

Report

Foundation Investigation and
Design Report
Proposed Noise Barrier Wall
Sta . 13+900 to 14+375
Highway 402
City of Sarnia, Ontario
District - London
G.W.P. 3038-03-00

STANTEC CONSULTING LTD.

PROJECT NO. 1012607
GEOCRES NO. 40J16-81

REPORT NO. 1012607

REPORT TO **Stantec Consulting Limited**
 1400 Rymal Road
 Hamilton, Ontario

FOR **Foundation Investigation and Design**
 Report

ON **Proposed Noise Barrier Wall**
 Sta. 13+900 to 14+375
 Highway 402
 City of Sarnia, Ontario
 G.W.P. 3038-03-00
 District – London
 GEOCRES NO. 40J16-81

November 7, 2008

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Table of Contents

FOUNDATION INVESTIGATION REPORT	1
1.0 INTRODUCTION.....	1
2.0 SITE DESCRIPTION.....	1
3.0 PHYSIOGRAPHY	2
4.0 SCOPE OF WORK	2
5.0 INVESTIGATION PROCEDURES.....	3
5.1 Field Program.....	3
5.2 Survey	3
5.3 Laboratory Testing	3
6.0 RESULTS OF THE INVESTIGATION	4
6.1 Subsurface Conditions	4
6.2 Soil	4
6.2.1 Asphalt	4
6.2.2 Sand and Gravel Fill	4
6.2.3 Silty Clay Fill.....	4
6.2.4 Silty Sand Fill.....	5
6.2.5 Native Sand (SM)	5
6.2.6 Silty Sand (SP-SM).....	6
6.2.7 Silty Clay (CL)	6
6.3 Borehole Cave and Groundwater Conditions.....	7
7.0 CLOSURE.....	8
FOUNDATION DESIGN REPORT	9
8.0 DISCUSSION.....	9
8.1 General	9
8.2 Proposed Development	9
8.3 Subsurface Conditions	10
9.0 RECOMMENDATIONS	10
9.1 Soil Parameters.....	10
9.2 Cast-In-Place Concrete Caissons.....	12
9.2.1 Design Approach.....	12
9.2.2 Lateral Deflections.....	12
9.3 Frost Considerations	12
9.4 Soil Profile Type and Seismic Forces	13
10.0 CONSTRUCTION RECOMMENDATIONS.....	13
10.1 Caisson Installation	13
10.2 Open Cut Excavations.....	13
10.3 Staging.....	13



10.4 Groundwater	13
11.0 CLOSURE.....	14

List of Appendices

APPENDIX A Borehole Location Plans	
APPENDIX B Terms and Symbols used On the Record of Borehole Sheet	
Record of Borehole Sheet	
APPENDIX C Geotechnical Laboratory Test Results	



FOUNDATION INVESTIGATION REPORT

**Proposed Noise Barrier Wall
Sta 13+900 to 14+375
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G.W.P. 3038-03-00
District – London**

1.0 INTRODUCTION

Jacques Whitford Limited (Jacques Whitford) was retained by Stantec Consulting Ltd. to complete a Foundation Investigation and Design Report for a proposed noise barrier wall to be located on the north side of Highway 402 between Stations (Sta.) 13+900 and 14+375 in the City of Sarnia, Ontario (W.P. No. 3038-03-00).

The work was carried out under Agreement No. 3005-E-0029 and in general accordance with the Subconsultant Agreement dated May 24, 2006. Authorization to proceed with the investigation was provided by Mr. David Emery, P.Eng., of Stantec Consulting Ltd., the prime consultant on this detailed design assignment.

The scope of work for the foundation investigation is incorporated within Stantec's project, which forms part of the above noted subconsultant agreement.

This foundation investigation report has been prepared specifically and solely for the project described herein. It contains the factual results of foundation investigation and laboratory testing.

2.0 SITE DESCRIPTION

The investigation is for a proposed noise barrier wall that will be located on the north side of Highway 402, east of Murphy Road, from approximately Sta. 13+900 to Sta. 14+375 in the City of Sarnia, Ontario.

Highway 402 is generally oriented in an east-west direction with two east bound and two west bound lanes. The highway is generally a semi-urban freeway with partially paved shoulders and a wide grass covered centre median. The highway is generally about 2 m to 3 m higher than the grade of the adjacent lands and 6 m to 9 m higher than the adjacent lands at overpasses.

Drainage is provided by ditches along the sides and in the central median of the highway. The ditches are sloped towards catch basins located along the existing highway. Regional drainage is towards the St. Clair River located approximately 4 km to the west of the noise barrier wall location.



3.0 PHYSIOGRAPHY

Based on the physiography of Southern Ontario by Chapman and Putnam (1984), this section of Highway 402 is situated in the physiographic region known as the Huron Fringe, a narrow geological strip between Lake Huron and the adjacent St. Clair Clay Plains. The Huron Fringe is composed mainly of surficial sands, silts and gravels, underlain by lacustrine clayey silt and silty clay.

The bedrock in the area consists of laminated, thinly bedded shale that is black to grey in colour and is of the Kettle Point Formation.

4.0 SCOPE OF WORK

The scope of work for the investigation was as follows:

- To investigate the soil and groundwater conditions along the length of the proposed noise barrier wall location by advancing a total of 7 boreholes (on the right shoulder) as outlined in the following table, and as shown on Drawings 1 and 2 in **Appendix A**.

Borehole Number	Borehole Location by Station	Borehole Offset from Centreline of Highway Median
08-2	14+370	19 m Lt
08-3	14+276	19 m Lt
08-4	14+206	20 m Lt
08-5	14+126	19 m Lt
08-6	14+098	25 m Lt
08-7	14+059	18 m Lt
08-8	13+978	21 m Lt
08-9	13+900	21 m Lt

- To conduct a laboratory testing program on selected samples of the soil obtained from the investigation; and,
- To prepare a Foundation Investigation and a Foundation Investigation and Design Report.

It is noted that Boreholes 08-1 and 08-6 were advanced to investigate the subsurface conditions for overhead sign support foundations. The factual results of Borehole 08-6 have been included in this report as they are within the study area. The factual results of Borehole 08-1 are provided under separate cover.



5.0 INVESTIGATION PROCEDURES

5.1 Field Program

Prior to commencing the investigation, the borehole locations were established in the field by Jacques Whitford personnel. The borehole locations were cleared of underground utilities by the various public utility companies.

Freeway traffic control during the drilling program was provided by On Track Safety Limited (OTS), using signs, traffic barrels and blocker vehicles, in accordance with the Ontario Traffic Manual (OTM) Book 7 Temporary Conditions.

The field investigation was carried out on August 7 and 8, 2008. The 8 boreholes (08-2 to 08-9) were advanced at the locations identified previously in this report and shown on the drawings provided in **Appendix A**.

The boreholes were advanced on the right shoulder of the highway to depths of approximately 6.6 m below existing grade using a truck mounted drill rig equipped with 150 mm diameter (outside diameter), solid-stem augers, supplied and operated by London Soils Inc. licensed under MOE Reg. 903 to install and decommission monitoring wells. Soil samples were recovered from the boreholes at regular intervals using a 50 mm Outside Diameter split-spoon sampler by conducting Standard Penetration Tests (SPTs) in general accordance with the procedures outlined in the ASTM specification D1586.

Jacques Whitford field personnel recorded the conditions encountered in the boreholes at the time of the investigation. Soils were described in accordance with the MTO Soils Classification System.

The groundwater levels, where encountered, were measured in the boreholes during and on completion of drilling. The boreholes were backfilled on completion of drilling in accordance with Ontario Ministry of the Environment Regulation 903.

All soil samples recovered from the boreholes were placed in moisture-proof bags and transported to our laboratory for detailed classification and testing as required.

The subsurface conditions encountered in the boreholes are summarized on the Record of Borehole sheets in **Appendix B**. Additional comments are provided in the subsequent sections of this report.

5.2 Survey

The borehole locations were established in the field by Jacques Whitford personal by measuring from existing site features with a known station reference. Borehole locations and offsets are referenced to the stations established for the Highway 402 median centreline.

The ground surface elevations at the respective borehole locations were inferred from drawings provided by Stantec Consulting Limited. It is understood that the drawing elevations are referenced to a Geodetic datum.

5.3 Laboratory Testing

All samples transported to the laboratory were subjected to detailed visual examination and classification. Approximately 25% of the soil samples were submitted for routine testing including grain



size distribution, Atterberg Limits and moisture content determination testing. The laboratory results are provided on the Record of Borehole sheets in **Appendix B**. The results of the grain size analyses and Atterberg Limits tests are shown on Figure Nos. 1 to 6 in **Appendix C**.

Unless requested in advance, all samples will be stored in our laboratory for a period of twelve months from the issue date of this report.

6.0 RESULTS OF THE INVESTIGATION

6.1 Subsurface Conditions

The subsurface conditions encountered in the boreholes are summarized on the Record of Borehole sheets provided in **Appendix B**. An explanation of the terms used on the Record of Borehole sheets is provided in **Appendix B**.

A summary of the soil and groundwater conditions encountered in the boreholes is provided below.

6.2 Soil

6.2.1 Asphalt

Asphalt was encountered at the ground surface in all boreholes and was approximately 150 mm thick.

6.2.2 Sand and Gravel Fill

Sand and gravel fill was encountered under the asphalt in all boreholes. The thickness of the sand and gravel ranged from approximately 0.6 m to 1.3 m.

