

FINAL

Foundation Investigation Report
Colborne Road Overpass
Site 14-38, Highway 402
City of Sarnia, Ontario
District - London

G.W.P. 3038-03-00

STANTEC CONSULTING LTD.

PROJECT NO. 1012607

GEOCRES NO. 40J16-80

REPORT NO. 1012607

REPORT TO	Stantec Consulting Inc. 1400 Rymal Road East Hamilton, ON L8W 3N9
FOR	Foundation Investigation Report
ON	Colborne Road Overpass Site 14-38, Highway 402 City of Sarnia District – London, Ontario G.W.P. 3038-03-00 Geocres. No. 40J16-80

September 8, 2008

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Record of Borehole Sheets
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FOUNDATION INVESTIGATION REPORT

**Colbourne Road Overpass
Site 14-38, Highway 402
City of Sarnia, Ontario
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 Report for the widening of the Highway 402 Colborne Road overpass, in the City of Sarnia, Ontario, (GWP 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 the foundation investigation and the laboratory testing.

2.0 SITE DESCRIPTION

The site location is on Highway 402 at the Colborne Road overpass in the City of Sarnia, Ontario.

Highway 402 at Colborne Road is built to a semi-urban freeway section with wide gravel shoulders and a wide grass covered centre median. The shoulders and centre median narrow at the bridge location. Highway 402 is built on embankments that are approximately 6 m to 7 m high at the bridge location. Highway 402 is generally oriented in an east west direction with two east bound lanes and two west bound lanes.

Colborne Road is four lanes wide at the structure. The road is generally at or near the ground surface elevation of the surrounding lands and is built with an urban section with concrete curbs. Drainage is provided by concrete gutters and a series of catchbasins located along the sides of the road.

Drainage for Highway 402 is provided by ditches located along the sides and in the central median. The ditches are sloped towards a limited number of catch basins located along the existing highway. Regional drainage is towards the St. Clair River located approximately 2 km southwest of the project site.



The existing bridge structure at Colborne Road is a single span steel girder bridge that spans approximately 18 m between the east and west abutments and is approximately 30 m wide. The bridge conveys two west bound lanes and two east bound lanes of Highway 402 over Colborne Road. The structure was reportedly constructed in 1957 and rehabilitated in 1997.

Based on Drawing Sheet No. J-278, dated March 1955, revised June 1968, by Proctor, Redfern & Laughlin, it is understood that the existing bridge structure is supported on 214 wood piles at each abutment. The notes on Drawing No. J-277, dated March 1955, revised June 1968, by Proctor, Redfern & Laughlin indicates the piles are creosote coated Class B timber piles with estimated lengths in the range of 30 feet to 40 feet (9.1 m to 12.2 m) and having a maximum load of 20 tons (approximately 180 kN) per piles. Based on the drawings, the pile heads are reportedly at an elevation of approximately 182.6 m.

Representative photographs of the bridge are provided in **Appendix D**.

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

4.0 BACKGROUND

Previous Investigations

A previous assessment of the site was carried out by Golder Associates Ltd. The results of the assessment were provided in a report titled:

Preliminary Foundation Investigation and Design Report, Proposed Colborne Road Overpass Structure Widening, Highway 402, GWP 3038-03-00, Agreement Number 3005-A-000394, Dated July 28, 2006, GEOCREs No. 40J16-68.

This preliminary report was based on factual data contained within the following report, supplemented by advancing additional boreholes at the site.

Department of Highways, Ontario, Report No. 55-F-212C titled, "Soil Investigations for the Colborne Road Overpass, Sarnia, Ontario", Dated April 4, 1955, GEOCREs No. 40J16-1

Four boreholes were drilled at the site for the 1955 (Boreholes BH1 to BH4) investigation and 2 boreholes were drilled at the site by Golder for the 2004 preliminary foundation investigation (Boreholes C-1 and C-2). The subsurface conditions reported by Golder included the following strata types:

Strata	Layer Thickness (m)	Depth to underside of Strata (m)
Surficial Fill and Topsoil	0.7 m to 1.5 m	0.7 to 1.5 m
Sand and Gravel	0.9 m to 2.4 m	1.8 m to 2.4 m
Sand, Silty Fine Sand and Sandy Silt	3.5 m to 5.2 m	5.3 m to 7.3 m
Peat and Organic Silt	0.5 m to 4.9 m	5.8 m to 11.6 m
Clayey Silt	1.5 m to 8.9 m	11.6 m to 14.6 m
Silty Clay	25.6 m Only one Borehole C-1 penetrated the full thickness of the layer.	All boreholes except Golder Borehole C-1 were terminated in the silty clay. The underside of the silty clay in this borehole was at a depth of approximately 40.4 m
Bedrock	Encountered at a depth of approximately 40.4 m	Borehole C-1 was terminated in the bedrock stratum

It is noted that the peat and organic silt layers are generally interbedded between clayey silt layers.

The surficial fill was reported to consist of silty fine sand and fine sand that was assessed to be loose based on a single N-value. The moisture contents were reported to be in the range of approximately 1% to 6%. The surficial topsoil was reported to be approximately 180 mm thick. A 310 mm thick layer of buried topsoil was encountered underlying the surficial fill in Borehole C-2.

The sand and gravel was reported in the boreholes for the 1955 investigation and was stated as being loose to dense, but more typically compact.

The sand, silty fine sand and sandy silt were reported as compact to dense with moisture contents ranging from approximately 18% to 27% with an average of approximately 25%.

The peat and organic soils reportedly contained layers of loose to compact silty fine sand and very soft to hard clayey silt. Moisture contents of the organic soils reportedly ranged from approximately 76% to 251%.

The clayey silt layer was stated to be firm to very stiff, with actual reported measurements indicating stiff to very stiff conditions. In situ shear vane tests ranged from approximately 65 kPa to >144 kPa (the limit of the equipment), indicating a stiff to very stiff consistency. Laboratory tests were reported as follows:

- Moisture contents of approximately 16% to 22%, average of about 18%;
- Average plastic limit of approximately 17%; and,
- Average liquid limit of approximately 29%.

The silty clay layer was stated to be very soft to stiff. An in situ shear vane test of the softer clay was 79 kPa indicating a stiff consistency. Laboratory tests were reported as follows:

- Moisture contents ranging from 20% to 32%, average of about 25%;

- Average plastic limit of approximately 18%; and,
- Average liquid limit of approximately 34%.

The bedrock was identified as black shale of the Kettle Point formation.

Groundwater was reported at depths in the range of about 1.8 m to 5.8 m below ground surface, corresponding to elevations between 177 m and 181 m. Within the 2004 Golder report, the depth ranges were between 2.0 to 2.4 m, corresponding to elevation ranges of 181 to 182 m.

5.0 INVESTIGATION PROCEEDURES

5.1 Field Program

The fieldwork for the present investigation was carried out on November 12, 2006, November 23 to December 5, 2006, and January 15 to 19, 2007. A total of 10 boreholes were advanced to depths ranging from approximately 12.8 m to 43.9 m below existing grade, using track and truck mounted drill rigs equipped with 250 mm (outside diameter) continuous flight, hollow-stem augers and mud-rotary drilling techniques. The drill rigs were supplied and operated by Aardvark Drilling Inc., and Walker Drilling Ltd.

Prior to commencing the field investigation, the borehole locations were established in the field by Jacques Whitford personnel. It was not possible to access the proposed location of Borehole CR-7 and CR-8, given the slope of the existing grade and that the locations were covered with a combination of trees and shrubs. These boreholes were relocated approximately 3 m north of the intended locations. Borehole CR-7 was relocated to the parking lot of the adjoining residential apartment building and Borehole CR-8 was relocated to Guthrie Drive. These boreholes were relocated and drilled with the permission of the property owners. The borehole locations were cleared of underground utilities by the various utility companies.

Soil samples were recovered from the boreholes at regular intervals using a 50 mm Outside Diameter split-tube sampler by conducting Standard Penetration Tests (SPTs) in general accordance with the procedures outlined in ASTM specification D1586-99. Relatively undisturbed samples were obtained by pushing thin walled sample tubes in general accordance with ASTM D1587.

Where cohesive soils were encountered, in situ shear vane testing was carried out using a vane meeting the MTO N-Vane design requirements and following the procedures outlined in ASTM D2573-94.

Rock cores were obtained using NQ wire line rock coring equipment. One borehole was advanced into the underlying bedrock using a tricone; the presence of rock was inferred by the rock fragments in the wash water.

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

The groundwater levels, where encountered and where practical, were measured in the boreholes during and on completion of drilling. All boreholes were backfilled in accordance with Ontario Regulation 903, using cement/bentonite slurry.

All soil samples recovered from the boreholes were placed in moisture-proof bags and returned to our laboratory for detailed classification and testing as required. All rock cores were placed in rock core boxes and transported to our laboratory for detailed examination and selected laboratory testing.

5.2 Survey

The borehole locations were established by Jacques Whitford personnel and referenced to the stations on Colborne Road or Highway 402, as noted on the Record of Borehole sheets. Offsets were referenced looking up chainage. The borehole locations are also referenced to Northing and Easting co-ordinates, which are provided on the Sheet Nos. 1 and 2 in **Appendix A** and on the Record of Borehole sheets in **Appendix B**.

The ground surface elevation at the borehole locations were surveyed by Jacques Whitford Personnel. The boreholes were surveyed to either the benchmark or temporary benchmarks noted below:

- GBM DHO 87-67, with a reported Geodetic elevation of 188.696 m. Located on the north east portion of the Colborne Street overpass;
- Temporary BM1, a catchbasin at Sta. 11+830 o/s 30 m left (looking up chainage), with a reported Geodetic elevation of 182.62 m, as provided by Stantec, February 2007; and,
- Temporary BM2, a manhole in the sidewalk on the west side of Colborne Road approximately 30 m north of the west bridge abutment, with a reported Geodetic elevation of 182.80 m, as provided by Stantec, February 2007.

The location of the benchmark and temporary benchmarks are shown on Sheet No. 1 in **Appendix A**.

5.3 Laboratory Testing

All samples returned 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 testing, Atterberg Limits testing, 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 through 10 in **Appendix C**.

Unless requested in advance, all samples will be stored in our laboratory for a period of 12 months, after issuance 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

also provided in **Appendix B**. Copies of the Record of Borehole sheets from the 1955 and 2004 investigation have been included in **Appendix B** for reference.

A Borehole Location Plan and a Strata Plot of the soils encountered in the boreholes are provided on Sheet No. 2 in **Appendix A**.

A summary of the soil and groundwater conditions encountered in the 2006/2007 boreholes is provided below.

6.2 Soil

6.2.1 Asphalt

Asphalt was encountered at the ground surface in Boreholes CR-1, CR-4, CR-7 and CR-8. The asphalt in Boreholes CR-1 and CR-4, advanced on the right shoulder of the west bound lanes of Highway 402, was approximately 250 mm to 300 mm thick. The asphalt encountered at the ground surface in Borehole CR-7, drilled in the parking lot of a neighbouring property, was approximately 80 mm thick. The asphalt encountered at the ground surface in Borehole CR-8, drilled on the right shoulder of Guthrie Drive, was approximately 100 mm thick.

6.2.2 Topsoil

Topsoil was encountered at the ground surface in Boreholes CR-5, CR-6 and CR-9. The thickness of the topsoil ranged from approximately 100 mm to 120 mm.

6.2.3 Sand and Gravel Fill (SW)

Sand and gravel fill was encountered at the ground surface in Borehole CR-3 and underlying the asphalt in Boreholes CR-1, CR-7 and CR-8. The sand and gravel fill ranged in thickness from approximately 0.1 m to 2.1 m.

The sand and gravel fill generally contained trace silt and was generally moist to wet.

Based on the N-Values obtained from the Standard Penetration Tests (SPTs), the compactness of the sand and gravel fill was assessed as compact.

Laboratory testing performed on selected samples consisted of moisture content tests. The test results are as follows:

- Moisture Content:
 - 6% to 27%.

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

6.2.4 Sand Fill (SP-SM/SW-SM)

Sand fill was encountered at the ground surface in Borehole CR-10 and underlying the topsoil, asphalt or sand and gravel fill in all boreholes except Borehole CR-7. The sand fill ranged in thickness from

approximately 0.9 m to 6.6 m. The thicker fills encountered in Boreholes CR-1 and CR-4 (6.6 and 5.6 m respectively) was associated with the approach embankments to the Highway 402 / Colborne Road overpass.

The sand fill generally contained trace to some gravel, trace silt, and was generally damp to wet.

Based on the N-Values obtained from the SPTs, the compactness of the sand fill was variable ranging from very loose to very dense. The upper 1.5 m of the sand fill within the approach embankments was generally compact becoming very loose to loose below this depth. The sand fill outside of the approach embankments was typically compact.

Laboratory testing performed on selected samples consisted of moisture content and grain size distribution tests. The test results are as follows:

- Moisture Content:
 - 5% to 30%.
- Grain Size Distribution
 - 1% to 30% gravel;
 - 65% to 95% sand; and,
 - 4% to 9% fines (silt and clay).

The results of the moisture content 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 provided on Figure 1 in **Appendix C**.

6.2.5 Native Sand (SM to SP-SM)

Native sand was encountered underlying the fill in all boreholes. The sand was encountered at depths of approximately 0.9 m to 7 m below existing grade, elevations of approximately 180.3 m to 182.9 m. The thickness of the sand ranged from approximately 3 m to 10.9 m. Boreholes CR-1 and CR-4 were terminated in the sand stratum.

The sand generally contained trace to some gravel, trace to some silt and clay, and was generally wet.

Based on the N-Values obtained from the SPTs, the compactness of the sand was variable ranging from very loose to very dense, but was more typically compact.

Laboratory testing performed on selected samples consisted of moisture content tests and grain size distribution tests. The test results are as follows:

- Moisture Contents:
 - 17% to 30%.
- Grain Size Distribution:
 - 0% to 10% gravel;
 - 72% to 95% sand; and,
 - 5% to 27% fines (silt and clay).

The results of the moisture content 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 Nos. 2 and 3 in **Appendix C**.

6.2.6 Silt (ML)

A localized deposit of silt was encountered in Borehole CR-2 at a depth of approximately 7.2 m, corresponding elevation of approximately 175.6 m and was approximately 1.5 m thick.

The silt generally contained some sand, some clay, some shell fragments and was generally saturated.

Based on the N-Values obtained from a single SPT, the compactness of the silt was assessed to be very loose.

Laboratory testing performed on a single silt sample consisted of a moisture content and a grain size distribution test. The test results are as follows:

- Moisture Content:
 - 42%.
- Grain Size Distribution:
 - 0% gravel;
 - 10% sand;
 - 78% silt; and,
 - 12% clay.

The results of the moisture content and grain size distribution tests 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 Organic Soil and Peat (OL)

A layer of organic soil and peat was encountered underlying the silt in Boreholes CR-2 and the sand in Borehole CR-3. The organic soil comprised of organic silt with layers of plant material and peat. The organic soil and peat was encountered at depths of approximately 8.7 m in Borehole CR-2 and approximately 7.2 m in Borehole CR-3, corresponding to elevations of 174.0 m and 175.6 m. The organic soil and peat was approximately 2 m thick in Borehole CR-2 and 4.5 m thick in Borehole CR-3.

