FOUNDATION INVESTIGATION
AND DESIGN REPORT
PROPOSED RECONSTRUCTION OF
SEVENTEEN (17) NON-STRUCTURAL CULVERTS
TOWNSHIP OF ST. VINCENT AND COLLINGWOOD
HIGHWAY 26 FROM MEAFORD TO THORNBURY

G.W.P. 57-00-00
Agreement # 3006-E-0002

I.E. Group

MTO GEOCRES No. 41A-207

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PART A – FOUNDATION INVESTIGATION

1.0 INTRODUCTION

This report presents the results of a foundation investigation carried out in July, August and September 2007 by Infrastructure Engineering Group Inc. (IEG) on behalf of Stantec Consulting Ltd. (Stantec).

This assignment involves the rehabilitation of the pavement structure on Highway 26 from 0.2 km east of the Thornbury west limit (Peel Street) westerly 10.06 km to the Town of Meaford east limit.

It includes the rehabilitation and extension of two existing structural culverts, as well as many non-structural culvert extensions and replacements. The project also includes intersection realignments, intersection improvements, construction of two new 1.5 km long passing lanes, minor horizontal and vertical alignment improvements and electrical work. The original assignment included the re-alignment of the Blue Mountains/Meaford Town Line which has been deleted from the assignment.

Foundation investigation and recommendations are required for the design and construction of culvert replacements and extension as part of the improvement of Highway 26. Two (2) structural culverts, twenty-four (24) non-structural culverts, two shale bin replacements, and a high cut area are to be investigated. There is a change in the scope of work to include two additional culvert extensions which were not part of the original scope of work for foundation investigations, and re-allocation of the foundations investigation work for three (3) CSP culverts to the geotechnical investigation portion of this assignment. This report covers the seventeen (17) non-structural culverts in the St. Vincent and Collingwood Township.

Seventeen (17) non-structural culverts are proposed for extensions at one or both ends as per the information supplied by the RFP documents and subsequent changes to the scope of work. The reinforced concrete shale bin at the upstream (south) end of Culvert 11A is to be replaced with a new permanent shale bin. The locations of these structures are shown in Appendix A, Borehole Location Plan, Drawings 1 and 2, and summarized in Table 1which also indicates the locations, dimensions, existing structure types and the intended work for these culverts.

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 work presented herein was undertaken under MTO G.W.P. 57-00-00, Agreement No. 3006-E-0002. Authorization to complete this assignment was given by Mr. Dan Green, P. Eng., of Stantec Consulting Ltd., the TPM Consultant who is completing this assignment for MTO under Agreement # 3006-E-0002.

Table 1
Summary of Existing Location, Structure Type, Dimensions

Culvert #	New Chainage (m)	Existing Culvert Type and Size (W X H X L)	Existing Overfill (m)	Intended Work
Township of St. Vincent				
01A	23+476	910 x 910 x 24.53 RFO	2.6	Extend north (outlet) end of culvert by 2.9 m Extend south (inlet) end of culvert by 3.2 m Off-take ditching
04A	24+527	1520 x 910 x 23.43 NRFO	1.0	Extend south (inlet) end of culvert
07A	25+720	910 x 910 x 18.29 NRFO	0.6	Extend north (outlet) end of culvert by 6.1 m Rip rap protection at inlet
08A	26+027	910 x 910 x 18.30 NRFO	0.6	Extend north (outlet) end of culvert by 4.7 m Off-take ditching, structural repair to end
09A	26+371	910 x 910 x 18.37 NRFO	0.6	Extend north (outlet) end of culvert by 3.4 m Off-take ditching, structural repair to end
10A	26+606	1520 x 910 x 25.5 NRFO	2.3	Extend north (outlet) end of culvert by 1.7 m Extend south end (inlet) end of culvert by 3.8 m Rip rap protection required at both ends and through culvert
11A	26+874	2440 x 1220 x 19.7 NRFB	1.1	Extend north (outlet) end of culvert by 3.2 m Extend south (inlet) end of culvert by 3.6 m Provide new permanent shale bin at upstream end (south) to replace existing shale bin
13A	27+293	910 x 1220 x 20.99 NRFO	1.8	Extend north (outlet) end of culvert by 2.2 m Structural repair to north end
14A	27+500	1520 x 910 x 20.01 NRFO	1.3	Extend north (outlet) end of culvert by 4.7 m Structural repair to north end
15A	27+868	1520 x 910 x 17.96 NRFB	1.7	Extend north (outlet) end of culvert by 7.6 m Extend south (inlet) end of culvert by 2.1 m
16A	28+126	1220 x 910 x 19.12 NRFB	1.3	Extend north (outlet) end of culvert by 5.0 m
17A	28+292	910 x 910 x 17.82 NRFB	1.2	Extend north (outlet) end of culvert by 6.0 m Off-take ditching
18A	28+402	1520 x 910 x 19.20 NRFB	1.4	Extend north (outlet) end of culvert by 6.0 m
19A	28+672	1520 x 910 x 19.20 NRFB	1.2	Extend north (outlet) end of culvert by 4.9 m Off-take ditching
Township of Collingwood				
23A	10+623	900 x 900 x 17.68 NRFO	1.2	Extend north (outlet) end of culvert by 2.7 m Extend south (inlet) end of culvert by 2.0 m
28A	13+863	900 x 900 x 24.10 NRFO	1.0	Extend south (inlet) end of culvert
29A	14+160	1520 x 900 x 17.51 NRFO	0.9	Extend south (inlet) end of culvert

2.0 SITE DESCRIPTION

2.1 Site Location

These seventeen (17) non-structural culverts are located on Highway 26, approximately 0.3 km to 19.9 km east of the east town limit of Meaford (STA 23+206). Table 1 summarizes the locations, existing structure types and dimensions of the existing culverts and the intended work for each culvert, as recommended by the PDR and provided in the RFP documents, and subsequent changes in the scope of work to include Culverts 28A and 29A. Locations of the individual culverts are illustrated in the Borehole Location Plan, Drawings 1 and 2 presented in Appendix A.

The existing concrete culverts are in good conditions and have adequate hydraulic capacity. The extensions are required in order to accommodate the pavement widening as well as intersection and geometric improvements.

These culvert sites are generally located within drainage valleys or surface water flow paths. The overfill heights range approximately between 0.6 m and 2.6 m. 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 March 2006 by Stantec and during the field work by IEG are provided in Appendix C.

2.2 Physiography and Topography

The Town of Meaford is situated at the mouth of the Bighead River where the river enters Nottawasaga Bay, part of the Georgian Bay of Lake Huron.

The subsurface of the Town of Meaford is comprised of predominately silty clay, and smooth to gently sloping topography. Pockets of sand and gravelly sands exist which also exhibit smooth to gently sloping topography.

The Town is located on the coastal plain left by glacial Lake Algonquin. East of Meaford, the Algonquin shore cliff coincides with the base of the Niagara Escarpment. The coastal plain in this area consists of sand and gravel beach terraces overlying the bedrock. Overburden thickness is generally less than 5 m. Bedrock consists of the shale and limestones of the Georgian Bay Formation. Grey, impure carbonate beds (limestone and dolomite) alternate with grey and blue/grey shale.

West of Meaford, the coastal plain consists of the same beach deposits as found in the east. To the west away from the Lake, overburden becomes glacio-lacustrine derived silt to clayey till. Numerous drumlins of calcareous till with red shale inclusions are found in the Meaford area.

Progressing west on Highway 26 toward Owen Sound and the Niagara Escarpment, the bedrock types progress from Queenston shales, the Clinton and Cataract shales and dolomites to the cap rock of the Amabel dolomites and limestones. Overburden thickness can be as much as 15 m, but is generally less than 5 m.

3.0 INVESTIGATION PROCEDURES

3.1 Field Investigation

In July, August and September, 2007, a Bombardier-mounted Diedriech drill rig and a truck-mounted CME 55 drill rig, supplied and operated by London Soil Test Ltd. of London, were used on site for drilling and Standard Penetration Testing (SPT, following the procedures of ASTM D 1586). Two boreholes (extension on one end) to three boreholes (extensions on both ends) at each site were drilled and sampled to obtain data for foundation and bedding design of the proposed culvert extensions. The boreholes were drilled to a minimum depth of 3.0 m for these non-structural culverts (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 extension and shale bin replacements.

The boreholes were advanced using continuous flight solid stem and hollow stem augers. 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.

The culvert borehole numbering system was established from the catchment area numbering system used in the Drainage Report of this project, as agreed with Stantec. A letter “A” or “B” was also added after the culvert numbers to delineate Part A or Part B of this assignment.

For the purpose of proper management of the Borehole Logs within gINT, the borehole logging software, a preceding 0 was added to the culverts with a letter “A” or “B”, and the last number being the borehole at the culvert site, i.e., “01A-1” refers to Borehole 1 at the location of Culvert 01A, etc.

Field pocket penetrometer was used on the retrieved SPT samples, where applicable, 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.

At the site of Culvert 01A, dynamic cone penetration tests were carried out to confirm the compactness condition of the saturated sand and silt deposits, as the SPT values were suspected to have been affected by the hydrostatic pressure during sampling. Where soft to firm silty clay deposit was encountered at Culvert 29A, the shear strength was determined by in situ shear vane tests. Thin-walled Shelby tube samples were obtained for laboratory consolidation test.

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 IEG 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.

A one-dimensional consolidation test (ASTM D 2435) was conducted on a relatively undisturbed thin-walled (Shelby tube) sample obtained from Borehole 29A-2A at a depth of 4.57 m. The consolidation test was carried out by Trow Associates Inc. of Brampton and the results are provided in a Void Ratio versus Pressure Curve plot enclosed in Appendix B as Figure C-29A.7.

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.

In general, the subsurface deposits encountered in the boreholes put down on the shoulder area at the culvert sites consist of loose to compact embankment fill placed on loose to compact sandy silt and compact sand and gravel at Culverts 01A and 04A. At the other fifteen (15) culverts, the topsoil and embankment fill were placed on stiff to hard silty clay till. Locally at Culverts 28A and 29A, there were frequent clayey silt layers within the silty clay till deposit. Localized stiff layers of limited thickness were encountered at Boreholes 10A-3, 11A-2, 11A-3, 13A-1, 17A-1, 17A-2 and 28A-1 and firm to stiff layers (approximately 3 to 4 m thick) in Boreholes 29A-1 and 29A-2.

4.1 Fill, Topsoil

The boreholes at the shoulders generally encountered a 0.23 to 0.76 m thick layer of granular fill (shoulder gravel). The shoulder gravel is underlain by mixed fill materials consisting of predominantly silty clay to clayey silt with sand, gravel and localized zones of organic inclusions, and extended to or slightly below the bottom of the culverts. Locally at Culvert 01, the fill extended to a depth of 6.71 m, much deeper than the anticipated culvert founding level.

The boreholes near the ends of the existing culverts generally encountered a 0.1 to 0.4 m thick layer of topsoil.

Standard penetration tests taken in the mixed fill yielded “N”-values from 1 to 33 blows per 0.3 m. The fill materials were typically loose to compact with very loose condition uncovered at a few locations, particularly at Culvert 01A.

The measured natural moisture contents of the mixed fill ranged from 5 to 48%. The higher moisture contents reflect the presence of topsoil and organic matters, as well as wet silty clay.

Grain size distributions of these fill materials are shown on the first figure of the corresponding culvert site in Appendix B, e.g. Figure C-01A.1 refers to the first figure of Culvert 01A, etc.

Table of Figures of Laboratory Test Results

Culvert Number	Grain Size Figure	Atterberg Limits Figure
01A	C-01A.1	C-01A.2
04A	C-04A.1	C-04A.2
07A	C-07A.1	N/A
08A	C-08A.1	N/A
10A	C-10A.1	C-10A.2
11A	C-11A.1	C-11A.2
13A	C-13A.1	C-13A.2
14A	C-14A.1	C-14A.2
15A	C-15A.1	C-15A.2
16A	C-16A.1	C-16A.2
23A	C-23A.1	C-23A.2
28A	C-28A.1	C-28A.2
29A	C-29A.1	C-29A.2

Eighteen (18) Atterberg Limits determinations were carried out and yielded the following results:

Atterberg Limits	Minimum	Maximum	Average
Liquid Limit (W_L), %	24.0	76.0	37.4
Plastic Limit (W_P), %	13.0	35.0	21.4
Plasticity Index (I_p), %	3.0	41.0	16.0

Unit weight of the fill was only determined on six samples due to the disturbance of the soil samples during sampling and sample retrieval. The unit weight of the silty clay to clayey silt fill was measured to be between 17.7 and 24.1 kN/m^3, with an average of 22.1 kN/m^3.

4.2 Silty Sand, Sandy Silt to Sand and Gravel (SM, ML, GM)

At Culverts 01A and 04A, granular deposits of sand and silt, gravelly sand to sand and gravel were encountered below the embankment fill and topsoil. Standard penetration tests yielded "N"-values of 3 to 15 blows per 0.3 m within the sand and silt or the sandy silt at Boreholes 01A-1, 01A-2 and 04A-1, indicative of very loose to compact compactness condition. Dynamic cone penetration tests in Boreholes 01A-2 and 01A-3 confirmed that the sand and silt deposit was in loose compactness condition. The natural moisture contents were between 9 and 21%.

At Boreholes 04A-1 and 04A-2, a gravelly sand to sand and gravel deposit was encountered below the embankment fill or the sandy silt layer. Standard penetration tests yielded "N"-values of 16 to over 100 blows per 0.3 m, indicative of compact to very dense compactness condition.

Minor and localized pockets of silty sand and gravel and sand were respectively encountered below the topsoil at Borehole 10A-1, and below the silty clay till stratum at Borehole 11A-2. The silty clay till was underlain by a fine sand layer (0.76 m thick) at the location of Borehole 13A-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

Culvert Number	Grain Size Figure	Atterberg Limits Figure
01A	C-01A.3	C-01A.4
04A	C-04A.3	N/A
13A	C-13A.5	N/A

The results of the Atterberg Limits test on the sand and silt are provided below:

Liquid Limit (W_L)	17%
Plastic Limit (W_P)	13%
Plasticity Index (I_p)	4%

4.3 Silty Clay Till (CL-CH)

With the exception of Culverts 01A and 04A, the topsoil layer at the ends of the culvert and under the embankment fill were underlain by silty clay till stratum which typically extended to the full depths of boreholes. At Boreholes 11A-2 and 13A-1, the silty clay till was underlain by silty sand and gravel and sand pockets. Locally, at Culverts 28A and 29A, there were frequent clayey silt to sandy clayey silt layers (CL-ML) within the silty clay till deposit.

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

Culvert Number	Grain Size Figure	Atterberg Limits Figure
01A	C-01A.3	C-01A.4
07A	C-07A.2	C-07A.3
08A	C-08A.2	C-08A.3
09A	C-09A.1	C-09A.2
10A	C-10A.3	C-10A.4
11A	C-11A.3	C-11A.4
13A	C-13A.3	C-13A.4
14A	C-14A.3	C-14A.4
15A	C-15A.3	C-15A.4
16A	C-16A.3	C-16A.4
17A	C-17A.1	C-17A.2
18A	C-18A.1	C-18A.2
19A	C-19A.1	C-19A.2
23A	C-23A.3	C-23A.4
28A	C-28A.3	C-28A.4
29A	C-29A.3 & C-29A.5	C-29A.4 & C-29A.6

Sixty-two (62) Atterberg Limits determinations yielded the following results:

Atterberg Limits	Minimum	Maximum	Average
Liquid Limit (W_L), %	23.0	59.0	37.6
Plastic Limit (W_P), %	15.0	30.0	20.8
Plasticity Index (I_p), %	8.0	29.0	16.8

The natural moisture contents were between 8 and 26%. The unit weight of the silty clay till was measured between 17.1 and 25.5 kN/m^3, with an average of 22.3 kN/m^3.

Standard penetration tests taken within the silty clay till yielded "N"-values from 8 to over 100 blows per 0.3 m. Undrained shear strength of the silty clay till generally increased with increasing depths. Localized stiff layers of limited thickness were encountered at Boreholes 10A-3, 11A-2, 11A-3, 13A-1, 17A-1, 17A-2 and 28A-1 and firm to stiff layers (approximately 3 to 4 m thick) in Boreholes 29A-1 and 29A-2.

Based on the above field and laboratory test results, together with visual and tactile examination, the silty clay till deposit generally exhibited very stiff to hard consistency with localized stiff conditions.

A one-dimensional consolidation test (ASTM D 2435) was conducted on a relatively undisturbed thin-walled (Shelby tube) sample of the firm to stiff layer taken from Borehole 29A-2A at a depth of 4.57 m. These results are shown in Figure C-29A.7 of Appendix B and summarized below:

Sample Depth:	4.57 m
Elevation:	189.95 m
Liquid Limit (W_L)	31%
Plastic Limit (W_P)	20%
Natural Moisture Content (W)	28 %
Compression Index (C_C)	0.192
Recompression Index (C_r)	0.026
Pre-consolidation Pressure (σ_p)	190 kPa
Effective Overburden Pressure (σ'_{vo})	99 kPa

4.4 Shale Till Complex to Shale Bedrock

The sand and silt at Boreholes 01A-2 and 01A-3 was underlain by a shale till complex at depths of 8.69 m (207.82 m) and 4.88 m (elevation 207.86 m). At Borehole 13A-1, the sand pocket was underlain by grey weathered shale bedrock at a depth of 5.64 m (elevation 228.07 m).

A grain size analysis 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

Culvert Number	Grain Size Figure	Atterberg Limits Figure
01A	C-01A.5	C-01A.6

The results of the Atterberg Limits test are provided below:

Liquid Limit (W_L)	30%
Plastic Limit (W_P)	19%
Plasticity Index (I_p)	11%

Standard penetration tests yielded "N"-values over 100 blows per 0.3 m. The measured natural moisture contents ranged from 9 to 14%. The unit weight of a single sample was measured to be 24.1 kN/m^3.

4.5 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.

	Groundwater Levels - Depth/Elevation (m)		
Culvert Number	**Borehole 1**	**Borehole 2**	**Borehole 3**
01A	3.65/212.67	5.50/211.01	1.80/210.94
04A	BD&O	BD&O	Not Required
07A	3.35/227.62	1.05/227.93 *	Not Required
08A	BD&O	BD&O	Not Required
09A	4.15/227.97	1.00/229.60 *	Not Required
10A	0.45/235.51	2.75/230.40	1.65/227.99
11A	4.10/230.93	BD&O	BD&O
13A	2.30/231.41	1.65/229.37	Not Required
14A	2.90/229.56	3.00/227.71	Not Required
15A	BD&O	2.10/229.30	1.50/227.89
16A	BD&O	BD&O	Not Required
17A	2.30/230.20	BD&O	Not Required
18A	4.40/228.86	BD&O	Not Required
19A	BD&O	BD&O	Not Required
23A	2.00/232.92	5.50/229.39	1.30/231.45
28A	BD&O	BD&O	Not Required
29A	BD&O	6.00/188.52	Not Required

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

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

At Culverts 07A and 09A, the water levels rose quickly after final sampling to depths of 1.05 and 1.00 m. This could suggest a hydrostatic connection between the upper and lower strata within the silty clay till, and a potential artesian condition exists.

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 extensions of the seventeen (17) non-structural culverts in the St. Vincent and Collingwood Township, 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.

These seventeen (17) non-structural culverts are located on Highway 26, approximately 0.3 km to 19.9 km east of the east town limit of Meaford (STA 23+206). Table 1 summarizes the locations, existing structure types and dimensions of the existing culverts and the intended work for each culvert, as recommended by the PDR and provided in the RFP documents, and subsequent changes in the scope of work to include Culverts 28A and 29A. Locations of the individual culverts are illustrated in the Borehole Location Plan, Drawings 1 and 2 presented in Appendix A.

The existing concrete culverts are in good conditions and have adequate hydraulic capacity, as determined by others. The extensions at one or both ends of each culvert are required in order to accommodate the pavement widening as well as intersection and geometric improvements. The reinforced concrete shale bin at the upstream (south) end of Culvert 11A is to be replaced with a new permanent shale bin.

These culvert sites are generally located within drainage valleys or surface water flow paths. The overfill heights range approximately between 0.6 m and 2.6 m. 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 March 2006 by Stantec and during the field work by IEG are provided in Appendix C.

In general, the subsurface deposits encountered in the boreholes put down on the shoulder area at the culvert sites consist of loose to compact embankment fill placed on loose to compact sandy silt and compact sand and gravel at Culverts 01A and 04A. At the other fifteen (15) culverts, the topsoil and embankment fill were placed on stiff to hard silty clay till. Locally at Culverts 28A and 29A, there were frequent clayey silt layers within the silty clay till deposit. Localized stiff layers of limited thickness were encountered at Boreholes 10A-3, 11A-2, 11A-3, 13A-1, 17A-1,

17A-2 and 28A-1 and firm to stiff layers (approximately 3 to 4 m thick) in Boreholes 29A-1 and 29A-2.

Table 1
Summary of Existing Location, Structure Type, Dimensions

Culvert #	New Chainage (m)	Existing Culvert Type and Size (W X H X L)	Existing Overfill (m)	Intended Work
Township of St. Vincent				
01A	23+476	910 x 910 x 24.53 RFO	2.6	Extend north (outlet) end of culvert by 2.9 m Extend south (inlet) end of culvert by 3.2 m Off-take ditching
04A	24+527	1520 x 910 x 23.43 NRFO	1.0	Extend south (inlet) end of culvert
07A	25+720	910 x 910 x 18.29 NRFO	0.6	Extend north (outlet) end of culvert by 6.1 m Rip rap protection at inlet
08A	26+027	910 x 910 x 18.30 NRFO	0.6	Extend north (outlet) end of culvert by 4.7 m Off-take ditching, structural repair to end
09A	26+371	910 x 910 x 18.37 NRFO	0.6	Extend north (outlet) end of culvert by 3.4 m Off-take ditching, structural repair to end
10A	26+606	1520 x 910 x 25.5 NRFO	2.3	Extend north (outlet) end of culvert by 1.7 m Extend south end (inlet) end of culvert by 3.8 m Rip rap protection required at both ends and through culvert
11A	26+874	2440 x 1220 x 19.7 NRFB	1.1	Extend north (outlet) end of culvert by 3.2 m Extend south (inlet) end of culvert by 3.6 m Provide new permanent shale bin at upstream end (south) to replace existing shale bin
13A	27+293	910 x 1220 x 20.99 NRFO	1.8	Extend north (outlet) end of culvert by 2.2 m Structural repair to north end
14A	27+500	1520 x 910 x 20.01 NRFO	1.3	Extend north (outlet) end of culvert by 4.7 m Structural repair to north end
15A	27+868	1520 x 910 x 17.96 NRFB	1.7	Extend north (outlet) end of culvert by 7.6 m Extend south (inlet) end of culvert by 2.1 m
16A	28+126	1220 x 910 x 19.12 NRFB	1.3	Extend north (outlet) end of culvert by 5.0 m
17A	28+292	910 x 910 x 17.82 NRFB	1.2	Extend north (outlet) end of culvert by 6.0 m Off-take ditching
18A	28+402	1520 x 910 x 19.20 NRFB	1.4	Extend north (outlet) end of culvert by 6.0 m
19A	28+672	1520 x 910 x 19.20 NRFB	1.2	Extend north (outlet) end of culvert by 4.9 m Off-take ditching
Township of Collingwood				
23A	10+623	900 x 900 x 17.68 NRFO	1.2	Extend north (outlet) end of culvert by 2.7 m Extend south (inlet) end of culvert by 2.0 m
28A	13+863	900 x 900 x 24.10 NRFO	1.0	Extend south (inlet) end of culvert
29A	14+160	1520 x 900 x 17.51 NRFO	0.9	Extend south (inlet) end of culvert

5.2 Summarized Construction Conditions

The following table summarizes the anticipated founding subgrade conditions during excavations, frost taper, bedding and backfill requirements and the excavation/cut slope methodology, along with the applicable OPSD's for construction of the proposed culvert extensions. The anticipated foundation subgrade was established based on the existing invert elevations, 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.

Table 2 - Summary of Construction Conditions

Culvert #	ANTICIPATED FOUNDING SUBGRADE	FROST TAPER BEDDING, BACKFILL	OHSA & O.Reg. 213/91 EXCAVATION SOIL TYPE
Township of St. Vincent			
01A	organic fill over loose to very loose sandy silt to sand & silt	OPSD 803.010	TYPES 3 AND 4
04A	fill over compact sandy silt to gravelly sand & sand and gravel	OPSD 803.010	TYPE 3
07A	fill over very stiff to hard silty clay till	OPSD 803.010 *	TYPES 3 AND 4
08A	fill over very stiff to hard silty clay till	OPSD 803.010	TYPE 3
09A	very stiff to hard silty clay till	OPSD 803.010 *	TYPES 3 AND 4
10A	very stiff to hard silty clay till	OPSD 803.010	TYPES 3 AND 4
11A	stiff to hard silty clay till	OPSD 803.010	TYPE 3
13A	stiff to hard silty clay till	OPSD 803.010	TYPES 3 AND 4
14A	fill over very stiff to hard silty clay till	OPSD 803.010	TYPES 3 AND 4
15A	fill over very stiff to hard silty clay till	OPSD 803.010	TYPES 3 AND 4
16A	very stiff to hard silty clay till	OPSD 803.010	TYPE 3
17A	stiff to hard silty clay till	OPSD 803.010	TYPE 3
18A	very stiff to hard silty clay till	OPSD 803.010	TYPE 3
19A	very stiff to hard silty clay till	OPSD 803.010	TYPE 3
Township of Collingwood			
23A	fill over very stiff to hard silty clay till	OPSD 803.010	TYPE 3
28A	very stiff to hard silty clay to clayey silt till	OPSD 803.010	TYPE 3
29A	firm to stiff silty clay to clayey silt till	OPSD 803.010	TYPE 3

Note: * means potential hydrostatic condition

5.3 Closed Box Culvert Extensions

The closed box culvert extensions 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.

A potential for artesian condition exists at Culverts 07A and 09A, based on preliminary assessment on the observations of the groundwater table during field sampling. During excavation for the culvert, signs of artesian/hydrostatic condition taken place should be assessed by the geotechnical engineer. If piping is deemed a concern, a drainage layer is recommended below the bedding layer for the culvert. For preliminary design purpose, the drainage layer should consist of a Class 1 non-woven geotextile (filter cloth as per OPSS 1860) placed over the subgrade and then a minimum 300 mm layer of 19 mm Type 1 clear crushed stone. The equivalent opening size of the filter fabric should be in the range of 75 to 150 μm. Where low hydraulic gradient is encountered during construction, HL 4 stone could be used in-lieu of the geotextile and 19 mm Type 1 clear stone, upon approval by the Getotechnical Engineer.

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 1.4 m (OPSD 3090.101).

The top of Culverts 04A, 07A, 08A, 09A, 11A, 14A, 16A, 17A, 19A, 23A, 28A and 29A will be placed at a depth of about 0.6 to 1.3 m 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 extensions shall follow OPSS 902 and SSP902S01.

5.3.1 Bedding

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 not 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 a leveling course.

Organic fill and deleterious fill materials of between 0.5 and 1.0 m below Culverts 04A, 07A, 08A, 14A, 15A and 23A, but as much as 3 m below the design invert of Culvert 01A could be encountered. 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 and/or engineered fill.

Under unfavourable wet weather condition, the subgrade could become softened and unstable. If unstable condition persists due to saturated sand and silt subgrade, the thickness of the bedding material will have to be increased to 600mm, such as at Culverts 01A and 04A.

5.3.2 Engineered Fill

In light of the approximately 3 m thick fill materials to be sub-excavate below the subgrade at Culvert 01A (especially at the north half of the site), the backfill should be constructed as "engineered fill" and follow the procedures described below.

Preparation for engineered fill construction should consist of removing all deleterious fill materials to expose the native sand and silt. The engineered fill subgrade should be inspected and approved by the Geotechnical Engineer, or a Quality Verification Engineer (QVE) as per SSP199S48, prior to placement of the engineered fill. Depending on the geometry of the engineered fill subgrade, benching of the subgrade may be required to provide adequate and uniform support of the engineered fill.

The engineered fill should consist of OPSS Granular "A", Granular "B" Type I, II or III, or Granular "C" materials. It should be placed and compacted in thin lifts to 100% of the material's standard Proctor maximum dry density (SPMDD), as determined using Method A of OPSS 501.08.02. The lift thickness of the engineered fill should be limited to between 150 mm and 300 mm depending on the compaction equipment used, as determined in the field by the Geotechnical Engineer. The engineered fill should be compacted under the full time supervision of the Geotechnical Engineer or a QVE. Compaction tests should be carried out on each lift of fill placed to confirm that the specified degree of compaction has been achieved. Subsequent lifts of fill should not be placed until the specified degree of compaction of the current lift is achieved. A certificate of conformance shall be provided to the Contract Administrator as per the requirements of SSP199S48.

Foundations constructed on the engineered fill improved subgrade could be designed to impose the following bearing resistances:

Engineered Fill Material	Factored Geotechnical Resistance at ULS (kPa)	Geotechnical Reaction at SLS (kPa)
Granular "A"	500	250
Granular "B"	400	200
Granular "C"	300	150

The SLS value given above is based on a maximum settlement of 25 mm under the culvert.

5.3.3 Backfilling

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 Shale Bin

The reinforced concrete shale bin at the upstream (south) end of Culvert 11A is to be replaced with a new permanent shale bin. The existing shale bin at the inlet of Culvert 11A is constructed as a concrete panel blocking the inlet and letting water flow into the culvert through the side openings. At the time of site visit after a period of rain (March 14, 2007), water was backed up from the shale bin. It is understood that periodic clearing of debris is required.

The design for the shale bin has not been finalized. The shale bin is subject to horizontal forces induced by the water flow, debris and earth pressure caused by shale pieces and sediments, as well as ice pressure in the winter. Its design is similar to a retaining structure.

The founding depth of the shale bin foundation should be designed cognizant of the hydraulic condition (CAN/CSA-S6-06, Section 1.9) and the frost depth of 1.4 m (OPSD 3090.101). A review of Borehole 11A-1 indicates that the anticipated founding material will be very stiff to hard silty clay till. The footings can be designed to a factored geotechnical resistence at ULS of 400 kPa and a geotechnical reaction at SLS of 200 kPa. The SLS value given above is based on a maximum settlement of 25 mm under the footing. This can be achieved provided that the founding subgrade is undisturbed during construction.

The sliding resistance of the cast-in-place footings should be checked. The unfactored horizontal resistance (Clause 6.7.5, CAN/CSA-S6-06) against sliding between concrete and undisturbed, silty clay till can be calculated using a coefficient of friction (friction factor) of 0.45 as per Table 24.4 CFEM 4th Edition, 2006.

If precast concrete blocks are used, the friction factor and adhesion should be reduced by a factor of 0.67.

5.5 Lateral Earth Pressures

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
γ = unit weight of soil, = 21.2 kN/m^3 for Granular "B"
= 22.8 kN/m^3 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" $\phi = 35^o$	**Granular "B"** $\phi = 30$ to 35^o
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 1.5 to 4.0 m high adjacent to the proposed culvert extension sites. 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. Granular materials are preferred over silty clay for compaction and drainage.

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 4.0 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 can be carried out 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 culvert extensions and shale bin. Depending on the design that is finally selected, the anticipated maximum depth of excavation below the existing grade of Highway 26 is between 3.0 and 5.5 m.

Excavation to depths of up to 5.5 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 sides 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.

Fill materials could be encountered at the subgrade of Culverts 01A, 04A, 07A, 08A, 14A, 15A and 23A. The thickness of the bedding material will have to be increased where loose fill or unsuitable soil is encountered at the bedding subgrade level. This applies to unstable subgrade condition resulted from wet weather. 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) could be encountered during excavation, such as Culverts 01A and 04A, 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 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, care should be exercised to minimize disturbance to the bedding subgrade. Any disturbed subgrade should be sub-excavated and replaced with thickened and compacted bedding material.

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 1.4 m in accordance with OPSD 3090.101. All foundations and spread footings should be provided with at least 1.4 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:

Soil Type	Permissible Velocity (m/sec)
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
Silty Clay Till	1.8

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

Appendix A

Drawing 1 & 2

Borehole Location Plan

BOREHOLE NO.	ELEV.	UTM CO-ORDINATES NORTH	UTM CO-ORDINATES EAST
C01A-1	216.32	4939877	219102
C01A-2	216.15	4939902	219111
C01A-3	212.74	4939908	219122

BOREHOLE NO.	ELEV.	UTM CO-ORDINATES NORTH	UTM CO-ORDINATES EAST
C04A-1	225.68	4939487	220069
C04A-2	226.40	4939500	220071

BOREHOLE NO.	ELEV.	UTM CO-ORDINATES NORTH	UTM CO-ORDINATES EAST
C07A-1	230.98	4939207	221219
C07A-2	228.98	4939218	221225

METRIC

DIMENSIONS ARE IN METRES AND/OR MILLIMETRES UNLESS OTHERWISE SHOWN

CONT No xxxx-xxxx
WP No GWP 57-00-00

NON-STRUCTURAL CULVERT EXTENSION
Highway 26
BOREHOLE LOCATION PLAN

SHEET 1

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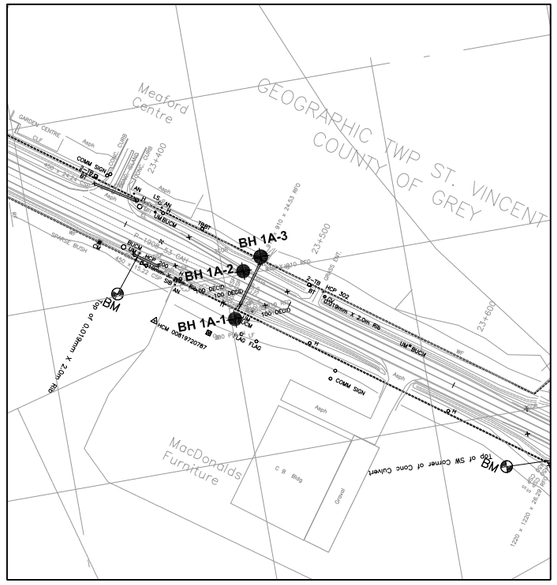

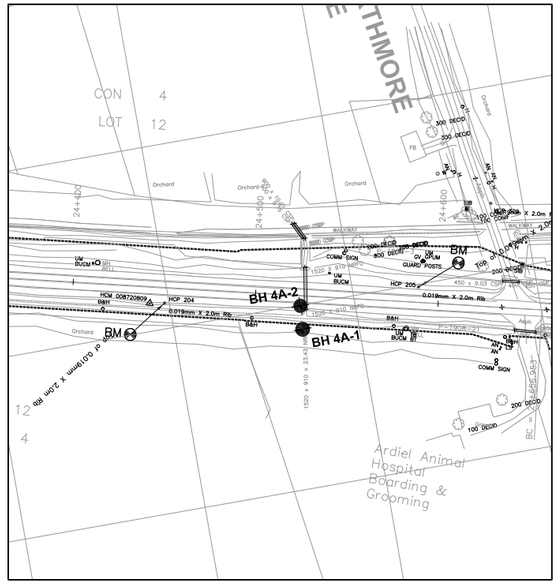

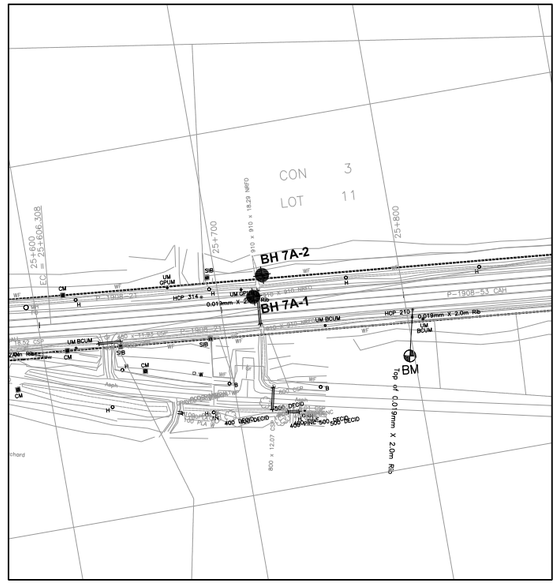

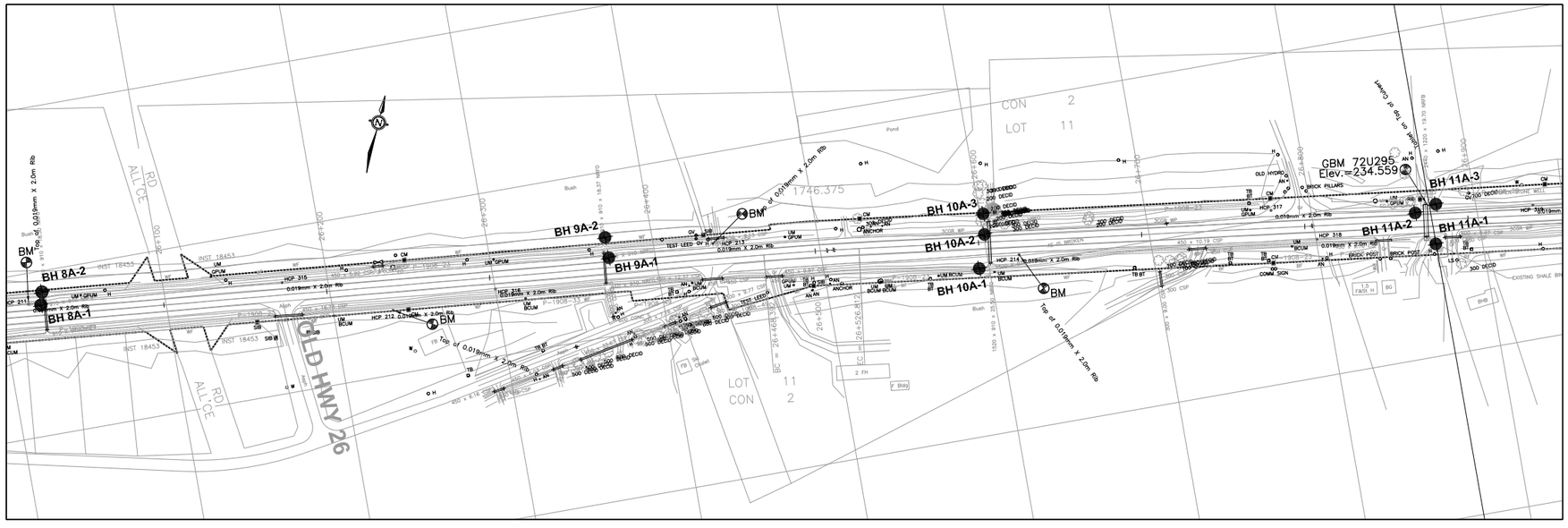

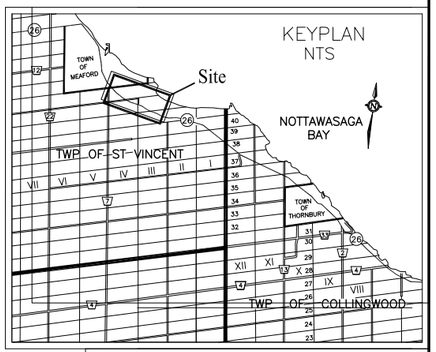

LEGEND

- Bore Hole
- Dynamic Cone Penetration Test (Cone)
- Bore Hole & Cone
- N — Blows/0.3m (Std Pen Test, 475 J/blow)
- CONE — 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.**

100m 0 50m
SCALE

BOREHOLE NO.	ELEV.	UTM CO-ORDINATES NORTH	UTM CO-ORDINATES EAST
C08A-1	230.76	4939179	221524
C08A-2	229.27	4939191	221529

BOREHOLE NO.	ELEV.	UTM CO-ORDINATES NORTH	UTM CO-ORDINATES EAST
C09A-1	232.12	4939148	221872
C09A-2	230.60	4939160	221872

BOREHOLE NO.	ELEV.	UTM CO-ORDINATES NORTH	UTM CO-ORDINATES EAST
C10A-1	230.96	4939102	222094
C10A-2	233.16	4939122	222101
C10A-3	229.64	4939134	222102

BOREHOLE NO.	ELEV.	UTM CO-ORDINATES NORTH	UTM CO-ORDINATES EAST
C11A-1	235.03	4939068	222372
C11A-2	235.70	4939089	222363
C11A-3	224.85	4939092	222376

REVISIONS	DATE	BY	DISCRIPTION
	09/04/09	J.L.	Final
	08/05/08	J.L.	Draft

MTO GEOCRES No. 41A-207

HWY No. HWY 26			DIST Owen Sound
SUBM'D J.L.	CHECKED E.C.	DATE 08/05/08	SITE C01A TO C11A
DRAWN J.L.	CHECKED J.L.	APPROVED E.C.	DWG 1

BOREHOLE NO.	ELEV.	UTM CO-ORDINATES NORTH	UTM CO-ORDINATES EAST
C13A-1	233.71	4939037	222787
C13A-2	231.02	4939045	222784

BOREHOLE NO.	ELEV.	UTM CO-ORDINATES NORTH	UTM CO-ORDINATES EAST
C14A-1	232.47	4939011	222997
C14A-2	230.71	4939021	222994

BOREHOLE NO.	ELEV.	UTM CO-ORDINATES NORTH	UTM CO-ORDINATES EAST
C15A-1	230.01	4938906	223342
C15A-2	231.40	4938926	223351
C15A-3	229.39	4938933	223348

BOREHOLE NO.	ELEV.	UTM CO-ORDINATES NORTH	UTM CO-ORDINATES EAST
C16A-1	231.50	4938804	223578
C16A-2	230.08	4938814	223591

METRIC

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CONT No xxxx-xxxx
WP No GWP 57-00-00

NON-STRUCTURAL CULVERT EXTENSION
Highway 26
BOREHOLE LOCATION PLAN

SHEET 2

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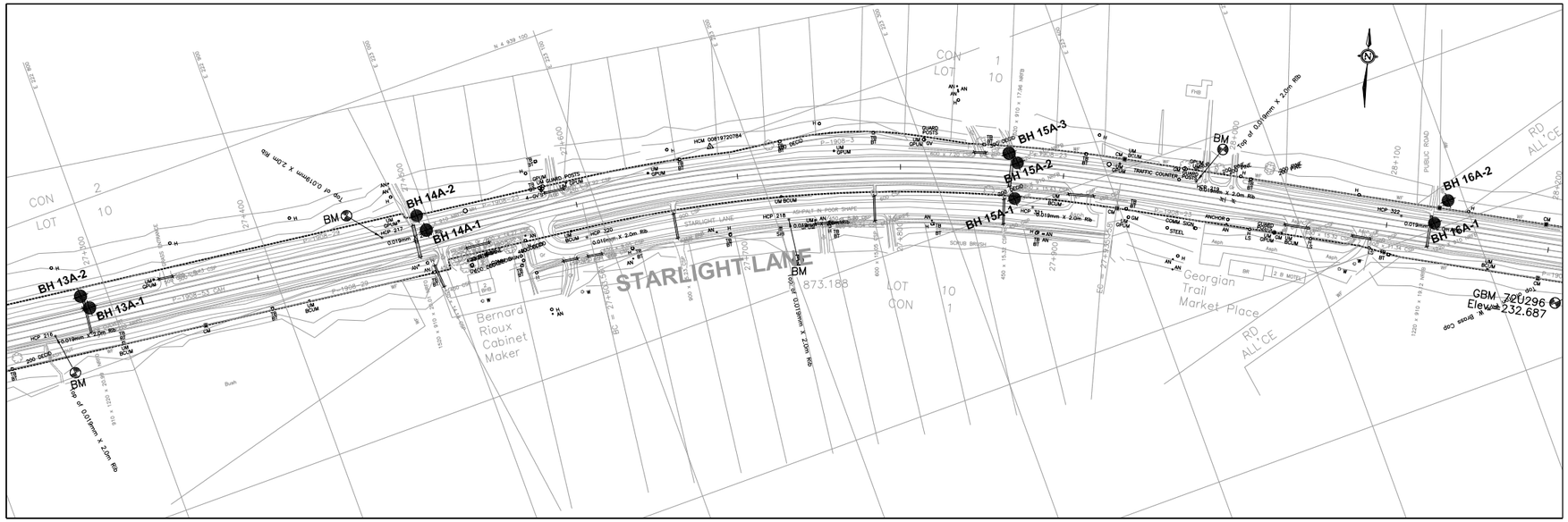

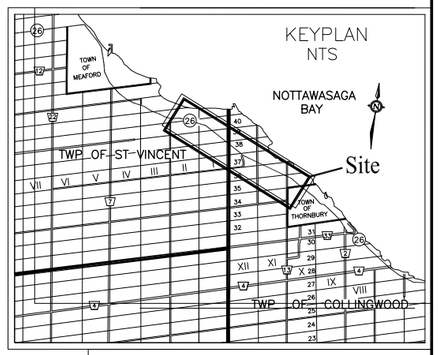

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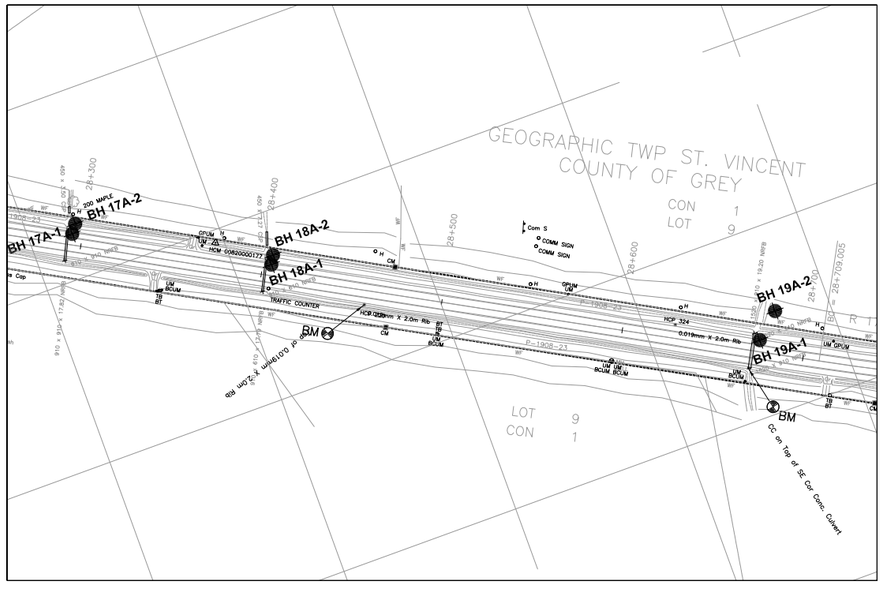
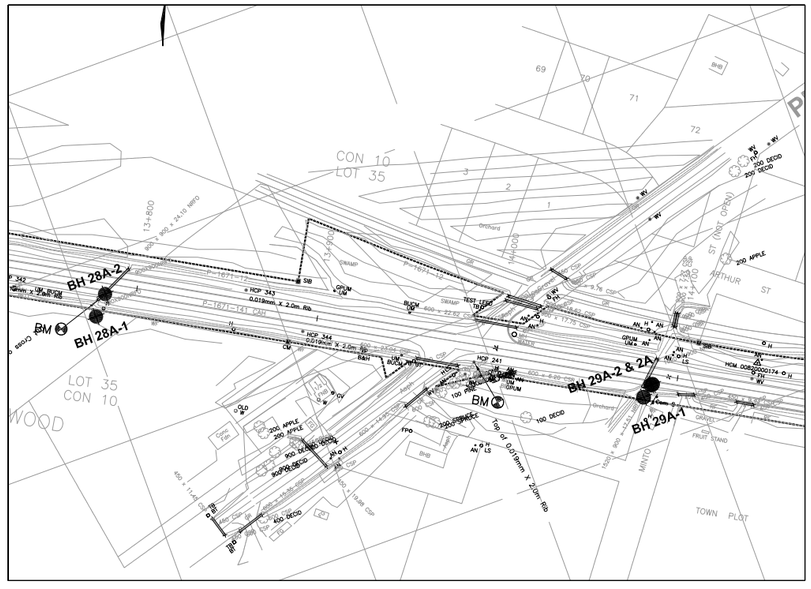
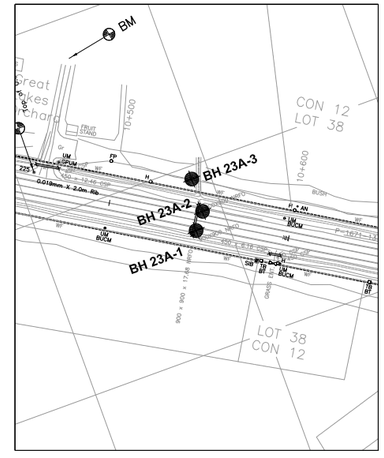
- Standpipe







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.**

100m 0 50m
SCALE

BOREHOLE NO.	ELEV.	UTM CO-ORDINATES NORTH	UTM CO-ORDINATES EAST
C17A-1	232.50	4938725	223723
C17A-2	230.91	4938729	223727

BOREHOLE NO.	ELEV.	UTM CO-ORDINATES NORTH	UTM CO-ORDINATES EAST
C18A-1	233.26	4938671	223820
C18A-2	231.63	4938676	223823

BOREHOLE NO.	ELEV.	UTM CO-ORDINATES NORTH	UTM CO-ORDINATES EAST
C19A-1	233.62	4938541	224057
C19A-2	231.97	4938553	224070

BOREHOLE NO.	ELEV.	UTM CO-ORDINATES NORTH	UTM CO-ORDINATES EAST
C23A-1	234.92	4938066	224882
C23A-2	234.89	4938074	224889
C23A-3	232.75	4938093	224890

BOREHOLE NO.	ELEV.	UTM CO-ORDINATES NORTH	UTM CO-ORDINATES EAST
C28A-1	196.17	4936980	227914
C28A-2	194.62	4936970	227905

BOREHOLE NO.	ELEV.	UTM CO-ORDINATES NORTH	UTM CO-ORDINATES EAST
C29A-1	193.58	4936826	228172
C29A-2	194.52	4936831	228178
C29A-2A	194.52	4936831	228179

REVISIONS			
09/04/09	J.L.	Final	
08/05/08	J.L.	Draft	
DATE	BY	DISCRIPTION	

MTO GEOCRES No. 41A-207

HWY No.	HWY 26			DIST	Owen Sound
SUBM'D J.L.	CHECKED E.C.	DATE 08/05/08		SITE	C-13A TO C-29A
DRAWN J.L.	CHECKED J.L.	APPROVED E.C.		DWG	2

Appendix B

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

Culvert Site	Borehole Logs	Grain Size	Atterberg Limits
01A	01A-1 to 3	Figures C-01A.1, 3 & 5	Figures C-01A.2, 4 & 6
04A	04A-1 & 2	Figures C-04A.1 & 3	Figure C-04A.2
07A	07A-1 & 2	Figures C-07A.1 & 2	Figure C07A.3
08A	08A-1 & 2	Figures C-08A.1 & 2	Figure C08A.3
09A	09A-1 & 2	Figure C-09A.1	Figure C-09A.2
10A	10A-1 to 3	Figures C-10A.1 & 3	Figures C-10A.2 & 4
11A	11A-1 to 3	Figures C-11A.1, 3 & 5	Figures C-11A.2 & 4
13A	13A-1 & 2	Figures C-13A.1, 3 & 5	Figures C-13A.2 & 4
14A	14A-1 & 2	Figures C-14A.1 & 3	Figures C-14A.2 & 4
15A	15A-1 to 3	Figures C-15A.1 & 3	Figures C-15A.2 & 4
16A	16A-1 & 2	Figures C-16A.1 & 3	Figures C-16A.2 & 4
17A	17A-1 & 2	Figure C-17A.1	Figure C-17A.2
18A	18A-1 & 2	Figure C-18A.1	Figure C-18A.2
19A	19A-1 & 2	Figure C-19A.1	Figure C-19A.2
23A	23A-1 to 3	Figures C-23A.1 & 3	Figures C-23A.2 & 4
28A	28A-1 & 2	Figures C-28A.1 & 3	Figures C-28A.2 & 4
29A	29A-1, 2 & 2A	Figures C-29A.1, 3 & 5	Figures C-29A.2, 4 & 6
		Figure C-29A.7, Consolidation Test Results	

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 (RQD), FOR MODIFIED RECOVERY, IS:

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

JOINTING AND BEDDING:

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

ABBREVIATIONS AND SYMBOLS

FIELD SAMPLING

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

STRESS AND STRAIN

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

MECHANICAL PROPERTIES OF SOIL

m_v	kPa^{-1}	COEFFICIENT OF VOLUME CHANGE
C_c	1	COMPRESSION INDEX
C_s	1	SWELLING INDEX
C_α	1	RATE OF SECONDARY CONSOLIDATION
c_v	m^2/s	COEFFICIENT OF CONSOLIDATION
H	m	DRAINAGE PATH
T_v	1	TIME FACTOR
U	%	DEGREE OF CONSOLIDATION
σ'_{vo}	kPa	EFFECTIVE OVERBURDEN PRESSURE
σ'_p	kPa	PRECONSOLIDATION PRESSURE
τ_f	kPa	SHEAR STRENGTH
c'	kPa	EFFECTIVE COHESION INTERCEPT
ϕ'	°	EFFECTIVE ANGLE OF INTERNAL FRICTION
c_u	kPa	APPARENT COHESION INTERCEPT
ϕ_u	°	APPARENT ANGLE OF INTERNAL FRICTION
τ_R	kPa	RESIDUAL SHEAR STRENGTH
τ_r	kPa	REMOULDED SHEAR STRENGTH
S_t	1	SENSITIVITY = $\frac{c_u}{\tau_r}$

PHYSICAL PROPERTIES OF SOIL

ρ_s	kg/m^3	DENSITY OF SOLID PARTICLES
γ_s	kN/m^3	UNIT WEIGHT OF SOLID PARTICLES
ρ_w	kg/m^3	DENSITY OF WATER
γ_w	kN/m^3	UNIT WEIGHT OF WATER
ρ	kg/m^3	DENSITY OF SOIL
γ	kN/m^3	UNIT WEIGHT OF SOIL
ρ_d	kg/m^3	DENSITY OF DRY SOIL
γ_d	kN/m^3	UNIT WEIGHT OF DRY SOIL
ρ_{sat}	kg/m^3	DENSITY OF SATURATED SOIL
γ_{sat}	kN/m^3	UNIT WEIGHT OF SATURATED SOIL
ρ'	kg/m^3	DENSITY OF SUBMERGED SOIL
γ'	kN/m^3	UNIT WEIGHT OF SUBMERGED SOIL

e	1, %	VOID RATIO
n	1, %	POROSITY
w	1, %	WATER CONTENT
S_r	%	DEGREE OF SATURATION
w_L	%	LIQUID LIMIT
w_P	%	PLASTIC LIMIT
w_s	%	SHRINKAGE LIMIT
I_P	%	PLASTICITY INDEX = $w_L - w_P$
I_L	1	LIQUIDITY INDEX = $\frac{w - w_P}{I_P}$
I_C		CONSISTENCY INDEX = $\frac{w_L - w}{I_P}$
e_{max}	1, %	VOID RATIO IN LOOSEST STATE

e_{min}	1, %	VOID RATIO IN DENSEST STATE
I_D	1	DENSITY INDEX = $\frac{e_{max} - e}{e_{max} - e_{min}}$
D	mm	GRAIN DIAMETER
D_n	mm	n PERCENT - DIAMETER
C_U	1	UNIFORMITY COEFFICIENT
h	m	HYDRAULIC HEAD OR POTENTIAL
q	m^3/s	RATE OF DISCHARGE
v	m/s	DISCHARGE VELOCITY
i	1	HYDRAULIC GRADIENT
k	m/s	HYDRAULIC CONDUCTIVITY
j	kN/m^3	SEEPAGE FORCE

RECORD OF BOREHOLE No 01A-1

1 OF 1

METRIC

W.P. GWP 57-00-00 LOCATION HWY 26, Thornbury to Meaford Northing - 4939877, Easting - 219102 ORIGINATED BY JL

DIST Owen Sound HWY 26 BOREHOLE TYPE S/S Augering, 110 mm dia. COMPILED BY JL

DATUM Geodetic DATE 08.02.07 - 08.02.07 CHECKED BY EC

ELEV / DEPTH	DESCRIPTION	STRAT PLOT	SAMPLES NUMBER	SAMPLES TYPE	SAMPLES "N" VALUES	GROUND WATER CONDITIONS	ELEVATION SCALE	PENETR. RESISTANCE STANDARD ● DYN. CONE (20 40 60 80 100) / SHEAR STRENGTH kPa ○ UNCONFINED ● QUICK TRIAXIAL + FIELD VANE × LAB VANE (20 40 60 80 100)	PLASTIC LIMIT w_P / NATURAL MOISTURE CONTENT w / LIQUID LIMIT w_L / WATER CONTENT (%) (10 20 30)	UNIT WEIGHT γ kN/m³	REMARKS & GRAIN SIZE DISTRIBUTION (%) GR SA SI CL
216.32	Ground										
0.00	75 mm TOPSOIL.						216				
	FILL Brown, damp, loose to compact, consisting mainly of silty sand to sandy silt, trace to some gravel, trace organics, occasional clayey layers.		1	SPT	9						10 54 24 12 (37)
			2	SPT	16		215				
			3	SPT	11		214				27 45 18 9 (28)
			4	SPT	7		213				
212.66						▽					Water level measured @ 3.65 m @ completion.
3.66			5	SPT	13					23.7	22 24 34 20 (54)
	Sandy SILT, ML Grey, wet, compact, with occasional silty sand and silty clay seams, some gravel.		6	SPT	17		212				
			7	SPT	20		211			24.1	
			8	SPT	21		210				
209.61											
6.71	End of borehole.										