The sand and gravel fill was generally moist and contained varying amounts of silt (trace to some).

Based on observations during drilling and the N-Values obtained from one Standard Penetration Test (SPT), the compactness of the sand and gravel fill was assessed to be compact.

Laboratory testing conducted on the one sample obtained consisted of moisture content testing. The test result was follows:

- Moisture Content:
 - 14%

The results of the moisture content test are provided on the Record of Borehole sheets in **Appendix B**.

6.2.3 Silty Clay Fill

Silty clay fill was encountered underlying the sand and gravel fill in Borehole 08-2 to 08-7 at depths of approximately 0.8 m (elevations of approximately 182.8 m to 188.2 m). The thickness of the silty clay fill ranged from approximately 0.7 m to 2.2 m.

The silty clay fill was generally moist and contained trace to some sand and trace gravel.



Based on the N-Value obtained from the SPT's, the consistency of the silty clay fill was assessed to be firm to hard.

Laboratory testing conducted on selected samples consisted of moisture content tests, two grain size distribution tests and a single Atterberg Limits test. The test results were as follows:

- Moisture Content:
 - 8% to 15%
- Grain Size Distribution:
 - 1% and 1% gravel;
 - 19% and 23% sand;
 - 43% and 37% silt; and,
 - 37% and 39% clay.
- Atterberg Limits:
 - Liquid Limit: 28%
 - Plastic Limit: 14%
 - Plasticity Index: 14%

The results of the moisture content, grain size distribution and Atterberg Limits tests, are provided on the Record of Borehole sheets in **Appendix B**.

The results of the grain size distribution tests are provided on Figure 1 in **Appendix C**. The results of the Atterberg Limits tests are provided on Figure 2 in **Appendix C**.

6.2.4 Silty Sand Fill

A layer of silty sand fill was encountered underlying the sand and gravel fill in Borehole 08-8 at a depth of approximately 0.8 m, (an elevation of approximately 182.2 m). The thickness of the silty sand fill was approximately 0.7 m.

The silty sand fill was generally moist and contained trace gravel and clay.

Based on the N-Value obtained from a single SPT, the compactness of the silty sand fill was assessed to be compact.

6.2.5 Native Sand (SM)

A deposit of native sand was encountered in underlying the fill in Borehole 08-7 at a depth of approximately 2.3 m (an elevation of approximately 181.3 m) below existing grade. The thickness of the sand stratum was approximately 3.8 m.

The sand was generally moist to wet and contained trace fines (silt and clay).

Based on the N-Values obtained from the SPTs, the compactness of the sand was assessed to be loose to compact.

Laboratory testing conducted on selected samples consisted of moisture content tests and a single grain size distribution test. The test results were as follows:

- Moisture Contents:



- 19% to 23%
- Grain Size Distribution:
 - 0% gravel;
 - 94% sand; and,
 - 6% fines (silt and clay).

The results of the moisture content tests and grain size distribution tests are provided on the Record of Borehole sheets in **Appendix B**.

The results of the grain size distribution tests are also provided on Figure 3 in **Appendix C**.

6.2.6 Silty Sand (SP-SM)

Silty sand was encountered underlying the fill in Boreholes 08-6, 08-8 and 08-9 and underlying the silty clay (described below) in Boreholes 08-5. The silty sand was encountered in these boreholes at depths of approximately 1.5 to 4.6 m below existing grade (elevations of approximately 180.2 m to 181.4 m). The thickness of the silty sand ranged from approximately 1.6 m to 3.1 m. Borehole 08-5 was terminated in the silty sand layer at a depth of approximately 6.6 m below existing grade (an elevation of approximately 178.2 m).

The silty sand was generally wet to saturated and contained trace to some clay and trace gravel.

Based on the N-Values obtained from the SPT's, the compactness of the silty sand was assessed to be very loose to compact.

Laboratory testing conducted on selected samples consisted of moisture content tests and a single grain size distribution test. The test results were as follows:

- Moisture Content:
 - 17% to 28%
- Grain Size Distribution:
 - 0% gravel;
 - 43% sand;
 - 47% silt; and,
 - 10% clay.

The results of the moisture content tests and grain size distribution test are provided on the Record of Borehole sheets in **Appendix B**.

The results of the grain size distribution test are also provided on Figure 4 in **Appendix C**.

6.2.7 Silty Clay (CL)

Silty clay was encountered underlying the fill, sand, and silty sand in all boreholes. The silty clay was encountered at depths in the range of approximately 1.5 m to 6.1 m below existing grade (elevations of approximately 177.5 m to 186.4 m). Boreholes 08-2 to 08-4 and 08-6 to 08-9 were terminated in the silty clay at a depth of approximately 6.6 m below existing grade (elevations of approximately 176.2 m to 182.4 m).



The silty clay was generally moist to damp and generally contained some sand and trace gravel. The possible presence of cobbles and boulders was inferred in Borehole 08-2.

Based on the N-Values obtained from the SPTs, the consistency of the silty clay was assessed to be stiff to very hard, but was more typically stiff to very stiff.

Laboratory testing conducted on selected samples consisted of moisture content tests and two grain size distribution and Atterberg Limits tests. The test results were as follows:

- Moisture Content:
 - 11% to 18%
- Grain Size Distribution:
 - 1% gravel;
 - 23% and 24% sand;
 - 38% and 43% silt; and,
 - 33% and 36% clay
- Atterberg Limits:
 - Liquid Limit: 25% and 29%
 - Plastic Limit: 13% and 14%
 - Plasticity Index: 12% and 15%

The results of the moisture content, grain size distribution and Atterberg Limits tests, are provided on the Record of Borehole sheets in **Appendix B**.

The results of the grain size distribution tests are provided on Figure 5 in **Appendix C**. The results of the Atterberg Limits tests are provided on Figure 6.

6.3 Borehole Cave and Groundwater Conditions

The following table outlines the cave and groundwater conditions encountered during drilling:

Borehole	Cave on completion of drilling		Groundwater conditions on completion of drilling	
	Depth (m)	Elevation (m)	Depth (m)	Elevation (m)
08-2	Open	-	Dry	-
08-3	Open	-	Dry	-
08-4	Open	-	Dry	-
08-5	4.4	180.3	4.3	180.4
08-6	3.4	180.9	3.4	180.9
08-7	3.4	180.2	3.4	180.2
08-8	2.4	180.6	2.4	180.6
08-9	2.4	180.4	2.4	180.4

It is noted that the groundwater conditions reported were based on measurements obtained during and immediately after drilling and may therefore not be representative of the equilibrated groundwater level. In addition, the levels noted are subject to seasonal fluctuations and in response to weather events.

7.0 CLOSURE

A soil investigation is a limited sampling of a site. The information provided herein was obtained at specific borehole locations and can only be extrapolated to an undefined limited area around the borehole locations. The extent of the limited area depends on the variability of the soil and groundwater conditions as influenced by geological processes, as well as the history of the site reflecting natural conditions, construction activities and site use. Should any conditions at the site be encountered which differ from those at the borehole locations, we request that we be notified immediately in order to assess the additional information.

We trust the above information meets with your present requirements. Should you have any questions or require further information, please do not hesitate to contact us at your convenience.

Regards,

JACQUES WHITFORD LIMITED

Original Signed by

Geoffrey Creer, P.Eng.
Geotechnical Engineer

Original Signed by

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FOUNDATION DESIGN REPORT

**Proposed Noise Barrier Wall
Sta 13+900 to 14+375
Highway 402
City of Sarnia, Ontario
G.W.P. 3038-03-00
District – London**

8.0 DISCUSSION

8.1 General

Highway 402 is generally oriented in an east-west direction with two east bound and two west bound lanes. The highway is generally a semi-urban freeway with partially paved shoulders and a wide grass covered centre median. The highway is generally about 2 m to 3 m higher than the grade of the adjacent lands and 6 m to 9 m higher than the adjacent lands at overpasses.

Drainage is provided by ditches along the sides and in the central median of the Highway. The ditches are sloped towards catch basins located along the existing highway. Regional drainage is towards the St. Clair River located approximately 4 km to the west of the noise barrier wall location.

8.2 Proposed Development

The Ministry of Transportation (MTO) is proposing to widen and upgrade this section of Highway 402 from the Blue Water International Bridge property east to Indian Road, a total distance of approximately 3.1 km (Sta. 10+500 to Sta. 13+600). The widening work will include construction of two additional westbound lanes.

The planned development will also include the construction of a noise barrier wall on the north side of the highway just east of the Murphy Road underpass, between Sta. 13+900 and Sta. 14+375.

It is understood that the noise barrier wall will likely consist of H-section vertical posts with steel, concrete, wood or composite panels spanning between the posts. The posts will be founded on drilled, cast-in-place concrete caissons. It is also understood that the wall will be approximately 5 m high.



8.3 Subsurface Conditions

The subsurface soil conditions encountered in the boreholes generally consisted of fill (comprised of sand and gravel, silty clay and silty sand fill) overlying strata of sand and silty sand and silty clay.

Boreholes 08-2 to 08-4 were open and dry on completion of drilling. Water was measured in Boreholes 08-5 to 08-9 at depths ranging from approximately 2.4 m to 4.4 m below existing grade (elevations of approximately 180.2 m to 180.9 m). Cave in was measured in Boreholes 08-5 to 08-9 at depths of approximately 2.4 to 4.4 m below existing grade (elevations of approximately 180.2 to 180.9 m).