Based on the N-Values obtained from the SPTs, the consistency of the organic soil and peat was considered to be very soft to soft.

Laboratory testing performed on samples consisted of moisture content tests and a grain size distribution test. The test results are as follows:

- Moisture Content:
 - 35% to 124%.
- Grain Size Distribution:
 - 0 gravel;
 - 12% sand;
 - 61% silt; and,

- 27% clay.

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

The results of the grain size distribution test are also provided on Figure 5 in **Appendix C**.

6.2.8 Silty Clay (CL)

Silty clay was encountered underlying the sand or silt in all boreholes except Boreholes CR-1 and CR-4, which terminated above the clay deposit. The silty clay was encountered at depths in the range of approximately 4.9 m to 12.7 m below existing grade, or elevation of approximately 170.1 m to 177.5 m. All boreholes except Boreholes CR-1 to CR-4 were terminated in the silty clay stratum. The silty clay was approximately 28.3 m to 29.3 m thick in Boreholes CR-3 and CR-2, respectively.

The silty clay generally contained some sand and trace gravel near the contact with the sand stratum described above, then containing less sand with increasing depth. The silty clay was generally moist to damp.

N-Values obtained from the SPTs, ranged from 20 within the upper part of the clay to less than 10 in the deeper part of the clay. The upper 2 m of the silty clay generally could be classified as very stiff, indicating this layer is likely a desiccated layer.

In situ shear vane testing was carried out in the silty clay. The results of the testing indicated that the shear strength of the silty clay was variable ranging from approximately 30 kPa to >100 kPa (the upper limit of the testing equipment). The in situ shear vane testing indicated that the consistency of the silty clay could be described as firm to very stiff.

Laboratory testing performed on selected samples consisted of moisture content, grain size distribution and Atterberg Limits tests. The test results are as follows:

- Moisture Content:
 - 14% to 52%; and,
 - Generally, the moisture content of the deeper portion of the clay are consistently in the range of 30% to 32%.
- Grain Size Distribution:
 - 0% to 5% gravel;
 - 5% to 17% sand;
 - 39% to 56% silt; and,
 - 34% to 56% clay.
- Atterberg Limits:
 - Liquid Limits: 28% to 43%; and,
 - Plastic Limits: 15% to 25%.

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 Figures 6 and 7 in **Appendix C**. The results of the Atterberg Limits tests are provided on Figures 8 and 9 in **Appendix C**.

6.2.9 Silty Sand (SM)

A localized deposit of silty sand was encountered in Borehole CR-3 at a depth of approximately 40 m below existing grade, corresponding to an elevation of approximately 142.8 m and was approximately 0.7 m thick.

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

Based on the N-Values obtained from a single SPT, the compactness of the silt was assessed to be compact.

Laboratory testing performed on a single sample consisted of a moisture content and a grain size distribution test. The test results are as follows:

- Moisture Content:
 - 12%.
- Grain Size Distribution:
 - 9% gravel;
 - 57% sand;
 - 31% silt; and,
 - 3% clay.

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

The results of the grain size distribution test are also provided on Figure 10 in **Appendix C**.

6.2.10 Bedrock

Bedrock was encountered in Boreholes CR-2 and CR-3 at depths of approximately 40 m and 40.7 m below existing grade, corresponding to elevations of approximately 142.0 m to 142.7 m. The bedrock consisted of black shale of the Kettlepoint formation.

Core samples of the bedrock were obtained from Borehole CR-3. The observations of the rock cores are summarized as follows:

- Total Core Recovery (TCR): 89% and 99%;
- Solid Core Recover (SCR): 65% and 93%; and,
- Rock Quality Designation (RQD): 98% and 98%.

The results of the rock core analysis are provided on the Record of Borehole sheets in **Appendix B**.

Borehole CR-2 was advanced approximately 3.3 m below the contact surface of the underlying shale using a tricone. The presence of shale was confirmed by the rock fragments which were brought to surface by the tricone wash water.

6.3 Groundwater

Ground water was encountered during drilling in three of the boreholes and in four of the boreholes on completion of drilling. The following table outlines the boreholes, depths and elevations at which groundwater was encountered during drilling, measured on completion of drilling and the depth to cave.

Borehole	Groundwater				Cave	
	Encountered During Drilling		Measured on Completion of Drilling		Depth (m)	Elevation (m)
	Depth (m)	Elevation (m)	Depth (m)	Elevation (m)		
CR-1	7.6	181.1	-	-	8.2	180.5
CR-4	6.2	182.5	-	-	8.6	180.1
CR-5	1.8	181.1	-	-	-	-
CR-6	-	-	1.8	180.8	2	180.6
CR-7	-	-	1.0	181.6	1.8	180.8
CR-8	-	-	1.8	181.0	2.3	180.5
CR-9	-	-	-	-	1.6	180.7
CR-10	-	-	1.4	180.8	1.7	180.5

Groundwater conditions could not be measured in Boreholes CR-2 and CR-3 given the drilling techniques used to keep the boreholes open. In addition, the drilling methods which include the use of drilling muds, would not permit the installation of standpipes. The boreholes were immediately decommissioned as per MOE regulations.

It is noted that ground water conditions will fluctuate depending on the time of year and the frequency of precipitation events.

7.0 CLOSURE

A soil investigation is a limited sampling of a site. The information is gathered 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 ground water 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:

Raymond Haché, M.Sc., P.Eng., PMP
Principal, Geotechnical Service Director, and
Designated Principal
MTO Foundations Contact

GC/RH/dd

Enclosures

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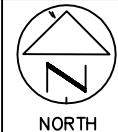


Appendix A

Drawings

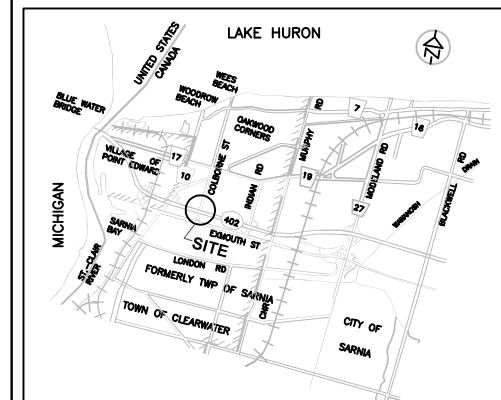
METRIC
DIMENSIONS ARE IN METRES
AND/OR MILLIMETRES
UNLESS OTHERWISE SHOWN

HWY 402
STA: 11+700 TO 12+300
GWP 3038-03-00



COLBORNE ROAD
SITE PLAN SHOWING
BOREHOLE LOCATIONS

SHEET
1



N.T.S

LEGEND

- BOREHOLE BY JACQUES WHITFORD (2006 / 2007)
- BOREHOLE BY GOLDER (2004)
- TEMPORARY BENCHMARK
- BENCHMARK
- BOREHOLE BY OTHERS (1955)

No	ELEVATION (m)	NORTHING	EASTING
CR-1	188.7	4 760 880.9	313 858.7
CR-2	182.7	4 760 895.7	313 862.1
CR-3	182.7	4 760 894.6	313 884.3
CR-4	188.7	4 760 879.0	313 887.0
CR-5	182.9	4 760 910.3	313 647.1
CR-6	182.6	4 760 905.3	313 738.0
CR-7	182.6	4 760 910.8	313 800.9
CR-8	182.8	4 760 899.9	313 946.1
CR-9	182.3	4 760 893.4	313 999.7
CR-10	182.2	4 760 887.9	314 091.1
C-1	183.03	4 760 839.1	313 858.0
C-2	182.77	4 760 896.0	313 885.2

NOTES

The boundaries between soil strata have been established only at Borehole Locations. Between Boreholes the boundaries are assumed from geological evidence.

Note 1) The complete foundation investigation and design report for this project and other related documents may be examined at the Engineering Institute Office, Downtown. Information contained in this report and related documents is specifically excluded in accordance with the conditions.

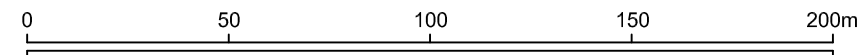
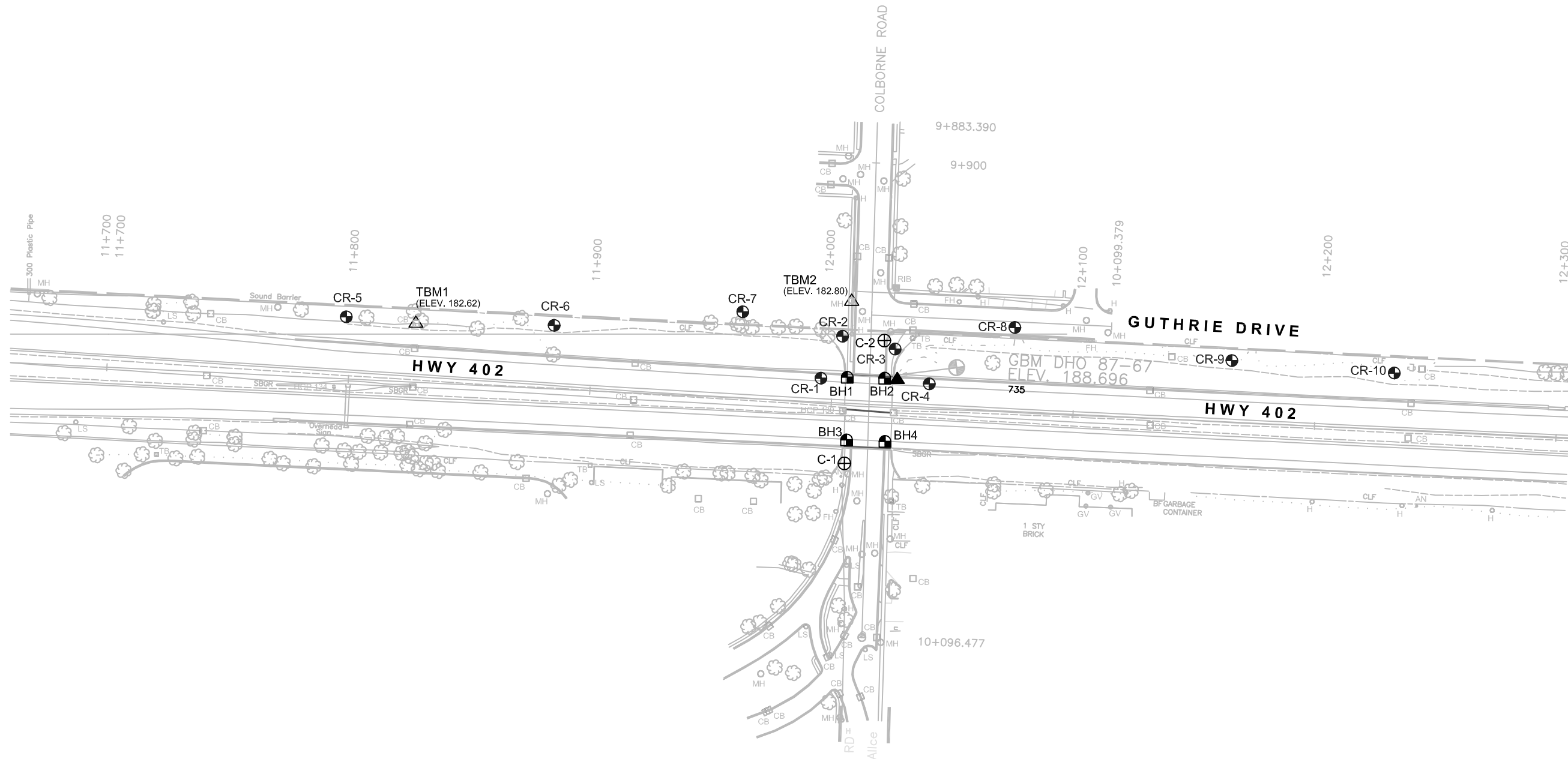
2) Base plan provided by Stantec Consulting Ltd.

3) This drawing is for information only. The surface features, proposed structure location and stratigraphy plots are shown for conceptual information purposes only.

REVISIONS	DATE	BY	DESCRIPTION

GEOCRES No 40J6-80

HWY No 402	CHECKED	DATE 2008-08-07	DIST LONDON
SUBM'D GC	CHECKED	APPROVED	SITE -
DRAWN PC	CHECKED		DWG 1



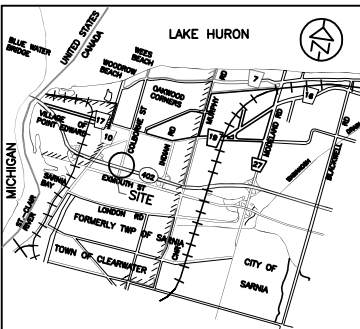
METRIC
DIMENSIONS ARE IN METRES
AND/OR MILLIMETRES
UNLESS OTHERWISE SHOWN

HWY 402
CONT No.:
WP No.:3038-03-00



BOREHOLE LOCATION PLAN
HIGHWAY 402 OVERPASS
WIDENING AT COLBOURNE ROAD

SHEET
2



KEY PLAN

N.T.S.

