

**FOUNDATION INVESTIGATION REPORT
RETAINING WALLS AND NOISE BARRIER WALLS
HIGHWAY 417 WIDENING
NICHOLAS STREET TO O.R.174
OTTAWA, ONTARIO**

G.W.P. 4091-07-00 and 4320-06-00

Geocres Number: 31G5-250

Report to

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Appendices A through H include: Record of Borehole Sheets
 Laboratory Test Results
 Borehole Locations and Soil Strata Drawings

Appendix I includes: Record of Borehole Sheets
 Borehole Location and Soil Strata Drawings

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PART 1: FACTUAL INFORMATION

1 INTRODUCTION

This report presents the factual data obtained from a foundation investigation carried out by Thurber Engineering Ltd. (Thurber) at proposed retaining wall and noise barrier locations along Highway 417 from Nicholas Street to O.R.174 in Ottawa, Ontario. These retaining walls and noise barriers are part of the Highway 417 Widening project. This report addresses all retaining walls and noise barriers included in the Highway 417 Widening final design, as identified by McCormick Rankin Corporation (MRC).

Twelve retaining walls (identified as 12N, 13N, 14N, 15N, 16N, 17N, 18N, 19N, 21S, 22S, 23S, and 1M) and one section of noise barrier (at Lees Avenue North) were initially proposed and investigated. During the course of the foundation investigation, four additional retaining walls were added to the highway widening design (identified as Nicholas Street Underpass South, Lees Avenue S-E Ramp, Lees Avenue North at Robinson Avenue, and Canadian Tire Parking Lot). Six of the initially proposed walls were also eliminated from the final design after boreholes had already been drilled at these locations (17N, 18N, 19N, 21S, 22S, 1M).

The purpose of this investigation was to explore the subsurface conditions along the proposed retaining wall and noise barrier alignments and, based on the data obtained, to provide borehole location plans, record of borehole sheets, stratigraphic profiles, laboratory test results and a written description of the subsurface conditions. A model of the subsurface conditions under the proposed retaining walls and noise barriers was developed from the data obtained in the course of the investigation.

Thurber carried out the investigation as a sub-consultant to McCormick Rankin Corporation, under the Ministry of Transportation Ontario (MTO) Agreement Number 4009-E-0007.

2 SITE DESCRIPTION

Highway 417 is currently a 3 to 4 lane divided highway. The widening of Highway 417 from Nicholas Street to O.R.174 includes the installation of new retaining walls and noise barriers. From Nicholas Street to O.R.174 along Highway 417 is approximately 4 km. Highway 417 crosses over the Rideau River approximately 805 m east of Nicholas Street.

The lands surrounding Highway 417 between Nicholas Street and O.R.174 primarily comprise commercial and industrial developments.

The Highway 417 project area lies within the Ottawa Valley Clay Plains physiographic region, a clay plains interrupted by ridges of sand or rock. The bedrock consists of the Carlsbad Formation, comprising dark grey shale interbedded with calcareous siltstone and limestone.

3 SITE INVESTIGATION AND FIELD TESTING

The site investigation and field testing for this project were carried out between July 18, 2011 and May 3, 2012 and consisted of drilling and sampling a total of fifty-four (54) boreholes for thirteen proposed retaining walls and one noise barrier wall. Subsequent to drilling, six of the proposed walls were deleted. A summary of the currently proposed retaining wall and noise barrier locations, the deleted wall designations, and corresponding boreholes is presented in Table 3.1.

The respective appendices, which include Record of Borehole sheets, laboratory test results, and Borehole Locations and Soil Strata Drawings for each wall, are also listed in Table 3.1.

The approximate locations of the boreholes are shown on the Borehole Locations and Soil Strata Drawings included in Appendix A through I. The coordinates and elevations of the boreholes are given on the drawings and on the individual Record of Borehole sheets.

The borehole locations were marked in the field, where possible and utility clearances were obtained prior to commencement of drilling operations. Boreholes were repositioned as necessary to avoid conflicts with utilities. A City of Ottawa Road Cut Permit was obtained for the two boreholes drilled on Robinson Avenue (Boreholes LE-08 and LE-09).

The drilling was carried out using both a track-mounted and a truck-mounted drill rig. A combination of hollow-stem auger drilling techniques and NQ coring methods were used to advance the boreholes. Overburden samples were obtained at selected intervals using a split spoon sampler in conjunction with Standard Penetration Testing (SPT). Where bedrock was encountered within the programmed exploration depth, cores of the rock were recovered. All rock cores were logged, and the Total Core Recovery (TCR), Solid Core Recovery (SCR), Rock Quality Designation (RQD) and the Fracture Indices (FI) were determined. The borehole depths ranged from 1.6 m to 14.6 m.

Table 3.1 – Summary of Proposed Retaining Walls and Noise Barriers and Corresponding Boreholes

Proposed Wall	Approx. Station	Length (m)	Boreholes	Appendix
Nicholas Street Underpass (South)	130+329 to 130+366	37	NSW-1 and NSW-2	A
Lees Avenue S-E Ramp	10+290 to 10+375	85	LSER-01 to LSER-04	B
Lees Avenue (North) at Robinson Avenue	230+718 to 230+751	33	LE-08 and LE-09	C
Lees Avenue (North) Noise Barrier	230+680 to 231+080	400	12N-01, 12N-02, 13N-01, NB8-01, 14N-01 to 03	D
Canadian Tire Parking Lot – Riverside to Belfast (North)	210+902 to 211+000	98	15N-01, CTW-1, CTW-2, OHS-07L	E
Belfast Road (North) Wall 15N	211+220 to 211+700	480	15N-01 to 15N-12	F
Belfast Road (South) Wall 23S	111+025 to 111+705	680	23S-01 to 23S-09	G
St. Laurent Blvd. N-W Ramp Wall 16N	212+000 to 212+200	200	16N-1 to 16N-3	H
Wall 21S	Cancelled		21S-01 to 21S-03	I
Wall 22S	Cancelled		22S-01 and 22S-02	I
Wall 1M	Cancelled		1M-01 and 1M-02	I
Wall 17N	Cancelled		17N-02	I
Wall 18N	Cancelled		18N-1 to 18N-3	I
Wall 19N	Cancelled		19N-1 and 19N-2	I

Groundwater conditions were observed in the open boreholes throughout the drilling operations, where possible. Standpipe piezometers consisting of 19 mm diameter PVC pipe with a slotted screen were installed in selected boreholes for monitoring of stabilized groundwater levels. The installation details of the piezometers are summarized in Table 3.2. Following the final water level reading, the piezometers will be decommissioned in general accordance with MOE Regulation 903.

Table 3.2 – Piezometer Installation Details

Borehole	Tip Position (m)		Completion Details
	Depth	Elev.	
NSW-1	11.9	47.2	Sand filter from 13.9 to 10.1 m, bentonite from 10.1 to 0.3 m, then asphalt to surface. Flush-mount casing protector at surface.
LSER-01	11.4	47.6	Sand filter from 11.4 to 6.9 m, bentonite from 6.9 to surface. Flush-mount casing protector at surface.
LSER-03	10.7	49.0	Sand filter from 11.3 to 5.8 m, bentonite from 5.8 to 0.9 m, sand from 0.9 to 0.2 m, then asphalt to surface. Flush-mount casing protector at surface.
LSER-04	11.8	48.1	Sand filter from 11.8 to 9.0 m, bentonite from 9.0 to 3.3 m, cuttings from 3.3 to 0.9 m, sand from 0.9 to 0.2 m, then asphalt to surface. Flush-mount casing protector at surface.
LE-08	8.9	51.8	Sand filter from 8.9 to 6.9 m, bentonite from 6.9 to 1.2 m, cuttings from 1.2 to 0.3 m, sand from 0.3 to 0.2 m, then asphalt to surface. Flush-mount casing protector at surface.
LE-09	7.6	52.9	Sand filter from 7.6 to 5.5 m, bentonite from 5.5 to 1.2 m, cuttings from 1.2 to 0.3 m, sand from 0.3 to 0.2 m, then asphalt to surface. Flush-mount casing protector at surface.
12N-02	4.6	56.3	Sand filter from 4.6 to 2.5 m, bentonite from 2.5 to 1.9 m, cuttings and bentonite mixture from 1.9 to 0.2 m, then asphalt cold patch to surface. Flush-mount casing protector at surface.
13N-01	6.1	54.3	Sand filter from 6.1 to 4.0 m, bentonite from 4.0 to 3.4 m, cuttings and bentonite mixture from 3.4 to 0.2 m, then asphalt cold patch to surface. Flush-mount casing protector at surface.
14N-02	6.1	54.0	Sand filter from 6.1 to 4.0 m, bentonite from 4.0 to 3.4m, cuttings and bentonite mixture from 3.4 to 0.2 m, then asphalt cold patch to surface. Flush-mount casing protector at surface.
CTW-1	10.1	50.9	Sand filter from 10.1 to 6.1 m, bentonite from 6.1 to 0.6 m, sand from 0.6 to 0.3 m, then asphalt to surface. Flush-mount casing protector at surface.
15N-01	4.6	56.5	Sand filter from 4.6 to 1.2 m, bentonite from 1.2 to 0.2 m, then asphalt cold patch to surface. Flush-mount casing protector at surface.
15N-03	5.3	56.6	Sand filter from 5.3 to 1.8 m, bentonite from 1.8 to 0.2 m, then asphalt cold patch to surface. Flush-mount casing protector at surface.
15N-05	5.3	57.5	Sand filter from 5.3 to 3.1 m, bentonite from 3.1 to 0.2 m, then asphalt cold patch to surface. Flush-mount casing protector at surface.
15N-07	4.6	59.9	Sand filter from 6.4 to 1.2 m, bentonite from 1.2 to 0.2 m, then asphalt cold patch to surface. Flush-mount casing protector at surface.
15N-09	3.1	63.1	Sand filter from 4.3 to 0.6 m, bentonite from 0.6 to 0.2 m, then asphalt cold patch to surface. Flush-mount casing protector at surface.

Borehole	Tip Position (m)		Completion Details
	Depth	Elev.	
15N-11	4.6	63.3	Sand filter from 4.6 to 1.2 m, bentonite from 1.2 to 0.3 m, cuttings from 0.3 to 0.2 m, then asphalt cold patch to surface. Flush-mount casing protector at surface.
23S-02	5.5	57.0	Sand filter from 5.5 to 2.1 m, bentonite from 2.1 to 0.2 m, then asphalt cold patch to surface. Flush-mount casing protector at surface.
23S-04	3.7	60.3	Sand filter from 8.0 to 1.8 m, bentonite from 1.8 to 0.9 m, cuttings from 0.9 to 0.2 m, then asphalt cold patch to surface. Flush-mount casing protector at surface.
23S-06	3.1	62.7	Sand filter from 4.3 to 0.9 m, bentonite from 0.9 to 0.2 m, then asphalt cold patch to surface. Flush-mount casing protector at surface.
23S-08	3.1	64.3	Sand filter from 4.3 to 0.9 m, bentonite from 0.9 to 0.2 m, then asphalt cold patch to surface. Flush-mount casing protector at surface.
16N-1	7.6	62.3	Sand filter from 7.6 to 4.3 m, bentonite from 4.3 to 2.5 m, cuttings from 2.5 to 0.1 m, then asphalt cold patch to surface. Flush-mount casing protector at surface.
16N-3	5.2	63.3	Sand filter from 5.2 to 3.4 m, bentonite from 3.4 to 2.1 m, cuttings from 2.1 to 0.1 m, then asphalt cold patch to surface. Flush-mount casing protector at surface.
21S-01	4.6	55.6	Sand filter from 4.6 to 2.8 m, bentonite from 2.8 to 2.1 m, cuttings from 2.1 to surface.
21S-03	4.6	55.8	Sand filter from 4.6 to 2.8 m, bentonite from 2.8 to 2.1 m, cuttings from 2.1 to surface.
22S-02	4.6	55.9	Sand filter from 4.6 to 2.8 m, bentonite from 2.8 to 2.1 m, cuttings from 2.1 to surface.
1M-02	3.0	57.8	Sand filter from 3.0 to 1.2 m, bentonite from 1.2 to 0.3 m, then concrete to surface.

The drilling and sampling operations were supervised on a full time basis by a member of Thurber's technical staff. The supervisor logged the boreholes and processed the recovered soil and bedrock samples for transport to Thurber's laboratory for further examination and testing.

4 LABORATORY TESTING

The recovered soil samples were subjected to Visual Identification (VI) and to natural moisture content determination. Selected samples were also subjected to gradation analysis (sieve and hydrometer) and Atterberg Limits testing, where appropriate. The results of this testing program are summarized on the Record of Borehole sheets and plotted on the figures included in Appendix A through Appendix I.

Point load tests were carried out on selected samples of intact bedrock core to assist in evaluation of the compressive strength of the bedrock. Results of the point load tests are included on the Record of Borehole sheets in Appendix A to I (as average per core run).

5 DESCRIPTION OF SUBSURFACE CONDITIONS

Reference is made to the Record of Borehole sheets and to the Borehole Locations and Soil Strata Drawings included in Appendix A through I for the details of the encountered soil stratigraphy. An overall description of the stratigraphy encountered in the boreholes at each currently proposed retaining wall and noise barrier is given in the following paragraphs. However, the factual data presented in the borehole logs takes precedence over this general description and interpretation of the site conditions. It must be recognized that soil conditions may vary between and beyond borehole locations.

More detailed descriptions of the individual strata encountered at each of the currently proposed walls are presented below. The Record of Borehole sheets for boreholes drilled at deleted wall locations (Appendix I) are provided for information purposes only.

5.1 Nicholas Street Underpass (South) – Station 130+329 to 130+366 (Appendix A: Boreholes NSW-1 and NSW-2)

Two boreholes, identified as NSW-1 and NSW-2, were drilled on the right shoulder of the Nicholas Street N-E ramp along the proposed alignment of the retaining wall under Nicholas Street at the south abutment. The stratigraphy encountered in the boreholes consisted of a pavement structure and sand fill underlain by successive layers of sand, silty clay, silt and silty sand till. Shale was encountered below the till.

5.1.1 Asphalt and Concrete

Asphalt was encountered at surface in both boreholes drilled at this location. The thickness of the asphalt ranged from 75 mm to 100 mm.

A layer of concrete was encountered below the asphalt in Borehole NSW-1, only. The concrete was 350 mm thick.

5.1.2 Sand Fill

A layer of sand fill was encountered below the asphalt in Borehole NSW-2 and below the concrete in Borehole NSW-1. The sand fill was brown and contained trace to some gravel and trace silt.

The sand fill was 1.9 m thick in Borehole NSW-1 and 2.2 m thick in Borehole NSW-2. The lower boundary of the sand fill was encountered at a depth of 2.3 m in both boreholes (Elevation 56.8).

SPT N-values recorded in the sand fill ranged from 22 to 45 blows for 0.3 m, indicating a compact to dense relative density.