$+^3$, $\times^3$: Numbers refer to Sensitivity

$\circ^{150}$ UNCONFINE SHEAR STRENGTH INFERRED FROM POCKET PENETROMETER READINGS

RECORD OF BOREHOLE No 01A-2

1 OF 1

METRIC

W.P. GWP 57-00-00 LOCATION HWY 26, Thornbury to Meaford Northing - 4939902, Easting - 219111 ORIGINATED BY JL

DIST Owen Sound HWY 26 BOREHOLE TYPE S/S Augering, 110 mm dia. COMPILED BY JL

DATUM Geodetic DATE 08.28.07 - 08.28.07 CHECKED BY EC

ELEV / DEPTH	DESCRIPTION	STRAT PLOT	SAMPLES NUMBER	SAMPLES TYPE	SAMPLES "N" VALUES	GROUND WATER CONDITIONS	ELEVATION SCALE	PENETR. RESISTANCE STANDARD ● DYN. CONE / SHEAR STRENGTH kPa ○ UNCONFINED ● QUICK TRIAXIAL + FIELD VANE × LAB VANE	PLASTIC LIMIT w_P / NATURAL MOISTURE CONTENT w / LIQUID LIMIT w_L / WATER CONTENT (%)	UNIT WEIGHT γ kN/m^3	REMARKS & GRAIN SIZE DISTRIBUTION (%) GR SA SI CL
216.51	Ground										
0.00	200 mm sand and gravel FILL.										
	FILL Brown, damp, loose to dense, consisting mainly of silt and silty sand, trace gravel.		1	SPT	5		216				
			2	SPT	6		215				
			3	SPT	30		214				3 61 27 9 (36)
			4	SPT	13		213				
212.55											
3.96			5	SPT	7					19.3	15 41 27 17 (44)
			6	SPT	7		212				Dynamic cone penetration test from 3.65 m to 7.3 m conducted 1.5 m away.
	FILL Greenish grey, moist, very loose to loose, consisting of organic stained silt to silty clay with organic pockets.		7	SPT	2	▽	211			22.3	Water level measured @ 5.5 m @ completion.
			8	SPT	3		210				
209.80											
6.71	Brown		9	SPT	11						
	SAND & SILT, SM-ML Wet to saturated, very loose to compact, trace gravel, occasional grey silty clay seams		10	SPT	3		209				5 45 39 11 (51)
	Grey										
207.82			11	SPT	40		208			26.1	
8.69	SHALE TILL COMPLEX Grey, moist, hard.										
207.21			12	SPT	100+						
9.30	End of borehole.										

+ ^{3}, × ^{3}: Numbers refer to Sensitivity

○ ^{150} UNCONFINE SHEAR STRENGTH INFERRED FROM POCKET PENETROMETER READINGS

JOE MTO 07-6-IEG1.GPJ ONTARIO MOT.GDT 04/12/09

RECORD OF BOREHOLE No 01A-3

1 OF 1

METRIC

W.P. GWP 57-00-00 LOCATION HWY 26, Thornbury to Meaford Northing - 4939908, Easting - 219122 ORIGINATED BY JL

DIST Owen Sound HWY 26 BOREHOLE TYPE S/S Augering, 110 mm dia. COMPILED BY JL

DATUM Geodetic DATE 08.01.07 - 08.01.07 CHECKED BY EC

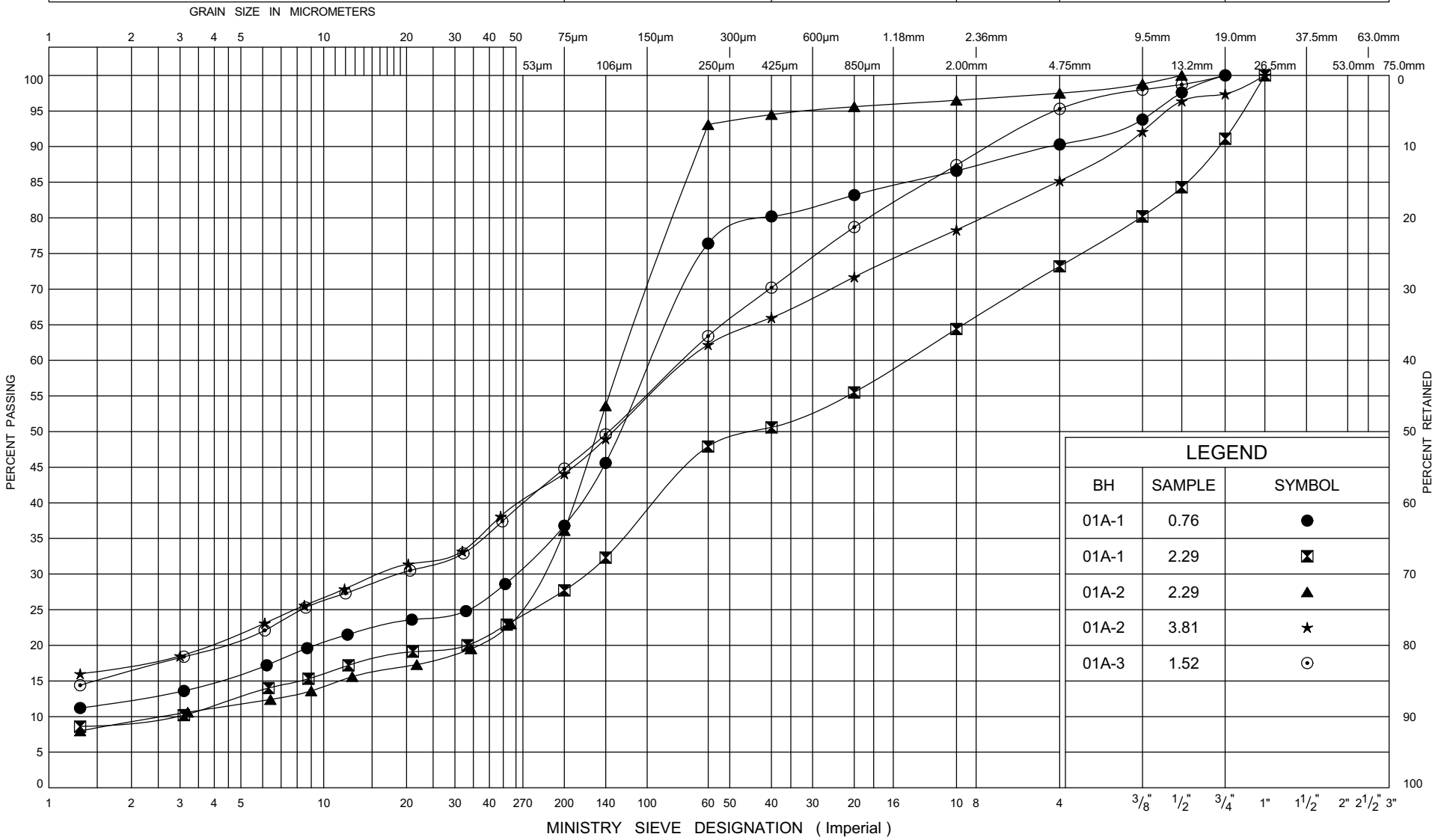
ELEV / DEPTH	DESCRIPTION	STRAT PLOT	SAMPLES NUMBER	SAMPLES TYPE	SAMPLES "N" VALUES	GROUND WATER CONDITIONS	ELEVATION SCALE	PENETR. RESISTANCE STANDARD ● DYN. CONE 20 40 60 80 100 / SHEAR STRENGTH kPa ○ UNCONFINED ● QUICK TRIAXIAL + FIELD VANE × LAB VANE 20 40 60 80 100	PLASTIC LIMIT w_P / NATURAL MOISTURE CONTENT w / LIQUID LIMIT w_L / WATER CONTENT (%) 10 20 30	UNIT WEIGHT γ kN/m³	REMARKS & GRAIN SIZE DISTRIBUTION (%) GR SA SI CL
212.74	Ground										
0.00	250 mm TOPSOIL.										
	FILL Brown, wet to saturated, compact to very loose, consisting mainly of sand and silt, some gravel, trace organics, occasional clayey layers.		1	SPT	10		212				Dynamic cone penetration test from 0.3 m to 5.5 m conducted 1.5 m away.
			2	SPT	2	▽	211				5 51 28 16 (45) Water level measured @ 1.8 m @ completion.
			3	SPT	2		210		42		
			4	SPT	1						
209.23											
3.51	SAND & SILT, SM-ML Brown, wet to saturated, loose to compact, trace gravel.		5	SPT	9		209				
			6	SPT	39		208				17 16 42 25 (68)
207.86											
4.88	SHALE TILL COMPLEX Grey, moist, hard.		7	SPT	100+						
207.25											
5.49	End of borehole.										

+ 3, × 3: Numbers refer to Sensitivity

○ 150 UNCONFINE SHEAR STRENGTH INFERRED FROM POCKET PENETROMETER READINGS

UNIFIED SOIL CLASSIFICATION SYSTEM

CLAY & SILT	SAND			GRAVEL	
	Fine	Medium	Coarse	Fine	Coarse



LEGEND		
BH	SAMPLE	SYMBOL
01A-1	0.76	●
01A-1	2.29	⊠
01A-2	2.29	▲
01A-2	3.81	★
01A-3	1.52	⊙

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GRAIN SIZE DISTRIBUTION

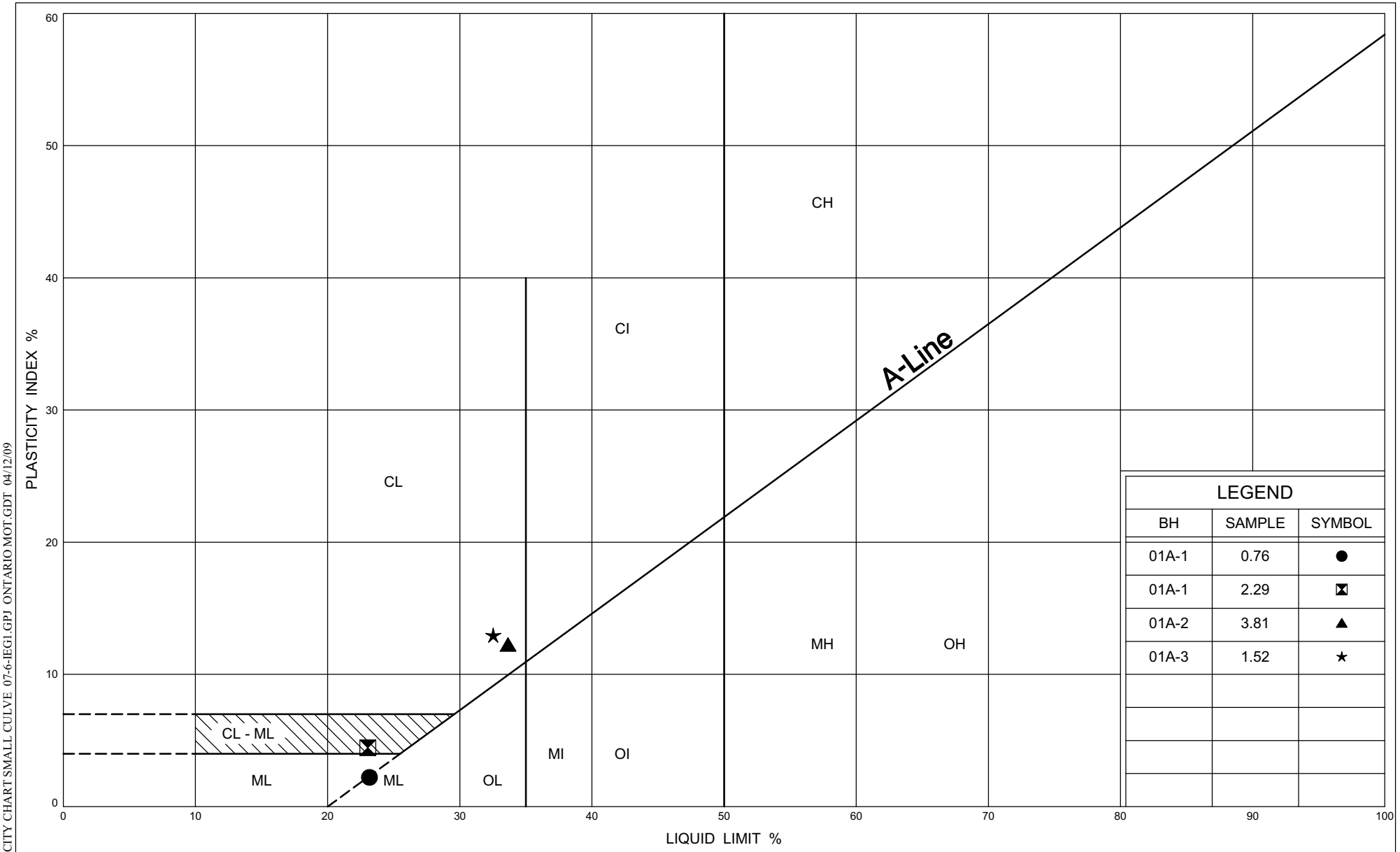
FILL

FIG No C- 01A.1

GWP 57-00-00

HWY 26, Thornbury to Meaford

Oct 75, FF - S - 21



LEGEND		
BH	SAMPLE	SYMBOL
01A-1	0.76	●
01A-1	2.29	⊠
01A-2	3.81	▲
01A-3	1.52	★

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PLASTICITY CHART
FILL

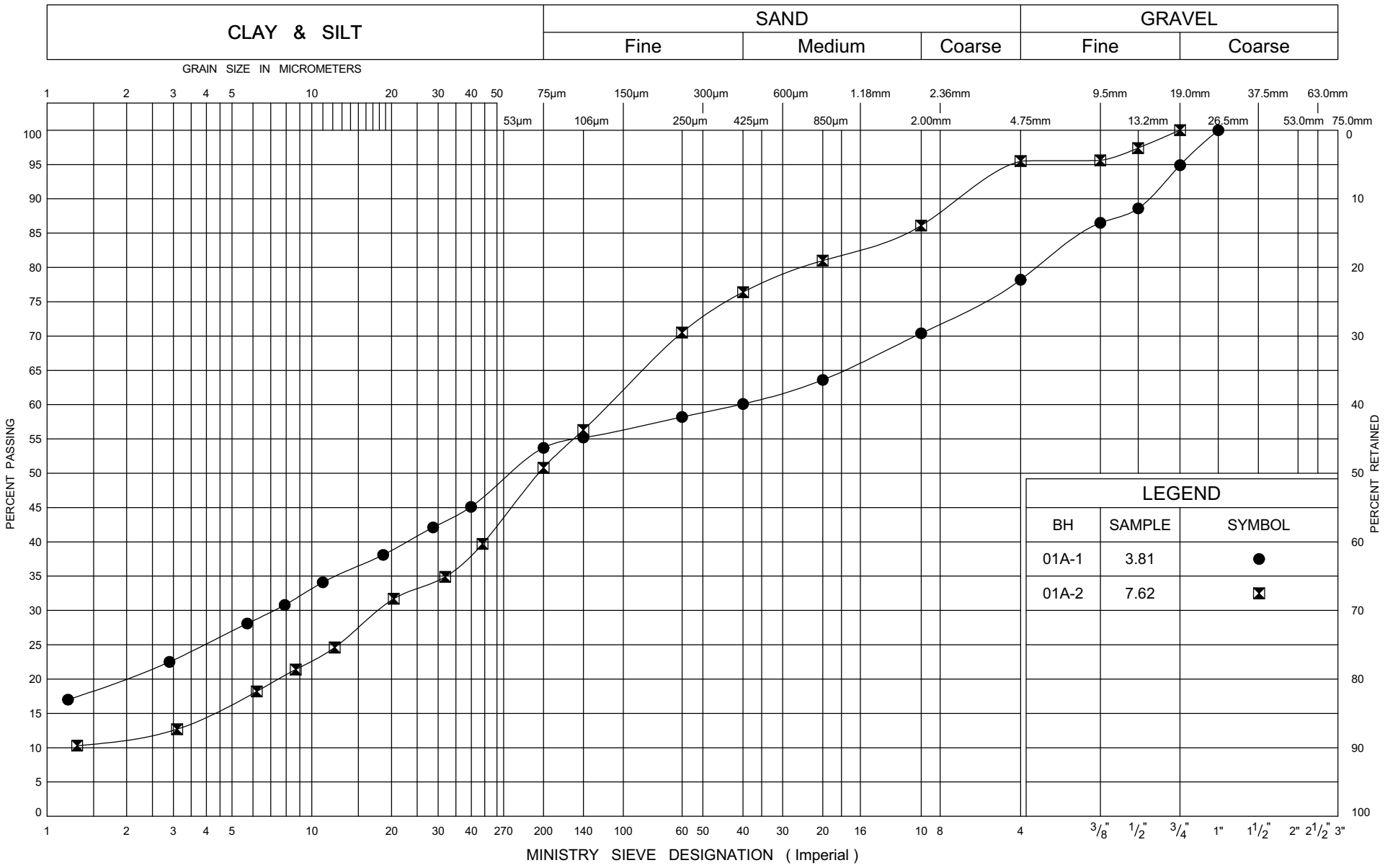
FIG No C- 01A.2

GWP 57-00-00

HWY 26, Thornbury to Meaford

ONTARIO MOT PLASTICITY CHART SMALL CULVE 07-6-IEG1.GPJ ONTARIO MOT.GDT 04/12/09

UNIFIED SOIL CLASSIFICATION SYSTEM



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GRAIN SIZE DISTRIBUTION

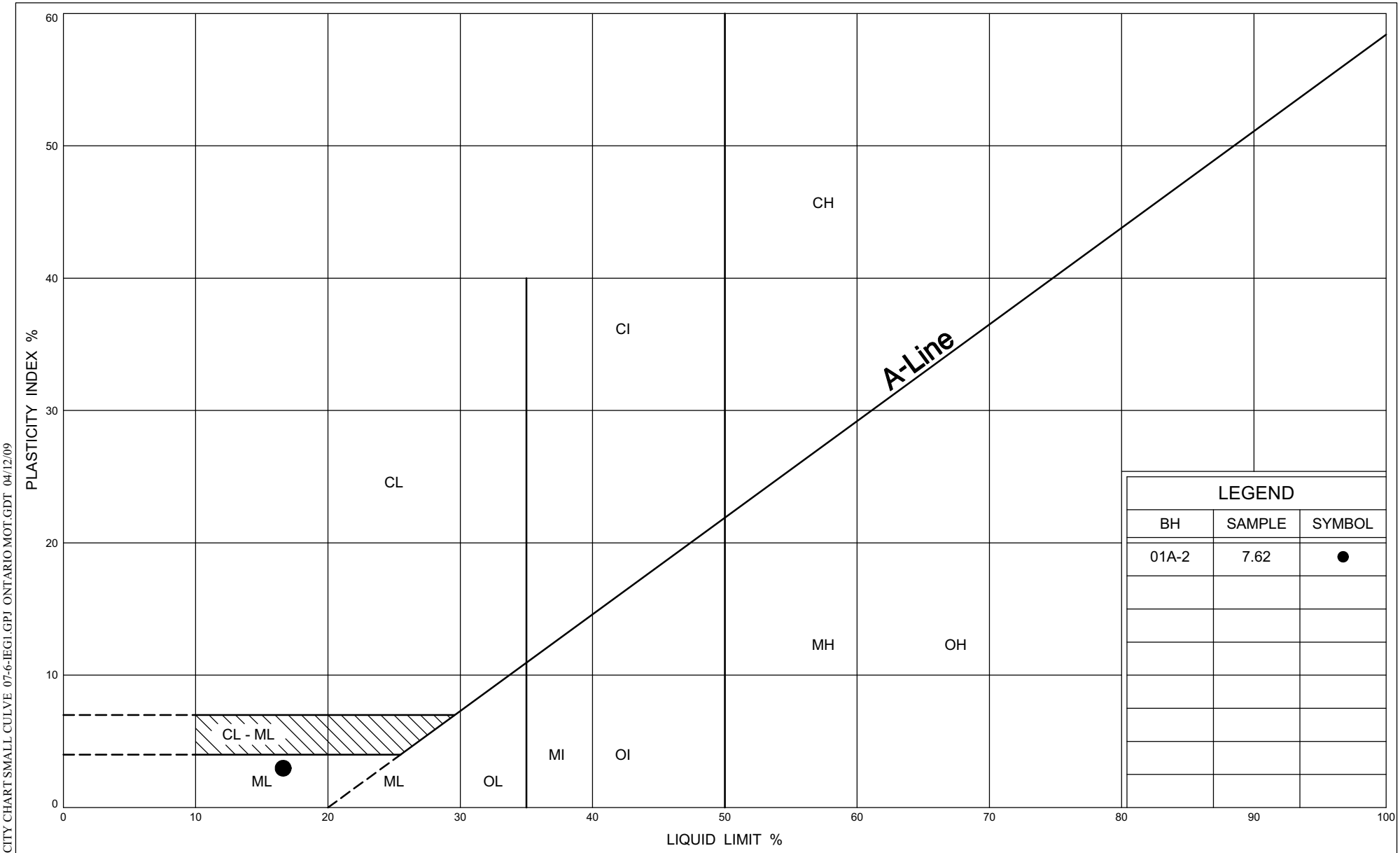
SANDY SILT TO SAND AND SILT, ML-SM

FIG No C- 01A.3

GWP 57-00-00

HWY 26, Thornbury to Meaford

Oct 75, FF - S - 21



ONTARIO MOT PLASTICITY CHART SMALL CULVE 07-6-IEG1.GPJ ONTARIO MOT.GDT 04/12/09

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PLASTICITY CHART

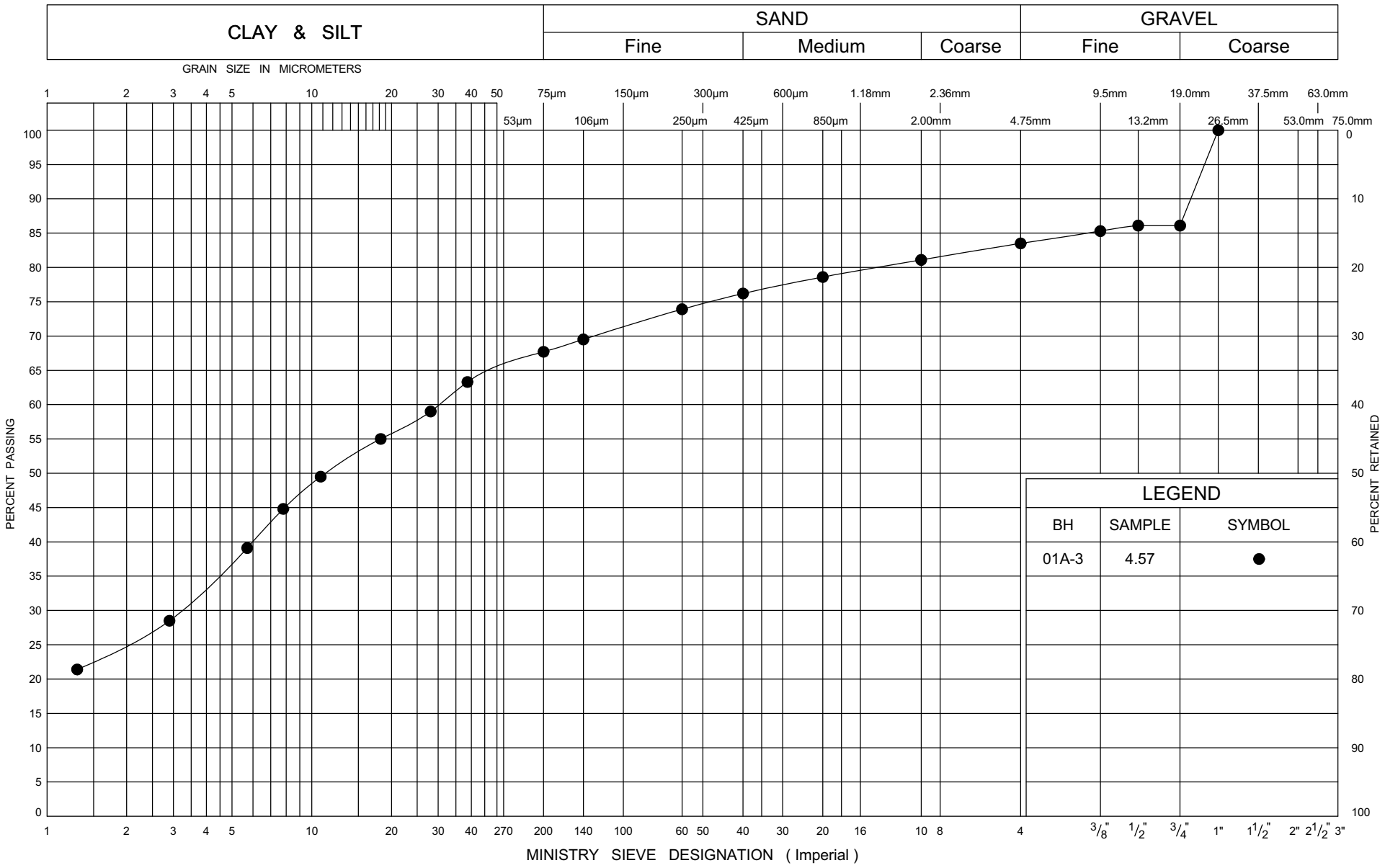
SANDY SILT TO SAND AND SILT, ML-SM

FIG No C- 01A.4

GWP 57-00-00

HWY 26, Thornbury to Meaford

UNIFIED SOIL CLASSIFICATION SYSTEM



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GRAIN SIZE DISTRIBUTION

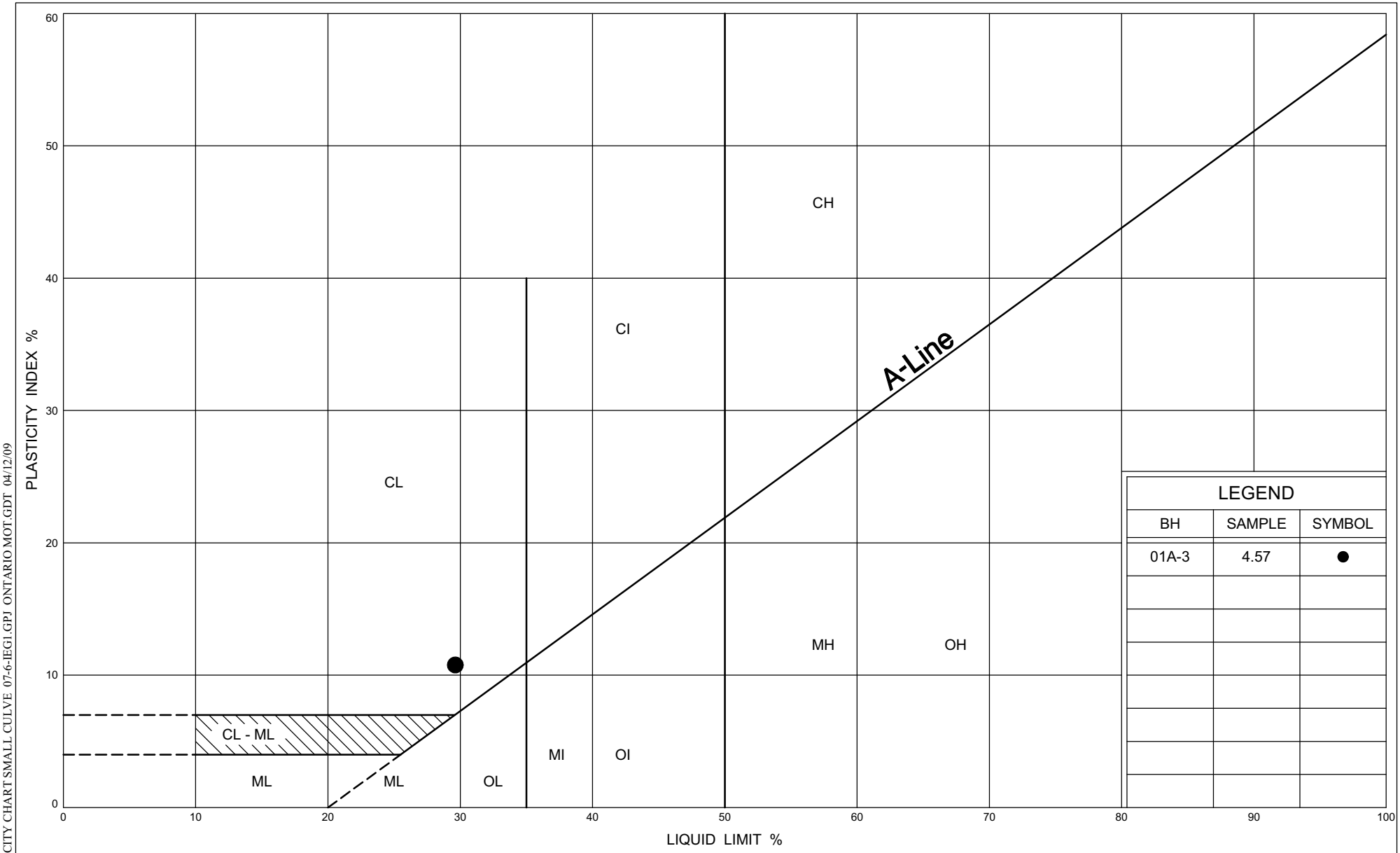
SHALE TILL COMPLEX

FIG No C- 01A.5

GWP 57-00-00

HWY 26, Thornbury to Meaford

Oct 75, FF - S - 21



LEGEND		
BH	SAMPLE	SYMBOL
01A-3	4.57	●

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PLASTICITY CHART
SHALE TILL COMPLEX

FIG No C- 01A.6

GWP 57-00-00

HWY 26, Thornbury to Meaford

ONTARIO MOT PLASTICITY CHART SMALL CULVE 07-6-IEG1.GPJ ONTARIO MOT.GDT 04/12/09

RECORD OF BOREHOLE No 04A-1 1 OF 1 METRIC

W.P. GWP 57-00-00 LOCATION HWY 26, Thornbury to Meaford Northing - 4939487, Easting - 220069 ORIGINATED BY JL

DIST Owen Sound HWY 26 BOREHOLE TYPE S/S Augering, 110 mm dia. COMPILED BY JL

DATUM Geodetic DATE 07.31.07 - 07.31.07 CHECKED BY EC

ELEV / DEPTH	DESCRIPTION	STRAT PLOT	SAMPLES: NUMBER	SAMPLES: TYPE	SAMPLES: "N" VALUES	GROUND WATER CONDITIONS	ELEVATION SCALE	PENETR. RESISTANCE / SHEAR STRENGTH kPa	PLASTIC LIMIT w_P / NATURAL MOISTURE CONTENT w / LIQUID LIMIT w_L	UNIT WEIGHT γ kN/m^3	REMARKS & GRAIN SIZE DISTRIBUTION (%) GR SA SI CL
225.68 0.00	Ground 150 mm TOPSOIL.										
	Sandy SILT, ML Brown, moist, compact to very dense, with embedded gravel and silty clay pockets.		1	SPT	100+		225				hit cobble @ 1.1m.
			2	SPT	15		224				
223.24 2.44	Gravelley SAND TO SAND & GRAVEL, SW-GW Brown, moist, dense to very dense, some silt.		3	SPT	30		223				41 39 14 6 (20)
			4	SPT	74						24 49 20 8 (27)
221.72			5	SPT	100+		222				
3.96	End of borehole.										Borehole dry and open @ completion.

PENETR. RESISTANCE: STANDARD ● DYN. CONE — 20 40 60 80 100
SHEAR STRENGTH kPa: ○ UNCONFINED + FIELD VANE ● QUICK TRIAXIAL × LAB VANE — 20 40 60 80 100
WATER CONTENT (%): 10 20 30

$+^3$, $\times^3$: Numbers refer to Sensitivity

$\circ^{150}$ UNCONFINE SHEAR STRENGTH INFERRED FROM POCKET PENETROMETER READINGS

RECORD OF BOREHOLE No 04A-2 1 OF 1 METRIC

W.P. GWP 57-00-00 LOCATION HWY 26, Thornbury to Meaford Northing - 4939500, Easting - 220071 ORIGINATED BY JL

DIST Owen Sound HWY 26 BOREHOLE TYPE S/S Augering, 110 mm dia. COMPILED BY JL

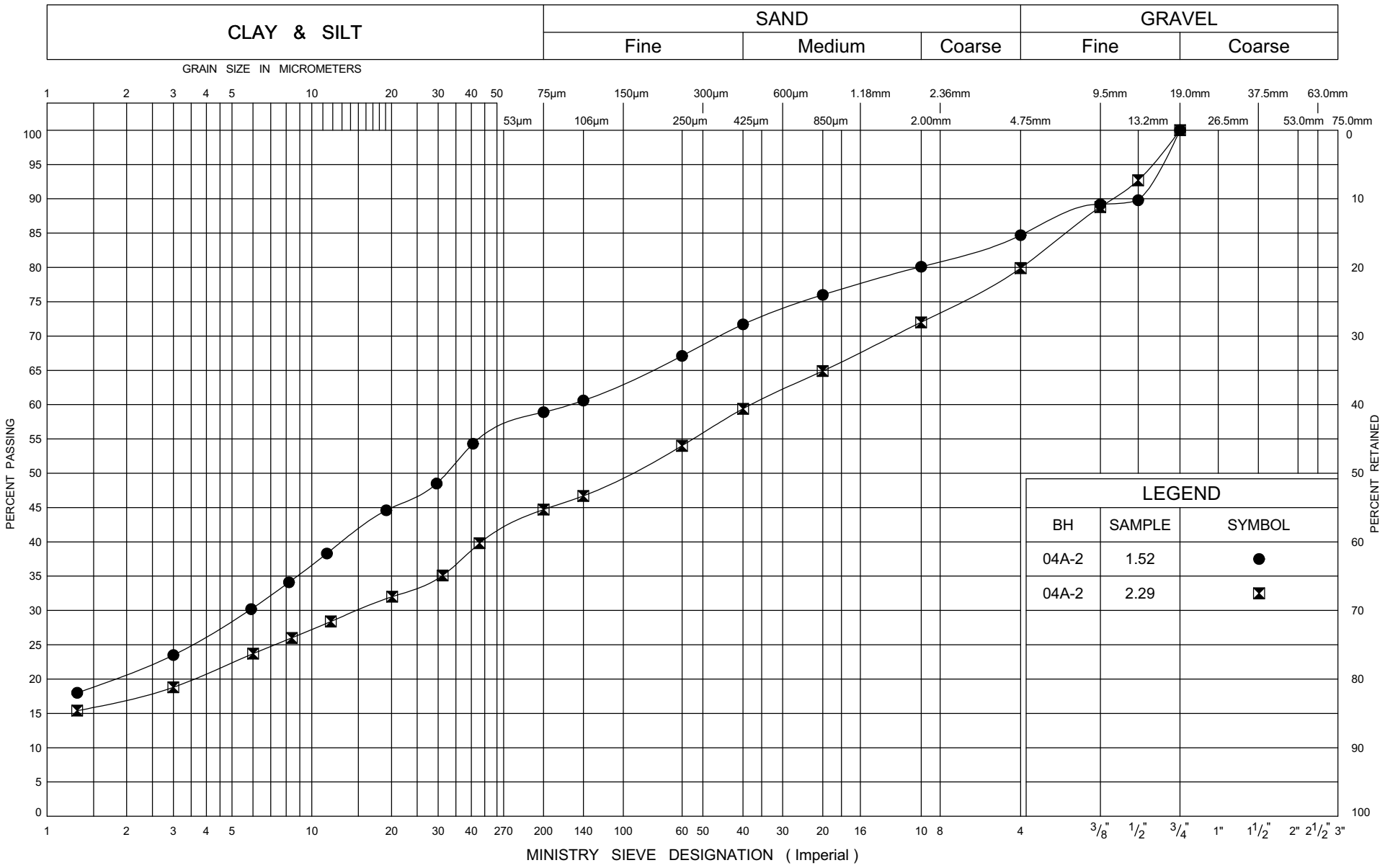
DATUM Geodetic DATE 07.31.07 - 07.31.07 CHECKED BY EC

ELEV / DEPTH	DESCRIPTION	STRAT PLOT	SAMPLES NUMBER	SAMPLES TYPE	SAMPLES "N" VALUES	GROUND WATER CONDITIONS	ELEVATION SCALE	PENETR. RESISTANCE STANDARD ● DYN. CONE (20 40 60 80 100) / SHEAR STRENGTH kPa ○ UNCONFINED ● QUICK TRIAXIAL + FIELD VANE × LAB VANE (20 40 60 80 100)	PLASTIC LIMIT w_P / NATURAL MOISTURE CONTENT w / LIQUID LIMIT w_L / WATER CONTENT (%) (10 20 30)	UNIT WEIGHT γ kN/m³	REMARKS & GRAIN SIZE DISTRIBUTION (%) GR SA SI CL
226.40	Ground										
0.00	350 mm sand and gravel FILL.						226				
	FILL Brown, moist, compact to loose, consisting mainly of clayey sandy silt to clayey silty sand.		1	SPT	15		225				
			2	SPT	10						15 26 38 21 (59)
223.50			3	SPT	4		224				20 35 28 17 (45)
2.90	GRAVELLY SAND TO SAND & GRAVEL, SW-GW Brown, moist, compact to very dense, some silt.		4	SPT	16		223				
			5	SPT	25		222				
221.37			6	SPT	100+						
5.03	End of borehole.										Borehole dry and open @ completion.

$+^{3}$, $\times^{3}$: Numbers refer to Sensitivity

$\circ^{150}$ UNCONFINE SHEAR STRENGTH INFERRED FROM POCKET PENETROMETER READINGS

UNIFIED SOIL CLASSIFICATION SYSTEM



Ministry of Transportation
Ontario

GRAIN SIZE DISTRIBUTION

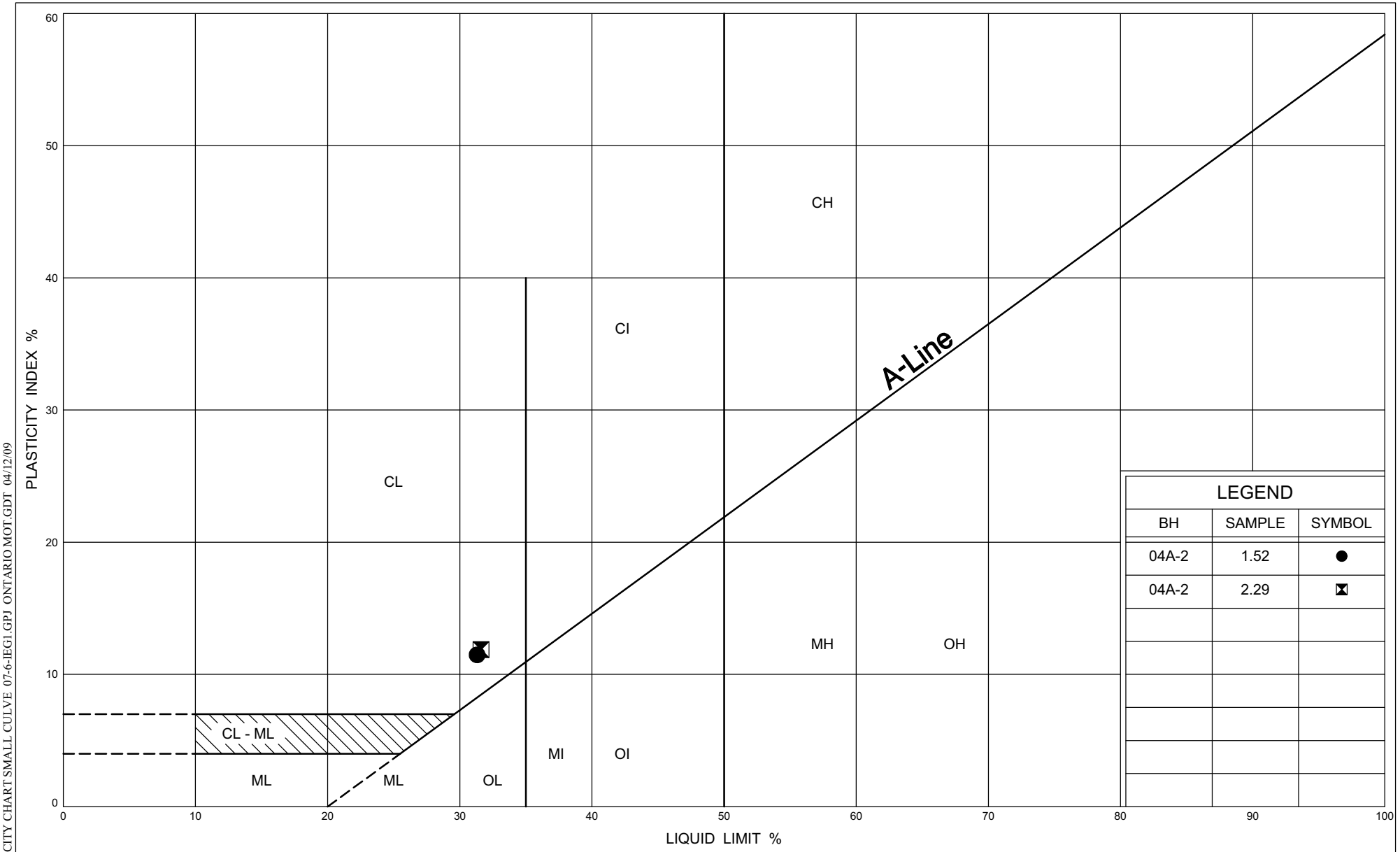
FILL

FIG No C- 04A.1

GWP 57-00-00

HWY 26, Thornbury to Meaford

Oct 75, FF - S - 21



Ministry of Transportation
Ontario

PLASTICITY CHART
FILL

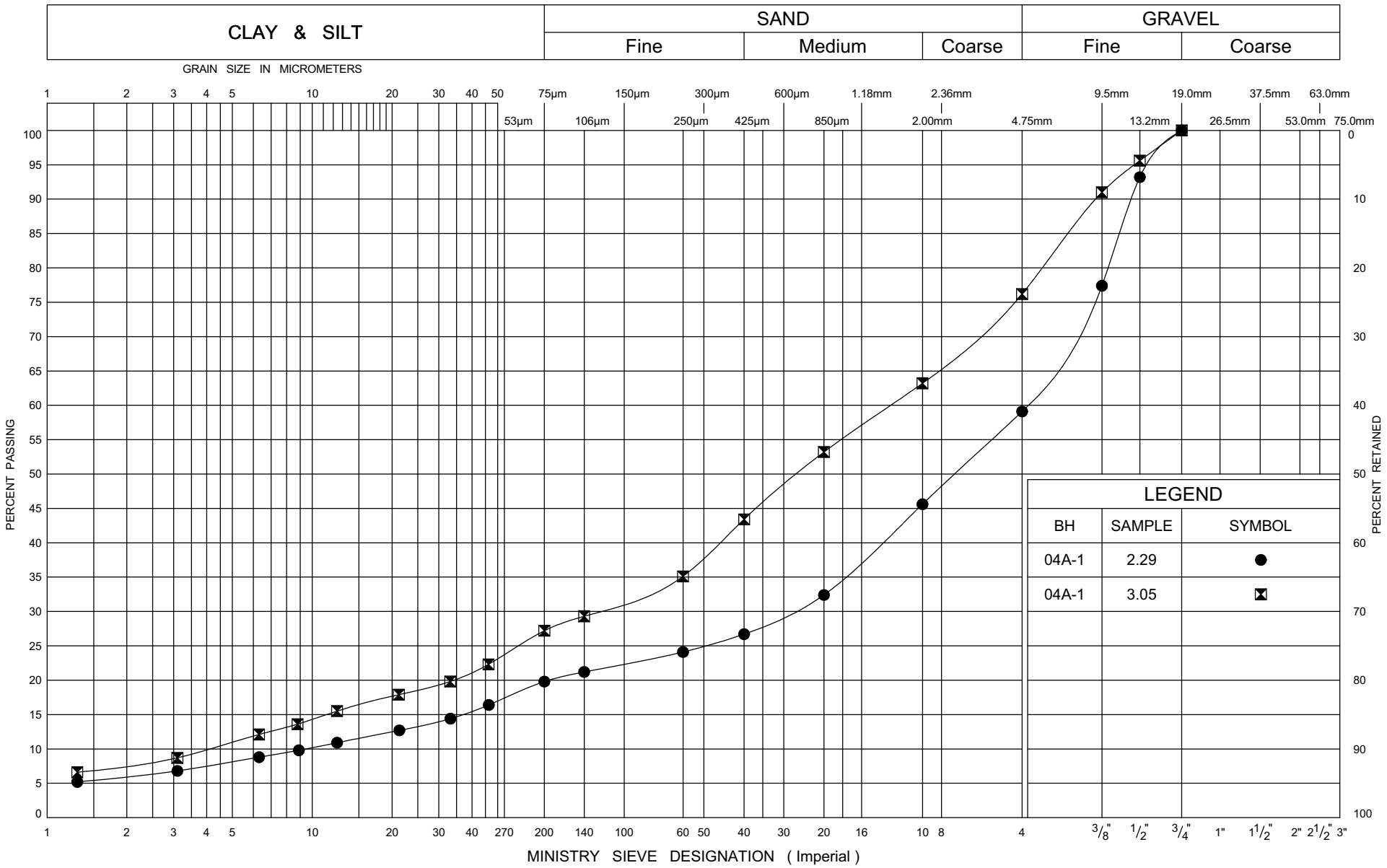
FIG No C- 04A.2

GWP 57-00-00

HWY 26, Thornbury to Meaford

ONTARIO MOT PLASTICITY CHART SMALL CULVE 07-6-IEG1.GPJ ONTARIO MOT.GDT 04/12/09

UNIFIED SOIL CLASSIFICATION SYSTEM



Ministry of Transportation
Ontario

GRAIN SIZE DISTRIBUTION

GRAVELLY SAND TO SAND AND GRAVEL, SW-GW

FIG No C- 04A.3

GWP 57-00-00

HWY 26, Thornbury to Meaford

RECORD OF BOREHOLE No 07A-1

1 OF 1

METRIC

W.P. GWP 57-00-00 LOCATION HWY 26, Thornbury to Meaford Northing - 4939207, Easting - 221219 ORIGINATED BY JL

DIST Owen Sound HWY 26 BOREHOLE TYPE S/S Augering, 110 mm dia. COMPILED BY JL

DATUM Geodetic DATE 07.30.07 - 07.30.07 CHECKED BY EC

ELEV / DEPTH	DESCRIPTION	STRAT PLOT	SAMPLES NUMBER	SAMPLES TYPE	SAMPLES "N" VALUES	GROUND WATER CONDITIONS	ELEVATION SCALE	PENETR. RESISTANCE STANDARD ● DYN. CONE 20 40 60 80 100 / SHEAR STRENGTH kPa ○ UNCONFINED ● QUICK TRIAXIAL + FIELD VANE × LAB VANE 20 40 60 80 100	PLASTIC LIMIT w_P / NATURAL MOISTURE CONTENT w / LIQUID LIMIT w_L / WATER CONTENT (%) 10 20 30	UNIT WEIGHT γ kN/m³	REMARKS & GRAIN SIZE DISTRIBUTION (%) GR SA SI CL
230.98	Ground										
0.00	FILL Brown, moist to wet, compact to loose, consisting of silty sand and gravel to silty sand, some clay.		1	SPT	27		230				
			2	SPT	8						4 58 26 13 (39)
228.69							229				
2.29	Silty CLAY TILL, CI Grey, moist, very stiff to hard, embedded sand and gravel.		3	SPT	15						
			4	SPT	20	▽	228			22.0	6 3 56 35 Water level measured @ 3.35 m @ completion. (91)
			5	SPT	58		227			21.0	
226.10			6	SPT	100+						
4.88	End of borehole.										