LEGEND

- BOREHOLE (BY JACQUES WHITFORD)
- BOREHOLE (BY GOLDER 2005)
- BM BENCH MARK
- TEMPORARY BENCH MARK
- ELEVATION (m)
- BOREHOLE (BY OTHERS 1955)

No	ELEVATION (m)	COORDINATES	
		NORTHING	EASTING
BOREHOLES BY JACQUES WHITFORD (2006)			
CR-1	188.70	4 760 880.9	313 858.7
CR-2	182.70	4 760 895.7	313 862.1
CR-3	182.70	4 760 894.6	313 884.3
CR-4	188.70	4 760 879.0	313 887.0
BOREHOLES BY GOLDER (2005)			
C-1	183.03	4 760 839.1	313 858.0
C-2	182.77	4 760 896.0	313 885.2
BOREHOLES BY OTHERS (1955)			
BH-1	183.3	-	-
BH-2	182.9	-	-
BH-3	183.3	-	-
BH-4	183.2	-	-

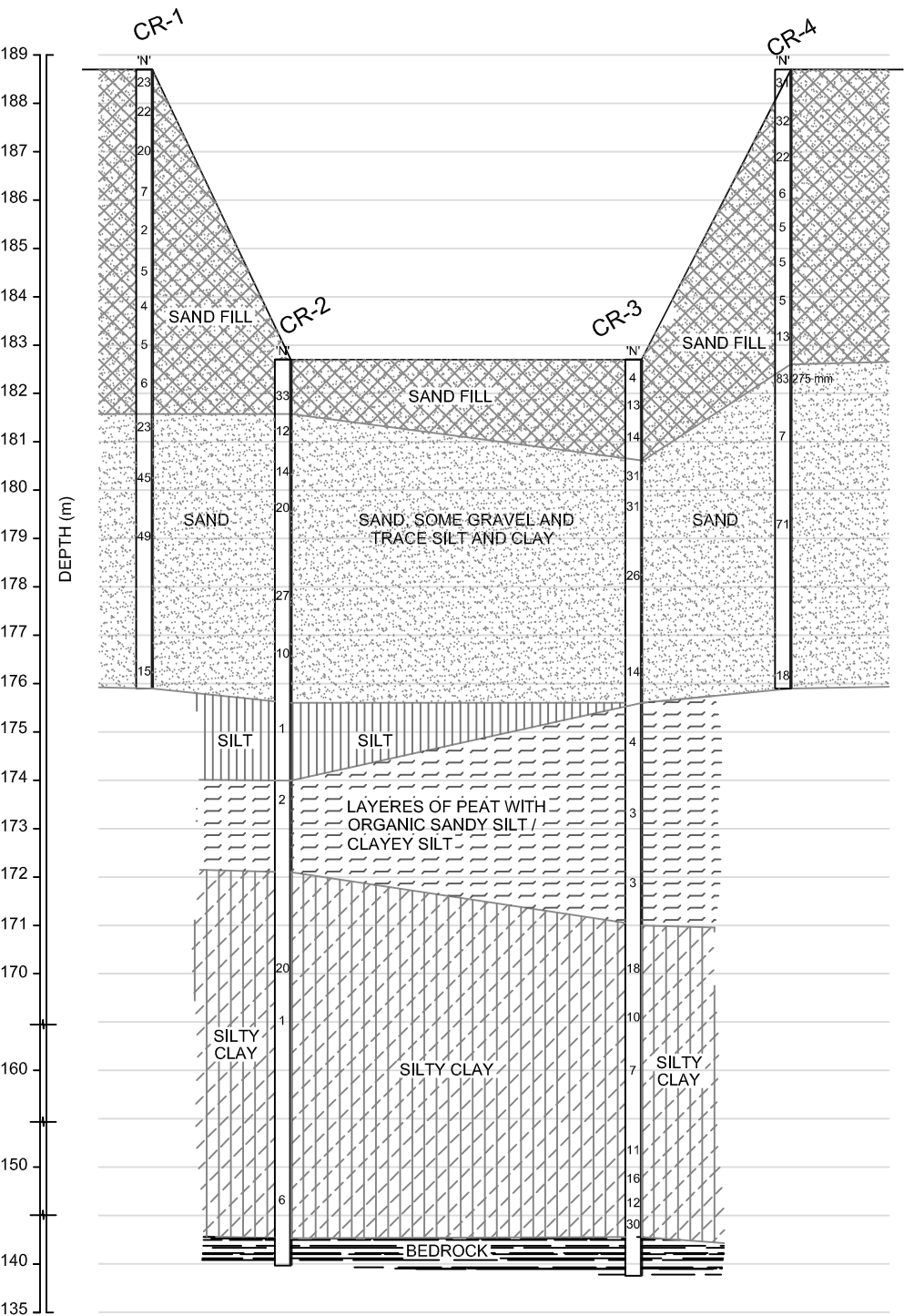
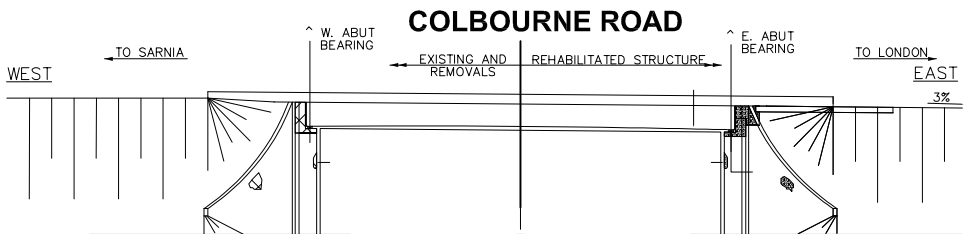
0 10 20 30m
HORI. SCALE: 1:400
VERT. SCALE: AS SHOWN

NOTES

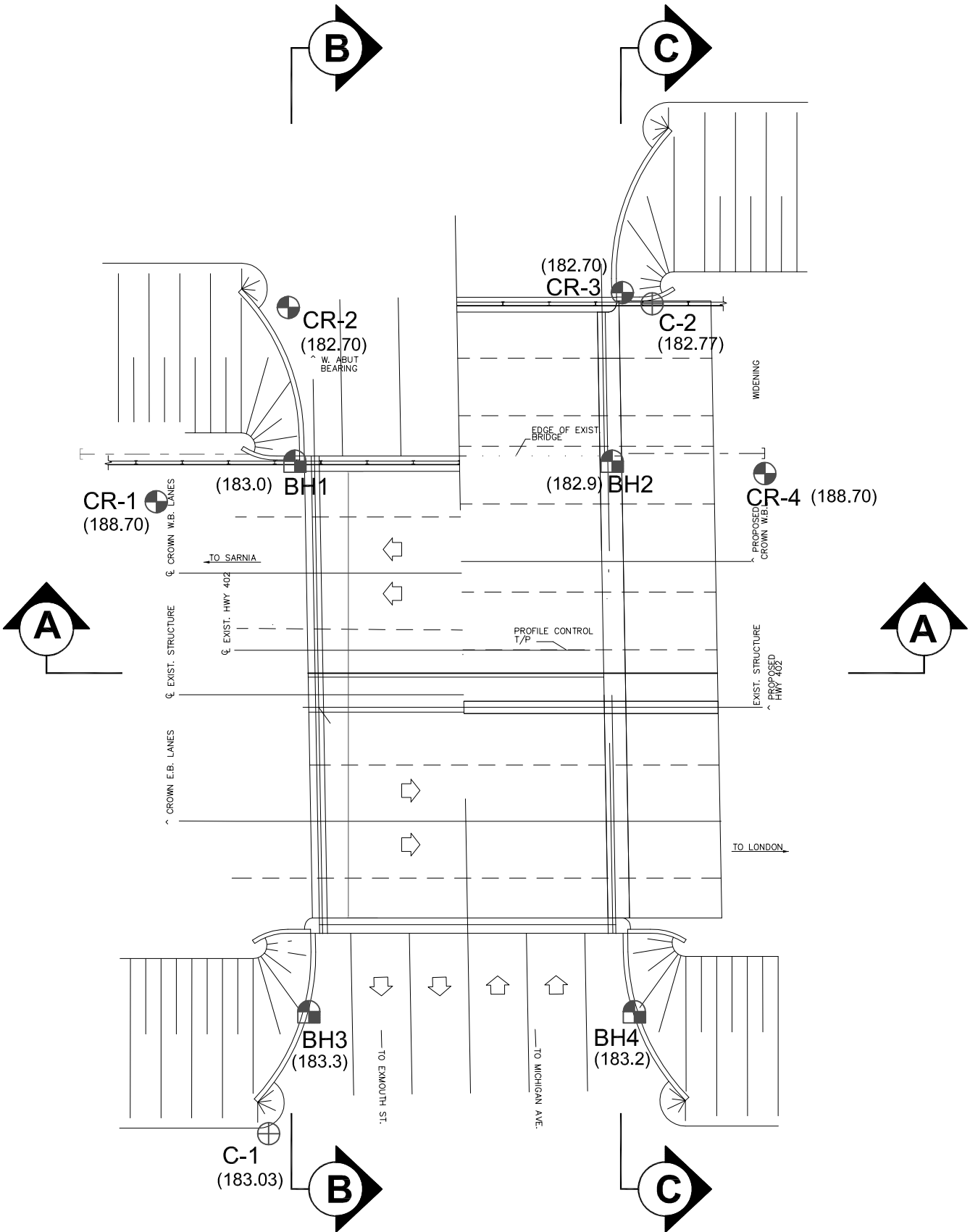
The boundaries between soil strata have been established only at Bore Hole locations. Between Bore holes the boundaries are assumed from geological evidence.

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 is specifically excluded in accordance with the conditions.
2) Base plan provided by Stantec Consulting Ltd.
3) This drawing is for information only. The surface features, proposed structure location and stratigraphy plots are shown for conceptual information purposes only.

REVISIONS	DATE	BY	DESCRIPTION
GEOCRES No 40J16-80			
HWY No 402			DIST LONDON
SUBM'D GC	CHECKED	DATE 2008-08-07	SITE
DRAWN P.C.	CHECKED	APPROVED	DWG 012807-GEO-CR-02



A-A CROSS SECTION



PLAN

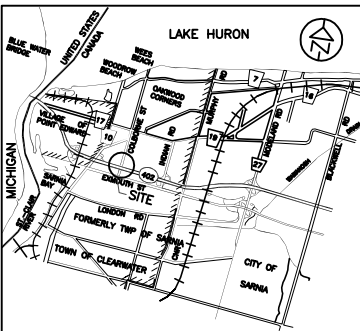
METRIC
DIMENSIONS ARE IN METRES
AND/OR MILLIMETRES
UNLESS OTHERWISE SHOWN

HWY 402
CONT No.:
WP No.:3038-03-00



SECTIONS B AND C
HIGHWAY 402 OVERPASS
WIDENING AT COLBOURNE ROAD

SHEET
3



KEY PLAN

N.T.S.

LEGEND

- BOREHOLE (BY JACQUES WHITFORD)
- BOREHOLE (BY GOLDER 2005)
- BM BENCH MARK
- TBM TEMPORARY BENCH MARK
- (178.3) ELEVATION (m)
- BOREHOLE (By Others 1955)

No	ELEVATION (m)	COORDINATES	
		NORTHING	EASTING
BOREHOLES BY JACQUES WHITFORD (2006)			
CR-1	188.70	4 760 880.9	313 858.7
CR-2	182.70	4 760 895.7	313 862.1
CR-3	182.70	4 760 894.6	313 884.3
CR-4	188.70	4 760 879.0	313 887.0
BOREHOLES BY GOLDER (2005)			
C-1	183.03	4 760 839.1	313 858.0
C-2	182.77	4 760 896.0	313 885.2
BOREHOLES BY OTHERS (1955)			
BH-1	183.3	-	-
BH-2	182.9	-	-
BH-3	183.3	-	-
BH-4	183.2	-	-

0 10 20 30m
HORI. SCALE: 1:400
VERT. SCALE: AS SHOWN

NOTES

The boundaries between soil strata have been established only at Bore Hole locations. Between Bore holes the boundaries are assumed from geological evidence.

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 is specifically excluded in accordance with the conditions.

2) Base plan provided by Stantec Consulting Ltd.

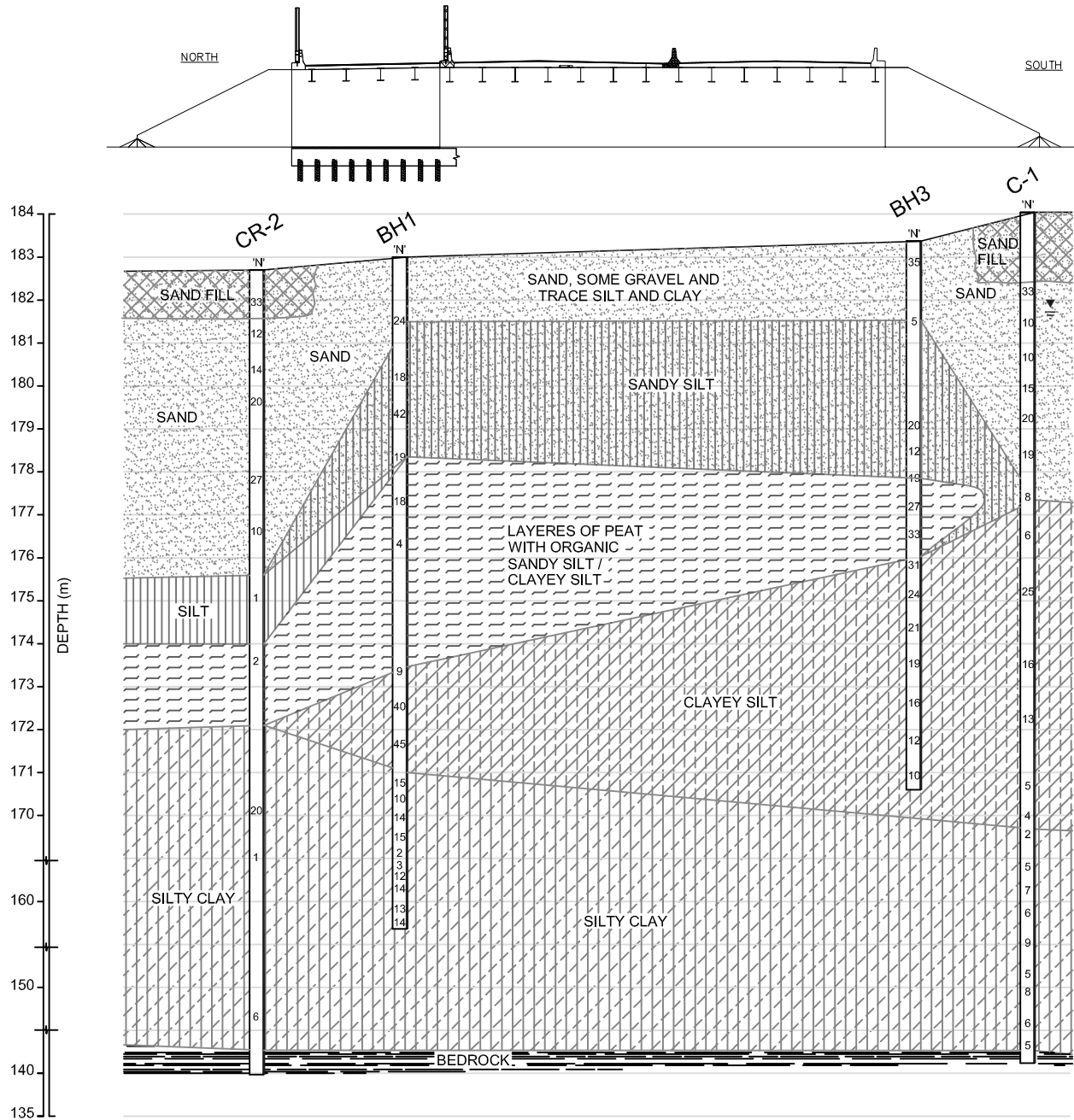
3) This drawing is for information only. The surface features, proposed structure location and stratigraphy plots are shown for conceptual information purposes only.