The moisture content of samples of the sand fill ranged from 4% to 11%.

One sample of the sand fill was selected for laboratory grain size analysis testing. The results of this test are summarized below. These results are also presented on the corresponding Record of Borehole sheet included in Appendix A and the grain size distribution curve for this sample is plotted on Figure A1, Appendix A.

Gravel %	14
Sand %	80
Silt & Clay %	6

5.1.3 Sand

Native sand was encountered below the sand fill in both boreholes. The native sand was brown to grey and contained trace to some silt, trace gravel and trace clay. The native sand encountered in Borehole NSW-1 became more coarse with increased depth.

The thickness of the native sand layer ranged from 0.7 m in Borehole NSW-2 to 1.7 m in Borehole NSW-1. The lower boundary of the native sand was encountered at depths of 3.0 m to 4.0 m (Elevation 56.1 to 55.1).

SPT N-values recorded in the native sand layer ranged from 7 to 23 blows for 0.3 m penetration, indicating a loose to compact relative density.

The moisture content of samples of the native sand ranged from 10% to 20%.

5.1.4 Silty Clay

A layer of silty clay was encountered below the native sand in both boreholes. The silty clay was grey in colour and contained trace sand.

The thickness of the silty clay layer was 2.1 m and 1.6 m in Boreholes NSW-1 and NSW-2, respectively. The lower boundary of the silty clay was encountered at a depth of 6.1 m in Borehole NSW-1 and at a depth of 4.6 m in Borehole NSW-2 (Elevation 53.0 and 54.5).

SPT N-values of 4 and 6 blows for 0.3 m penetration were recorded in the silty clay. These N-values indicate that the silty clay has a soft to firm consistency.

The moisture content of two samples of the silty clay were 46% and 48%.

One sample of the silty clay underwent laboratory grain size analysis and Atterberg Limits testing, the results of which are summarized below. These results are presented on the corresponding Record of Borehole sheet in Appendix A and the lab results are plotted on Figures A2 and A5.

Gravel %	0
Sand %	2
Silt %	48
Clay %	50
Liquid Limit%	44
Plastic Limit %	20

The Atterberg Limits indicate that the clay is of medium plasticity with a symbol of CI.

5.1.5 Silt

Below the silty clay, a layer of silt was encountered in both boreholes. The silt was grey and contained trace to some sand and trace to some clay.

The layer of silt was 3.0 m thick in Borehole NSW-1 and 2.7 m thick in Borehole NSW-2. The lower boundary of the silt was encountered at depths of 9.1 m and 7.3 m (Elevation 50.0 and 51.8).

SPT N-values recorded in the silt ranged from 7 to 13 blows for 0.3 m penetration, indicating a loose to compact relative density.

The moisture content of samples of the silt ranged from 17% to 36%.

Two samples of the silt underwent laboratory grain size analysis testing, the results of which are summarized below. These results are also presented on the Record of Borehole sheets included in Appendix A and the grain size distribution curves for these samples are plotted on Figure A3, Appendix A.

Gravel %	0
Sand %	6 to 8
Silt %	77 to 88
Clay %	6 to 15

5.1.6 Silty Sand Till

Silty sand till was encountered below the silt layer in both boreholes. The silty sand till was grey and contained trace clay to clayey and trace to some gravel.

The thickness of the silty sand till was 4.8 m in Borehole NSW-1 and 6.6 m in Borehole NSW-2. In Borehole NSW-1, the lower boundary of the silty sand till was inferred from auger refusal on probable bedrock at a depth of 13.9 m (Elevation 45.2). The lower boundary of the silty sand till was encountered at a depth of 13.9 m in Borehole NSW-2 (Elevation 45.2).

SPT N-values recorded in the silty sand till ranged from 2 blows for 0.3 m penetration to 50 blows for 0.15 m penetration, indicating that the relative density of the silty sand till

varies from very loose to very dense. Based on the recorded SPT N-values, the silty sand till generally has a compact relative density.

The moisture content of the silty sand till ranged from 7% to 13%.

Two samples of the silty sand till underwent laboratory grain size analysis testing. The results of these tests are summarized below and are also presented on the Record of Borehole sheets included in Appendix A. The grain size distribution curves for these samples are plotted on Figure A4, Appendix A.

Gravel %	10
Sand %	39 to 53
Silt %	27 to 29
Clay %	10 to 23

It should be noted that glacial tills inherently contain cobbles and boulders.

5.1.7 Bedrock

Probable bedrock was encountered below the till in both boreholes. Borehole NSW-1 was terminated at a depth of 13.9 m upon auger refusal on probable bedrock (Elevation 45.2). Borehole NSW-2 encountered bedrock at a depth of 13.9 m (Elevation 45.2) and was advanced 0.7 m into bedrock with hollow stem augers.

5.1.8 Groundwater

Groundwater levels were measured in the open boreholes during drilling. One standpipe piezometer was installed along the proposed retaining wall alignment upon completion of drilling. The groundwater depths and elevations measured in the piezometer as well as in the open boreholes during drilling are shown in Table 5.1.1.

Table 5.1.1 – Groundwater Depths and Elevations

Borehole	Date	Water Level (m)		Comment
		Depth	Elevation	
NSW-1	1-May-2012	3.3	55.8	Open Borehole
	2-May-2012	3.4	55.7	Piezometer
	3-May-2012	3.4	55.7	Piezometer
NSW-2	2-May-2012	4.2	54.9	Open Borehole

The above values are short-term readings and seasonal fluctuations of the groundwater level are to be expected. In particular, the groundwater level may be at a higher elevation after the spring snowmelt or after periods of heavy rainfall.

5.2 Lees Avenue S-E Ramp – Station 10+290 to 10+375 (Appendix B: Boreholes LSER-01 to 04)

Four boreholes, identified as LSER-01 to LSER-04, were drilled on the west side of the Lees Avenue S-E ramp adjacent to the existing crib retaining wall. The stratigraphy encountered in the boreholes generally consisted of a composite pavement (asphalt and concrete) over sand fill, underlain by silty clay, then a silt layer and sandy silt to silty sand till.

5.2.1 Asphalt and Concrete

Asphalt was encountered at surface in the four boreholes drilled along the west side of the Lees Avenue S-E Ramp. The thickness of the asphalt ranged from 90 mm to 100 mm.

A layer of concrete was encountered below the asphalt in all four boreholes. The thickness of the concrete ranged from 200 mm to 250 mm.

5.2.2 Sand Fill

A layer of sand fill was encountered below the concrete in all four boreholes drilled at this location. The sand fill was brown to grey and contained trace to some gravel with occasional gravelly zones, some silt and clay, occasional cobbles, and asphalt fragments locally.

The thickness of the sand fill ranged from 3.1 m to 3.9 m, with the lower boundary of the sand fill encountered at depths of 3.4 m to 4.3 m (Elevation 55.9 to 55.6).

SPT N-values recorded in the sand fill ranged from 22 blows for 0.3 m penetration to 100 blows for 0.1 m penetration, indicating a compact to very dense relative density. Generally, SPT N-values recorded in the sand fill were greater than 33 blows for 0.3 m penetration, indicating the sand fill generally has a dense to very dense relative density.

Moisture contents of samples of the sand fill ranged from 3% to 19%. In general, the moisture content of the sand fill increased with depth.

One sample of the sand fill underwent laboratory grain size analysis testing, the results of which are summarized below. These results are also presented on the Record of Borehole sheets included in Appendix B and the grain size distribution curve for this sample is plotted on Figure B1, Appendix B. The results of this test identify one of the gravelly zones encountered in the sand fill.

Gravel %	29
Sand %	58
Silt and Clay %	13

5.2.3 Silty Clay

A layer of silty clay was encountered locally in all four boreholes, below the sand fill. The silty clay was grey and contained trace sand.

The thickness of the silty clay layer ranged from 1.8 m to 4.2 m, with the lower boundary of this layer encountered at depths of 6.1 m to 7.7 m (Elevation 53.8 to 51.4).

SPT N-values recorded in the silty clay ranged from 2 to 6 blows for 0.3 m penetration, indicating a soft to firm consistency. In situ vane shear testing carried out in the clay indicated undrained shear strengths of 40 and 54 kPa.

Moisture contents of samples of the silty clay ranged from 28% to 52%.

Three samples of the silty clay underwent laboratory grain size analysis and Atterberg Limits testing, the results of which are summarized below. These results are also presented on the Record of Borehole sheets included in Appendix B and the grain size distribution curves for these samples are plotted on Figure B2, Appendix B. The results of the Atterberg Limits results are plotted on Figure B5, Appendix B.

	High Plasticity	Low Plasticity
Gravel %	0	0
Sand %	2	4 to 5
Silt %	33	66 to 72
Clay %	64	24 to 29
Liquid Limit%	53	24 to 31
Plastic Limit %	23	17 to 18

The Atterberg Limits indicate that the plasticity of the silty clay varies from low (CL) to high (CH).

5.2.4 Silt

A layer of silt was encountered below the silty clay in all boreholes. The silt was grey and contained trace to some clay and trace to some sand.

The thickness of the silt layer ranged from 1.1 m to 3.0 m, with the lower boundary of the silt encountered at depths of 8.7 m to 9.4 m (Elevation 50.8 to 50.0).

SPT N-values recorded in the silt layer ranged from 3 to 26 blows for 0.3 m penetration, indicating a very loose to compact relative density. In general, the silt had a loose to compact relative density.

The moisture content of samples of the silt ranged from 22% to 34%.

Three samples of the silt were selected for laboratory grain size analysis testing, the results of which are summarized below. These results are also presented on the Record of

Borehole sheets included in Appendix B and the grain size distribution curves for these samples are plotted on Figure B3, Appendix B.

Gravel %	0
Sand %	0 to 11
Silt %	72 to 81
Clay %	17 to 19

5.2.5 Sandy Silt to Silty Sand Till

Sandy silt to silty sand till was encountered below the silt in all boreholes. The till was dark brown to dark grey and contained some clay and trace to some gravel.

The till was 2.7 m thick in Boreholes LSER-01 and LSER-04 which penetrated this layer. The lower boundary of the till was encountered at depths of 11.4 and 11.8 m (Elevation 47.6 and 48.1), where these boreholes were terminated upon probable bedrock. Boreholes LSER-02 and LSER-03 were terminated at a depth of 11.3 m (Elevation 48.1 and 48.4) in the till layer.

SPT N-values recorded in the till ranged from 5 to 35 blows for 0.3 m penetration, indicating a loose to dense relative density.

The moisture content of samples of the till ranged from 7% to 19%.

Two samples of the till were selected for laboratory grain size analysis testing, the results of which are summarized below. These results are also presented on the Record of Borehole sheets included in Appendix B and the grain size distribution curves for these samples are plotted on Figure B4, Appendix B.

Gravel %	1 to 11
Sand %	26 to 36
Silt %	37 to 61
Clay %	12 to 16

It should be noted that glacial tills inherently contain cobbles and boulders.

5.2.6 Bedrock

Boreholes LSER-01 and LSER-04 were terminated upon probable bedrock. These boreholes were terminated at depths of 11.4 m and 11.8 m, respectively (Elevation 47.6 and 48.1).

5.2.7 Water Levels

Where possible, groundwater levels were measured in the open boreholes during the drilling operations. Three standpipe piezometers were installed at this location upon completion of drilling. The piezometer installed in Borehole LSER-01 was unable to be

read because the flushmount casing could not be opened. The groundwater depths and elevations measured in the piezometers and open boreholes are shown in Table 5.2.1.

Table 5.2.1 – Groundwater Depths and Elevations

Borehole	Date	Water Level (m)		Comment
		Depth	Elevation	
LSER-01	27-Mar-2012	-	-	Could not open
LSER-02	06-Mar-2012	4.1	55.2	Open Borehole
LSER-03	27-Mar-2012	4.8	54.9	Piezometer
LSER-04	27-Mar-2012	4.4	55.5	Piezometer

The above values are short-term readings and seasonal fluctuations of the groundwater level are to be expected. In particular, the groundwater level may be at a higher elevation after the spring snowmelt or after periods of heavy rainfall.

5.3 Lees Avenue (North) at Robinson Avenue – Station 230+718 to 230+751 (Appendix C: Boreholes LE-08 and LE-09)

Two boreholes, identified as LE-08 and LE-09, were drilled on Robinson Avenue near the ends of the proposed retaining wall alignment under the Lees Avenue underpass at the north abutment. The stratigraphy encountered in the boreholes consisted of a pavement structure underlain by silty sand to sand and gravel fill, then native sand to sand and gravel, over sandy silt to silty sand till. Bedrock and probable bedrock were encountered below the silt/till.

5.3.1 Asphalt

Asphalt was encountered at surface in both boreholes drilled on Robinson Avenue in proximity of the proposed retaining wall. The thickness of the asphalt ranged from 50 mm to 100 mm.

5.3.2 Sand Fill

Brown sand fill was encountered below the asphalt in Boreholes LE-08 and LE-09. The sand fill contained trace silt to silty (in Borehole LE-09), trace gravel, and trace to some clay.

The sand fill was 0.4 m thick in Borehole LE-08 while the sand and silty sand fill in Borehole LE-09 had a total thickness of 2.2 m. The lower boundary of the sand to silty sand fill was encountered at depths of 0.5 m and 2.2 m (Elevation 60.2 and 58.3).

SPT N-values recorded in the sand to silty sand fill ranged from 15 to 19 blows for 0.3 m penetration, indicating a compact relative density.

Moisture contents of samples of the sand to silty sand fill ranged from 2% to 9%.

A sample of the silty sand fill was selected for laboratory grain size analysis testing. The results of this testing are presented on the corresponding Record of Borehole sheet in Appendix C and the grain size distribution curve for this sample is plotted on Figure C1, Appendix C. The results of this test are as follows:

Gravel %	8
Sand %	50
Silt %	28
Clay %	14

5.3.3 Sand and Gravel Fill

A layer of sand and gravel fill was encountered locally in Borehole LE-08, below the sand fill. The sand and gravel fill was dark brown and contained some silt.

The sand and gravel fill layer was 1.7 m thick, with the lower boundary of this layer encountered at a depth of 2.2 m (Elevation 58.5).

SPT N-values recorded in the sand and gravel fill ranged from 30 blows for 0.3 m penetration to 87 blows for 0.275 m penetration, indicating a dense to very dense relative density.

The moisture content of samples of the sand and gravel fill ranged from 9% to 10%.

5.3.4 Sand

Native sand was encountered below the sand and gravel fill in Borehole LE-08. The native sand was dark brown becoming grey at approximately 6 m depth and contained trace gravel to gravelly, trace silt to silty, and trace clay.

The sand was 6.6 m thick in Borehole LE-08 and the lower boundary of the sand was encountered at a depth of 8.8 m (Elevation 51.9).

SPT N-values recorded in the sand ranged from 25 to 80 blows for 0.3 m penetration, indicating a compact to very dense relative density. In general, SPT N-values recorded in the sand were greater than 50 blows for 0.3 m penetration, indicating the sand typically has a very dense relative density.