$+^{3}$, $\times^{3}$: Numbers refer to Sensitivity

$\circ^{150}$ UNCONFINE SHEAR STRENGTH INFERRED FROM POCKET PENETROMETER READINGS

RECORD OF BOREHOLE No 07A-2 1 OF 1 METRIC

W.P. GWP 57-00-00 LOCATION HWY 26, Thornbury to Meaford Northing - 4939218, Easting - 221225 ORIGINATED BY JL

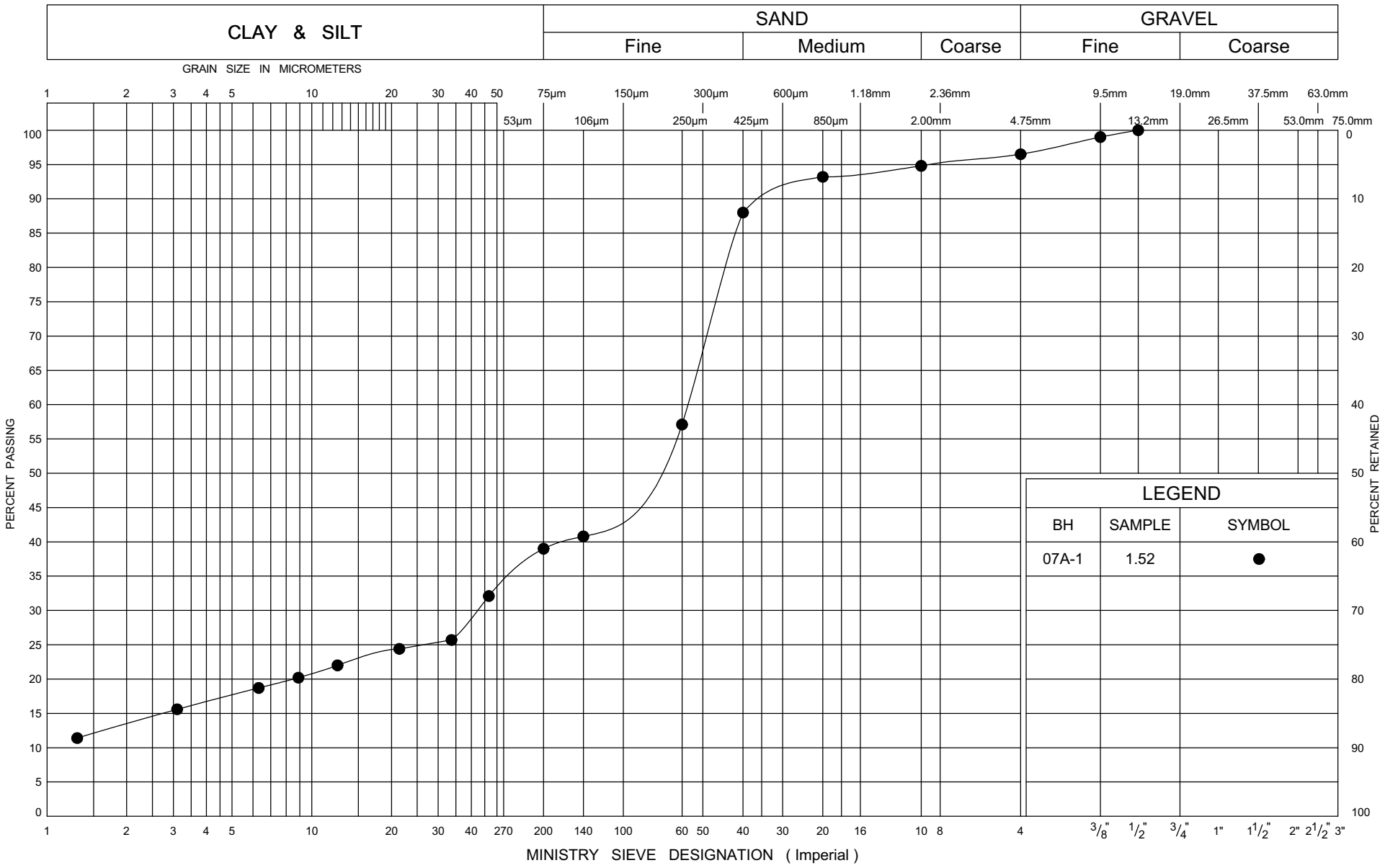
DIST Owen Sound HWY 26 BOREHOLE TYPE S/S Augering, 110 mm dia. COMPILED BY JL

DATUM Geodetic DATE 07.30.07 - 07.30.07 CHECKED BY EC

ELEV / DEPTH	DESCRIPTION	STRAT PLOT	SAMPLES NUMBER	SAMPLES TYPE	SAMPLES "N" VALUES	GROUND WATER CONDITIONS	ELEVATION SCALE	PENETR. RESISTANCE STANDARD ● DYN. CONE / SHEAR STRENGTH kPa ○ UNCONFINED ● QUICK TRIAXIAL + FIELD VANE × LAB VANE	PLASTIC LIMIT w_P / NATURAL MOISTURE CONTENT w / LIQUID LIMIT w_L / WATER CONTENT (%)	UNIT WEIGHT γ kN/m³	REMARKS & GRAIN SIZE DISTRIBUTION (%) GR SA SI CL
228.98	Ground							20 40 60 80 100	10 20 30		
0.00	230 mm TOPSOIL.										
	brown		1	SPT	17	▽	228		42		3 2 53 42 Water level(95) measured @ 1.05 m @ completion.
			2	SPT	21					22.5	
	Silty CLAY TILL, CI Moist to wet, very stiff to hard, embedded sand and gravel, occasional shale fragments.						227				
			3	SPT	84						1 3 61 35 (96)
	grey						226				
			4	SPT	100+						spoon wet
225.02			5	SPT	100+					24.3	
3.96	End of borehole.										

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

UNIFIED SOIL CLASSIFICATION SYSTEM



Ministry of Transportation
Ontario

GRAIN SIZE DISTRIBUTION

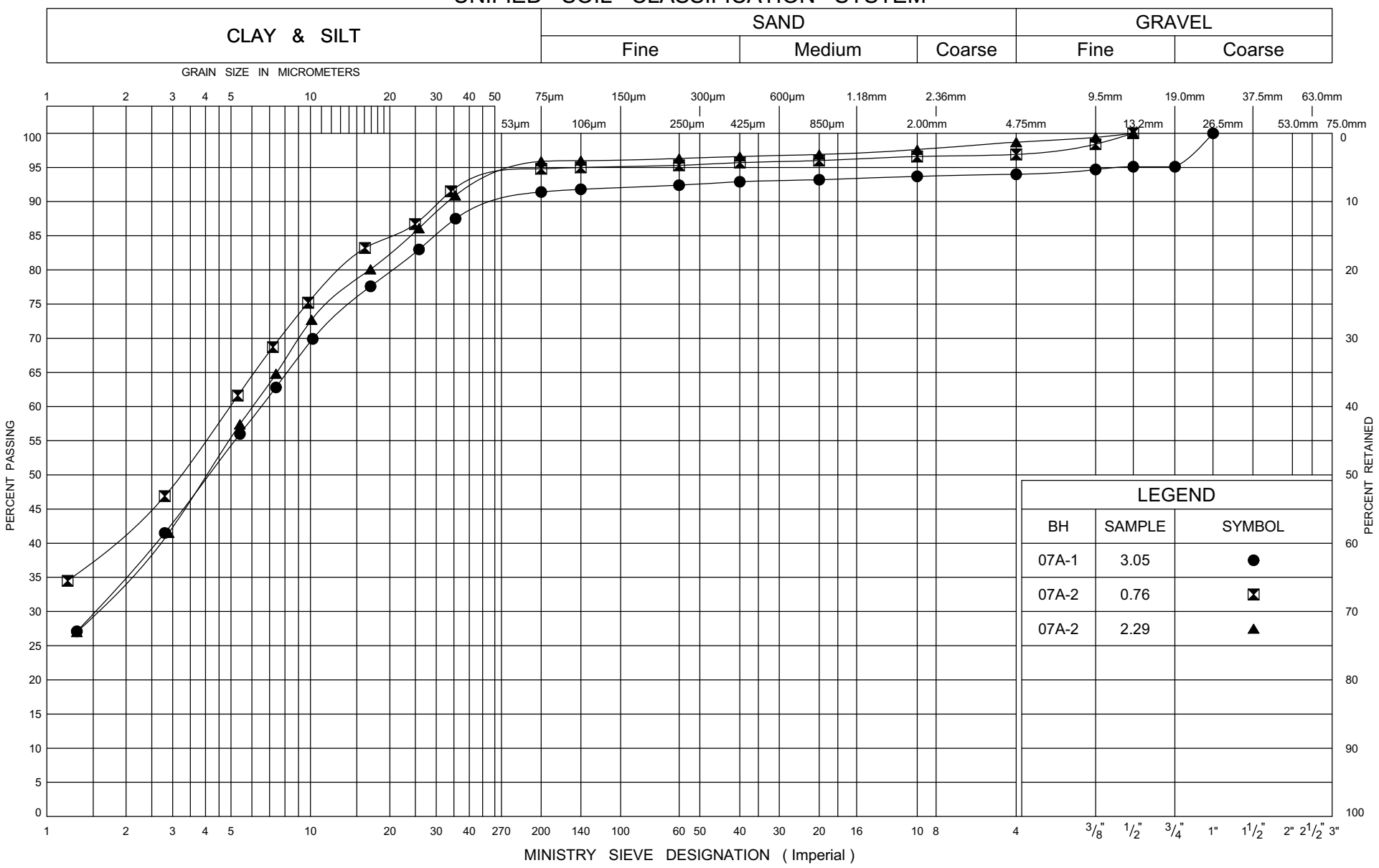
FILL

FIG No C- 07A.1

GWP 57-00-00

HWY 26, Thornbury to Meaford

UNIFIED SOIL CLASSIFICATION SYSTEM



Ministry of Transportation
Ontario

GRAIN SIZE DISTRIBUTION

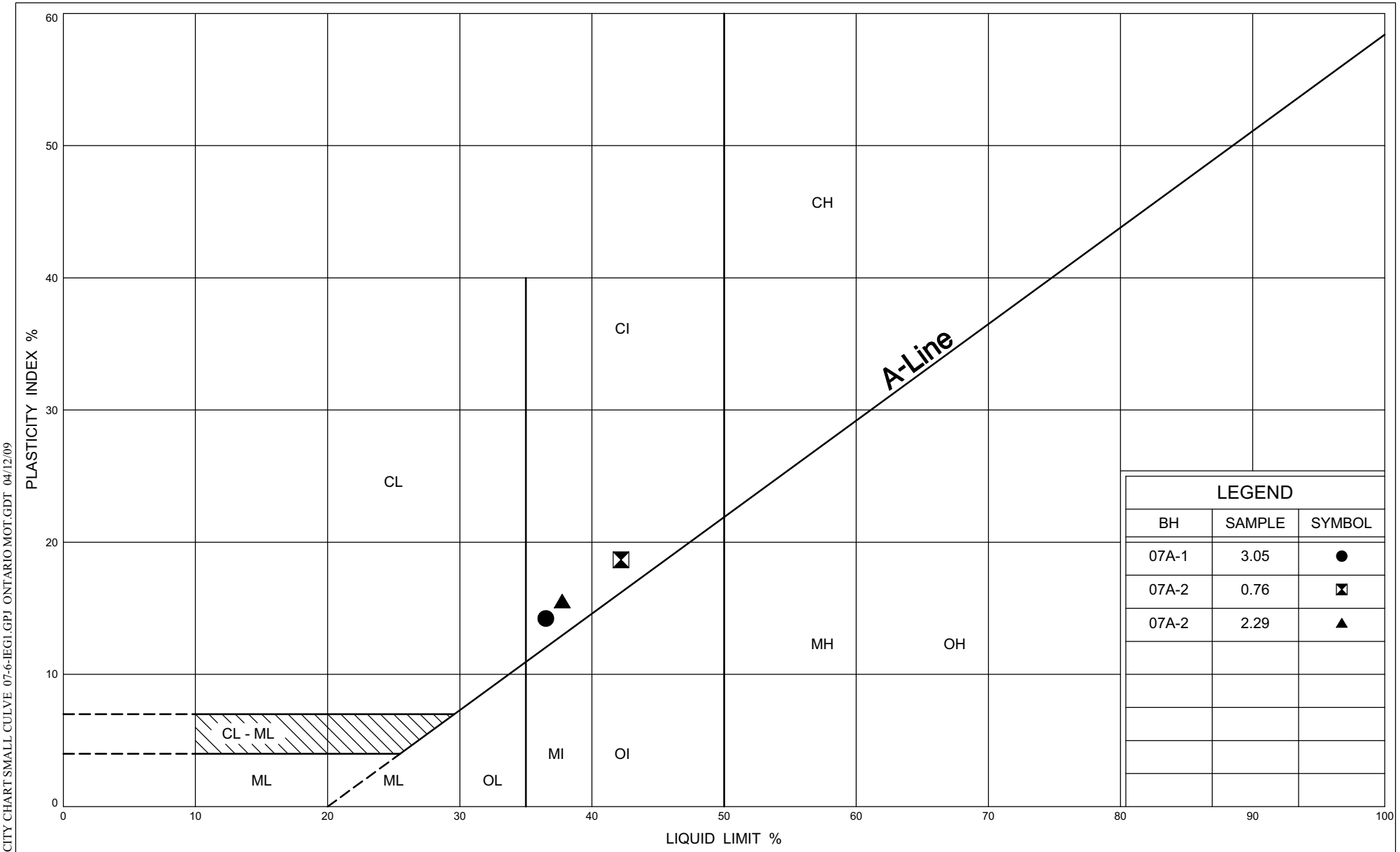
SILTY CLAY TILL, CI

FIG No C- 07A.2

GWP 57-00-00

HWY 26, Thornbury to Meaford

Oct 75, FF - S - 21



LEGEND		
BH	SAMPLE	SYMBOL
07A-1	3.05	●
07A-2	0.76	⊠
07A-2	2.29	▲

ONTARIO MOT PLASTICITY CHART SMALL CULVE 07-6-IEG1.GPJ ONTARIO MOT.GDT 04/12/09

Ministry of Transportation
Ontario

PLASTICITY CHART
SILTY CLAY TILL, CI

FIG No C- 07A.3

GWP 57-00-00

HWY 26, Thornbury to Meaford

RECORD OF BOREHOLE No 08A-1 1 OF 1 METRIC

W.P. GWP 57-00-00 LOCATION HWY 26, Thornbury to Meaford Northing - 4939179, Easting - 221524 ORIGINATED BY JL

DIST Owen Sound HWY 26 BOREHOLE TYPE S/S Augering, 110 mm dia. COMPILED BY JL

DATUM Geodetic DATE 07.26.07 - 07.26.07 CHECKED BY EC

ELEV / DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE	"N" VALUES	GROUND WATER CONDITIONS	ELEVATION SCALE	PENETR. RESISTANCE STANDARD ● DYN. CONE 20 40 60 80 100 / SHEAR STRENGTH kPa ○ UNCONFINED ● QUICK TRIAXIAL + FIELD VANE × LAB VANE 20 40 60 80 100	PLASTIC LIMIT w_P / NATURAL MOISTURE CONTENT w / LIQUID LIMIT w_L WATER CONTENT (%) 10 20 30	UNIT WEIGHT γ kN/m^3	REMARKS & GRAIN SIZE DISTRIBUTION (%) GR SA SI CL
230.76	Ground										
0.00 / 230.15	FILL Brown, moist, consisting of sand and gravel.										
0.61	FILL Brown, moist, loose to compact, consisting mainly of sandy silty clay, gravel pieces.		1	SPT	15		230				60 27 9 4 (13)
			2	SPT	6		229				
	greenish grey		3	SPT	23		228				
227.71											
3.05	shale seams		4	SPT	100				162.5		32 22 30 16 (46)
	Silty CLAY TILL, CL Grey, moist, firm to hard, embedded sand and gravel, with shale seams.		5	SPT	73		227			24.8	
226.04			6	SPT	100+						
4.72	End of borehole.										spoon wet at tip. Borehole dry and open @ completion.

$+^3, \times^3$: Numbers refer to Sensitivity

$\circ^{150}$ UNCONFINE SHEAR STRENGTH INFERRED FROM POCKET PENETROMETER READINGS

RECORD OF BOREHOLE No 08A-2 1 OF 1 METRIC

W.P. GWP 57-00-00 LOCATION HWY 26, Thornbury to Meaford Northing - 439191, Easting - 221529 ORIGINATED BY JL

DIST Owen Sound HWY 26 BOREHOLE TYPE S/S Augering, 110 mm dia. COMPILED BY JL

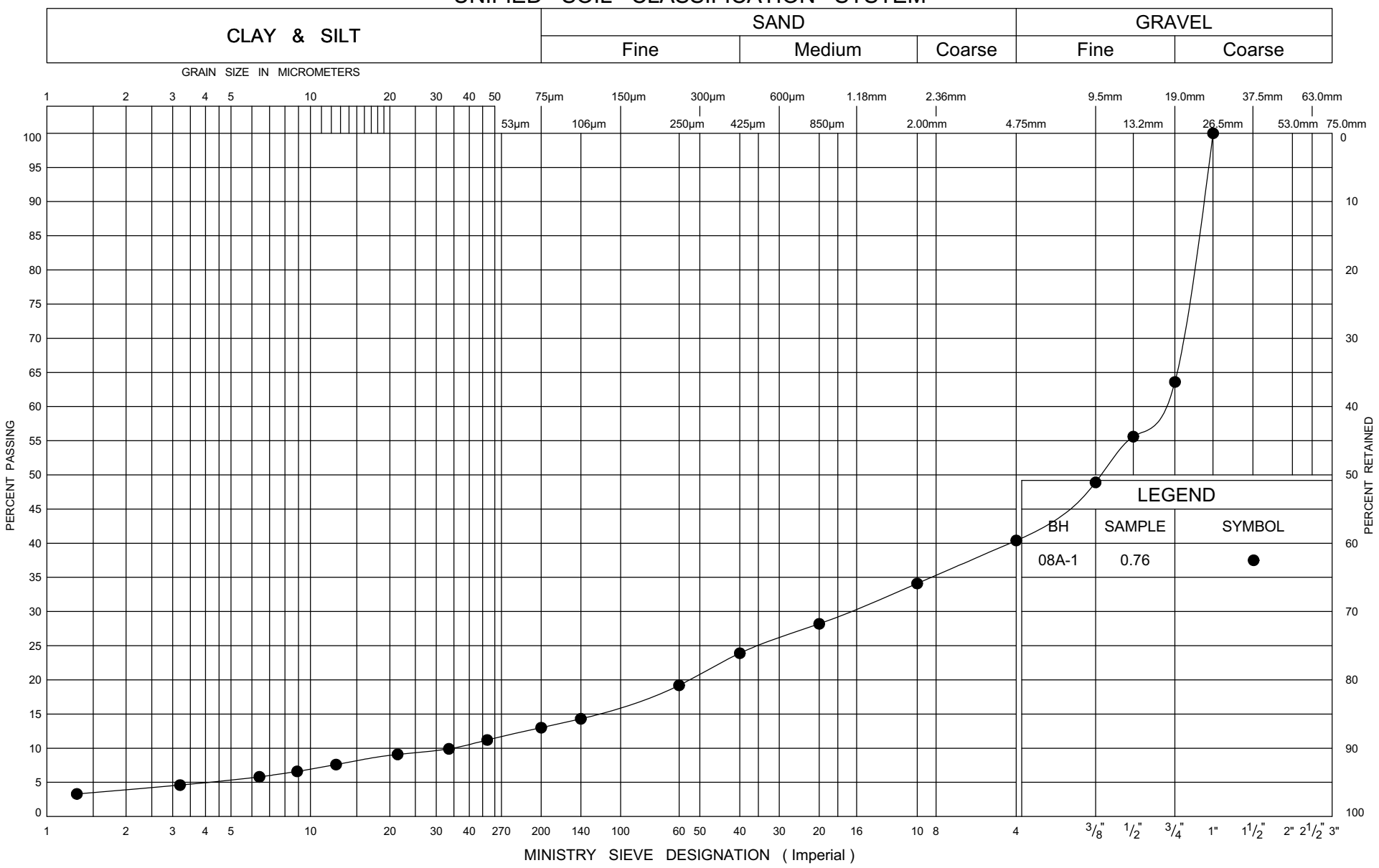
DATUM Geodetic DATE 07.30.07 - 07.30.07 CHECKED BY EC

ELEV / DEPTH	DESCRIPTION	STRAT PLOT	SAMPLES NUMBER	SAMPLES TYPE	SAMPLES "N" VALUES	GROUND WATER CONDITIONS	ELEVATION SCALE	PENETR. RESISTANCE STANDARD ● DYN. CONE (20 40 60 80 100) / SHEAR STRENGTH kPa ○ UNCONFINED ● QUICK TRIAXIAL + FIELD VANE × LAB VANE (20 40 60 80 100)	PLASTIC LIMIT w_P / NATURAL MOISTURE CONTENT w / LIQUID LIMIT w_L / WATER CONTENT (%) (10 20 30)	UNIT WEIGHT γ kN/m³	REMARKS & GRAIN SIZE DISTRIBUTION (%) GR SA SI CL
229.27	Ground										
0.00	200 mm TOPSOIL.						229				
	brown		1	SPT	29				225+		4 3 59 34 (93)
	Silty CLAY TILL, CI Moist to wet, very stiff to hard, embedded sand and gravel, shale fragments.		2	SPT	35		228			24.9	
	grey		3	SPT	51		227				3 6 54 38 (92)
226.07			4	SPT	100+						possibly shale or boulder.
3.20	End of borehole.										auger refusal. Borehole dry and open @ completion.

$+^{3}$, $\times^{3}$: Numbers refer to Sensitivity

$\circ^{150}$ UNCONFINE SHEAR STRENGTH INFERRED FROM POCKET PENETROMETER READINGS

UNIFIED SOIL CLASSIFICATION SYSTEM



Ministry of Transportation
Ontario

GRAIN SIZE DISTRIBUTION

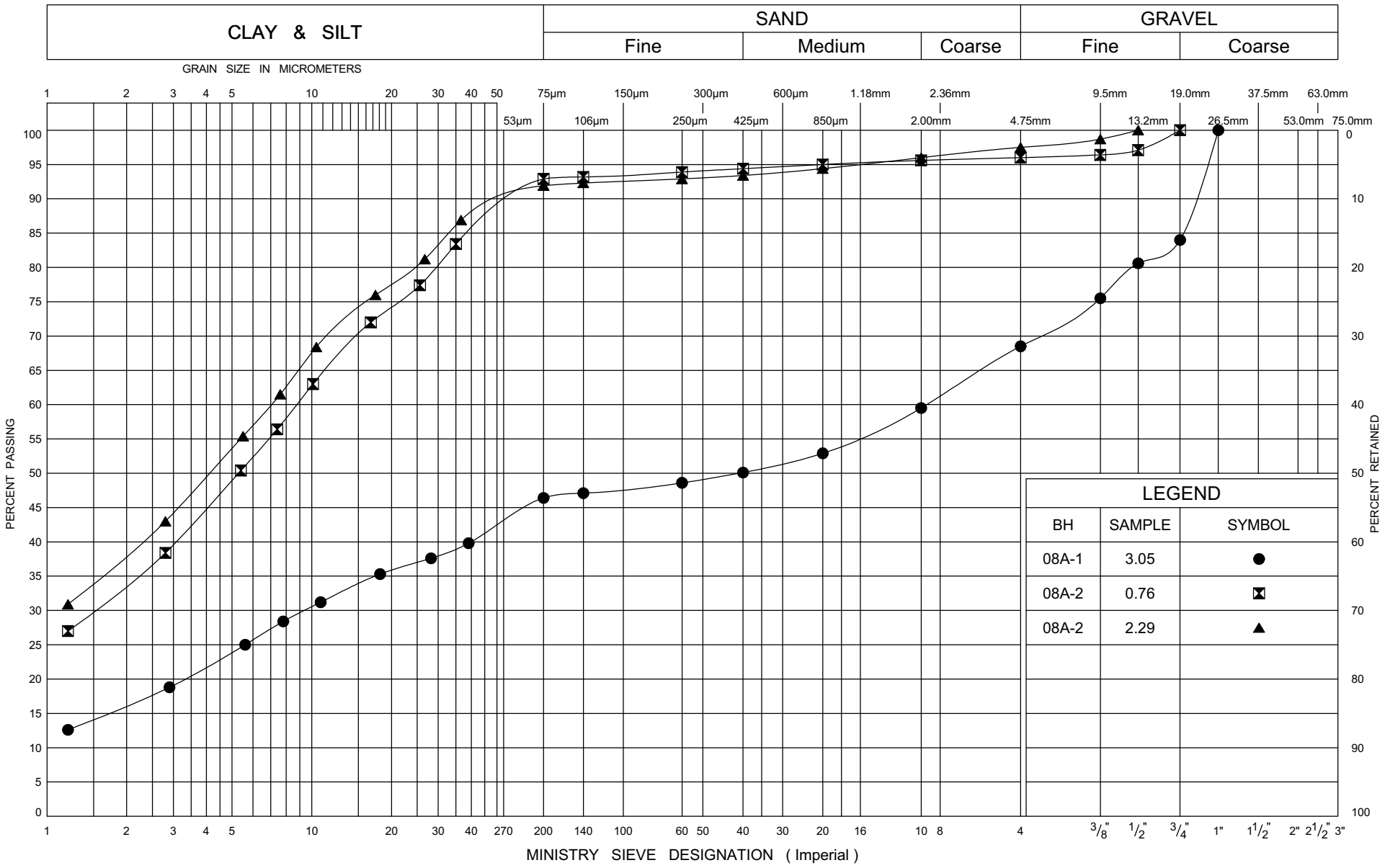
FILL

FIG No C- 08A.1

GWP 57-00-00

HWY 26, Thornbury to Meaford

UNIFIED SOIL CLASSIFICATION SYSTEM



Ministry of Transportation
Ontario

GRAIN SIZE DISTRIBUTION

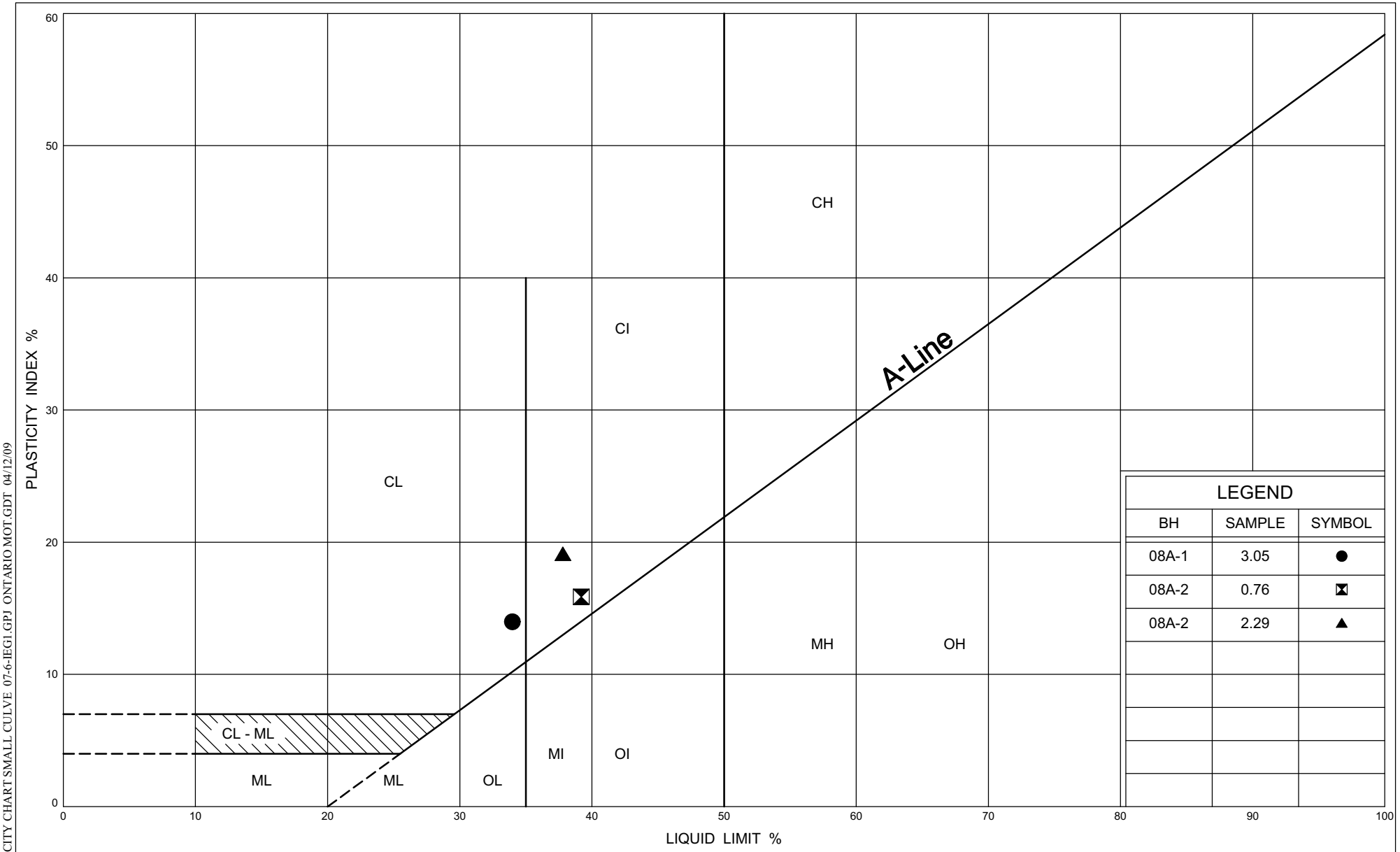
SILTY CLAY TILL WITH SHALE FRAGMENTS, CL-CI

FIG No C- 08A.2

GWP 57-00-00

HWY 26, Thornbury to Meaford

Oct 75, FF - S - 21



LEGEND		
BH	SAMPLE	SYMBOL
08A-1	3.05	●
08A-2	0.76	⊠
08A-2	2.29	▲

ONTARIO MOT PLASTICITY CHART SMALL CULVE 07-6-IEG1.GPJ ONTARIO MOT.GDT 04/12/09

Ministry of Transportation
Ontario

PLASTICITY CHART

SILTY CLAY TILL WITH SHALE FRAGMENTS, CL-CI

FIG No C- 08A.3

GWP 57-00-00

HWY 26, Thornbury to Meaford

RECORD OF BOREHOLE No 09A-1

1 OF 1

METRIC

W.P. GWP 57-00-00 LOCATION HWY 26, Thornbury to Meaford Northing - 4939148, Easting - 221872 ORIGINATED BY JL

DIST Owen Sound HWY 26 BOREHOLE TYPE S/S Augering, 110 mm dia. COMPILED BY JL

DATUM Geodetic DATE 07.26.07 - 07.26.07 CHECKED BY EC

ELEV / DEPTH	DESCRIPTION	STRAT PLOT	SAMPLES NUMBER	SAMPLES TYPE	SAMPLES "N" VALUES	GROUND WATER CONDITIONS	ELEVATION SCALE	PENETR. RESISTANCE STANDARD ● DYN. CONE 20 40 60 80 100 / SHEAR STRENGTH kPa ○ UNCONFINED ● QUICK TRIAXIAL + FIELD VANE × LAB VANE 20 40 60 80 100	PLASTIC LIMIT w_P / NATURAL MOISTURE CONTENT w / LIQUID LIMIT w_L / WATER CONTENT (%) 10 20 30	UNIT WEIGHT γ kN/m^3	REMARKS & GRAIN SIZE DISTRIBUTION (%) GR SA SI CL
232.12	Ground										
0.00	360 mm sand and gravel FILL						232				
	FILL Brown, moist to wet, loose to compact, consisting mostly of silty clay, some sand, trace gravel.		1	SPT	6		231				
			2	SPT	11						
229.99							230				
2.13	brown Silty CLAY TILL, CI Moist, very stiff to hard, embedded sand and gravel.		3	SPT	24					23.9	7 19 40 34 (75)
			4	SPT	35		229				5 14 50 32 (82) spoon wet
	grey		5	SPT	30	▼	228			21.2	
227.85											
4.27	End of borehole.										Water level measured @ 4.15 m @ completion.

$+^3, \times^3$: Numbers refer to Sensitivity

$\circ^{150}$ UNCONFINE SHEAR STRENGTH INFERRED FROM POCKET PENETROMETER READINGS

RECORD OF BOREHOLE No 09A-2 1 OF 1 METRIC

W.P. GWP 57-00-00 LOCATION HWY 26, Thornbury to Meaford Northing - 4939160, Easting - 221872 ORIGINATED BY JL

DIST Owen Sound HWY 26 BOREHOLE TYPE S/S Augering, 110 mm dia. COMPILED BY JL

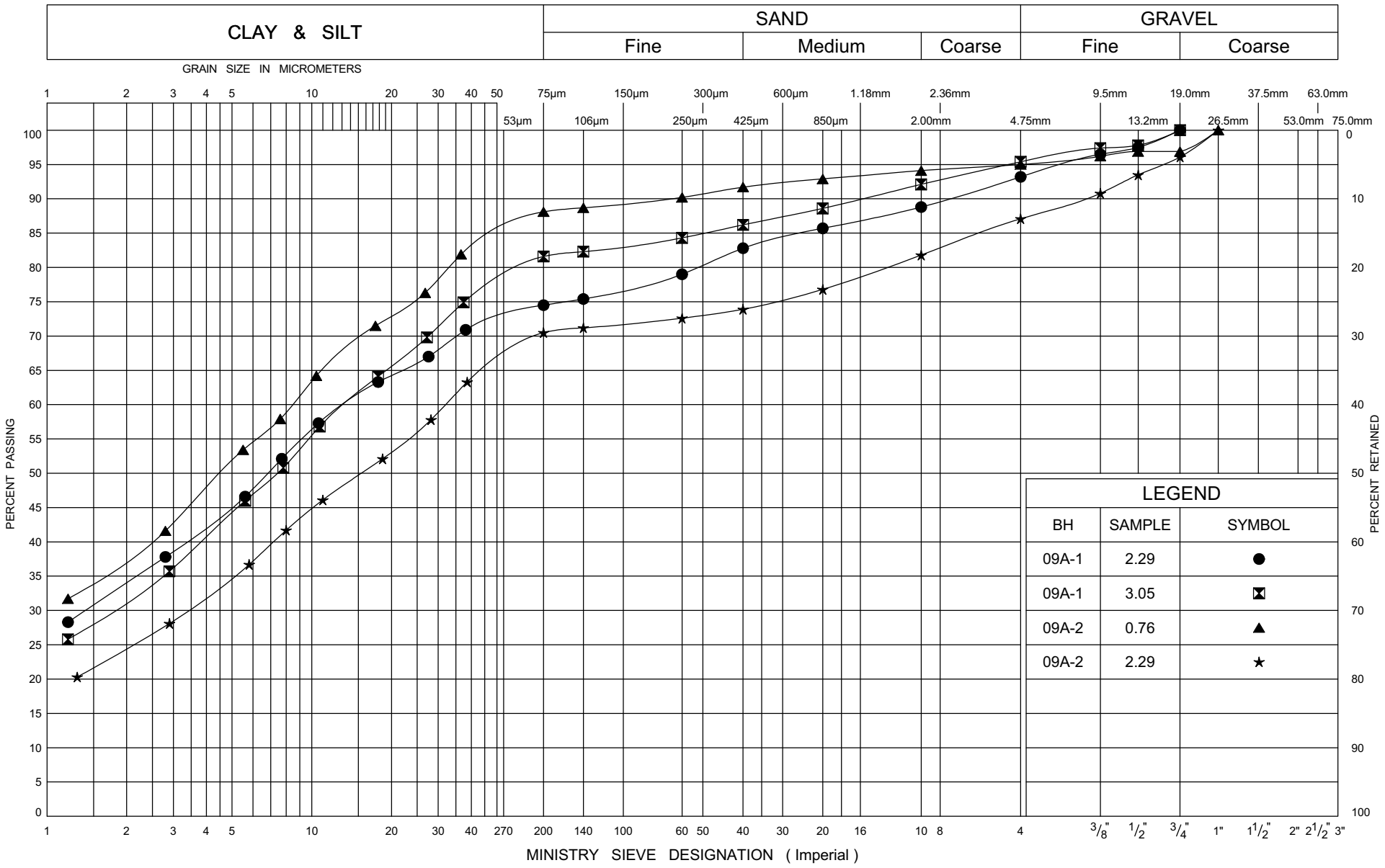
DATUM Geodetic DATE 07.30.07 - 07.30.07 CHECKED BY EC

ELEV / DEPTH	DESCRIPTION	STRAT PLOT	SAMPLES NUMBER	SAMPLES TYPE	SAMPLES "N" VALUES	GROUND WATER CONDITIONS	ELEVATION SCALE	PENETR. RESISTANCE STANDARD ● DYN. CONE (20 40 60 80 100) / SHEAR STRENGTH kPa ○ UNCONFINED ● QUICK TRIAXIAL + FIELD VANE × LAB VANE (20 40 60 80 100)	PLASTIC LIMIT w_P / NATURAL MOISTURE CONTENT w / LIQUID LIMIT w_L / WATER CONTENT (%) (10 20 30)	UNIT WEIGHT γ kN/m³	REMARKS & GRAIN SIZE DISTRIBUTION (%) GR SA SI CL
230.60	Ground										
0.00	180 mm TOPSOIL.										
	brown		1	SPT	18	▽	230			19.1	5 7 50 38 (88)
			2	SPT	100+		229				spoon bouncing on 150 mm diam cobble
	Silty CLAY TILL, CL-CI Moist to wet, very stiff to hard, embedded sand and gravel.		3	SPT	48		228				13 17 46 24 (71)
	grey		4	SPT	54					19.8	
							227				
226.41			5	SPT	100+						spoon wet
4.19	End of borehole.										Borehole dry and open at completion. Water level measured @ 1 m approximately 3 hours after completion. Potential artesian condition.

$+^3, \times^3$: Numbers refer to Sensitivity

$\circ^{150}$ UNCONFINE SHEAR STRENGTH INFERRED FROM POCKET PENETROMETER READINGS

UNIFIED SOIL CLASSIFICATION SYSTEM



Ministry of Transportation
Ontario

GRAIN SIZE DISTRIBUTION

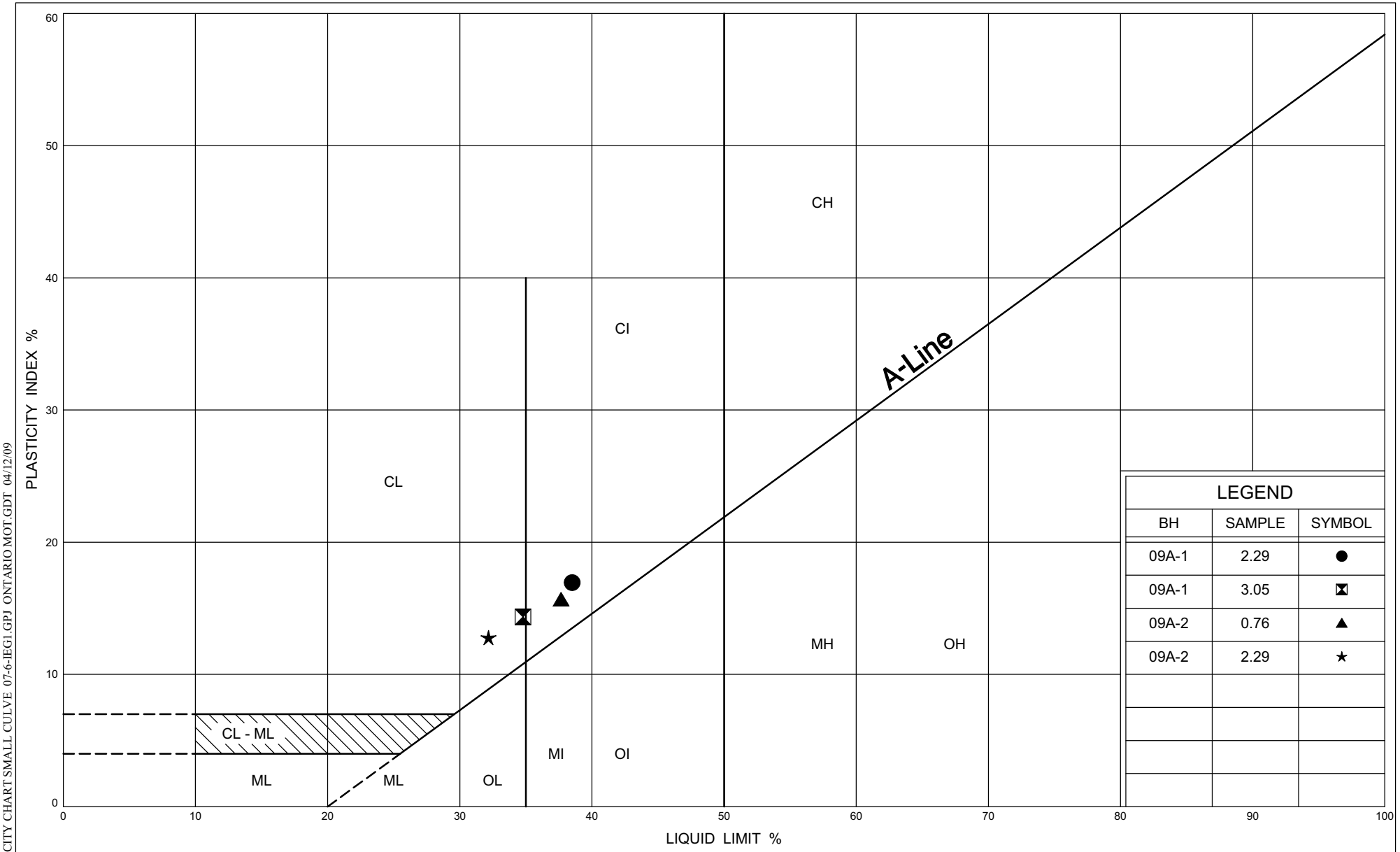
SILTY CLAY TILL, CL-CI

FIG No C- 09A.1

GWP 57-00-00

HWY 26, Thornbury to Meaford

Oct 75, FF - S - 21



LEGEND		
BH	SAMPLE	SYMBOL
09A-1	2.29	●
09A-1	3.05	⊠
09A-2	0.76	▲
09A-2	2.29	★

Ministry of Transportation
Ontario

PLASTICITY CHART

SILTY CLAY TILL, CL-CI

FIG No C- 09A.2

GWP 57-00-00

HWY 26, Thornbury to Meaford

ONTARIO MOT PLASTICITY CHART SMALL CULVE 07-6-IEG1.GPJ ONTARIO MOT.GDT 04/12/09

RECORD OF BOREHOLE No 10A-1

1 OF 1

METRIC

W.P. GWP 57-00-00 LOCATION HWY 26, Thornbury to Meaford Northing - 4939102, Easting - 222094 ORIGINATED BY JL

DIST Owen Sound HWY 26 BOREHOLE TYPE S/S Augering, 110 mm dia. COMPILED BY JL

DATUM Geodetic DATE 07.30.07 - 07.30.07 CHECKED BY EC

ELEV / DEPTH	DESCRIPTION	STRAT PLOT	SAMPLES NUMBER	SAMPLES TYPE	SAMPLES "N" VALUES	GROUND WATER CONDITIONS	ELEVATION SCALE	PENETR. RESISTANCE STANDARD ● DYN. CONE (20 40 60 80 100) / SHEAR STRENGTH kPa ○ UNCONFINED ● QUICK TRIAXIAL + FIELD VANE × LAB VANE (20 40 60 80 100)	PLASTIC LIMIT w_P / NATURAL MOISTURE CONTENT w / LIQUID LIMIT w_L / WATER CONTENT (%) (10 20 30)	UNIT WEIGHT γ kN/m³	REMARKS & GRAIN SIZE DISTRIBUTION (%) GR SA SI CL
230.96	Ground										
0.00	75 mm TOPSOIL.					▽					Water level measured @ 0.45m @ completion.
230.05	Silty SAND, SM Brown, wet, compact.		1	SPT	55		230				0 5 63 32 (95)
0.91			2	SPT	36					21.8	
	Silty CLAY TILL CL-CI Grey, moist, hard, embedded sand, gravel and cobbles.		3	SPT	47		229				
			4	SPT	79		228				1 4 64 32 (96)
227.00			5	SPT	100+						
3.96	End of borehole.						227				auger refusal

JOE MTO 07-6-IEG1.GPJ ONTARIO MOT.GDT 04/12/09

$+^3, \times^3$: Numbers refer to Sensitivity

$\circ^{150}$ UNCONFINE SHEAR STRENGTH INFERRED FROM POCKET PENETROMETER READINGS

RECORD OF BOREHOLE No 10A-2 1 OF 1 METRIC

W.P. GWP 57-00-00 LOCATION HWY 26, Thornbury to Meaford Northing - 4939122, Easting - 222101 ORIGINATED BY JL

DIST Owen Sound HWY 26 BOREHOLE TYPE S/S Augering, 110 mm dia. COMPILED BY JL

DATUM Geodetic DATE 07.30.07 - 07.30.07 CHECKED BY EC

ELEV / DEPTH	DESCRIPTION	STRAT PLOT	SAMPLES NUMBER	TYPE	"N" VALUES	GROUND WATER CONDITIONS	UNIT WEIGHT γ kN/m³	REMARKS & GRAIN SIZE DISTRIBUTION (%) GR SA SI CL
233.16	Ground							
0.00	FILL Brown, moist, consisting of sand and gravel.							
232.55								
0.61			1	SPT	13			
	FILL Brown, moist, compact to loose, consisting of silty clay with some sand , trace to some gravel.		2	SPT	6			25 14 30 31 (61)
			3	SPT	6	▽		Water level measured @ 2.75 m @ completion.
230.11								
3.05	brown		4	SPT	32		21.2	4 23 31 42 (73)
			5	SPT	27			17 5 49 29 (78)
	Silty CLAY TILL, CL-CI Moist, very stiff to hard, embedded sand and gravel.		6	SPT	33			
	grey		7	SPT	75			
			8	SPT	100+			
226.00			9	SPT	100+			
7.16	End of borehole.							