REVISIONS	DATE	BY	DESCRIPTION

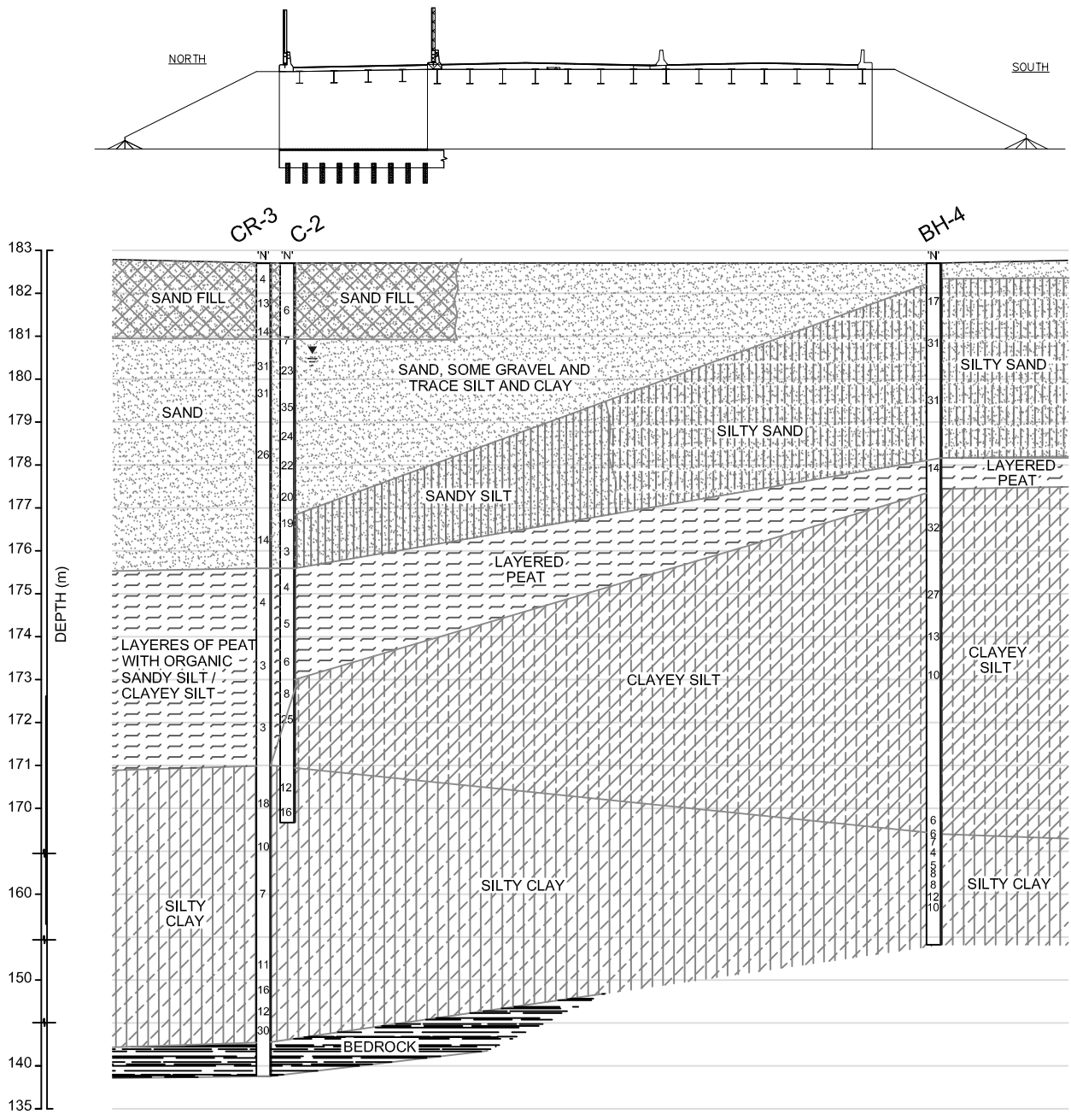
GEORES No 40J16-80

HWY No 402	CHECKED	DATE 2008-08-07	SITE	---	DIST LONDON
SUBM'D GC	CHECKED	DATE 2008-08-07	SITE	---	---
DRAWN P.C.	CHECKED	DATE 2008-08-07	SITE	---	---

DWG012807-GE0-CR-03



**B-B CROSS SECTION
WEST ABUTMENT**



**C-C CROSS SECTION
EAST ABUTMENT**

Appendix B

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

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						

Jacques Whitford
2006/2007 Investigation
Record of Borehole Sheets



RECORD OF BOREHOLE No CR-1

1 OF 1

METRIC

W.P. 3038-03-00 LOCATION Highway 402, Stn.: 11+999 o/s: 12 m Lt, Twp of Sarnia; N4760880.9, E313858.7 ORIGINATED BY MW
 DIST London HWY 402 BOREHOLE TYPE Hollow Stem Auger, Split Spoon COMPILED BY MW
 DATUM Geodetic DATE 11.12.06 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									WATER CONTENT (%)			GR	SA	SI	CL
								○ UNCONFINED	✕ FIELD VANE	● QUICK TRIAXIAL	✕ LAB VANE												
188.7 0.0	Hwy 402 W.B. Rt. Shldr. 300 mm ASPHALT							20	40	60	80	100											
188.4 0.4	75 mm SAND and GRAVEL (FILL), damp Grey SAND (FILL) (SP-SM / SW-SM), trace gravel, trace silt and clay, moist Brown Compact - some gravel		1	SS	23		188							○				13	79	(9)			
			2	SS	22		187																
			3	SS	20																		
	- loose, trace gravel, trace silt		4	SS	7		186																
	- very loose		5	SS	2		185																
	- loose		6	SS	5		184																
			7	SS	4																		
			8	SS	5		183							○				1	95	(4)			
	- trace organic matter		9	SS	6		182																
	- trace wood chips		10a																				
181.7 7.0	SAND (SM to SP-SM), some silt and clay, trace gravel, wet Brown Compact to dense		10b	SS	23		181								○			1	95	(5)			
			11	SS	45																		
180.2 8.5	- grey, some silt and clay, trace gravel, wet						180																
			12	SS	49		179																
							178																
							177																
175.9 12.8	END OF BOREHOLE at approximately 12.8 m Water first encountered on spoon at a depth of approximately 7.6 m (Elev. 181.1 m) below grade Borehole caved to a depth of approximately 8.2 m (Elev. 180.5 m) on completion of drilling		13	SS	15		176																

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

RECORD OF BOREHOLE No CR-2

1 OF 3

METRIC

W.P. 3038-03-00 LOCATION Colborne Rd., Stn.: 9+977 o/s: 10 m Rt, Twp of Samia; N4760895.7, E313862.1 ORIGINATED BY KH
DIST London HWY 402 BOREHOLE TYPE Hollow Stem Auger, Tricone, Split Spoon COMPILED BY MW
DATUM Geodetic DATE 11.28.06 - 12.5.06 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/m ³	REMARKS & GRAIN SIZE DISTRIBUTION (%)					
ELEV DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE	"N" VALUES			SHEAR STRENGTH kPa					WATER CONTENT (%)							
182.7	Colborne Rd. S.B. Rt. Shldr.																			
0.0	SAND (FILL) (SP-SM / SW-SM), some gravel, trace silt and clay, mosit Brown Compact to dense		1	SS	33															
181.2																				
1.5	SAND (SM to SP-SM), trace silt and clay, wet Brown Compact		2	SS	12															
			3	SS	14															
	- some silt and clay		4	SS	20															
			5	SS	27															
177.1	- grey																			
5.6	- with silt		6	SS	10															
175.6																				
7.2	SILT (ML), some sand, some clay, trace shale fragement, saturated Grey Very soft		7	SS	1															
174.0																				
8.7	Organic SILT (OL) with PEAT, some sand and clay, some shells, saturated Grey to dark grey Very loose		8	SS	2															
172.1																				
10.7	Silty CLAY (CL), trace gravel, trace sand, wet Grey Very stiff to hard		9	SS	20															

Continued Next Page

Numbers refer to
Sensitivity

STRAIN AT FAILURE

METRIC

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

 $\bigcirc^{3\%}$ STRAIN AT FAILURE

METRIC

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

 $\bigcirc^{3\%}$ STRAIN AT FAILURE

RECORD OF BOREHOLE No CR-3

1 OF 3

METRIC

W.P. 3038-03-00 LOCATION Highway 402, Stn.: 9+975 o/s: 11 m lt, Twp of Samia: N4760894.6, E313884.3 ORIGINATED BY RM
DIST London HWY 402 BOREHOLE TYPE Hollow Stem Auger, Split Spoon COMPILED BY OL
DATUM Geodetic DATE 1.16.07 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/m ³	REMARKS & GRAIN SIZE DISTRIBUTION (%)																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																							
ELEV DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE	"N" VALUES			SHEAR STRENGTH kPa		W _P	W	W _L		WATER CONTENT (%)																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																							
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182.7 180.6 0.1	100 mm SAND and GRAVEL (FILL), trace silt, moist Grey Loose SAND (FILL) (SP-SM / SW-SM), some gravel, trace silt, moist Brown Very loose to compact		1	SS	4																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																</

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\times^3, \times^3 : Numbers refer to Sensitivity \circ 3% STRAIN AT FAILURE

METRIC

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

 $\bigcirc^{3\%}$ STRAIN AT FAILURE

METRIC

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

 $\bigcirc^{3\%}$ STRAIN AT FAILURE

RECORD OF BOREHOLE No CR-4

1 OF 1

METRIC

W.P. 3038-03-00 LOCATION Highway 402, Stn.: 12+030 o/s: 12 m Lt, Twp of Sarnia; N4760879.0, E313887.0 ORIGINATED BY MW
DIST London HWY 402 BOREHOLE TYPE Hollow Stem Auger, Split Spoon COMPILED BY MW
DATUM Geodetic DATE 11.12.06 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									WATER CONTENT (%)			GR	SA	SI	CL
								○ UNCONFINED × FIELD VANE ● QUICK TRIAXIAL × LAB VANE															
188.7	Hwy 402 W.B. Rt. Shldr.						20	40	60	80	100												
188.9	250 mm ASPHALT																						
0.3	SAND (FILL) (SP-SM / SW-SM), trace gravel, trace silt and clay, moist Brown Loose to compact		1	SS	31								○										
			2	SS	32								○										
			3	SS	22								○					3	91 (7)				
	- loose		4	SS	6								○										
			5	SS	5								○										
			6	SS	5								○										
			7	SS	5								○										
182.9			8	SS	13								○										
5.8	SAND (SM to SP-SM), some gravel, trace silt and clay, moist Brown																						
182.5	Very dense		9	SS	83/ 275mm									○				10	83 (7)				
6.2	- grey, wet - possible cobble and/or boulder																						
	- 380 mm brown sand - 75 mm black wood chips with organic matter		10	SS	7									○									
	- some silt, trace gravel, trace clay		11	SS	71										○								
	- compact		12	SS	18										○			2	84 (14)				
175.9	END OF BOREHOLE at approximately 12.8 m																						
12.8	Water first encountered on spoon at a depth of approximately 6.2 m (Elev. 182.5 m) below grade Borehole caved to a depth of approximately 8.6 m (Elev. 180.1 m) on completion of drilling																						


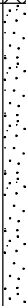
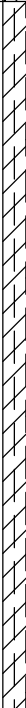
×³, ×³: Numbers refer to Sensitivity ○ 3% STRAIN AT FAILURE

RECORD OF BOREHOLE No CR-5

1 OF 1

METRIC

W.P. 3038-03-00 LOCATION Highway 402, Stn.: 11+790 o/s: 29 m Lt, Twp of Sarnia; N4760910.3, E313647.1 ORIGINATED BY KH
DIST London HWY 402 BOREHOLE TYPE Hollow Stem Auger, Split Spoon COMPILED BY MW
DATUM Geodetic DATE 11.27.06 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								
								○ UNCONFINED	✕ FIELD VANE						● QUICK TRIAXIAL	✕ LAB VANE
182.9 180.0 0.1	Hwy 402 W.B. Rt. Ditch 120 mm TOPSOIL SAND (FILL) (SP-SM / SW-SM), with gravel, trace silt and clay, moist Brown Loose to compact		1	SS	7	182								30 65 (5)		
			2	SS	18											
	- wet		3a				181									
	- 50 mm black sand seam, with asphalt fragements		3b	SS	20											
180.3 2.6	SAND (SM to SP-SM), trace gravel, some silt and clay, moist Grey Compact to dense		4	SS	24		180								0 74 (26)	
			5	SS	28											
			6	SS	40			179								
			7	SS	17		178									
177.2 5.6	Silty CLAY (CL), some sand, trace gravel, moist Grey Stiff to hard			8	SS			39	177							
							176									
	- very stiff	9		SS	27			175								
						174										
	- stiff, wet	10		SS	11		173									
						172										
170.1 12.8	END OF BOREHOLE at approximately 12.8 m Water first encountered on spoon at a depth of approximately 1.8 m (Elev. 181.1 m) below grade		11	SS	8		171							2 16 46 36		

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

RECORD OF BOREHOLE No CR-6

1 OF 1

METRIC

W.P. 3038-03-00 LOCATION Highway 402, Stn.: 11+880 o/s: 29 m Lt, Twp of Sarnia; N4760905.3, E313738.0 ORIGINATED BY KH
 DIST London HWY 402 BOREHOLE TYPE Hollow Stem Auger, Split Spoon COMPILED BY MW
 DATUM Geodetic DATE 11.24.06 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												
								20	40	60	80	100						WATER CONTENT (%)		
						○ UNCONFINED × FIELD VANE ● QUICK TRIAXIAL × LAB VANE														
182.6	Hwy 402 W.B. Rt. Ditch																			
180.6	100 mm TOPSOIL		1	SS	8	▽	182							○			0 85 (15)			
	SAND (FILL) (SP-SM / SW-SM), some organic matter, trace gravel, trace silt and clay, wet Brown Loose		2	SS	7		181							○						
			3	SS	50/ 100 mm		180							○						
180.5	SAND (SM to SP-SM), some silt and clay, wet Grey Compact to dense		4	SS	19		179							○						
2.1			5	SS	13		178							○						
	- dense		6	SS	47		177							○						
	- some silt and clay, trace gravel		7a	SS	24		176							○						
177.5	Silty CLAY (CL), some sand, trace gravel, moist Grey Stiff to hard		7b				175							○						
5.1			8	SS	38		174							○						
	- very stiff		9	SS	29		173							○						
			10	SS	14		172							○						
	- stiff					171														
						170							●	○	●	5 14 47 34				
169.8	- wet		11	SS	11															
12.8	END OF BOREHOLE at approximately 12.8 m																			
	Groundwater measured at a depth of 1.8 m (Elev. 180.8 m) on completion of drilling																			
	Borehole caved to a depth of 2.0 m (Elev. 180.6 m) on completion of drilling																			

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

RECORD OF BOREHOLE No CR-7

1 OF 1

METRIC

W.P. 3038-03-00 LOCATION Highway 402, Stn.: 11+960 o/s: 20 m lt, Twp of Sarnia: N4760910.8, E313800.9 ORIGINATED BY RM
 DIST London HWY 402 BOREHOLE TYPE Hollow Stem Auger, Split Spoon COMPILED BY OL
 DATUM Geodetic DATE 1.15.07 CHECKED BY GC