9.0 RECOMMENDATIONS

The noise barrier wall should be designed and constructed in accordance with special provision SP599F01.

The following sections provide soil parameters and recommendations for the design of the noise barrier wall foundations.

9.1 Soil Parameters

The results of the field investigation and laboratory testing described herein have been used to estimate soil parameters for use in the design of the noise barrier wall foundations.

Soils at the site have been grouped as cohesive or non-cohesive and have been assigned values of undrained shear strength (C_u) or angle of internal friction (ϕ'), and bulk unit weight (γ). The Rankine passive earth pressure coefficients have been calculated based on the assigned angle of internal friction. The design parameters recommended for use on this project are shown in the table below. When using the table, the following should be considered:

- The soil parameters provided represent ultimate values and will need to be factored in accordance with the CHBDC.
- The unit weights provided are bulk unit weights. Below the groundwater table the submerged unit weights should be used, which can be obtained by subtracting 9.8 kN/m^3 from the bulk unit weights provided.
- The bulk unit weight for soils within the frost zone (1.2 m from the ground surface) may be presumed to be 20 kN/m^3 .

Borehole Location by Station Borehole Number	Depth (m)	Soil Type	Group	Compactness or Consistency	Unit Weight (kN/m ³)	Effective Friction Angle (degrees)	Rankine Passive Earth Pressure Coefficient	Undrained Shear Strength (kPa)
13+900 08-9	1.2 – 1.5	Sand and gravel fill	Non-cohesive	Compact	21	31	3.12	-
	1.5 – 4.6	Silty Sand	Non-cohesive	Compact to very loose	19	28	2.77	-
	4.6 – 6.6	Silty clay	Cohesive	Hard to very stiff	20	-	-	100
13+978 08-8	1.2 – 1.5	Silty sand fill	Non-cohesive	Compact	19	28	2.77	-
	1.5 – 4.6	Silty sand	Non-cohesive	Compact to loose	19	28	2.77	-
	4.6 – 6.6	Silty clay	Cohesive	Very stiff to stiff	20	-	-	75
14+059 08-7	1.2 – 2.3	Silty clay fill	Cohesive	Very stiff	20	-	-	75
	2.3 – 6.1	Sand	Non-cohesive	Compact to loose	19	30	3.00	-
	6.1 – 6.6	Silty clay	Cohesive	Very stiff	20	-	-	75
14+098 08-06	1.2 – 3	Silty clay	Cohesive	Very stiff	20	-	-	75
	3 – 4.6	Silty Sand	Non-cohesive	Dense	19	30	3.00	-
	4.6 – 6.6	Silty clay	Cohesive	Stiff to hard	20	-	-	100
14+126 08-5	1.2 – 2.1	Silty clay fill	Cohesive	Very stiff	20	-	-	75
	2.1 – 4.6	Silty clay	Cohesive	Very stiff	20	-	-	75
	4.6 – 6.6	Silty sand	Non-cohesive	Compact	19	28	2.77	-
14+206 08-4	1.2 – 1.5	Silty clay fill	Cohesive	Firm	19	-	-	50
	1.5 – 6.6	Silty clay	Cohesive	Hard to very stiff	20	-	-	100
14+276 08-3	1.2 – 1.5	Silty clay fill	Cohesive	Very stiff to hard	20	-	-	100
	1.5 – 6.6	Silty clay	Cohesive	Hard to very stiff	20	-	-	100
14+370 08-2	1.2 – 2.5	Silty clay fill	Cohesive	Hard to very stiff	20	-	-	100
	2.5 – 6.6	Silty clay	Cohesive	Hard to very stiff	20	-	-	100

Note: The parameters provided herein are only applicable to the drilled and sampled depth of the boreholes.



9.2 Cast-In-Place Concrete Caissons

9.2.1 Design Approach

The foundation must be designed to resist overturning moments caused by wind loads and should be designed in accordance with the CHBDC Section 6.13, and the method described by B. B. Broms in the following papers, using the parameters provided in Section 9.1 above.

- Broms, B. B. 1964, "Lateral Resistance of Piles in Cohesive Soils." J. of Soil Mech. And Found. Div., ASCE, vol. 90, SM2: 27-63.
- Broms, B. B. 1964, "Lateral Resistance of Piles in Cohesionless Soils." J. of Soil Mech. And Found. Div., ASCE, vol. 90, SM3: 123-156.
- Broms, B. B. 1965, "Design of Laterally Loaded Piles." J. of Soil Mech. And Found. Div., ASCE, vol. 91, SM3: 79-99.

For this site, the fill materials can be used in the calculations of lateral resistance as the N-values indicate that the materials were placed with compaction.

9.2.2 Lateral Deflections

The horizontal subgrade reaction may be calculated based on the procedures outlined in the Canadian Foundation Engineering Manual.

The coefficient of horizontal subgrade reaction that is used for deflection calculations may be estimated for cohesive soils as follows:

$$k_s = 67 C_u/d$$

Where k_s = the coefficient of horizontal subgrade reaction (pressure per length)

C_u = undrained shear strength of the soil = 50 kPa to 100 kPa for this application (see Table in Section 9.1)

d = caisson diameter

The coefficient of horizontal subgrade reaction that is used for deflection calculations for non-cohesive soils may be estimated as follows:

$$k_s = n_h(z/d)$$

Where k_s = the coefficient of horizontal subgrade reaction (pressure per length)

n_h = Coefficient related to soil density. This may be taken as 4,400 kN/m³ for compact sandy soils (Table 20.3, p. 315, of the Canadian Foundation Engineering Manual, 3rd Edition, 1992)

z = depth below grade (m)

d = caisson diameter (m)

9.3 Frost Considerations

The site is located in an area with a mean freezing index of between 250 and 500 Degree days (°Days), (Canadian Foundation Engineering Manual 2006). Based on Figure 3.4 of the MTO Pavement Design and Rehabilitation Manual, the frost penetration depth for this area is 1.2 m.



The material within the zone of frost penetration should not be included in the calculations of lateral resistance.

9.4 Soil Profile Type and Seismic Forces

The zonal acceleration ratio for the Sarnia area, as obtained from CHBDC (2006) Table A3.1.7., is 0.00.

It is recommended that Soil Profile IV as defined in CHBDC Section 4.4.6 be used in the seismic design of this site.

10.0 CONSTRUCTION RECOMMENDATIONS

10.1 Caisson Installation

Boreholes 08-2 to 08-4 were open and dry on completion of drilling. Water was measured in Boreholes 08-5 to 08-9 at depths ranging from approximately 2.4 m to 4.4 m below existing grade (elevations of approximately 180.2 m to 180.9 m). Cave in was measured in Boreholes 08-5 to 08-9 at depths of approximately 2.4 to 4.4 m below existing grade (elevations of approximately 180.2 to 180.9 m).

Given that cave-in and groundwater was measured in the boreholes and that wet and saturated silty sand and sands were encountered, it is recommended that a temporary liner be used to keep the caisson holes open.

All loose material should be removed from the base of the caisson prior to placement of the reinforcing steel cage (as required) and concrete. Inspection and approval of the caisson by the geotechnical consultant is recommended prior to installation of the reinforcing cage and placement of the concrete. Installation and inspection should be carried out in accordance with SP903S01.

On completion of the foundation installation it is recommended that the ground surface surrounding the noise barrier wall be graded to prevent surface water from ponding adjacent to the foundation.

10.2 Open Cut Excavations

Excavations and open trenches are not anticipated at this site.

10.3 Staging

Through discussions with representatives of Stantec Consulting, it is understood that the construction of the noise barrier wall will be incorporated into the widening construction and rehabilitation of the highway. Issues due to staging are not anticipated.

10.4 Groundwater

Boreholes 08-2 to 08-4 were dry on completion of drilling. Water was measured in Boreholes 08-5 to 08-9 at depths ranging from approximately 2.4 m to 4.4 m below existing grade (elevations of approximately 180.2 m to 180.9 m). Perched water conditions may be encountered anywhere through



the soil profiles, but are more likely to be encountered in the fill materials and native silty sand and sand soils.

Given the conditions encountered during the investigation, seepage should be expected. However, the seepage into caissons open for a relatively short period of time is anticipated to be readily handled by conventional pumping techniques.

11.0 CLOSURE

Use of this report is subject to the Statement of General Conditions attached. It is the responsibility of Stantec Consulting Limited and the Ministry of Transportation Ontario, who are identified as “the Client” within the Statement of General Conditions, and its agents to review the conditions and to notify Jacques Whitford Limited should any of these not be satisfied. The Statement of General Conditions addresses the following:

- Use of the report
- Basis of the report
- Standard of care
- Interpretation of site conditions
- Varying or unexpected site conditions
- Planning, design or construction

Regards,

JACQUES WHITFORD LIMITED

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Principal, and
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STATEMENT OF GENERAL CONDITIONS

USE OF THIS REPORT: This report has been prepared for the sole benefit of the Client or its agent and may not be used by any third party without the express written consent of Jacques Whitford Limited and the Client. Any use which a third party makes of this report is the responsibility of such third party.