PENETR. RESISTANCE STANDARD ● DYN. CONE
20 40 60 80 100
SHEAR STRENGTH kPa
○ UNCONFINED + FIELD VANE
● QUICK TRIAXIAL × LAB VANE
20 40 60 80 100

PLASTIC LIMIT w_P NATURAL MOISTURE CONTENT w LIQUID LIMIT w_L
WATER CONTENT (%)
10 20 30

ELEVATION SCALE
233
232
231
230
229
228
227

43

$+^3$, $\times^3$: Numbers refer to Sensitivity ○ 150 UNCONFINE SHEAR STRENGTH INFERRED FROM POCKET PENETROMETER READINGS

RECORD OF BOREHOLE No 10A-3 1 OF 1 METRIC

W.P. GWP 57-00-00 LOCATION HWY 26, Thornbury to Meaford Northing - 4939134, Easting - 222102 ORIGINATED BY JL

DIST Owen Sound HWY 26 BOREHOLE TYPE S/S Augering, 110 mm dia. COMPILED BY JL

DATUM Geodetic DATE 07.25.07 - 07.25.07 CHECKED BY EC

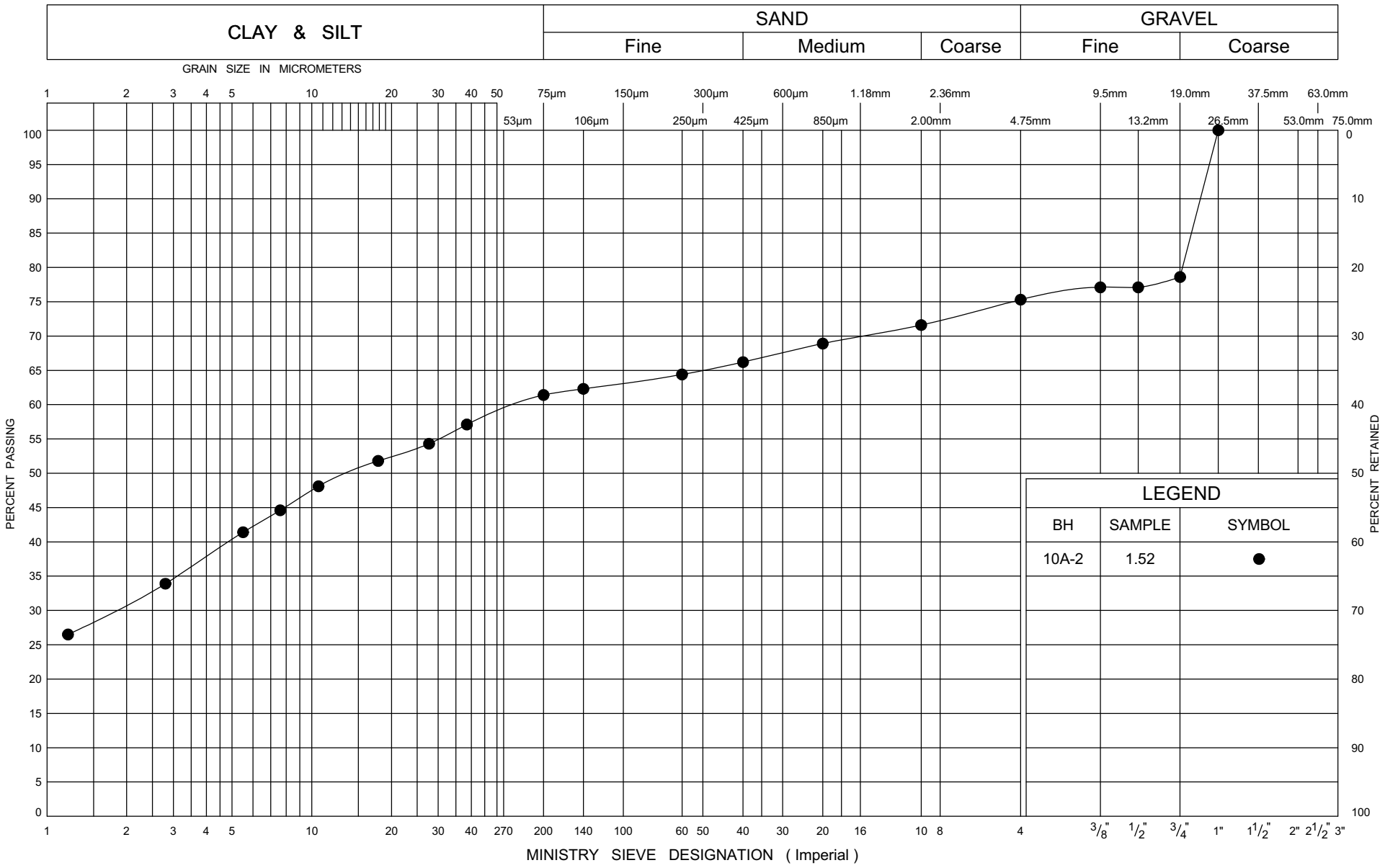
ELEV / DEPTH	DESCRIPTION	STRAT PLOT	SAMPLES NUMBER	SAMPLES TYPE	SAMPLES "N" VALUES	GROUND WATER CONDITIONS	ELEVATION SCALE	PENETR. RESISTANCE STANDARD ● DYN. CONE (20 40 60 80 100) / SHEAR STRENGTH kPa ○ UNCONFINED ● QUICK TRIAXIAL + FIELD VANE × LAB VANE (20 40 60 80 100)	PLASTIC LIMIT w_P / NATURAL MOISTURE CONTENT w / LIQUID LIMIT w_L / WATER CONTENT (%) (10 20 30)	UNIT WEIGHT γ kN/m³	REMARKS & GRAIN SIZE DISTRIBUTION (%) GR SA SI CL
229.64	Ground										
0.00	100 mm TOPSOIL.										
	brown		1	SPT	9		229			21.2	1 21 40 38 (78)
	wet silty sand seams		2	SPT	4	▽	228				Water level measured @ 1.65 m @ completion.
227.66											
1.98	Silty CLAY TILL, CL Moist, stiff to hard, embedded sand, gravel and shale fragments, with wet silty sand seams.		3	SPT	80		227				12 11 50 28 (78)
	grey		4	SPT	100+					21.9	
							226				
225.53			5	SPT	100+						
4.11	End of borehole.										

JOE MTO 07-6-IEG1.GPJ ONTARIO MOT.GDT 04/12/09

$+^{3}$, $\times^{3}$: Numbers refer to Sensitivity

$\circ^{150}$ UNCONFINE SHEAR STRENGTH INFERRED FROM POCKET PENETROMETER READINGS

UNIFIED SOIL CLASSIFICATION SYSTEM



Ministry of Transportation
Ontario

GRAIN SIZE DISTRIBUTION

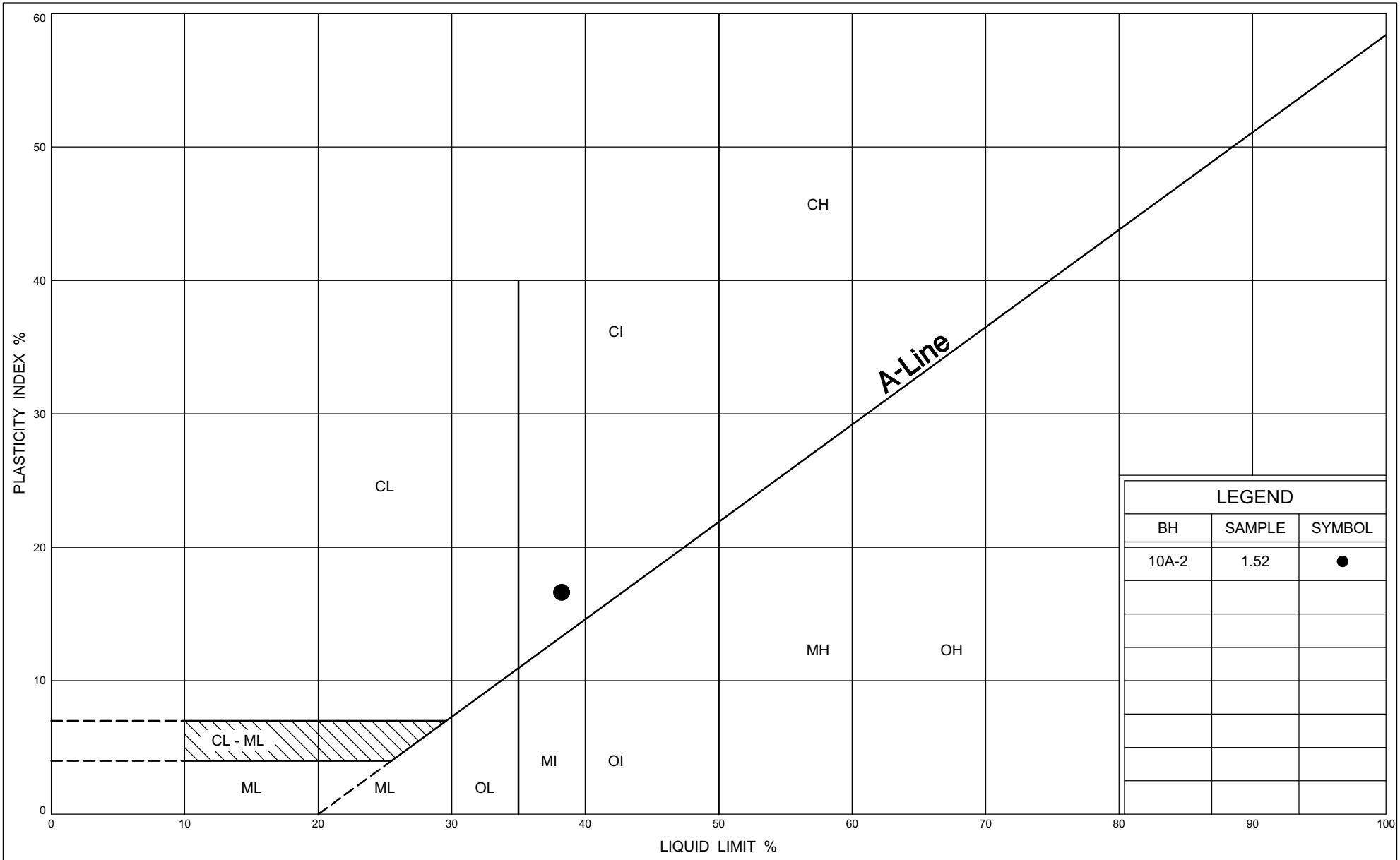
FILL

FIG No C- 10A.1

GWP 57-00-00

HWY 26, Thornbury to Meaford

Oct 75, FF - S - 21



ONTARIO MOT PLASTICITY CHART SMALL CULVE 07-6-IEG1.GPJ ONTARIO MOT.GDT 04/12/09

Ministry of Transportation
Ontario

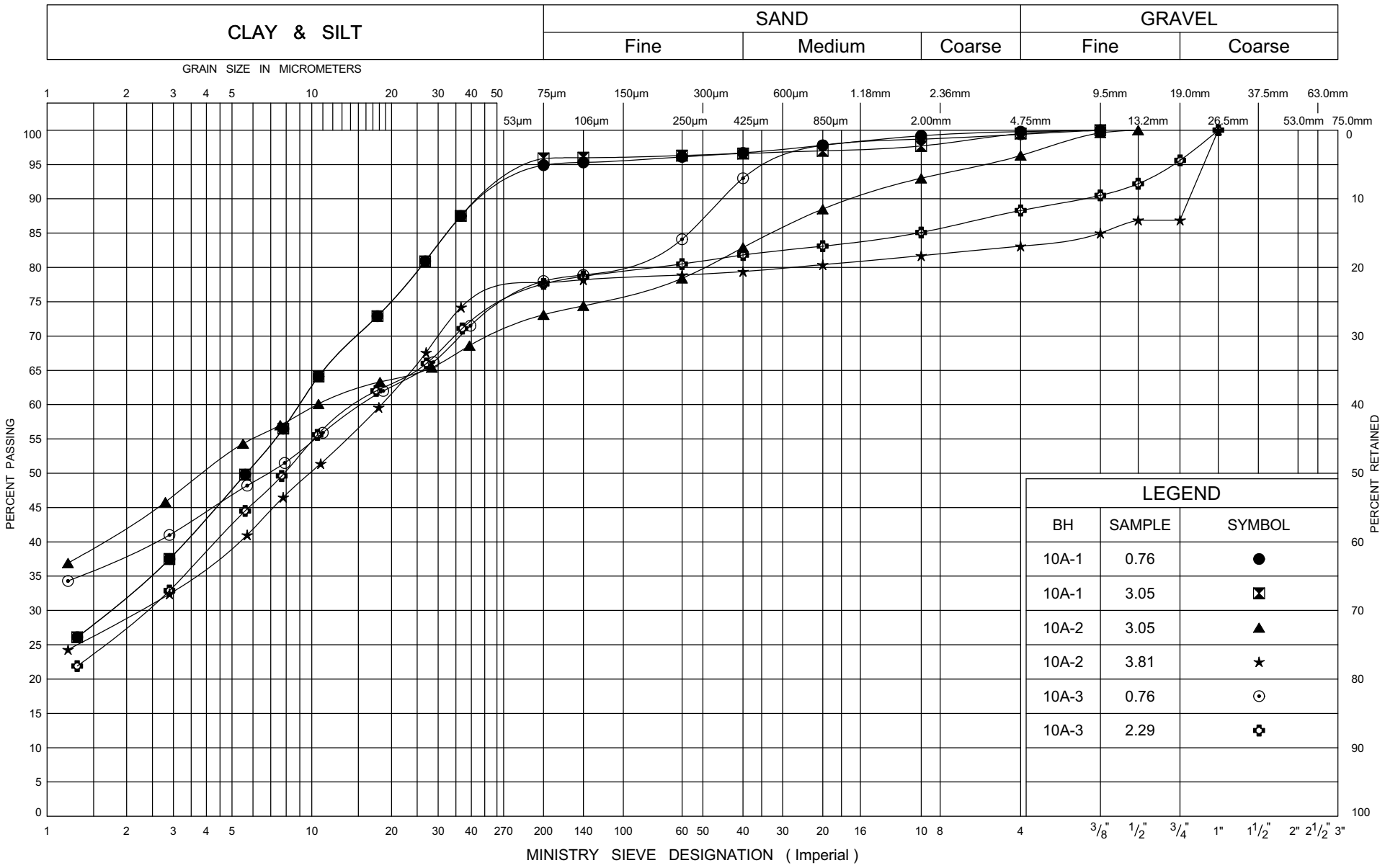
PLASTICITY CHART
FILL

FIG No C- 10A.2

GWP 57-00-00

HWY 26, Thornbury to Meaford

UNIFIED SOIL CLASSIFICATION SYSTEM



Ministry of Transportation
Ontario

GRAIN SIZE DISTRIBUTION

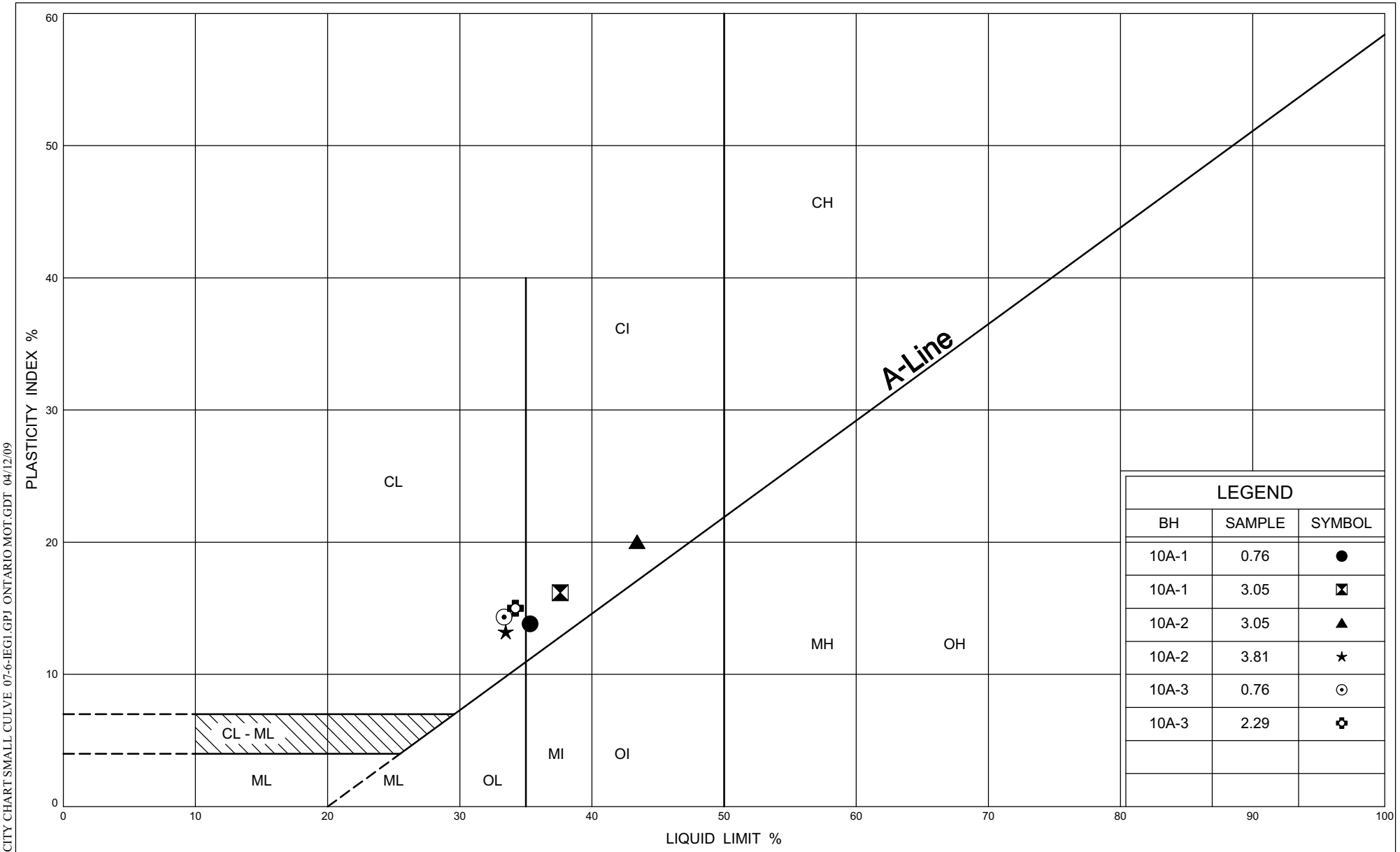
SILTY CLAY TILL, CL-CI

FIG No C- 10A.3

GWP 57-00-00

HWY 26, Thornbury to Meaford

Oct 75, FF - S - 21



LEGEND		
BH	SAMPLE	SYMBOL
10A-1	0.76	●
10A-1	3.05	⊠
10A-2	3.05	▲
10A-2	3.81	★
10A-3	0.76	⊙
10A-3	2.29	✿

Ministry of Transportation
Ontario

PLASTICITY CHART
SILTY CLAY TILL, CL-CI

FIG No C- 10A.4

GWP 57-00-00

HWY 26, Thornbury to Meaford

ONTARIO MOT PLASTICITY CHART SMALL CULVE 07-6-IEG1.GPJ ONTARIO MOT.GDT 04/12/09

RECORD OF BOREHOLE No 11A-1

1 OF 1

METRIC

W.P. GWP 57-00-00 LOCATION HWY 26, Thornbury to Meaford Northing - 4939068, Easting - 222372 ORIGINATED BY JL

DIST Owen Sound HWY 26 BOREHOLE TYPE S/S Augering, 110 mm dia. COMPILED BY JL

DATUM Geodetic DATE 07.26.07 - 07.26.07 CHECKED BY EC

ELEV / DEPTH	DESCRIPTION	STRAT PLOT	SAMPLES NUMBER	SAMPLES TYPE	SAMPLES "N" VALUES	GROUND WATER CONDITIONS	ELEVATION SCALE	PENETR. RESISTANCE STANDARD ● DYN. CONE 20 40 60 80 100 / SHEAR STRENGTH kPa ○ UNCONFINED ● QUICK TRIAXIAL + FIELD VANE × LAB VANE 20 40 60 80 100	PLASTIC LIMIT w_P / NATURAL MOISTURE CONTENT w / LIQUID LIMIT w_L / WATER CONTENT (%) 10 20 30	UNIT WEIGHT γ kN/m³	REMARKS & GRAIN SIZE DISTRIBUTION (%) GR SA SI CL
235.03	Ground										
0.00	100 mm TOPSOIL.										
	POSSIBLE FILL Reddish brown, moist to wet, loose to compact, consisting of silty clay with embedded sand, and shale pieces.		1	SPT	7		234				15 17 38 30 (68)
			2	SPT	9		233				
			3	SPT	12						35 15 30 20 (51)
			4	SPT	14		232				
231.37											
3.66			5	SPT		▽	231				22 24 34 20 (54) spoon bouncing on cobble
	brown		6	SPT	26						
	Silty CLAY TILL, CL-CI Moist, very stiff to hard, embedded sand, gravel and shale fragments, with wet silty sand seams.		7	SPT	45		230				15 16 40 30 (69)
	grey shale layers		8	SPT	56		229				
			9	SPT	56		228			24.4	7 11 43 39 (82)
227.71											
7.32	End of borehole.										Water level measured @ 4.1 m @ completion.

JOE MTO 07-6-IEG1.GPJ ONTARIO MOT.GDT 04/12/09

$+^{3}, \times^{3}$: Numbers refer to Sensitivity

○ 150 UNCONFINE SHEAR STRENGTH INFERRED FROM POCKET PENETROMETER READINGS

RECORD OF BOREHOLE No 11A-2

1 OF 1

METRIC

W.P. GWP 57-00-00 LOCATION HWY 26, Thornbury to Meaford Northing - 4939089, Easting - 222363 ORIGINATED BY JL

DIST Owen Sound HWY 26 BOREHOLE TYPE S/S Augering, 110 mm dia. COMPILED BY JL

DATUM Geodetic DATE 07.26.07 - 07.26.07 CHECKED BY EC

ELEV / DEPTH	DESCRIPTION	STRAT PLOT	SAMPLES NUMBER	SAMPLES TYPE	SAMPLES "N" VALUES	GROUND WATER CONDITIONS	ELEVATION SCALE	PENETR. RESISTANCE STANDARD ● DYN. CONE 20 40 60 80 100 / SHEAR STRENGTH kPa ○ UNCONFINED ● QUICK TRIAXIAL + FIELD VANE × LAB VANE 20 40 60 80 100	PLASTIC LIMIT w_P / NATURAL MOISTURE CONTENT w / LIQUID LIMIT w_L / WATER CONTENT (%) 10 20 30	UNIT WEIGHT γ kN/m³	REMARKS & GRAIN SIZE DISTRIBUTION (%) GR SA SI CL
235.70	Ground										
0.00 / 234.94	FILL Brown, moist, consisting of sand and gravel.						235				
0.76 / 233.87	FILL Brown, moist, compact to loose, consisting of silty clay with some sand, trace gravel.		1	SPT	8						
			2	SPT	6		234				
1.83	brown		3	SPT	12				43		37 18 25 19 (45)
			4	SPT	12		233				19 19 33 29 (62)
	Silty CLAY TILL, CL-CI Moist, stiff to very stiff, embedded sand and gravel.		5	SPT	13		232				45 18 23 14 (37)
	reddish brown		6	SPT	14		231				
5.33 / 230.37	Silty SAND & GRAVEL, GM-SM Brown, moist, compact, trace to some gravel.		7	SPT	16		230				33 28 25 14 (39)
			8	SPT	27						
6.55 / 229.15	End of borehole.										Borehole dry and open @ completion.

$+^{3}, \times^{3}$: Numbers refer to Sensitivity

$\circ^{150}$ UNCONFINE SHEAR STRENGTH INFERRED FROM POCKET PENETROMETER READINGS

RECORD OF BOREHOLE No 11A-3

1 OF 1

METRIC

W.P. GWP 57-00-00 LOCATION HWY 26, Thornbury to Meaford Northing - 4939092, Easting - 222376 ORIGINATED BY JL

DIST Owen Sound HWY 26 BOREHOLE TYPE S/S Augering, 110 mm dia. COMPILED BY JL

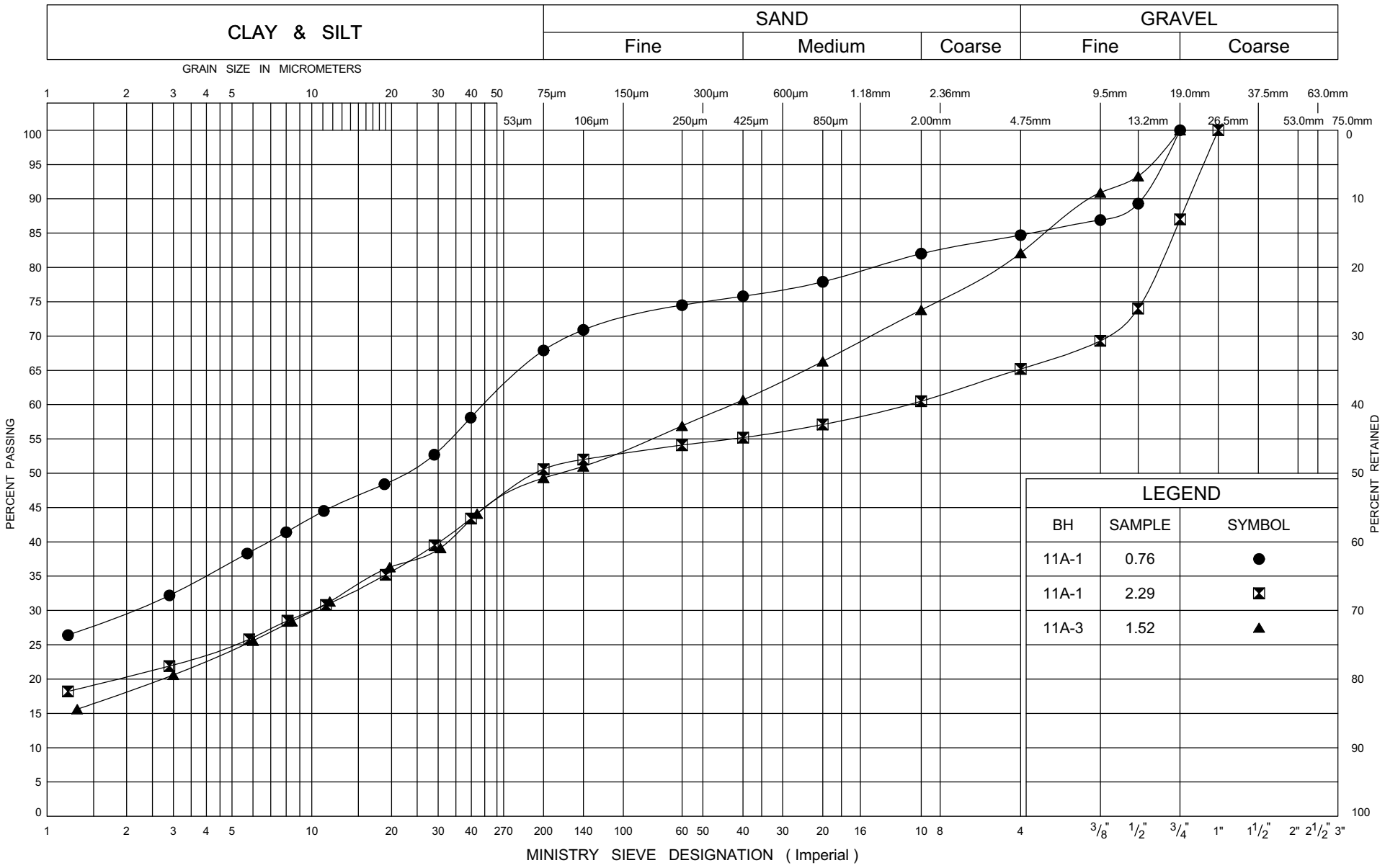
DATUM Geodetic DATE 07.26.07 - 07.26.07 CHECKED BY EC

ELEV / DEPTH	DESCRIPTION	STRAT PLOT	SAMPLES NUMBER	SAMPLES TYPE	SAMPLES "N" VALUES	GROUND WATER CONDITIONS	ELEVATION SCALE	PENETR. RESISTANCE STANDARD ● DYN. CONE 20 40 60 80 100 / SHEAR STRENGTH kPa ○ UNCONFINED ● QUICK TRIAXIAL + FIELD VANE × LAB VANE 20 40 60 80 100	PLASTIC LIMIT w_P / NATURAL MOISTURE CONTENT w / LIQUID LIMIT w_L / WATER CONTENT (%) 10 20 30	UNIT WEIGHT γ kN/m³	REMARKS & GRAIN SIZE DISTRIBUTION (%) GR SA SI CL
234.85	Ground										
0.00	75 mm TOPSOIL.										
	POSSIBLE FILL Brown, moist to wet, compact to loose, consisting mainly of sand and gravel, with some silty clay lumps.		1	SPT	16		234				
			2	SPT	9		233				18 33 31 18 (49)
232.72											
2.13	Silty CLAY TILL, CL-CI Brown, moist, stiff to very stiff, embedded sand, gravel and shale fragments, with wet silty sand seams.		3	SPT	12		232				
			4	SPT	15					22.6	22 11 36 30 (66)
			5	SPT	21		231				
			6	SPT	22		230				31 23 30 17 (46)
	shale layers		7	SPT	28						
229.06											
5.79	End of borehole.										Borehole dry and open @ completion.

$+^3, \times^3$: Numbers refer to Sensitivity

$\circ^{150}$ UNCONFINE SHEAR STRENGTH INFERRED FROM POCKET PENETROMETER READINGS

UNIFIED SOIL CLASSIFICATION SYSTEM



Ministry of Transportation
Ontario

GRAIN SIZE DISTRIBUTION

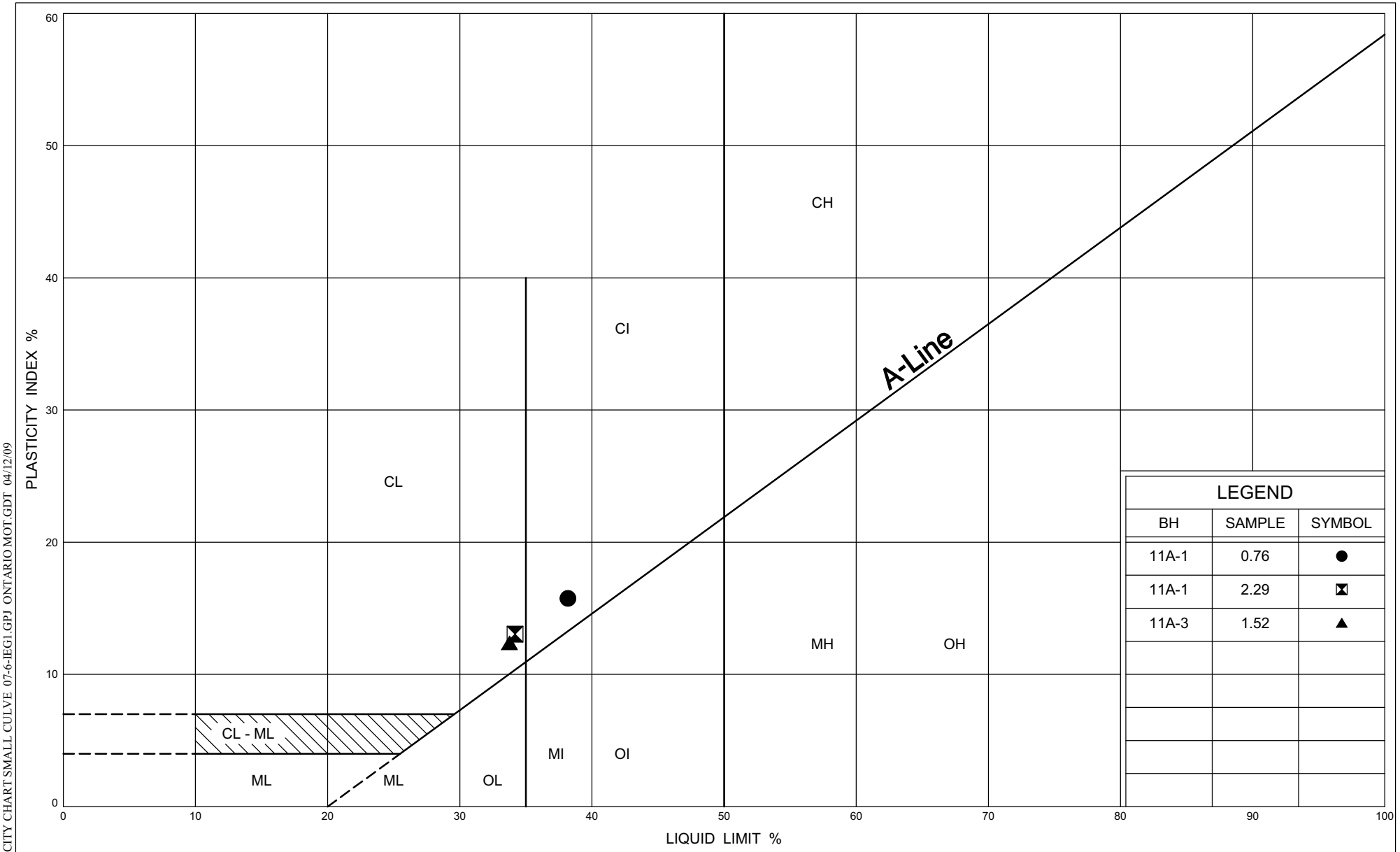
FILL

FIG No C- 11A.1

GWP 57-00-00

HWY 26, Thornbury to Meaford

Oct 75, FF - S - 21



LEGEND		
BH	SAMPLE	SYMBOL
11A-1	0.76	●
11A-1	2.29	⊠
11A-3	1.52	▲

Ministry of Transportation
Ontario

PLASTICITY CHART
FILL

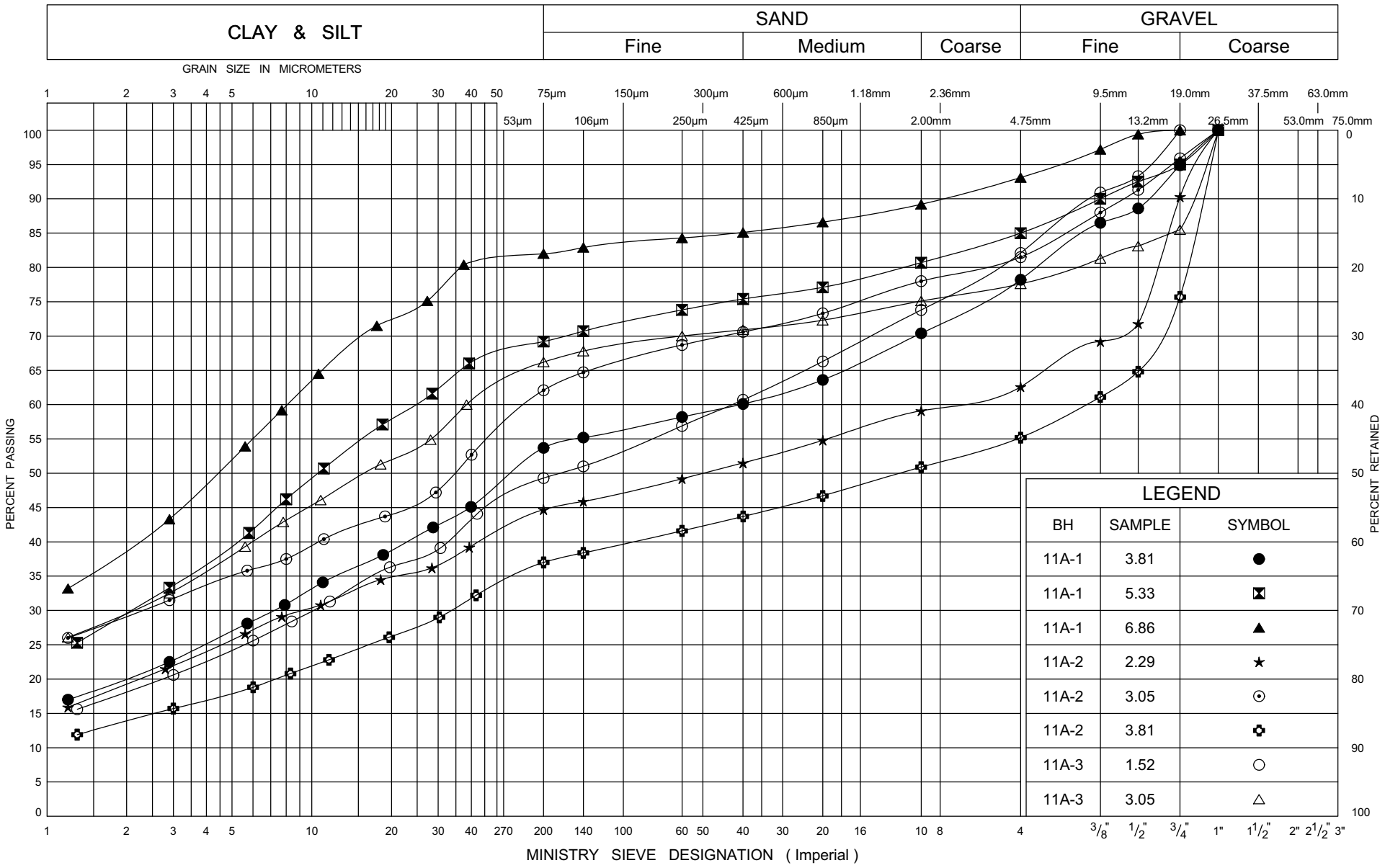
FIG No C- 11A.2

GWP 57-00-00

HWY 26, Thornbury to Meaford

ONTARIO MOT PLASTICITY CHART SMALL CULVE 07-6-IEG1.GPJ ONTARIO MOT.GDT 04/12/09

UNIFIED SOIL CLASSIFICATION SYSTEM



Ministry of Transportation
Ontario

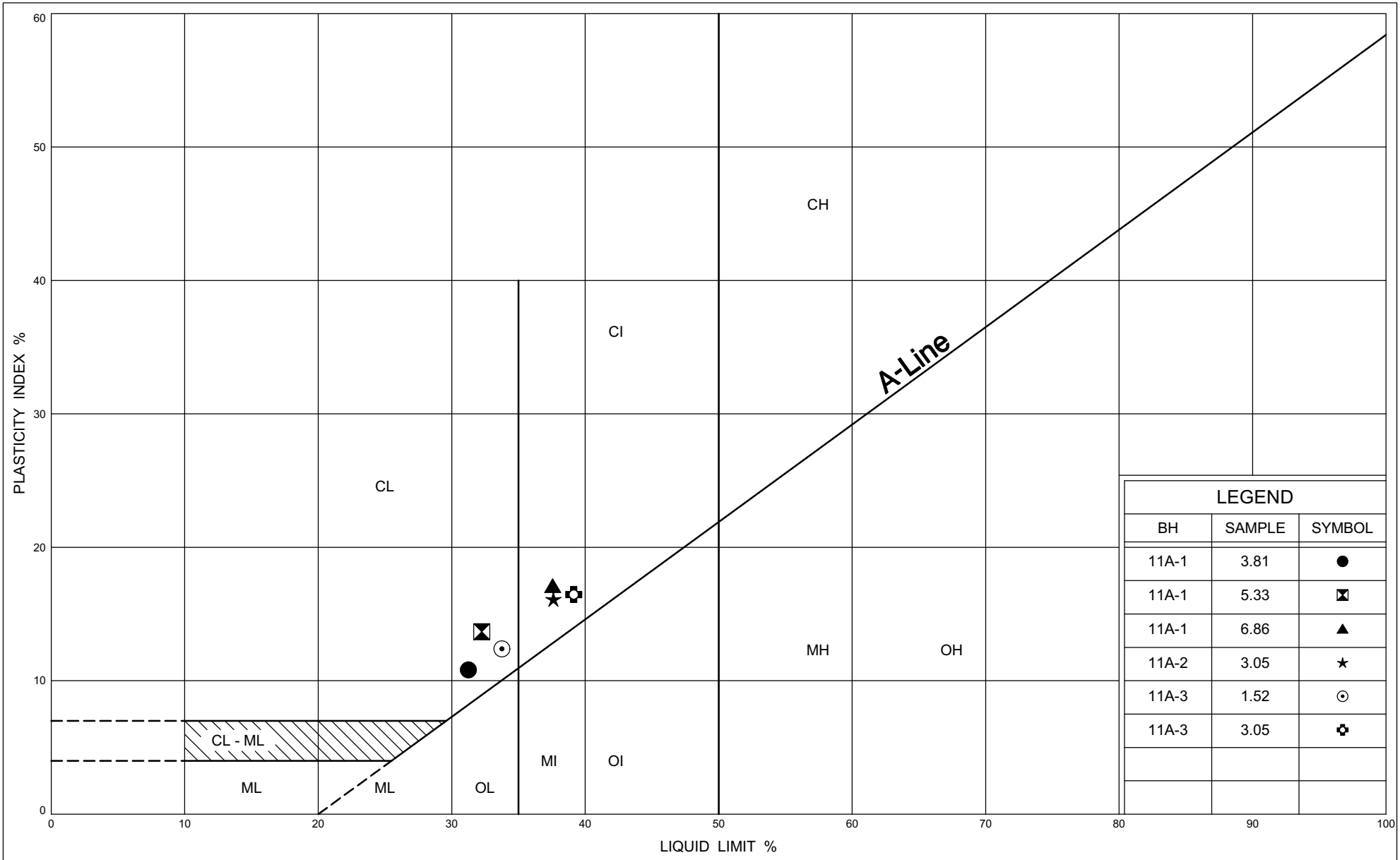
GRAIN SIZE DISTRIBUTION

SILTY CLAY TILL, CL-CI

FIG No C- 11A.3

GWP 57-00-00

HWY 26, Thornbury to Meaford



LEGEND		
BH	SAMPLE	SYMBOL
11A-1	3.81	●
11A-1	5.33	⊠
11A-1	6.86	▲
11A-2	3.05	★
11A-3	1.52	⊙
11A-3	3.05	✿

Ministry of Transportation
Ontario

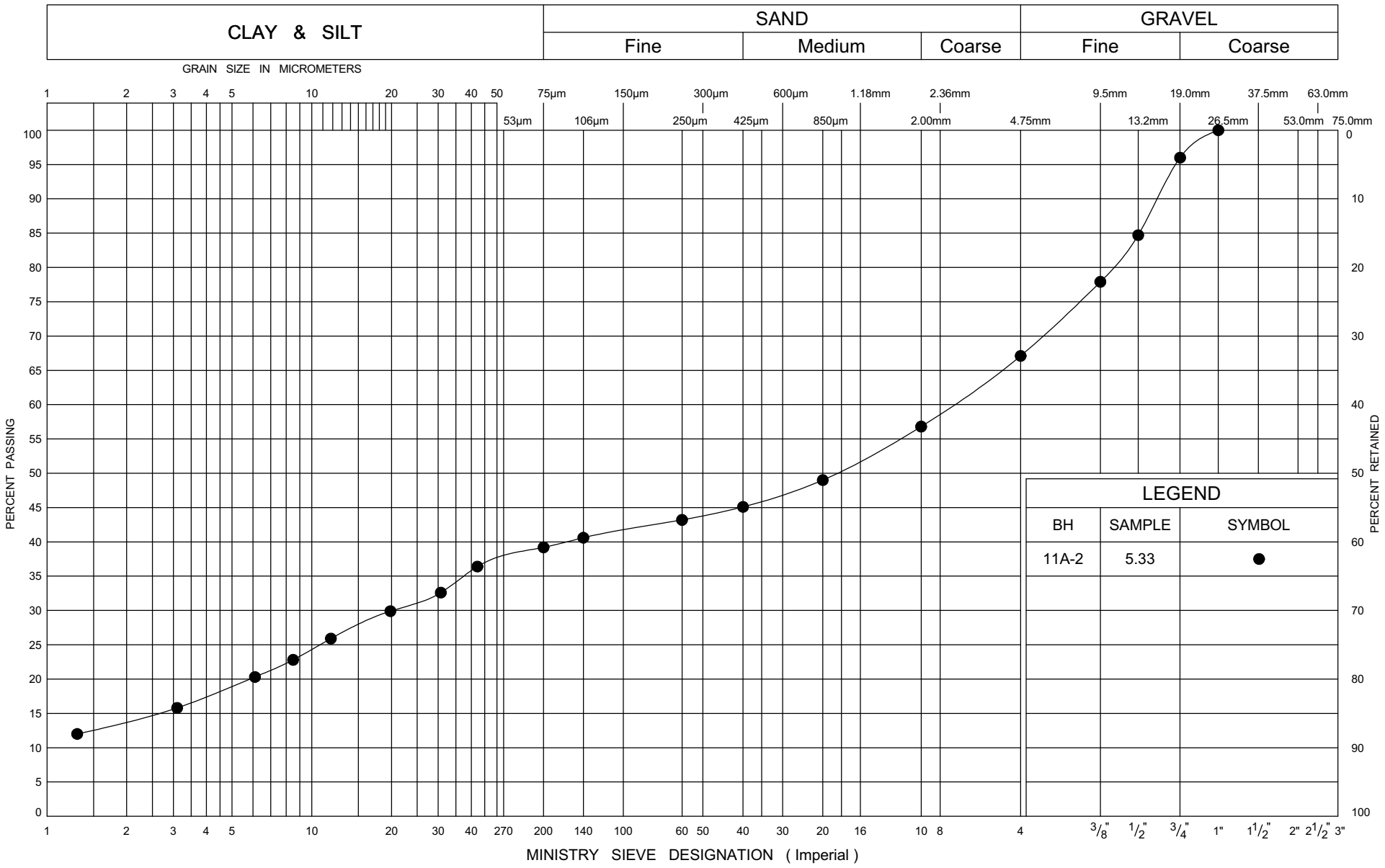
PLASTICITY CHART
SILTY CLAY TILL, CL-CI

FIG No C- 11A.4

GWP 57-00-00

HWY 26, Thornbury to Meaford

UNIFIED SOIL CLASSIFICATION SYSTEM



Ministry of Transportation
Ontario

GRAIN SIZE DISTRIBUTION

SILTY SAND & GRAVEL, GM-SM

FIG No C- 11A.5

GWP 57-00-00

HWY 26, Thornbury to Meaford

RECORD OF BOREHOLE No 13A-1 1 OF 1 METRIC

W.P. GWP 57-00-00 LOCATION HWY 26, Thornbury to Meaford Northing - 4939037, Easting - 222787 ORIGINATED BY JL

DIST Owen Sound HWY 26 BOREHOLE TYPE S/S Augering, 110 mm dia. COMPILED BY JL

DATUM Geodetic DATE 07.30.07 - 07.30.07 CHECKED BY EC

ELEV / DEPTH	DESCRIPTION	STRAT PLOT	SAMPLES NUMBER	SAMPLES TYPE	SAMPLES "N" VALUES	GROUND WATER CONDITIONS	ELEVATION SCALE	PENETR. RESISTANCE STANDARD ● DYN. CONE 20 40 60 80 100 / SHEAR STRENGTH kPa ○ UNCONFINED ● QUICK TRIAXIAL + FIELD VANE × LAB VANE 20 40 60 80 100	PLASTIC LIMIT w_P / NATURAL MOISTURE CONTENT w / LIQUID LIMIT w_L WATER CONTENT (%) 10 20 30	UNIT WEIGHT γ kN/m^3	REMARKS & GRAIN SIZE DISTRIBUTION (%) GR SA SI CL
233.71	Ground										
0.00 / 232.95	FILL Brown, moist, consisting of sand and gravel.										
0.76 / 231.58	FILL Brown, moist, compact to loose, consisting of silty clay with some sand, trace gravel.		1 2	SPT SPT	20 10		233 232				
2.13 / 228.83	Silty CLAY TILL, CL-CH Brown, moist to wet, stiff to very stiff, embedded sand and gravel.		3 4 5 6	SPT SPT SPT SPT	29 14 11 13	▽	231 230 229			17.1	Water level measured @ 2.3 m @ completion. 3 6 28 63 (91)
4.88 / 228.07	SAND, SW Grey, wet, compact to dense, SAND, some gravel and silt.		7	SPT	36		228				15 63 16 7 (22)
5.64	Grey weathered SHALE BEDROCK.										
	End of borehole.										

