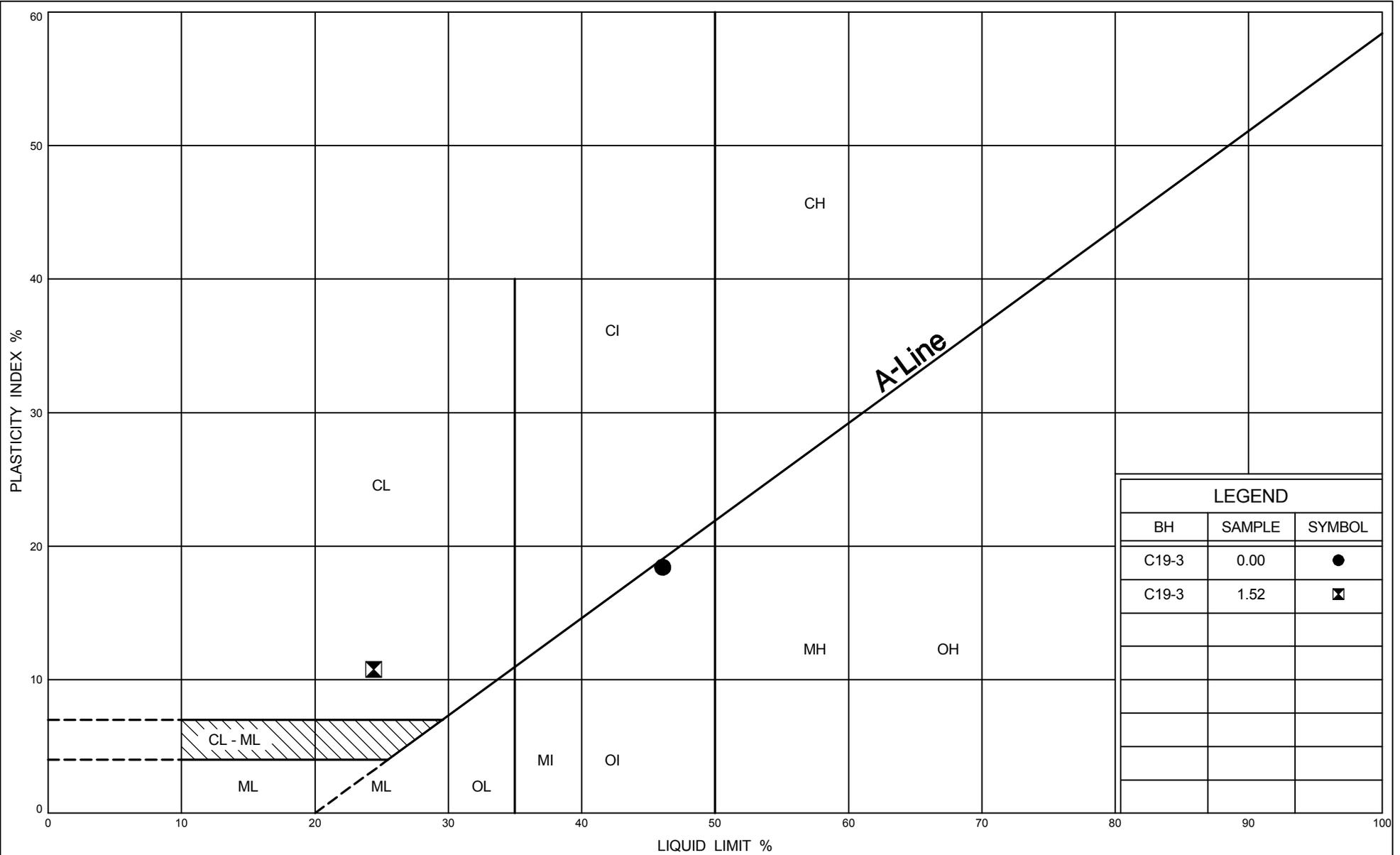
LEGEND		
BH	SAMPLE	SYMBOL
C19-3	0.00	●
C19-3	1.52	⊠

ONTARIO MOT GRAIN SIZE 06-8-1EG2.GPJ ONTARIO MOT.GDT 4/17/07



GRAIN SIZE DISTRIBUTION  
SILTY CLAY (CL TO CI)

FIG No C19-2  
GWP 408-94-00  
Highway 21-Kincardine to Tiverton



LEGEND		
BH	SAMPLE	SYMBOL
C19-3	0.00	●
C19-3	1.52	⊠

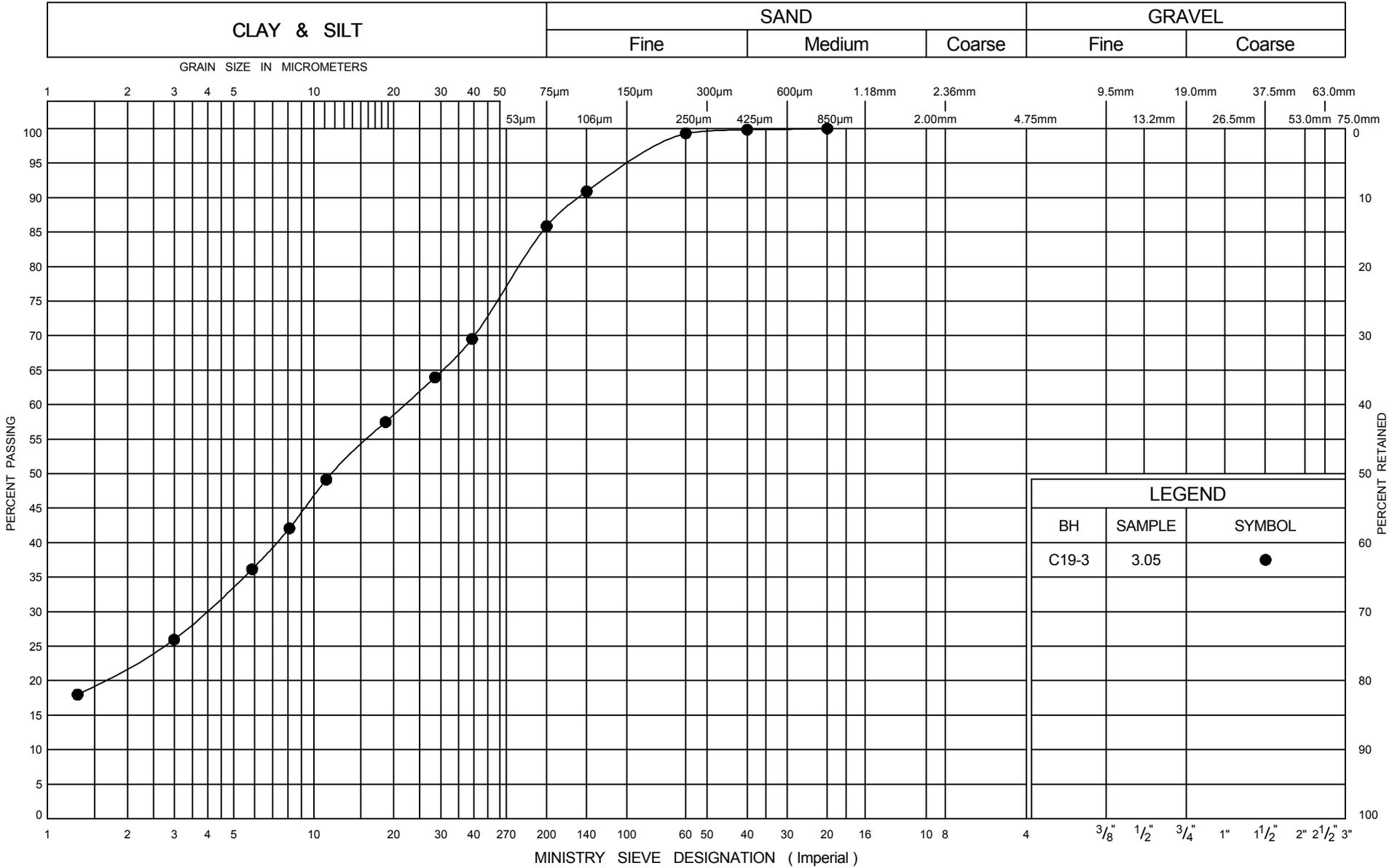
ONTARIO MOT PLASTICITY CHART\_06-8-1EG2.GPJ\_ONTARIO MOT.GDT\_4/17/07



**PLASTICITY CHART**  
**SILTY CLAY TILL (CL TO CI)**

FIG No C19-3  
GWP 408-94-00  
Highway 21-Kincardine to Tiverton

### UNIFIED SOIL CLASSIFICATION SYSTEM



ONTARIO MOT GRAIN SIZE 06-8-1EG2.GPJ ONTARIO MOT.GDT 4/17/07



## GRAIN SIZE DISTRIBUTION SILT (ML)

FIG No C19-4  
GWP 408-94-00  
Highway 21-Kincardine to Tiverton



**RECORD OF BOREHOLE No C20-2**

1 OF 1

**METRIC**

W.P. GWP 408-94-00 LOCATION Culvert No. 20 Northing - 4902296, Easting - 380497 ORIGINATED BY RB  
 DIST Owen Sound HWY 21 BOREHOLE TYPE 100mm SST Auger COMPILED BY JL  
 DATUM Geodetic DATE 9.21.06 - 9.21.06 CHECKED BY EC

SOIL PROFILE		SAMPLES			GROUND WATER CONDITIONS	ELEVATION SCALE	PENETR. RESISTANCE					PLASTIC NATURAL LIQUID			UNIT WEIGHT	REMARKS & GRAIN SIZE DISTRIBUTION (%)	
ELEV. DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE			"N" VALUES	STANDARD ●	DYN. CONE ○	W <sub>p</sub>	W	W <sub>L</sub>	WATER CONTENT (%)	γ			GR
235.98	Ground Surface																
0.00	FILL - 300mm sand and gravel (shoulder gravel)		1	AUGER													56 34 (10)
235.68	FILL Brown, moist, compact, consisting of clayey silt to silty clay and sand and gravel, trace organics.		2	SS	14												70 27 (3)
0.30			3	SS	10												
				4	SS	20											
233.69	Silty CLAY TILL (CL) Brown, moist, very stiff, with embedded sand and gravel.		5	SS	20												
2.29			6	SS	18												
232.17	grey silt layer																
3.81																	
231.71	End of borehole.																
4.27																	

JOE MTO 06-8-IEG2.GPJ ONTARIO.MOT.GDT 4/17/07

+ 3, X 3: Numbers refer to Sensitivity ○ 150 UNCONFINED SHEAR STRENGTH INFERRED FROM POCKET PENETROMETER READINGS

**RECORD OF BOREHOLE No C20-3**

1 OF 1

**METRIC**

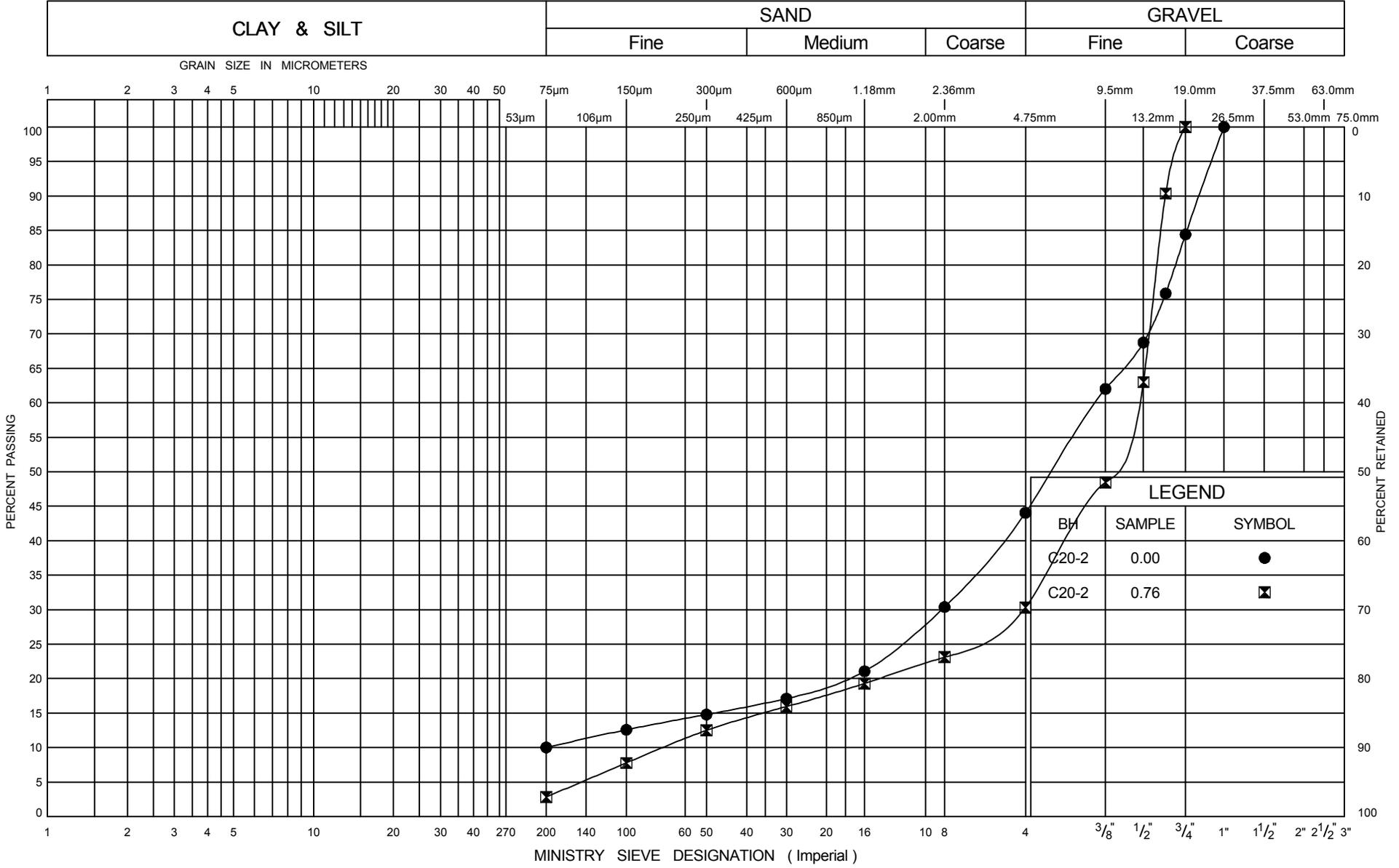
W.P. GWP 408-94-00 LOCATION Culvert No. 20 Northing - 4902286, Easting - 380512 ORIGINATED BY RB  
 DIST Owen Sound HWY 21 BOREHOLE TYPE 100mm SST Auger COMPILED BY JL  
 DATUM Geodetic DATE 9.25.06 - 9.25.06 CHECKED BY EC

SOIL PROFILE		SAMPLES			GROUND WATER CONDITIONS	ELEVATION SCALE	PENETR. RESISTANCE		PLASTIC LIMIT W <sub>p</sub>	NATURAL MOISTURE CONTENT w	LIQUID LIMIT W <sub>L</sub>	UNIT WEIGHT γ	REMARKS & GRAIN SIZE DISTRIBUTION (%)	
ELEV. DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE			"N" VALUES	STANDARD ●						DYN. CONE ○
235.24	Ground Surface													
0.00	TOPSOIL - 560mm.		1	SS	8									
234.68	Brown Silty CLAY TILL (CL to CI) Moist, stiff to hard, with embedded sand and gravel, occasional silt layers.	CL	2	SS	13		100					3 17 43 37 (81)		
0.56														
					3	SS	34		125				23.1	3 18 52 27 (79)
					4	SS	16							
					5	SS	10		125					0 3 49 48 (97)
231.73	Grey	CI												
3.51	End of borehole.											Borehole dry and open at completion.		