Moisture contents measured in the sand ranged from 2% to 18%.

Two samples of the sand were selected for laboratory grain size analysis testing, the results of which are summarized below. These results are also presented on the Record of Borehole sheets included in Appendix C and the grain size distribution curves for these samples are plotted on Figures C2 and C3 of Appendix C.

	Silty Sand	Sand
Gravel %	16	0
Sand %	54	90
Silt %	23	-
Clay %	7	-
Silt and Clay %	-	10

5.3.5 Gravelly Sand to Sand and Gravel

Native gravelly sand to sand and gravel was encountered in Borehole LE-09, below the silty sand fill. The gravelly sand to sand and gravel was brown to grey and contained some silt, occasional cobbles, and possible boulders.

The gravelly sand layer was 3.9 m thick, with the lower boundary encountered at a depth of 6.1 m (Elevation 54.4). The sand and gravel layer was encountered below the gravelly sand and was 2.4 m thick, with the lower boundary of the sand and gravel encountered at a depth of 8.5 m (Elevation 52.0).

SPT N-values recorded in the gravelly sand to sand and gravel ranged from 95 blows for 0.3 m penetration to 100 blows for no penetration, indicating a very dense relative density and the occurrence of probable cobbles and/or boulders. Coring techniques were required to advance the borehole at a depth of 2.9 m in Borehole LE-09.

The moisture content of samples of the gravelly sand to sand and gravel was measured to range from 6% to 11%.

5.3.6 Sandy Silt

A layer of sandy silt was encountered locally in Borehole LE-09, below the sand and gravel. The sandy silt was grey and contained trace clay and trace gravel.

The sandy silt was 1.2 m thick, with the lower boundary of the sandy silt encountered at a depth of 9.7 m (Elevation 50.8).

A single SPT N-value, of 50 blows for 0.1 m penetration, was recorded in the sandy silt, indicating a very dense relative density.

The moisture content of one sample of the sandy silt was measured to be 15%.

One sample of the sandy silt underwent laboratory grain size analysis testing. These results are presented on the Record of Borehole sheets included in Appendix C and the grain size distribution curve for this sample is plotted on Figure C4. The results of this test are as follows:

Gravel %	4
Sand %	18
Silt %	74
Clay %	4

5.3.7 Silty Sand Till

Silty sand till was encountered below the sand in Borehole LE-08. The silty sand till was dark grey and contained occasional shale fragments.

The silty sand till was 0.8 m thick, with the lower boundary of the till encountered at a depth of 9.6 m (Elevation 51.1), at which depth the borehole was terminated upon probable bedrock.

An SPT N-value of 148 blows for 0.275 m penetration was recorded in the silty sand till, indicating a very dense relative density. It is worth noting that this SPT N-value was recorded at the till-bedrock interface and may not be representative of the relative density of the till.

The moisture content of one sample of the silty sand till was measured to be 12%.

It should be noted that glacial tills inherently contain cobbles and boulders.

5.3.8 Bedrock

Both boreholes were terminated upon probable bedrock, at depths of 9.6 m and 9.8 m in Boreholes LE-08 and LE-09, respectively (Elevation 51.1 and 50.7).

5.3.9 Water Levels

A standpipe piezometer was installed in each borehole drilled at this location upon completion of drilling. The groundwater depths and elevations measured in the piezometers are summarized in Table 5.3.1.

Table 5.3.1 – Groundwater Depths and Elevations

Borehole	Date	Water Level (m)	
		Depth	Elevation
LE-08	23-Mar-2012	1.1	59.6
LE-09	23-Mar-2012	1.0	59.5

The above values are short-term readings and seasonal fluctuations of the groundwater level are to be expected. In particular, the groundwater level may be at a higher elevation after the spring snowmelt or after periods of heavy rainfall.

5.4 Lees Avenue (North) Noise Barrier – Station 230+680 to 231+ 080 (Appendix D: Boreholes 12N-01, 12N-02, 13N-01, 14N-01 to 03, NB8-01)

Seven boreholes were drilled along the alignment of the proposed noise barrier wall at Lees Avenue north (Boreholes 12N-01, 12N-02, NB8-01, 13N-01, 14N-01 to 14N-03). The stratigraphy encountered in the boreholes typically consisted of an asphalt or topsoil layer overlying silty sand to sand and gravel fill, underlain by sand to sand and gravel near Lees Avenue and silty sand till along the remainder of the alignment.

5.4.1 Asphalt

Asphalt was encountered at surface in five of the seven boreholes drilled along the proposed noise barrier alignment (Boreholes 12N-01, 12N-02, 13N-01, 14N-02, and 14N-03). These boreholes were drilled on the right shoulder of the westbound lanes of Highway 417. The thickness of the asphalt ranged from 150 mm to 175mm.

5.4.2 Topsoil

Topsoil was encountered at surface in the other two boreholes drilled along the proposed noise barrier alignment (Boreholes NB8-01 and 14N-01). These boreholes were drilled in the grass area north of the westbound lanes of Highway 417. The topsoil was approximately 50 mm thick in both boreholes.

5.4.3 Sand Fill

Sand fill was encountered below the asphalt in Boreholes 12N-01, 12N-02, 13N-01, 14N-02, and 14N-03 and below the topsoil in Boreholes NB8-01 and 14N-01. The sand fill was typically brown and generally contains some gravel, some silt and trace clay. In Borehole 12N-01 the fill varied to sand and gravel and in Boreholes 14N-01 to 14N-03 a layer of silty sand fill was encountered below the sand fill.

The thickness of the sand to silty sand fill ranged from 1.3 m to 3.0 m, with the lower boundary of the fill encountered at depths of 1.5 m to 3.0 m (Elevation 59.0 to 57.2).

SPT 'N' values recorded in the fill ranged from 13 blows for 0.3 m penetration to 50 blows for 0.05 m penetration, indicating variable relative density ranging from a compact to very dense.

The moisture content of samples of the sand fill ranged from 1% to 10%. In general, the higher moisture contents were measured in samples collect from Boreholes NB8-01 and 14N-01, which were located in the grass area north of the shoulder of the highway.

Two samples of the sand fill underwent laboratory grain size analysis testing. The results of these tests are plotted in Figure D1, Appendix D and summarized below. These results are also presented on the Record of Borehole sheets included in Appendix D.

Gravel %	5 to 12
Sand %	59 to 61
Silt %	20 to 29
Clay%	7

5.4.4 Sand

Native sand was encountered locally in Borehole 12N-01, below the sand fill. The sand was brown and medium grained and contained trace gravel and trace silt and clay.

The sand was 4.7 m thick in this borehole, though it was not fully penetrated. Borehole 12N-01 was terminated at a depth of 6.7 m (Elevation 54.3).

SPT N-values recorded in the sand ranged from 28 to 71 blows for 0.3 m penetration, indicating a compact to very dense condition.

The moisture content of samples of the sand ranged from 3% to 19%. In general, the moisture content of the sand increased with depth.

Two samples of the sand underwent laboratory grain size analysis testing, the results of which are summarized below. These results are also presented on the Record of Borehole sheets included in Appendix D and the grain size distribution curves for these samples are plotted on Figure D2, Appendix D.

Gravel %	0 to 7
Sand %	85 to 91
Silt and Clay %	8 to 9

5.4.5 Sand and Gravel

A layer of sand and gravel was encountered below the sand fill in Boreholes 12N-02 and 14N-02. The sand and gravel was greyish brown and contained some silt. A hydrocarbon odour was noted in the sand and gravel in Borehole 14N-02.

Borehole 12N-02 was terminated upon auger refusal within the sand and gravel layer at a depth of 4.6 m (Elevation 56.3). The sand and gravel layer was 0.9 m thick in Borehole 14N-02, with a lower boundary at 3.0 m depth (Elevation 57.1).

SPT 'N' values ranging from 31 blows for 0.3 m penetration to 100 blows for 0.025 m penetration were recorded in the sand and gravel, indicating a dense to very dense relative density.

The moisture content of the sand and gravel was typically 3% in Borehole 12N-02. One moisture content of 9% was measured in Borehole 14N-02.

One sample of sand and gravel underwent grain size analysis testing, the results of which are plotted on Figure D3, Appendix D and are summarized below. This result is also presented on the corresponding Record of Borehole sheet included in Appendix D.

Gravel %	40
Sand %	44
Silt and Clay%	16

5.4.6 Silty Sand Till

Brown to grey/black silty sand till was encountered below the sand fill in Boreholes NB8-01, 13N-01, 14N-01, 14N-02, and 14N-03. The silty sand till contains trace to some clay and trace to some gravel.

The silty sand till was 3.2 m to 5.2 m thick and extended to the maximum depth of exploration in these boreholes. These five boreholes were terminated at depths of 6.2 m to 6.7 m (Elevation 54.9 to 53.4).

SPT 'N' values recorded in the silty sand till ranged from 9 blows for 0.3 m penetration to 101 blows for 0.225 m penetration, indicating a loose to very dense relative density. In general, SPT N-values were greater than 14 blows for 0.3 m penetration, indicating a compact to very dense relative density.

Moisture contents of samples of the silty sand till typically ranged from 6% and 11%.

Six samples of the silty sand till were selected for laboratory grain size analysis testing, the results of which are summarized below. These results are also presented on the Record of Borehole sheets included in Appendix D and the grain size distribution curves for these samples are plotted on Figure D4, Appendix D.

Gravel %	6 to 15
Sand %	43 to 56
Silt%	27 to 38
Clay%	7 to 10

One sample of the silty sand till exhibited sufficient plasticity for Atterberg Limits testing. The results of these tests are plotted on Figure D5, Appendix D and are as follows:

Liquid Limit%	16
Plastic Limit %	11

The Atterberg Limits indicate that the silty sand till has some zones of low plasticity.

It should be noted that glacial tills inherently contain cobbles and boulders.

5.4.7 Water Levels

Water levels were observed in the open boreholes during drilling operations. Three standpipe piezometers were installed along the proposed noise barrier alignment upon completion of drilling. The groundwater depths and elevations measured in the piezometers are shown in Table 5.4.1, along with the measurements made in the open boreholes.

Table 5.4.1 – Groundwater Depths and Elevations

Borehole	Date	Water Level (m)		Comments
		Depth	Elev.	
12N-01	22-Aug-2011	5.8	55.2	Open Borehole
12N-02	22-Aug-2011	3.7	57.2	Open Borehole
	12-Oct-2011	-	-	Piezometer plugged at 3.0 m
NB8-01	16-Aug-2011	DRY		Open Borehole
13N-01	12-Oct-2011	-	-	Piezometer plugged at 1.5 m
14N-01	15-Aug-2011	DRY		Open Borehole
14N-02	12-Oct-2011	2.5	57.6	Piezometer
14N-03	15-Aug-2011	DRY		Open Borehole

Seasonal fluctuations of the groundwater level are to be expected. In particular, the groundwater level may be at a higher elevation after the spring snowmelt or after periods of heavy rainfall.

5.5 Canadian Tire Parking Lot – Riverside Drive to Belfast Road (North) – Station 210+902 to 211+000 (Appendix E: Boreholes 15N-01, CTW-1 & 2, and OHS-7L)

Four boreholes (15N-01, CTW-1, CTW-2, and OHS-07L) were drilled along the alignment of the proposed retaining wall at the Canadian Tire parking lot. The stratigraphy encountered in the boreholes generally consisted of pavement structure (asphalt over sand fill) overlying sandy silt to silty sand fill at the west end of the alignment, underlain by sandy silt to silty sand till which overlies shale bedrock.

5.5.1 Asphalt

A layer of asphalt was encountered at surface in all four boreholes. The asphalt was 100 mm to 200 mm thick. All four boreholes were drilled on the right shoulder of the westbound lanes of Highway 417.

5.5.2 Sand Fill

A layer of sand fill was encountered below the asphalt in all four boreholes. The sand fill was brown and contained trace gravel to gravelly and some silt.

The thickness of the sand fill layer ranged from 0.5 m to 0.9 m, with the lower boundary of this fill layer encountered at depths of 0.6 to 1.1 m (Elevation 60.4 to 59.8).

SPT N-values recorded in the sand to gravelly sand fill ranged from 18 to 22 blows for 0.3 m penetration, indicating a compact relative density.

The moisture content of the sand to gravelly sand fill ranged from 2% to 8%.

5.5.3 Sandy Silt to Silty Sand Fill

Sandy silt to silty sand fill was encountered below the sand fill in Borehole CTW-1 and below a localized 0.4 m thick layer of clayey silt fill in Borehole OHS-07L, which was encountered below the sand fill. The sandy silt to silty sand till was dark grey and contained trace gravel and some clay.

The sandy silt to silty sand fill was 1.6 m thick in Borehole CTW-1 and 1.4 m thick in Borehole OHS-07L. The lower boundary of the sandy silt to silty sand fill was encountered at depths of 2.3 and 2.9 m in Boreholes CTW-1 and OHS-07L, respectively (Elevation 58.7 and 58.0).

SPT N-values recorded in the sandy silt to silty sand fill ranged from 12 to 38 blows for 0.3 m penetration, indicating a compact to dense relative density.

The moisture content of samples of the sandy silt to silty sand till generally ranged from 6% to 20%. A moisture content of 40% was measured in a sample from Borehole OHS-07L at a depth of 2.7 m.

One sample of the silty sand fill and one sample of the sandy silt fill underwent laboratory grain size analysis testing, the results of which are summarized below. These results are also presented on the Record of Borehole sheets included in Appendix E and the grain size distribution curves for these samples are plotted on Figure E1, Appendix E.

Gravel %	0
Sand %	30 to 53
Silt %	31 to 53
Clay %	16 to 17

One sample of the sandy silt fill had sufficient plasticity for Atterberg Limits testing. The results of these tests are summarized below and are plotted on Figure E3, Appendix E.

Liquid Limit%	21
Plastic Limit %	13

The Atterberg Limits indicate that the sandy silt fill has some low plastic zones.

5.5.4 Sandy Silt to Silty Sand Till

Sandy silt to silty sand till was encountered below the fill in all four boreholes. The sandy silt to silty sand till was brown to dark grey and contained some clay to clayey and trace gravel.

The thickness of the till ranged from 3.2 m to 3.8 m, with the lower boundary of the till encountered at depths of 4.1 to 6.1 m (Elevation 56.9 to 54.9). Borehole OHS-07L was terminated in the till at 6.1 m (Elevation 54.8).

SPT N-values recorded in the till generally ranged from 13 to 29 blows for 0.3 m penetration, indicating a compact relative density. An SPT N-value of 7 blows for 0.3 m penetration (loose) was recorded in Borehole CTW-2 at a depth of 3.5 m (Elevation 57.5). SPT N-values greater than 45 blows for 0.3 m penetration were recorded in Borehole 15N-01 near the upper boundary of the till layer.

The moisture content of samples of the till generally ranged from 8% to 17%. A moisture content of 34% was measured at a depth of 2.5 m in Borehole CTW-2.