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

RECORD OF BOREHOLE No 13A-2 1 OF 1 METRIC

W.P. GWP 57-00-00 LOCATION HWY 26, Thornbury to Meaford Northing - 4939045, Easting - 222784 ORIGINATED BY JL

DIST Owen Sound HWY 26 BOREHOLE TYPE S/S Augering, 110 mm dia. COMPILED BY JL

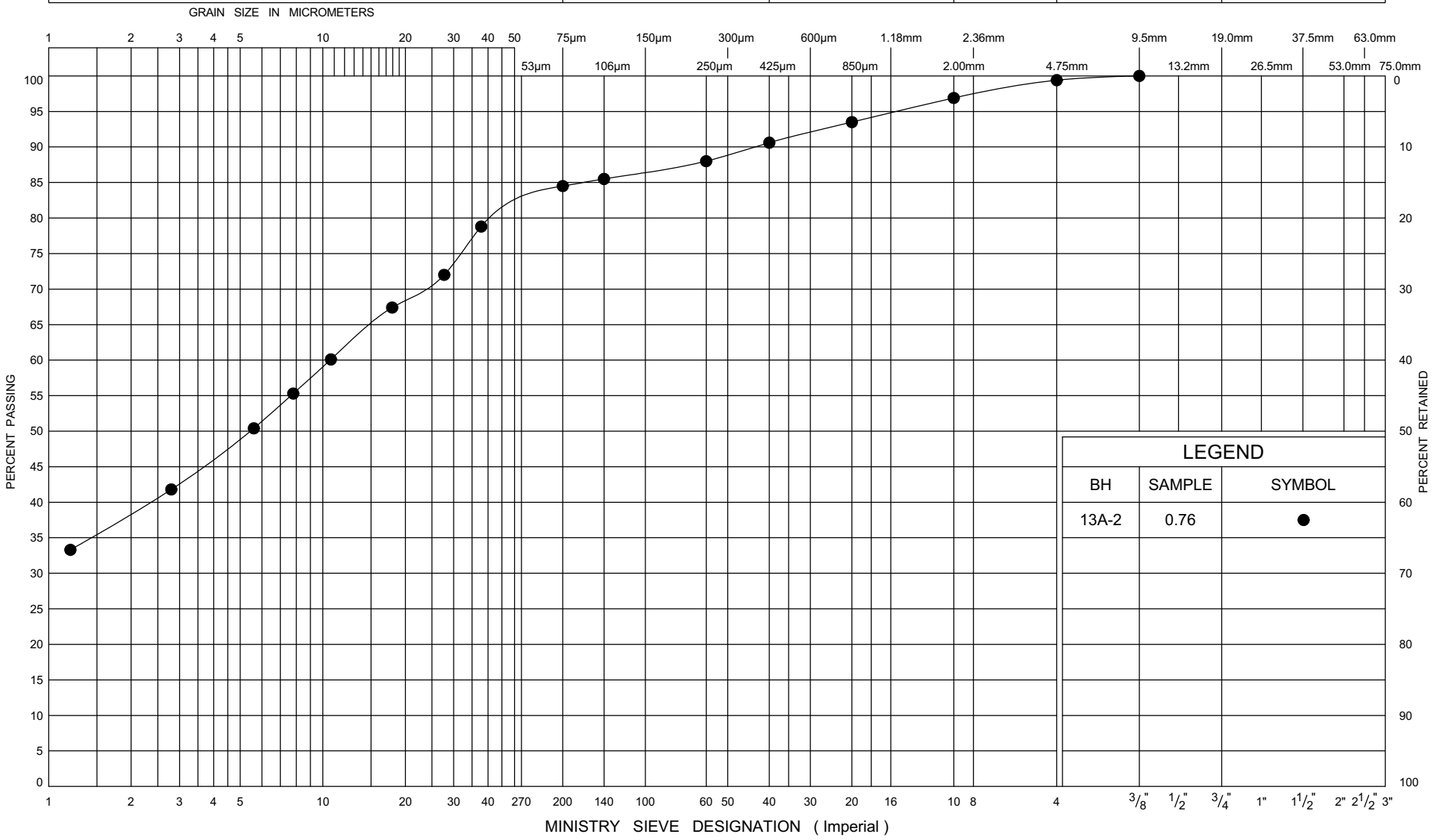
DATUM Geodetic DATE 07.25.07 - 07.25.07 CHECKED BY EC

ELEV / DEPTH	DESCRIPTION	STRAT PLOT	SAMPLES NUMBER	SAMPLES TYPE	SAMPLES "N" VALUES	GROUND WATER CONDITIONS	ELEVATION SCALE	PENETR. RESISTANCE STANDARD ● DYN. CONE (20 40 60 80 100) / SHEAR STRENGTH kPa ○ UNCONFINED ● QUICK TRIAXIAL + FIELD VANE × LAB VANE (20 40 60 80 100)	PLASTIC LIMIT w_P / NATURAL MOISTURE CONTENT w / LIQUID LIMIT w_L / WATER CONTENT (%) (10 20 30)	UNIT WEIGHT γ kN/m³	REMARKS & GRAIN SIZE DISTRIBUTION (%) GR SA SI CL
231.02	Ground										
0.00	FILL Brown, moist, very loose, consisting of silty clay with some sand, trace gravel.		1	SPT	3		230		48		1 15 46 38 (85)
229.34			2	SPT	13	▽	229			20.6	Water level measured @ 1.65m @ completion.
1.68	brown		3	SPT	15						1 31 49 19 (68)
	Silty CLAY TILL, CL Moist to wet, stiff to hard, embedded sand and gravel.		4	SPT	84		228			22.7	
	grey		5	SPT	100+		227				
226.14			6	SPT	100+						
4.88	End of borehole.										

+ 3, × 3: Numbers refer to Sensitivity

○ 150 UNCONFINE SHEAR STRENGTH INFERRED FROM POCKET PENETROMETER READINGS

UNIFIED SOIL CLASSIFICATION SYSTEM



Ministry of Transportation
Ontario

GRAIN SIZE DISTRIBUTION

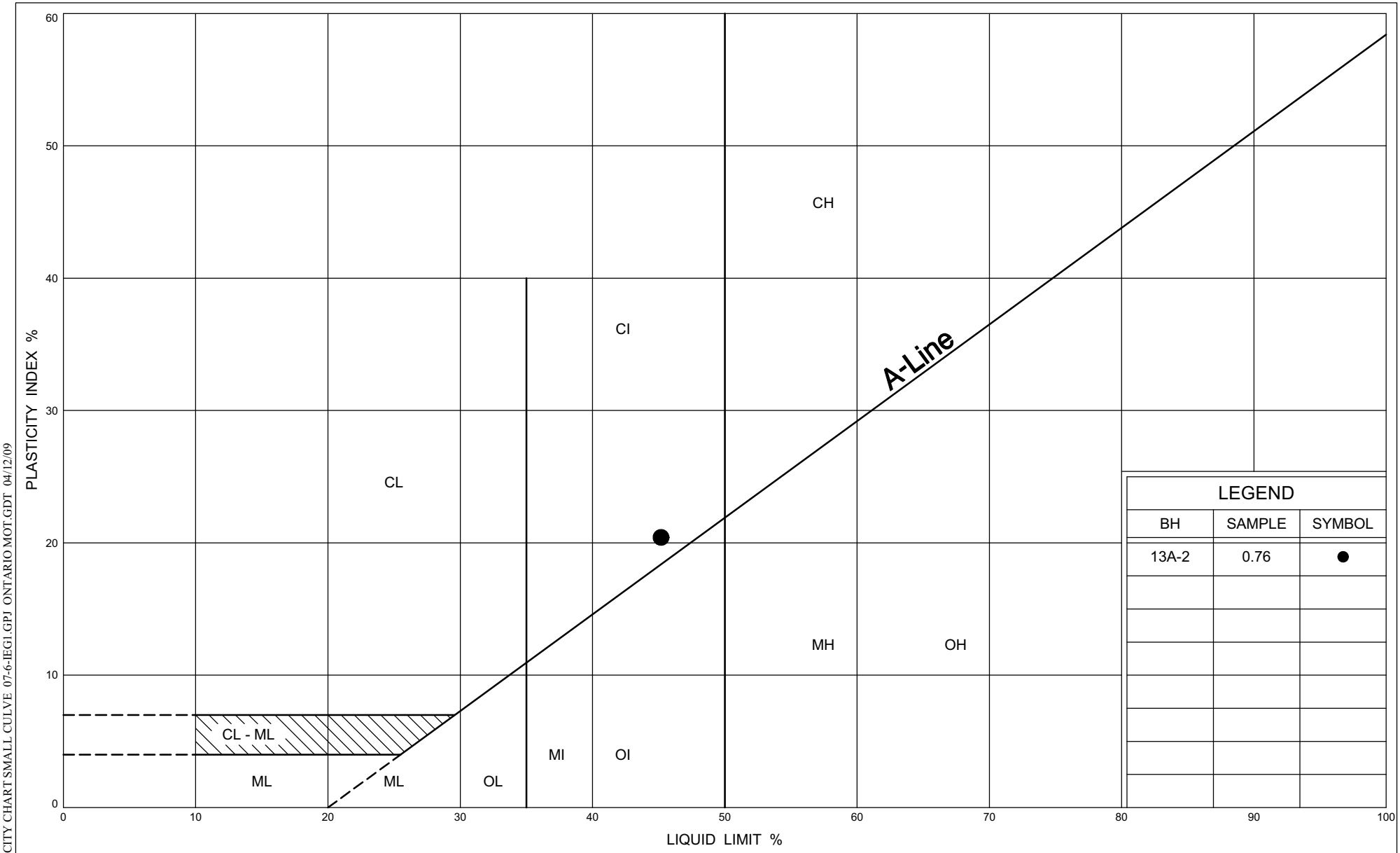
FILL

FIG No C- 13A.1

GWP 57-00-00

HWY 26, Thornbury to Meaford

Oct 75, FF - S - 21



ONTARIO MOT PLASTICITY CHART SMALL CULVE 07-6-IEG1.GPJ ONTARIO MOT.GDT 04/12/09

Ministry of Transportation
Ontario

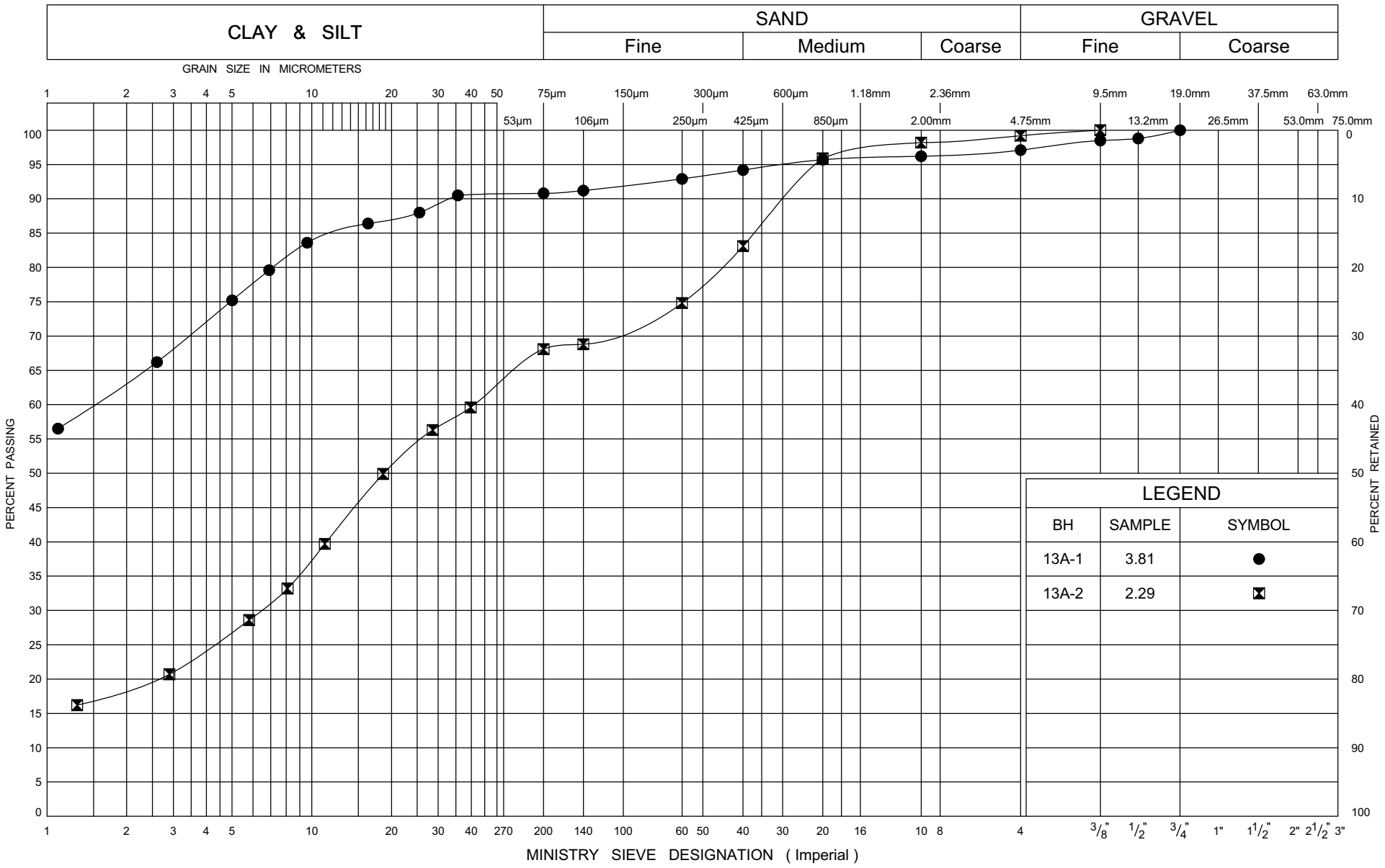
PLASTICITY CHART
FILL

FIG No C- 13A.2

GWP 57-00-00

HWY 26, Thornbury to Meaford

UNIFIED SOIL CLASSIFICATION SYSTEM



Ministry of Transportation
Ontario

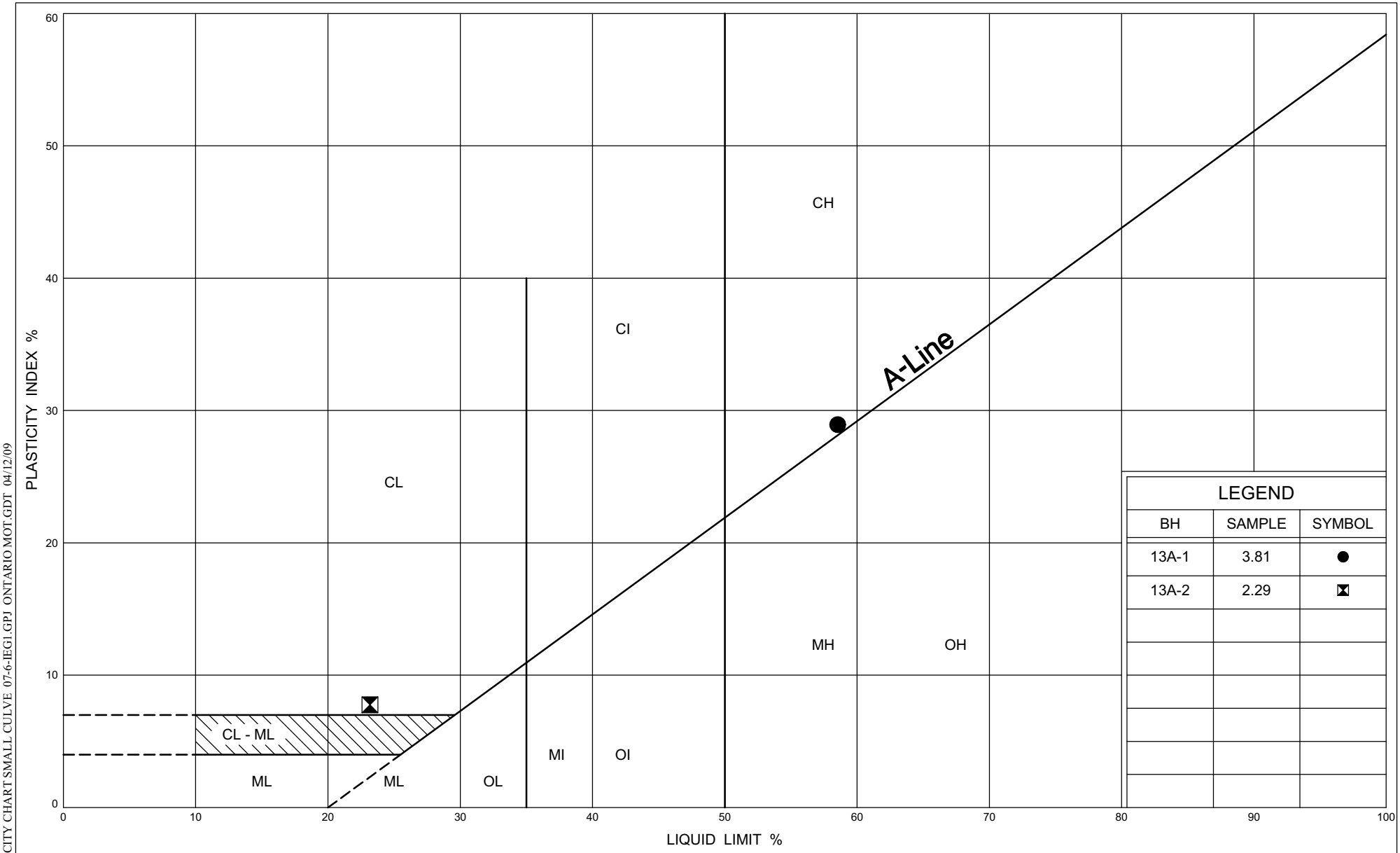
GRAIN SIZE DISTRIBUTION

SILTY CLAY TILL, CL-CH

FIG No C- 13A.3

GWP 57-00-00

HWY 26, Thornbury to Meaford



LEGEND		
BH	SAMPLE	SYMBOL
13A-1	3.81	●
13A-2	2.29	⊠

Ministry of Transportation
Ontario

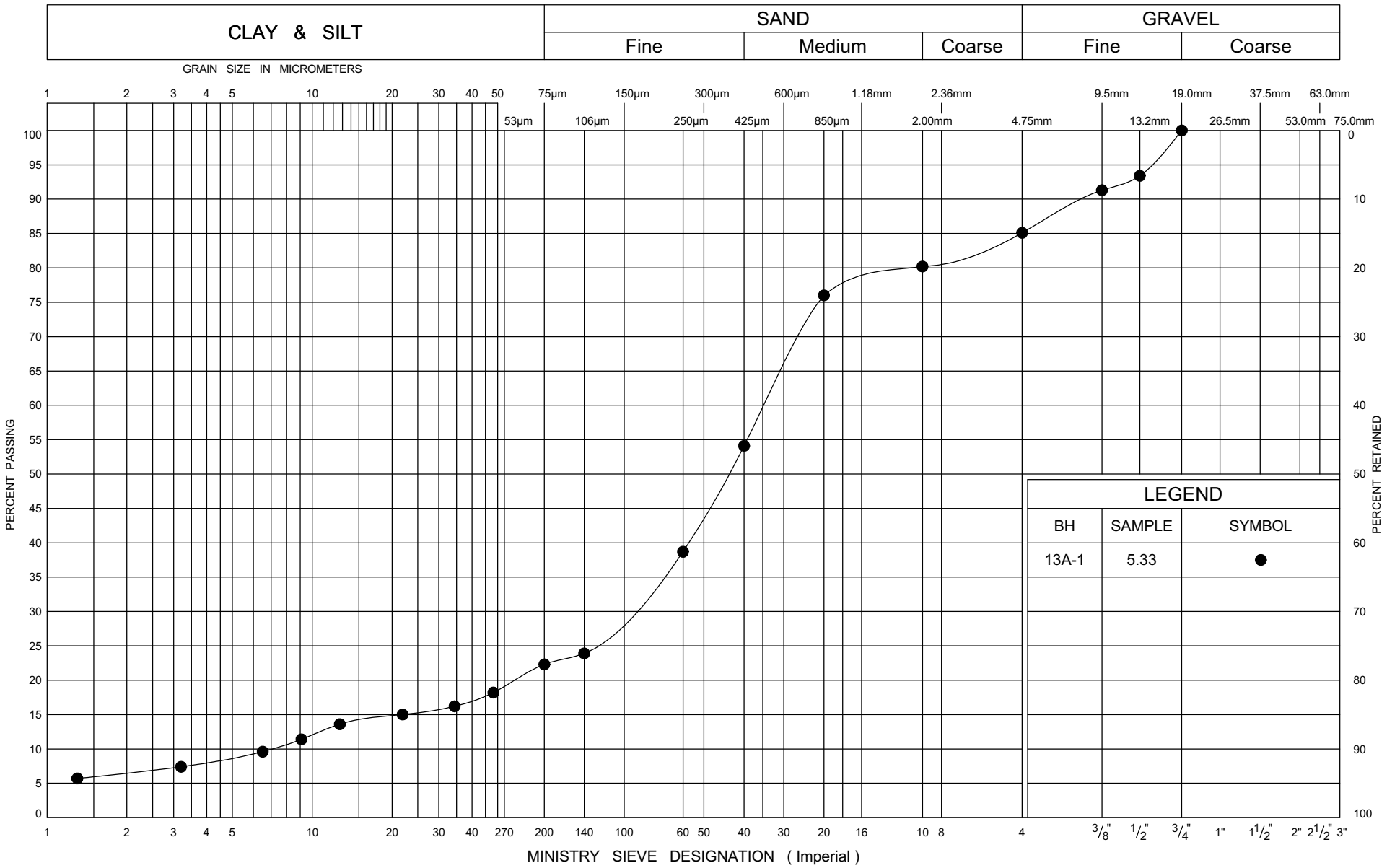
PLASTICITY CHART
SILTY CLAY TILL, CL-CH

FIG No C- 13A.4

GWP 57-00-00

HWY 26, Thornbury to Meaford

UNIFIED SOIL CLASSIFICATION SYSTEM



Ministry of Transportation
Ontario

GRAIN SIZE DISTRIBUTION

SAND, SW

FIG No C- 13A.5

GWP 57-00-00

HWY 26, Thornbury to Meaford

RECORD OF BOREHOLE No 14A-1

1 OF 1

METRIC

W.P. GWP 57-00-00 LOCATION HWY 26, Thornbury to Meaford Northing - 4939011, Easting - 222997 ORIGINATED BY JL

DIST Owen Sound HWY 26 BOREHOLE TYPE S/S Augering, 110 mm dia. COMPILED BY JL

DATUM Geodetic DATE 07.26.07 - 07.26.07 CHECKED BY EC

ELEV / DEPTH	DESCRIPTION	STRAT PLOT	SAMPLES NUMBER	SAMPLES TYPE	SAMPLES "N" VALUES	GROUND WATER CONDITIONS	ELEVATION SCALE	PENETR. RESISTANCE STANDARD ● DYN. CONE (20 40 60 80 100) / SHEAR STRENGTH kPa ○ UNCONFINED ● QUICK TRIAXIAL + FIELD VANE × LAB VANE (20 40 60 80 100)	PLASTIC LIMIT w_P / NATURAL MOISTURE CONTENT w / LIQUID LIMIT w_L / WATER CONTENT (%) (10 20 30)	UNIT WEIGHT γ kN/m³	REMARKS & GRAIN SIZE DISTRIBUTION (%) GR SA SI CL
232.47	Ground										
0.00	350 mm sand and gravel FILL.						232				
			1	SPT	9						
							231				
			2	SPT	7					17.7	
	FILL Brown, moist, loose to compact, consisting mainly of silty clay and organic pockets.										
			3	SPT	11		230			22.4	
						▽					Water level measured @ 2.9m @ completion.
			4	SPT	6						0 31 43 27 (69)
228.81							229				
3.66			5	SPT	29					23.8	
	Silty CLAY TILL, CI Grey, moist, very stiff to hard, embedded sand and gravel.						228				
			6	SPT	60						3 5 56 36 (92)
227.44											
5.03	End of Borehole.										

+ 3, × 3: Numbers refer to Sensitivity

○ 150 UNCONFINE SHEAR STRENGTH INFERRED FROM POCKET PENETROMETER READINGS

RECORD OF BOREHOLE No 14A-2 1 OF 1 METRIC

W.P. GWP 57-00-00 LOCATION HWY 26, Thornbury to Meaford Northing - 4939021, Easting - 222994 ORIGINATED BY JL

DIST Owen Sound HWY 26 BOREHOLE TYPE S/S Augering, 110 mm dia. COMPILED BY JL

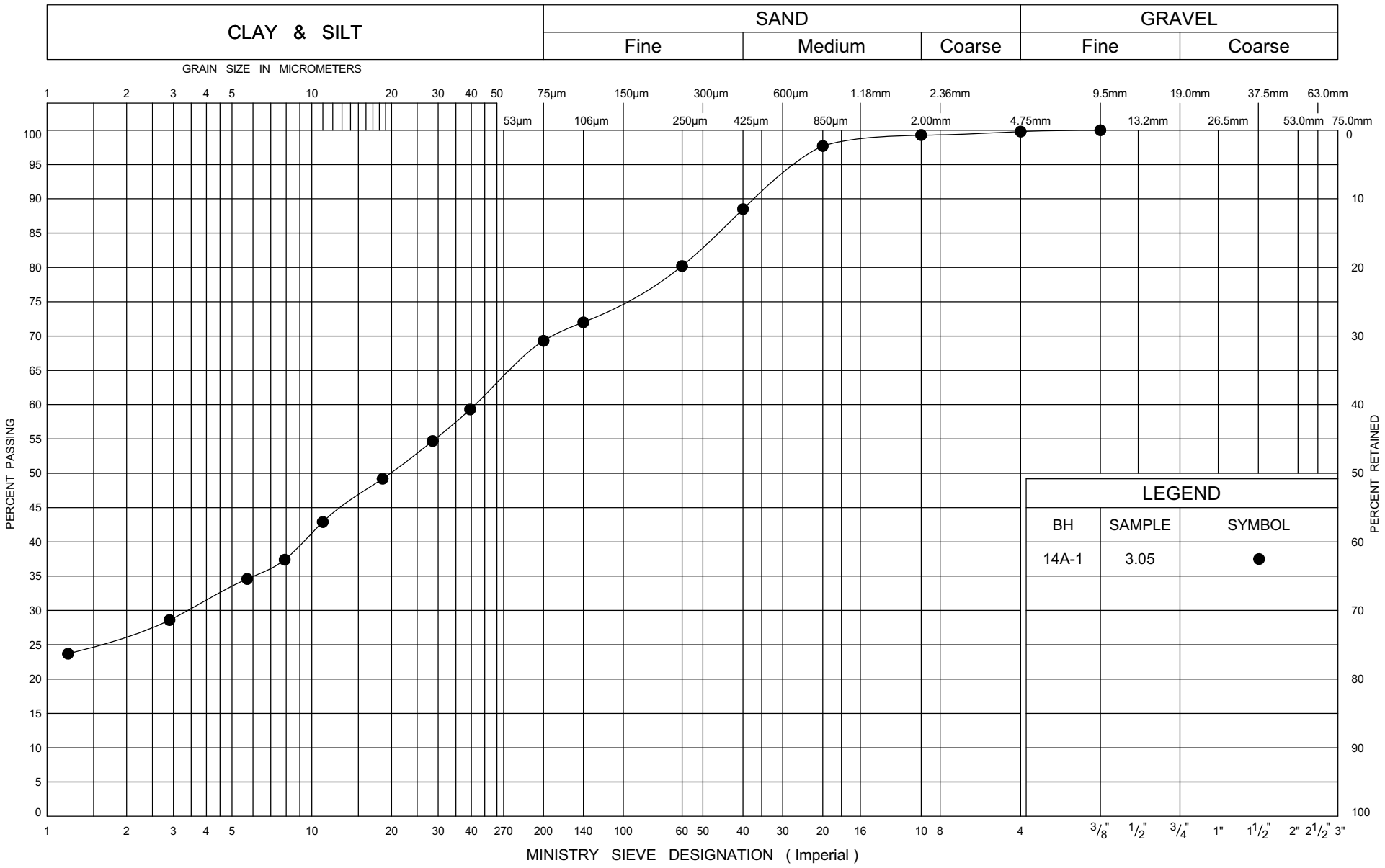
DATUM Geodetic DATE 07.25.07 - 07.25.07 CHECKED BY EC

ELEV / DEPTH	DESCRIPTION	STRAT PLOT	SAMPLES NUMBER	SAMPLES TYPE	SAMPLES "N" VALUES	GROUND WATER CONDITIONS	ELEVATION SCALE	PENETR. RESISTANCE STANDARD ● DYN. CONE (20 40 60 80 100) / SHEAR STRENGTH kPa ○ UNCONFINED ● QUICK TRIAXIAL + FIELD VANE × LAB VANE (20 40 60 80 100)	PLASTIC LIMIT w_P / NATURAL MOISTURE CONTENT w / LIQUID LIMIT w_L / WATER CONTENT (%) (10 20 30)	UNIT WEIGHT γ kN/m³	REMARKS & GRAIN SIZE DISTRIBUTION (%) GR SA SI CL
230.71	Ground										
0.00	100mm TOPSOIL										
	Brown		1	SPT	15		230				
			2	SPT	28		229		42		1 4 47 48 (95)
	Silty CLAY TILL, CI Moist to wet, very stiff to hard, embedded sand and gravel.		3	SPT	36		228				
	Grey		4	SPT	39	▽					Water level measured @ 3 m @ completion. 3 4 60 34 (93)
226.75			5	SPT	100+		227				
3.96	End of Borehole.										

+ 3, × 3: Numbers refer to Sensitivity

○ 150 UNCONFINE SHEAR STRENGTH INFERRED FROM POCKET PENETROMETER READINGS

UNIFIED SOIL CLASSIFICATION SYSTEM



Ministry of Transportation
Ontario

GRAIN SIZE DISTRIBUTION

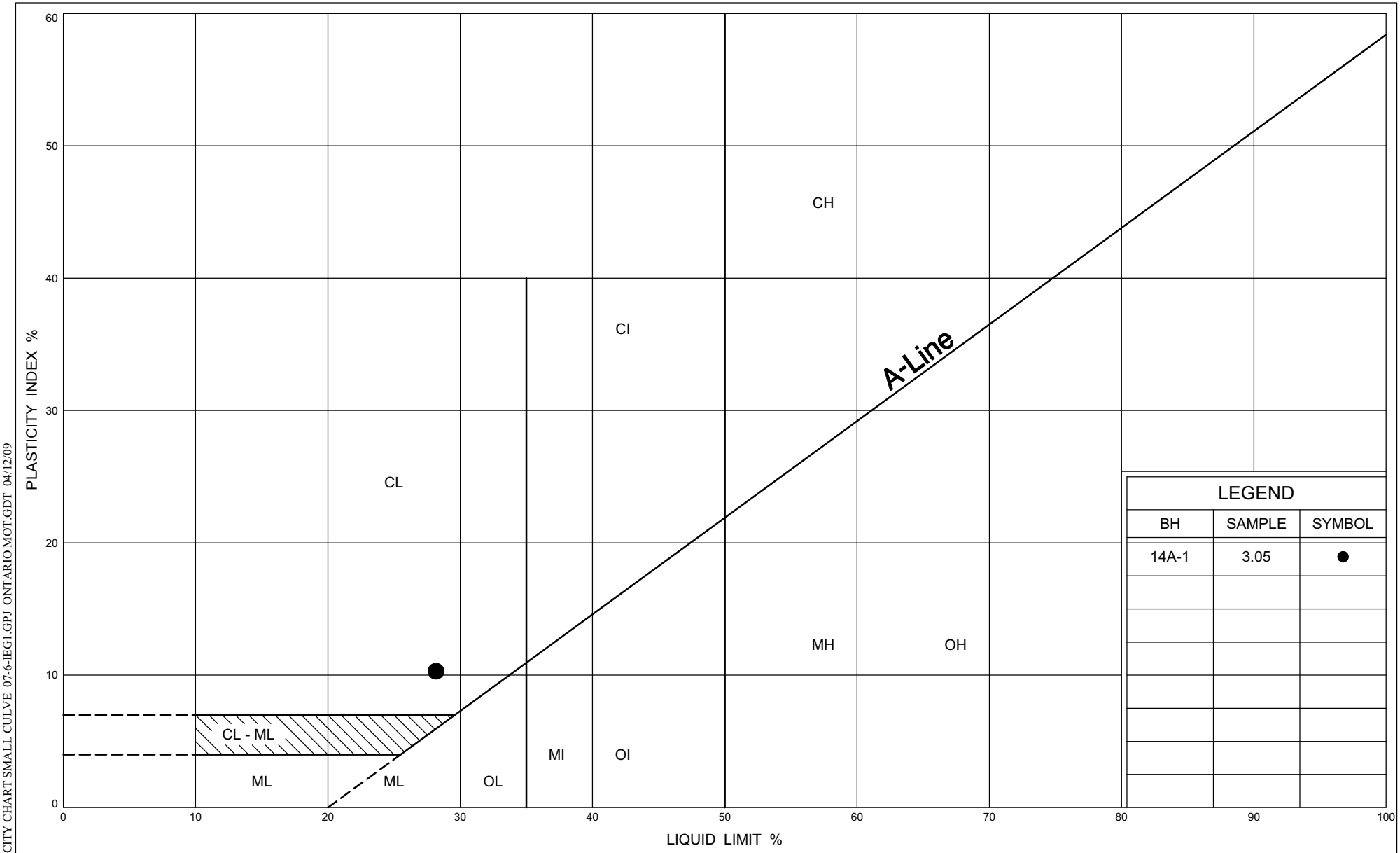
FILL

FIG No C- 14A.1

GWP 57-00-00

HWY 26, Thornbury to Meaford

Oct 75, FF - S - 21



ONTARIO MOT PLASTICITY CHART SMALL CULVE 07-6-IEG1.GPJ ONTARIO MOT.GDT 04/12/09

Ministry of Transportation
Ontario

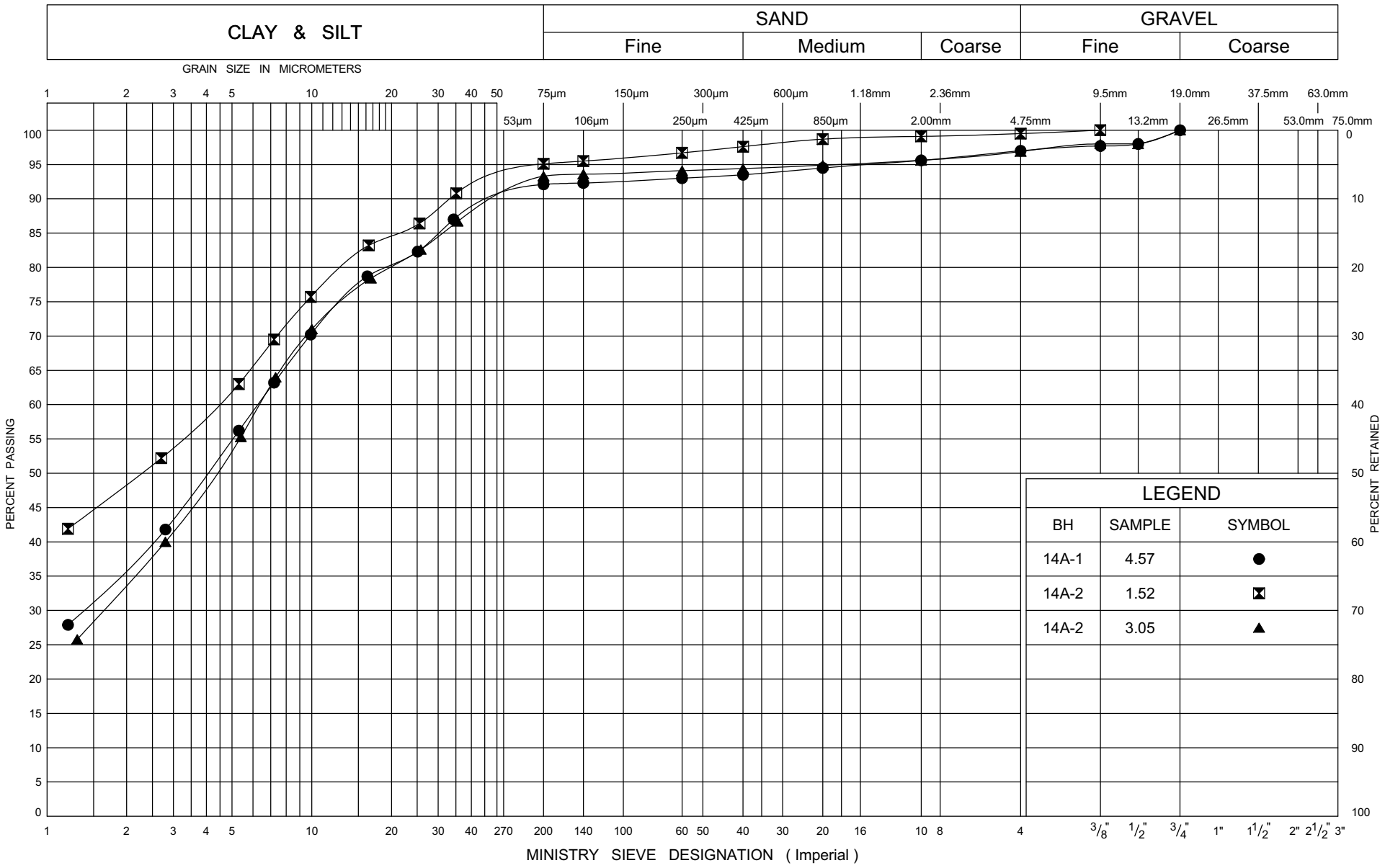
PLASTICITY CHART
FILL

FIG No C- 14A.2

GWP 57-00-00

HWY 26, Thornbury to Meaford

UNIFIED SOIL CLASSIFICATION SYSTEM



Ministry of Transportation
Ontario

GRAIN SIZE DISTRIBUTION

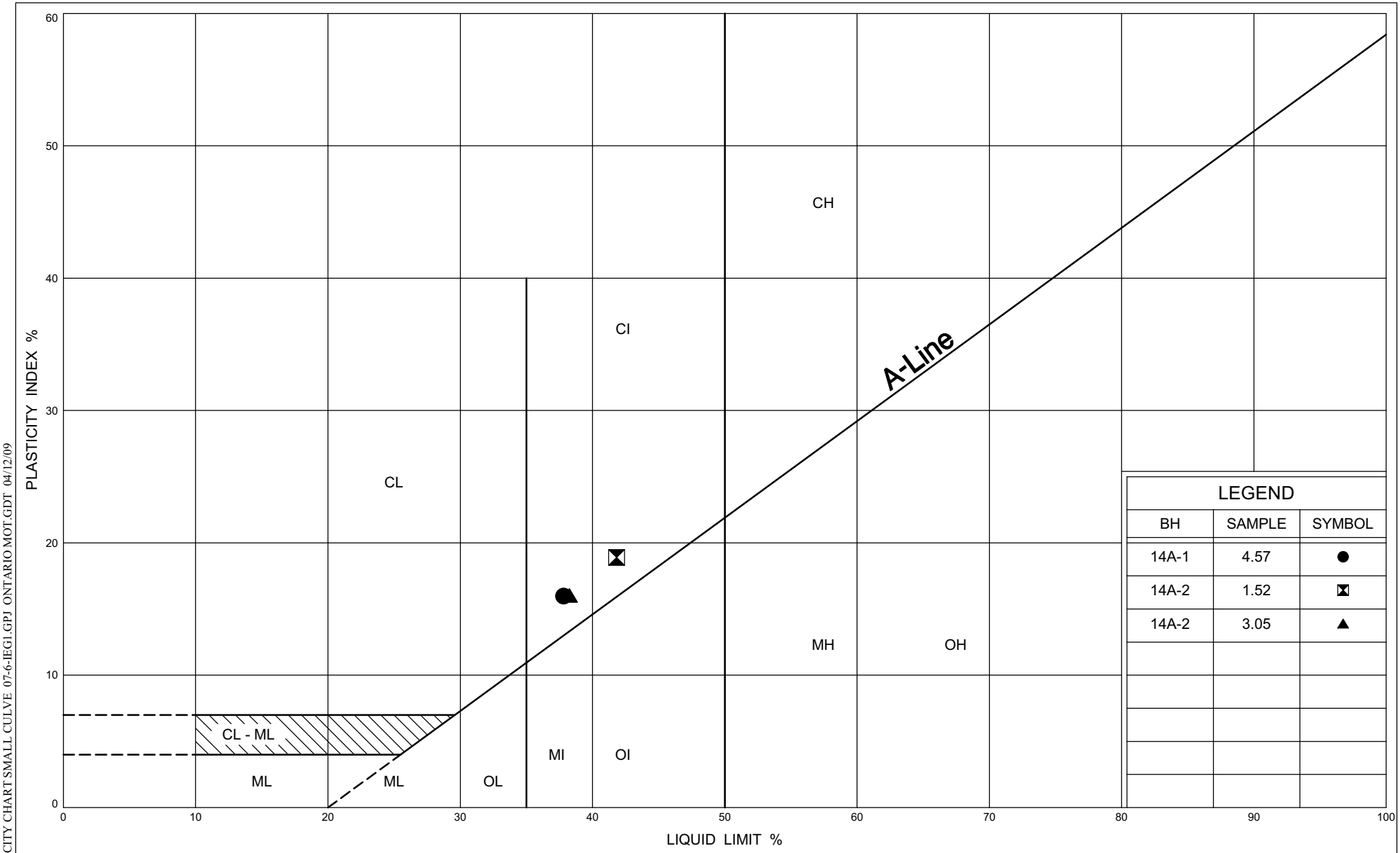
SILTY CLAY TILL, CI

FIG No C- 14A.3

GWP 57-00-00

HWY 26, Thornbury to Meaford

Oct 75, FF - S - 21



LEGEND		
BH	SAMPLE	SYMBOL
14A-1	4.57	●
14A-2	1.52	⊠
14A-2	3.05	▲

ONTARIO MOT PLASTICITY CHART SMALL CULVE 07-6-IEG1.GPJ ONTARIO MOT.GDT 04/12/09

Ministry of Transportation
Ontario

PLASTICITY CHART
SILTY CLAY TILL, CI

FIG No C- 14A.4

GWP 57-00-00

HWY 26, Thornbury to Meaford

RECORD OF BOREHOLE No 15A-1 1 OF 1 METRIC

W.P. GWP 57-00-00 LOCATION HWY 26, Thornbury to Meaford Northing - 4938906, Easting - 223342 ORIGINATED BY JL

DIST Owen Sound HWY 26 BOREHOLE TYPE S/S Augering, 110 mm dia. COMPILED BY JL

DATUM Geodetic DATE 07.25.07 - 07.25.07 CHECKED BY EC

ELEV / DEPTH	DESCRIPTION	STRAT PLOT	SAMPLES NUMBER	SAMPLES TYPE	SAMPLES "N" VALUES	GROUND WATER CONDITIONS	ELEVATION SCALE	PENETR. RESISTANCE STANDARD ● DYN. CONE (20 40 60 80 100) / SHEAR STRENGTH kPa ○ UNCONFINED ● QUICK TRIAXIAL + FIELD VANE × LAB VANE (20 40 60 80 100)	PLASTIC LIMIT w_P / NATURAL MOISTURE CONTENT w / LIQUID LIMIT w_L / WATER CONTENT (%) (10 20 30)	UNIT WEIGHT γ kN/m³	REMARKS & GRAIN SIZE DISTRIBUTION (%) GR SA SI CL
230.01	Ground										
0.00	200 mm TOPSOIL										
	Brown		1	SPT	25		229		43		7 4 48 41 (89)
			2	SPT	35					20.9	
	Silty CLAY TILL, CI Moist to wet, very stiff to hard, embedded sand and gravel.						228				
			3	SPT	48						0 2 59 39 (98)
	Grey		4	SPT	100+		227				
225.90			5	SPT	100+		226				
4.11	End of Borehole.										Auger Refusal. Borehole dry and open @ completion.

+ 3, × 3: Numbers refer to Sensitivity

○ 150 UNCONFINE SHEAR STRENGTH INFERRED FROM POCKET PENETROMETER READINGS

RECORD OF BOREHOLE No 15A-2

1 OF 1

METRIC

W.P. GWP 57-00-00 LOCATION HWY 26, Thornbury to Meaford Northing - 4938926, Easting - 223351 ORIGINATED BY JL

DIST Owen Sound HWY 26 BOREHOLE TYPE S/S Augering, 110 mm dia. COMPILED BY JL

DATUM Geodetic DATE 07.25.07 - 07.25.07 CHECKED BY EC

ELEV / DEPTH	DESCRIPTION	STRAT PLOT	SAMPLES: NUMBER	SAMPLES: TYPE	SAMPLES: "N" VALUES	GROUND WATER CONDITIONS	ELEVATION SCALE	PENETR. RESISTANCE: STANDARD ● DYN. CONE (20 40 60 80 100) / SHEAR STRENGTH kPa: ○ UNCONFINED ● QUICK TRIAXIAL + FIELD VANE × LAB VANE (20 40 60 80 100)	PLASTIC LIMIT w_P / NATURAL MOISTURE CONTENT w / LIQUID LIMIT w_L / WATER CONTENT (%) (10 20 30)	UNIT WEIGHT γ kN/m³	REMARKS & GRAIN SIZE DISTRIBUTION (%) GR SA SI CL
231.40	Ground										
0.00 / 230.64	FILL Brown, moist, consisting of sand and gravel.										
0.76	150 mm ASPHALT		1	SPT	33						
			2	SPT	15	▽					Water level measured @ 2.1 m @ completion.
	FILL Grey, moist to wet, consisting of silty clay and organic pockets.		3	SPT	12				62	18.9	2 10 45 43 (88)
			4	SPT	25						
227.59											
3.81			5	SPT	36					21.5	
	Silty CLAY TILL, CI Moist to wet, hard, embedded sand and gravel.		6	SPT	59				43		1 3 59 38 (96)
			7	SPT	100						
225.61											
5.79	End of Borehole.										

$+^{3}$, $\times^{3}$: Numbers refer to Sensitivity

$\circ^{150}$ UNCONFINE SHEAR STRENGTH INFERRED FROM POCKET PENETROMETER READINGS

RECORD OF BOREHOLE No 15A-3

1 OF 1

METRIC

W.P. GWP 57-00-00 LOCATION HWY 26, Thornbury to Meaford Northing - 4938933, Easting - 223348 ORIGINATED BY JL

DIST Owen Sound HWY 26 BOREHOLE TYPE S/S Augering, 110 mm dia. COMPILED BY JL

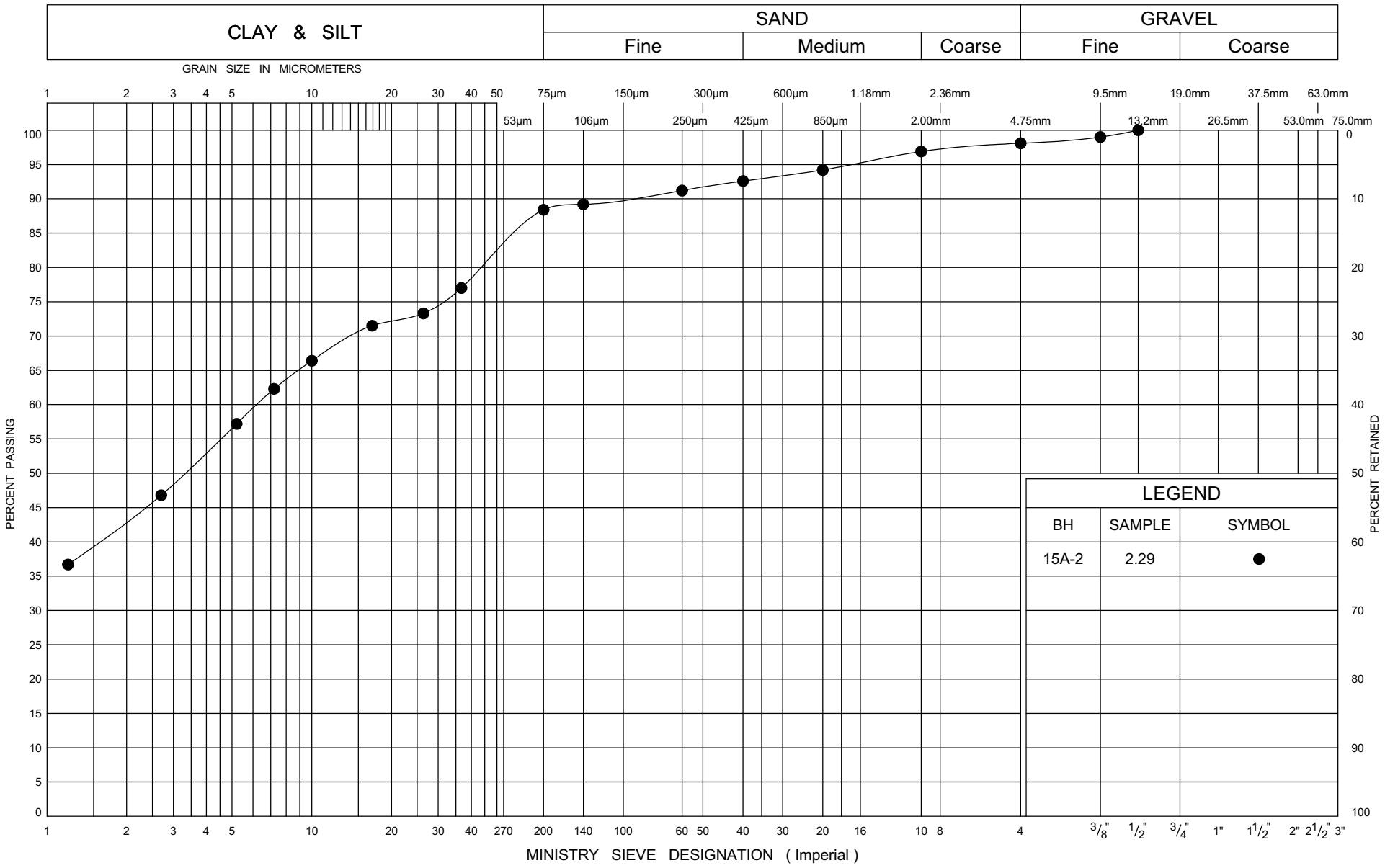
DATUM Geodetic DATE 07.25.07 - 07.25.07 CHECKED BY EC

ELEV / DEPTH	DESCRIPTION	STRAT PLOT	SAMPLES NUMBER	SAMPLES TYPE	SAMPLES "N" VALUES	GROUND WATER CONDITIONS	ELEVATION SCALE	PENETR. RESISTANCE STANDARD ● DYN. CONE (20 40 60 80 100) / SHEAR STRENGTH kPa ○ UNCONFINED ● QUICK TRIAXIAL + FIELD VANE × LAB VANE (20 40 60 80 100)	PLASTIC LIMIT w_P / NATURAL MOISTURE CONTENT w / LIQUID LIMIT w_L / WATER CONTENT (%) (10 20 30)	UNIT WEIGHT γ kN/m³	REMARKS & GRAIN SIZE DISTRIBUTION (%) GR SA SI CL
229.39	Ground										
0.00	100 mm TOPSOIL						229				
	Brown		1	SPT	14	▽			53		0 1 45 54 (99)
							228				
			2	SPT	25					21.1	Water level measured @ 1.5 m @ completion.
	Silty CLAY TILL, CI-CH – – Moist to wet, stiff to hard, embedded sand and gravel, shale fragments.										
			3	SPT	30		227			22.0	
	Grey								43		
			4	SPT	65		226				15 5 39 41 (81)
225.28	– –		5	SPT	100+						
4.11	End of Borehole.										