JOE MTO 06-8-IEG2.GPJ ONTARIO.MOT.GDT 4/17/07

+ 3, X 3: Numbers refer to Sensitivity ○ 150 UNCONFINED SHEAR STRENGTH INFERRED FROM POCKET PENETROMETER READINGS

### UNIFIED SOIL CLASSIFICATION SYSTEM



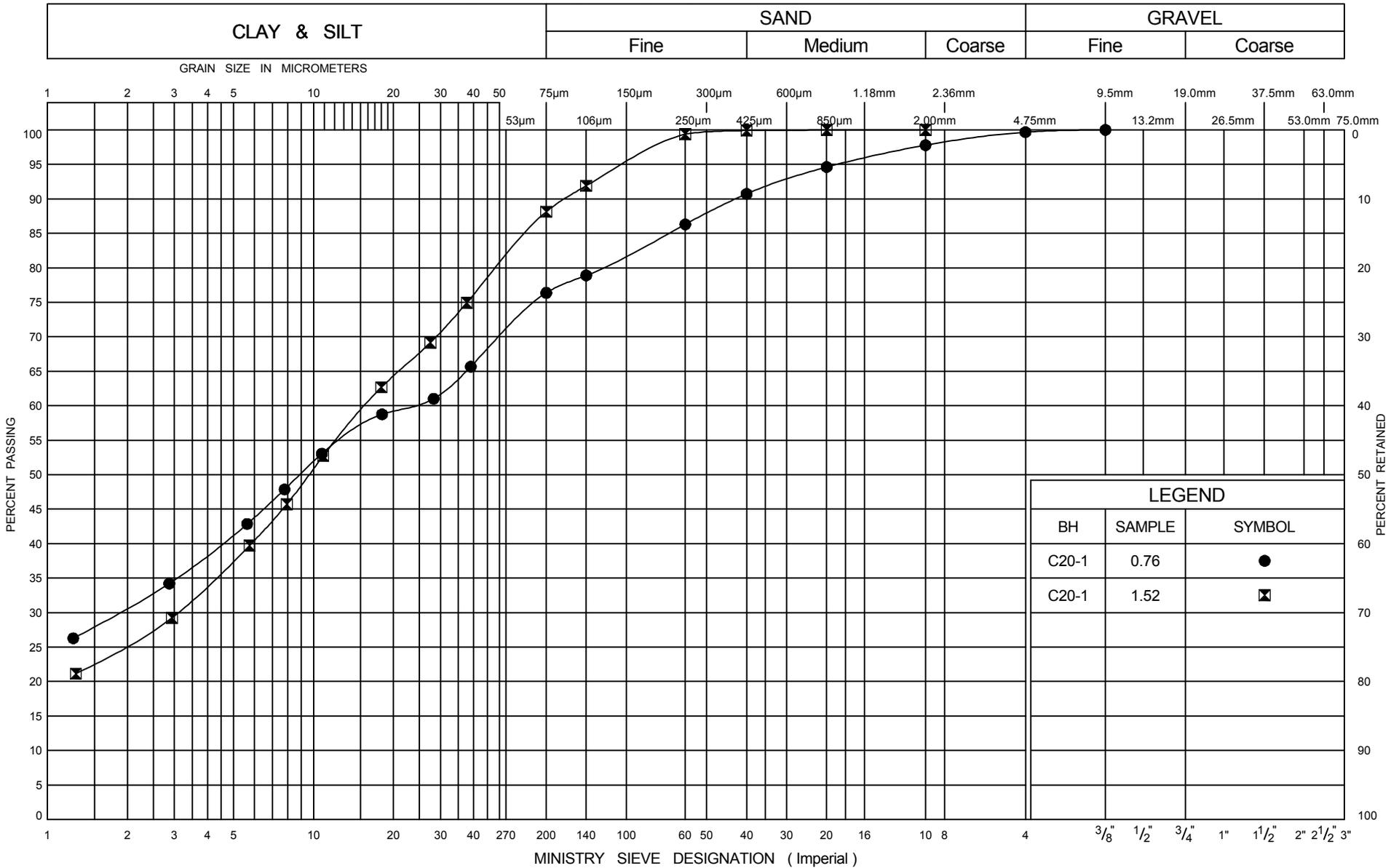
ONTARIO MOT GRAIN SIZE 06-8-1EG2.GPJ ONTARIO MOT.GDT 4/17/07



## GRAIN SIZE DISTRIBUTION FILL

FIG No C20-1  
GWP 408-94-00  
Highway 21-Kincardine to Tiverton

UNIFIED SOIL CLASSIFICATION SYSTEM



LEGEND		
BH	SAMPLE	SYMBOL
C20-1	0.76	●
C20-1	1.52	⊠

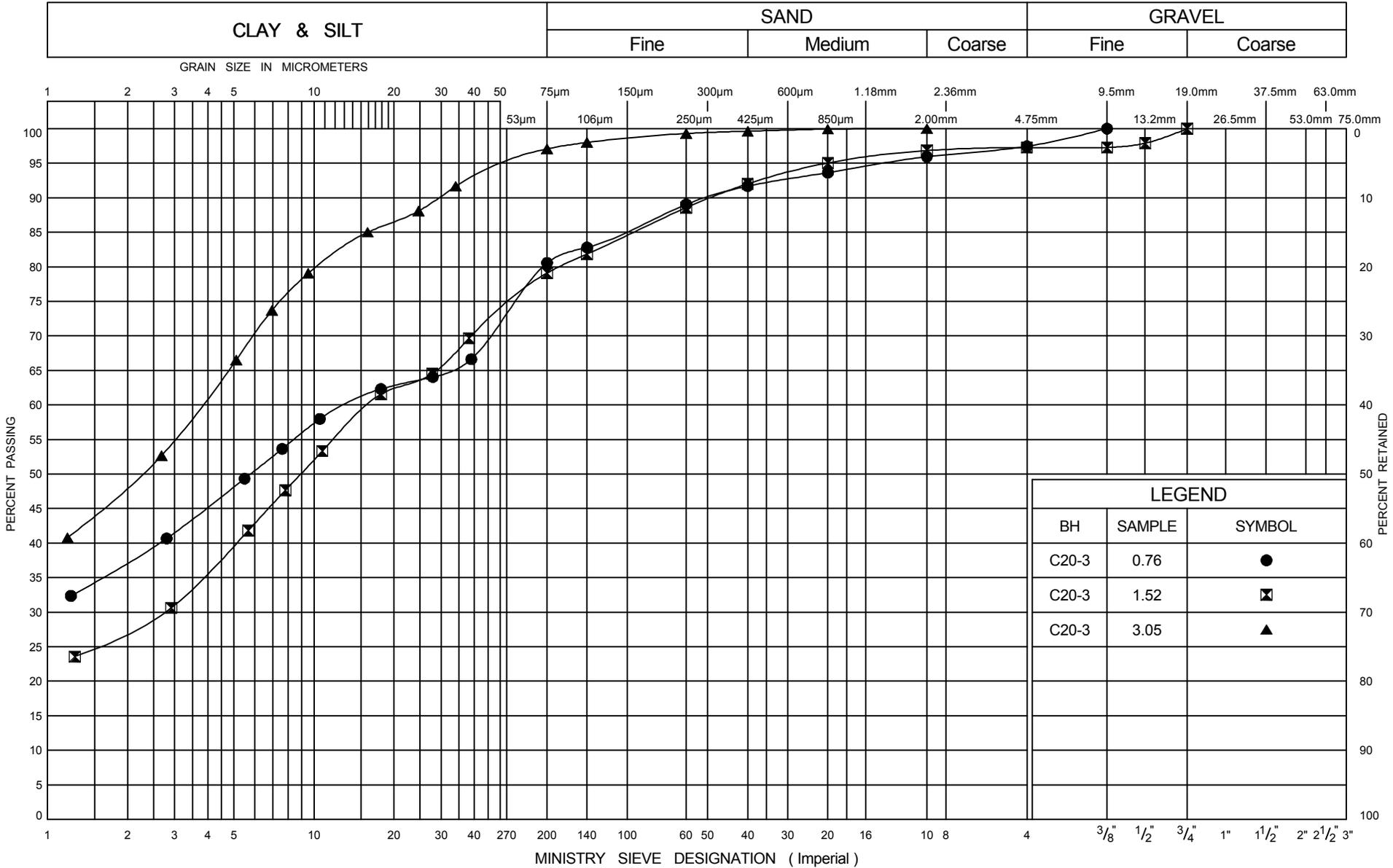
ONTARIO MOT GRAIN SIZE 06-8-1EG2.GPJ ONTARIO MOT.GDT 4/17/07



GRAIN SIZE DISTRIBUTION  
SILT WITH CLAY PARTING SEAMS & LAYERS (ML)

FIG No C20-2  
GWP 408-94-00  
Highway 21-Kincardine to Tiverton

### UNIFIED SOIL CLASSIFICATION SYSTEM



ONTARIO MOT GRAIN SIZE 06-8-1EG2.GPJ ONTARIO MOT.GDT 4/17/07

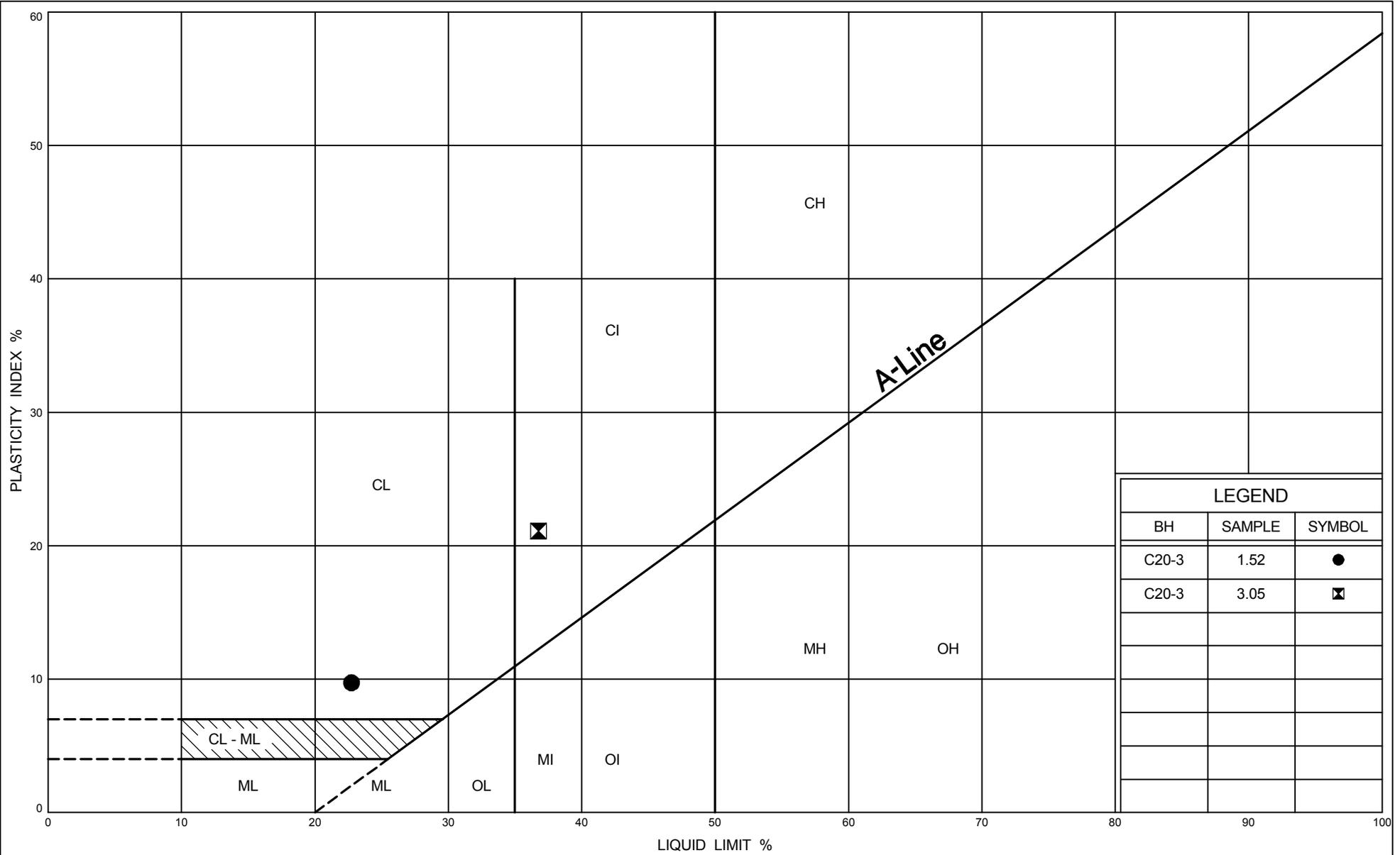


**GRAIN SIZE DISTRIBUTION**  
**SILTY CLAY TILL (CL TO CI)**

FIG No C20-3

GWP 408-94-00

Highway 21-Kincardine to Tiverton



LEGEND		
BH	SAMPLE	SYMBOL
C20-3	1.52	●
C20-3	3.05	⊠

ONTARIO MOT PLASTICITY CHART\_06-8-1EG2.GPJ\_ONTARIO MOT.GDT\_4/17/07



**PLASTICITY CHART**  
**SILTY CLAY TILL (CL TO CI)**

FIG No C20-4  
GWP 408-94-00  
Highway 21-Kincardine to Tiverton

**RECORD OF BOREHOLE No C21-1**

1 OF 1

**METRIC**

W.P. GWP 408-94-00 LOCATION Culvert No. 21 Northing - 4902572, Easting - 380628 ORIGINATED BY RB  
 DIST Owen Sound HWY 21 BOREHOLE TYPE 100mm SST Auger COMPILED BY JL  
 DATUM Geodetic DATE 09.21.06 - 09.21.06 CHECKED BY EC