SOIL PROFILE			SAMPLES			GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT			UNIT WEIGHT γ kN/m ³	REMARKS & GRAIN SIZE DISTRIBUTION (%)		
ELEV DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE	"N" VALUES			SHEAR STRENGTH kPa						
								20	40	60			80	100
						○ UNCONFINED	✕ FIELD VANE							
						● QUICK TRIAXIAL	✕ LAB VANE							
						WATER CONTENT (%)								
						w _p w w _L								
						PLASTIC LIMIT NATURAL MOISTURE CONTENT LIQUID LIMIT								
182.6														
180.8	80 mm ASPHALT		1	SS	22									
180.2	80 mm SAND and GRAVEL (FILL), trace silt, moist Brown Compact		2	SS	16									
	SAND and GRAVEL (FILL) (SW), trace silt, wood fragments Brown Compact		3	SS	14									
180.4														
2.2	SAND (SM to SP-SM), trace gravel, trace silt, moist Brown Compact		4	SS	23									
			5	SS	31									
			6	SS	24									
	- grey		7	SS	3									
175.4	Silty CLAY (CL), trace to some sand, moist Grey Very soft to firm		8	SS	2									
7.2														
			9	SS	4									

x³, x³: Numbers refer to Sensitivity O 3% STRAIN AT FAILURE

RECORD OF BOREHOLE No CR-8

1 OF 2

METRIC

W.P. 3038-03-00 LOCATION Highway 402, Stn.: 12+080 o/s: 22 m lt, Twp of Sarnia: N4760899.9, E313946.1 ORIGINATED BY RM
DIST London HWY 402 BOREHOLE TYPE Hollow Stem Auger, Split Spoon COMPILED BY OL
DATUM Geodetic DATE 1.19.07 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/m ³	REMARKS & GRAIN SIZE DISTRIBUTION (%)					
ELEV DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE	"N" VALUES			SHEAR STRENGTH kPa		WATER CONTENT (%)				GR	SA	SI	CL		
182.8	100 mm ASPHALT					▽													
182.4	SAND and GRAVEL (FILL), trace silt, wet Brown Compact		1	SS	14														
182.0	SAND (FILL) (SP-SM / SW-SM), trace gravel, trace sand, moist to wet Brown Compact		2	SS	6														9 86 (6)
181.0	SAND (SM to SP-SM), trace to some silt, trace gravel, moist to wet Brown to grey Compact to dense		3	SS	5														
180.0			4	SS	13														3 91 (6)
179.0			5	SS	40														
178.0			6	SS	30														
177.0			7	SS	16														
176.0			8	SS	13														
175.0			9	SS	16														
174.0																			
173.0																			
172.0																			
171.0																			
170.1	Silty CLAY (CL), trace to some sand, wet Grey Soft		10	SS	2														
170.0	END OF BOREHOLE at approximately 12.8 m																		
170.0	Borehole caved to a depth of approximately 2.3 m (Elev. 180.5 m) on completion of drilling																		
170.0	Groundwater measured in caved borehole at a depth of approximately																		

Continued Next Page

\times^3, \times^3 : Numbers refer to Sensitivity \circ 3% STRAIN AT FAILURE

RECORD OF BOREHOLE No CR-8

2 OF 2

METRIC

W.P. 3038-03-00 LOCATION Highway 402, Stn.: 12+080 o/s: 22 m lt, Twp of Sarnia: N4760899.9, E313946.1 ORIGINATED BY RM
 DIST London HWY 402 BOREHOLE TYPE Hollow Stem Auger, Split Spoon COMPILED BY OL
 DATUM Geodetic DATE 1.19.07 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/m ³	REMARKS & GRAIN SIZE DISTRIBUTION (%) GR SA SI CL
ELEV DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE			"N" VALUES	SHEAR STRENGTH kPa					WATER CONTENT (%)			
							20	40	60	80	100	W _p	W	W _L		
	1.8 m (Elev. 181.0 m) below existing grade on completion of drilling															

RECORD OF BOREHOLE No CR-9

1 OF 1

METRIC

W.P. 3038-03-00 LOCATION Highway 402, Stn.: 12+140 o/s: 30 m Lt, Twp of Sarnia; N4760893.4, E313999.7 ORIGINATED BY KH
DIST London HWY 402 BOREHOLE TYPE Hollow Stem Auger, Split Spoon COMPILED BY MW
DATUM Geodetic DATE 11.23.06 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/m ³	REMARKS & GRAIN SIZE DISTRIBUTION (%)
ELEV DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE	"N" VALUES			SHEAR STRENGTH kPa		W _p W W _L				
								○ UNCONFINED ● QUICK TRIAXIAL	✕ FIELD VANE ✕ LAB VANE	WATER CONTENT (%)				
182.3	Hwy 402 W.B. Rt. Ditch		1a											
180.0	100 mm TOPSOIL		1b	SS	3		182							
	SAND (FILL) (SP-SM / SW-SM), some gravel, trace silt and clay, trace organic matter, moist Brown Very loose to compact		2	SS	9		181							
180.5			3	SS	14		180							
1.8	SAND (SM to SP-SM), some silt and clay, trace gravel, wet Brown Compact to dense		4	SS	23		179							
179.2	- grey, dense		5	SS	36		178							5 83 (13)
3.0			6	SS	33		177							
			7a	SS	28		176							
177.4	Silty CLAY (CL), trace sand, trace gravel, moist Grey Firm to hard		7b				175							
4.9	- hard		8	SS	34		174							
	- stiff		9	SS	10		173							3 17 46 34
			10	SS	10		172							
							171							
							170							
	- trace sand		11	SS	9									2 9 42 48
	- firm													
169.0			12	VT										
13.3	END OF BOREHOLE at approximately 13.3 m													
	Borehole caved to a depth of 1.6 m (Elev. 180.7 m) on completion of drilling													

\times^3, \times^3 : Numbers refer to Sensitivity \circ^3 STRAIN AT FAILURE

ONTARIO MOT 1012607.GPJ ONTARIO MOT.GDT 11/19/08

RECORD OF BOREHOLE No CR-10

1 OF 1

METRIC

W.P. 3038-03-00 LOCATION Highway 402, Stn.: 12+235 o/s: 30 m Lt, Twp of Sarnia; N4760887.9, E314091.1 ORIGINATED BY KH
 DIST London HWY 402 BOREHOLE TYPE Hollow Stem Auger, Split Spoon COMPILED BY MW
 DATUM Geodetic DATE 11.23.06 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/m ³	REMARKS & GRAIN SIZE DISTRIBUTION (%)
ELEV DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE	"N" VALUES			SHEAR STRENGTH kPa			W _p	W	W _L		
								○ UNCONFINED ● QUICK TRIAXIAL	✕ FIELD VANE ✕ LAB VANE						
182.2	Hwy 402 W.B. Rt. Shldr.							20 40 60 80 100							
0.0	SAND (FILL) (SP-SM / SW-SM), with organic matter, trace gravel, trace silt and clay, wet Brown Compact		1	SS	10		182								
181.3		2a													
0.9	SAND (SM to SP-SM), some silt and clay, wet Brown Compact	2b		SS	20		181								0 83 (17)
			3	SS	23		180								
			4	SS	15		179								
			5	SS	29		178								
			6	SS	13		177								
	- 50 mm silt seam with organic matter														
		7a		SS	22		176								0 88 (12)
		7b													
177.1															
5.1	Silty CLAY (CL), some sand, trace gravel, moist Grey Firm to stiff														
			8	SS	12		175								
	- wet		9	SS	9		174								
	- firm		10	SS	7		173								
							172								
							171								
							170								
			11	SS	9										
169.4															
12.8	END OF BOREHOLE at approximately 12.8 m														
	Groundwater measured at a depth of 1.4 m (Elev. 180.8 m) on completion of drilling														
	Borehole caved to a depth of approximately 1.7 m (Elev. 180.5 m) on completion of drilling														

\times^3, \times^3 : Numbers refer to Sensitivity \circ 3% STRAIN AT FAILURE

1955 and 2004 Investigation
Record of Borehole Sheets

RECORD OF BOREHOLE No C-1

1 OF 3

METRIC

PROJECT 041-130099-7

G.W.P. 3038-03-00

LOCATION N 4760839.1 E 313858.0

ORIGINATED BY LK

DIST 1 HWY 402

BOREHOLE TYPE MUD ROTARY / N TRICONE

COMPILED BY DCH

DATUM GEODETIC

DATE July 28, 2005 - July 29, 2005

CHECKED BY

SOIL PROFILE			SAMPLES			GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT			PLASTIC LIMIT w _p	NATURAL MOISTURE CONTENT w	LIQUID LIMIT w _L	UNIT WEIGHT γ	REMARKS & GRAIN SIZE DISTRIBUTION (%)
ELEV DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE	"N" VALUES			20 40 60 80 100	20 40 60 80 100	20 40 60 80 100					
183.03	GROUND SURFACE														
0.00	TOPSOIL, silty clay, Black														
0.18	(FILL), silty fine sand, Compact, Brown														
182.12	SAND, fine, some silt, trace gravel, Compact to dense, Brown becoming grey at about elevation 178.4m		1	SS	33		182								
0.91			2	SS	10		181								
			3	SS	10		180								
			4	SS	15		179								
			5	SS	20		178								
			6	SS	19		177								
177.85	SILTY FINE SAND, Loose, Gray		7	SS	8		176								
5.18	CLAYEY SILT with sand layers, Stiff, Gray		8	SS	6		175								
177.37			9	SS	25		174								
5.66	CLAYEY SILT, trace sand, trace gravel, Very stiff to stiff, Gray		10	SS	16		173								
176.70			11	SS	13		172								
6.33			12	SS	5		171								
			13	SS	4		170								
168.43	SILTY CLAY						169								
14.60															

ON MTO 041-130099-7.GPJ ON MOT.GDT 9/8/05

Continued Next Page

+ 3, X 3: Numbers refer to Sensitivity

○ 3% STRAIN AT FAILURE



ON_MTO 041-130099-7.GPJ ON MOT.GDT 9/8/05



RECORD OF BOREHOLE No C-2

1 OF 1

METRIC

PROJECT 041-130099-7

G.W.P. 3038-03-00

LOCATION N 4760896.0; E 313885.2

ORIGINATED BY LK

DIST 1 HWY 402

BOREHOLE TYPE POWER AUGER/HOLLOW STEM AUGERS

COMPILED BY DCH

DATUM GEODETIC

DATE July 22, 2005

CHECKED BY

SOIL PROFILE			SAMPLES			GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT					UNIT WEIGHT γ kN/m ³	REMARKS & GRAIN SIZE DISTRIBUTION (%)
ELEV DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE	"N" VALUES			20	40	60	80	100		
182.77	GROUND SURFACE													
0.00	(FILL), sand fine, trace silt, gravel, cinders, Loose, Brown		1	SS	6		182							
181.25														
1.52	TOPSOIL, silty, Loose, Black		2	SS	7		181							
180.84														
1.83	SAND, fine, some silt, trace gravel, Compact to dense, Brown		3	SS	23		180							
			4	SS	35									
			5	SS	24		179							
			6	SS	22		178							
			7	SS	20		177							
176.83														
5.94	SANDY SILT, trace clay Compact, Grey		8	SS	19		176							
176.07														
6.70	CLAYEY SILT, trace sand, shells Soft, Grey		9	SS	3		175							
			10	SS	4									
174.54														
8.23	LAYERED PEAT and organic silt, Firm, Grey		11	SS	5		174						75.9	
			12	SS	6								251	
173.02														
9.75	CLAYEY SILT, trace sand, gravel, sand seams, Stiff to very stiff, Grey		13	SS	8		173							
			14	SS	25		172							
171.19														
11.58	SILTY CLAY, trace sand, trace gravel, Stiff to very stiff, Grey		15	SS	12		171							
			16	SS	16		170							
169.36														
13.41	END OF BOREHOLE													
	Groundwater encountered during drilling at elevation 180.8m on July 22, 2005 Groundwater measured at elevation 180.8m August 3, 2005													

ON MTO 041-130099-7 GPJ ON MTO GDT 9805

+ 3, x 3: Numbers refer to
Sensitivity

○ 3% STRAIN AT FAILURE

SOIL INVESTIGATIONS AND TESTING LTD.

57 YONGE STREET SOUTH
TORONTO, ONTARIO
M5E 1B4

Job Name COLBORNE ROAD OVERPASS CAH # 402, SARNIA, ONTARIO.
Client PROCTOR, REDFERN & LAUGHLIN, (PROJECT - NO. E.O. 556)
DEPARTMENT OF HIGHWAYS, (WORK ORDER NO. 4-1081)

Order No. SI-55/9

Borehole No. 1 Diameter 2 1/2" Date MARCH 15th - 17th/55

Borehole Location Refer to plot plan.

Elevation 600.3'

Description	Elevation	Legend	SAMPLE	Depth	Thickness	Blows Split- tube	Depth To Water Below Ground Level
				0'-0"			140 lb. hammer 30" drop
Fine to coarse sand & fine to coarse gravel (moist)				3'-0"	1'-0"	24	
Medium dense grey fine to coarse sand & fine to coarse gravel (wet)			1	4'-0"			
As sample #1				7'-0"	1'-0"	18	
Medium grey silty sand (wet)			2	8'-0"			
As sample #2				11'-0"	1'-0"	42	
Dense grey fine silty sand (wet)			3	12'-0"			
As sample #3				16'-0"	1'-0"	19	
Medium dense grey fine silty sand containing decayed vegetation (wet)			4	17'-0"			
As sample #4				20'-0"	1'-0"	18	
Medium grey fine silty sand (wet)			5	21'-0"			
Grey clayey silt (moist)				22'-0"			
Very soft grey clayey silt and decayed vegetation (moist)			6	24'-0"	1'-0"	4	
As sample #6				25'-0"			
As sample #6				28'-0"	3'-0"	PUSHED SAMPLER	
Medium stiff grey peat with slight clay content & decayed vegetation (moist)			7	31'-0"	1'-0"	9	
Soft grey silty clay (moist)				32'-0"			
Hard greyish brown silty clay containing fine to medium gravel (slightly moist)			8	34'-0"	1'-0"	40	
As sample #8				35'-0"	1'-0"	45	
As sample #8				36'-0"			
Stiff grey clay containing coarse sand (moist)			9	38'-0"	1'-0"	15	
As sample #9				39'-0"			
Medium stiff grey clay containing coarse sand (moist)				42'-0"	1'-0"	10	
No change				43'-0"			
Stiff grey plastic clay containing fine gravel (moist)			10	46'-0"	1'-0"	14	
				47'-0"			

CONTINUED

SOIL INVESTIGATIONS ~~XXXXXXXXXXXX~~ LTD.