$+^3$, $\times^3$: Numbers refer to Sensitivity

$\circ^{150}$ UNCONFINE SHEAR STRENGTH INFERRED FROM POCKET PENETROMETER READINGS

UNIFIED SOIL CLASSIFICATION SYSTEM



Ministry of Transportation
Ontario

GRAIN SIZE DISTRIBUTION

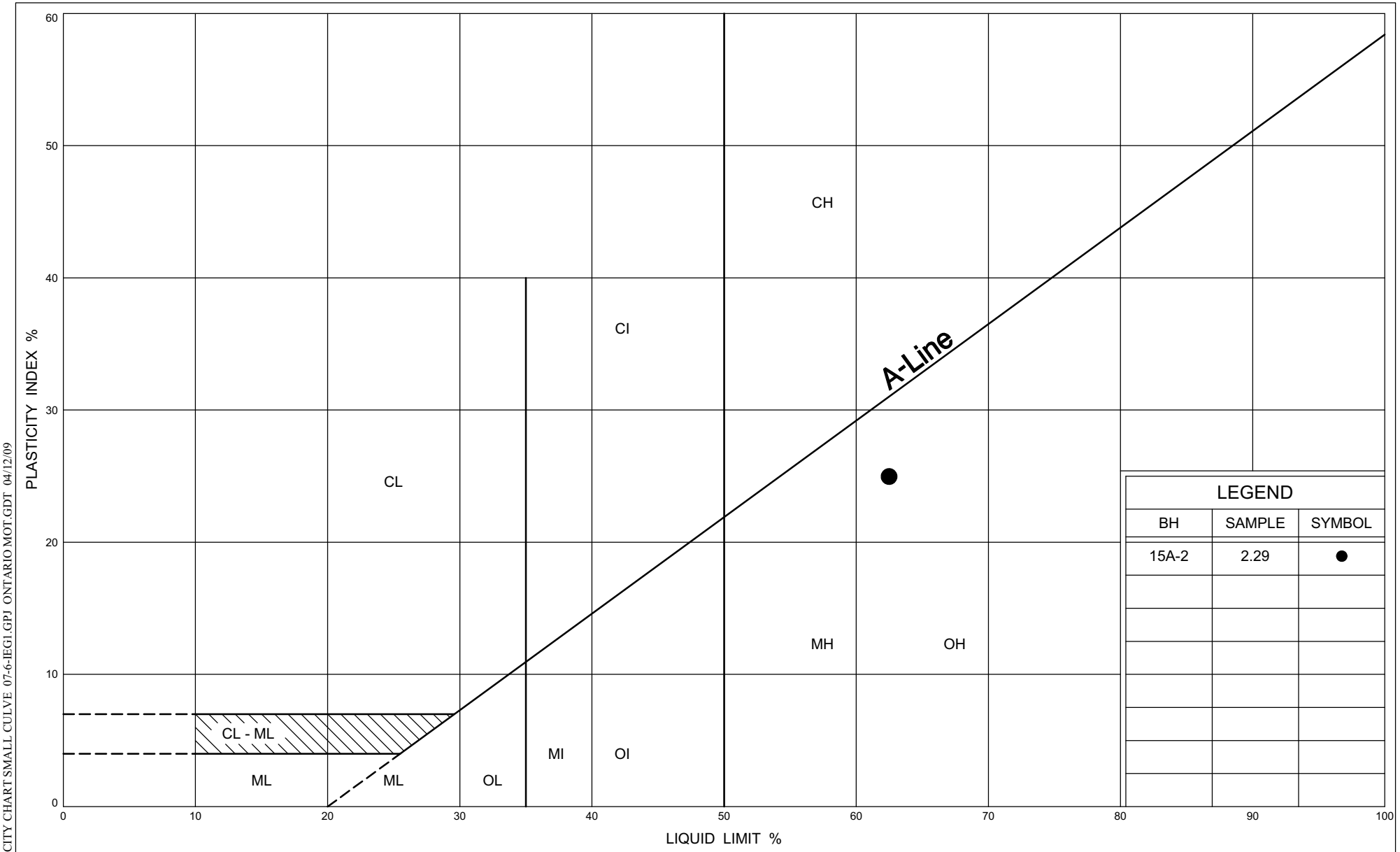
FILL

FIG No C- 15A.1

GWP 57-00-00

HWY 26, Thornbury to Meaford

Oct 75, FF - S - 21



ONTARIO MOT PLASTICITY CHART SMALL CULVE 07-6-IEG1.GPJ ONTARIO MOT.GDT 04/12/09

Ministry of Transportation
Ontario

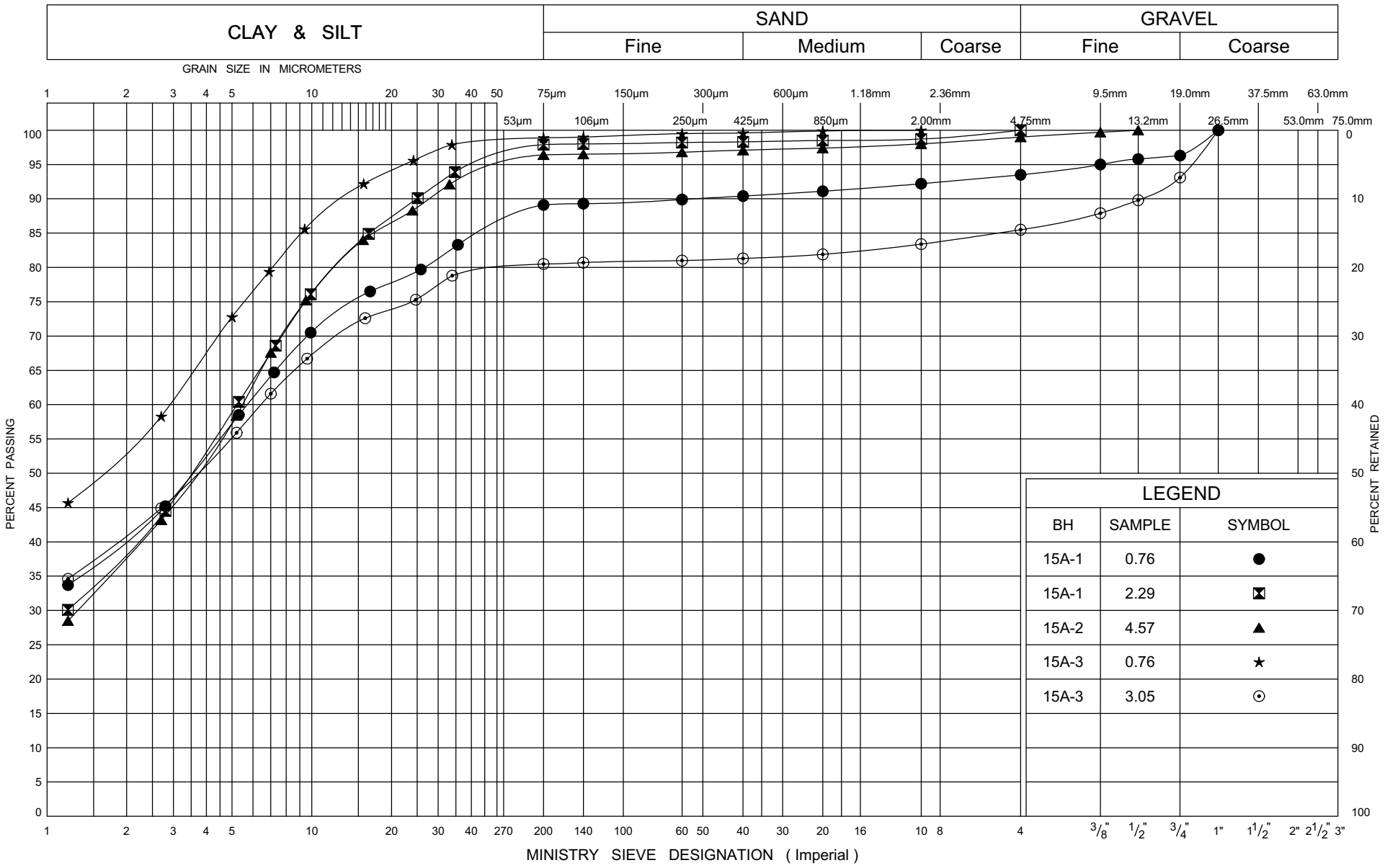
PLASTICITY CHART
FILL

FIG No C- 15A.2

GWP 57-00-00

HWY 26, Thornbury to Meaford

UNIFIED SOIL CLASSIFICATION SYSTEM



Ministry of Transportation
Ontario

GRAIN SIZE DISTRIBUTION

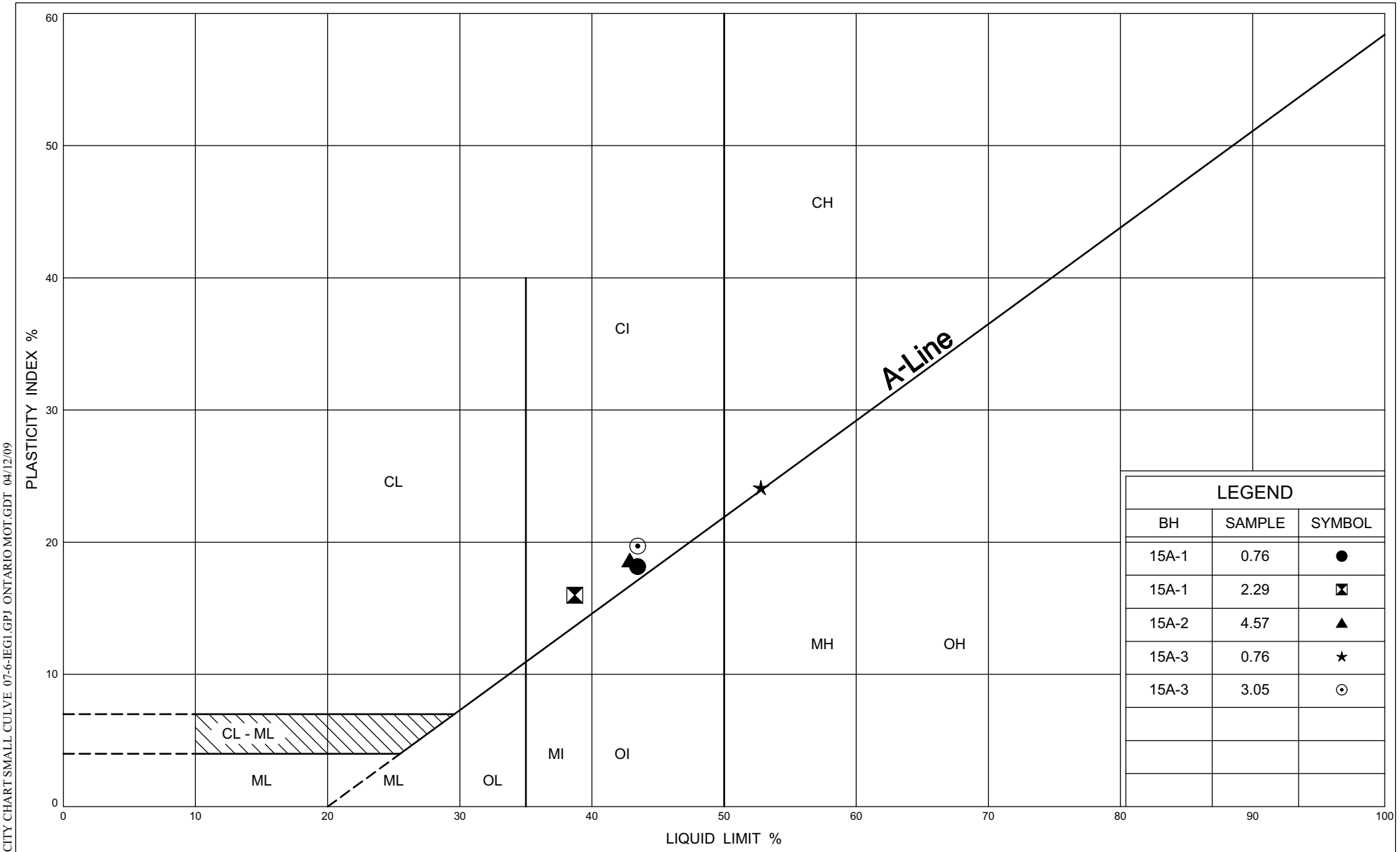
SILTY CLAY TILL, CI-CH

FIG No C- 15A.3

GWP 57-00-00

HWY 26, Thornbury to Meaford

Oct 75, FF - S - 21



LEGEND		
BH	SAMPLE	SYMBOL
15A-1	0.76	●
15A-1	2.29	⊠
15A-2	4.57	▲
15A-3	0.76	★
15A-3	3.05	⊙

Ministry of Transportation
Ontario

PLASTICITY CHART
SILTY CLAY TILL, CI-CH

FIG No C- 15A.4

GWP 57-00-00

HWY 26, Thornbury to Meaford

ONTARIO MOT PLASTICITY CHART SMALL CULVE 07-6-IEG1.GPJ ONTARIO MOT.GDT 04/12/09

RECORD OF BOREHOLE No 16A-1

1 OF 1

METRIC

W.P. GWP 57-00-00 LOCATION HWY 26, Thornbury to Meaford Northing - 4938804, Easting - 223578 ORIGINATED BY JL

DIST Owen Sound HWY 26 BOREHOLE TYPE S/S Augering, 110 mm dia. COMPILED BY JL

DATUM Geodetic DATE 07.25.07 - 07.25.07 CHECKED BY EC

ELEV / DEPTH	DESCRIPTION	STRAT PLOT	SAMPLES NUMBER	SAMPLES TYPE	SAMPLES "N" VALUES	GROUND WATER CONDITIONS	ELEVATION SCALE	PENETR. RESISTANCE STANDARD ● DYN. CONE (20 40 60 80 100) / SHEAR STRENGTH kPa ○ UNCONFINED ● QUICK TRIAXIAL + FIELD VANE × LAB VANE (20 40 60 80 100)	PLASTIC LIMIT w_P / NATURAL MOISTURE CONTENT w / LIQUID LIMIT w_L — WATER CONTENT (%) (10 20 30)	UNIT WEIGHT γ kN/m³	REMARKS & GRAIN SIZE DISTRIBUTION (%) GR SA SI CL
231.50	Ground										
0.00	230 mm sand and gravel FILL.										
	FILL Dark brown, moist, loose, consisting of silty clay and organic pockets.		1	SPT	9		231				
			2	SPT	6		230		w 76	20.6	6 5 30 59 (90)
228.91			3	SPT	14		229		59		2 11 34 53 (87)
2.59	Brown		4	SPT	38		228			22.2	
	Silty CLAY TILL, CI Moist, very stiff to hard, embedded sand and gravel.		5	SPT	59				42		0 1 56 43 (99)
	Grey		6	SPT	100+		227			22.2	
226.47											
5.03	End of Borehole										Borehole dry and open @ completion.

+ 3, × 3: Numbers refer to Sensitivity

○ 150 UNCONFINE SHEAR STRENGTH INFERRED FROM POCKET PENETROMETER READINGS

RECORD OF BOREHOLE No 16A-2 1 OF 1 METRIC

W.P. GWP 57-00-00 LOCATION HWY 26, Thornbury to Meaford Northing - 4938814, Easting - 223591 ORIGINATED BY JL

DIST Owen Sound HWY 26 BOREHOLE TYPE S/S Augering, 110 mm dia. COMPILED BY JL

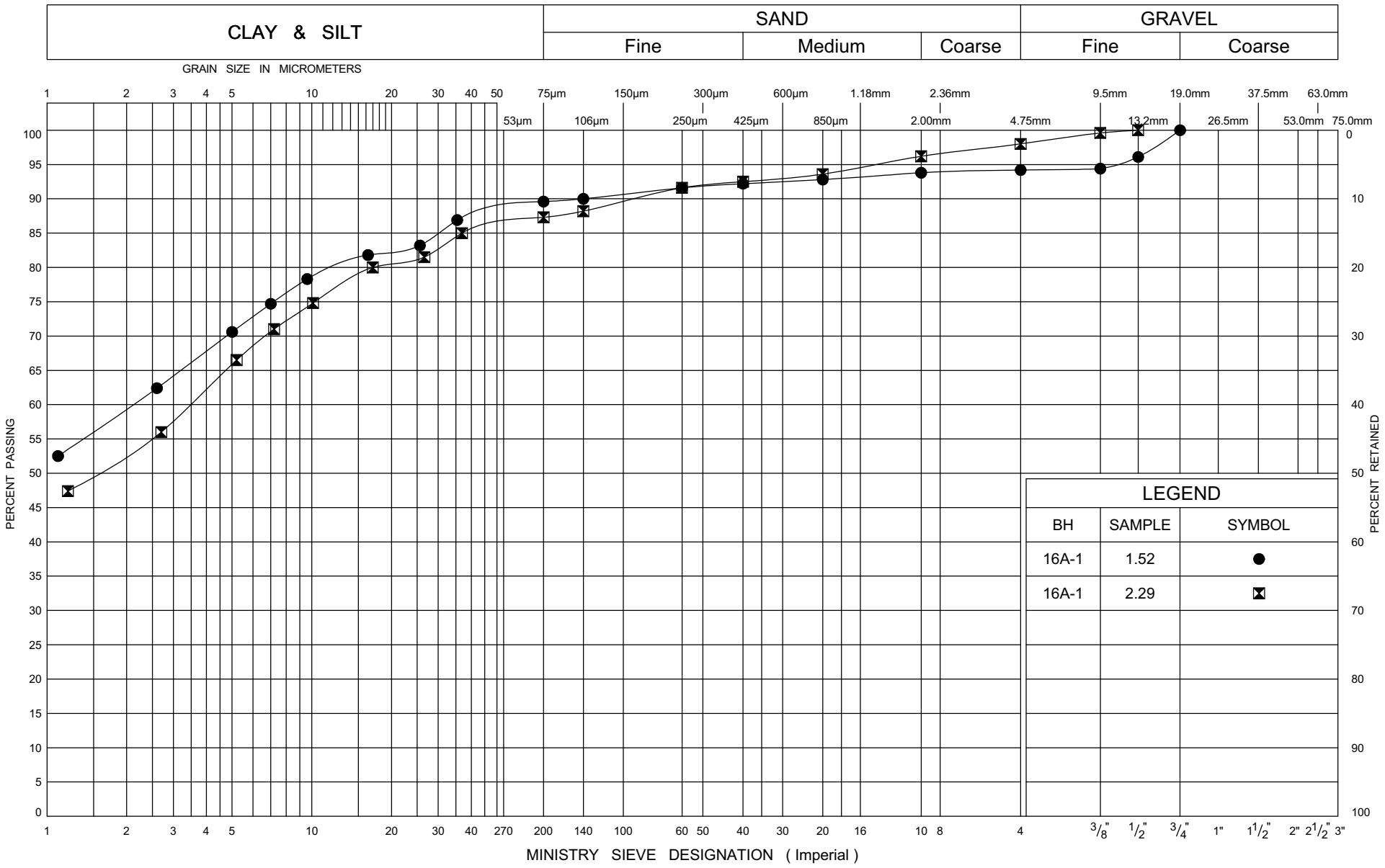
DATUM Geodetic DATE 09.17.07 - 09.17.07 CHECKED BY EC

ELEV / DEPTH	DESCRIPTION	STRAT PLOT	SAMPLES NUMBER	SAMPLES TYPE	SAMPLES "N" VALUES	GROUND WATER CONDITIONS	ELEVATION SCALE	PENETR. RESISTANCE STANDARD ● DYN. CONE (20 40 60 80 100) / SHEAR STRENGTH kPa ○ UNCONFINED ● QUICK TRIAXIAL + FIELD VANE × LAB VANE (20 40 60 80 100)	PLASTIC LIMIT w_P / NATURAL MOISTURE CONTENT w / LIQUID LIMIT w_L / WATER CONTENT (%) (10 20 30)	UNIT WEIGHT γ kN/m³	REMARKS & GRAIN SIZE DISTRIBUTION (%) GR SA SI CL
230.08	Ground										
0.00	200 mm TOPSOIL						230				
	Silty CLAY TILL, CI Moist, very stiff to hard, embedded sand and gravel.		1	SPT	23		229		45	20.8	0 1 50 49 (99)
	Brown		2	SPT	27						
			3	SPT	100+		228		41		0 2 60 38 (98)
	Grey		4	SPT	100+		227				
226.42											
3.66	End of Borehole.										auger refusal Borehole dry and open @ completion.

$+^{3}$, $\times^{3}$: Numbers refer to Sensitivity

$\circ^{150}$ UNCONFINE SHEAR STRENGTH INFERRED FROM POCKET PENETROMETER READINGS

UNIFIED SOIL CLASSIFICATION SYSTEM



Ministry of Transportation
Ontario

GRAIN SIZE DISTRIBUTION

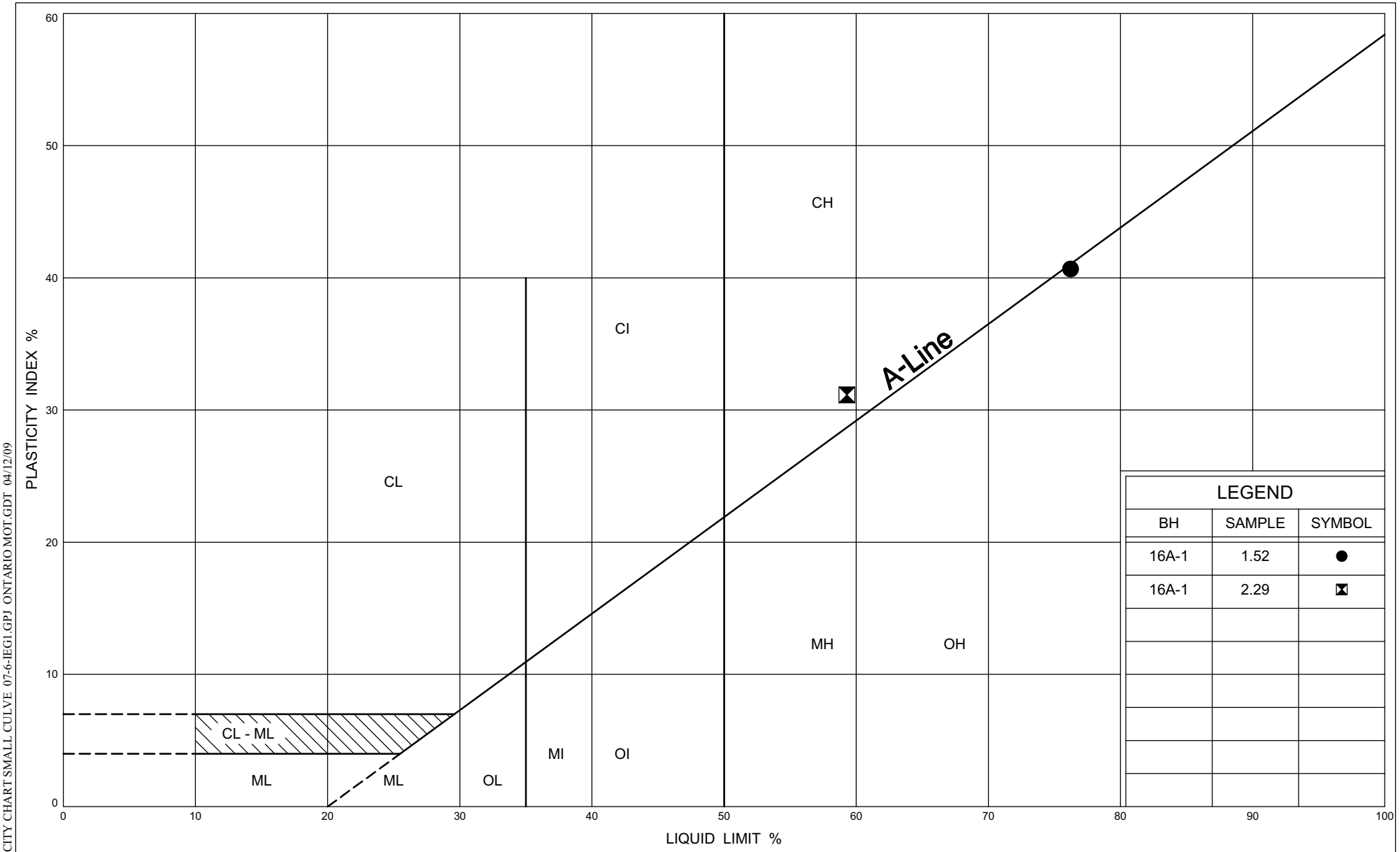
FILL

FIG No C- 16A.1

GWP 57-00-00

HWY 26, Thornbury to Meaford

Oct 75, FF - S - 21



LEGEND		
BH	SAMPLE	SYMBOL
16A-1	1.52	●
16A-1	2.29	⊠

Ministry of Transportation
Ontario

PLASTICITY CHART
FILL

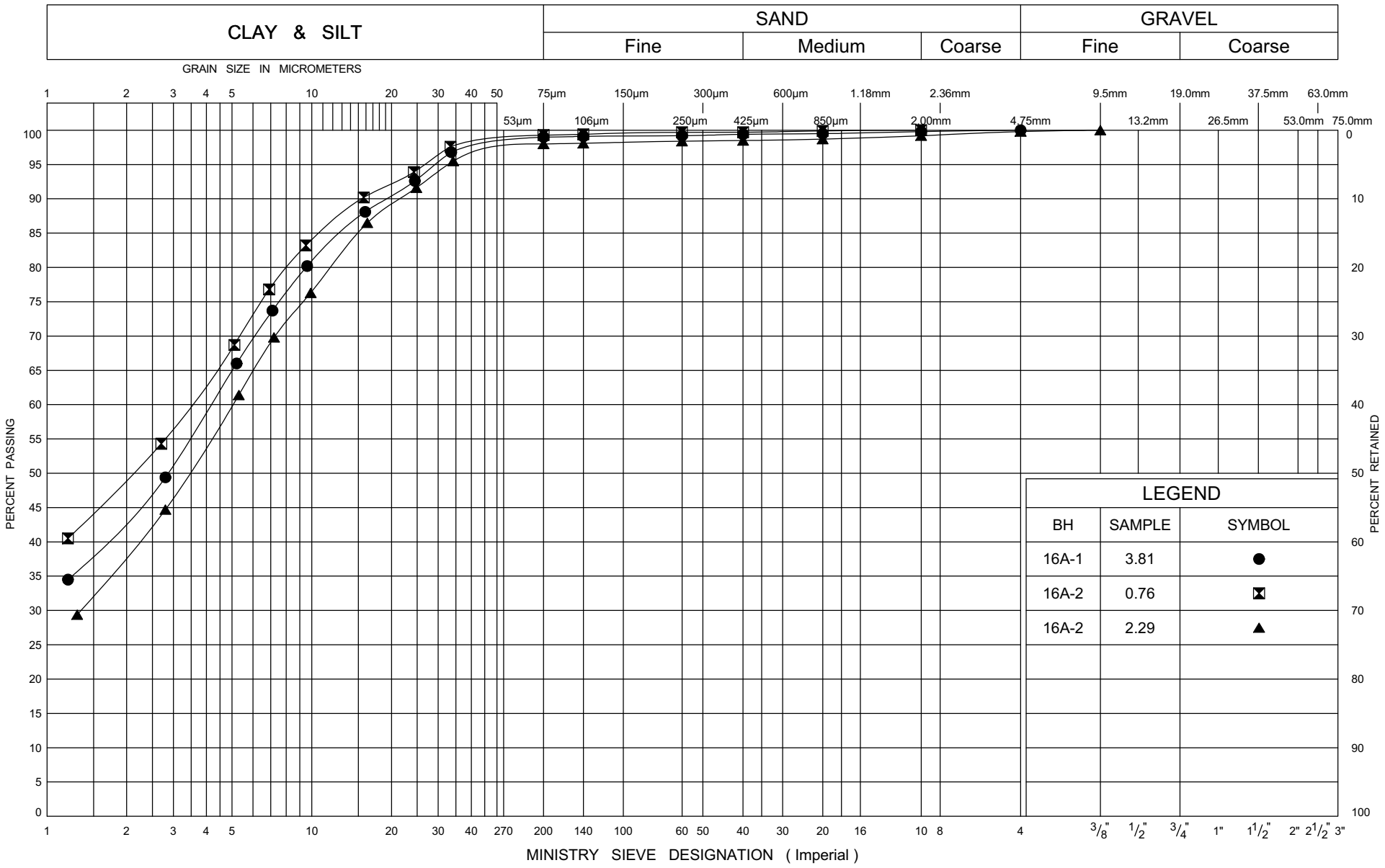
FIG No C- 16A.2

GWP 57-00-00

HWY 26, Thornbury to Meaford

ONTARIO MOT PLASTICITY CHART SMALL CULVE 07-6-IEG1.GPJ ONTARIO MOT.GDT 04/12/09

UNIFIED SOIL CLASSIFICATION SYSTEM



Ministry of Transportation
Ontario

GRAIN SIZE DISTRIBUTION

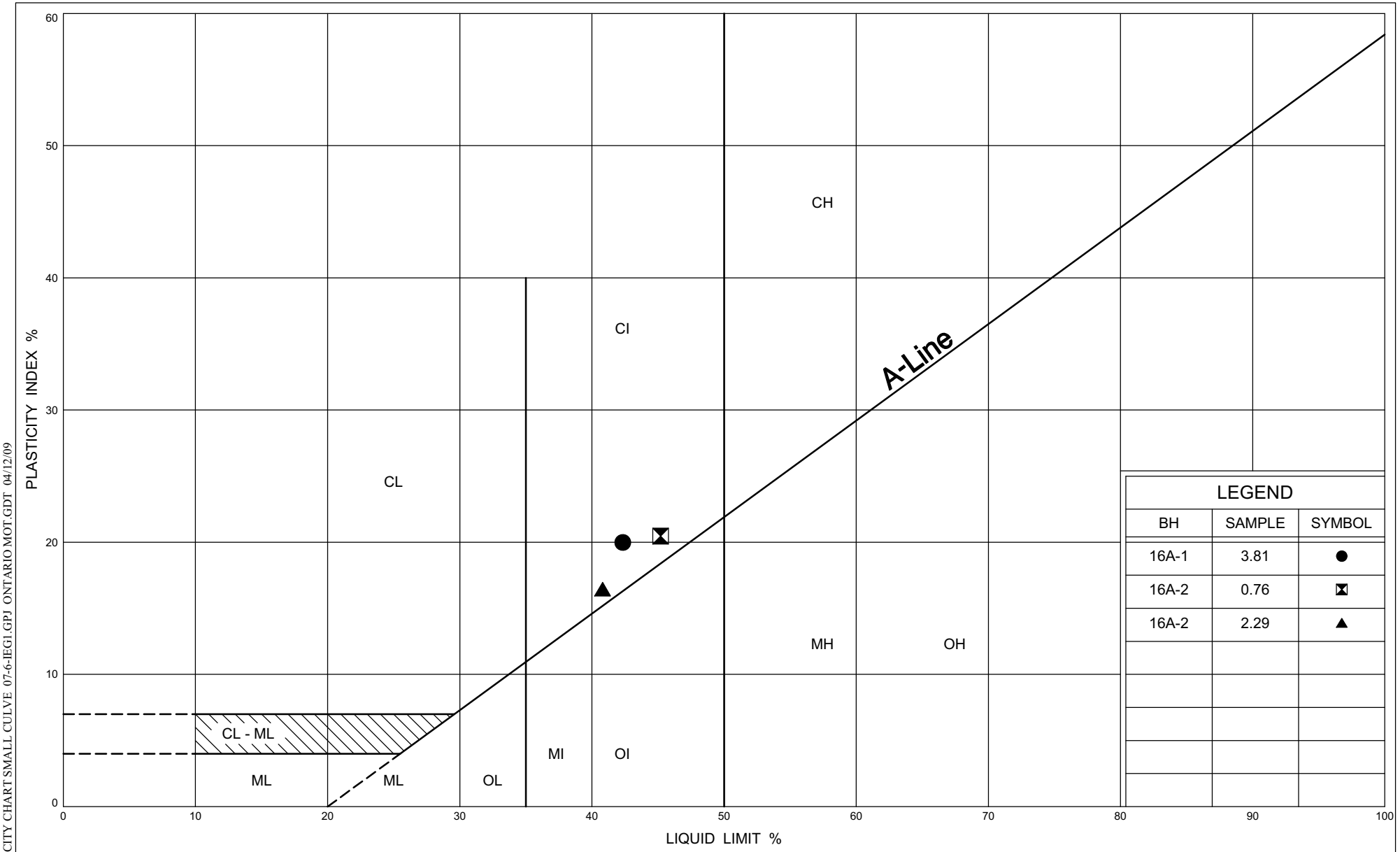
SILTY CLAY TILL, CI

FIG No C- 16A.3

GWP 57-00-00

HWY 26, Thornbury to Meaford

Oct 75, FF - S - 21



ONTARIO MOT PLASTICITY CHART SMALL CULVE 07-6-IEG1.GPJ ONTARIO MOT.GDT 04/12/09

Ministry of Transportation
Ontario

PLASTICITY CHART
SILTY CLAY TILL, CI

FIG No C- 16A.4

GWP 57-00-00

HWY 26, Thornbury to Meaford

RECORD OF BOREHOLE No 17A-1 1 OF 1 METRIC

W.P. GWP 57-00-00 LOCATION HWY 26, Thornbury to Meaford Northing - 4938725, Easting - 223723 ORIGINATED BY JL

DIST Owen Sound HWY 26 BOREHOLE TYPE S/S Augering, 110 mm dia. COMPILED BY JL

DATUM Geodetic DATE 07.25.07 - 07.25.07 CHECKED BY EC

ELEV / DEPTH	DESCRIPTION	STRAT PLOT	SAMPLES NUMBER	SAMPLES TYPE	SAMPLES "N" VALUES	GROUND WATER CONDITIONS	ELEVATION SCALE	PENETR. RESISTANCE STANDARD ● DYN. CONE 20 40 60 80 100 / SHEAR STRENGTH kPa ○ UNCONFINED ● QUICK TRIAXIAL + FIELD VANE × LAB VANE 20 40 60 80 100	PLASTIC LIMIT w_P / NATURAL MOISTURE CONTENT w / LIQUID LIMIT w_L WATER CONTENT (%) 10 20 30	UNIT WEIGHT γ kN/m³	REMARKS & GRAIN SIZE DISTRIBUTION (%) GR SA SI CL
232.50	Ground										
0.00	FILL Brown, moist, consisting of sand and gravel, and cobbles.										
231.74											
0.76	FILL Brown, moist, compact, consisting of silty clay, trace fine sand.		1	SPT	11						
			2	SPT	13						
230.37											
2.13	Brown		3	SPT	12	▽				23.4	7 14 49 30 (80)
	Silty CLAY TILL, CL-CI Moist, stiff to hard, embedded sand and gravel.		4	SPT	38				45	23.5	2 1 52 45 (97)
	Grey		5	SPT	34					22.8	
			6	SPT	88						
227.47											
5.03	End of Borehole.										Water level measured @ 2.3 m @ completion.

JOE MTO 07-6-IEG1.GPJ ONTARIO MOT.GDT 04/12/09

+ 3, × 3: Numbers refer to Sensitivity

○ 150 UNCONFINE SHEAR STRENGTH INFERRED FROM POCKET PENETROMETER READINGS

RECORD OF BOREHOLE No 17A-2 1 OF 1 METRIC

W.P. GWP 57-00-00 LOCATION HWY 26, Thornbury to Meaford Northing - 4938729, Easting - 223727 ORIGINATED BY JL

DIST Owen Sound HWY 26 BOREHOLE TYPE S/S Augering, 110 mm dia. COMPILED BY JL

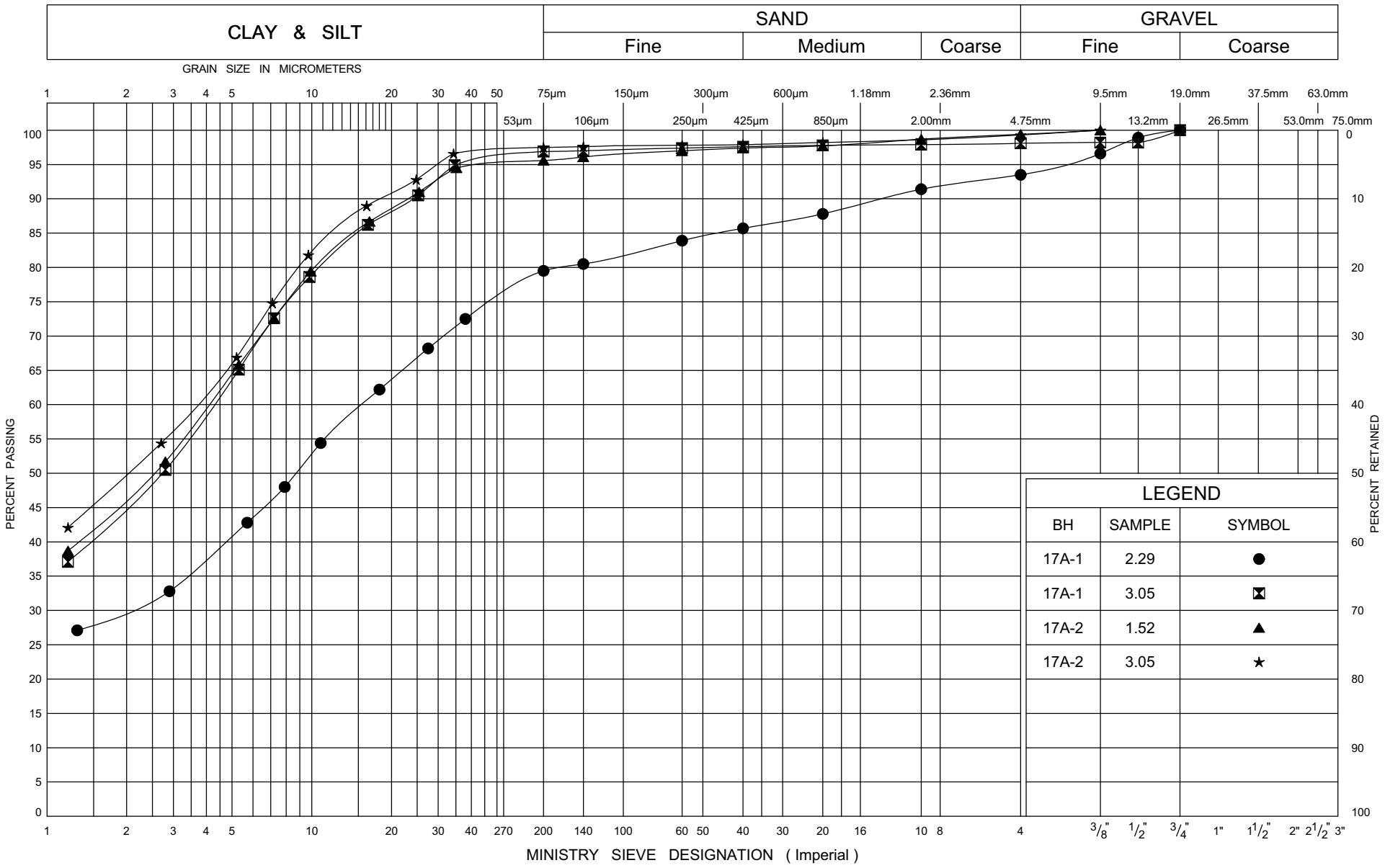
DATUM Geodetic DATE 07.25.07 - 07.25.07 CHECKED BY EC

ELEV / DEPTH	DESCRIPTION	STRAT PLOT	SAMPLES NUMBER	SAMPLES TYPE	SAMPLES "N" VALUES	GROUND WATER CONDITIONS	ELEVATION SCALE	PENETR. RESISTANCE STANDARD ● DYN. CONE 20 40 60 80 100 / SHEAR STRENGTH kPa ○ UNCONFINED ● QUICK TRIAXIAL + FIELD VANE × LAB VANE 20 40 60 80 100	PLASTIC LIMIT w_P / NATURAL MOISTURE CONTENT w / LIQUID LIMIT w_L / WATER CONTENT (%) 10 20 30	UNIT WEIGHT γ kN/m^3	REMARKS & GRAIN SIZE DISTRIBUTION (%) GR SA SI CL
230.91	Ground										
0.00	250 mm TOPSOIL										
	Brown		1	SPT	14		230				
			2	SPT	29		229		45	21.1	1 4 49 47 (96)
	Silty CLAY TILL, CI Moist, stiff to hard, embedded sand and gravel.		3	SPT	41		228				
	Grey		4	SPT	100+				42		1 2 48 50 (98)
226.64			5	SPT	95		227				
4.27	End of Borehole.										Borehole dry and open @ completion.

$+^3$, $\times^3$: Numbers refer to Sensitivity

$\circ^{150}$ UNCONFINE SHEAR STRENGTH INFERRED FROM POCKET PENETROMETER READINGS

UNIFIED SOIL CLASSIFICATION SYSTEM



Ministry of Transportation
Ontario

GRAIN SIZE DISTRIBUTION

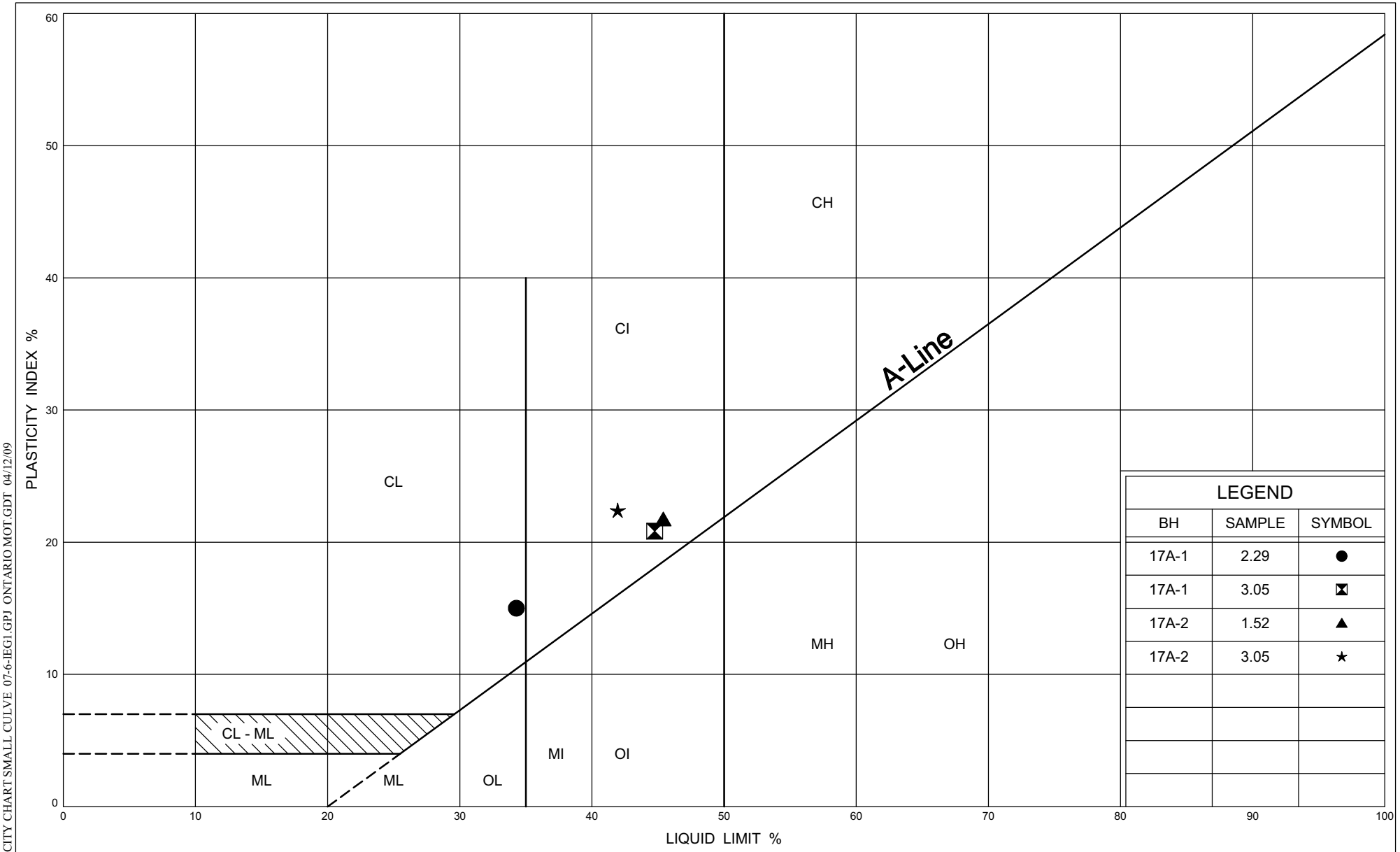
SILTY CLAY TILL, CL-CI

FIG No C- 17A.1

GWP 57-00-00

HWY 26, Thornbury to Meaford

Oct 75, FF - S - 21



ONTARIO MOT PLASTICITY CHART SMALL CULVE 07-6-IEG1.GPJ ONTARIO MOT.GDT 04/12/09

Ministry of Transportation
Ontario

PLASTICITY CHART
SILTY CLAY TILL, CL-CI

FIG No C- 17A.2

GWP 57-00-00

HWY 26, Thornbury to Meaford

RECORD OF BOREHOLE No 18A-1 1 OF 1 METRIC

W.P. GWP 57-00-00 LOCATION HWY 26, Thornbury to Meaford Northing - 4938671, Easting - 223820 ORIGINATED BY JL

DIST Owen Sound HWY 26 BOREHOLE TYPE S/S Augering, 110 mm dia. COMPILED BY JL

DATUM Geodetic DATE 07.25.07 - 07.25.07 CHECKED BY EC

ELEV / DEPTH	DESCRIPTION	STRAT PLOT	SAMPLES NUMBER	SAMPLES TYPE	SAMPLES "N" VALUES	GROUND WATER CONDITIONS	ELEVATION SCALE	PENETR. RESISTANCE STANDARD ● DYN. CONE 20 40 60 80 100 / SHEAR STRENGTH kPa ○ UNCONFINED ● QUICK TRIAXIAL + FIELD VANE × LAB VANE 20 40 60 80 100	PLASTIC LIMIT w_P / NATURAL MOISTURE CONTENT w / LIQUID LIMIT w_L / WATER CONTENT (%) 10 20 30	UNIT WEIGHT γ kN/m³	REMARKS & GRAIN SIZE DISTRIBUTION (%) GR SA SI CL
233.26	Ground										
0.00	300 mm sand and gravel FILL.						233				
	FILL Brown, moist, loose to compact, consisting of silty sand and gravel.		1	SPT	16		232				
			2	SPT	6						
231.13							231				
2.13	Brown		3	SPT	20				43	23.4	3 5 48 44 (92)
			4	SPT	87		230			22.3	
	Silty CLAY TILL, CI Moist, very stiff to hard, embedded sand and gravel.		5	SPT	83						7 4 54 35 (89)
	Grey					▽	229				Water level measured @ 4.4 m @ completion.
228.23			6	SPT	90						
5.03	End of Borehole.										

$+^{3}$, $\times^{3}$: Numbers refer to Sensitivity

○ 150 UNCONFINE SHEAR STRENGTH INFERRED FROM POCKET PENETROMETER READINGS

RECORD OF BOREHOLE No 18A-2 1 OF 1 METRIC

W.P. GWP 57-00-00 LOCATION HWY 26, Thornbury to Meaford Northing - 4938676, Easting - 223823 ORIGINATED BY JL

DIST Owen Sound HWY 26 BOREHOLE TYPE S/S Augering, 110 mm dia. COMPILED BY JL

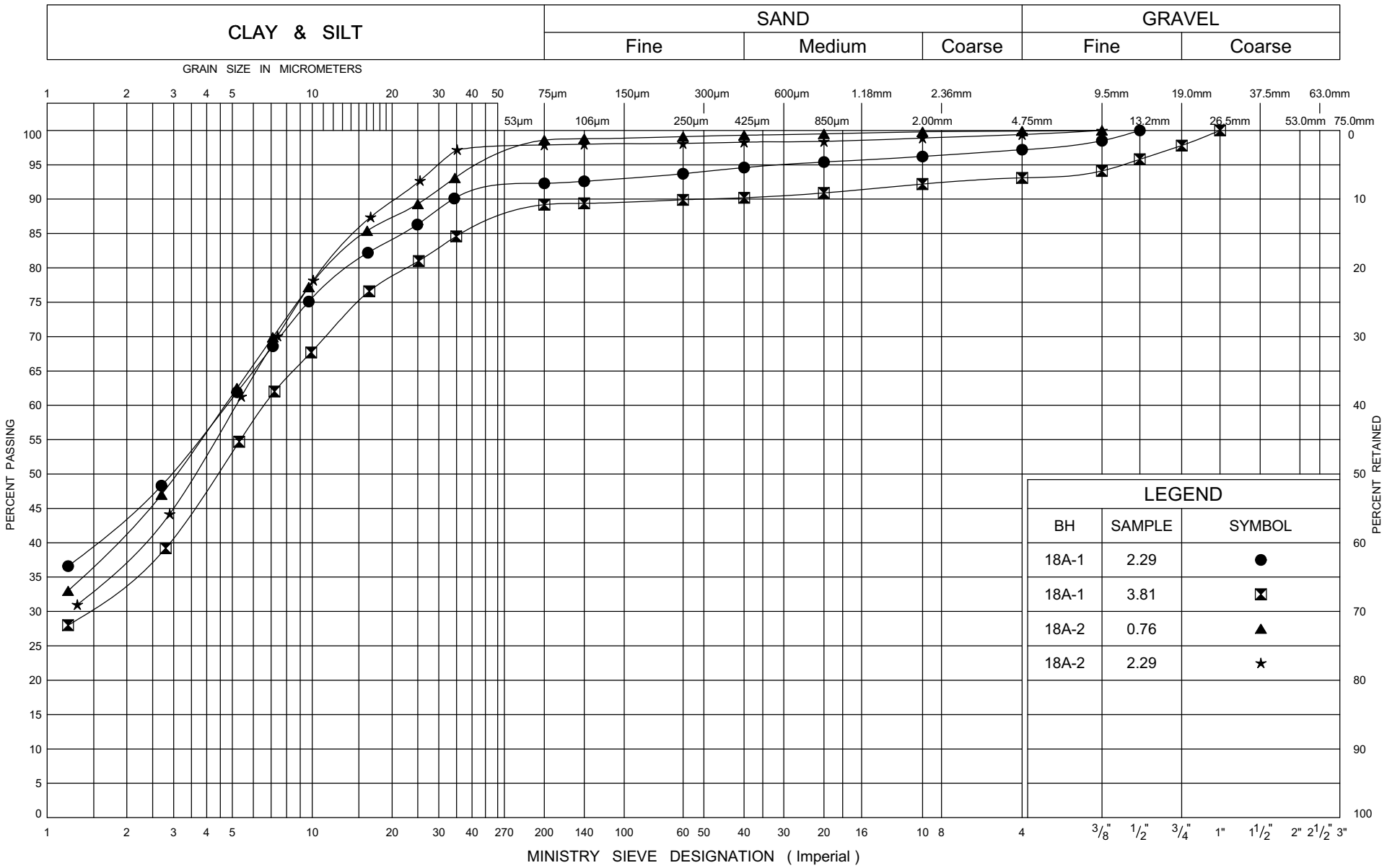
DATUM Geodetic DATE 07.25.07 - 07.25.07 CHECKED BY EC

ELEV / DEPTH	DESCRIPTION	STRAT PLOT	SAMPLES NUMBER	SAMPLES TYPE	SAMPLES "N" VALUES	GROUND WATER CONDITIONS	ELEVATION SCALE	PENETR. RESISTANCE STANDARD ● DYN. CONE (20 40 60 80 100) / SHEAR STRENGTH kPa ○ UNCONFINED ● QUICK TRIAXIAL + FIELD VANE × LAB VANE (20 40 60 80 100)	PLASTIC LIMIT w_P / NATURAL MOISTURE CONTENT w / LIQUID LIMIT w_L / WATER CONTENT (%) (10 20 30)	UNIT WEIGHT γ kN/m³	REMARKS & GRAIN SIZE DISTRIBUTION (%) GR SA SI CL
231.63	Ground										
0.00	250 mm TOPSOIL.										
	Brown		1	SPT	27		231		45	22.6	0 1 57 42 (99)
			2	SPT	36		230			22.6	
	Silty CLAY TILL, CI Moist, very stiff to hard, embedded sand and gravel.		3	SPT	83		229		41		1 2 60 38 (98)
	Grey		4	SPT	100+		228				
227.59			5	SPT	100+						
4.04	End of Borehole.										Borehole dry and open @ completion.