SOIL PROFILE		SAMPLES			GROUND WATER CONDITIONS	ELEVATION SCALE	PENETR. RESISTANCE STANDARD ● DYN. CONE ○					PLASTIC NATURAL LIQUID LIMIT MOISTURE LIMIT CONTENT CONTENT			UNIT WEIGHT $\gamma$ kN/m <sup>3</sup>	REMARKS & GRAIN SIZE DISTRIBUTION (%) GR SA SI CL	
ELEV DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE			"N" VALUES	SHEAR STRENGTH kPa					W <sub>p</sub>	W			W <sub>L</sub>
						20	40	60	80	100							
233.10	Ground Surface																
0.00																	
232.64	TOPSOIL - 460mm.		1	SS	11											18.7	3 31 43 24 (67)
0.46																	
231.73	Silty CLAY (CL) Brown, moist, stiff, with sand and silt seams.	organic inclusions	2	SS	12												
1.37																	
230.20	SILT to Sandy SILT (ML) Grey, moist to saturated, compact, some clay.		3	SS	12												0 7 72 21 (93)
1.90																	
230.20	Silty SAND (SM) Grey, saturated, compact		4	SS	13												
2.90																	
229.59			5	SS	12												0 66 29 5 (34)
3.51	End of borehole.																Water level measured at 2.1m at completion.

JOE.MTO 06-8-IEG2.GPJ ONTARIO.MOT.GDT 09/26/07

+<sup>3</sup>, X<sup>3</sup>: Numbers refer to Sensitivity

○ 150 UNCONFINED SHEAR STRENGTH INFERRED FROM POCKET PENETROMETER READINGS

**RECORD OF BOREHOLE No C21-2**

1 OF 1

**METRIC**

W.P. GWP 408-94-00 LOCATION Culvert No. 21 Northing - 4902562, Easting - 380642 ORIGINATED BY RB  
 DIST Owen Sound HWY 21 BOREHOLE TYPE 100mm SST Auger COMPILED BY JL  
 DATUM Geodetic DATE 9.21.06 - 9.21.06 CHECKED BY EC

SOIL PROFILE		SAMPLES			GROUND WATER CONDITIONS	ELEVATION SCALE	PENETR. RESISTANCE					PLASTIC NATURAL LIQUID			UNIT WEIGHT	REMARKS & GRAIN SIZE DISTRIBUTION (%)
ELEV. DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE			"N" VALUES	STANDARD	DYN. CONE	W <sub>p</sub>	MOISTURE CONTENT	W <sub>L</sub>	W <sub>p</sub>	W		
						20 40 60 80 100	○ UNCONFINED + FIELD VANE									
						20 40 60 80 100	● QUICK TRIAXIAL × LAB VANE									
236.75	Ground Surface															
0.00																
236.29	FILL - 460mm sand and gravel (shoulder gravel)		1	AUGER											28 54	(18)
0.46																
	FILL Brown, moist, loose to compact. Mixed FILL consisting of clayey silt to silty clay with embedded sand and gravel.		2	SS	13										40 38 17 5	(22)
			3	SS	6											
			4	SS	11											
			5	SS	10										4 22 44 30	(74)
			6	SS	7											
232.33	Silty CLAY (CL) Brown changing to grey, moist to wet, very stiff, with embedded sand and gravel.		7	SS	22											
4.42																
231.57	SILT to Sandy SILT (ML) Grey, wet, compact.		8	SS	19											
5.18																
230.81	Silty CLAY (CL) Grey, moist, very stiff, with embedded sand and gravel.		9	SS	20											
5.94																
230.20	End of borehole.															
6.55																Water level measured at 5.95m at completion.

JOE MTO 06-8-IEG2.GPJ ONTARIO.MOT.GDT 4/17/07

+ 3, × 3: Numbers refer to Sensitivity ○ 150 UNCONFINED SHEAR STRENGTH INFERRED FROM POCKET PENETROMETER READINGS

**RECORD OF BOREHOLE No C21-3**

1 OF 1

**METRIC**

W.P. GWP 408-94-00 LOCATION Culvert No. 21 Northing - 4902554, Easting - 380661 ORIGINATED BY RB  
 DIST Owen Sound HWY 21 BOREHOLE TYPE 100mm SST Auger COMPILED BY JL  
 DATUM Geodetic DATE 09.25.06 - 09.25.06 CHECKED BY EC

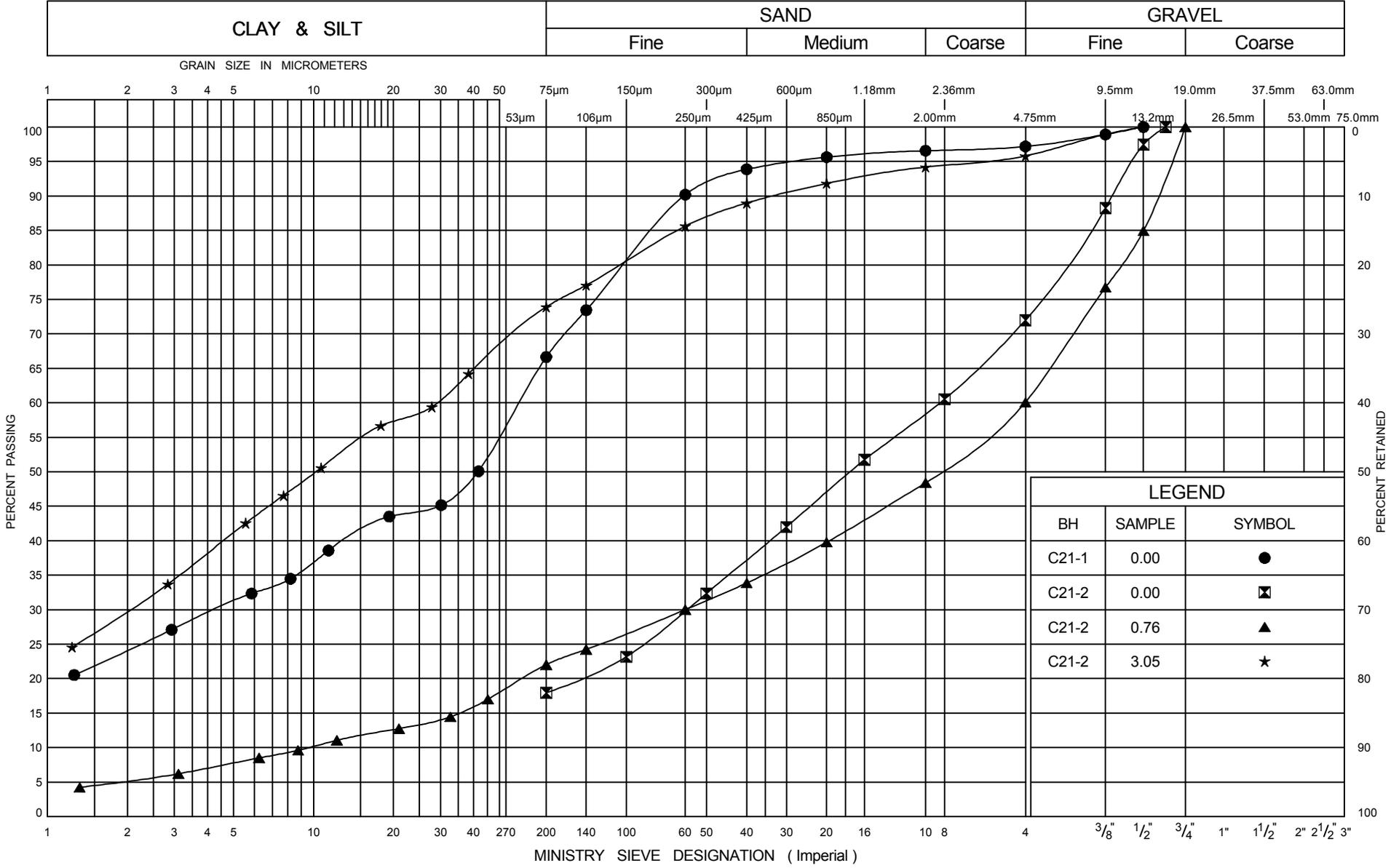
SOIL PROFILE		SAMPLES			GROUND WATER CONDITIONS	ELEVATION SCALE	PENETR. RESISTANCE		PLASTIC LIMIT W <sub>p</sub>	NATURAL MOISTURE CONTENT W	LIQUID LIMIT W <sub>L</sub>	UNIT WEIGHT γ	REMARKS & GRAIN SIZE DISTRIBUTION (%)
ELEV DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE			"N" VALUES	STANDARD ●					
233.22 0.00	Ground Surface												
232.66 0.56	TOPSOIL - 560mm.		1	SS	10								
231.85 1.37	Silty CLAY (CH) Brown, moist, very stiff, with sand and silt seams.		2	SS	24						52	20.8	2 17 38 43 (81)
230.32 2.90	SILT to Sandy SILT (ML) Grey, moist to saturated, compact, with silty clay seams and partings.		3	SS	18								
229.71 3.51	Silty CLAY (CL) Grey, moist, stiff, with sand and silt seams.		4	SS	28								0 37 51 12 (63)
	End of borehole.		5	SS	12								Water level measured at 1.9m at completion.

JOE.MTO\_06-8-IEG2.GPJ ONTARIO.MOT.GDT 09/26/07

+ 3, X 3: Numbers refer to Sensitivity

○ 150 UNCONFINE SHEAR STRENGTH INFERRED FROM POCKET PENETROMETER READINGS

UNIFIED SOIL CLASSIFICATION SYSTEM



LEGEND		
BH	SAMPLE	SYMBOL
C21-1	0.00	●
C21-2	0.00	⊠
C21-2	0.76	▲
C21-2	3.05	★

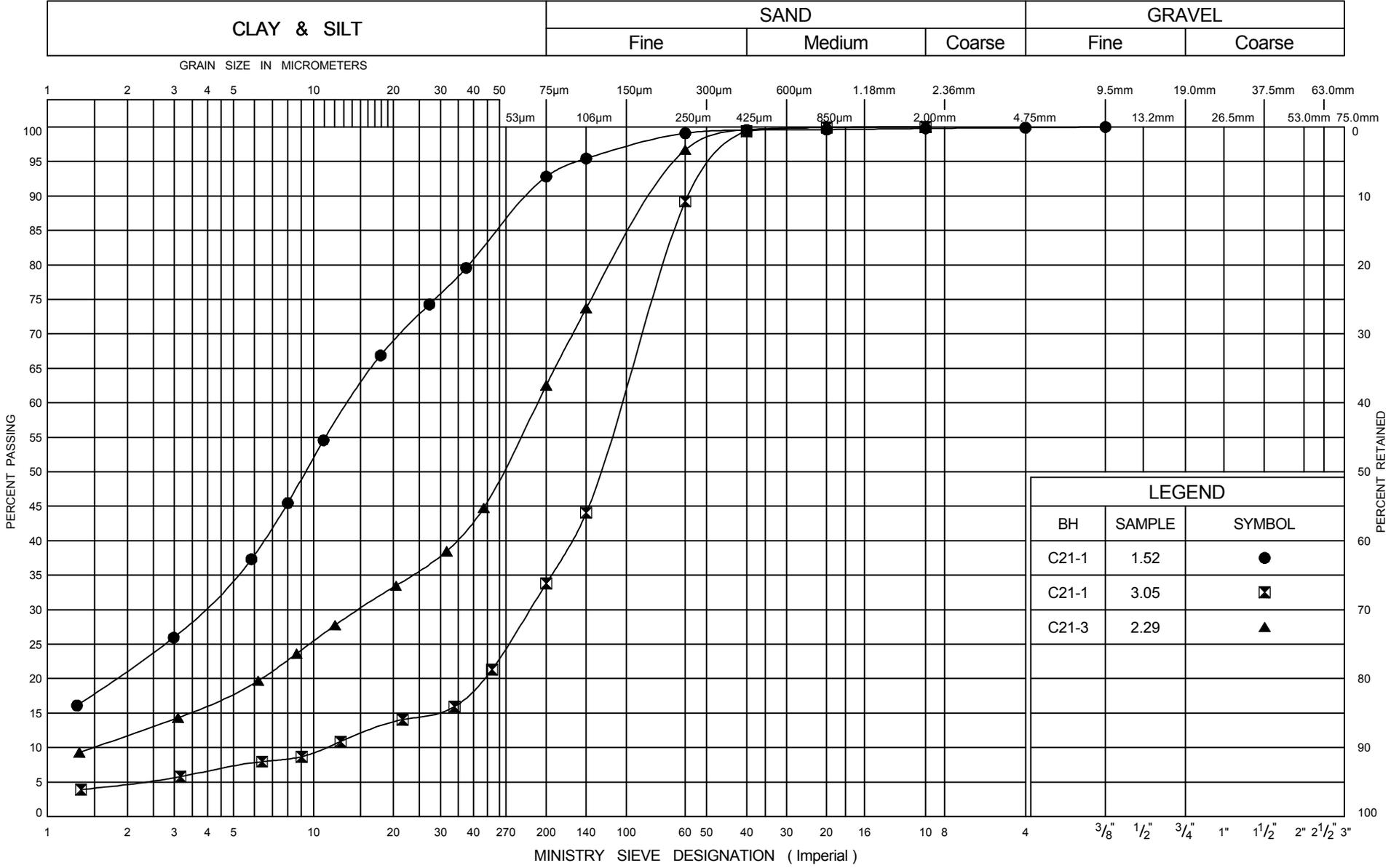
ONTARIO MOT GRAIN SIZE 06-8-1EG2.GPJ ONTARIO MOT.GDT 4/17/07