5 YONGE STREET SOUTH
~~XXXXXXXXXXXXXXXXXXXXXXXXXXXX~~
 BOX 747
 RICHMOND HILL, ONTARIO

Job Name COLBORNE ROAD OVERPASS CAM #402, SARNIA, ONTARIO.
 Client PROCTOR, REOFERN & LAUGHLIN, (PROJECT - NO. E.O. 556)
 DEPARTMENT OF HIGHWAYS, (WORK ORDER NO. 4-1081)

Order No. 51-55/9

Borehole No. 1 Diameter 2 1/2" Date MARCH 17th-18th/55

Borehole Location Refer to plot plan. Elevation 600.3'

Description	Elevation	Legend	SAMPLE	Depth	Thickness	Blows Split- tube	Depth To Water Below Ground Level
		CONTINUED		47'-0"			140 lb. hammer 30" drop
Stiff grey plastic clay containing fine gravel (moist) No change				51'-0"	1'-0"	15	
Stiff grey plastic clay containing 2" seam of grey fine silty sand (moist)			11	52'-0"			
Grey plastic clay (moist)				56'-0"	1'-0"	2	
Very soft grey clay with slight silt content (moist)			12	57'-0"			
As sample #12				61'-0"	1'-0"	3	
As sample #12				62'-0"			
As sample #12				66'-0"	1'-0"	12	
Medium stiff grey clay with a slight silt content (moist)			13	67'-0"			
As sample #13				71'-0"	1'-0"	14	
Stiff greyish blue clay (moist)			14	72'-0"			
As sample #14				81'-0"	1'-0"	13	
Stiff greyish blue clay with slight silt content containing fine gravel (moist)			15	82'-0"			
As sample #15				86'-0"	1'-0"	14	
As sample #15				87'-0"			
		HOLE COMPLETED					

5, YONGE STREET SOUTH
RICHMOND HILL, ONTARIO

Order No. 51-55/9

Borehole No. 2 Diameter $2\frac{1}{2}"$ Date MARCH 12th/55

Elevation 600.2'

Description	Elevation	Legend	SAMPLE	Depth	Thickness	Blows Split- tube	Depth To Water Below Ground Level
				0'-0"			140 lb. hammer 30" drop
Fine to coarse gravel (moist)							
				7'-0"			
Medium dense grey fine silty sand (highly saturated)			1	8'-0"	1'-0"	25	
As sample #1							
Dense grey fine silty sand (highly saturated)			2	12'-0"	1'-0"	35	
As sample #2							
Medium dense grey fine silty sand (wet)			3	16'-0"	1'-0"	24	
As sample #3							
As sample #3				20'-0"	1'-0"	22	
Soft grey clayey silt (moist)			4	25'-0"	1'-0"	5	
Very soft grey silty clay (moist)					5'-0"	PUSHED	SAMPLER
Very soft grey silty clay (moist)				30'-0"			
					3'-0"	PUSHED	SAMPLER
Soft brown peat containing thin seams of grey fine silty sand (moist)			5	34'-0"	1'-0"	7	
As sample #5							
Medium stiff grey silty clay containing seams of coarse grey sand (moist)				39'-0"	1'-0"	10	
				40'-0"	1'-0"	8	
	HOLE COMPLETED						

قوله تعالى

XXXXXXXXXXXXXXXXXXXXXXXXXXXX

PAUSE 7:45

INTERESTING TITLE, CONTAINS

Order No. SI-55/9

Borehole No. 3 Diameter 2 1/2"

Elevation 601.3'

Description	Elevation	Legend	Sample	Depth	Thickness	Blows Spill- Tube	Depth To Water Below Ground Level
							140 lb. Hammer 30" drop
Grey fine to coarse sand & coarse gravel (moist)				0'-0"			
Dense grey fine to medium sand & coarse gravel (moist)			1	3'-0" 4'-0"	3'-0" 1'-0"	35	
As sample #1							
Loose grey fine sand containing fine to coarse gravel (wet)			2	7'-0" 8'-0"	1'-0"	5	
Grey fine silty sand (highly saturated)							9'-0" 12:30 10' PM
Medium dense grey fine silty sand (highly saturated)			3	11'-0" 12'-0"	1'-0"	20	BAILED DRY 12 NOON
Grey fine silty sand (wet)							
Medium grey fine silty sand (wet)			4	15'-0" 16'-0"	1'-0"	12	
As sample #4							
Very stiff grey silty clay containing decayed vegetation (moist)			5	19'-0" 20'-0"	1'-0"	19	
Grey silty clay (moist)							19'
Grey silty clay containing decayed vegetation (jar sample)			6	22'-6" 23'-6" 24'-4" 25'-0"	1'-0" 0'-10"	27 33	WATER RISE 8 AM MARCH 11th
Hard greyish brown silty clay containing fine gravel (slightly moist)			7	26'-0" 27'-0" 28'-0" 29'-0"	1'-0" 1'-0" 1'-0" 1'-0"	31 24 24 20	2" SHELBY-TUBE
Very stiff greyish brown clay containing coarse sand and fine gravel (moist)			8	30'-0" 31'-0" 32'-0" 33'-0" 34'-0"	1'-0" 1'-0" 1'-0" 1'-0" 1'-0"	21 18 19 18 16	
Stiff grey silty clay with coarse sand content (moist)			9	35'-0" 36'-0"	1'-0" 1'-0"	14 12	
As sample #9							
As sample #9							
Medium stiff grey silty clay (moist)			10	39'-0" 40'-0"	1'-0"	10	
							26'

HOLE COMPLETED

5 YONGE STREET SOUTH
BOX 767
RECEIVED 1111. (ONTARIO)

Order No. SI-55/9

Borehole Location	Refer to plot plan	Elevation	601.0'
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Description	Elevation	Legend	SAMPLE	Depth	Thickness	Blows Split- tube	Depth To Wafer Below Ground Level
				0'-0"			140 lb. hammer 30" drop
Gray fine sand (moist)					3'-0"		
Medium gray fine to coarse sand & fine to medium gravel (wet) As sample #1			1	3'-0" 4'-0"	1'-0"	17	
Gray fine silty sand (wet) Dense gray fine silty sand (wet) As sample #2			2	6'-0" 7'-0" 8'-0"	1'-0"	31	6'-0"
Dense gray fine silty sand (highly saturated) As sample #3			3	12'-0" 13'-0"	1'-0"	31	
Lost sample As sample #3				16'-0" 17'-0" 17'-6" 18'-0"	1'-0"	28	
Stiff gray silty clay containing decayed vegetation (moist) Greyish brown silty clay containing coarse sand & fine gravel (slightly moist) Hard greyish brown clay containing coarse sand & fine gravel (slightly moist) As sample #5			4	18'-0" 19'-0"	1'-0"	14	
Very stiff greyish brown clay con- taining silt content, coarse sand & fine gravel (moist) As sample #6 becoming softer with depth			5	22'-0" 23'-0" 24'-0" 25'-0" 26'-0"	1'-0" 1'-0" 1'-0" 1'-0" 1'-0"	32 33 31 30	
Stiff greyish brown clay contain- ing fine to medium gravel (moist) As sample #7			6	27'-0" 28'-0" 29'-0"	1'-0" 1'-0" 1'-0"	27 27 24	
			7	32'-0" 33'-0"	1'-0"	13	
				36'-0" 37'-0" 38'-0" 39'-0" 40'-0"	1'-0" 1'-0" 1'-0" 1'-0" 1'-0"	11 12 10 11	
HOLE COMPLETED			8				

SOIL INVESTIGATIONS AND ENGINEERING LTD.

5 YONGE STREET SOUTH

 BOX 747
 RICHMOND HILL, ONTARIO

Job Name COLBORNE ROAD OVERPASS CAM #1102, GARRIA, ONTARIO.

Order No. 51-55/9

Client PROCTOR, REDFERN & LAUGHLIN, (PROJECT - NO. E.O. 556)
 DEPARTMENT OF HIGHWAYS, (WORK ORDER NO. 4-1081)

Borehole No. 4 Diameter 2 1/2" CONTINUED

Date MARCH 28th - 30th/55

Borehole Location Refer to plot plan.

Elevation 601.0'

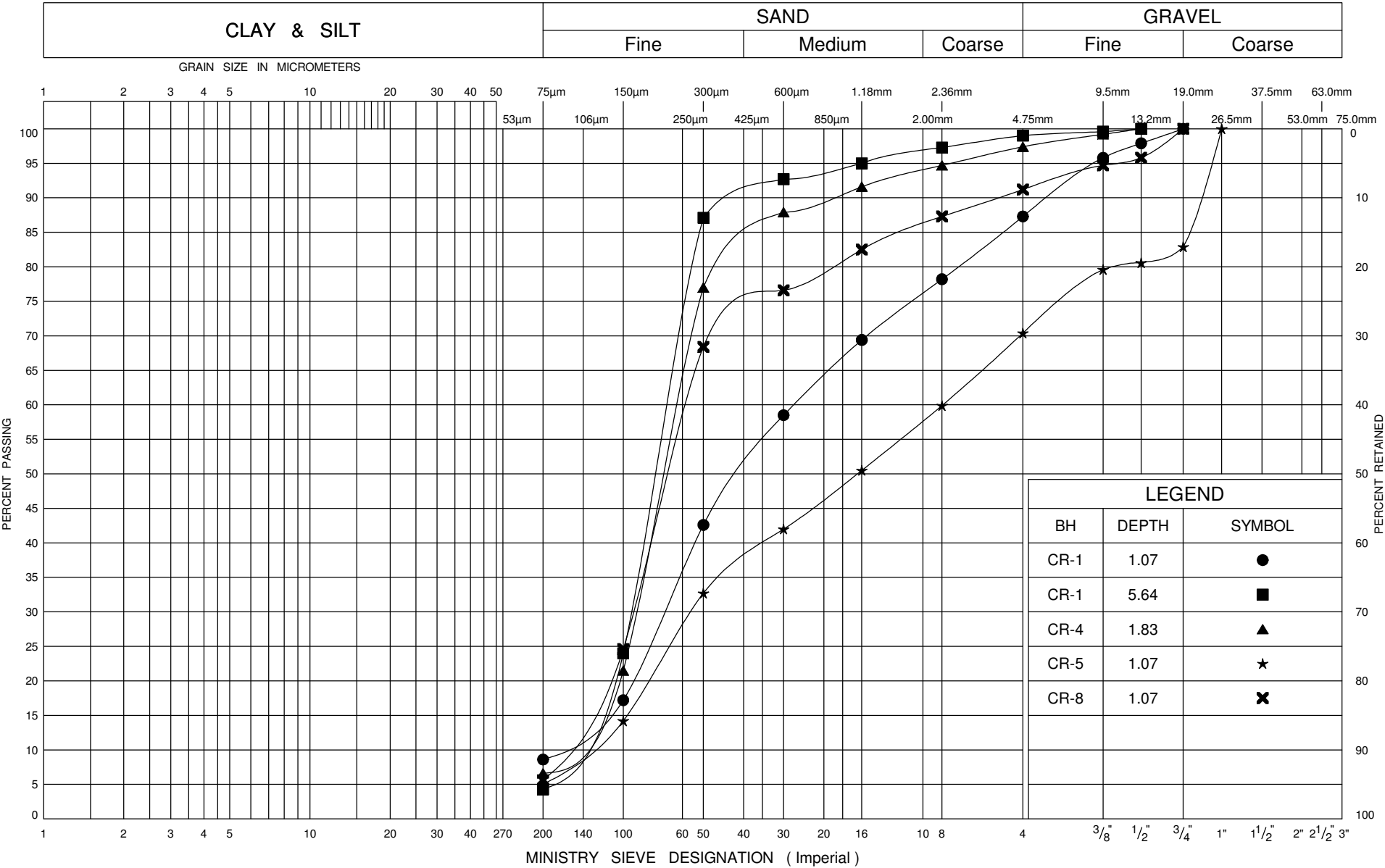
Description	Elevation	Legend	Depth	Thi	Blows split-	Depth To Water Below Ground Level
No sampling or soil classifications required			40'-0"	5'-0"	tube	140 lb. hammer 30" drop
Soft grey clay containing coarse sand & fine gravel (moist)			45'-0" 46'-0"	1'-0"	6	NO FREE WATER @ 46'
As sample #1						
Soft grey clay containing pieces of coarse sand & fine gravel (moist)			50'-0" 51'-0" 52'-0"	1'-0" 1'-0"	6 7	2" SHELBY TUBE
As sample #2 with pieces of medium gravel						
Soft grey clay containing pieces of coarse sand (moist)			57'-0" 58'-0"	1'-0"	4	
As sample #3						
Soft grey clay (moist)			62'-0" 63'-0" 64'-0"	1'-0" 1'-0"	5 8	2" SHELBY TUBE
Soft grey clay containing pieces of coarse sand & fine to medium gravel (moist)						
No change			69'-0" 70'-0"	1'-0"	8	
No change						
Medium stiff grey clay containing pieces of coarse sand & fine gravel (moist)			75'-0" 76'-0"	1'-0"	12	HOLE DRY @ 76'
Medium stiff grey clay containing pieces of fine to medium & coarse gravel (moist)			79'-0" 80'-0" 81'-0"	1'-0" 1'-0"	12 14	HOLE DRY @ 81'
Medium stiff grey clay containing pieces of fine to medium gravel (moist)			82'-0" 83'-0" 84'-0"	1'-0" 1'-0"	10 15 20	
Drove 2" cross chopping bit			85'-0" 86'-0" 87'-0" 88'-0" 89'-0" 90'-0" 91'-0" 92'-0" 93'-0" 94'-0" 95'-0"	1'-0" 1'-0" 1'-0" 1'-0" 1'-0" 1'-0" 1'-0" 1'-0" 1'-0" 1'-0"	36 48 57 59 63 61 77 72 92 93	similar to driving dynamic cone