BASIS OF THE REPORT: The information, opinions, and/or recommendations made in this report are in accordance with Jacques Whitford's present understanding of the site specific project as described by the Client. The applicability of these is restricted to the site conditions encountered at the time of the investigation or study. If the proposed site specific project differs or is modified from what is described in this report or if the site conditions are altered, this report is no longer valid unless Jacques Whitford is requested by the Client to review and revise the report to reflect the differing or modified project specifics and/or the altered site conditions.

STANDARD OF CARE: Preparation of this report, and all associated work, was carried out in accordance with the normally accepted standard of care in the state or province of execution for the specific professional service provided to the Client. No other warranty is made.

INTERPRETATION OF SITE CONDITIONS: Soil, rock, or other material descriptions, and statements regarding their condition, made in this report are based on site conditions encountered by Jacques Whitford at the time of the work and at the specific testing and/or sampling locations. Classifications and statements of condition have been made in accordance with normally accepted practices which are judgmental in nature; no specific description should be considered exact, but rather reflective of the anticipated material behavior. Extrapolation of in situ conditions can only be made to some limited extent beyond the sampling or test points. The extent depends on variability of the soil, rock and groundwater conditions as influenced by geological processes, construction activity, and site use.

VARYING OR UNEXPECTED CONDITIONS: Should any site or subsurface conditions be encountered that are different from those described in this report or encountered at the test locations, Jacques Whitford must be notified immediately to assess if the varying or unexpected conditions are substantial and if reassessments of the report conclusions or recommendations are required. Jacques Whitford will not be responsible to any party for damages incurred as a result of failing to notify Jacques Whitford that differing site or sub-surface conditions are present upon becoming aware of such conditions.

PLANNING, DESIGN, OR CONSTRUCTION: Development or design plans and specifications should be reviewed by Jacques Whitford, sufficiently ahead of initiating the next project stage (property acquisition, tender, construction, etc), to confirm that this report completely addresses the elaborated project specifics and that the contents of this report have been properly interpreted. Specialty quality assurance services (field observations and testing) during construction are a necessary part of the evaluation of sub-subsurface conditions and site preparation works. Site work relating to the recommendations included in this report should only be carried out in the presence of a qualified geotechnical engineer; Jacques Whitford cannot be responsible for site work carried out without being present.



Appendix A

Borehole Location Plans

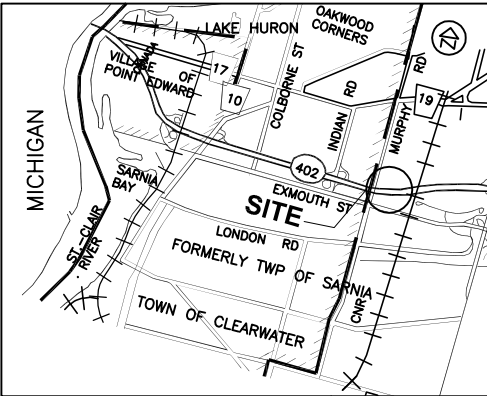
METRIC
DIMENSIONS ARE IN METRES
AND/OR MILLIMETRES
UNLESS OTHERWISE SHOWN

CONT. No.
WP No. 3038-03-00



BOREHOLE LOCATION PLAN
13+850 TO 14+400
PROPOSED NOISE BARRIER WALL
HIGHWAY 402,
SARNIA, ONTARIO

SHEET



LEGEND

BOREHOLE
(Jacques Whitford, 2008)

BH No.	ELEVATION (m)	STA.	OFF SET
08-2	188.9	14+370	19 m LT
08-3	187.7	14+276	19 m LT
08-4	186.4	14+206	20 m LT
08-5	184.7	14+126	19 m LT
08-6	184.3	14+098	25 m LT
08-7	183.6	14+059	18 m LT
08-8	182.9	13+978	21 m LT
08-9	182.8	13+900	21 m LT

0 m 100 m

Scale

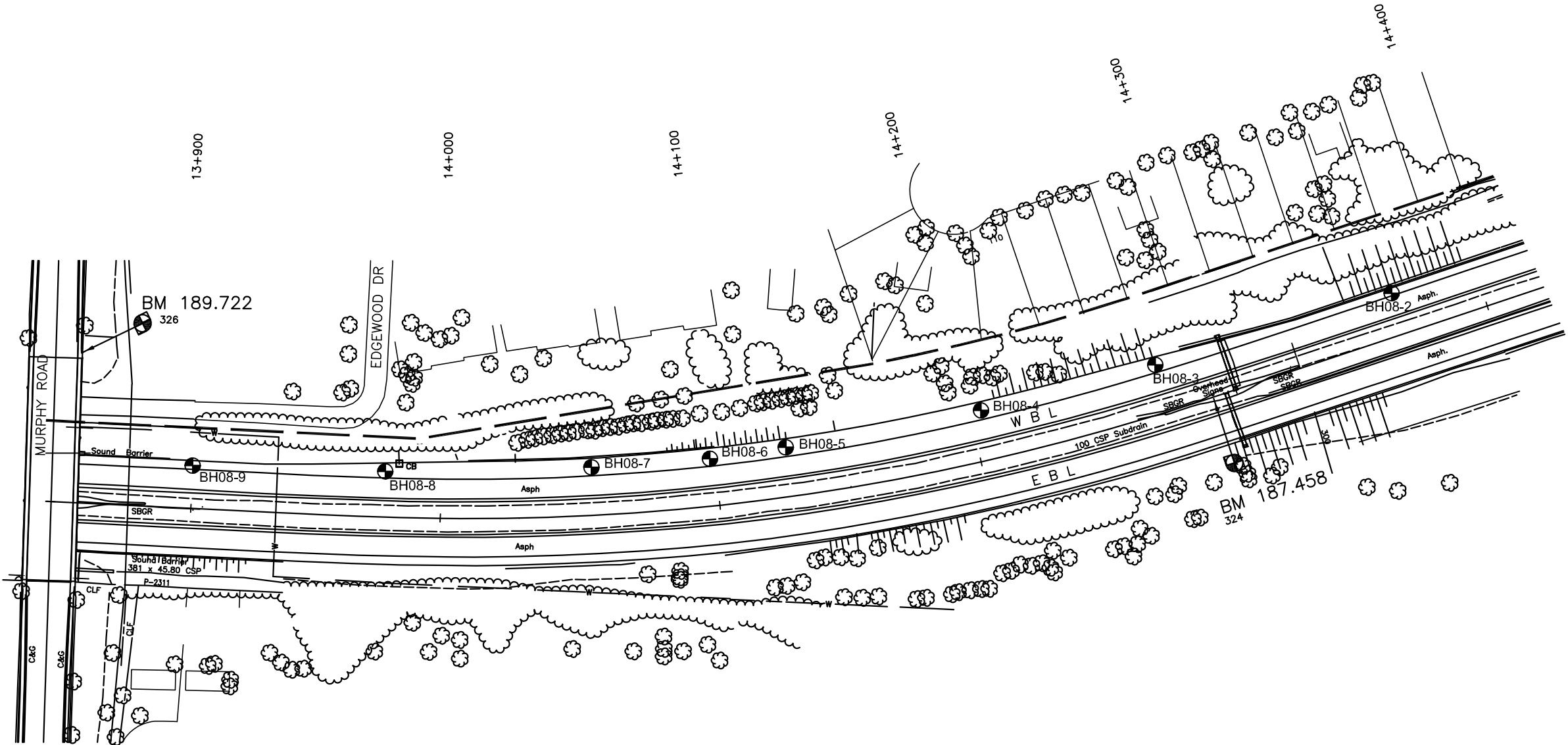
NOTE:
* Base Plan provided by Stantec Consulting.
* Borehole locations and site features shown are approximate and may vary from that shown.

NOTE: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 is specifically excluded in accordance with the conditions of Section 102-2 of Form 100.
2) This drawing is for subsurface information only. Surface details and features are for conceptual illustration.

REVISIONS	DATE	BY	DESCRIPTION
---	---	---	---

GEOGRES No 40 J16-81

HWY No 402	CHECKED	DATE 2008-10-29	DIST LONDON
SUBM'D GC	CHECKED	APPROVED	SITE -
DRAWN PC/HZ	CHECKED		DWG 1



Appendix B

Terms and Symbols Used on the Record of Borehole Sheet
Record of Borehole Sheet

EXPLANATION OF TERMS USED IN REPORT

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

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

SOILS ARE DESCRIBED BY THEIR COMPOSITION AND CONSISTENCY OR DENSENESS.