GRAIN SIZE DISTRIBUTION  
FILL

FIG No C21-1  
GWP 408-94-00  
Highway 21-Kincardine to Tiverton

UNIFIED SOIL CLASSIFICATION SYSTEM



ONTARIO MOT GRAIN SIZE 06-8-1EG2.GPJ ONTARIO MOT.GDT 4/17/07

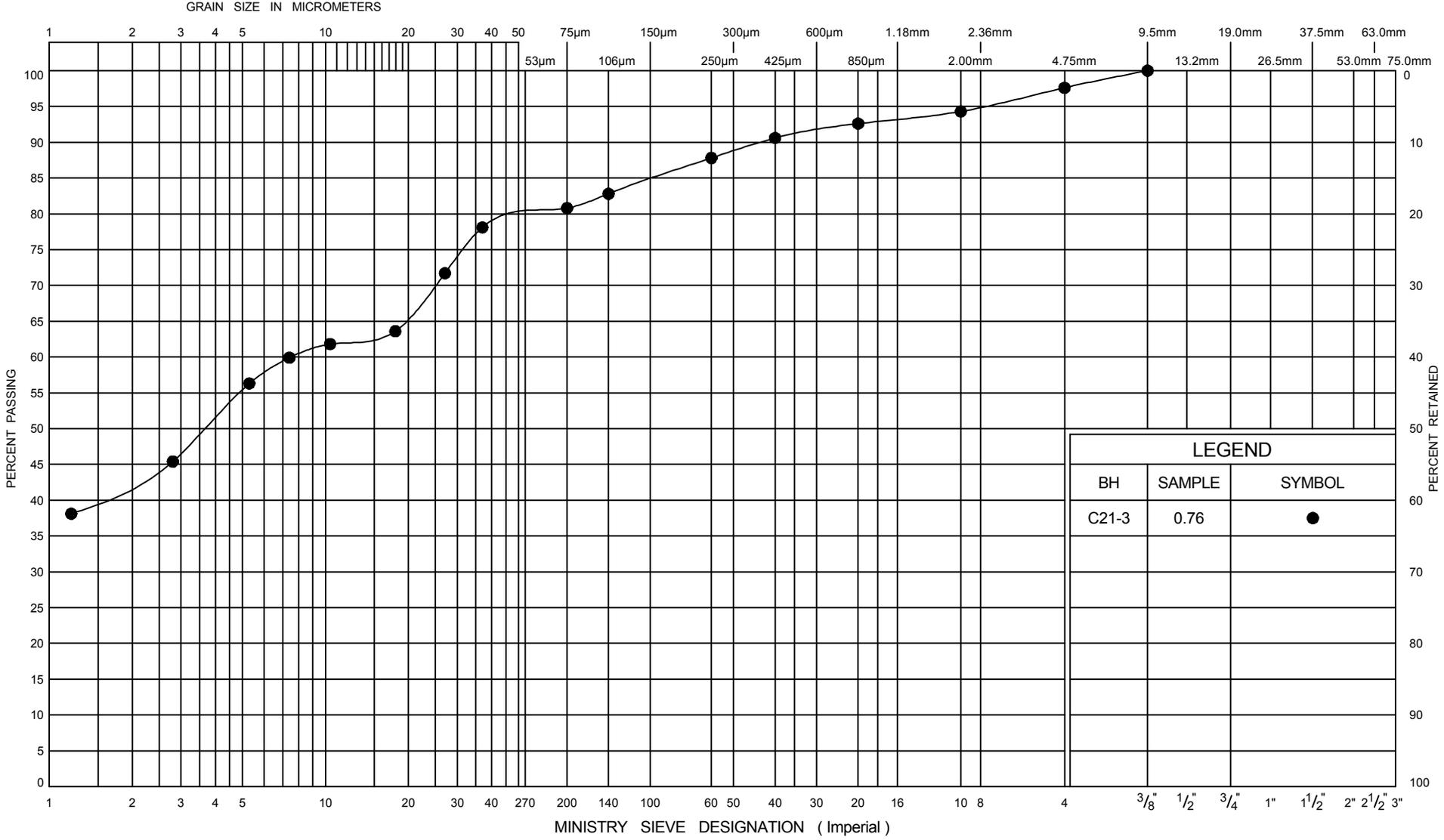


GRAIN SIZE DISTRIBUTION  
SILT TO SILTY SAND (ML TO SM)

FIG No C21-2  
GWP 408-94-00  
Highway 21-Kincardine to Tiverton

### UNIFIED SOIL CLASSIFICATION SYSTEM

CLAY & SILT	SAND			GRAVEL	
	Fine	Medium	Coarse	Fine	Coarse



LEGEND		
BH	SAMPLE	SYMBOL
C21-3	0.76	●

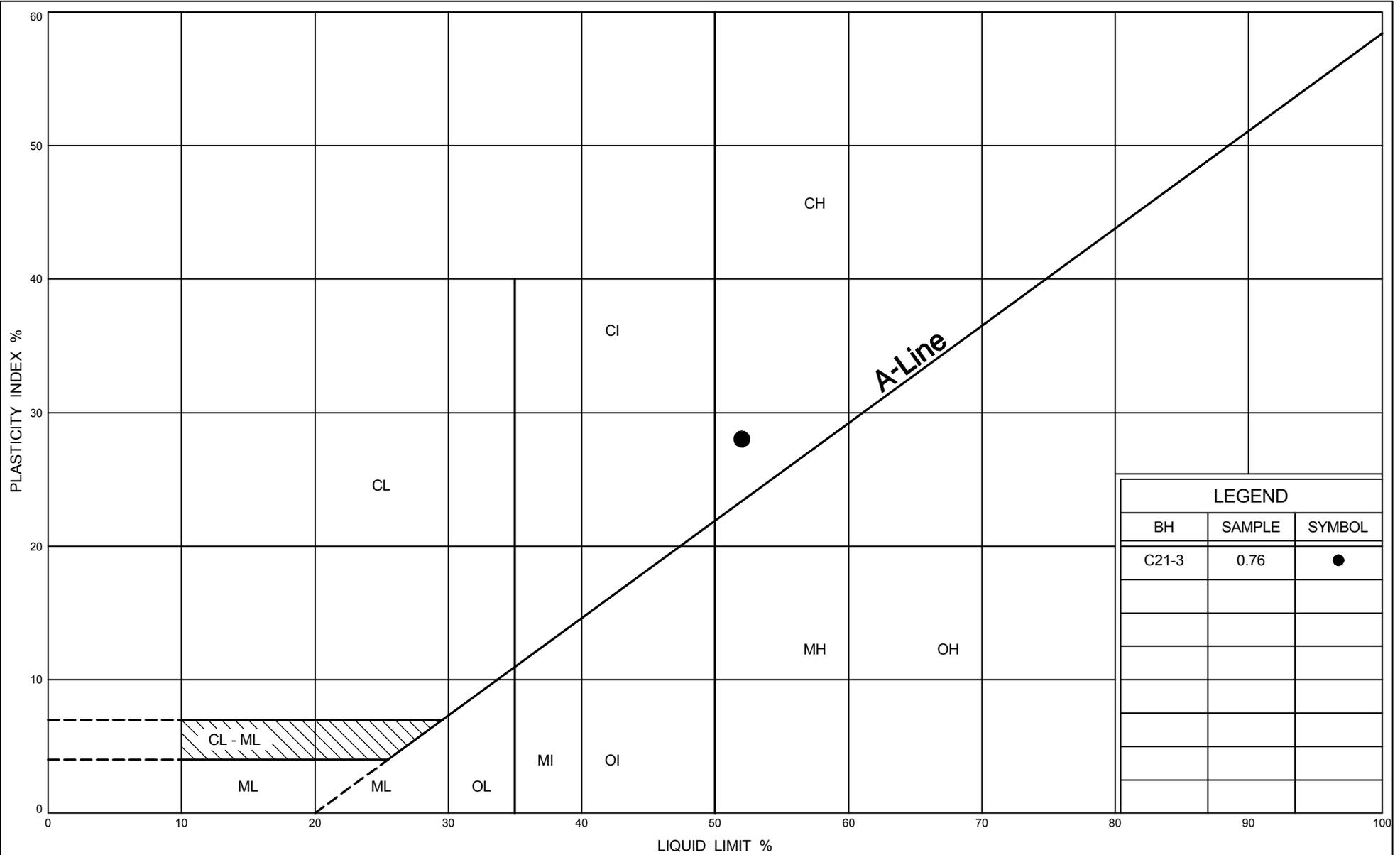
ONTARIO MOT GRAIN SIZE 06-8-1EG2.GPJ ONTARIO MOT.GDT 4/17/07



## GRAIN SIZE DISTRIBUTION

### SILTY CLAY TILL (CH)

FIG No C21-3  
 GWP 408-94-00  
 Highway 21-Kincardine to Tiverton



LEGEND		
BH	SAMPLE	SYMBOL
C21-3	0.76	●

ONTARIO MOT PLASTICITY CHART\_06-8-1EG2.GPJ\_ONTARIO MOT.GDT\_4/17/07



**PLASTICITY CHART**  
**SILTY CLAY TILL (CH)**

FIG No C21-4  
GWP 408-94-00  
Highway 21-Kincardine to Tiverton

**RECORD OF BOREHOLE No C22-1**

1 OF 1

**METRIC**

W.P. GWP 408-94-00 LOCATION Culvert No. 22 Northing - 4903440, Easting - 381142 ORIGINATED BY RB  
 DIST Owen Sound HWY 21 BOREHOLE TYPE 100mm SST Auger COMPILED BY JL  
 DATUM Geodetic DATE 9.27.06 - 9.27.06 CHECKED BY EC

SOIL PROFILE		SAMPLES			GROUND WATER CONDITIONS	ELEVATION SCALE	PENETR. RESISTANCE		PLASTIC LIMIT W <sub>p</sub>	NATURAL MOISTURE CONTENT w	LIQUID LIMIT W <sub>L</sub>	UNIT WEIGHT γ	REMARKS & GRAIN SIZE DISTRIBUTION (%)
ELEV. DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE			"N" VALUES	STANDARD ●					
236.66 0.00	Ground Surface												
236.05 0.61	TOPSOIL - 610mm.		1	SS	10						61		
	SILT (ML) Brown, wet to saturated, compact, occasional silty clay seams.		2	SS	11								0 8 79 13 (92)
			3	SS	12								
234.22 2.44		Silty CLAY TILL (CL) Grey, moist, very stiff to hard, with embedded sand and gravel.		4	SS	29			150			23.0	
			5	SS	25								
232.39 4.27			6	SS	40						23.0		4 10 57 29 (86)
	End of borehole.												Water level measured at 0.85m at completion.

JOE MTO 06-8-IEG2.GPJ ONTARIO.MOT.GDT 4/17/07

+ 3, X 3: Numbers refer to Sensitivity

○ 150 UNCONFINED SHEAR STRENGTH INFERRED FROM POCKET PENETROMETER READINGS

**RECORD OF BOREHOLE No C22-2**

1 OF 1

**METRIC**

W.P. GWP 408-94-00 LOCATION Culvert No. 22 Northing - 4903447, Easting - 381132 ORIGINATED BY RB  
 DIST Owen Sound HWY 21 BOREHOLE TYPE 100mm SST Auger COMPILED BY JL  
 DATUM Geodetic DATE 9.27.06 - 9.27.06 CHECKED BY EC

SOIL PROFILE		SAMPLES			GROUND WATER CONDITIONS	ELEVATION SCALE	PENETR. RESISTANCE					PLASTIC NATURAL LIQUID			UNIT WEIGHT	REMARKS & GRAIN SIZE DISTRIBUTION (%)
ELEV. DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE			"N" VALUES	STANDARD	DYN. CONE	W <sub>p</sub>	MOISTURE CONTENT	W <sub>L</sub>	W <sub>p</sub>	W		
						20 40 60 80 100	20 40 60 80 100									
237.67	Ground Surface															
0.00	ASPHALT - 50mm.		1	AUGER												
	FILL Brown, damp, compact to dense, sand and gravel to gravelly sand (shoulder gravel).		2	SS	38											26 66 (8)
236.30																
1.37	Buried TOPSOIL.		3	SS	5											
235.69																
1.98	SILT to Clayey SILT (ML to ML-CL) Brown, moist, compact or very stiff.		4	SS	16											
234.77																
2.90	Brown Silty CLAY TILL (CL) Moist, hard, Silty CLAY, with embedded sand and gravel.		5	SS	30						150			23.6	1 13 56 30 (86)	
	Grey		6	SS	31						200					
233.40																
4.27	End of borehole.															Water level measured at 3.5m at completion.