* Same as sample #7

Appendix C

Geotechnical Laboratory Test Results

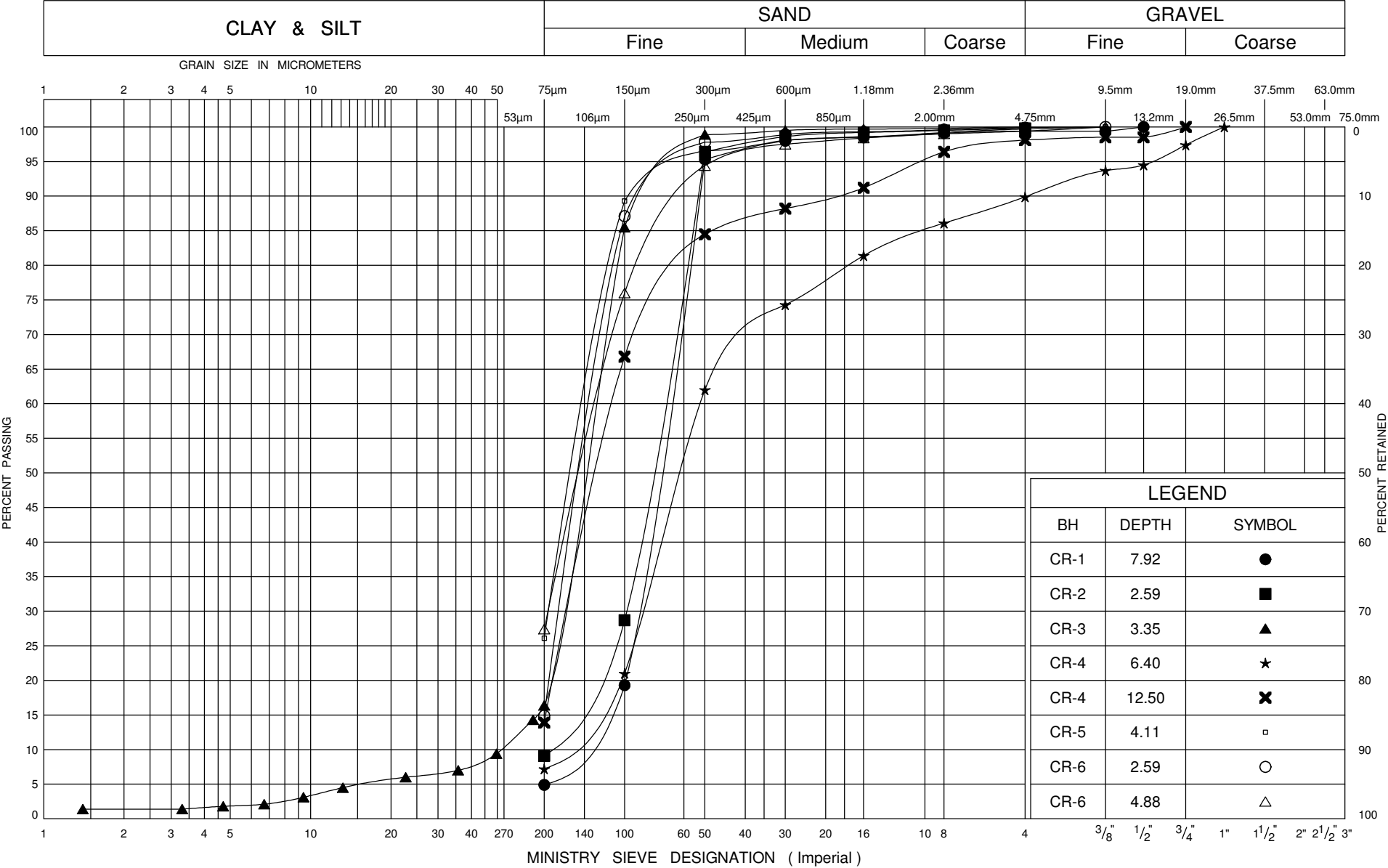
UNIFIED SOIL CLASSIFICATION SYSTEM



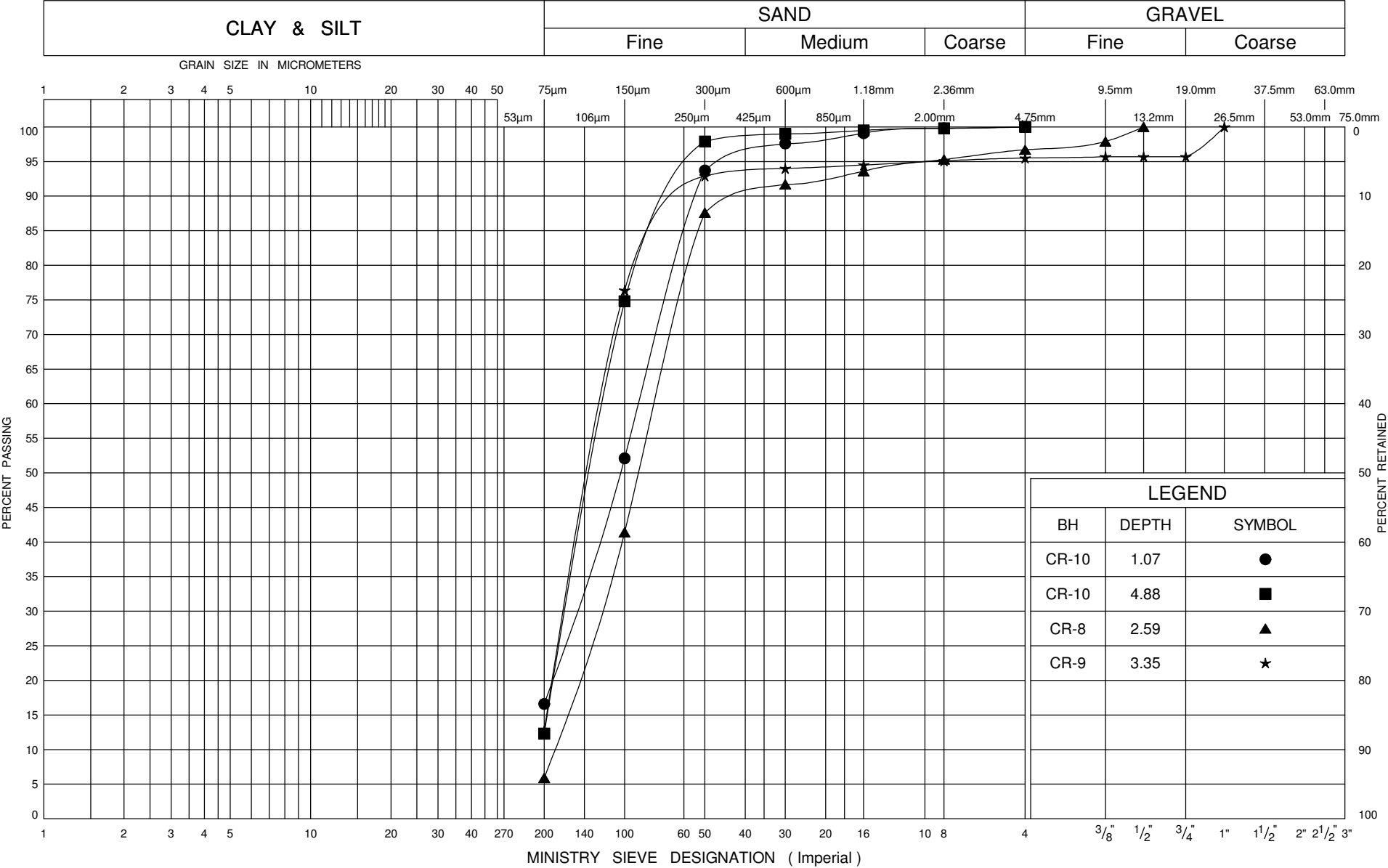
GRAIN SIZE DISTRIBUTION
Sand Fill (SP-SM / SW-SM)

FIG No 1
W P 3038-03-00
Hwy 402, Township of Sarnia

UNIFIED SOIL CLASSIFICATION SYSTEM



UNIFIED SOIL CLASSIFICATION SYSTEM



GRAIN SIZE DISTRIBUTION
Native Sand (SM to SP-SM)

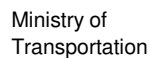
FIG No 3
W P 3038-03-00
Hwy 402, Township of Sarnia

GRAIN SIZE IN MICROMETERS

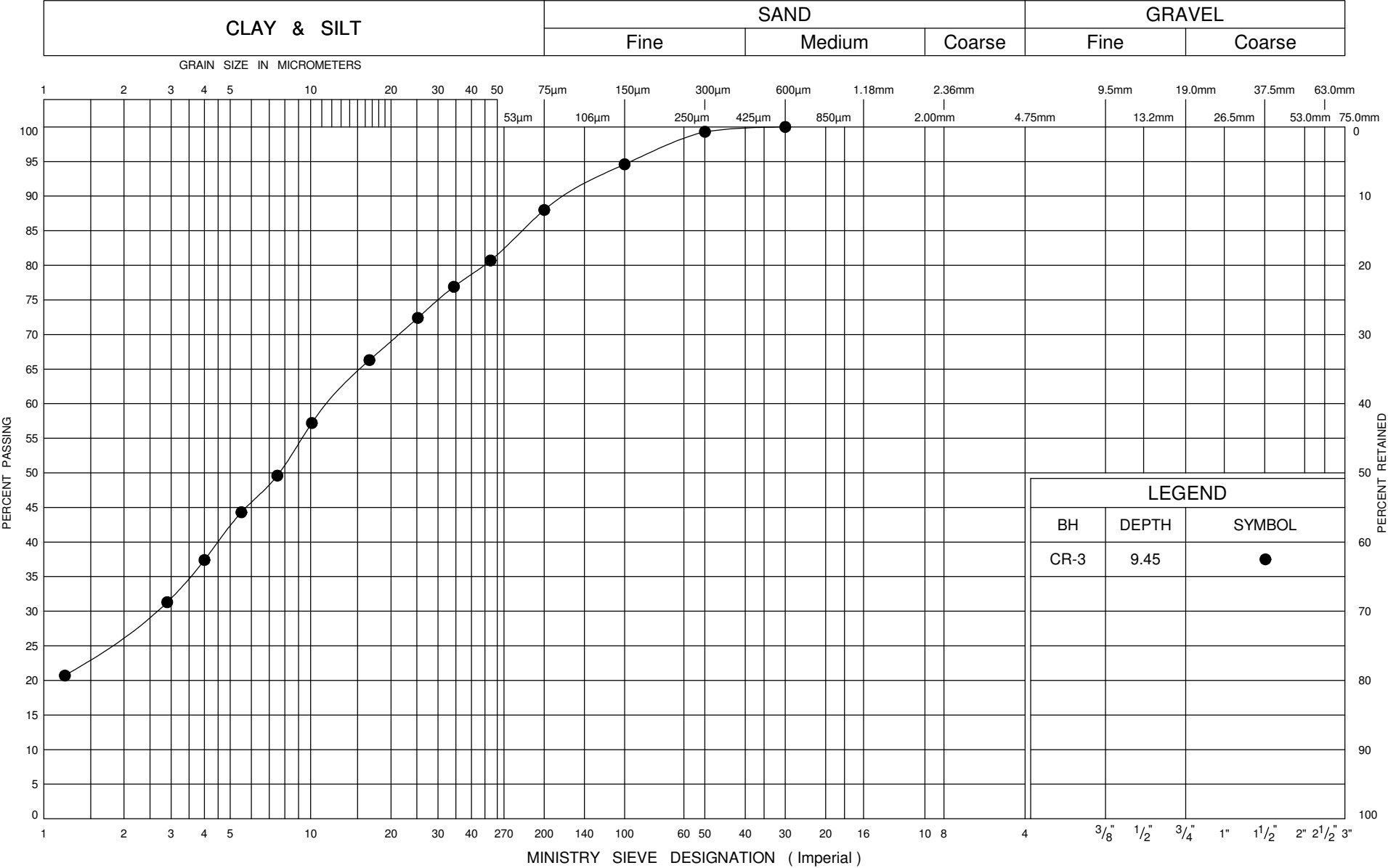


MINISTRY SIEVE DESIGNATION (Imperial)