Three samples of the till were selected for laboratory grain size analysis testing, the results of which are summarized below. These results are also presented on the Record of Borehole sheets included in Appendix E and the grain size distribution curves for these samples are plotted on Figure E2, Appendix E.

Gravel %	0 to 7
Sand %	24 to 55
Silt %	24 to 59
Clay %	14 to 22

One sample of the till had sufficient plasticity for Atterberg Limits testing. The results of these tests are summarized below and are plotted on Figure E4, Appendix E.

Liquid Limit%	25
Plastic Limit %	16

The Atterberg Limits indicate that the sandy silt to silty sand till has some low plastic zones.

It should be noted that glacial tills inherently contain cobbles and boulders.

5.5.5 Bedrock

Bedrock was encountered below the till in Boreholes CTW-1 and CTW-2. Probable bedrock was encountered below the till in Borehole 15N-01. The depths and elevations at which bedrock and probable bedrock were encountered are summarized in Table 5.5.1.

Table 5.5.1 – Depths and Elevations of Bedrock Surface

Borehole	Bedrock Surface		Comment
	Depth (m)	Elevation (m)	
CTW-1	6.1	54.9	Proven by coring
CTW-2	4.1	56.9	Proven by coring
15N-01	4.6	56.5	Probable Bedrock

Where proven by coring, the bedrock was described as thinly bedded grey shale with occasional limestone interbeds. The shale was generally described as slightly weathered to fresh with increased depth. Occasional horizontal joints and highly broken zones were observed in the bedrock cores. Total Core Recovery (TCR) ranged from 93% to 100% in the bedrock cores. The RQD values ranged from 87 to 100%, indicating a good to excellent rock quality. In general, RQD values increased with depth. The Fracture Index (FI) of the rock, expressed as fractures per 0.3 m of core, was typically less than 3.

The estimated unconfined compressive strength of the rock, interpreted from point load tests conducted on intact rock cores, ranged from 15 to 21 MPa, indicating a weak rock strength classification. It should be noted that higher rock strengths may be obtained in the hard limestone interbeds.

5.5.6 Water Levels

Water was not observed in Boreholes CTW-1 and CTW-2 during drilling, prior to water being introduced into the borehole for coring operations. Three standpipe piezometers were installed along the proposed retaining wall alignment upon completion of drilling. The groundwater depths and elevations measured in the piezometers as well as in the open boreholes during drilling are shown in Table 5.5.2.

Table 5.5.2 – Groundwater Depths and Elevations

Borehole	Date	Water Level (m)		Comment
		Depth	Elevation	
CTW-1	2-May-2012	Dry		Prior to coring
	3-May-2012	0.3*	60.7	Piezometer
CTW-2	3-May-2012	Dry		Prior to coring
OHS-07L	22-Mar-2012	2.2	58.7	Piezometer
15N-01	26-Jul-2011	3.5	57.6	Piezometer
	18-Aug-2011	3.5	57.6	Piezometer
	12-Oct-2011	2.7	58.4	Piezometer

*Very short term reading. May indicate level of water added to borehole during coring.

The above values are short-term readings and seasonal fluctuations of the groundwater level are to be expected. In particular, the groundwater level may be at a higher elevation after the spring snowmelt or after periods of heavy rainfall.

5.6 Belfast Road (North), Wall 15N – Station 211+220 to 211+700 (Appendix F: Boreholes 15N-01 to 15N-12)

Twelve boreholes, identified as 15N-01 to 15N-12, were drilled for the proposed retaining wall near Belfast Road on the north side of the highway from Station 211+025 to 211+825. The final design for this retaining wall was shortened to Station 211+220 to 211+700, therefore only Boreholes 15N-04 to 15N-10 have been considered for the following description of the subsurface conditions. The Record of Borehole sheets for all Boreholes 15N-01 to 15N-12 are included in Appendix F.

The stratigraphy encountered in the boreholes generally consisted of a pavement structure (asphalt over gravelly sand) underlain by silt/sand fill along the west part of the alignment, overlying silty sand to sandy silt till. Shale bedrock was encountered below the till.

5.6.1 Asphalt

Asphalt was encountered at surface in the seven boreholes drilled along the proposed retaining wall alignment. These boreholes were drilled on the right shoulder of the westbound lanes of Highway 417. The thickness of the asphalt ranged from 150 mm to 300 mm.

5.6.2 Gravelly Sand Fill

A layer of gravelly sand fill was encountered below the asphalt in all seven boreholes drilled at this proposed retaining wall. The gravelly sand fill was typically brown and contained some silt.

The thickness of the gravelly sand fill ranged from 0.5 m to 0.8 m, with the lower boundary of the gravelly sand fill encountered at depths of 0.8 m to 1.1 m (Elevation 66.3 to 61.5).

One SPT N-value of 62 blows for 0.225 m penetration was recorded in the gravelly sand fill, indicating a very dense relative density. This value was measured at the fill-bedrock interface and may include resistance on the bedrock surface.

Moisture contents of samples of the sand fill typically ranged from 1% to 2%. A moisture content of 8% was measured in one sample of the gravelly sand fill in Borehole 15N-09.

One sample of the gravelly sand fill underwent laboratory grain size analysis testing, the results of which are summarized below. These results are also presented on the Record of

Borehole sheets included in Appendix F and the grain size distribution curve for this sample is plotted on Figure F1, Appendix F.

Gravel %	27
Sand %	50
Silt %	17
Clay %	6

5.6.3 Sandy Silt to Silty Sand Fill

A layer of sandy silt to silty sand fill was encountered below the gravelly sand fill in Boreholes 15N-04, 15N-05, and 15N-06. The sandy silt to silty sand fill was brown and contained trace clay and trace to some gravel.

The thickness of the sandy silt to silty sand fill ranged from 0.6 m to 1.4 m, with the lower boundary of this fill encountered at depths of 1.4 m to 2.2 m (Elevation 62.3 to 60.1).

SPT N-values recorded in the sandy silt to silty sand fill ranged from 17 to 47 blows for 0.3 m penetration, indicating a compact to dense relative density. In general, the sandy silt to silty sand fill had a dense relative density

Moisture contents of samples of the sandy silt to silty sand fill ranged from 7% to 14%.

Two samples of the sandy silt to silty sand fill underwent laboratory grain size analysis testing, the results of which are summarized below. These results are also presented on the Record of Borehole sheets included in Appendix F and the grain size distribution curves for these samples are plotted on Figure F2, Appendix F.

Gravel %	3 to 11
Sand %	42 to 52
Silt %	33 to 50
Clay %	3 to 5

5.6.4 Silty Sand to Sandy Silt Till

Silty sand to sandy silt till was encountered below the silty sand fill in Boreholes 15N-04 to 15N-06 and below the gravelly sand fill in Borehole 15N-07. In Borehole 15N-10 the till consisted of silt with some sand. Till was not encountered in Borehole 15N-09. The silty sand till was dark grey while the sandy silt till was grey and the silt till was brown. In general, the till contained trace gravel and trace clay. Occasional shale fragments were also observed in the till.

The thickness of the till ranged from 0.6 m in borehole 15N-08 to 3.2 m in Borehole 15N-06. The lower boundary of the till was encountered at depths of 1.4 m to 5.3 m (Elevation 65.6 to 57.4).

SPT N-values recorded in the till ranged from 32 blows for 0.3 m penetration to 50 blows for 0.025 m penetration, indicating a dense to very dense relative density.

The moisture content of samples of the till ranged from 6% to 10%.

Two samples of the till were selected for laboratory grain size analysis testing, the results of which are summarized below. These results are also presented on the Record of Borehole sheets included in Appendix F and the grain size distribution curves for these samples are plotted on Figure F3, Appendix F.

Gravel %	9 to 10
Sand %	51 to 62
Silt %	25 to 33
Clay %	3 to 7

It should be noted that glacial tills inherently contain cobbles and boulders.

5.6.5 Bedrock

Bedrock was encountered below the till in Boreholes 15N-04 to 15N-08 and 15N-10, and below the gravelly sand fill in Borehole 15N-09. The depths and elevations at which bedrock was encountered are summarized in Table 5.6.1.

Table 5.6.1 – Depths and Elevations of Bedrock Surface

Borehole	Bedrock Surface	
	Depth (m)	Elevation (m)
15N-04	4.6	57.7
15N-05	5.3	57.4
15N-06	4.6	59.1
15N-07	3.0*	61.5
15N-08	1.4*	64.0
15N-09	1.1*	65.1
15N-10	1.5*	65.6

*Bedrock proven by coring.

The bedrock was described as laminated grey shale and typically contained hard limestone interbeds up to 75 mm in thickness. The shale was generally described as slightly weathered to fresh with increased depth. Occasional moderately to highly fractured zones were observed in the bedrock cores. Total Core Recovery (TCR) was 100% in all bedrock cores. The RQD values ranged from 10 to 100%, indicating a variable rock quality ranging from very poor to excellent. In general, RQD values

increased with depth. The Fracture Index (FI) of the rock, expressed as fractures per 0.3 m of core, was also quite variable and ranged from 0 to greater than 20.

The estimated unconfined compressive strength of the rock, interpreted from point load tests conducted on intact rock cores, ranged from 12 to 27 MPa, indicating a weak to medium strong rock strength classification. It should be noted that higher rock strengths may be obtained in the hard limestone interbeds.

5.6.6 Water Levels

Three standpipe piezometers were installed along the proposed retaining wall alignment upon completion of drilling. The groundwater depths and elevations measured in the piezometers are shown in Table 5.6.2.

Table 5.6.2 – Groundwater Depths and Elevations

Borehole	Date	Water Level (m)		Comment
		Depth	Elevation	
15N-05	26-Jul-2011	2.9	59.9	Piezometer
	18-Aug-2011	3.0	59.8	Piezometer
	12-Oct-2011	3.2	59.6	Piezometer
15N-07	26-Jul-2011	3.6	60.9	Piezometer
	18-Aug-2011	3.5	61.0	Piezometer
	12-Oct-2011	4.0	60.5	Piezometer
15N-09	26-Jul-2011	2.2	64.0	Piezometer
	18-Aug-2011	2.2	64.0	Piezometer
	12-Oct-2011	2.5	63.5	Piezometer

The above values are short-term readings and seasonal fluctuations of the groundwater level are to be expected. In particular, the groundwater level may be at a higher elevation after the spring snowmelt or after periods of heavy rainfall.

5.7 Belfast Road (South), Wall 23S – Station 111+090 to 111+705 (Appendix G: Boreholes 23S-01 to 23S-09)

Nine boreholes, identified as 23S-01 to 23S-09 were drilled for the proposed retaining wall at this location. The final retaining wall alignment was shifted west and now covers Station 111+090 to 111+705, therefore only Boreholes 23S-01 to 23S-08 have been included in the description of subsurface conditions below. The Record of Borehole sheets for all nine boreholes are included in Appendix G.

The stratigraphy encountered in the boreholes consisted of a pavement structures (asphalt over gravelly sand) underlain by silty sand till then bedrock. Silty sand fill was encountered below the pavement structure at the west end of the alignment.

5.7.1 Asphalt

Asphalt was encountered at surface in the eight boreholes drilled along the retaining wall alignment. These boreholes were drilled on the right shoulder of the eastbound lanes of Highway 417. The thickness of the asphalt ranged from 150 mm to 300 mm.

5.7.2 Sand to Gravelly Sand Fill

A layer of sand with some gravel to gravelly sand fill was encountered below the asphalt in all the boreholes drilled along the proposed retaining wall alignment, except Borehole 23S-04. The sand to gravelly sand fill was brown and contained trace to some silt.

The thickness of the sand to gravelly sand fill ranged from 0.5 m to 0.6 m, with the lower boundary of the sand to gravelly sand fill encountered at depths of 0.8 m to 0.9 m (Elevation 66.6 to 61.1).

Samples of the sand to gravelly sand fill were collected from the augers. Moisture contents ranged from 2% to 3%.

One sample of the sand fill (from Borehole 23S-06) underwent laboratory grain size analysis testing, the results of which are summarized below. These results are also presented on the Record of Borehole sheets included in Appendix G and the grain size distribution curve for this sample is plotted on Figure G1, Appendix G.

Gravel %	16
Sand %	59
Silt %	18
Clay %	7

5.7.3 Silty Sand Fill

A layer of silty sand fill was encountered below the sand to gravelly sand fill in Boreholes 23S-01 and 23S-02, and directly below the asphalt in Borehole 23S-04. The silty sand fill was brown and contained trace clay and trace to some gravel.

The thickness of the silty sand fill ranged from 0.5 m to 1.4 m, with the lower boundary of this fill encountered at depths of 0.8 m to 2.2 m (Elevation 63.2 to 59.7).

SPT N-values recorded in the silty sand fill ranged from 16 to 39 blows for 0.3 m penetration, indicating a compact to dense relative density.

Moisture contents of samples of the silty sand fill ranged from 2% to 8%.

One sample of the silty sand fill (from Borehole 23S-01) underwent laboratory grain size analysis testing, the results of which are summarized below. These results are also presented on the Record of Borehole sheets included in Appendix G and the grain size distribution curve for this sample is plotted on Figure G1.

Gravel %	8
Sand %	62
Silt %	24
Clay %	6

5.7.4 Silty Sand Till

Silty sand till was encountered below the silty sand fill in Boreholes 23S-01, 23S-02, and 23S-04 and below the sand to gravelly sand in Boreholes 23S-03 and 23S-05 to 23S-08. The silty sand till was typically dark grey, though locally it was brown in colour. The silty sand till contained trace to some gravel, trace to some clay, and occasional shale fragments.

The thickness of the silty sand till ranged from 0.4 m to 5.0 m, with the lower boundary of the till encountered at depths of 1.2 m to 6.0 m (Elevation 66.2 to 55.9).

SPT N-values recorded in the silty sand till ranged from 26 blows for 0.3 m penetration to 84 blows for 0.02 m penetration, indicating a compact to very dense relative density. In general, SPT N-values were greater than 50 blows for 0.3 m penetration, indicating a very dense relative density.

The moisture content of samples of the silty sand till ranged from 2% to 12%. Typically, moisture contents were less than 10% in the silty sand till.

Six samples of the silty sand till were selected for laboratory grain size analysis testing, the results of which are summarized below. These results are also presented on the Record of Borehole sheets included in Appendix G and the grain size distribution curves for these samples are plotted on Figure G2, Appendix G.

Gravel %	6 to 12
Sand %	45 to 61
Silt %	22 to 35
Clay %	4 to 16

It should be noted that glacial tills inherently contain cobbles and boulders.

5.7.5 Bedrock

Bedrock was encountered below the silty sand till in all eight boreholes drilled along the retaining wall alignment. The depths and elevations at which bedrock was encountered are summarized in Table 5.7.1.