JOE MTO 06-8-IEG2.GPJ ONTARIO.MOT.GDT 4/17/07

+ 3, X 3: Numbers refer to Sensitivity      ○ 150 UNCONFINED SHEAR STRENGTH INFERRED FROM POCKET PENETROMETER READINGS

**RECORD OF BOREHOLE No C22-3**

1 OF 1

**METRIC**

W.P. GWP 408-94-00 LOCATION Culvert No. 22 Northing - 4903447, Easting - 381106 ORIGINATED BY RB  
 DIST Owen Sound HWY 21 BOREHOLE TYPE 100mm SST Auger COMPILED BY JL  
 DATUM Geodetic DATE 9.26.06 - 9.26.06 CHECKED BY EC

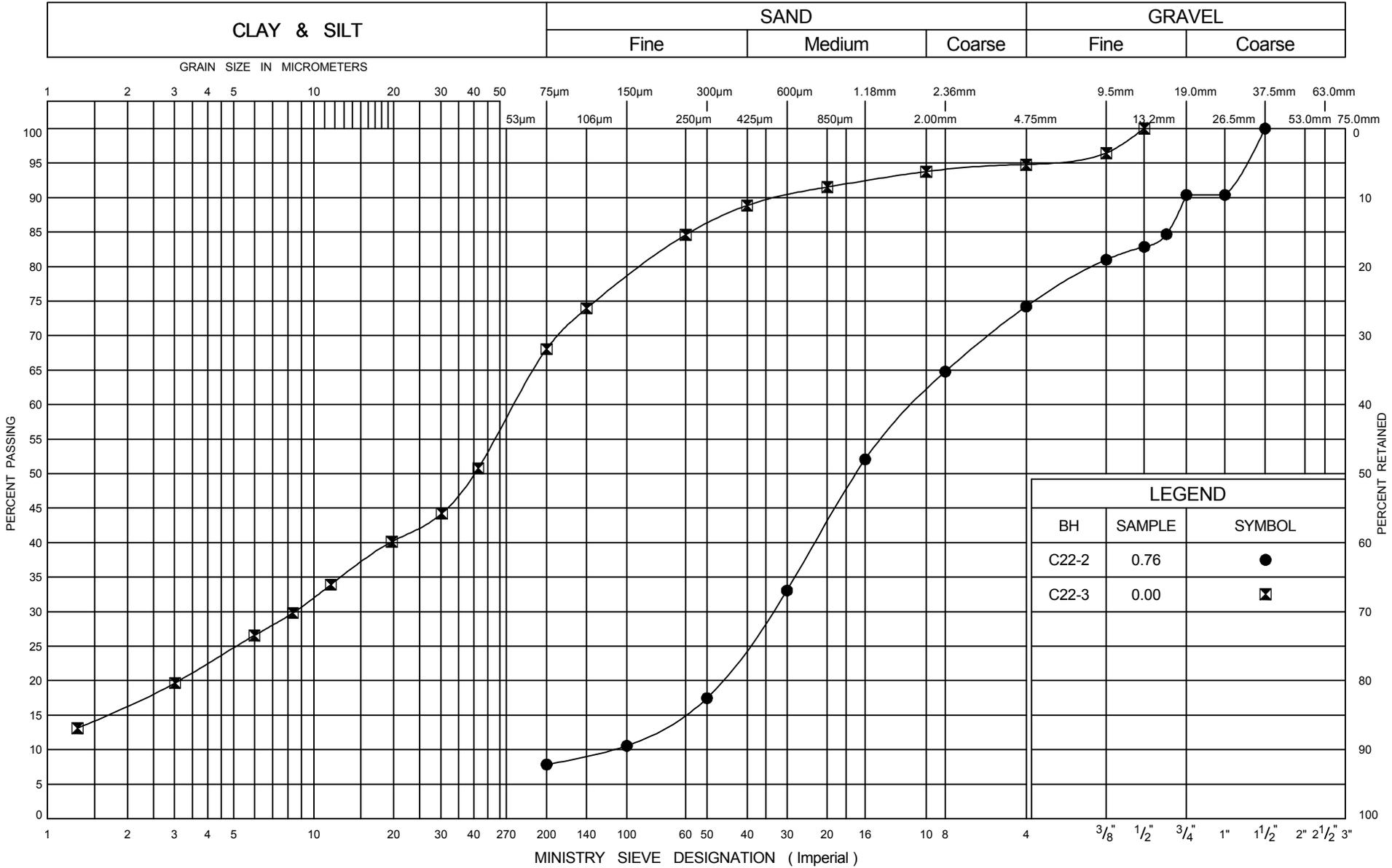
SOIL PROFILE		SAMPLES			GROUND WATER CONDITIONS	ELEVATION SCALE	PENETR. RESISTANCE					PLASTIC NATURAL LIQUID			UNIT WEIGHT $\gamma$ kN/m <sup>3</sup>	REMARKS & GRAIN SIZE DISTRIBUTION (%)	
ELEV. DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE			"N" VALUES	STANDARD	DYN. CONE	W <sub>p</sub>	MOISTURE CONTENT	W <sub>L</sub>	W	GR			SA
236.35 0.00	Ground Surface																
235.74 0.61	FILL - 610mm, consisting of topsoil and sandy silt.		1	SS	5											5 27 52 16 (68)	
	Sandy SILT to SILT (ML) Brown, saturated, compact, trace to some clay, trace gravel.		2	SS	18											4 40 48 8 (56)	
			3	SS	11												0 7 79 14 (93)
			4	SS	13												
233.45 2.90			Silty CLAY TILL (CL) Grey, moist, very stiff to hard, with embedded sand and gravel.		5	SS	24										
232.08 4.27	End of borehole.		6	SS	35											Water level measured at 1m at completion.	

JOE MTO 06-8-IEG2.GPJ ONTARIO.MOT.GDT 4/17/07

+ 3, X 3: Numbers refer to Sensitivity

○ 150 UNCONFINED SHEAR STRENGTH INFERRED FROM POCKET PENETROMETER READINGS

### UNIFIED SOIL CLASSIFICATION SYSTEM



LEGEND		
BH	SAMPLE	SYMBOL
C22-2	0.76	●
C22-3	0.00	⊠

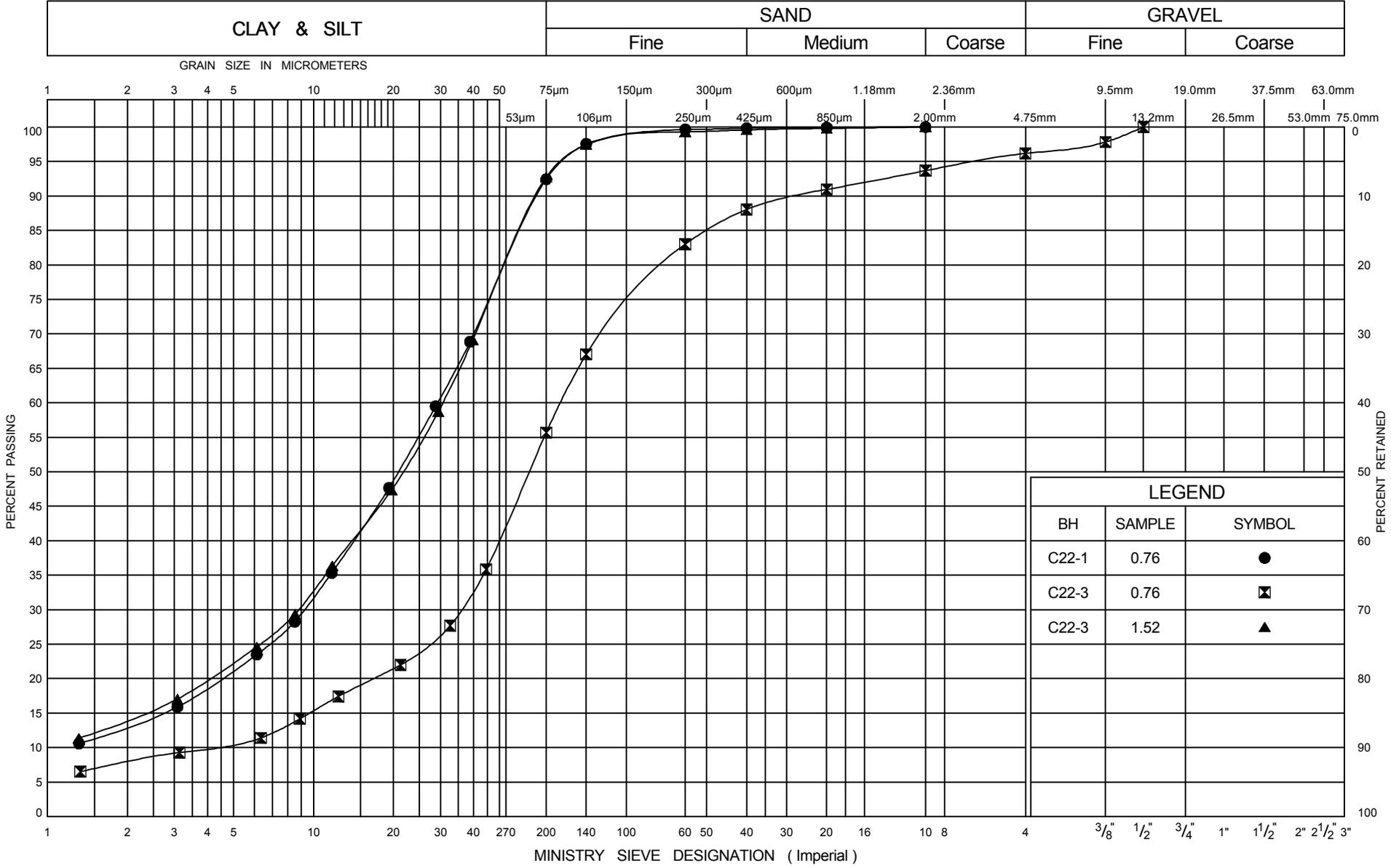
ONTARIO MOT GRAIN SIZE 06-8-1EG2.GPJ ONTARIO MOT.GDT 4/17/07



## GRAIN SIZE DISTRIBUTION SILTY CLAY TILL (CH)

FIG No C22-1  
GWP 408-94-00  
Highway 21-Kincardine to Tiverton

UNIFIED SOIL CLASSIFICATION SYSTEM



LEGEND		
BH	SAMPLE	SYMBOL
C22-1	0.76	●
C22-3	0.76	⊠
C22-3	1.52	▲

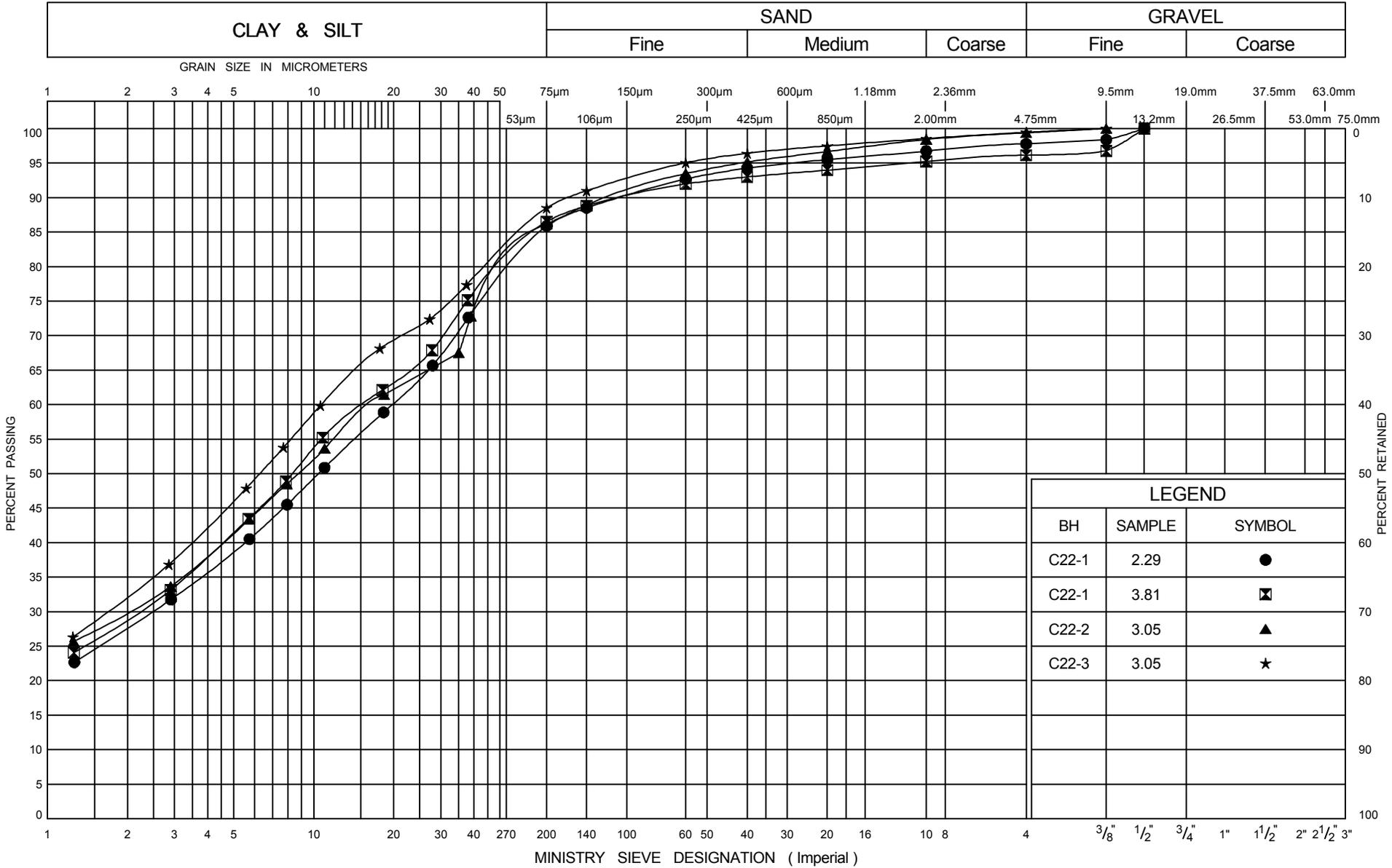
ONTARIO MOT GRAIN SIZE 06-8-1EG2.GPJ ONTARIO MOT.GDT 4/17/07



GRAIN SIZE DISTRIBUTION  
SILT TO SANDY SILT (ML)