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

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

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

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

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

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

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

R Q D (%)	0 - 25	25 - 50	50 - 75	75 - 90	90 - 100
	VERY POOR	POOR	FAIR	GOOD	EXCELLENT

JOINTING AND BEDDING:

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

ABBREVIATIONS AND SYMBOLS

FIELD SAMPLING

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

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

RECORD OF BOREHOLE No 08-2

1 OF 1

METRIC

W.P. 3038-03-00 LOCATION Highway 402, Stn.: 14+370 o/s: 19 m Lt, Twp of Sarnia ORIGINATED BY OL
 DIST London HWY 402 BOREHOLE TYPE Solid Stem Auger, Split Spoon COMPILED BY OL
 DATUM Geodetic DATE 8.7.08 - 8.7.08 CHECKED BY GC

SOIL PROFILE			SAMPLES			GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT					PLASTIC LIMIT w _p	NATURAL MOISTURE CONTENT w	LIQUID LIMIT w _L	UNIT WEIGHT γ	REMARKS & GRAIN SIZE DISTRIBUTION (%)
ELEV DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE	"N" VALUES			SHEAR STRENGTH kPa									
188.9	Hwy 402 W.B. Rt. Shoulder						20	40	60	80	100						
188.8	150 mm ASPHALT																
0.2	SAND and GRAVEL (FILL), damp Brown																
188.2																	
0.8	Silty CLAY (FILL), trace to some sand, trace gravel, moist, hard to very stiff, brown		1	SS	36												
			2	SS	28												
186.4			3	SS	30												
2.5	Silty CLAY, trace to some sand, trace gravel, moist, hard to very stiff, brown (CL)		4	SS	29												
	- Augers Grinding on possible cobble or boulder		5	SS	50 / 150 mm												
	- Augers Grinding on possible cobble or boulder																
	- hard		6	SS	36												
182.4																	
6.6	END OF BOREHOLE at approximately 6.6 m Borehole open and dry on completion of drilling																

RECORD OF BOREHOLE No 08-3

1 OF 1

METRIC

W.P. 3038-03-00 LOCATION Highway 402, Stn.: 14+276 o/s: 19 m Lt, Twp of Sarnia ORIGINATED BY OL
 DIST London HWY 402 BOREHOLE TYPE Solid Stem Auger, Split Spoon COMPILED BY OL
 DATUM Geodetic DATE 8.7.08 - 8.7.08 CHECKED BY GC

SOIL PROFILE			SAMPLES			GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT					PLASTIC LIMIT w _p	NATURAL MOISTURE CONTENT w	LIQUID LIMIT w _L	UNIT WEIGHT γ	REMARKS & GRAIN SIZE DISTRIBUTION (%)	
ELEV DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE	"N" VALUES			SHEAR STRENGTH kPa										WATER CONTENT (%)
187.7	Hwy 402 W.B. Rt. Shoulder						187										GR SA SI CL	
187.6	150 mm ASPHALT		1	AS	--													
0.2	SAND and GRAVEL (FILL), damp Brown																	
186.9			2	SS	23													
0.8	Silty CLAY (FILL), trace to some gravel and sand, moist, very stiff to hard, brown																	
186.1			3	SS	24													
1.5	Silty CLAY, some sand and trace gravel, moist, very stiff to hard, brown (CL)																	
			4	SS	33	185												
	- very stiff		5	SS	20													
			6	SS	24	183												
						182												
181.1			7	SS	28											1 23 43 33		
6.6	END OF BOREHOLE at approximately 6.6 m Borehole open and dry on completion of drilling																	

RECORD OF BOREHOLE No 08-4

1 OF 1

METRIC

W.P. 3038-03-00 LOCATION Highway 402, Stn.: 14+206 o/s: 20 m Lt, Twp of Sarnia ORIGINATED BY OL
 DIST London HWY 402 BOREHOLE TYPE Solid Stem Auger, Split Spoon COMPILED BY OL
 DATUM Geodetic DATE 8.7.08 - 8.7.08 CHECKED BY GC

SOIL PROFILE			SAMPLES			GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT		PLASTIC LIMIT NATURAL MOISTURE CONTENT LIQUID LIMIT			UNIT WEIGHT γ kN/m³	REMARKS & GRAIN SIZE DISTRIBUTION (%)
ELEV DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE	"N" VALUES			SHEAR STRENGTH kPa		w _p	w	w _L		
186.4	Hwy 402 W.B. Rt. Shoulder							20	40	60	80	100		
186.0	150 mm ASPHALT							20	40	60	80	100		
0.2	SAND and GRAVEL (FILL), damp Brown						186							
185.6														
0.8	Silty CLAY (FILL), some sand, trace gravel, moist, firm, brown		1	SS	6		185							
184.8														
1.5	Silty CLAY, some sand, trace gravel, moist to damp, very stiff to hard, brown (CL)		2	SS	25		185							
			3	SS	34		184							
			4	SS	21		183							
							182							
			5	SS	26		181							
							180							
179.8			6	SS	19									
6.6	END OF BOREHOLE at approximately 6.6 m Borehole open and dry on completion of drilling													

RECORD OF BOREHOLE No 08-5

1 OF 1

METRIC

W.P. 3038-03-00 LOCATION Highway 402, Stn.: 14+126 o/s: 19 m Lt, Twp of Sarnia ORIGINATED BY OL
 DIST London HWY 402 BOREHOLE TYPE Solid Stem Auger, Split Spoon COMPILED BY OL
 DATUM Geodetic DATE 8.7.08 - 8.7.08 CHECKED BY GC

SOIL PROFILE			SAMPLES			GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT				PLASTIC LIMIT w _p	NATURAL MOISTURE CONTENT w	LIQUID LIMIT w _L	UNIT WEIGHT γ kN/m ³	REMARKS & GRAIN SIZE DISTRIBUTION (%) GR SA SI CL	
ELEV DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE	"N" VALUES			SHEAR STRENGTH kPa									
<div>○ UNCONFINED ✕ FIELD VANE ● QUICK TRIAXIAL ✕ LAB VANE</div> <div>20 40 60 80 100 10 20 30</div>																	
184.7	Hwy 402 W.B. Rt. Shoulder					▽	184										
184.6	150 mm ASPHALT																
0.2	SAND and GRAVEL (FILL), damp, brown		1	AS	-												
184.0																	
0.8	Silty CLAY (FILL), some sand, trace to some gravel, moist, very stiff, brown		2	SS	15												
			3	SS	15												
182.6							183										
2.1	Silty CLAY, some sand, trace gravel, moist, very stiff, brown (CL)		4	SS	18		182										
	- stiff - moist to wet		5	SS	12												
							181										
180.2			6	SS	12		180										
4.6	Silty SAND, wet, compact, grey (SP-SM)																
							179										
	- saturated		7	SS	17												
178.2																	
6.6	END OF BOREHOLE at approximately 6.6 m Borehole caved to a depth of approximately 4.4 m (Elev. 180.3 m) below existing grade on completion of drilling Groundwater measured in caved borehole at a depth of approximately 4.3 m (Elev. 180.4 m) below existing grade on completion of drilling																

RECORD OF BOREHOLE No 08-6

1 OF 1

METRIC

W.P. 3038-03-00 LOCATION Highway 402, Stn.: 14+098 o/s: 25 m Lt, Twp of Sarnia ORIGINATED BY OL
 DIST London HWY 402 BOREHOLE TYPE Solid Stem Auger, Split Spoon COMPILED BY OL
 DATUM Geodetic DATE 8.7.08 - 8.7.08 CHECKED BY GC

SOIL PROFILE			SAMPLES			GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT			PLASTIC LIMIT w _p	NATURAL MOISTURE CONTENT w	LIQUID LIMIT w _L	UNIT WEIGHT γ	REMARKS & GRAIN SIZE DISTRIBUTION (%)	
ELEV DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE	"N" VALUES			SHEAR STRENGTH kPa								WATER CONTENT (%)
184.3	Hwy 402 W.B. Rt. Shoulder					▽										
180.0	150 mm ASPHALT															
0.2	SAND and GRAVEL (FILL), damp, brown															
183.5	Silty CLAY (FILL), trace to some gravel, very stiff, damp, brown (CL)		1	SS	17											
0.8			2	SS	26											
			3	SS	16											
181.2	Silty SAND, trace gravel, dense, wet, grey (SM)		4	SS	35											
3.0																
179.7	Silty CLAY, moist to wet, stiff to hard, grey (CL)		5	SS	9											
4.6																
177.7			6	SS	35											
6.6	END OF BOREHOLE at approximately 6.6 m Borehole caved to a depth of approximately 3.4 m (Elev. 180.9 m) below existing grade on completion of drilling Groundwater measured in caved borehole at a depth of approximately 3.4 m (Elev. 180.9 m) below existing grade on completion of drilling															

RECORD OF BOREHOLE No 08-7

1 OF 1

METRIC

W.P. 3038-03-00 LOCATION Highway 402, Stn.: 14+059 o/s: 18 m Lt, Twp of Sarnia ORIGINATED BY OL
 DIST London HWY 402 BOREHOLE TYPE Solid Stem Auger, Split Spoon COMPILED BY OL
 DATUM Geodetic DATE 8.7.08 - 8.7.08 CHECKED BY GC

SOIL PROFILE			SAMPLES			GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT		PLASTIC LIMIT NATURAL MOISTURE CONTENT LIQUID LIMIT			UNIT WEIGHT γ	REMARKS & GRAIN SIZE DISTRIBUTION (%)			
ELEV DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE	"N" VALUES			SHEAR STRENGTH kPa		WATER CONTENT (%)							
183.6	Hwy 402 W.B. Rt. Shoulder					▽							183	GR SA SI CL			
183.0	150 mm ASPHALT														182		
0.2	SAND and GRAVEL (FILL), damp, brown																
182.8	Silty CLAY (FILL), some sand, trace gravel, very stiff, moist, grey		1	SS	16												
0.8			2	SS	24												
181.3	SAND, trace silt, compact to loose, moist, grey (SM) - trace topsoil in upper 200 mm		3	SS	18												
			4	SS	16												
				5	SS	9											
177.5																	
6.1	Silty CLAY, some sand, trace gravel, very stiff, moist, grey (CL)		6	SS	16												
177.0																	
6.6	END OF BOREHOLE at approximately 6.6 m																
	Borehole caved to a depth of approximately 3.4 m (Elev. 180.2 m) on completion of drilling																
	Groundwater measured in caved borehole at a depth of approximately 3.4 m (Elev. 180.2 m) below existing grade on completion of drilling																