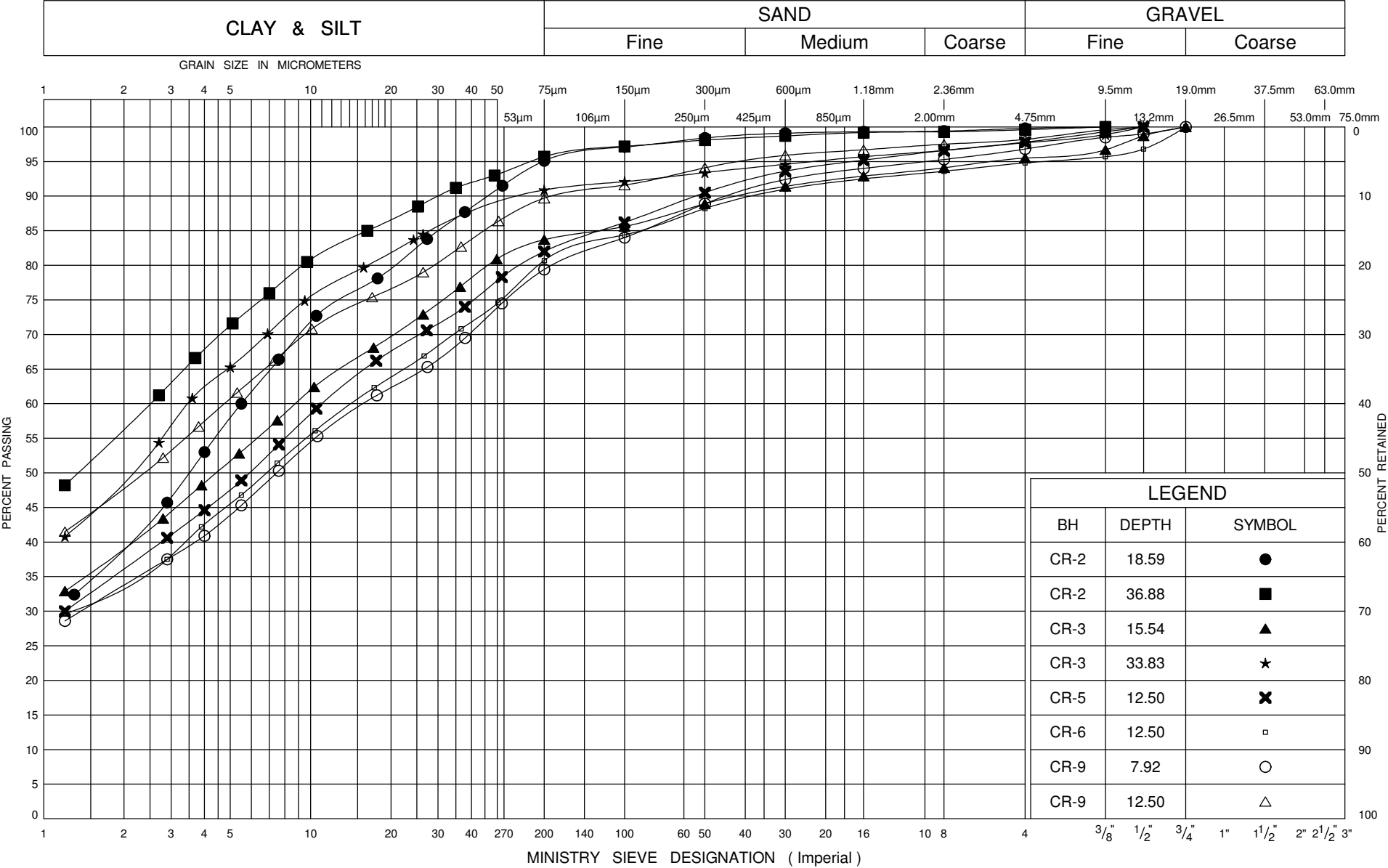
Hwy 402, Township of Sarnia



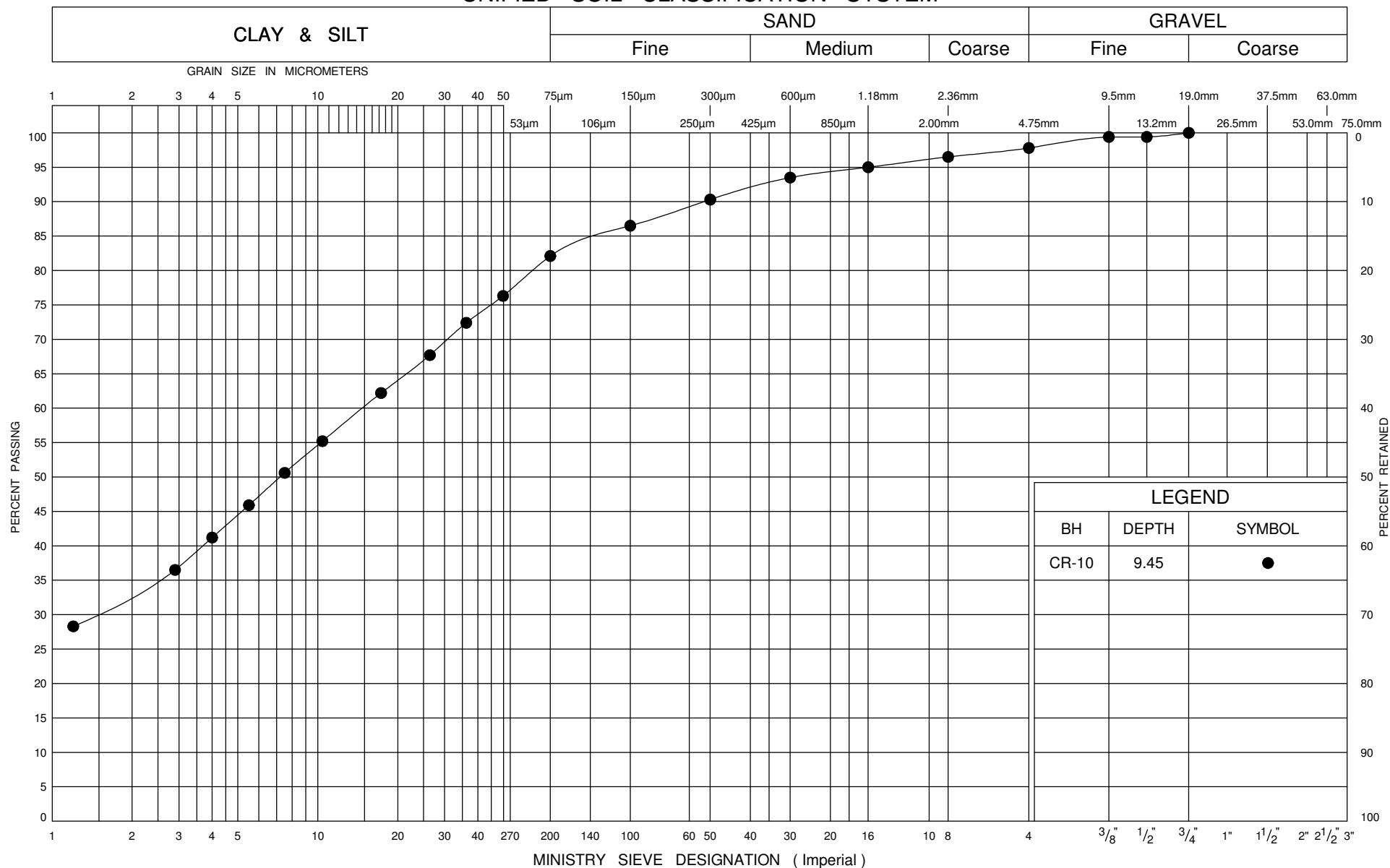
UNIFIED SOIL CLASSIFICATION SYSTEM



UNIFIED SOIL CLASSIFICATION SYSTEM



UNIFIED SOIL CLASSIFICATION SYSTEM



Ministry of
Transportation

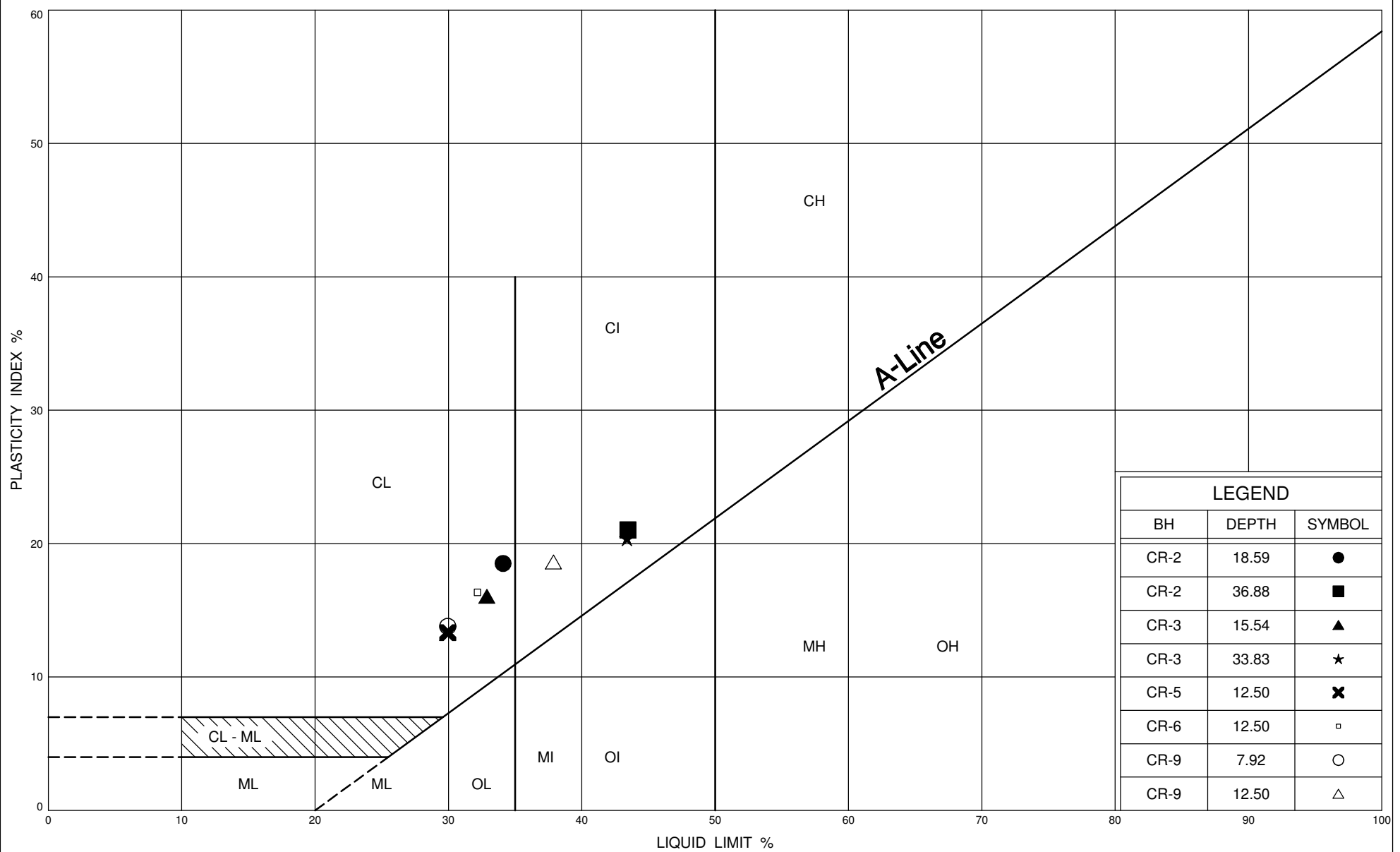
GRAIN SIZE DISTRIBUTION

Silty Clay (CL)

FIG No 7

W P 3038-03-00

Hwy 402, Township of Sarnia



Ministry of
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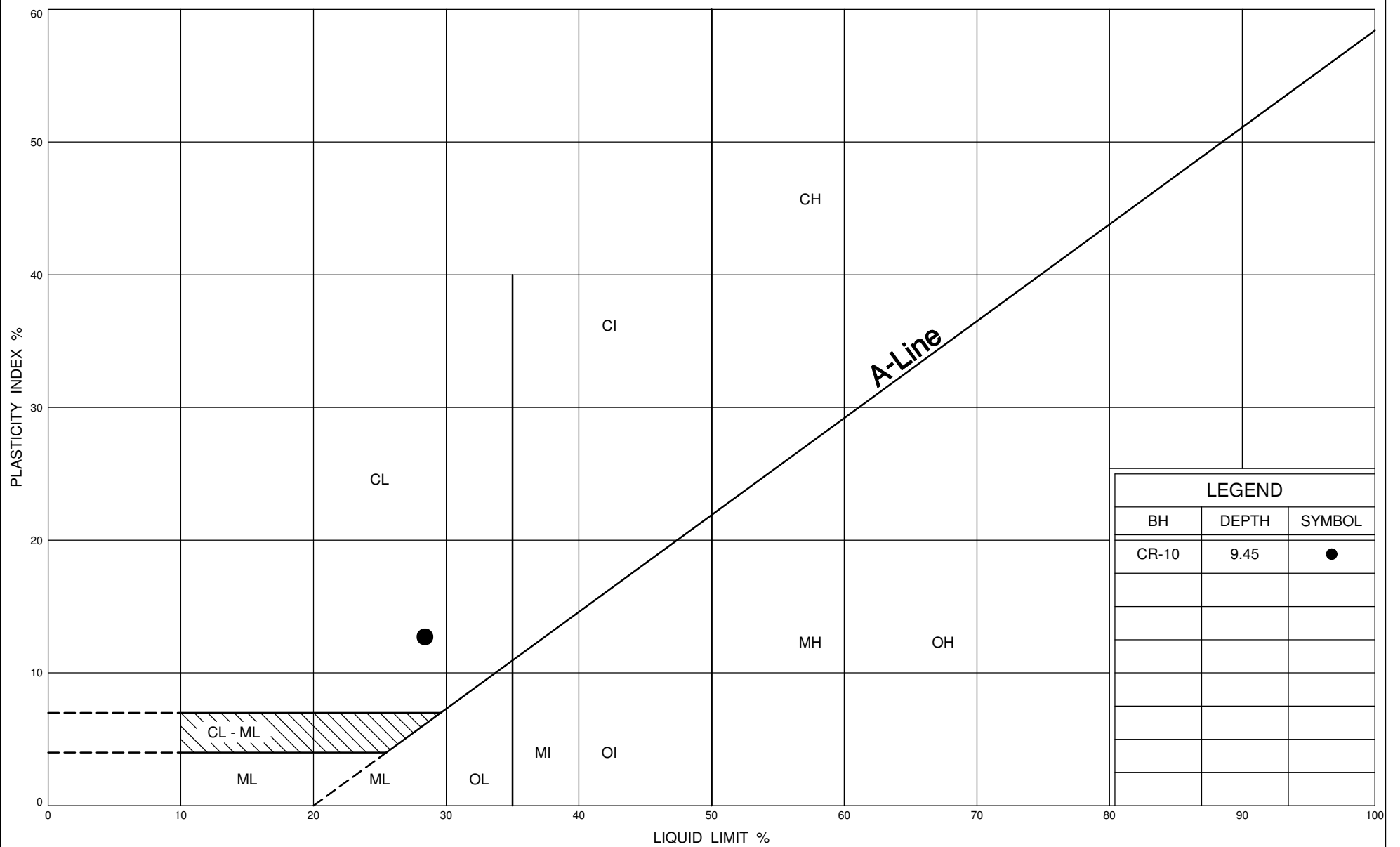
PLASTICITY CHART

Silty Clay (CL)

FIG No 8

W P 3038-03-00

Hwy 402, Township of Sarnia



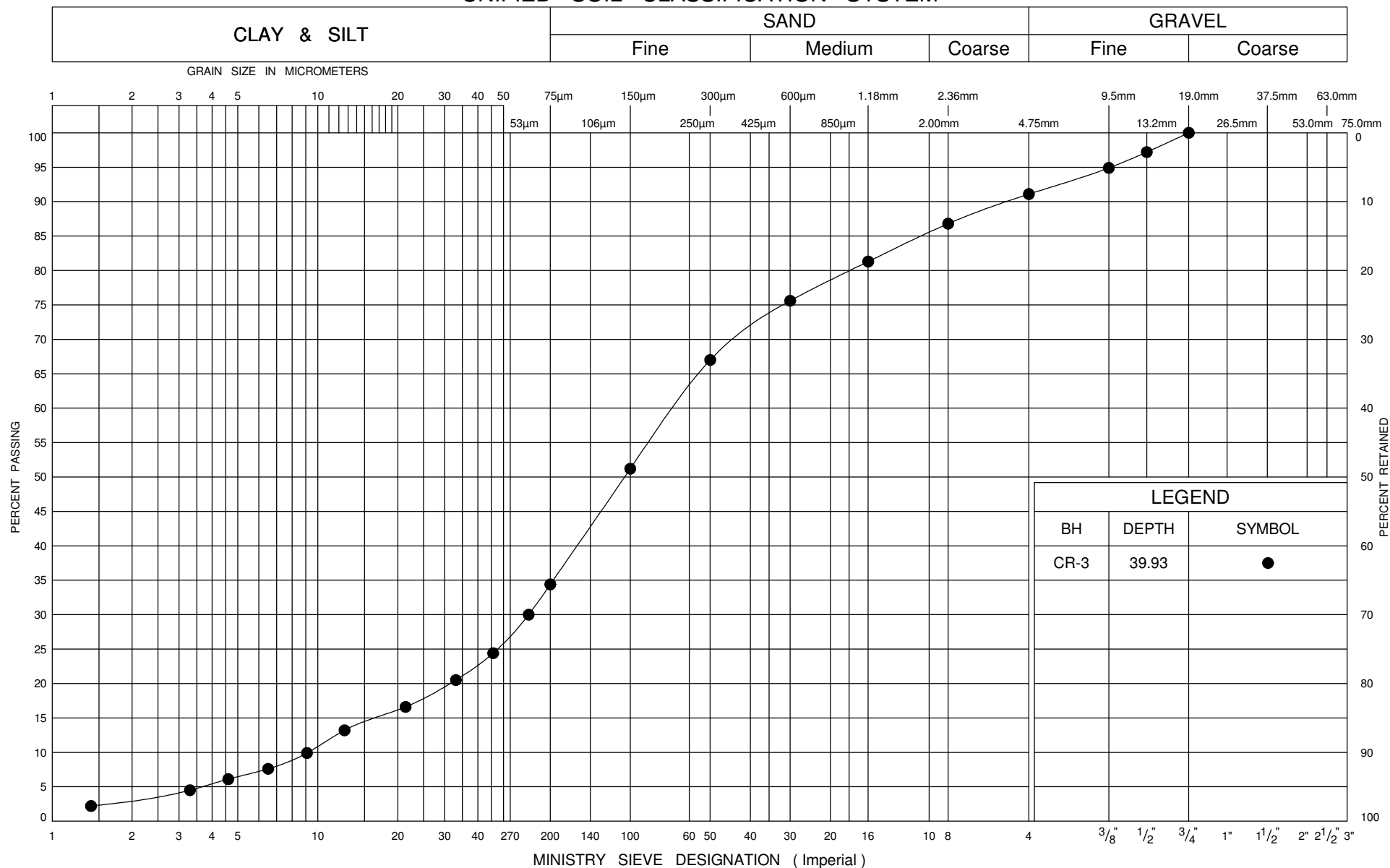
PLASTICITY CHART Silty Clay (CL)

FIG No 9

W P 3038-03-00

Hwy 402, Township of Sarnia

UNIFIED SOIL CLASSIFICATION SYSTEM



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Transportation

GRAIN SIZE DISTRIBUTION
Silty Sand (SM)

FIG No 10

W P 3038-03-00

Hwy 402, Township of Sarnia



**Jacques Whitford
Limited**

7271 Warden Ave,
Markham, Ontario
L3R 5X5
Tel: (905) 474 -7700
Fax: (905) 479-9326

**Density/Bulk Unit Weight
Of Soil Specimen**

Figure 10

Client: Stantec / Ontario Ministry of Transportation

Project No.: 1012607

Location: Highway 402, Sarnia, Ontario

Date Sampled: 01 Dec, 2006

Date Tested: 20 Dec, 2006

Tested By: HW

	<i>Unit</i>		1	2
Borehole No.			BH (CR5-8)	BH (CR9-7B)
Mass of soil specimen in air	<i>gms</i>	A	157.1	154.5
Mass of soil specimen in liquid (oil)	<i>gms</i>	B	96.2	97.1
Mass of Liquid displaced	<i>cc</i>	C=(A-B)	60.9	57.4
Specific Gravity of Liquid (oil)		γ_L	0.8714	0.8714
Density of soil sample	<i>Kg/m³</i>	$D = 1000A*\gamma_L / (A-B)$	2248	2345
Unit Weight of soil sample	<i>KN/m³</i>	$U = D*0.009807$	22.1	23.0

Appendix D

Representative Site Photographs



Photo 1: Colborne Road Overpass (east abutment) - looking south from Colborne Road.



Photo 2: Colborne Road Overpass (west abutment) - looking south from Colborne Road.