FIG No C22-2  
GWP 408-94-00  
Highway 21-Kincardine to Tiverton

UNIFIED SOIL CLASSIFICATION SYSTEM



ONTARIO MOT GRAIN SIZE 06-8-1EG2.GPJ ONTARIO MOT.GDT 4/17/07

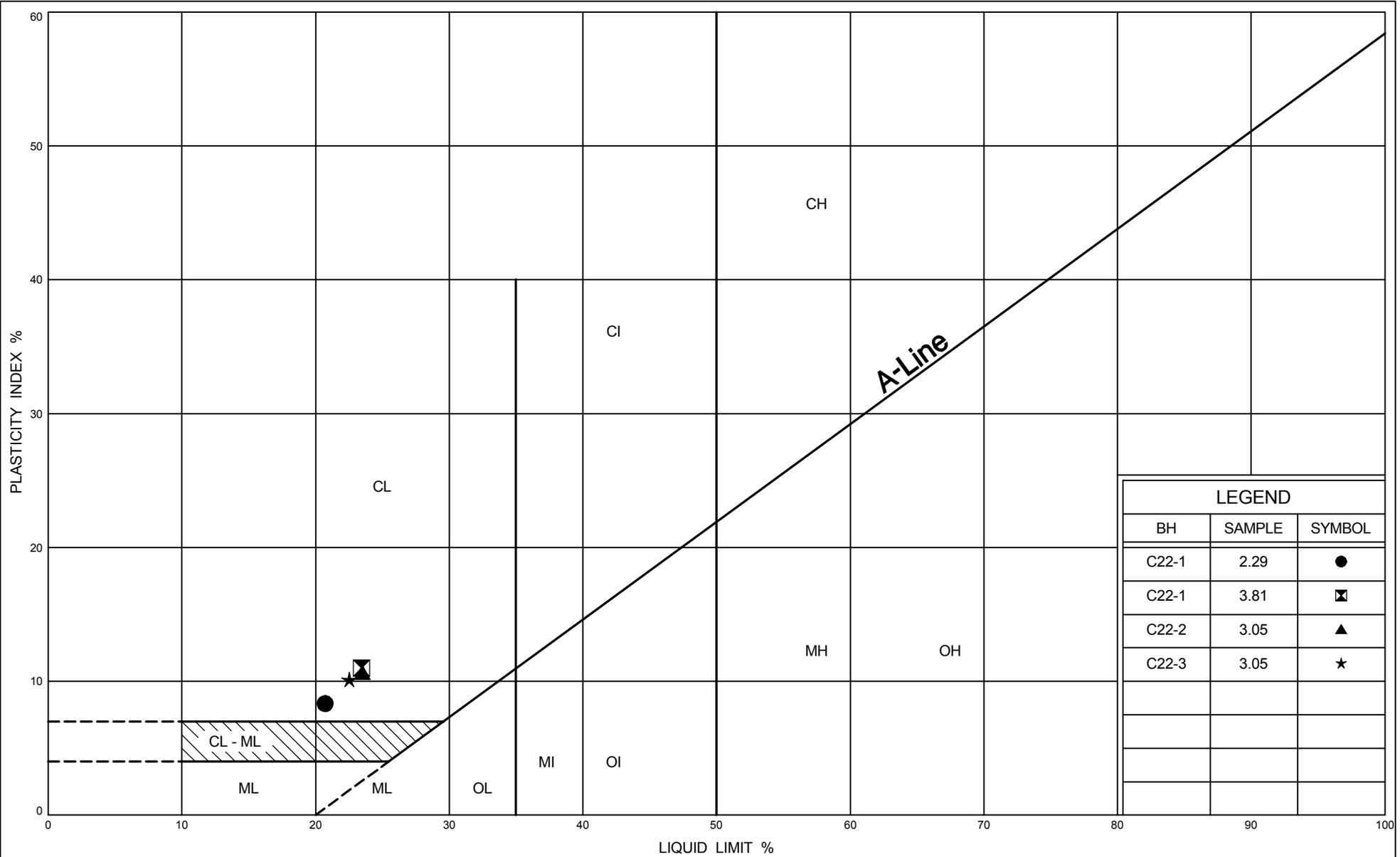


GRAIN SIZE DISTRIBUTION  
SILTY CLAY TILL (CL)

FIG No C22-3

GWP 408-94-00

Highway 21-Kincardine to Tiverton



LEGEND		
BH	SAMPLE	SYMBOL
C22-1	2.29	●
C22-1	3.81	⊠
C22-2	3.05	▲
C22-3	3.05	★

ONTARIO MOT PLASTICITY CHART\_06-8-1EG2.GPJ\_ONTARIO MOT.GDT\_4/17/07



**PLASTICITY CHART**  
**SILTY CLAY TILL (CL)**

FIG No C22-4  
GWP 408-94-00  
Highway 21-Kincardine to Tiverton

**RECORD OF BOREHOLE No C23-1**

1 OF 1

**METRIC**

W.P. GWP 408-94-00 LOCATION Culvert No. 23 Northing - 4903343, Easting - 381449 ORIGINATED BY RB  
 DIST Owen Sound HWY 21 BOREHOLE TYPE 100mm SST Auger COMPILED BY JL  
 DATUM Geodetic DATE 9.26.06 - 9.26.06 CHECKED BY EC

SOIL PROFILE		SAMPLES			GROUND WATER CONDITIONS	ELEVATION SCALE	PENETR. RESISTANCE		PLASTIC LIMIT W <sub>p</sub>	NATURAL MOISTURE CONTENT W	LIQUID LIMIT W <sub>L</sub>	UNIT WEIGHT γ	REMARKS & GRAIN SIZE DISTRIBUTION (%)
ELEV DEPTH	DESCRIPTION	NUMBER	TYPE	"N" VALUES			STANDARD ● DYN. CONE ○	20 40 60 80 100					
239.36	Ground Surface												
0.00													
238.98	TOPSOIL - 380mm.	1	SS	4		239							
0.38													
	Brown	2	SS	13	▽				175			4 21 49 26 (75)	
	Silty CLAY TILL (CL) Damp to moist, stiff to hard, with embedded sand and gravel.	3	SS	38		238			225+				
		4	SS	38		237			225+		23.0	2 10 52 36 (88)	
	Grey	5	SS	34		236			225+				
235.85	End of borehole.												Water level measured at 0.9m at completion.
3.51													

JOE MTO 06-8-IEG2.GPJ ONTARIO.MOT.GDT 4/17/07

+ 3, X 3: Numbers refer to Sensitivity

○ 150 UNCONFINED SHEAR STRENGTH INFERRED FROM POCKET PENETROMETER READINGS

**RECORD OF BOREHOLE No C23-2**

1 OF 1

**METRIC**

W.P. GWP 408-94-00 LOCATION Culvert No. 23 Northing - 4903359, Easting - 381439 ORIGINATED BY RB  
 DIST Owen Sound HWY 21 BOREHOLE TYPE 100mm SST Auger COMPILED BY JL  
 DATUM Geodetic DATE 9.26.06 - 9.26.06 CHECKED BY EC

SOIL PROFILE		SAMPLES			GROUND WATER CONDITIONS	ELEVATION SCALE	PENETR. RESISTANCE		PLASTIC LIMIT W <sub>p</sub>	NATURAL MOISTURE CONTENT w	LIQUID LIMIT W <sub>L</sub>	UNIT WEIGHT γ	REMARKS & GRAIN SIZE DISTRIBUTION (%)	
ELEV. DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE			"N" VALUES	STANDARD ●						DYN. CONE ○
240.32 0.00	Ground Surface													
	FILL Brown, moist to wet, compact to loose, sand and gravel to silty sand.		1	AUGER									35 55 (11)	
			2	SS	13									15 59 17 9 (26)
			3	SS	6									10 71 12 7 (19)
238.19 2.13	Brown Silty CLAY TILL (CL) Moist, very stiff to hard, with embedded sand and gravel.		4	SS	24									
			5	SS	52									
236.05 4.27	Grey		6	SS	55									
	End of borehole.												Wet cave-in measured at 0.9m at completion.	

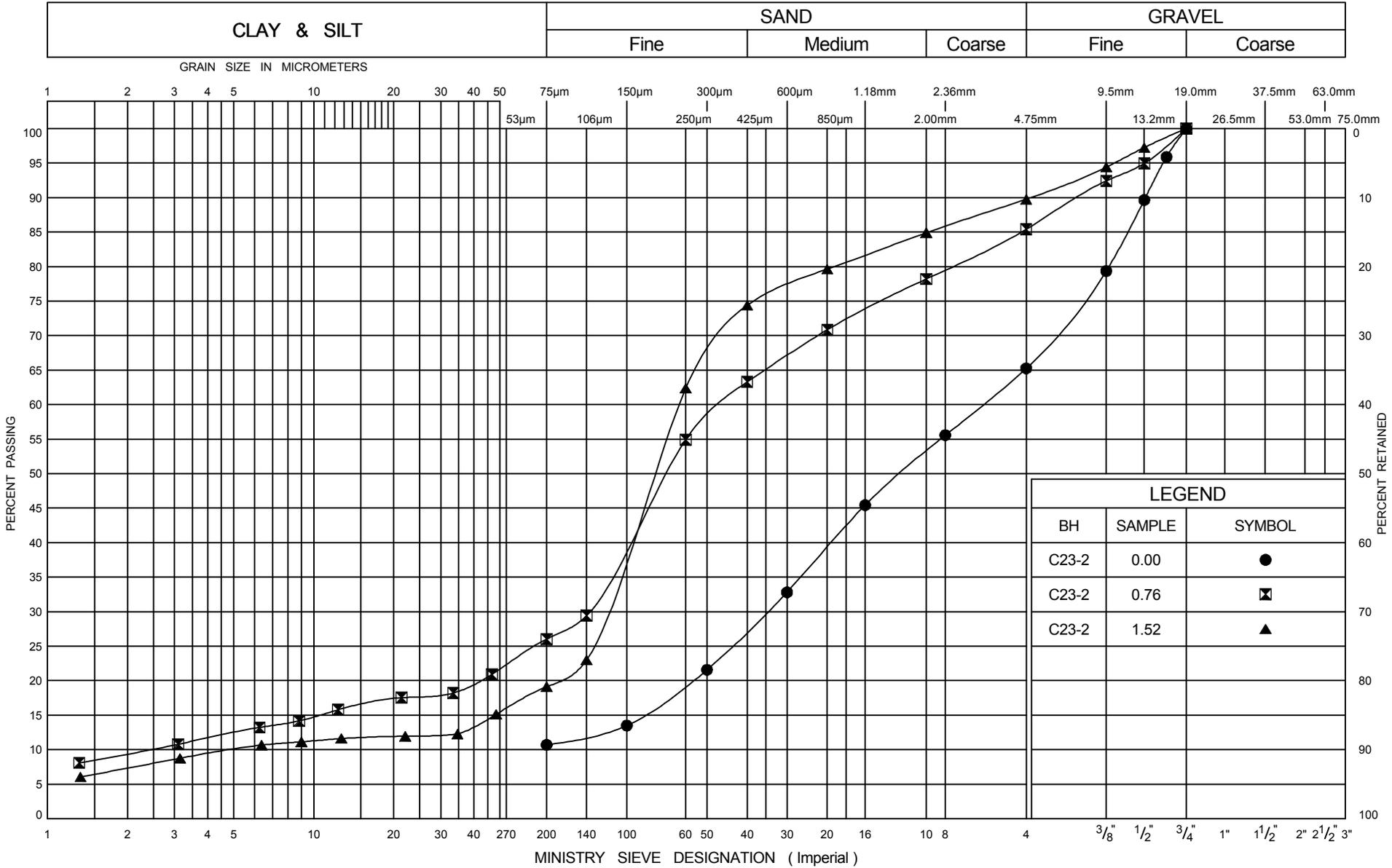
JOE MTO 06-8-IEG2.GPJ ONTARIO.MOT.GDT 4/17/07