RECORD OF BOREHOLE No 08-8

1 OF 1

METRIC

W.P. 3038-03-00 LOCATION Highway 402, Stn.: 13+978 o/s: 21 m Lt, Twp of Sarnia ORIGINATED BY OL
 DIST London HWY 402 BOREHOLE TYPE Solid Stem Auger, Split Spoon COMPILED BY OL
 DATUM Geodetic DATE 8.7.08 - 8.7.08 CHECKED BY GC

SOIL PROFILE			SAMPLES			GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT					PLASTIC LIMIT w _p	NATURAL MOISTURE CONTENT w	LIQUID LIMIT w _L	UNIT WEIGHT γ kN/m ³	REMARKS & GRAIN SIZE DISTRIBUTION (%)
ELEV DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE	"N" VALUES			SHEAR STRENGTH kPa									
182.9	Hwy 402 W.B. Rt. Shoulder							20	40	60	80	100					
180.6	150 mm ASPHALT							20	40	60	80	100					
0.2	SAND and GRAVEL (FILL), damp, brown																
182.2							182										
0.8	Silty SAND (FILL), trace to some gravel and clay, compact, moist, brown		1	SS	19												
181.4																	
1.5	Silty SAND, trace clay, compact to loose, moist, brown (SP-SM)		2	SS	17		181										
			3	SS	14		180										
			4	SS	7		179										
178.4																	
4.6	Silty CLAY, some sand, trace gravel, very stiff to stiff, moist to wet, grey (CL)		5	SS	25		178										
							177										
176.4			6	SS	12												
6.6	END OF BOREHOLE at approximately 6.6 m Borehole caved to a depth of approximately 2.4 m (Elev. 180.6 m) below existing grade on completion of drilling Groundwater measured in caved borehole at a depth of approximately 2.4 m (Elev. 180.6 m) below existing grade on completion of drilling																

RECORD OF BOREHOLE No 08-9

1 OF 1

METRIC

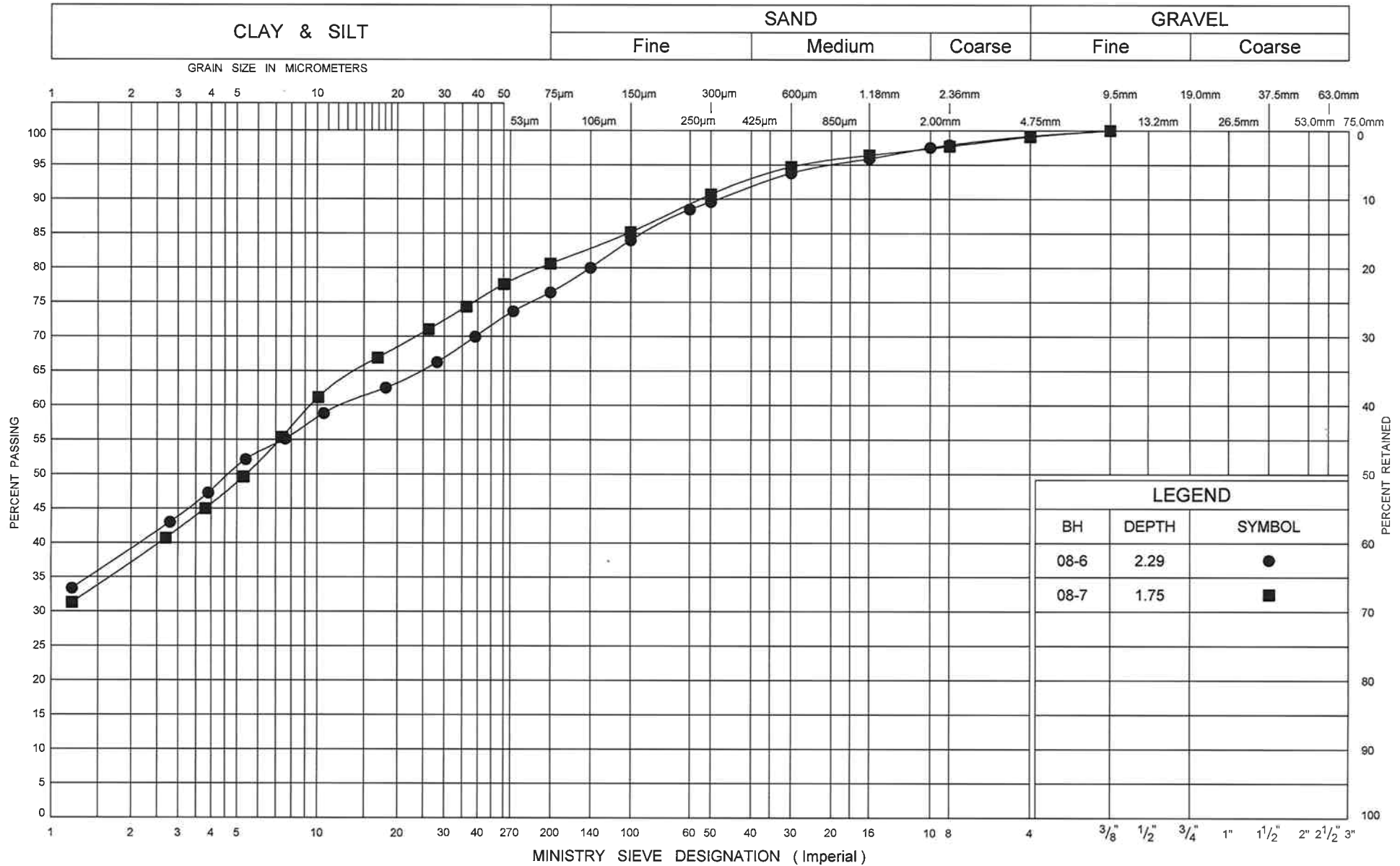
W.P. 3038-03-00 LOCATION Highway 402, Stn.: 13+900 o/s: 21 m Lt, Twp of Sarnia ORIGINATED BY OL
 DIST London HWY 402 BOREHOLE TYPE Solid Stem Auger, Split Spoon COMPILED BY OL
 DATUM Geodetic DATE 8.8.08 - 8.8.08 CHECKED BY GC

SOIL PROFILE			SAMPLES			GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT					PLASTIC LIMIT W _p	NATURAL MOISTURE CONTENT W	LIQUID LIMIT W _L	UNIT WEIGHT γ	REMARKS & GRAIN SIZE DISTRIBUTION (%)
ELEV DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE	"N" VALUES			SHEAR STRENGTH kPa									
182.8	Hwy 402 W.B. Rt. Shoulder							20	40	60	80	100					
180.6	150 mm ASPHALT							20	40	60	80	100					
0.2	SAND and GRAVEL (FILL), damp, brown																
181.2			1	SS	17		182										
1.5	Silty SAND, trace to some clay, compact to very loose, moist, brown (SP-SM)		2	SS	11		181										
			3	SS	8		180										
	- wet		4	SS	2		179										
178.2																	
4.6	Silty CLAY, some sand, trace gravel, hard to very stiff, moist, grey (CL)		5	SS	34		178										
176.2			6	SS	19		177										
6.6	END OF BOREHOLE at approximately 6.6 m Borehole caved to a depth of approximately 2.4 m (Elev. 180.4 m) below existing grade on completion of drilling Groundwater measured in caved borehole at a depth of approximately 2.4 m (Elev. 180.4 m) below existing grade on completion of drilling																