Table 5.7.1 – Depths and Elevations of Bedrock Surface

Borehole	Bedrock Surface	
	Depth (m)	Elevation (m)
23S-01	6.0	55.9
23S-02	4.6	57.9
23S-03	5.8	57.4
23S-04	4.6	59.4
23S-05	2.7	62.2
23S-06	1.2	64.6
23S-07	1.2	65.4
23S-08	1.2	66.2

The bedrock was described as laminated grey shale and typically contained hard limestone interbeds up to 75 mm in thickness. The shale was generally described as slightly weathered to fresh with increased depth. Occasional highly fractured zones were observed in the bedrock cores. Total Core Recovery (TCR) was typically 100% in the bedrock cores. The RQD values ranged from 0 to 100%, indicating a variable rock quality ranging from very poor to excellent. In general, RQD values were less than 58%, indicating a fair to very poor rock quality. The Fracture Index (FI) of the rock, expressed as fractures per 0.3 m of core, was also quite variable and ranged from 0 to greater than 10.

The estimated unconfined compressive strength of the rock, interpreted from point load tests conducted on intact rock cores, ranged from 8 to 32 MPa, indicating a weak to medium strong rock strength classification. It should be noted that higher rock strengths may be obtained in the hard limestone interbeds.

5.7.6 Water Levels

Four standpipe piezometers were installed along the proposed retaining wall alignment upon completion of drilling. The groundwater depths and elevations measured in the piezometers are shown in Table 5.7.2.

Table 5.7.2 – Groundwater Depths and Elevations

Borehole	Date	Water Level (m)	
		Depth	Elevation
23S-02	26-Jul-2011	2.8	59.7
	18-Aug-2011	2.8	59.7
	12-Oct-2011	3.9	58.6
23S-04*	21-Jul-2011	2.6	61.4
	26-Jul-2011	2.5	61.5
	18-Aug-2011	2.5	61.5
	12-Oct-2011	2.5	61.5
23S-06	21-Jul-2011	3.0	62.8
	26-Jul-2011	3.1	62.7
	18-Aug-2011	3.1	62.7
	12-Oct-2011	3.2	62.6
23S-08	21-Jul-2011	2.8	64.6
	26-Jul-2011	2.8	64.6
	18-Aug-2011	2.8	64.6
	12-Oct-2011	2.8	64.6

*Piezometer likely plugged at 2.5 m

The above values are short-term readings and seasonal fluctuations of the groundwater level are to be expected. In particular, the groundwater level may be at a higher elevation after the spring snowmelt or after periods of heavy rainfall.

5.8 St. Laurent Boulevard N-W Ramp, Wall 16N – Station 212+000 to 212+200 (Appendix H: Boreholes 16N-1 to 16N-3)

Three boreholes, designated Boreholes 16N-1 to 16N-3, were drilled along the N-W Ramp at the St. Laurent Boulevard interchange. The stratigraphy encountered in the boreholes generally consisted of a pavement structure overlying various sand to clayey silt fills, underlain by silty sand, then sandy silt to silty sand till. Bedrock was encountered below the till.

5.8.1 Asphalt

Asphalt was encountered at surface in the three boreholes drilled along the south side of the St. Laurent Boulevard N-W ramp. The thickness of the asphalt ranged from 100 mm to 150 mm.

5.8.2 Gravelly Sand Fill

A layer of gravelly sand fill was encountered below the asphalt in all three boreholes drilled at this location. The gravelly sand fill was brown and contained some silt.

The thickness of the gravelly sand fill ranged from 0.7 m to 2.2 m, with the lower boundary of the gravelly sand fill encountered at depths of 0.8 m to 2.3 m (Elevation 69.1 to 67.0).

SPT N-values recorded in the gravelly sand fill ranged from 30 blows for 0.3 m penetration to 50 blows for 0.125 m penetration, indicating a dense to very dense relative density.

Moisture contents of samples of the gravelly sand fill ranged from 2% to 5%.

5.8.3 Silty Sand to Sand Fill

A layer of silty sand to sand fill was encountered below the gravelly sand fill in Boreholes 16N-1 and 16N-2. The fill was brown and contained some silt to silty, trace to some clay, and trace to some gravel.

The silty sand fill layer in Borehole 16N-1 was 1.5 m thick while the sand fill in Borehole 16N-2 was 0.7 m thick. The lower boundary of this fill was encountered at a depth of 2.3 m in Borehole 16N-1 and 3.0 m in Borehole 16N-2 (Elevation 67.6 and 66.3).

SPT N-values recorded in the silty sand to sand fill ranged from 7 blows for 0.3 m penetration to 50 blows for 0.125 m penetration, indicating a variable relative density, ranging from loose to very dense.

Moisture contents of samples of the silty sand to sand fill ranged from 9% to 31%.

One sample of the silty sand fill underwent laboratory grain size analysis testing, the results of which are summarized below. These results are also presented on the Record of Borehole sheets included in Appendix H and the grain size distribution curve for this sample is plotted on Figure H1, Appendix H.

Gravel %	6
Sand %	48
Silt %	29
Clay %	18

5.8.4 Clayey Silt Fill

A layer of clayey silt fill was encountered locally in Borehole 16N-1, below the silty sand fill. The clayey silt fill was brown and grey and contained some sand and trace gravel.

The layer of clayey silt fill was 0.7 m thick, with the lower boundary of this layer encountered at a depth of 3.0 m (Elevation 66.9).

A single SPT N-value, of 8 blows for 0.3 m penetration, was recorded in the clayey silt fill layer. This value is indicative of a firm to stiff consistency.

The moisture content of one sample of the clayey silt fill was measured to be 38%.

5.8.5 Silty Sand

A layer of native silty sand was encountered below the clayey silt fill in Borehole 16N-1, below the sand fill in Borehole 16N-2, and below the gravelly sand fill in Borehole 16N-3. The silty sand was brown to grey and contained trace gravel and trace clay.

The thickness of the silty sand layer ranged from 0.8 m to 1.6 m, with the lower boundary of the silty sand encountered at depths of 2.3 m to 4.6 m (Elevation 66.2 to 64.7).

SPT N-values recorded in the silty sand layer ranged from 11 to 39 blows for 0.3 m penetration, indicating a compact to dense relative density.

The moisture content of samples of the silty sand ranged from 12% to 23%.

One sample of the silty sand underwent laboratory grain size analysis testing, the results of which are summarized below. These results are also presented on the Record of Borehole sheets included in Appendix H and the grain size distribution curve for this sample is plotted on Figure H2, Appendix H.

Gravel %	0
Sand %	60
Silt %	30
Clay %	7

5.8.6 Sandy Silt to Silty Sand Till

Sandy silt to silty sand till was encountered below the silty sand in all three boreholes drilled at this location. The till was brown to dark grey and contained trace gravel, occasional shale fragments, and trace to some clay with occasional clayey zones.

The thickness of the till ranged from 1.2 m to 2.6 m, with the lower boundary of the till encountered at depths of 4.9 m to 5.8 m (Elevation 64.1 to 63.5).

SPT N-values recorded in the till ranged from 14 blows for 0.3 m penetration to 50 blows for 0.025 m penetration, indicating a compact to very dense relative density.

The moisture content of samples of the sandy silt to silty sand till typically ranged from 8% to 10%. A moisture content of 26% was measured in a sample collected from a clayey zone within the till in Borehole 16N-3.

Two samples of the till were selected for laboratory grain size analysis testing, the results of which are summarized below. These results are also presented on the Record of

Borehole sheets included in Appendix H and the grain size distribution curves for these samples are plotted on Figures H3 and H4, Appendix H.

	Silty Sand Till	Clayey Silt & Sand Till
Gravel %	3	0
Sand %	54	26
Silt %	38	53
Clay %	5	21

A sample collected from the clayey zone also underwent Atterberg Limits testing. These results are presented on the Record of Borehole sheets included in Appendix H and are plotted on Figure H5, Appendix H. These results are summarized as follows:

Liquid Limit%	46
Plastic Limit %	20

The Atterberg Limits indicate intermediate plasticity with a group symbol of CI.

It should be noted that glacial tills inherently contain cobbles and boulders.

5.8.7 Bedrock

Bedrock was encountered below the till in all three boreholes. The depths and elevations at which bedrock was encountered are summarized in Table 5.8.1.

Table 5.8.1 – Depths and Elevations of Bedrock Surface

Borehole	Bedrock Surface	
	Depth (m)	Elevation (m)
16N-1	5.8	64.1
16N-2	5.8	63.5
16N-3	4.9	63.6

The bedrock was described as laminated grey shale and typically contained hard limestone interbeds up to 75 mm in thickness. The shale was generally described as slightly weathered to fresh with increased depth. Occasional vertical fractures, rubble zones, and clay seams were observed in the bedrock cores. Total Core Recovery (TCR) in the bedrock ranged from 77 % to 100%, typically 100%. The RQD values ranged from 25 to 100%, indicating a variable rock quality ranging from poor to excellent. In general, RQD values increased with depth. The Fracture Index (FI) of the rock, expressed as fractures per 0.3 m of core, was also quite variable and ranged from 0 to greater than 10.

The estimated unconfined compressive strength of the rock, interpreted from point load tests conducted on intact rock cores, ranged from 15 to 34 MPa, indicating a weak to medium strong rock strength classification. It should be noted that higher rock strengths may be obtained in the hard limestone interbeds.

5.8.8 Water Levels

Two standpipe piezometers were installed at this location upon completion of drilling. The groundwater depths and elevations measured in the piezometers are shown in Table 5.8.2.

Table 5.8.2 – Groundwater Depths and Elevations

Borehole	Date	Water Level (m)	
		Depth	Elevation
16N-1	20-Sep-2011	5.2	64.7
	12-Oct-2011	5.8	64.1
16N-3	18-Aug-2011	4.7	63.8
	20-Sep-2011	3.7	64.8
	12-Oct-2011	3.7	64.8

The above values are short-term readings and seasonal fluctuations of the groundwater level are to be expected. In particular, the groundwater level may be at a higher elevation after the spring snowmelt or after periods of heavy rainfall.

6 MISCELLANEOUS

The borehole locations were selected and established in the field by Thurber Engineering Ltd. Surveyors from MMM Group determined the co-ordinates and ground surface elevations at the boreholes after completion of the site investigation.

Underground Service Locators Inc. obtained utility clearances on behalf of Thurber for the selected borehole locations prior to drilling.

Eastern Ontario Diamond Drilling Ltd. from Hawkesbury, Ontario supplied both track-mounted and truck-mounted drill rigs and conducted the drilling, sampling and in-situ testing operations.

The field investigation was supervised by Ms. Eckie Siu, Mr. George Azzopardi, Mr. Ryan Kromer, E.I.T. and Mr. Luke Gilarski, E.I.T. of Thurber. Overall planning and supervision of the field program was conducted by Ms. Lindsey Blaine, E.I.T.

Routine laboratory testing was carried out by Thurber Engineering Ltd.

Interpretation of the data and preparation of the report were carried out by Ms. Lindsey Blaine, E.I.T. and Ms. Mei Cheong, M.Phil.

The report was reviewed by Mr. M.R. Anderson, P.Eng., M.Eng. and Dr. P.K. Chatterji, P.Eng., a Designated Principal Contact for MTO Foundations Projects.

Thurber Engineering Ltd.

Lindsey Blaine, E.I.T.
Project Manager



Murray R. Anderson, P.Eng., M.Eng.
Senior Foundations Engineer



P.K. Chatterji, P.Eng., Ph.D.
Review Principal, Designated MTO Contact

Appendix A

Nicholas Street Underpass (South)

Boreholes NSW-1 and NSW-2

RECORD OF BOREHOLE No NSW-1

1 OF 2

METRIC

W.P. 4091-07-00 LOCATION N 5 031 020.7 E 369 459.8 ORIGINATED BY GA
 HWY 417 BOREHOLE TYPE Hollow Stem Augers COMPILED BY AN
 DATUM Geodetic DATE 2012.04.30 - 2012.05.01 CHECKED BY LRB

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 (%)				
								○ UNCONFINED + FIELD VANE ● QUICK TRIAXIAL × LAB VANE	w _p w w _L					
59.1							20 40 60 80 100							
0.0	ASPHALT: (75mm)													
0.1														
58.7	CONCRETE: (350mm)		1	GS										
0.4	SAND, trace to some gravel, trace silt Dense Brown Dry (FILL)		2	SS	38									
			3	SS	37									
56.8														
2.3	SAND, some silt, trace gravel, trace clay Compact Brown Dry		4	SS	23									
56.1														
3.0	SAND, medium to coarse grained Loose Grey Wet		5	SS	7									
55.1														
4.0	Silty CLAY, trace sand Soft Grey		6	SS	4									
53.0														
6.1	SILT, trace to some sand, trace clay Compact Grey Wet		7	SS	12									
			8	SS	13									
50.0														
9.1	Silty SAND, trace to some gravel, trace to some clay Compact Grey Wet (FILL)		9	SS	19									

Continued Next Page

+³ ×³ Numbers refer to
Sensitivity 15 20 5 10 (%) STRAIN AT FAILURE

RECORD OF BOREHOLE No NSW-1

2 OF 2

METRIC

W.P. 4091-07-00 LOCATION N 5 031 020.7 E 369 459.8 ORIGINATED BY GA
 HWY 417 BOREHOLE TYPE Hollow Stem Augers COMPILED BY AN
 DATUM Geodetic DATE 2012 04 30 - 2012 05 01 CHECKED BY LRB

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					
	Continued From Previous Page												
	Silty SAND, trace to some gravel, trace to some clay Compact Grey Wet (TILL)		10	SS	15								10 53 27 10
			11	SS	26								
45.2			12	SS	50/								
13.9	END OF BOREHOLE AT 13.9m UPON AUGER REFUSAL ON PROBABLE BEDROCK. BOREHOLE OPEN TO 13.9m AND WATER LEVEL AT 3.3m UPON COMPLETION. Piezometer installation consists of 19mm diameter Schedule 40 PVC pipe with a 1.52m slotted screen. WATER LEVEL READINGS: DATE DEPTH (m) ELEV. (m) May 02/12 3.4 55.7 May 03/12 3.4 55.7				0.150								

RECORD OF BOREHOLE No NSW-2

1 OF 2

METRIC

W.P. 4091-07-00 LOCATION N 5 031 041 6 E 369 492 2 ORIGINATED BY GA
 HWY 417 BOREHOLE TYPE Hollow Stem Augers COMPILED BY AN
 DATUM Geodetic DATE 2012 05 01 - 2012 05 01 CHECKED BY LRB