+ 3, X 3: Numbers refer to Sensitivity

○ 150 UNCONFINED SHEAR STRENGTH INFERRED FROM POCKET PENETROMETER READINGS



### UNIFIED SOIL CLASSIFICATION SYSTEM



ONTARIO MOT GRAIN SIZE 06-8-1EG2.GPJ ONTARIO MOT.GDT 4/17/07



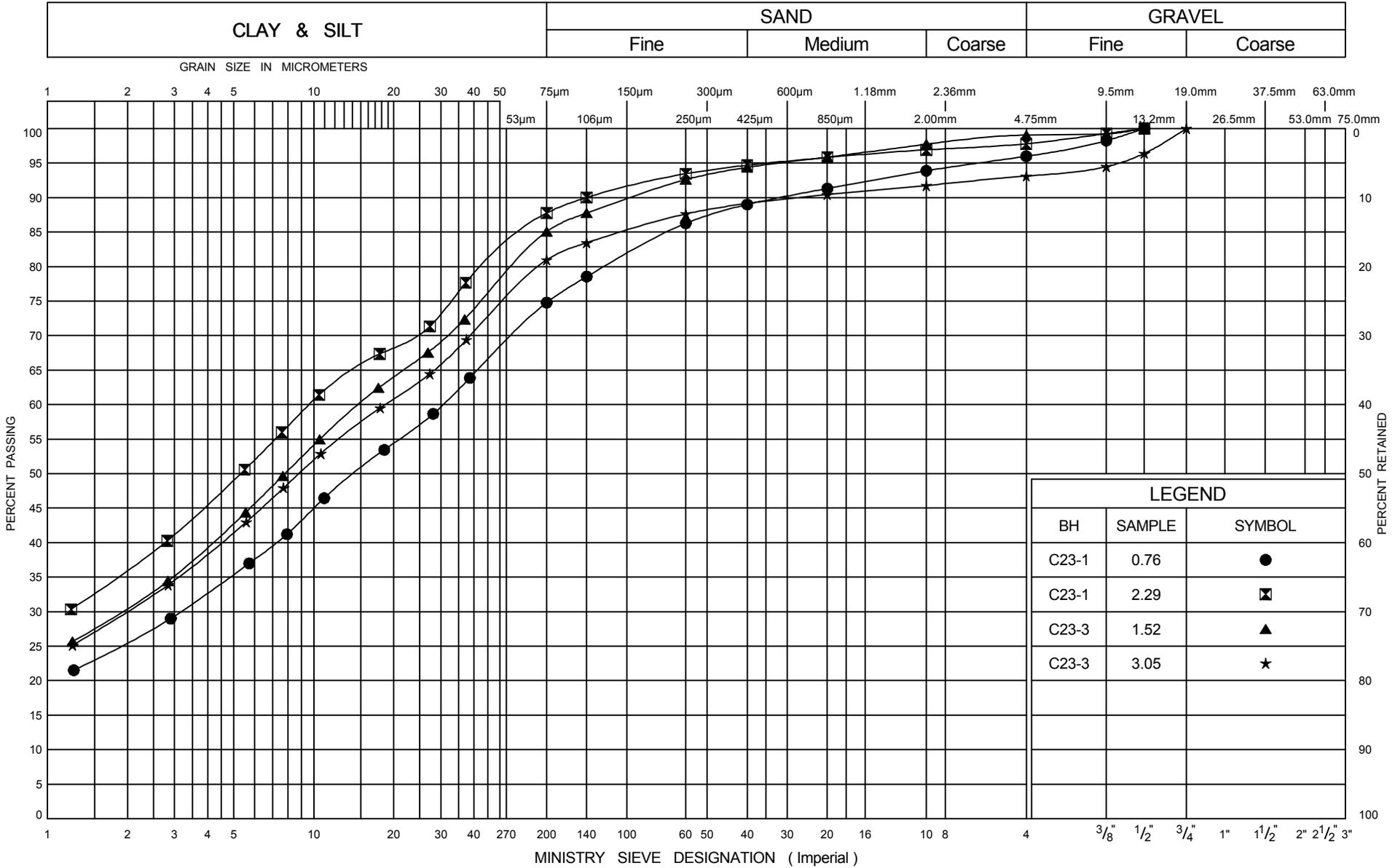
## GRAIN SIZE DISTRIBUTION FILL

FIG No C23-1

GWP 408-94-00

Highway 21-Kincardine to Tiverton

### UNIFIED SOIL CLASSIFICATION SYSTEM



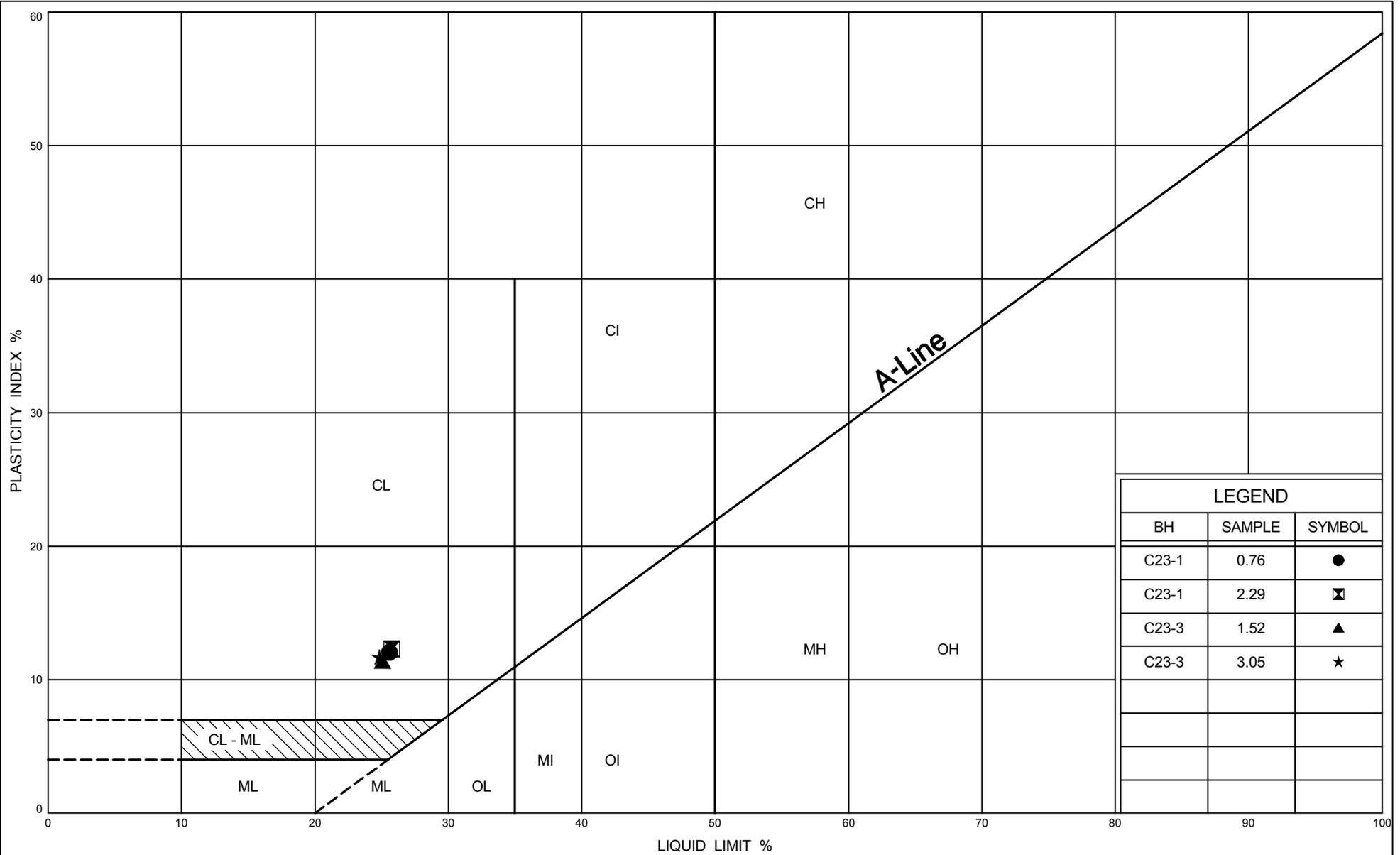
LEGEND		
BH	SAMPLE	SYMBOL
C23-1	0.76	●
C23-1	2.29	⊠
C23-3	1.52	▲
C23-3	3.05	★

ONTARIO MOT GRAIN SIZE 06-8-1EG2.GPJ ONTARIO MOT.GDT 4/17/07



**GRAIN SIZE DISTRIBUTION**  
**SILTY CLAY TILL (CL)**

FIG No C23-2  
GWP 408-94-00  
Highway 21-Kincardine to Tiverton



LEGEND		
BH	SAMPLE	SYMBOL
C23-1	0.76	●
C23-1	2.29	⊠
C23-3	1.52	▲
C23-3	3.05	★

ONTARIO MOT PLASTICITY CHART\_06-8-1EG2.GPJ\_ONTARIO MOT.GDT\_4/17/07



**PLASTICITY CHART**  
**SILTY CLAY TILL (CL)**

FIG No C23-3  
GWP 408-94-00  
Highway 21-Kincardine to Tiverton

**RECORD OF BOREHOLE No C24-1**

1 OF 1

**METRIC**

W.P. GWP 408-94-00 LOCATION Culvert No. 24 Northing - 4902941, Easting - 382202 ORIGINATED BY RB  
 DIST Owen Sound HWY 21 BOREHOLE TYPE 100mm SST Auger COMPILED BY JL  
 DATUM Geodetic DATE 9.26.06 - 9.26.06 CHECKED BY EC

SOIL PROFILE		SAMPLES			GROUND WATER CONDITIONS	ELEVATION SCALE	PENETR. RESISTANCE					PLASTIC NATURAL LIQUID			UNIT WEIGHT	REMARKS & GRAIN SIZE DISTRIBUTION (%)	
ELEV. DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE			"N" VALUES	STANDARD	DYN. CONE	W <sub>p</sub>	W	W <sub>L</sub>	WATER CONTENT (%)	γ			GR
242.59	Ground Surface																
0.00	FILL - 460mm sand and gravel (shoulder gravel)		1	AUGER													41 47 (12)
242.13			2	SS	31												
0.46	FILL Brown, moist, dense to loose, sand and gravel, some silt.		3	SS	8												62 30 (8)
240.46			4	SS	12												
2.13	FILL Brown, moist, compact, silty clay with embedded sand and gravel.		5	SS	37												
239.47			6	SS	26												
3.12	Brown Silty CLAY TILL (CL) Moist, very stiff to hard, with embedded sand and gravel.		7	SS	39												
	Grey																
237.56	End of borehole.																Borehole dry and open at completion.
5.03																	

JOE MTO 06-8-IEG2.GPJ ONTARIO.MOT.GDT 4/17/07

+ 3, X 3: Numbers refer to Sensitivity      ○ 150 UNCONFINE SHEAR STRENGTH INFERRED FROM POCKET PENETROMETER READINGS

**RECORD OF BOREHOLE No C24-2**

1 OF 1

**METRIC**

W.P. GWP 408-94-00 LOCATION Culvert No. 24 Northing - 4902933, Easting - 382196 ORIGINATED BY RB  
 DIST Owen Sound HWY 21 BOREHOLE TYPE 100mm SST Auger COMPILED BY JL  
 DATUM Geodetic DATE 9.26.06 - 9.26.06 CHECKED BY EC

SOIL PROFILE		SAMPLES			GROUND WATER CONDITIONS	ELEVATION SCALE	PENETR. RESISTANCE					PLASTIC NATURAL LIQUID			UNIT WEIGHT	REMARKS & GRAIN SIZE DISTRIBUTION (%)	
ELEV. DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE			"N" VALUES	STANDARD	DYN. CONE	W <sub>p</sub>	W	W <sub>L</sub>	WATER CONTENT (%)	γ			GR
239.98	Ground Surface																
0.00	TOPSOIL - 510mm.		1	SS	6												
239.47	FILL Brown to black, moist to wet, loose, consisting of silt, silty clay and organics.		2	SS	7												0 16 59 24 (84)
0.51																	
238.46	Brown		3	SS	20												
1.52	Silty CLAY TILL (CL) Moist, very stiff, with embedded sand and gravel.		4	SS	15												1 9 60 30 (90)
	Grey																
236.47	End of borehole.		5	SS	20												Borehole dry and open at completion.
3.51																	

JOE MTO 06-8-IEG2.GPJ ONTARIO.MOT.GDT 4/17/07

+ 3, X 3: Numbers refer to Sensitivity

○ 150 UNCONFINED SHEAR STRENGTH INFERRED FROM POCKET PENETROMETER READINGS

**RECORD OF BOREHOLE No C24-3**

1 OF 1

**METRIC**

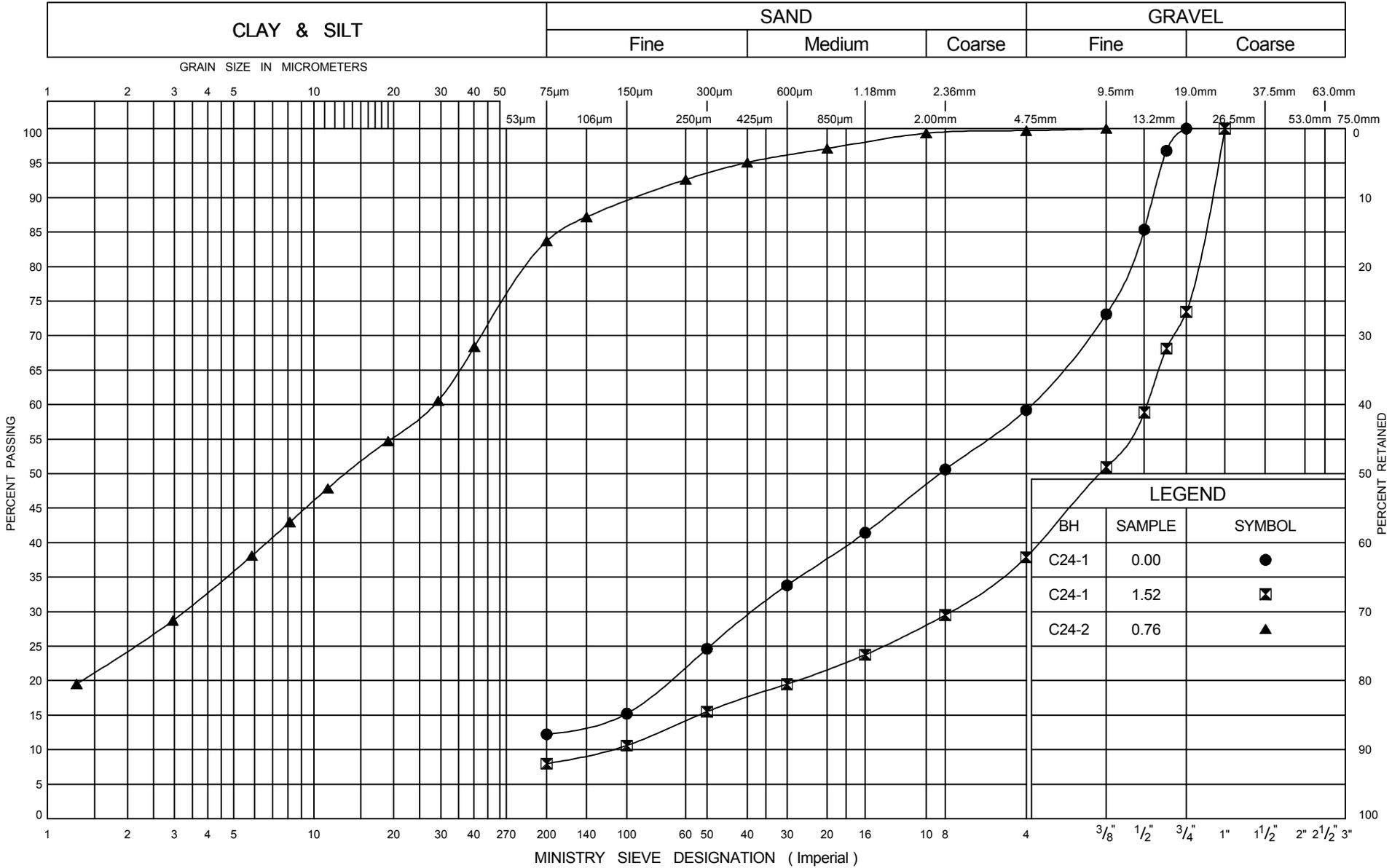
W.P. GWP 408-94-00 LOCATION Culvert No. 24 Northing - 4902959, Easting - 382213 ORIGINATED BY RB  
 DIST Owen Sound HWY 21 BOREHOLE TYPE 100mm SST Auger COMPILED BY JL  
 DATUM Geodetic DATE 9.26.06 - 9.26.06 CHECKED BY EC

SOIL PROFILE		SAMPLES			GROUND WATER CONDITIONS	ELEVATION SCALE	PENETR. RESISTANCE		PLASTIC LIMIT W <sub>p</sub>	NATURAL MOISTURE CONTENT w	LIQUID LIMIT W <sub>L</sub>	UNIT WEIGHT γ	REMARKS & GRAIN SIZE DISTRIBUTION (%)	
ELEV. DEPTH	DESCRIPTION	STRAT. PLOT	NUMBER	TYPE			"N" VALUES	STANDARD ●						DYN. CONE ○
241.88 0.00	Ground Surface													
240.81 1.07	FILL Dark brown to black, moist, loose to compact, consisting of topsoil and organics.  Brown Silty CLAY TILL (CL) Moist, stiff to very stiff, with embedded sand and gravel.  Grey		1	SS	7		●							
			2	SS	11		●			○	○			
			3	SS	27		●			○	○	○	225+	0 11 55 33 (88)
			4	SS	24		●			○	○	○	175	
			5	SS	27		●							0 14 57 29 (86)
238.37 3.51	End of borehole.												Borehole dry and open at completion.	