Appendix C

Geotechnical Laboratory Test Results

UNIFIED SOIL CLASSIFICATION SYSTEM



GRAIN SIZE DISTRIBUTION

Silty Clay Fill

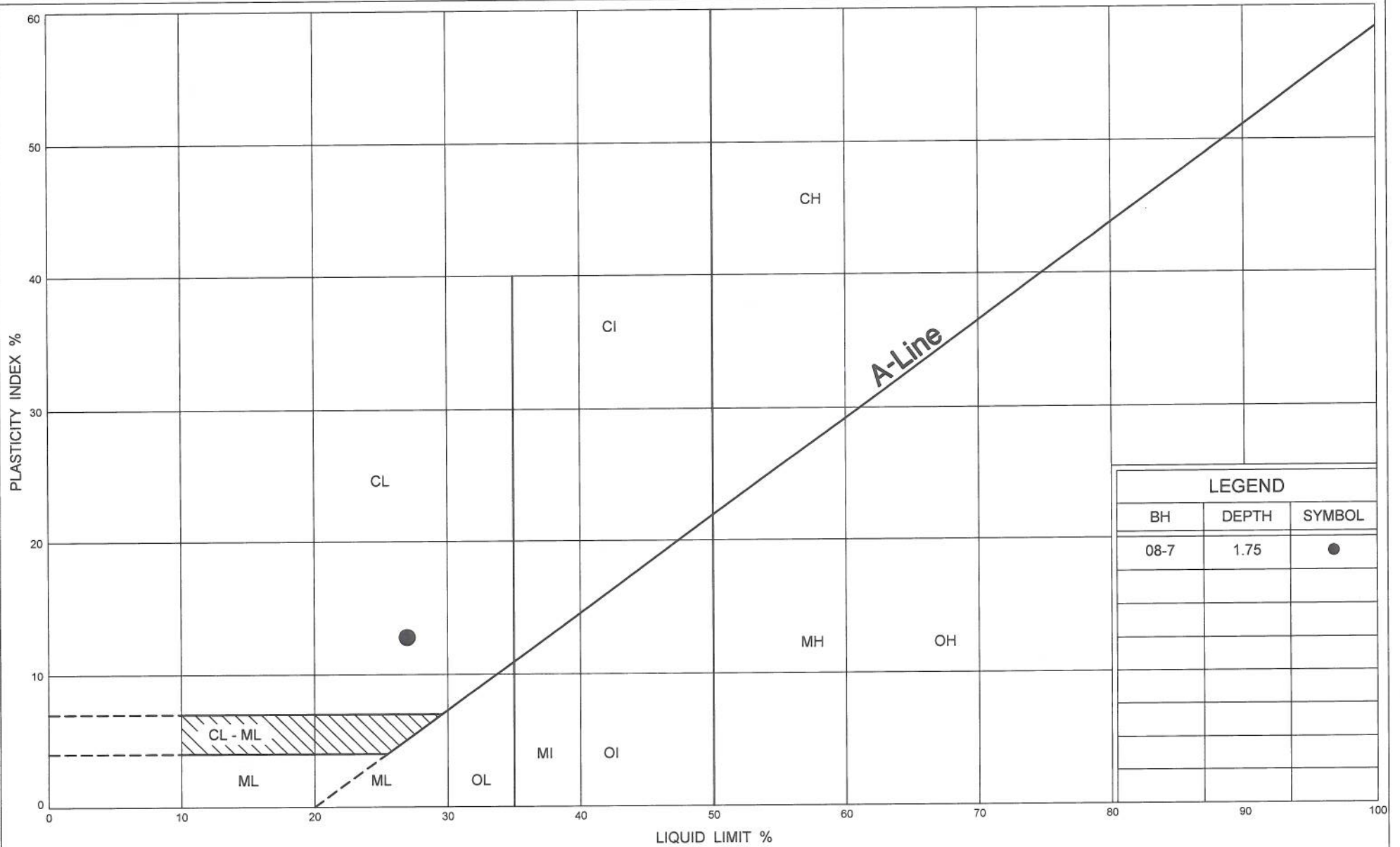
FIG No 1

W P 3038-03-00

Hwy 402, Township of Sarnia

Ministry of
Transportation

Ontario



Ministry of
Transportation

PLASTICITY CHART

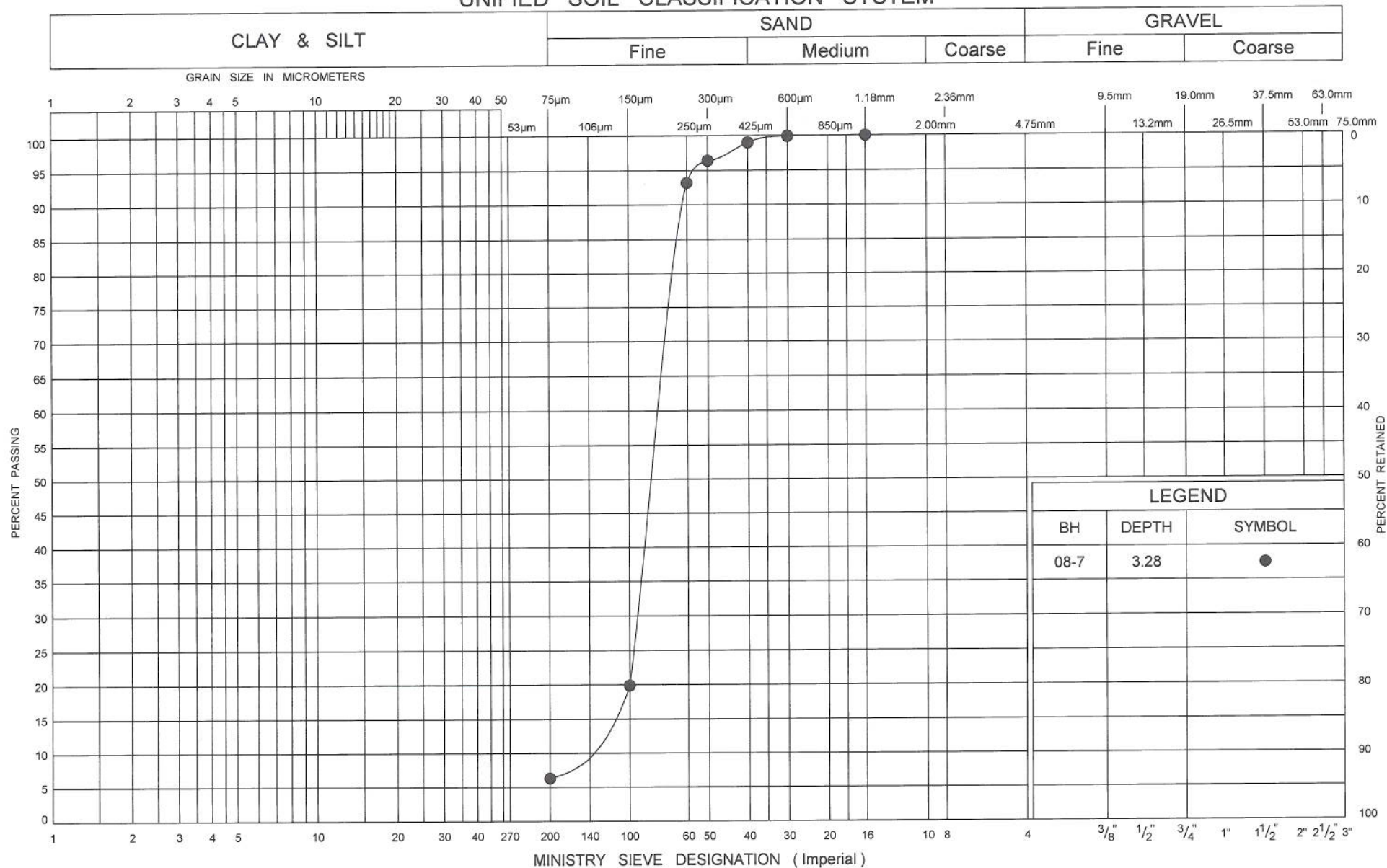
Silty Clay Fill

FIG No 2

W P 3038-03-00

Hwy 402, Township of Sarnia

UNIFIED SOIL CLASSIFICATION SYSTEM



GRAIN SIZE DISTRIBUTION

Sand, Trace Silt (SM)

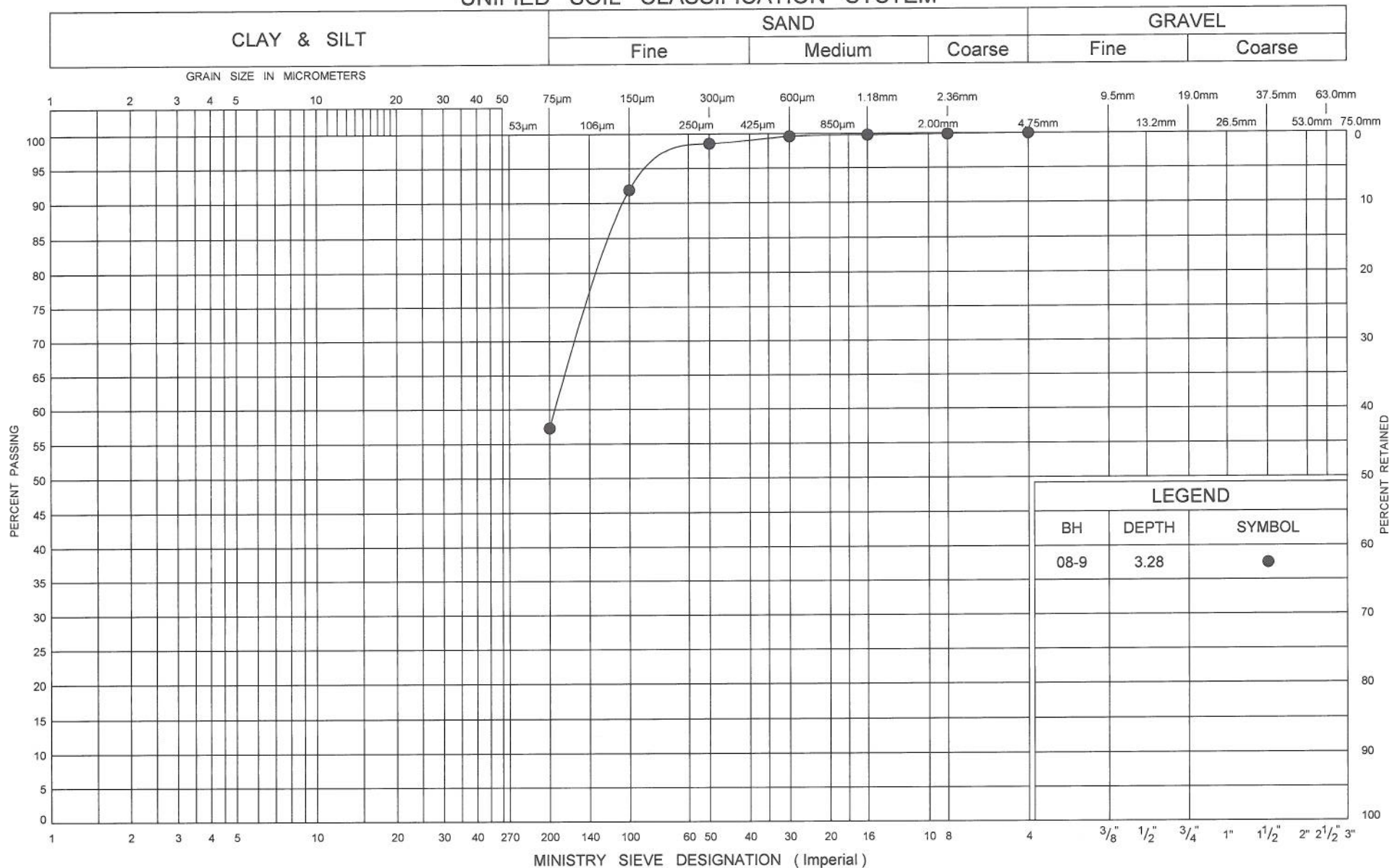
FIG No 3

W P 3038-03-00

Hwy 402, Township of Sarnia

Ministry of
Transportation

UNIFIED SOIL CLASSIFICATION SYSTEM



GRAIN SIZE DISTRIBUTION

Silty Sand (SP-SM)