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	PLASTIC LIMIT	NATURAL MOISTURE CONTENT	LIQUID LIMIT	
59.1								SHEAR STRENGTH kPa	W _P	W	W _L	
0.0	ASPHALT: (100mm)							○ UNCONFINED + FIELD VANE				
0.1	SAND, trace to some gravel, trace silt Compact to Dense Brown Dry (FILL)		1	SS	22		59	● QUICK TRIAXIAL x LAB VANE				
			2	SS	32		58					14 80 6 (SI+CL)
			3	SS	45		57					
56.8												
2.3	SAND, trace silt, trace gravel Compact Brown Damp		4	SS	13		56					
56.1							55					
3.0	Silty CLAY Firm Grey		5	SS	6		54					
							53					
54.5							52					
4.6	SILT, some clay, trace sand Compact to Loose Grey Wet		6	SS	11		51					
							50					
			7	SS	7							0 8 77 15
51.8												
7.3	Silty SAND, some clay to clayey, trace gravel Very Loose to Compact Grey Wet (TILL)		8	SS	2							
			9	SS	12							

Continued Next Page



+³ . X³ : Numbers refer to
Sensitivity 20
15 10 5 (%) STRAIN AT FAILURE

RECORD OF BOREHOLE No NSW-2

2 OF 2

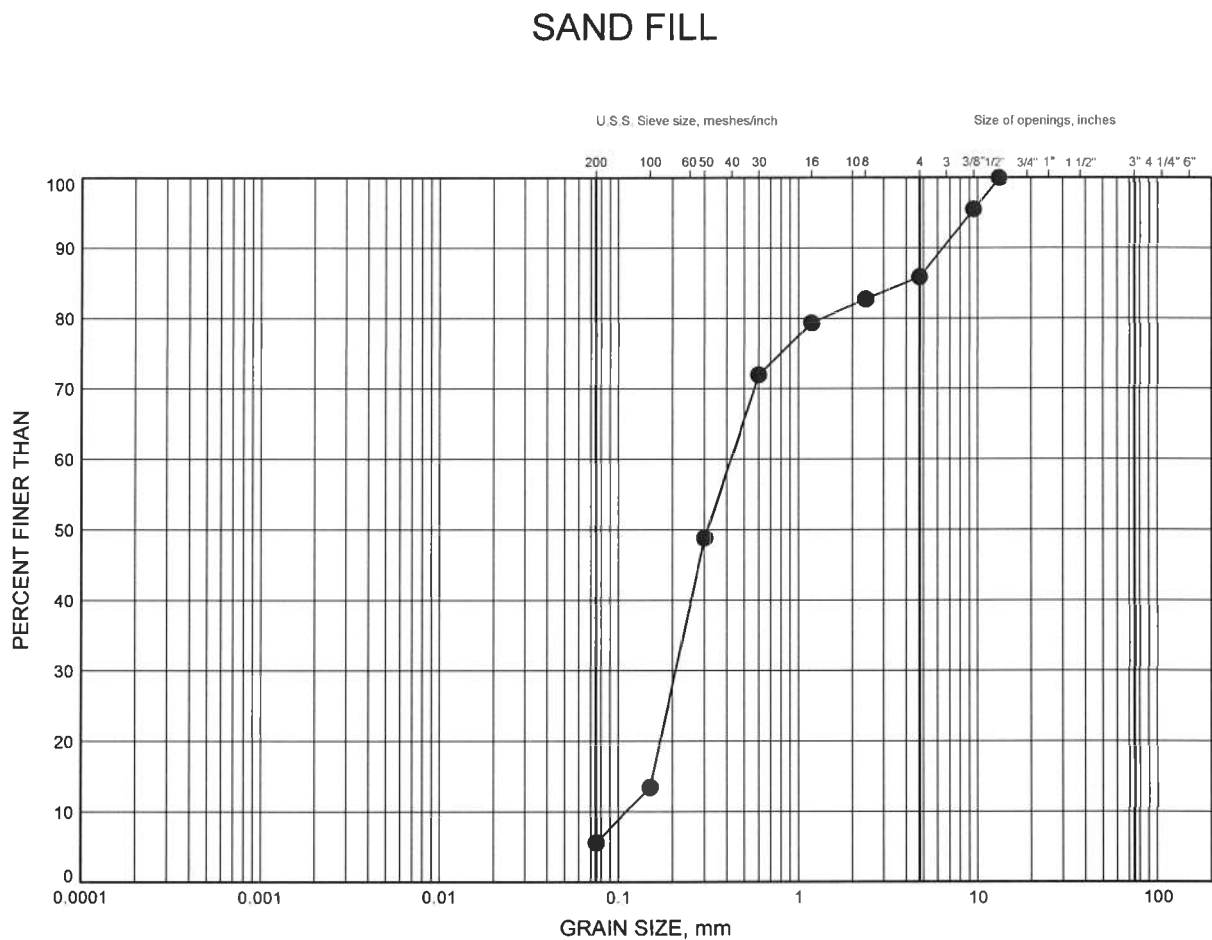
METRIC

W.P. 4091-07-00 LOCATION N 5 031 041.6 E 369 492.2 ORIGINATED BY GA
HWY 417 BOREHOLE TYPE Hollow Stem Augers COMPILED BY AN
DATUM Geodetic DATE 2012 05 01 - 2012 05 01 CHECKED BY LRB

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	20 40 60							
								○ UNCONFINED + FIELD VANE ● QUICK TRIAXIAL × LAB VANE								
Continued From Previous Page																
	Silly SAND , some clay to clayey, trace gravel Compact to Very Dense Grey Wet (TILL)		10	SS	14		49									10 38 29 23
							48									
							47									
			11	SS	50/ 0.150		46									
45.2							45									
13.9	SHALE , highly weathered, grey		12	SS	100											
44.5																
14.6	END OF BOREHOLE AT 14.6m UPON AUGER REFUSAL. BOREHOLE OPEN TO 14.6m AND WATER LEVEL AT 4.2m UPON COMPLETION. BOREHOLE BACKFILLED WITH BENTONITE HOLEPLUG FROM 14.6m TO 0.3m, CONCRETE FROM 0.3m TO 0.1m, THEN ASPHALT TO SURFACE.															

Highway 417 Ottawa: Nicholas to Vanier
GRAIN SIZE DISTRIBUTION

FIGURE A1



SILT and CLAY	FINE	MEDIUM	COARSE	FINE	COARSE	COBBLE SIZE
FINE GRAINED	SAND			GRAVEL		

LEGEND

SYMBOL	BOREHOLE	DEPTH (m)	ELEV. (m)
●	NSW-2	1.07	58.03

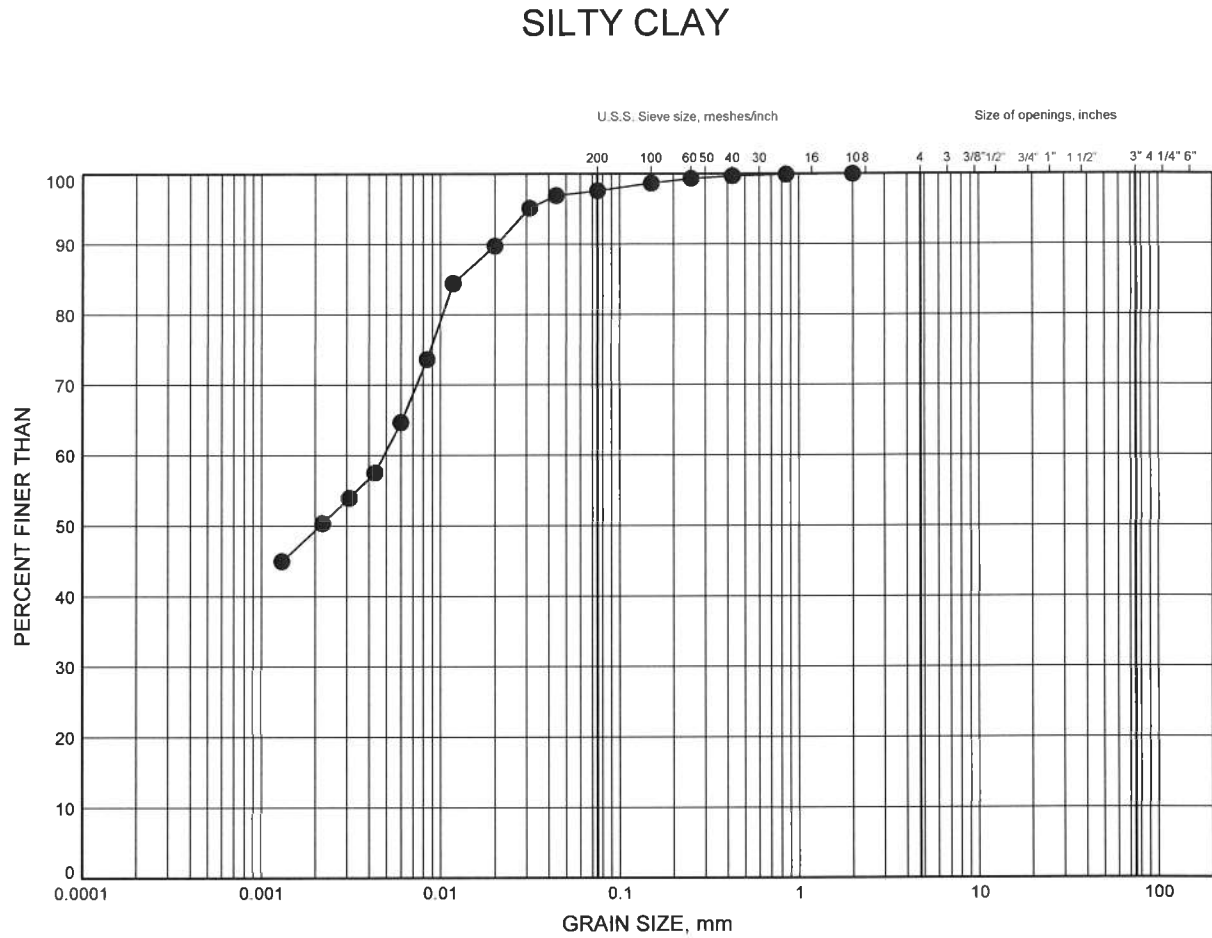
GRAIN SIZE DISTRIBUTION - THURBER 1201A.GPJ 5/9/12

W.P.# 4091-07-00
 Prepared By AN
 Checked By LRB



Highway 417 Ottawa: Nicholas to Vanier GRAIN SIZE DISTRIBUTION

FIGURE A2



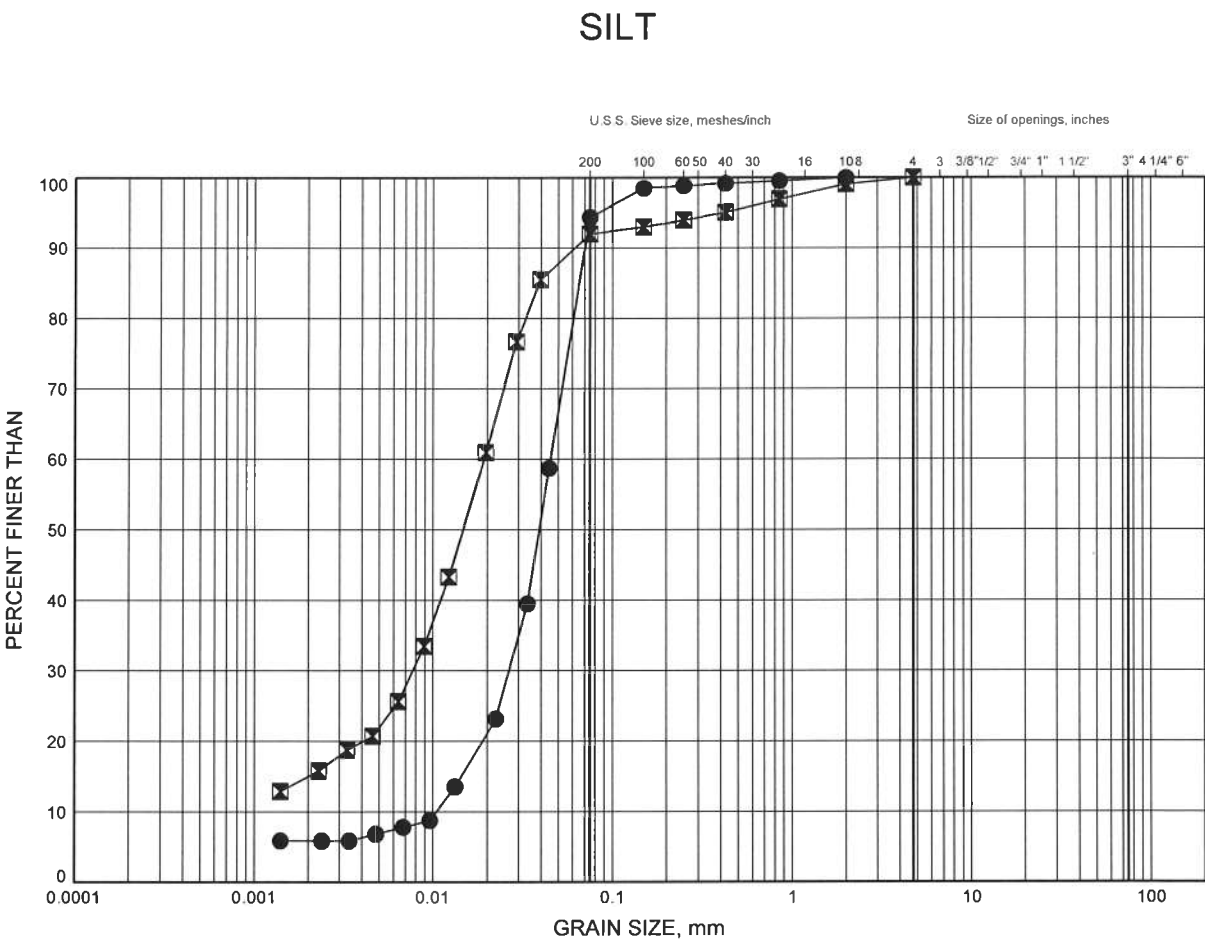
SILT and CLAY	FINE	MEDIUM	COARSE	FINE	COARSE	COBBLE SIZE
FINE GRAINED	SAND			GRAVEL		