+ 3, × 3: Numbers refer to Sensitivity

○ 150 UNCONFINE SHEAR STRENGTH INFERRED FROM POCKET PENETROMETER READINGS

UNIFIED SOIL CLASSIFICATION SYSTEM



Ministry of Transportation
Ontario

GRAIN SIZE DISTRIBUTION

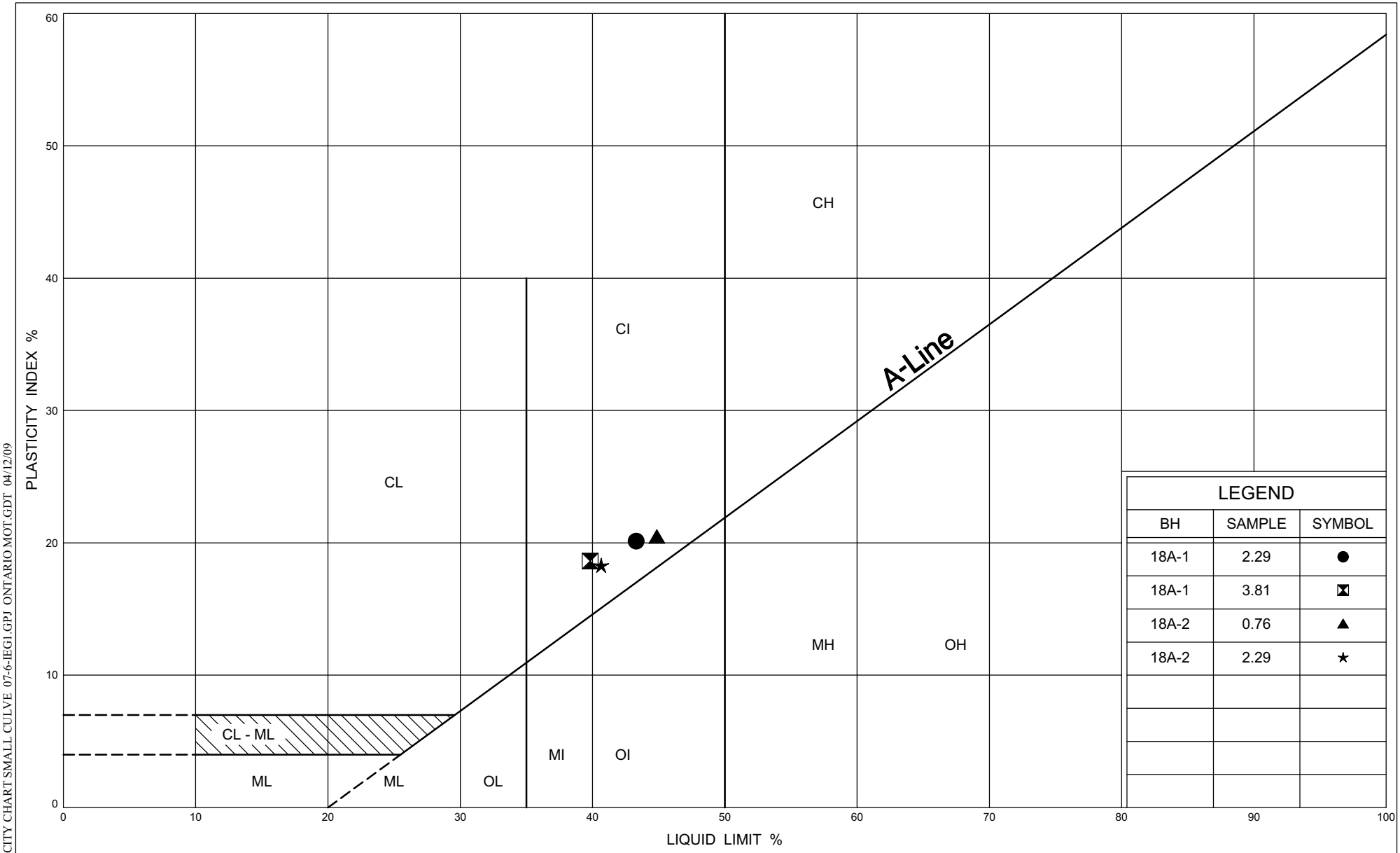
SILTY CLAY TILL, CI

FIG No C- 18A.1

GWP 57-00-00

HWY 26, Thornbury to Meaford

Oct 75, FF - S - 21



ONTARIO MOT PLASTICITY CHART SMALL CULVE 07-6-IEG1.GPJ ONTARIO MOT.GDT 04/12/09

Ministry of Transportation
Ontario

PLASTICITY CHART
SILTY CLAY TILL, CI

FIG No C- 18A.2

GWP 57-00-00

HWY 26, Thornbury to Meaford

RECORD OF BOREHOLE No 19A-1 1 OF 1 METRIC

W.P. GWP 57-00-00 LOCATION HWY 26, Thornbury to Meaford Northing - 4938541, Easting - 224057 ORIGINATED BY JL

DIST Owen Sound HWY 26 BOREHOLE TYPE S/S Augering, 110 mm dia. COMPILED BY JL

DATUM Geodetic DATE 07.25.07 - 07.25.07 CHECKED BY EC

ELEV / DEPTH	DESCRIPTION	STRAT PLOT	SAMPLES NUMBER	SAMPLES TYPE	SAMPLES "N" VALUES	GROUND WATER CONDITIONS	ELEVATION SCALE	PENETR. RESISTANCE STANDARD ● DYN. CONE (20 40 60 80 100) / SHEAR STRENGTH kPa ○ UNCONFINED ● QUICK TRIAXIAL + FIELD VANE × LAB VANE (20 40 60 80 100)	PLASTIC LIMIT w_P / NATURAL MOISTURE CONTENT w / LIQUID LIMIT w_L / WATER CONTENT (%) (10 20 30)	UNIT WEIGHT γ kN/m³	REMARKS & GRAIN SIZE DISTRIBUTION (%) GR SA SI CL
233.62	Ground										
0.00 / 233.27	300 mm sand and gravel FILL.										
0.35	FILL Grey, moist, loose to compact, consisting of silty clay.		1	SPT	7		233				
			2	SPT	16		232				
231.49											
2.13	Brown Silty CLAY TILL CI Moist, very stiff to hard, embedded sand and gravel.		3	SPT	18		231			21.7	
			4	SPT	40				41		7 5 50 38 (88)
	Grey		5	SPT	51		230				2 2 57 39 (96)
228.82			6	SPT	100+		229				
4.80	End of Borehole.										Borehole dry and open @ completion.

$+^{3}$, $\times^{3}$: Numbers refer to Sensitivity

$\circ^{150}$ UNCONFINE SHEAR STRENGTH INFERRED FROM POCKET PENETROMETER READINGS

RECORD OF BOREHOLE No 19A-2 1 OF 1 METRIC

W.P. GWP 57-00-00 LOCATION HWY 26, Thornbury to Meaford Northing - 4938553, Easting - 224070 ORIGINATED BY JL

DIST Owen Sound HWY 26 BOREHOLE TYPE S/S Augering, 110 mm dia. COMPILED BY JL

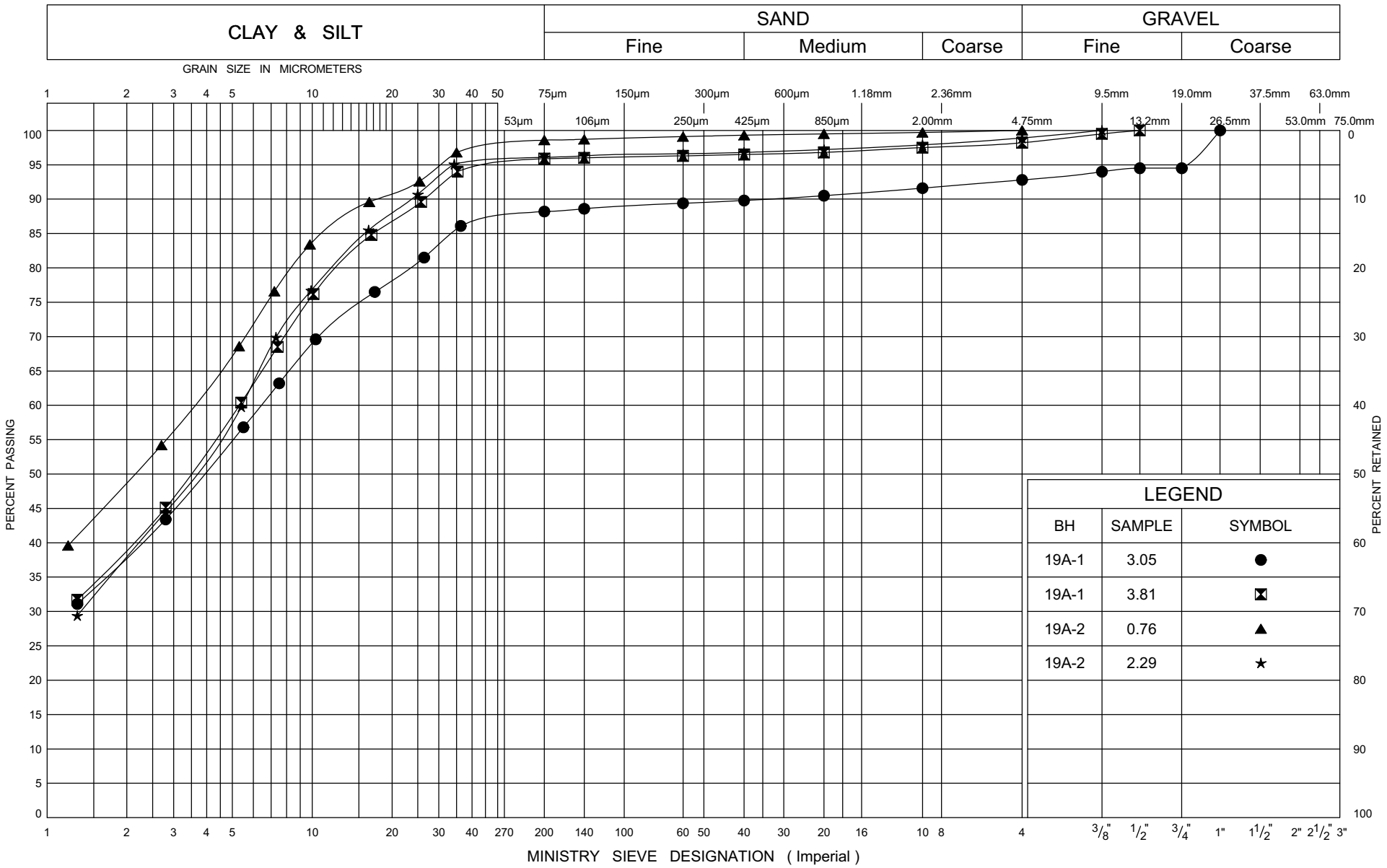
DATUM Geodetic DATE 09.17.07 - 09.17.07 CHECKED BY EC

ELEV / DEPTH	DESCRIPTION	STRAT PLOT	SAMPLES: NUMBER	SAMPLES: TYPE	SAMPLES: "N" VALUES	GROUND WATER CONDITIONS	ELEVATION SCALE	PENETR. RESISTANCE: STANDARD ● DYN. CONE (20 40 60 80 100) / SHEAR STRENGTH kPa: ○ UNCONFINED + FIELD VANE ● QUICK TRIAXIAL × LAB VANE (20 40 60 80 100)	PLASTIC LIMIT w_P / NATURAL MOISTURE CONTENT w / LIQUID LIMIT w_L / WATER CONTENT (%) (10 20 30)	UNIT WEIGHT γ kN/m³	REMARKS & GRAIN SIZE DISTRIBUTION (%) GR SA SI CL
231.97	Ground										
0.00	150 mm TOPSOIL										
	Brown Silty CLAY TILL, CI Moist, very stiff to hard, embedded sand and gravel.		1	SPT	19		231		46	23.7	0 1 50 49 (99)
			2	SPT	42		230			19.8	
	Grey		3	SPT	52						1 3 58 38 (96)
228.62			4	SPT	100+		229				
3.35	End of Borehole.										Borehole dry and open @ completion.

$+^3, \times^3$: Numbers refer to Sensitivity

$\circ^{150}$ UNCONFINE SHEAR STRENGTH INFERRED FROM POCKET PENETROMETER READINGS

UNIFIED SOIL CLASSIFICATION SYSTEM



Ministry of Transportation
Ontario

GRAIN SIZE DISTRIBUTION

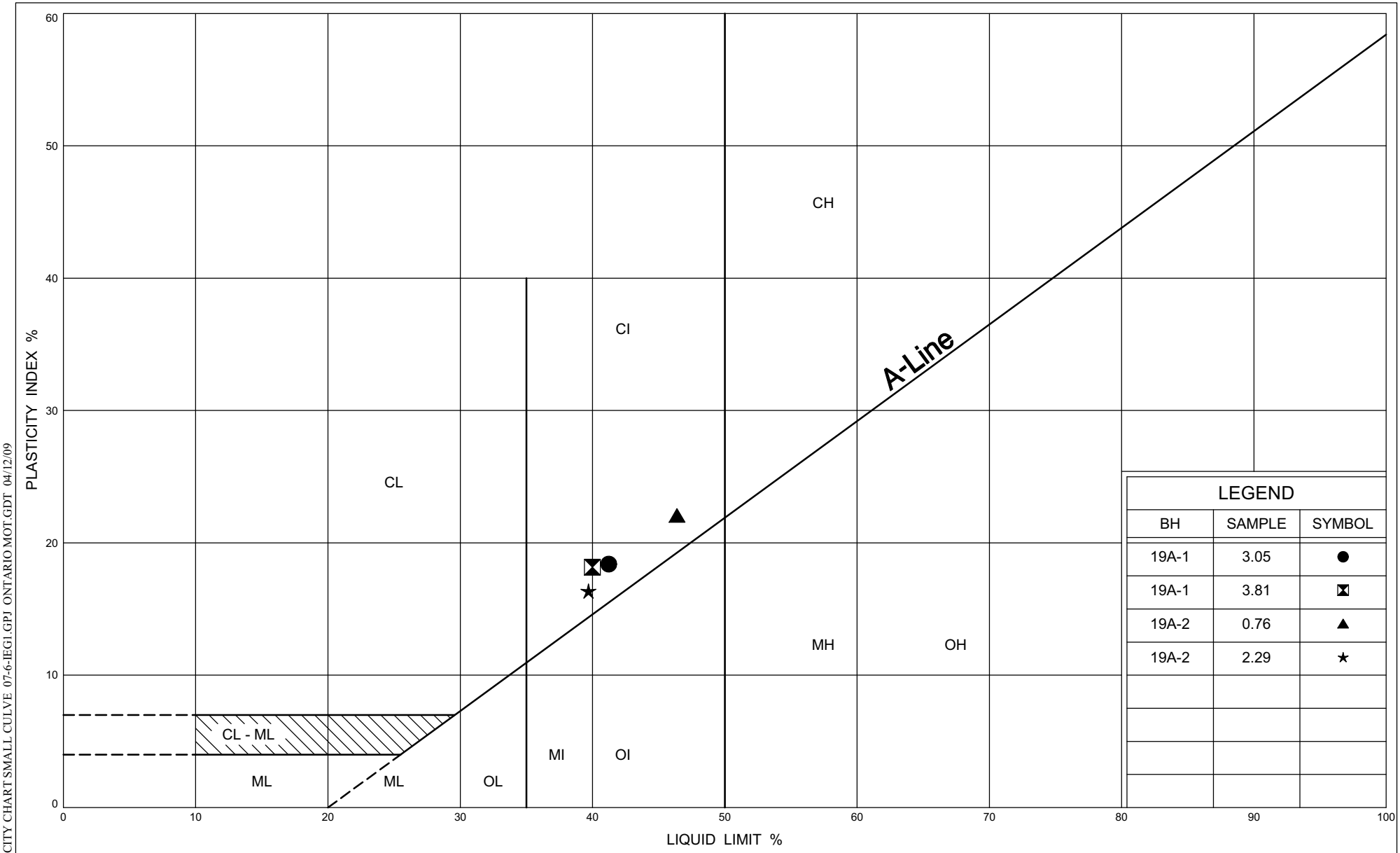
SILTY CLAY TILL, CI

FIG No C- 19A.1

GWP 57-00-00

HWY 26, Thornbury to Meaford

Oct 75, FF - S - 21



LEGEND		
BH	SAMPLE	SYMBOL
19A-1	3.05	●
19A-1	3.81	⊠
19A-2	0.76	▲
19A-2	2.29	★

Ministry of Transportation
Ontario

PLASTICITY CHART
SILTY CLAY TILL, CI

FIG No C- 19A.2

GWP 57-00-00

HWY 26, Thornbury to Meaford

ONTARIO MOT PLASTICITY CHART SMALL CULVE 07-6-IEG1.GPJ ONTARIO MOT.GDT 04/12/09

RECORD OF BOREHOLE No 23A-1

1 OF 1

METRIC

W.P. GWP 57-00-00 LOCATION HWY 26, Thornbury to Meaford Northing - 4938066, Easting - 224882 ORIGINATED BY JL

DIST Owen Sound HWY 26 BOREHOLE TYPE S/S Augering, 110 mm dia. COMPILED BY JL

DATUM Geodetic DATE 07.24.07 - 07.24.07 CHECKED BY EC

ELEV / DEPTH	DESCRIPTION	STRAT PLOT	SAMPLES NUMBER	SAMPLES TYPE	SAMPLES "N" VALUES	GROUND WATER CONDITIONS	ELEVATION SCALE	PENETR. RESISTANCE STANDARD ● DYN. CONE (20 40 60 80 100) / SHEAR STRENGTH kPa ○ UNCONFINED ● QUICK TRIAXIAL + FIELD VANE × LAB VANE (20 40 60 80 100)	PLASTIC LIMIT w_P / NATURAL MOISTURE CONTENT w / LIQUID LIMIT w_L — WATER CONTENT (%) (10 20 30)	UNIT WEIGHT γ kN/m³	REMARKS & GRAIN SIZE DISTRIBUTION (%) GR SA SI CL
234.92	Ground										
0.00	300 mm sand and gravel FILL.										
	FILL Brown, moist to wet, compact, consisting of gravelly sand, some silt.		1	SPT	100+		234				hit cobbles.
			2	SPT	15	▽	233				44 41 9 5 (14)
232.79											Water level measured @ 2 m @ completion.
2.13	FILL Brown, moist to wet, compact, consisting of clayey sand and silt.		3	SPT	12						
231.72							232				
3.20	Brown		4	SPT	29						7 4 55 33 (88)
	Silty CLAY TILL, CI Moist, very stiff to hard, embedded sand and gravel.		5	SPT	42		231			23.8	
	Grey		6	SPT	86		230				5 7 57 31 (88)
229.43			7	SPT	100+						
5.49	End of Borehole.										

+ 3, × 3: Numbers refer to Sensitivity

○ 150 UNCONFINE SHEAR STRENGTH INFERRED FROM POCKET PENETROMETER READINGS

RECORD OF BOREHOLE No 23A-2

1 OF 1

METRIC

W.P. GWP 57-00-00 LOCATION HWY 26, Thornbury to Meaford Northing - 4938074, Easting - 224889 ORIGINATED BY JL

DIST Owen Sound HWY 26 BOREHOLE TYPE S/S Augering, 110 mm dia. COMPILED BY JL

DATUM Geodetic DATE 07.24.07 - 07.24.07 CHECKED BY EC

ELEV / DEPTH	DESCRIPTION	STRAT PLOT	SAMPLES NUMBER	SAMPLES TYPE	SAMPLES "N" VALUES	GROUND WATER CONDITIONS	ELEVATION SCALE	PENETR. RESISTANCE STANDARD ● DYN. CONE (20 40 60 80 100) / SHEAR STRENGTH kPa ○ UNCONFINED ● QUICK TRIAXIAL + FIELD VANE × LAB VANE (20 40 60 80 100)	PLASTIC LIMIT w_P / NATURAL MOISTURE CONTENT w / LIQUID LIMIT w_L / WATER CONTENT (%) (10 20 30)	UNIT WEIGHT γ kN/m³	REMARKS & GRAIN SIZE DISTRIBUTION (%) GR SA SI CL
234.89	Ground										
0.00	200 mm sand and gravel FILL.										
	FILL Brown, moist to wet, loose to compact, consisting of gravelly sand.		1	SPT	16		234				
			2	SPT	6		233				
232.76											
2.13	FILL Brown, moist to wet, stiff, consisting of clayey sand and silt, some gravel.		3	SPT	10						19 34 33 14 (48)
231.84							232				
3.05	Brown Silty CLAY TILL, CL-CI Moist, very stiff to hard, embedded sand and gravel.		4	SPT	26					24.0	7 5 53 35 (88)
			5	SPT	65		231				15 12 47 26 (73)
	Grey		6	SPT	80		230				
			7	SPT	100+	▽					Water level measured @ 5.5 m @ completion.
228.64			8	SPT	100+		229				
6.25	End of Borehole.										

+ 3, × 3: Numbers refer to Sensitivity

○ 150 UNCONFINE SHEAR STRENGTH INFERRED FROM POCKET PENETROMETER READINGS

RECORD OF BOREHOLE No 23A-3 1 OF 1 METRIC

W.P. GWP 57-00-00 LOCATION HWY 26, Thornbury to Meaford Northing - 4938093, Easting - 224890 ORIGINATED BY JL

DIST Owen Sound HWY 26 BOREHOLE TYPE S/S Augering, 110 mm dia. COMPILED BY JL

DATUM Geodetic DATE 07.24.07 - 07.24.07 CHECKED BY EC

ELEV / DEPTH	DESCRIPTION	STRAT PLOT	SAMPLES NUMBER	SAMPLES TYPE	SAMPLES "N" VALUES	GROUND WATER CONDITIONS	ELEVATION SCALE	PENETR. RESISTANCE STANDARD ● DYN. CONE / SHEAR STRENGTH kPa ○ UNCONFINED ● QUICK TRIAXIAL + FIELD VANE × LAB VANE	PLASTIC LIMIT w_P / NATURAL MOISTURE CONTENT w / LIQUID LIMIT w_L / WATER CONTENT (%)	UNIT WEIGHT γ kN/m³	REMARKS & GRAIN SIZE DISTRIBUTION (%) GR SA SI CL
232.75	Ground										
0.00	150 mm TOPSOIL										
	Brown		1	SPT	38	▽	232				
			2	SPT	27		231				Water level measured @ 1.3 m @ completion. 1 5 56 38 (95)
	Silty CLAY TILL, CI Moist, very stiff to hard, embedded sand and gravel.		3	SPT	77					25.5	
	Grey		4	SPT	100+		230				
228.64			5	SPT	100+		229				1 8 60 31 (92)
4.11	End of Borehole.										

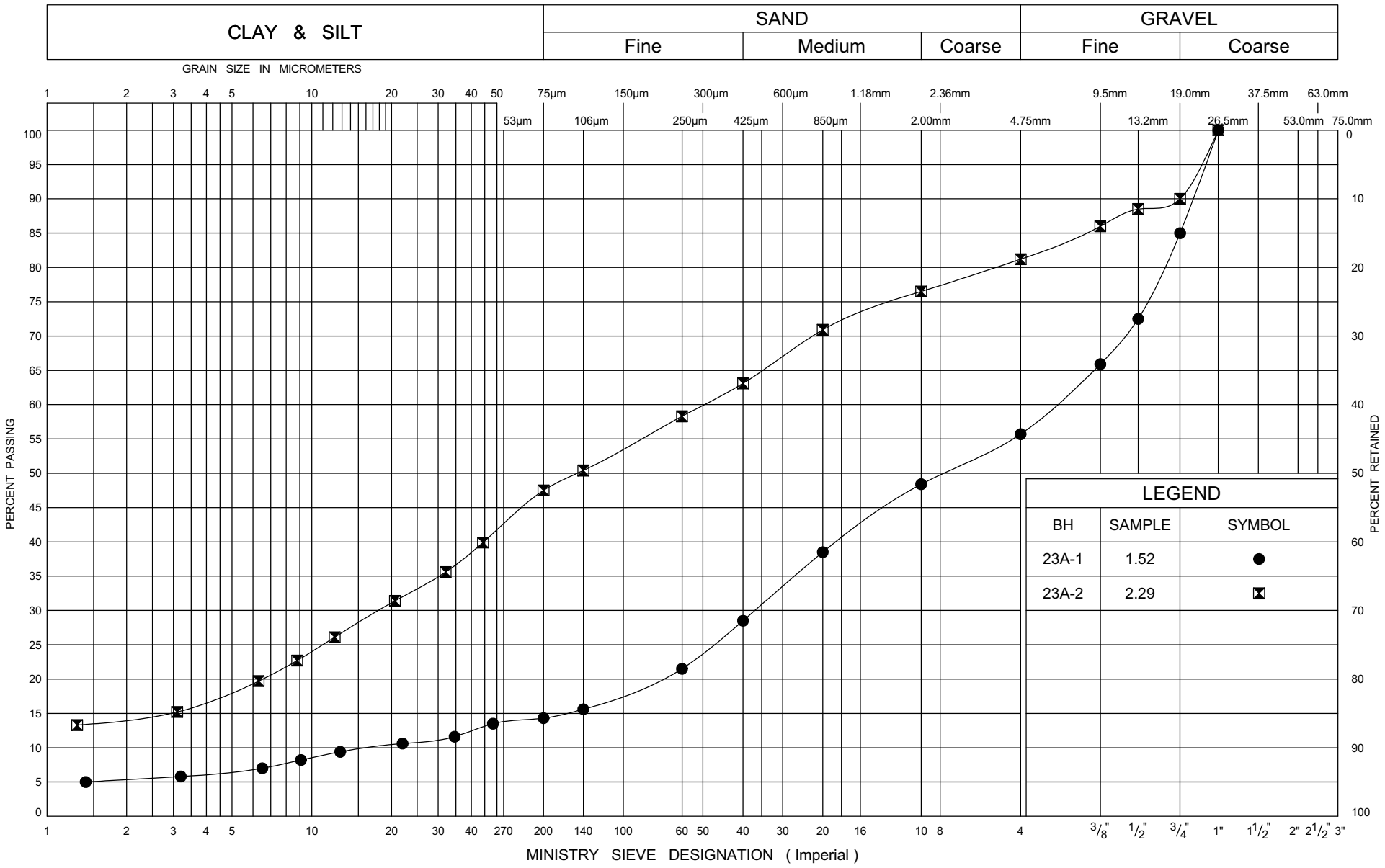
PENETR. RESISTANCE: 20 40 60 80 100
SHEAR STRENGTH kPa: 20 40 60 80 100
WATER CONTENT (%): 10 20 30

JOE MTO 07-6-IEG1.GPJ ONTARIO MOT.GDT 04/12/09

$+^{3}, \times^{3}$: Numbers refer to Sensitivity

$\circ^{150}$ UNCONFINE SHEAR STRENGTH INFERRED FROM POCKET PENETROMETER READINGS

UNIFIED SOIL CLASSIFICATION SYSTEM



Ministry of Transportation
Ontario

GRAIN SIZE DISTRIBUTION

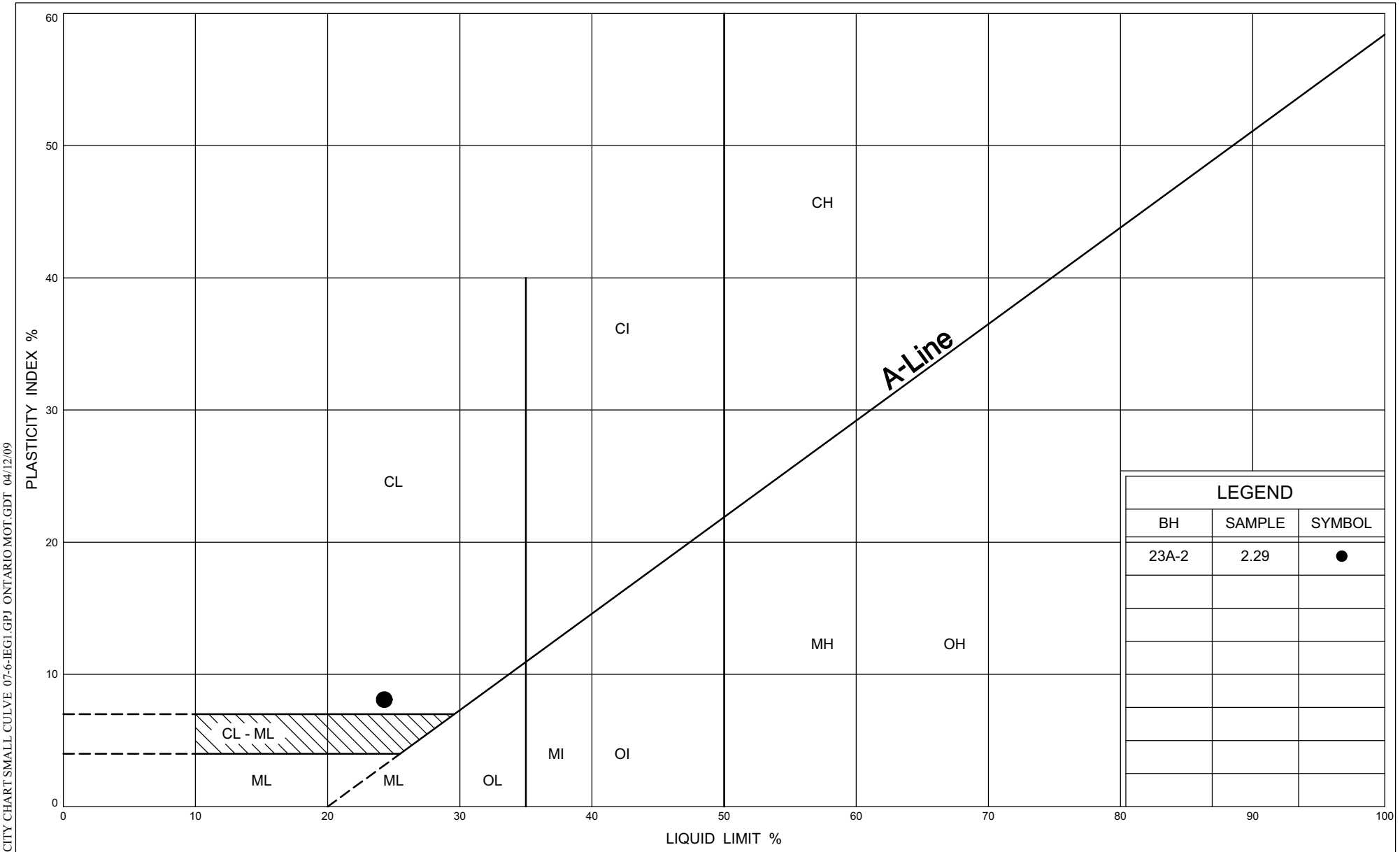
FILL

FIG No C- 23A.1

GWP 57-00-00

HWY 26, Thornbury to Meaford

Oct 75, FF - S - 21



ONTARIO MOT PLASTICITY CHART SMALL CULVE 07-6-IEG1.GPJ ONTARIO MOT.GDT 04/12/09

Ministry of Transportation
Ontario

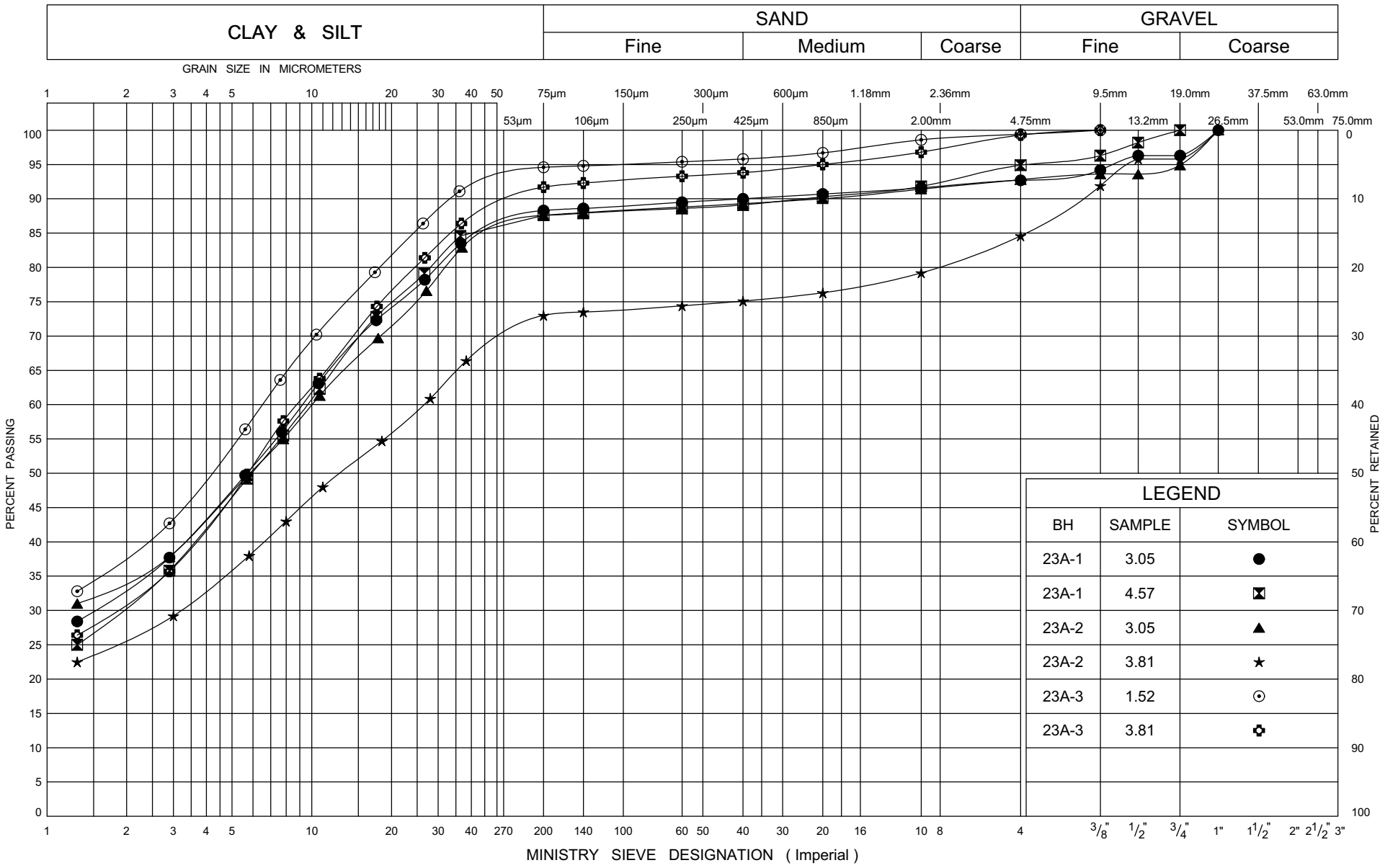
PLASTICITY CHART
FILL

FIG No C- 23A.2

GWP 57-00-00

HWY 26, Thornbury to Meaford

UNIFIED SOIL CLASSIFICATION SYSTEM



Ministry of Transportation
Ontario

GRAIN SIZE DISTRIBUTION

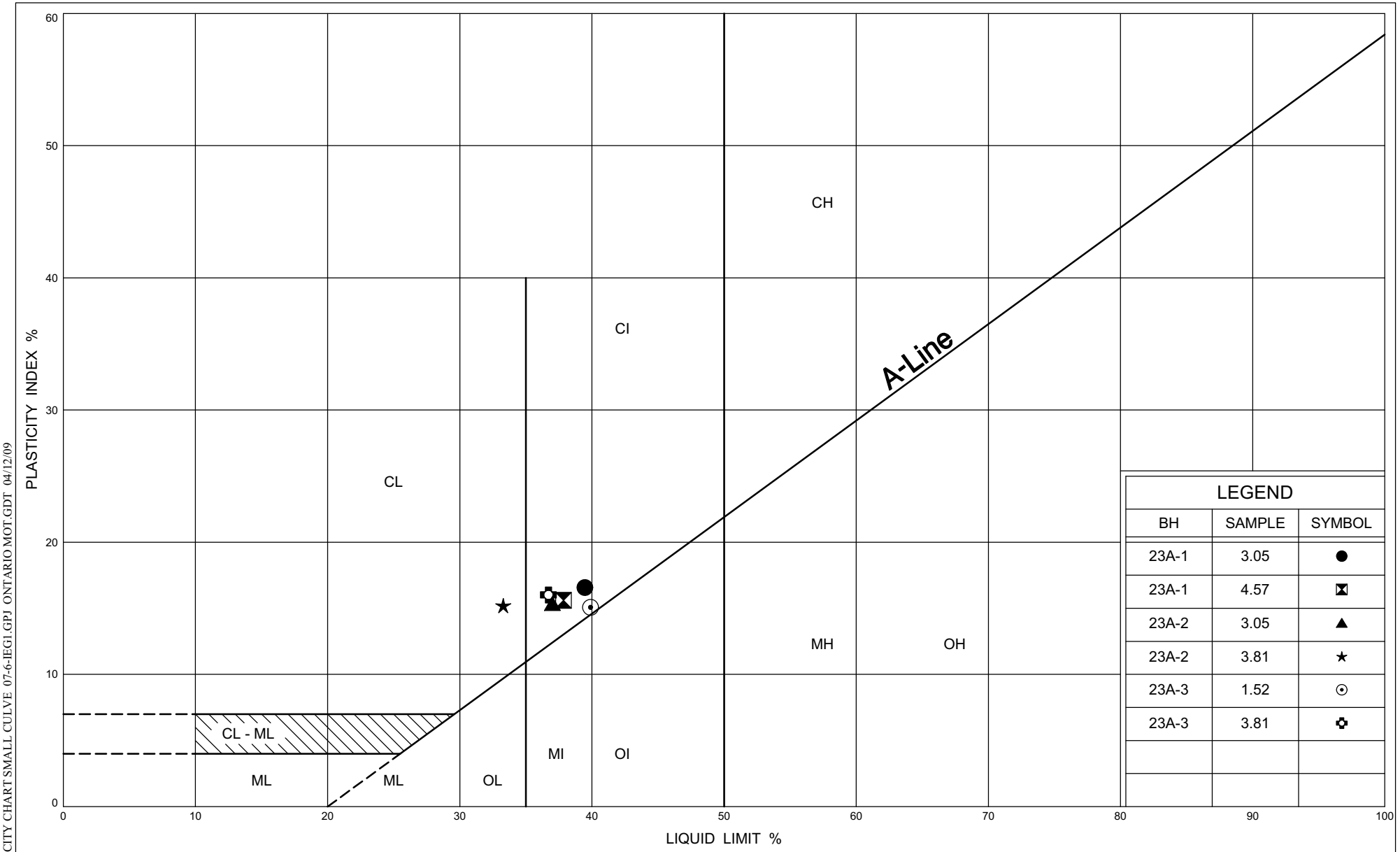
SILTY CLAY TILL, CL-CI

FIG No C- 23A.3

GWP 57-00-00

HWY 26, Thornbury to Meaford

Oct 75, FF - S - 21



LEGEND		
BH	SAMPLE	SYMBOL
23A-1	3.05	●
23A-1	4.57	⊠
23A-2	3.05	▲
23A-2	3.81	★
23A-3	1.52	⊙
23A-3	3.81	✿

Ministry of Transportation
Ontario

PLASTICITY CHART

SILTY CLAY TILL, CL-CI

FIG No C- 23A.4

GWP 57-00-00

HWY 26, Thornbury to Meaford

ONTARIO MOT PLASTICITY CHART SMALL CULVE 07-6-IEG1.GPJ ONTARIO MOT.GDT 04/12/09

RECORD OF BOREHOLE No 28A-1

1 OF 1

METRIC

W.P. GWP 57-00-00 LOCATION HWY 26, Thornbury to Meaford Northing - 4936970, Easting - 227905 ORIGINATED BY JL

DIST Owen Sound HWY 26 BOREHOLE TYPE S/S Augering, 110 mm dia. COMPILED BY JL

DATUM Geodetic DATE 07.23.07 - 07.23.07 CHECKED BY EC

ELEV / DEPTH	DESCRIPTION	STRAT PLOT	SAMPLES NUMBER	SAMPLES TYPE	SAMPLES "N" VALUES	GROUND WATER CONDITIONS	ELEVATION SCALE	PENETR. RESISTANCE STANDARD ● DYN. CONE 20 40 60 80 100 / SHEAR STRENGTH kPa ○ UNCONFINED ● QUICK TRIAXIAL + FIELD VANE × LAB VANE 20 40 60 80 100	PLASTIC LIMIT w_P / NATURAL MOISTURE CONTENT w / LIQUID LIMIT w_L / WATER CONTENT (%) 10 20 30	UNIT WEIGHT γ kN/m³	REMARKS & GRAIN SIZE DISTRIBUTION (%) GR SA SI CL
194.62	Ground										
0.00 / 194.26	350mm TOPSOIL										
0.36	Brown Silty CLAY to Clayey SILT TILL, Cl to CL-ML Moist, very stiff to hard, frequent silt layers.		1	SPT	9		194			22.0	0 8 60 32 (92)
			2	SPT	21		193			20.4	
			3	SPT	19		192			20.5	
			4	SPT	39					22.3	1 12 67 20 (87)
	Grey		5	SPT	49		191				
190.35											
4.27	End of Borehole.										Borehole dry and open @ completion.

$+^3, \times^3$: Numbers refer to Sensitivity

$\circ^{150}$ UNCONFINE SHEAR STRENGTH INFERRED FROM POCKET PENETROMETER READINGS

RECORD OF BOREHOLE No 28A-2 1 OF 1 METRIC

W.P. GWP 57-00-00 LOCATION HWY 26, Thornbury to Meaford Northing - 4936980, Easting - 227914 ORIGINATED BY JL

DIST Owen Sound HWY 26 BOREHOLE TYPE S/S Augering, 110 mm dia. COMPILED BY JL

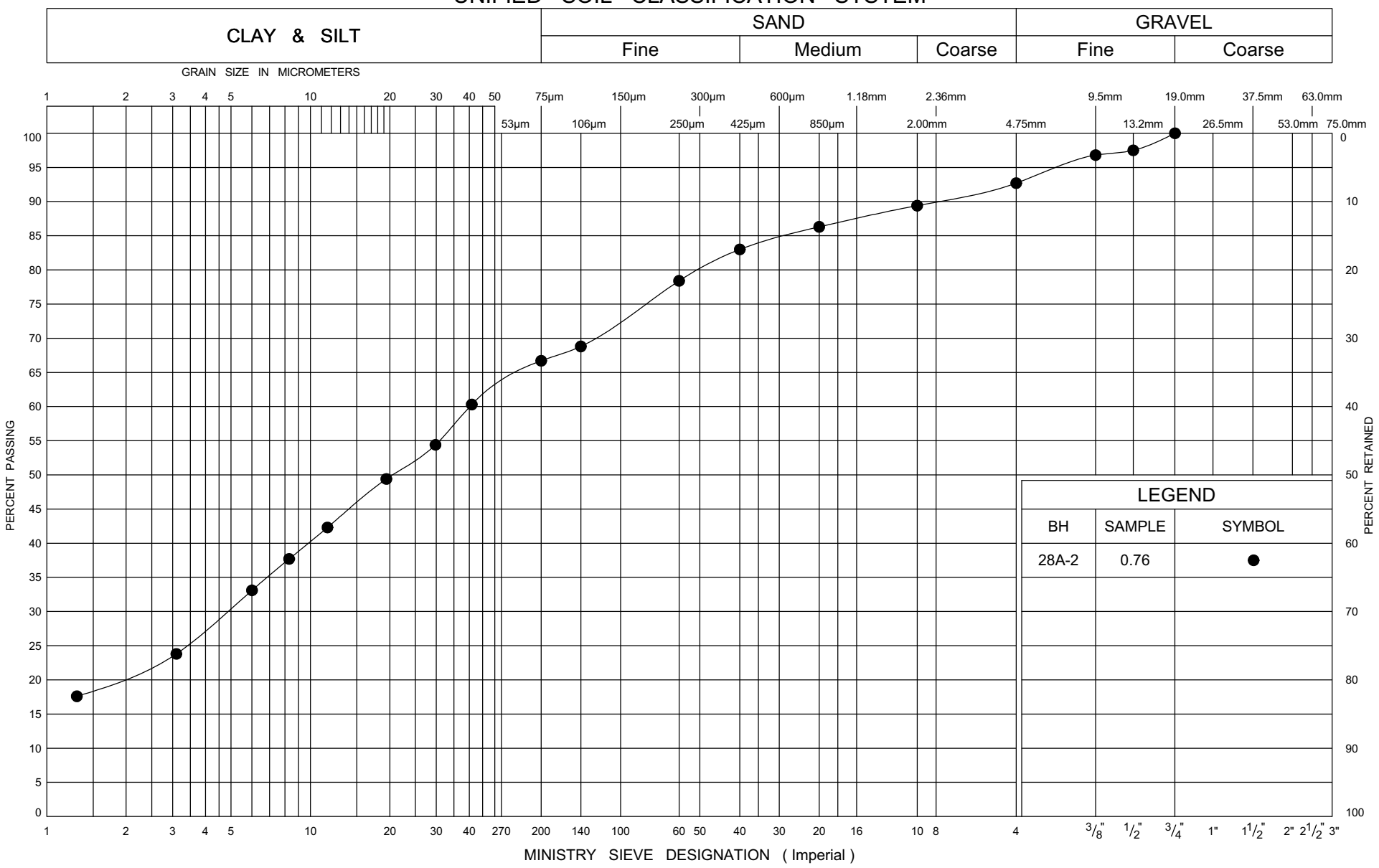
DATUM Geodetic DATE 07.18.07 - 07.18.07 CHECKED BY EC

ELEV / DEPTH	DESCRIPTION	STRAT PLOT	SAMPLES NUMBER	SAMPLES TYPE	SAMPLES "N" VALUES	GROUND WATER CONDITIONS	ELEVATION SCALE	PENETR. RESISTANCE STANDARD ● DYN. CONE (20 40 60 80 100) / SHEAR STRENGTH kPa ○ UNCONFINED ● QUICK TRIAXIAL + FIELD VANE × LAB VANE (20 40 60 80 100)	PLASTIC LIMIT w_P / NATURAL MOISTURE CONTENT w / LIQUID LIMIT w_L / WATER CONTENT (%) (10 20 30)	UNIT WEIGHT γ kN/m^3	REMARKS & GRAIN SIZE DISTRIBUTION (%) GR SA SI CL
196.17	Ground										
0.00 / 195.87 / 0.30	300 mm sand and gravel FILL.						196				
	FILL Brown, moist, compact, consisting of sandy silty clay, some gravel, trace organics.		1	SPT	14		195				7 26 46 21 (67)
			2	SPT	16						
193.88							194				
2.29	Brown Silty CLAY to Clayey SILT TILL, CL to CL-ML Moist, very stiff to hard, frequent silt layers.		3	SPT	33					22.8	0 8 63 29 (92)
			4	SPT	36		193				
	Grey		5	SPT	18		192			23.1	0 0 80 20 (100)
			6	SPT	38						
191.14											
5.03	End of Borehole.										Borehole dry and open @ completion.