JOE MTO 06-8-IEG2.GPJ ONTARIO.MOT.GDT 4/17/07

+ 3, × 3: Numbers refer to Sensitivity ○ 150 UNCONFINED SHEAR STRENGTH INFERRED FROM POCKET PENETROMETER READINGS

### UNIFIED SOIL CLASSIFICATION SYSTEM



LEGEND		
BH	SAMPLE	SYMBOL
C24-1	0.00	●
C24-1	1.52	⊠
C24-2	0.76	▲

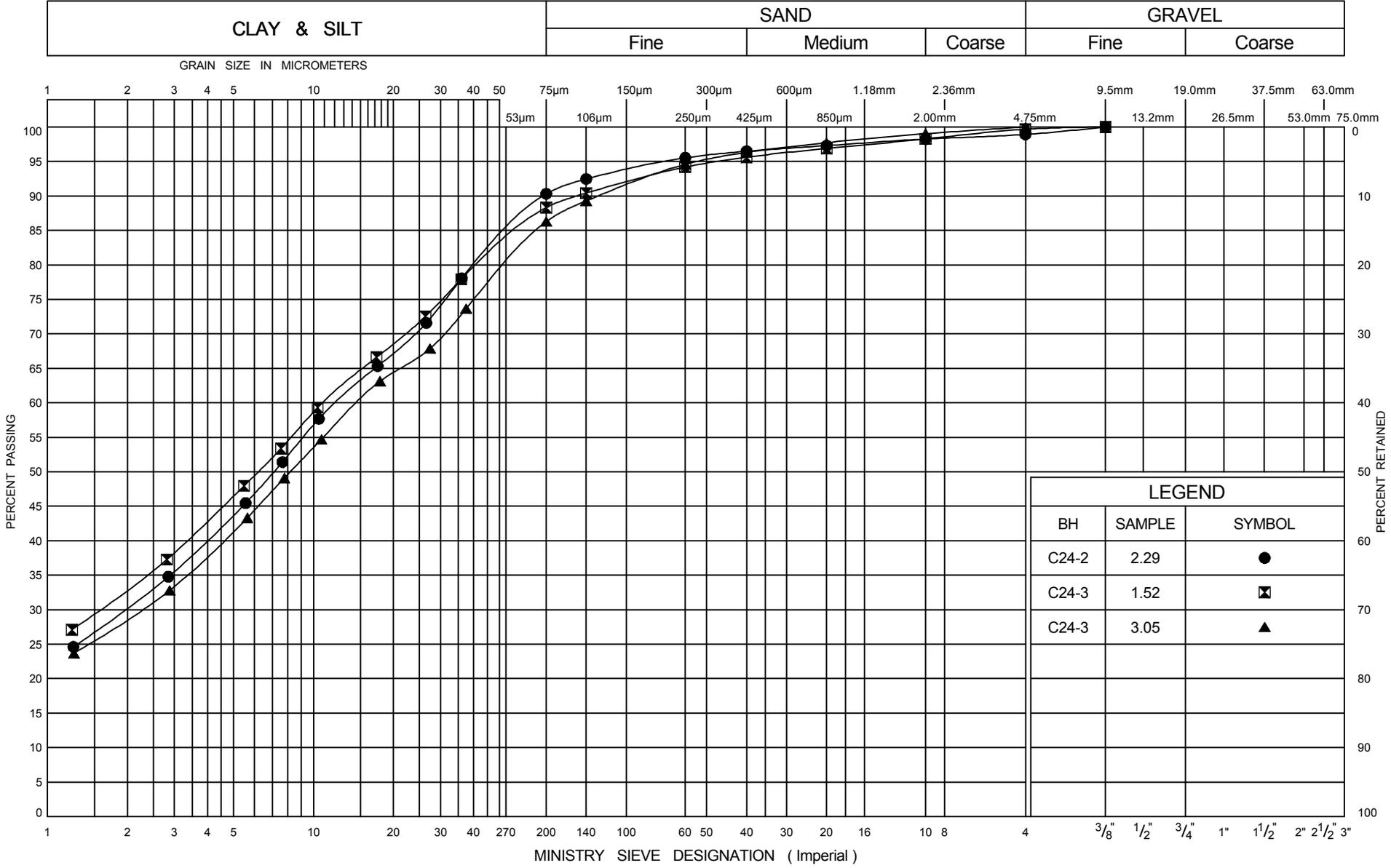
ONTARIO MOT GRAIN SIZE 06-8-1EG2.GPJ ONTARIO MOT.GDT 4/17/07



## GRAIN SIZE DISTRIBUTION FILL

FIG No C24-1  
GWP 408-94-00  
Highway 21-Kincardine to Tiverton

UNIFIED SOIL CLASSIFICATION SYSTEM



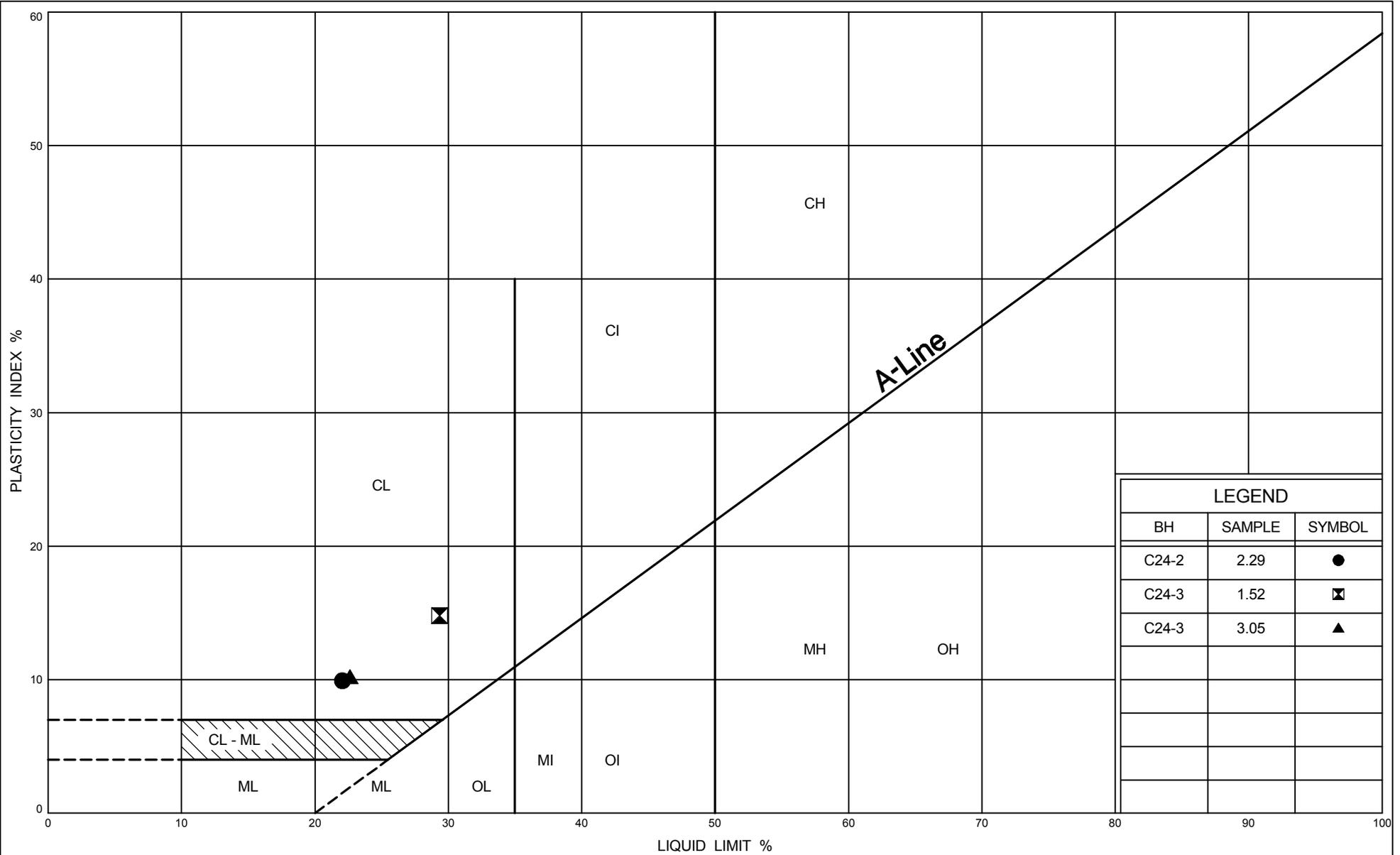
LEGEND		
BH	SAMPLE	SYMBOL
C24-2	2.29	●
C24-3	1.52	⊠
C24-3	3.05	▲

ONTARIO MOT GRAIN SIZE 06-8-1EG2.GPJ ONTARIO MOT.GDT 4/17/07



GRAIN SIZE DISTRIBUTION  
SILTY CLAY TILL (CL)

FIG No C24-2  
GWP 408-94-00  
Highway 21-Kincardine to Tiverton



LEGEND		
BH	SAMPLE	SYMBOL
C24-2	2.29	●
C24-3	1.52	⊠
C24-3	3.05	▲

ONTARIO MOT PLASTICITY CHART\_06-8-1EG2.GPJ\_ONTARIO MOT.GDT\_4/17/07



**PLASTICITY CHART**  
**SILTY CLAY TILL (CL)**

FIG No C24-3  
GWP 408-94-00  
Highway 21-Kincardine to Tiverton

Ministry of Transportation/SNC-LAVALIN  
G.W.P. 408-94-00  
Reconstruction of Highway 21 from Kincardine northerly to Tiverton  
Agreement # 3005-E-0038

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## Appendix C

### Site Photographs



Culvert C-1, overall view



Culvert C-1, east inlet end



Culvert C-1, west outlet end



Culvert C-2, overall view



Culvert C-2, east inlet end



Culvert C-2, west outlet end



Culvert C-3, overall view



Culvert C-3, east inlet end



Culvert C-3, west outlet end



Culvert C-4, overall view



Culvert C-5, east inlet side



Culvert C-5, west outlet side



Culvert C-6, east inlet side



Culvert C-6, west outlet side



Culvert C-7, east inlet side



Culvert C-7, west outlet side



Culvert C-8, east inlet side



Culvert C-8, west outlet side



Culvert C-9, east inlet side



Culvert C-9, west outlet side



Culvert C-10, overall view



Culvert C-10, east inlet side



Culvert C-10, east inlet side



Culvert C-11, overall view



Culvert C-11, east inlet side



Culvert C-11, west outlet side



Culvert C-12, east inlet side



Culvert C-12, west outlet side



Culvert C-13, overall view



Culvert C-13, east inlet side



Culvert C-13, west outlet side



Culvert C-14, east inlet side



Culvert C-14, west outlet side



Culvert C-15, overall view



Culvert C-15, east inlet side



Culvert C-15, west outlet side



Culvert C-16, east inlet side



Culvert C-16, west outlet side



Culvert C-17, overall view



Culvert C-17, east inlet side



Culvert C-17, west outlet side



Culvert C-18, east inlet side



Culvert C-18, west outlet side



Culvert C-19, east inlet side



Culvert C-19, west outlet side



Culvert C-20, overall view



Culvert C-20, east inlet side



Culvert C-20, west outlet side



Culvert C-21, overall view



Culvert C-21, east inlet side



Culvert C-21, west outlet side



Culvert C-22, overall view



Culvert C-22, east inlet side



Culvert C-22, west outlet side



Culvert C-23, overall view



Culvert C-23, north inlet side



Culvert C-23, south outlet side



Culvert C-24, overall view



Culvert C-24, north inlet side



Culvert C-24, south outlet side



Reference Chainage STA 16+900



Chainage STA 16+942 (location of 900 CSP)



Inlet of 900 Culvert @ STA 16+942 (east side)



Catchbasin covered with metal plate @ STA 16+942 (east side)



Catchbasin grate @ STA 16+942 (west side)



Outlet (buried) of 900 Culvert @ STA 16+942 (west side)



Chainage STA 16+950 (location of 250 CSP)



Outlet of 250 Culvert @ STA 16+950 (west side)



Borehole Location on west side of 250 Culvert @ STA 16+950



Pumping Station at west side of 250 culvert @ STA 16+950



Pumping Station at west side of 250 culvert @ STA 16+950



Catchbasin in field west of STA 16+950



STA 16+950 east side, catchbasin covered with metal plate



STA 16+950 - east end of culvert (buried)



STA 16+950 - east end of culvert (buried)



STA 16+950 - Borehole Location on east side



Chainage STA 16+967



East end of 600 Culvert C4 at STA 16+967



East end of 600 Culvert C4 at STA 16+967



STA 16+967 - transverse crack on pavement above Culvert C4 looking west



STA 16+967 - transverse crack on pavement above Culvert C4 looking east



West end of 600 Culvert C4 @ STA 16+967



West end of 600 Culvert C4 @ STA 16+967



General view looking south



General view looking north

Ministry of Transportation/SNC-LAVALIN  
G.W.P. 408-94-00  
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## Appendix D

### Limitations of Report

## **APPENDIX D**

### **LIMITATIONS OF REPORT**

The conclusions and recommendations given in this report are based on information determined at the testhole locations. Subsurface and groundwater conditions between and beyond the testholes may differ from those encountered at the testhole locations, and conditions may become apparent during construction which could not be detected or anticipated at the time of the site investigation. It is recommended practice that the Soils Engineer be retained during construction to confirm that the subsurface conditions throughout the site do not deviate materially from those encountered in the testholes.

The comments made in this report on potential construction problems and possible methods are intended only for the guidance of the designer. The number of testholes may not be sufficient to determine all the factors that may affect construction methods and costs. For example, the thickness of surficial topsoil or fill layers may vary markedly and unpredictably. The contractors bidding on this project or undertaking the construction should, therefore, make their own interpretation of the factual information presented and draw their own conclusion as to how the subsurface conditions may affect their work.

The benchmark and elevations mentioned in this report were obtained strictly for use in the geotechnical design of the project and by this office only, and should not be used by any other parties for any other purposes.

Any use which a third party makes of this report, or any reliance on or decisions to be made based on it, are the responsibility of such third parties. Infrastructure Engineering Group Inc. accepts no responsibility for damages, if any, suffered by any third party as a result of decisions made or actions based on this report.

This report does not reflect the environmental issues or concerns unless otherwise stated in the report.

The design recommendations given in this report are applicable only to the project described in the text and then only if constructed substantially in accordance with the details stated in this report. Since all details of the design may not be known, IEG recommends that we be retained during the final design stage to verify that the design is consistent with our recommendations, and that assumptions made in our analysis are valid.