LEGEND

SYMBOL	BOREHOLE	DEPTH (m)	ELEV. (m)
●	NSW-1	4.88	54.22

Highway 417 Ottawa: Nicholas to Vanier
GRAIN SIZE DISTRIBUTION

FIGURE A3



SILT and CLAY	FINE	MEDIUM	COARSE	FINE	COARSE	COBBLE SIZE
FINE GRAINED	SAND			GRAVEL		

LEGEND

SYMBOL	BOREHOLE	DEPTH (m)	ELEV. (m)
●	NSW-1	7.92	51.18
■	NSW-2	6.40	52.70

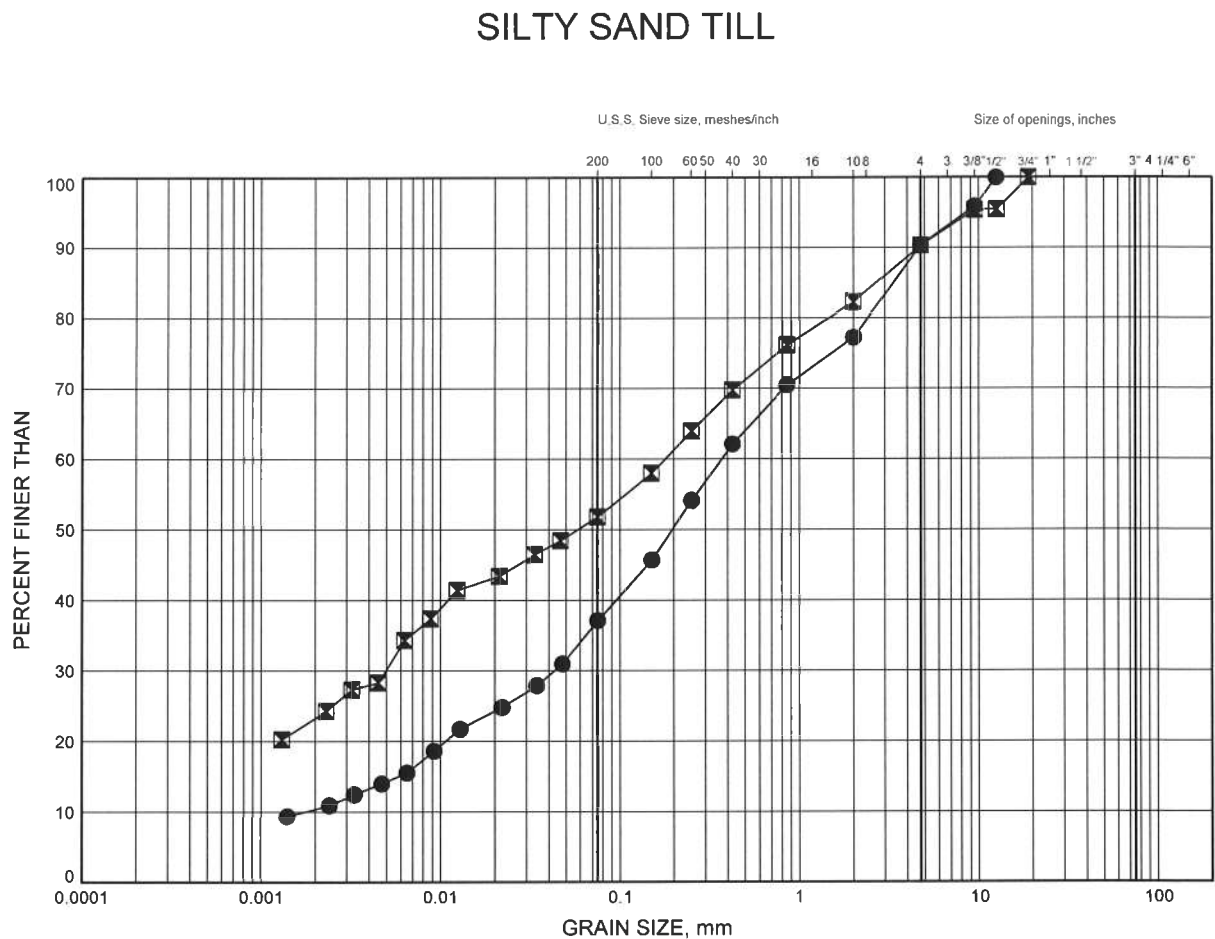
GRAIN SIZE DISTRIBUTION - THURBER 1201A.GPJ 5/9/12

W.P.# 4091-07-00
Prepared By AN
Checked By LRB



Highway 417 Ottawa: Nicholas to Vanier
GRAIN SIZE DISTRIBUTION

FIGURE A4



SILT and CLAY	FINE	MEDIUM	COARSE	FINE	COARSE	COBBLE SIZE
FINE GRAINED	SAND			GRAVEL		

LEGEND

SYMBOL	BOREHOLE	DEPTH (m)	ELEV. (m)
●	NSW-1	10.97	48.13
■	NSW-2	12.50	46.60

GRAIN SIZE DISTRIBUTION - THURBER 1201A GPJ 5/9/12

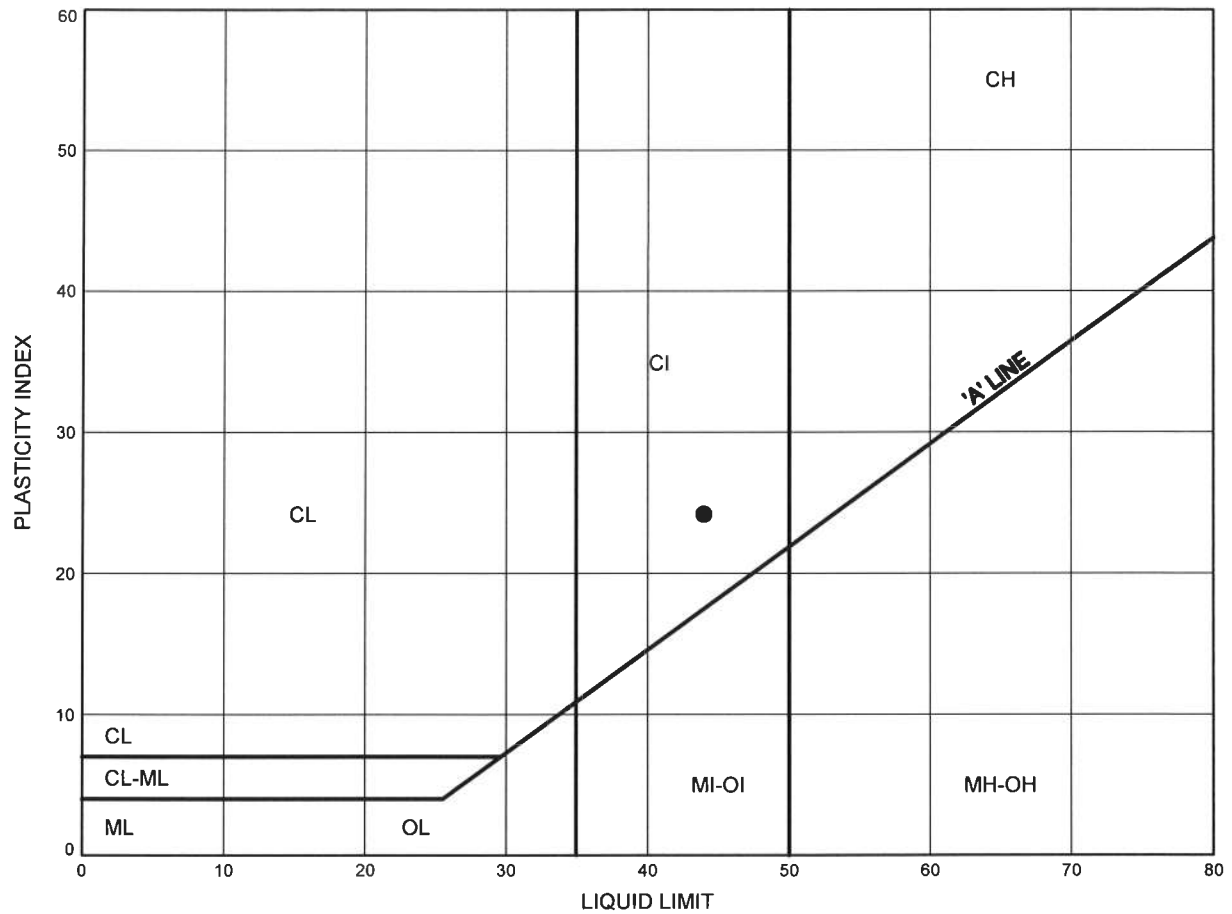
W.P.# 4091-07-00
Prepared By AN
Checked By LRB



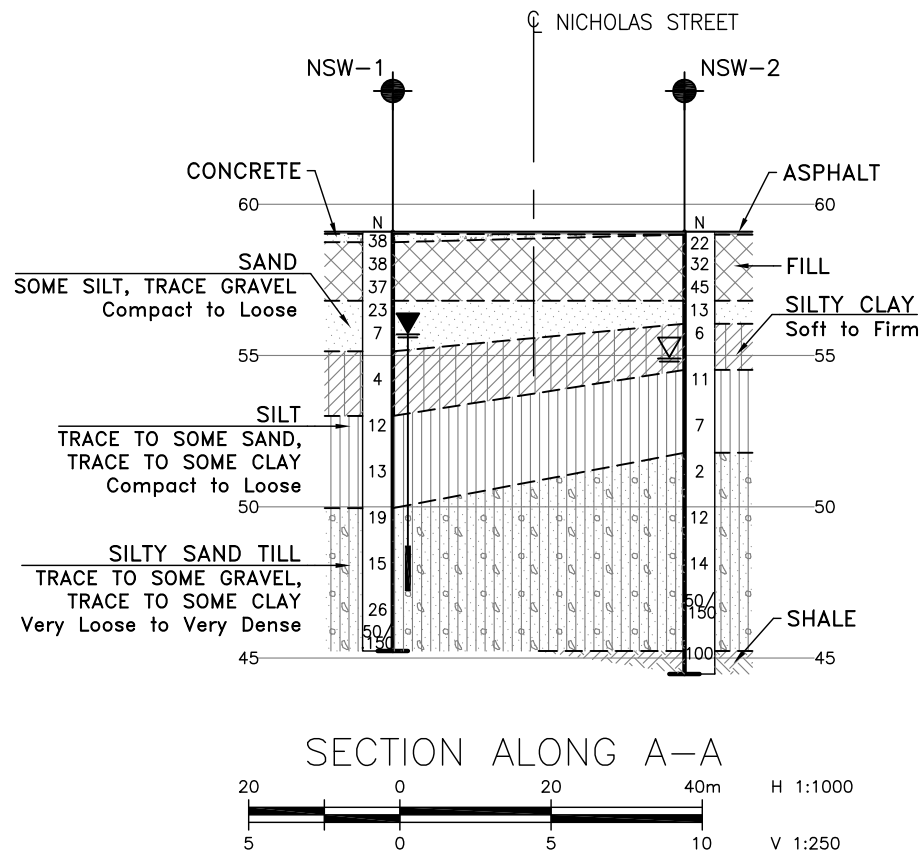
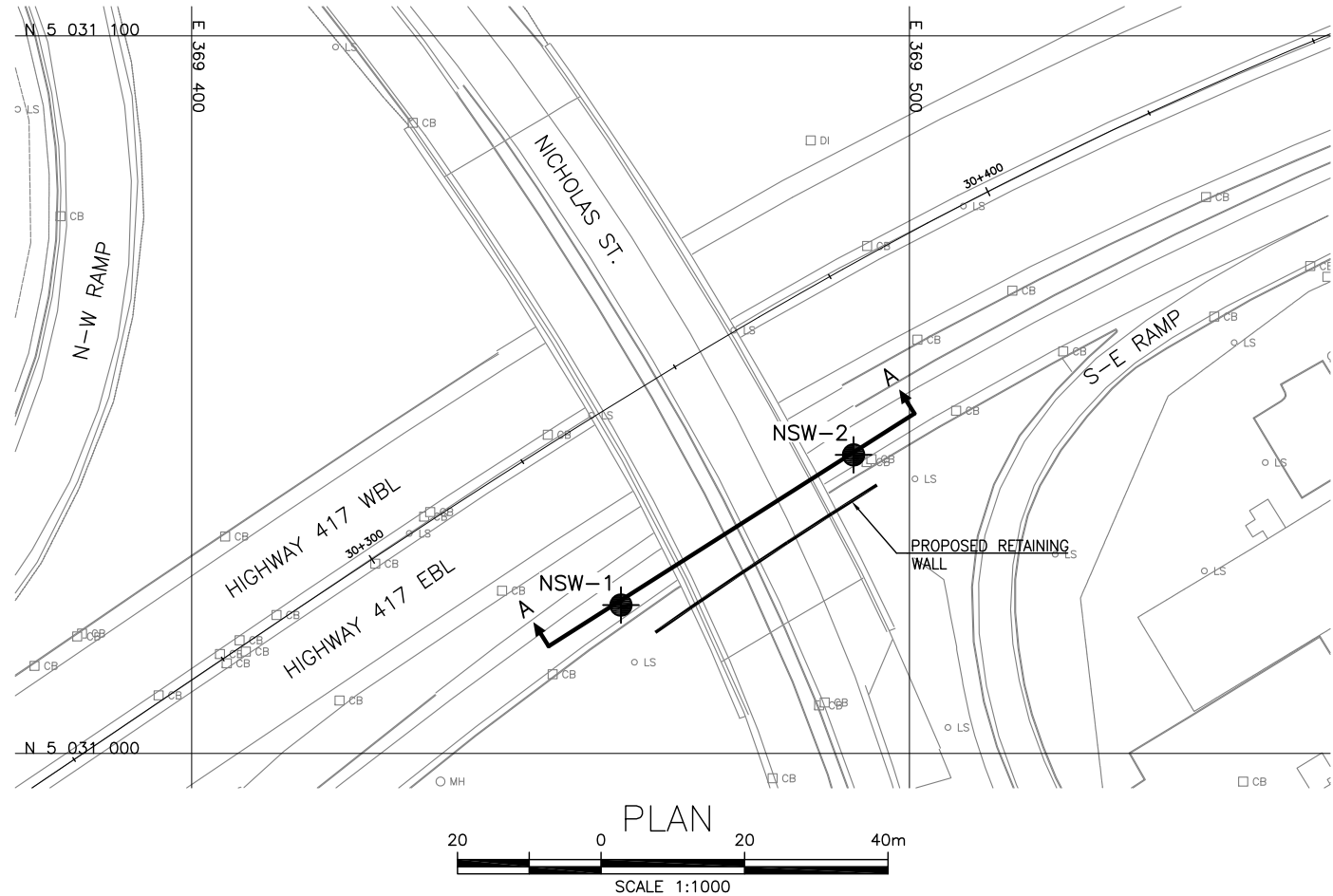
Highway 417 Ottawa: Nicholas to Vanier
ATTERBERG LIMITS TEST RESULTS

FIGURE A5

SILTY CLAY



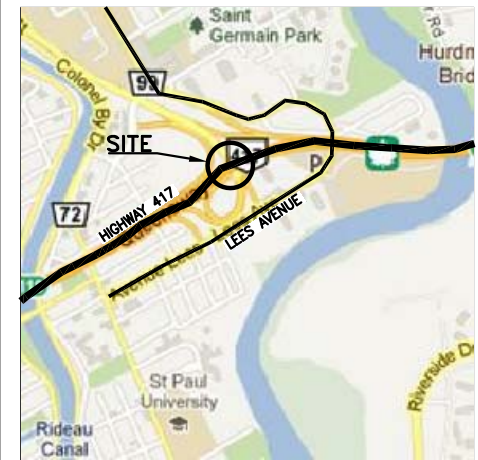
SYMBOL	BH	DEPTH (m)	ELEV. (m)
●	NSW-1	4.88	54.22



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

CONT No
WP No 4091-07-00

HIGHWAY 417
NICHOLAS STREET (SOUTH)
BOREHOLE LOCATION PLAN & SOIL STRATA



KEYPLAN

LEGEND

	Borehole
	Borehole and Cone
N	Blows /0.3m (Std Pen Test, 475J/blow)
CONE	Blows /0.3m (60' Cone, 475J/blow)
PH	Pressure, Hydraulic
	Water Level
	Head Artesian Water
	Piezometer
90%	Rock Quality Designation (RQD)
A/R	Auger Refusal

NO	ELEVATION	NORTHING	EASTING
NSW-1	59.1	5 031 020.7	369 459.8
NSW-2	59.1	5 031 041.6	369 492.2

-NOTES-

- 1) The boundaries between soil strata have been established only at Borehole locations. Between Boreholes the boundaries are assumed from geological evidence.
- 2) This drawing is for subsurface information only. Surface details and features are for conceptual illustration.