$+^3, \times^3$: Numbers refer to Sensitivity

○ 150 UNCONFINE SHEAR STRENGTH INFERRED FROM POCKET PENETROMETER READINGS

UNIFIED SOIL CLASSIFICATION SYSTEM



Ministry of Transportation
Ontario

GRAIN SIZE DISTRIBUTION

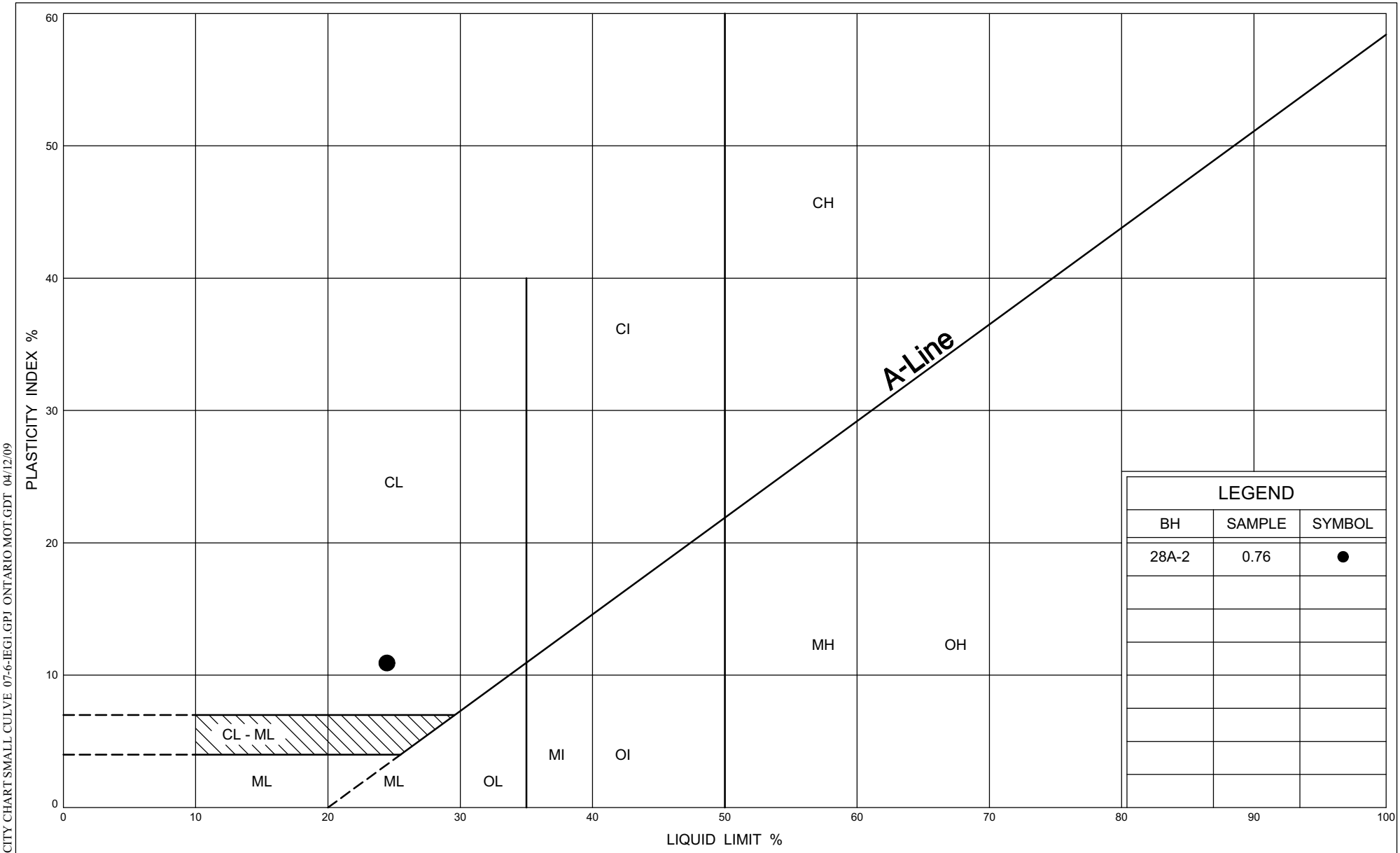
FILL

FIG No C- 28A.1

GWP 57-00-00

HWY 26, Thornbury to Meaford

Oct 75, FF - S - 21



ONTARIO MOT PLASTICITY CHART SMALL CULVE 07-6-IEG1.GPJ ONTARIO MOT.GDT 04/12/09

Ministry of Transportation
Ontario

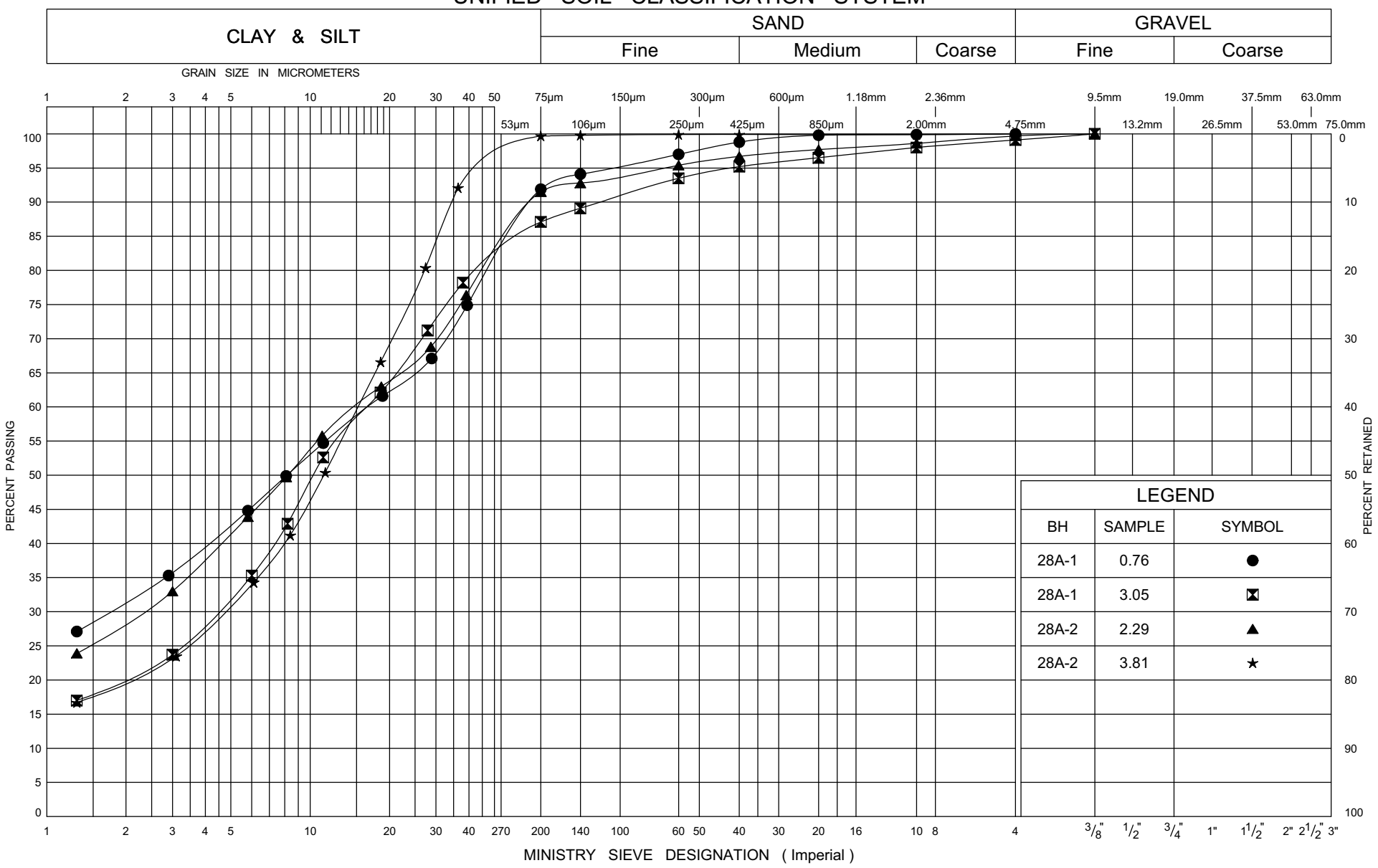
PLASTICITY CHART
FILL

FIG No C- 28A.2

GWP 57-00-00

HWY 26, Thornbury to Meaford

UNIFIED SOIL CLASSIFICATION SYSTEM



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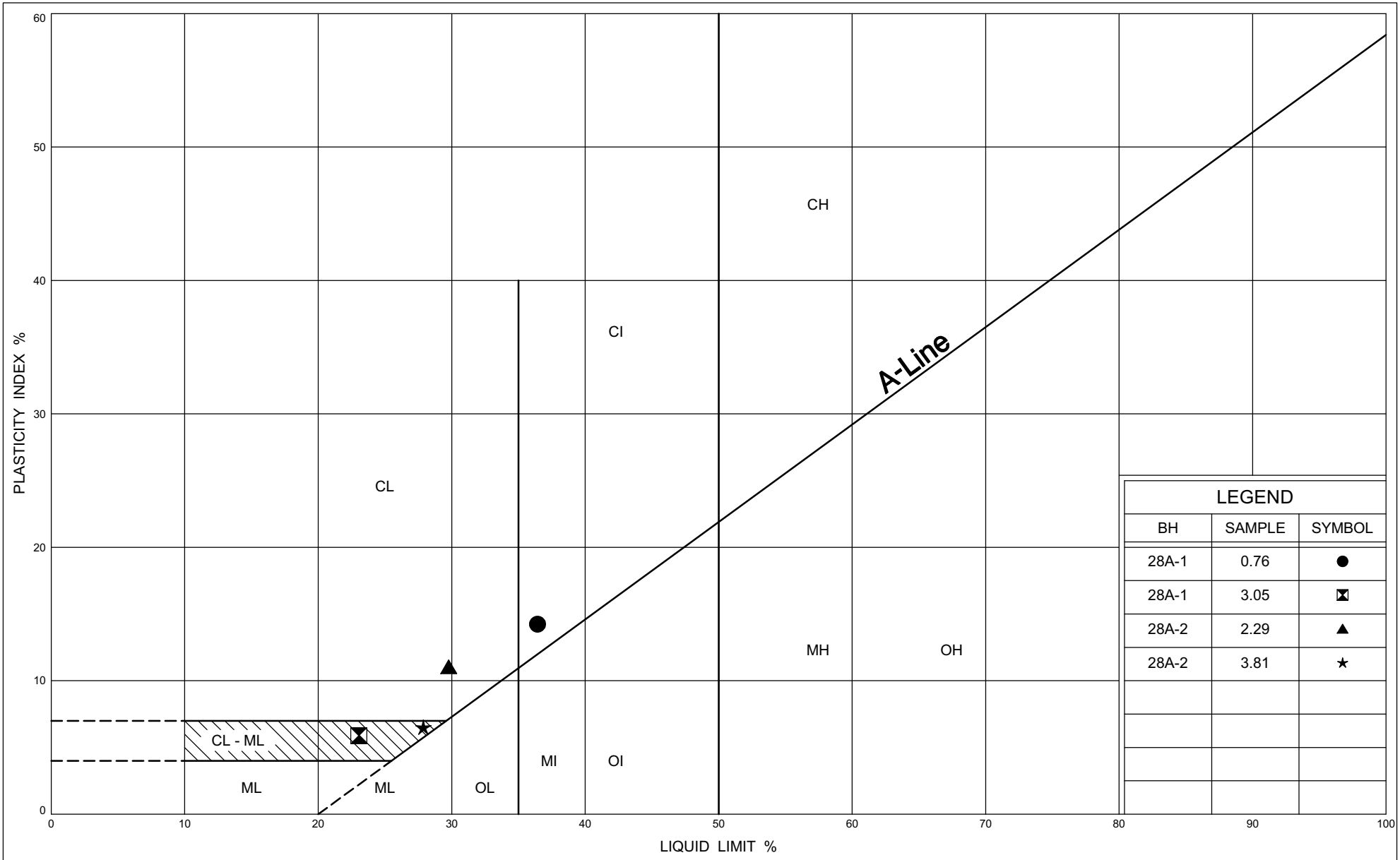
GRAIN SIZE DISTRIBUTION

SILTY CLAY TILL WITH FREQUENT SILT LAYERS
CI TO CL TO CL-ML

FIG No C- 28A.3

GWP 57-00-00

HWY 26, Thornbury to Meaford



LEGEND		
BH	SAMPLE	SYMBOL
28A-1	0.76	●
28A-1	3.05	⊠
28A-2	2.29	▲
28A-2	3.81	★

Ministry of Transportation
Ontario

PLASTICITY CHART

SILTY CLAY TILL WITH FREQUENT SILT LAYERS
CI TO CL TO CL-ML

FIG No C- 28A.4

GWP 57-00-00

HWY 26, Thornbury to Meaford

ONTARIO MOT PLASTICITY CHART SMALL CULVE 07-6-IEG1.GPJ ONTARIO MOT.GDT 04/12/09

RECORD OF BOREHOLE No 29A-1 1 OF 1 METRIC

W.P. GWP 57-00-00 LOCATION HWY 26, Thornbury to Meaford Northing - 4936826, Easting - 228172 ORIGINATED BY JL

DIST Owen Sound HWY 26 BOREHOLE TYPE S/S Augering, 110 mm dia. COMPILED BY JL

DATUM Geodetic DATE 07.23.07 - 07.23.07 CHECKED BY EC

ELEV / DEPTH	DESCRIPTION	STRAT PLOT	SAMPLES NUMBER	TYPE	"N" VALUES	GROUND WATER CONDITIONS	ELEVATION SCALE	PENETR. RESISTANCE STANDARD ● DYN. CONE 20 40 60 80 100 / SHEAR STRENGTH kPa ○ UNCONFINED ● QUICK TRIAXIAL + FIELD VANE × LAB VANE 20 40 60 80 100	PLASTIC LIMIT w_P / NATURAL MOISTURE CONTENT w / LIQUID LIMIT w_L / WATER CONTENT (%) 10 20 30	UNIT WEIGHT γ kN/m³	REMARKS & GRAIN SIZE DISTRIBUTION (%) GR SA SI CL
193.58	Ground										
0.00	300 mm Organic TOPSOIL										
	Brown		1	SPT	11		193			22.2	
			2	SPT	19		192			22.2	0 2 67 31 (98)
	Silty CLAY, CL Moist to wet, very stiff to firm, silt to sand silt layers.		3	SPT	6		191			20.9	
			4	SPT	8						
	Grey			VANE			190	+ 1.2			
			5	SPT	6						0 0 63 36 (100)
188.63			6	SPT	11		189			24.8	
4.95			7	SPT	61		188				10 31 40 20 (59)
	Sandy Clayey SILT TILL, CL-ML Grey, moist, stiff to hard, embedded sand and gravel.		8	SPT	42		187				
			9	SPT	60						
			10	SPT	53		186			24.6	
185.50											
8.08	End of Borehole.										Borehole dry and open @ completion.

$+^{3}$, $\times^{3}$: Numbers refer to Sensitivity

$\circ^{150}$ UNCONFINE SHEAR STRENGTH INFERRED FROM POCKET PENETROMETER READINGS

RECORD OF BOREHOLE No 29A-2 1 OF 1 METRIC

W.P. GWP 57-00-00 LOCATION HWY 26, Thornbury to Meaford Northing - 4936831, Easting - 228178 ORIGINATED BY JL

DIST Owen Sound HWY 26 BOREHOLE TYPE S/S Augering, 110 mm dia. COMPILED BY JL

DATUM Geodetic DATE 07.23.07 - 07.23.07 CHECKED BY EC

ELEV / DEPTH	DESCRIPTION	STRAT PLOT	SAMPLES NUMBER	TYPE	"N" VALUES	GROUND WATER CONDITIONS	UNIT WEIGHT γ kN/m³	REMARKS & GRAIN SIZE DISTRIBUTION (%) GR SA SI CL
194.52	Ground							
0.00	350 mm sand and gravel FILL.							
	FILL Dark brown, moist, loose, consisting of silty clay, trace organics.		1	SPT	7			
			2	SPT	7			1 18 52 29 (81)
192.54								
1.98	Buried TOPSOIL							
192.23								
2.29			3	SPT	15			
			4	SPT	10		23.6	
	Brown							
	Silty CLAY, CL Moist to wet, very stiff to firm, silt to sand silt layers.		5	SPT	7		24.3	
				VANE	1.5			
			6	SPT	5			0 1 59 39 (99)
	Grey		7	SPT	8			1 1 74 25 (98)
188.42						▽		Water level measured @ 6 m @ completion.
6.10			8	SPT	20			
			9	SPT	71			
	Sandy Clayey SILT TILL, CL-ML Grey, moist, stiff to hard, embedded sand and gravel.							
			10	SPT	100+			
			11	SPT	90		25.5	
185.68								
8.84	End of Borehole.							

PENETR. RESISTANCE STANDARD ● DYN. CONE — 20 40 60 80 100

SHEAR STRENGTH kPa — ○ UNCONFINED + FIELD VANE ● QUICK TRIAXIAL × LAB VANE — 20 40 60 80 100

PLASTIC LIMIT w_P NATURAL MOISTURE CONTENT w LIQUID LIMIT w_L

WATER CONTENT (%) — 10 20 30

ELEVATION SCALE: 194, 193, 192, 191, 190, 189, 188, 187, 186

$+^3$, $\times^3$: Numbers refer to Sensitivity

$\circ^{150}$ UNCONFINE SHEAR STRENGTH INFERRED FROM POCKET PENETROMETER READINGS

RECORD OF BOREHOLE No 29A-2A 1 OF 1 METRIC

W.P. GWP 57-00-00 LOCATION HWY 26, Thornbury to Meaford Northing - 4936831, Easting - 228179 ORIGINATED BY JL

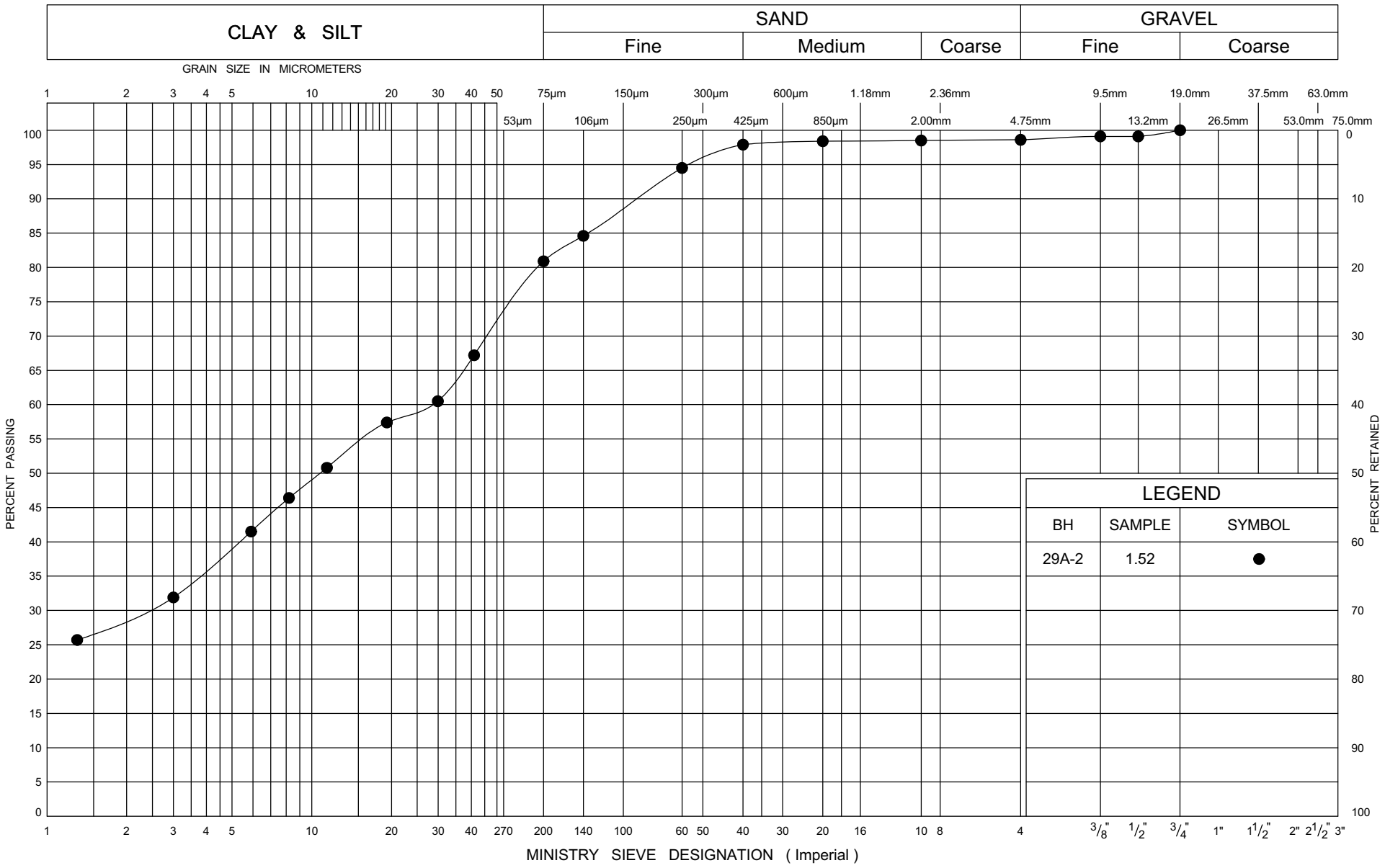
DIST Owen Sound HWY 26 BOREHOLE TYPE S/S Augering, 110 mm dia. COMPILED BY JL

DATUM Geodetic DATE 08.29.07 - 08.29.07 CHECKED BY EC

ELEV / DEPTH	DESCRIPTION	STRAT PLOT	SAMPLES: NUMBER	SAMPLES: TYPE	SAMPLES: "N" VALUES	GROUND WATER CONDITIONS	ELEVATION SCALE	PENETR. RESISTANCE: STANDARD ● DYN. CONE (20 40 60 80 100); SHEAR STRENGTH kPa: ○ UNCONFINED ● QUICK TRIAXIAL + FIELD VANE × LAB VANE (20 40 60 80 100)	PLASTIC LIMIT w_P / NATURAL MOISTURE CONTENT w / LIQUID LIMIT w_L; WATER CONTENT (%) (10 20 30)	UNIT WEIGHT γ kN/m³	REMARKS & GRAIN SIZE DISTRIBUTION (%) GR SA SI CL
194.52	Ground										
0.00	Refer to Borehole 29A-2		1	SH			194	× 4	○		Moved 1m east of Borehole 29A-2. Auger with no sampling to 3 m. for vane testing and shelby sampling.
				VANE			193				
				SH			192				Sample sent to TROW for consolidation testing.
				VANE			191	+ 2	○		
				SH			190	× 3	○	17.2	sample likely disturbed.
188.58							189				
5.94	End of Borehole due toshelby sampler refusal.							>>	1.45		Cannot advance shelby any further. Borehole dry and open @ completion.

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

UNIFIED SOIL CLASSIFICATION SYSTEM



Ministry of Transportation
Ontario

GRAIN SIZE DISTRIBUTION

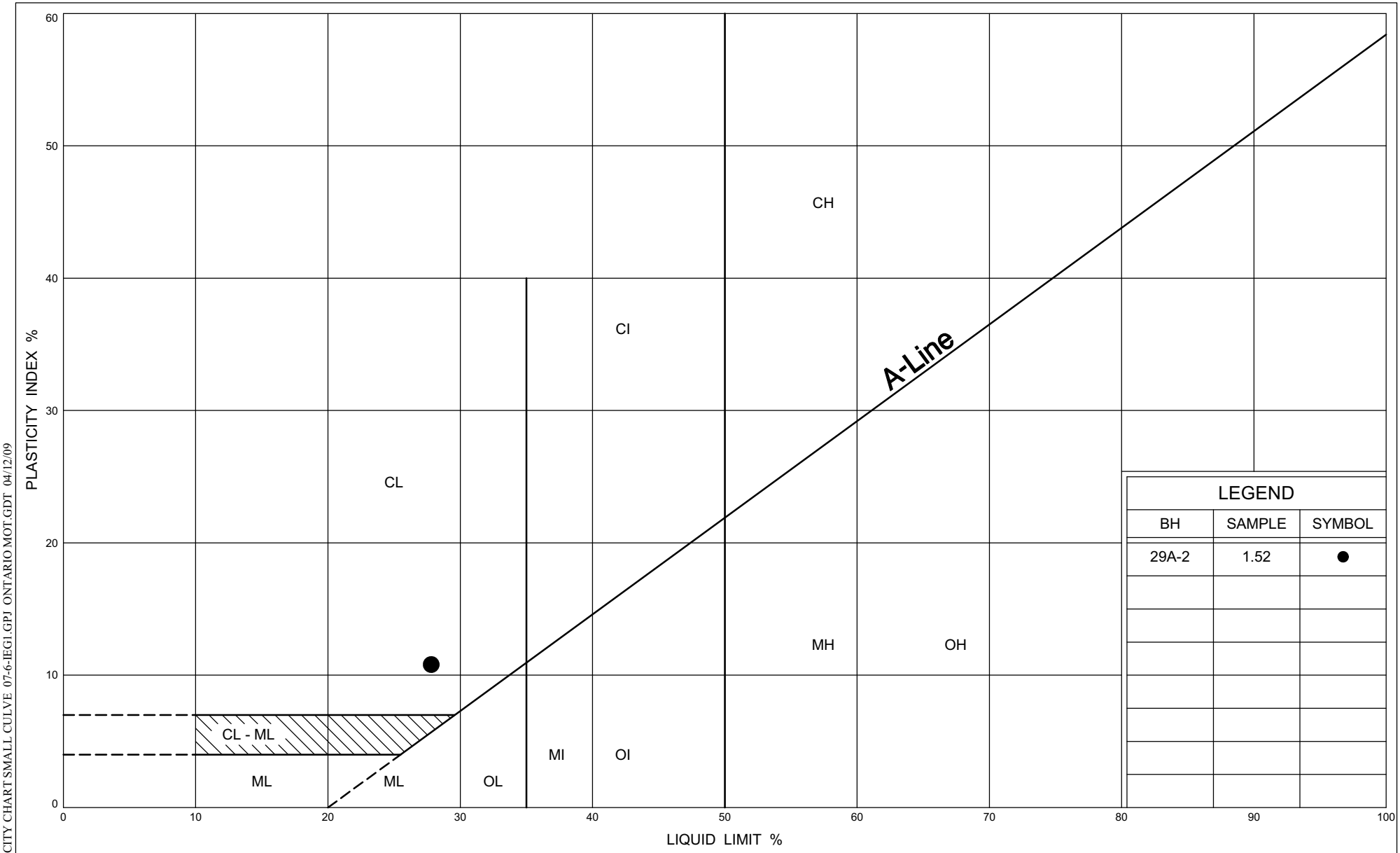
FILL

FIG No C- 29A.1

GWP 57-00-00

HWY 26, Thornbury to Meaford

Oct 75, FF - S - 21



ONTARIO MOT PLASTICITY CHART SMALL CULVE 07-6-IEG1.GPJ ONTARIO MOT.GDT 04/12/09

Ministry of Transportation
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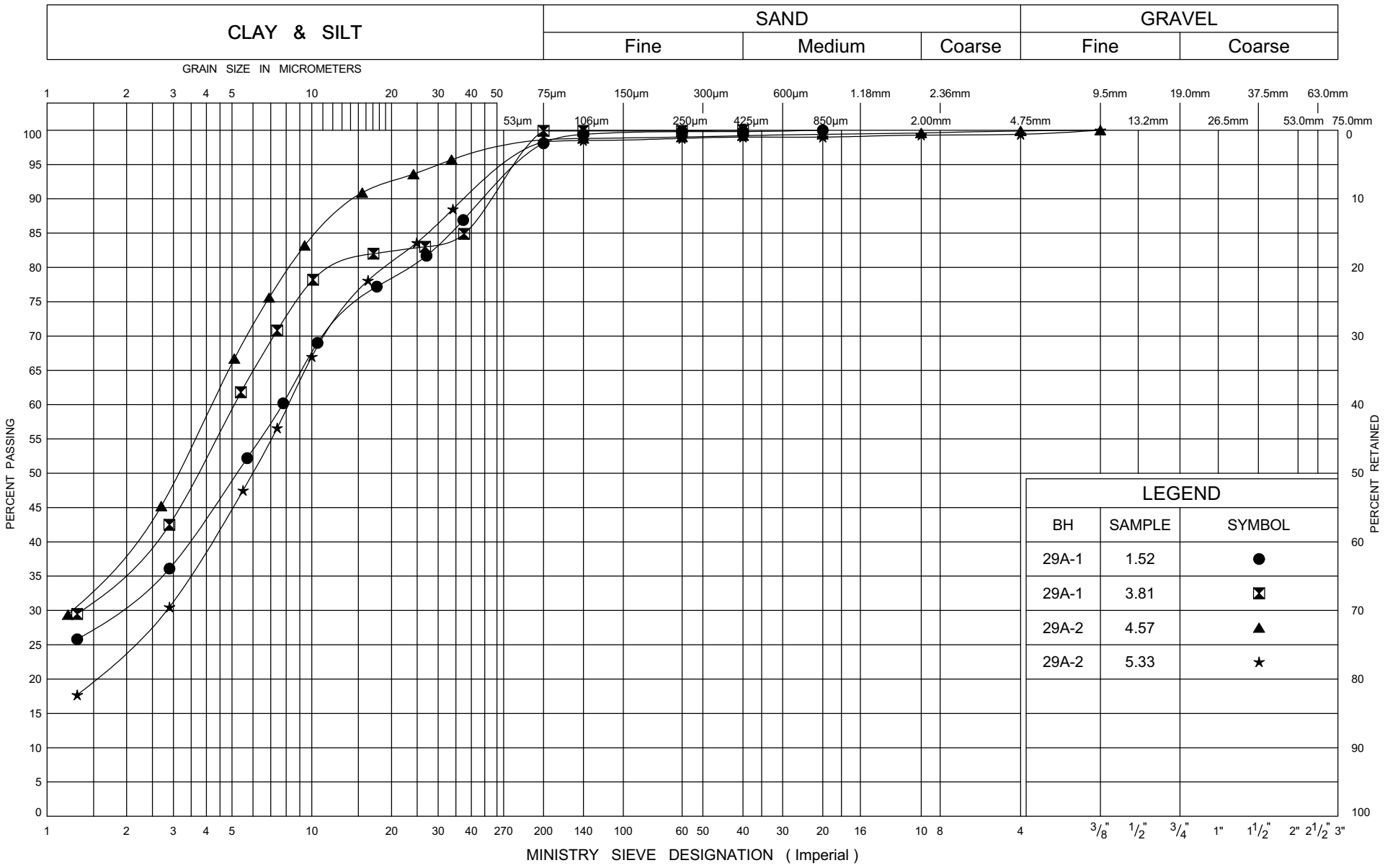
PLASTICITY CHART
FILL

FIG No C- 29A.2

GWP 57-00-00

HWY 26, Thornbury to Meaford

UNIFIED SOIL CLASSIFICATION SYSTEM



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GRAIN SIZE DISTRIBUTION

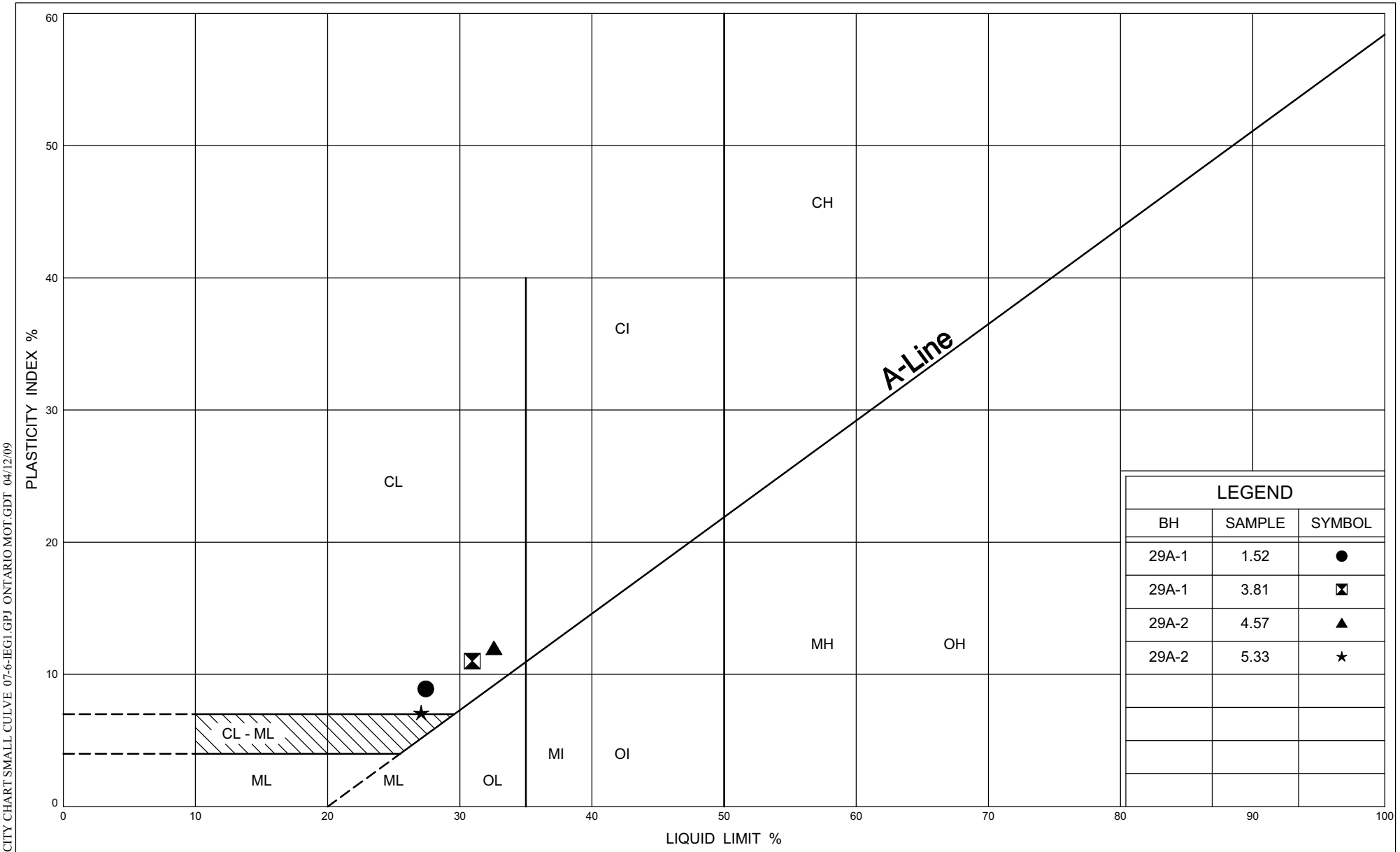
SILTY CLAY, CL

FIG No C- 29A.3

GWP 57-00-00

HWY 26, Thornbury to Meaford

Oct 75, FF - S - 21



LEGEND		
BH	SAMPLE	SYMBOL
29A-1	1.52	●
29A-1	3.81	⊠
29A-2	4.57	▲
29A-2	5.33	★

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PLASTICITY CHART
SILTY CLAY, CL

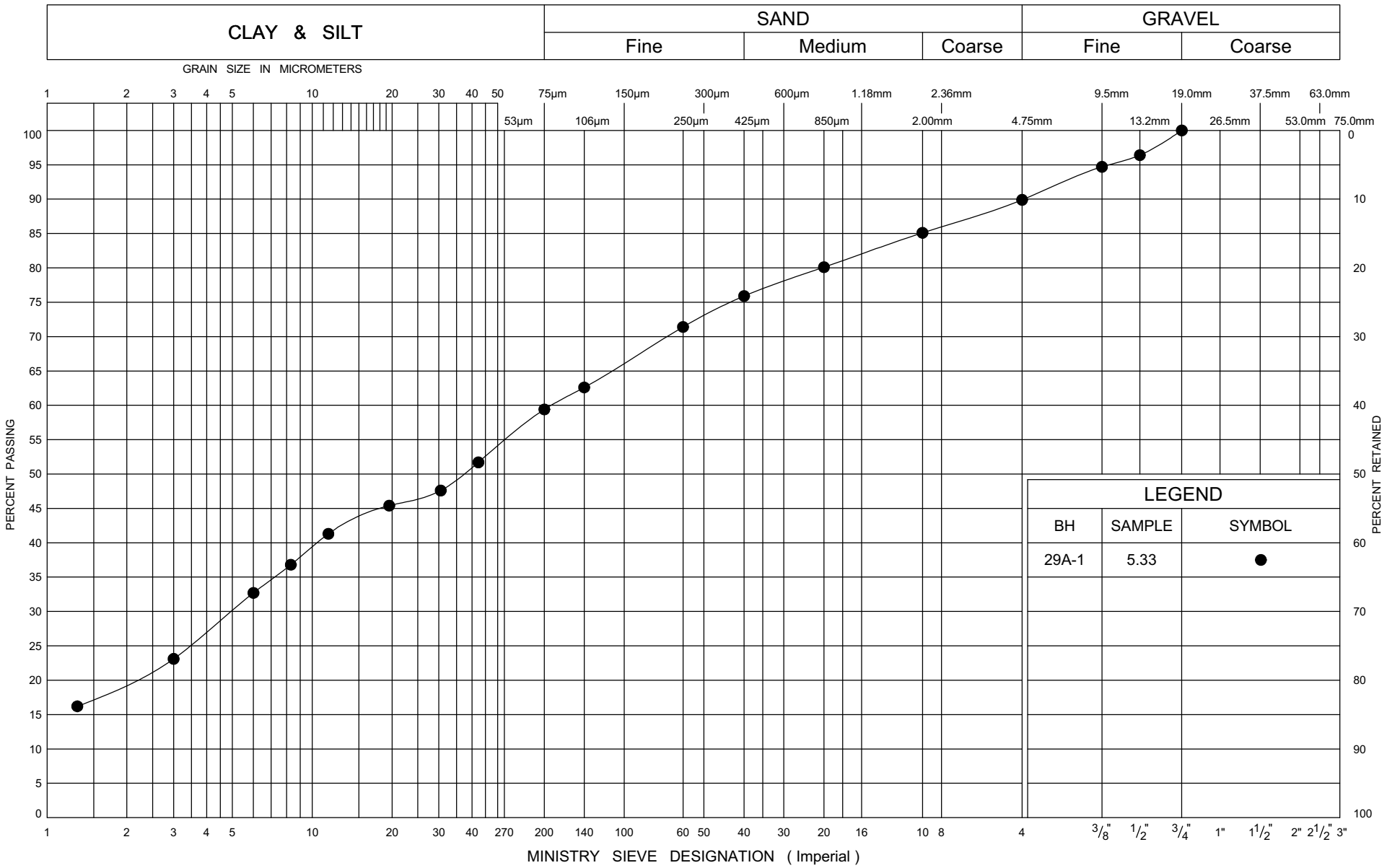
FIG No C- 29A.4

GWP 57-00-00

HWY 26, Thornbury to Meaford

ONTARIO MOT PLASTICITY CHART SMALL CULVE 07-6-IEG1.GPJ ONTARIO MOT.GDT 04/12/09

UNIFIED SOIL CLASSIFICATION SYSTEM



ONTARIO MOT GRAIN SIZE SMALL CULVERTS 07-6-IEG1.GPJ ONTARIO MOT.GDT 04/12/09

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Ontario

GRAIN SIZE DISTRIBUTION

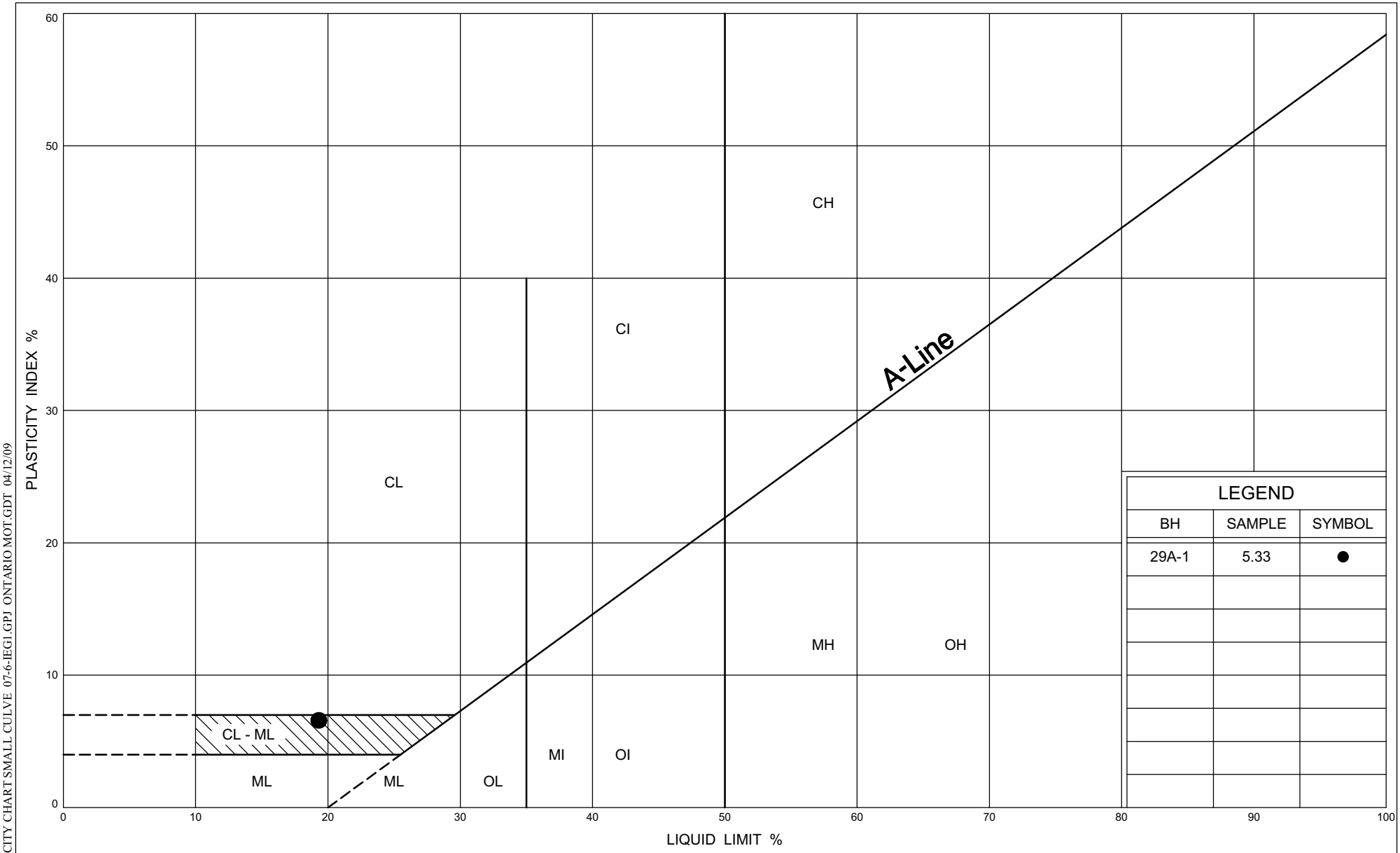
SANDY CLAYEY SILT TILL, CL-ML

FIG No C- 29A.5

GWP 57-00-00

HWY 26, Thornbury to Meaford

Oct 75, FF - S - 21



LEGEND		
BH	SAMPLE	SYMBOL
29A-1	5.33	●

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PLASTICITY CHART

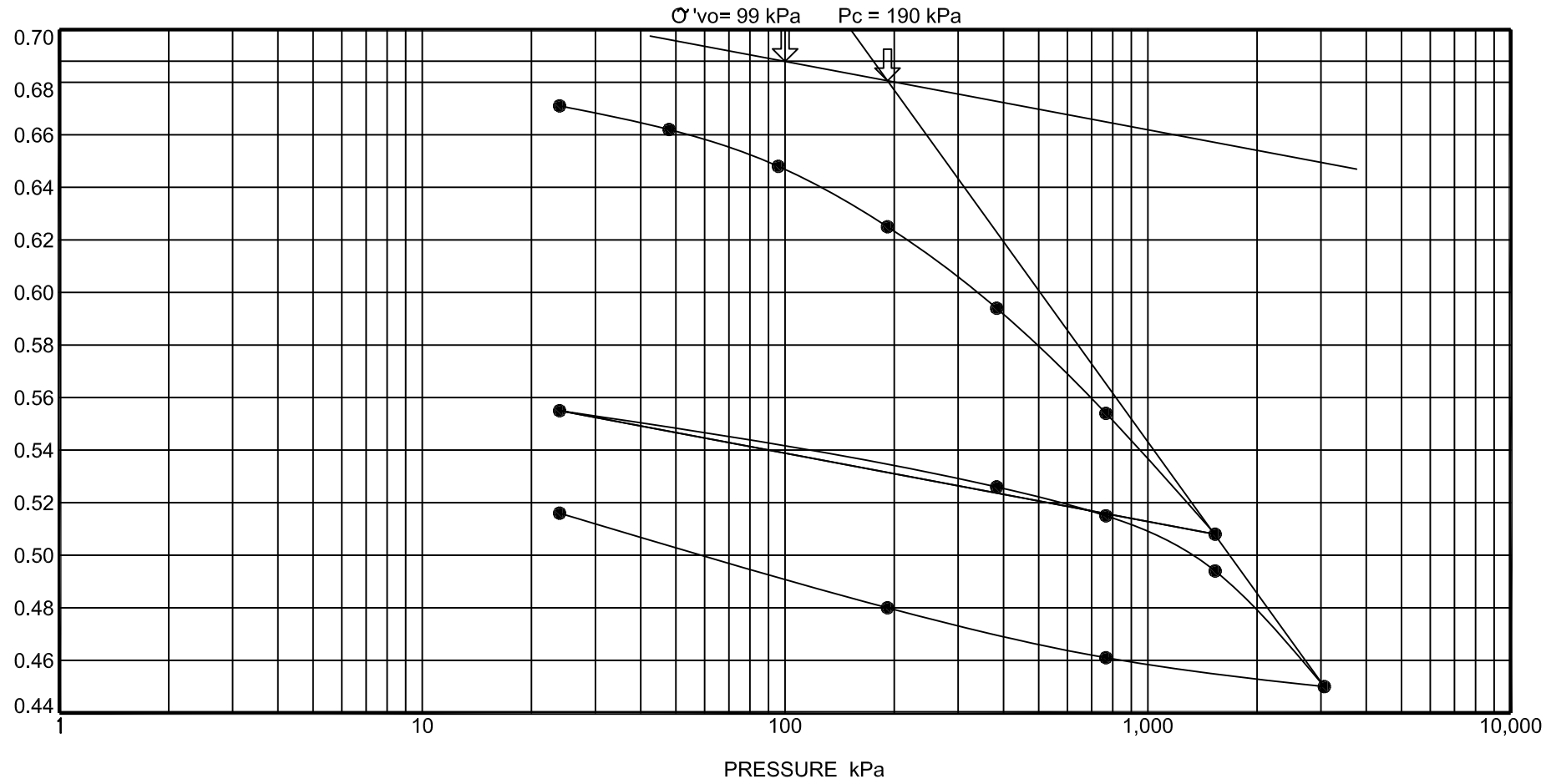
SANDY CLAYEY SILT TILL, CL-ML

FIG No C- 29A.6

GWP 57-00-00

HWY 26, Thornbury to Meaford

ONTARIO MOT PLASTICITY CHART SMALL CULVE 07-6-IEG1.GPJ ONTARIO MOT.GDT 04/12/09



	B H	DEPTH	ELEV.	WL	WP	W	Cc	Cr	Ơ'vo	γ_d	Classification
●	29A-2A	4.57	189.95	31	20	28	0.192	0.026	99	17.2	CL

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VOID RATIO - PRESSURE CURVE

FIG No C-29A.7
GWP 57-00-00
HWY 26, Thornbuy to Meaford

Appendix C

Site Photographs

Station 23+476 – Looking downstream (north)

Station 23+476 – Downstream end (north)

Station 23+476 – Looking upstream (south)

Station 23+476 – Upstream end (south)

Station 24+527 – Looking downstream (north)

Station 24+527 – Looking upstream (south)

Station 24+527 – Downstream end (north)

Station 24+527 – Upstream end (south)

Station 25+720 – Looking downstream (north)

Station 25+720 – Looking upstream (south)

Station 25+720 – Downstream end (north)

Station 25+720 – Upstream end (south)

Station 26+027 – Looking downstream (north)

Station 26+027 – Downstream end (north)

Station 26+027 – Looking upstream (south)

Station 26+027 – Upstream end (south)

Station 26+371 – Looking downstream (north)

Station 26+371 – Looking upstream (south)

Station 26+371 – Downstream end (north)

Station 26+371 – Upstream end (south)

Station 26+606 – Looking downstream (north)

Station 26+606 – Looking upstream (south)

Station 26+606– Downstream end (north)

Station 26+606 – Upstream end (south)

Station 26+874 – Looking downstream (north)

Station 26+874 – Looking upstream (south)

Station 26+874 – Downstream end (north)

Station 26+874 – Upstream end (south)

Station 27+293 – Looking downstream (north)

Station 27+293 – Downstream end (north)

Station 27+293 – Looking upstream (south)

Station 27+293 – Upstream end (south)

Station 27+500 – Looking downstream (north)

Station 27+500 – Downstream end (north)

Station 27+500 – Looking upstream (south)

Station 27+500 – Upstream end (south)

Station 27+868 – Looking downstream (north)

Station 27+868 – Downstream end (north)

Station 27+868 – Looking upstream (south)

Station 27+868 – Upstream end (south)

Station 28+126 – Looking downstream (north)

Station 28+126 – Looking upstream (south)

Station 28+126 – Downstream end (north)

Station 28+126 – Upstream end (south)

Station 28+292 – Looking downstream (north)

Station 28+292 – Downstream end (north)

Station 28+292 – Looking upstream (south)

Station 28+292 – Upstream end (south)

Station 28+402 – Looking downstream (north)

Station 28+402 – Downstream end (north)

Station 28+402 – Looking Upstream (south)

Station 28+402 – Upstream end (south)

Station 28+672 – Looking downstream (north)

Station 28+672 – Downstream end (north)

Station 28+672 – Looking upstream (south)

Station 28+672 – Upstream end (south)

Station 10+548 – Looking downstream (north)

Station 10+548 –Downstream end (north)

Station 10+548 – Looking upstream (south)

Station 10+548 – Upstream end (south)

Culvert 28A - STA 13+862, South Side

Culvert 29A - STA 14+160, south side

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.