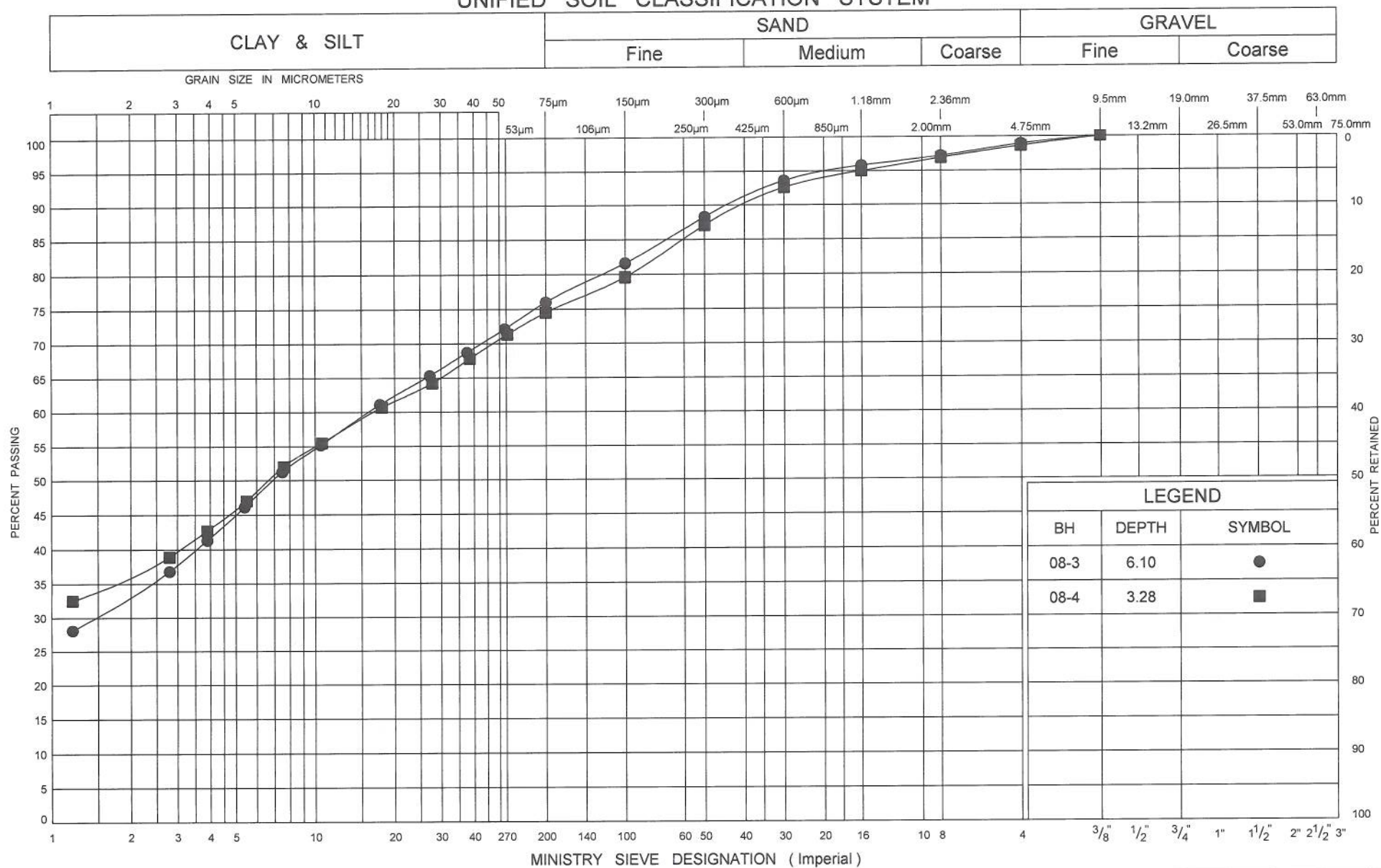
FIG No 4

W P 3038-03-00

Hwy 402, Township of Sarnia

Ministry of
Transportation

UNIFIED SOIL CLASSIFICATION SYSTEM



GRAIN SIZE DISTRIBUTION

Silty Clay (CL)

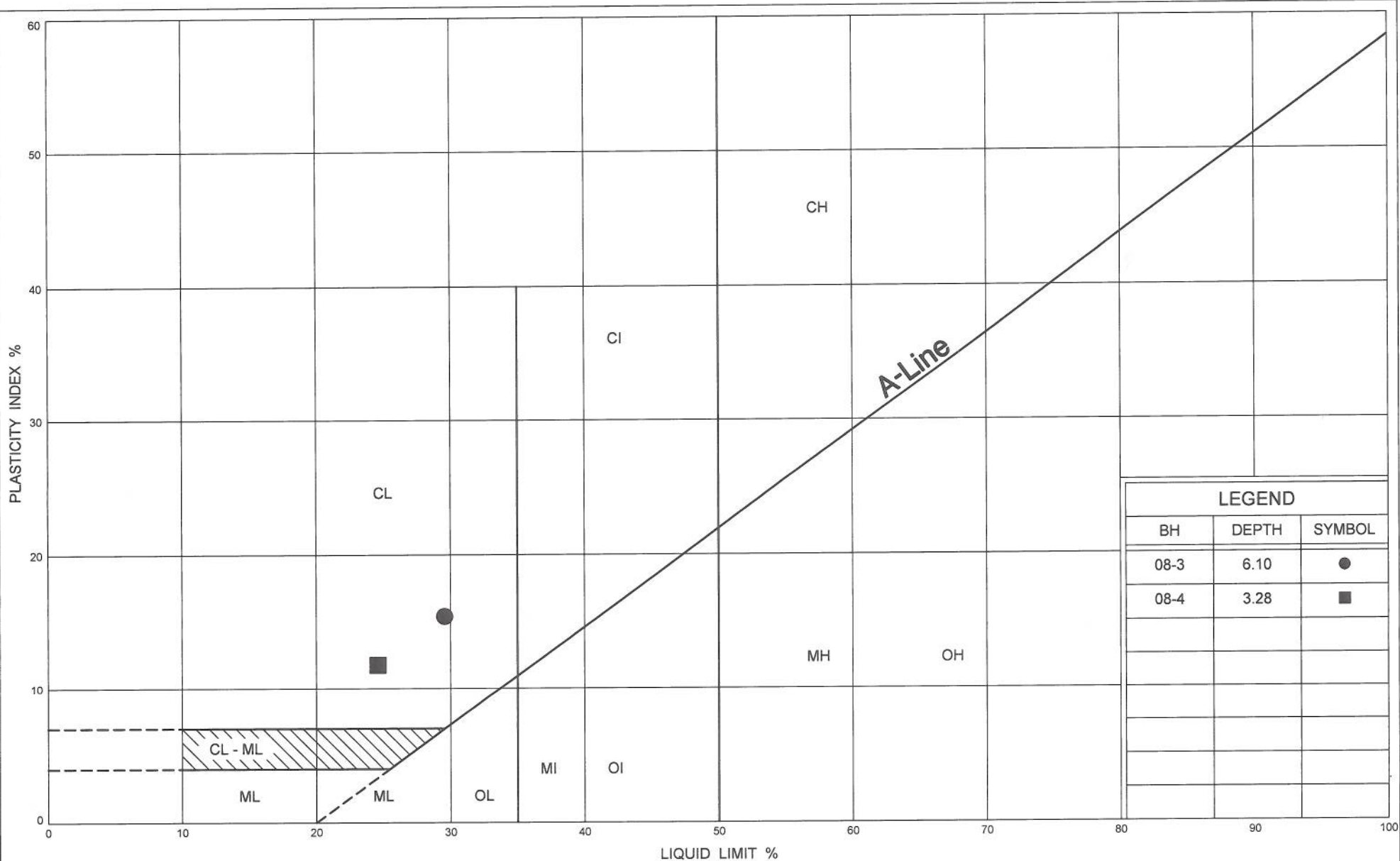
FIG No 5

W P 3038-03-00

Hwy 402, Township of Sarnia


 Ministry of
Transportation

Ontario



Ministry of
Transportation

PLASTICITY CHART Silty Clay (CL)

FIG No 6

W P 3038-03-00

Hwy 402, Township of Sarnia