GEOCRES No. 31G5-250

REVISIONS	DATE	BY	DESCRIPTION
DESIGN	LRB	CHK	LRB
DRAWN	AN	CHK	SITE
LOAD	DATE	AUG. 2012	
STRUCT	DWG	1	

Appendix B

Lees Avenue S-E Ramp

Boreholes LSER-01 to LSER-04

RECORD OF BOREHOLE No LSER-01

1 OF 2

METRIC

W.P. 4091-07-00 LOCATION N 5 030 931.3 E 369 549.9 ORIGINATED BY RK
 HWY 417 BOREHOLE TYPE Hollow Stem Augers COMPILED BY AN
 DATUM Geodetic DATE 2011.11.26 - 2011.11.26 CHECKED BY LRB

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					
59.0							20	40	60	80	100		
0.0	ASPHALT: (90mm)												
0.1													
58.7	CONCRETE, with rebar												
0.3	SAND, trace to some gravel, trace silt Very Dense Brown Moist (FILL)		1	SS	88								
			2	SS	58/ 0.075								
	Grey		3	SS	53/ 0.100								
55.6			4	SS	13								
3.4	Silty CLAY, trace sand Soft Grey												
			5	SS	2								
			6	SS	2								
51.4													
7.6	SILT, some clay, trace sand Loose Grey Wet		7	SS	9								
50.3													
8.7	SILT and SAND, some clay, some gravel Compact Grey Moist to Wet (TILL)		8	SS	26								

Continued Next Page

+ 3 x 3 : Numbers refer to
Sensitivity

20
15 10 5
(%) STRAIN AT FAILURE

RECORD OF BOREHOLE No LSER-01

2 OF 2

METRIC

W.P. 4091-07-00 LOCATION N 5 030 931.3 E 369 549.9 ORIGINATED BY RK
 HWY 417 BOREHOLE TYPE Hollow Stem Augers COMPILED BY AN
 DATUM Geodetic DATE 2011.11.26 - 2011.11.26 CHECKED BY LRB

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 (%)				
	Continued From Previous Page							20 40 60 80 100		20 40 60				
								○ UNCONFINED + FIELD VANE ● QUICK TRIAXIAL x LAB VANE						
47.6	Shale fragments		9	SS	10		48							
11.4	END OF BOREHOLE AT 11.4m UPON AUGER REFUSAL ON PROBABLE BEDROCK. Piezometer installation consists of 19mm diameter Schedule 40 PVC pipe with a 3.0m slotted screen. WATER LEVEL READINGS: DATE DEPTH (m) ELEV (m) Flushmount casing could not be opened													

RECORD OF BOREHOLE No LSER-02

1 OF 2

METRIC

W.P. 4091-07-00 LOCATION N 5 030 952.8 E 369 538.3 ORIGINATED BY ES
 HWY 417 BOREHOLE TYPE Hollow Stem Augers COMPILED BY AN
 DATUM Geodetic DATE 2012.03.06 - 2012.03.06 CHECKED BY LRB

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			
59.3							20 40 60 80 100	PLASTIC LIMIT w _P	MATURAL MOISTURE CONTENT w	LIQUID LIMIT w _L	GR SA SI CL
0.0	ASPHALT: (100mm)						20 40 60 80 100				
0.1							20 40 60 80 100				
0.3	CONCRETE: (200mm)						20 40 60 80 100				
	SAND, some gravel, some silt and clay Dense to Very Dense Brown Damp (FILL)		1	GS							
			1	SS	48						
	Gravelly, occasional cobble		2	SS	79						29 58 13 (SI+CL)
	No recovery		3	SS	100/ 0.100						
			4	SS	33						
55.9											
3.5	Silly CLAY, trace sand Soft to Firm Grey										
			5	SS	3						
			6	SS	6						0 4 72 24
51.6											
7.7	SILT, trace clay, trace sand Compact Grey Wet		7	SS	26						
50.0											
9.4	Sandy SILT, some clay, trace gravel Compact Dark Grey		8	SS	18						

Continued Next Page

+³, ×³: Numbers refer to
Sensitivity


20
15
10
(%) STRAIN AT FAILURE

RECORD OF BOREHOLE No LSER-02

2 OF 2

METRIC

W.P. 4091-07-00 LOCATION N 5 030 952.8 E 369 538.3 ORIGINATED BY ES
HWY 417 BOREHOLE TYPE Hollow Stem Augers COMPILED BY AN
DATUM Geodetic DATE 2012.03.06 - 2012.03.06 CHECKED BY LRB

SOIL PROFILE			SAMPLES			GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT					UNIT WEIGHT γ kN/m ³	REMARKS & GRAIN SIZE DISTRIBUTION (%) GR SA SI CL			
ELEV DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE	"N" VALUES			SHEAR STRENGTH kPa ○ UNCONFINED + FIELD VANE ● QUICK TRIAXIAL × LAB VANE							PLASTIC LIMIT NATURAL MOISTURE CONTENT LIQUID LIMIT w _p w w _L WATER CONTENT (%)		
	Continued From Previous Page							20	40	60	80	100	20	40	60		
48.1	Sandy SILT, some clay, trace gravel Compact Dark Grey Moist (TILL)		9	SS	35		49										
11.3	END OF BOREHOLE AT 11.3m. WATER LEVEL AT 4.1m UPON COMPLETION. BOREHOLE BACKFILLED WITH BENTONITE HOLEPLUG TO 1.2m, CUTTINGS TO 0.1m THEN ASPHALT TO SURFACE.																

RECORD OF BOREHOLE No LSER-03

1 OF 2

METRIC

W.P. 4091-07-00 LOCATION N 5 030 976 4 E 369 525 6 ORIGINATED BY ES
HWY 417 BOREHOLE TYPE Hollow Stem Augers COMPILED BY AN
DATUM Geodetic DATE 2012.03.06 - 2012.03.06 CHECKED BY LRB

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	20 40 60 80 100	20 40 60 80 100		
59.7												
0.0	ASPHALT: (100mm)											
59.4	CONCRETE: (200mm)											
0.3	SAND, some gravel, some silt and clay Very Dense Brown Damp to Moist (FILL)		1	GS			59					
			1	SS	59							
			2	SS	55		58					
	Faint odour Occasional cobbles, occasional asphalt fragments		3	SS	106		57					
	Compact Dark Grey		4	SS	22		56					
55.6												
4.1	Silty CLAY, trace sand Soft Grey		5	SS	3		55					
							54					
53.3			6	SS	3							
6.4	SILT, some clay, trace sand Loose Grey Wet						53					
			7	SS	6		52					
							51					
50.3												
9.4	Sandy SILT, some clay, trace gravel Compact Grey to Dark Brown		8	SS	14		50					

Continued Next Page

+³ ×³ Numbers refer to Sensitivity 20 15 10 5 0 (%) STRAIN AT FAILURE

RECORD OF BOREHOLE No LSER-03

2 OF 2

METRIC

W.P. 4091-07-00 LOCATION N 5 030 976.4 E 369 525.6 ORIGINATED BY ES
 HWY 417 BOREHOLE TYPE Hollow Stem Augers COMPILED BY AN
 DATUM Geodetic DATE 2012.03.06 - 2012.03.06 CHECKED BY LRB

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			20 40 60 80 100	20 40 60 80 100	W _P W W _L	20 40 60			
48.4	Continued From Previous Page Sandy SILT, some clay, trace gravel Compact Grey to Dark Brown Wet (TILL)		9	SS	18		49							
11.3	END OF BOREHOLE AT 11.3m. Piezometer installation consists of 19mm diameter Schedule 40 PVC pipe with a 1.52m slotted screen. WATER LEVEL READINGS: DATE DEPTH (m) ELEV. (m) Mar.27/12 4.8 54.9													

RECORD OF BOREHOLE No LSER-04

1 OF 2

METRIC

W.P. 4091-07-00 LOCATION N 5 030 996.6 E 369 515.8 ORIGINATED BY ES
 HWY 417 BOREHOLE TYPE Hollow Stem Augers COMPILED BY AN
 DATUM Geodetic DATE 2012.03.07 - 2012.03.07 CHECKED BY LRB

SOIL PROFILE			SAMPLES			GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT				UNIT WEIGHT Y kN/m ³	REMARKS & GRAIN SIZE DISTRIBUTION (%)
ELEV DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE	"N" VALUES			20 40 60 80 100	20 40 60 80 100	PLASTIC LIMIT w _p	NATURAL MOISTURE CONTENT w	LIQUID LIMIT w _L	
59.9													
0.0	ASPHALT: (100mm)												
0.1													
59.6	CONCRETE: (250mm)												
0.4	SAND, fine grained Very Dense to Dense Brown Damp (FILL)		1	GS									
			1	SS	58		59						
			2	SS	36		58						
57.6													
2.3	SAND, some gravel, occasional cobbles Very Dense to Compact Brown Damp to Moist (FILL)		3	SS	75		57						
			4	SS	26								
							56						
55.7													
4.3	Silty CLAY, trace sand Firm Grey		5	SS	5		55						0 5 66 29
							54						
53.8													
6.1	SILT, some clay, some sand Loose to Compact Grey Wet		6	SS	5		53						0 11 72 17
							52						
			7	SS	11								
							51						
50.8													
9.1	Silty SAND, trace to some gravel, some clay Loose to Compact Grey Saturated (TILL)		8	SS	5		50						

Continued Next Page

+ 3 X 3 Numbers refer to 20 15 10 5 0 (%) STRAIN AT FAILURE
 Sensitivity

RECORD OF BOREHOLE No LSER-04

2 OF 2

METRIC

W.P. 4091-07-00 LOCATION N 5 030 996 6 E 369 515 8 ORIGINATED BY ES
HWY 417 BOREHOLE TYPE Hollow Stem Augers COMPILED BY AN
DATUM Geodetic DATE 2012.03.07 - 2012.03.07 CHECKED BY LRB

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									
	Continued From Previous Page		9	SS	15		49										
48.1																	
11.8	<p>END OF BOREHOLE AT 11.8m UPON AUGER REFUSAL ON PROBABLE BEDROCK. Piezometer installation consists of 19mm diameter Schedule 40 PVC pipe with a 1.52m slotted screen.</p> <p>WATER LEVEL READINGS: DATE DEPTH (m) ELEV. (m) Mar.27/12 4.4 55.5</p>																

+³, ×³: Numbers refer to
Sensitivity

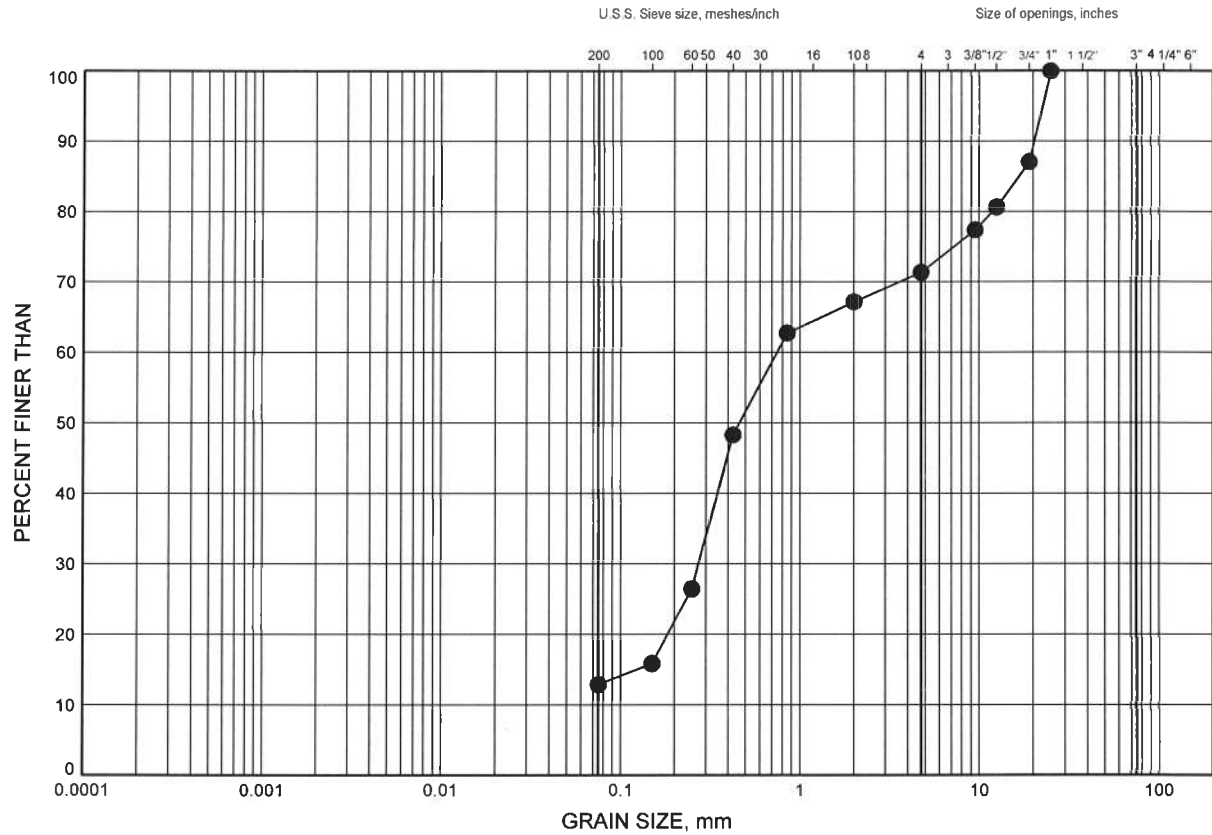
20
15
10

(%) STRAIN AT FAILURE

Highway 417 Ottawa: Nicholas to Vanier
GRAIN SIZE DISTRIBUTION

FIGURE B1

Gravelly Sand Fill



SILT and CLAY	FINE	MEDIUM	COARSE	FINE	COARSE	COBBLE SIZE
FINE GRAINED	SAND			GRAVEL		

LEGEND

SYMBOL	BOREHOLE	DEPTH (m)	ELEV. (m)
●	LSER-02	1.75	57.59

GRAIN SIZE DISTRIBUTION - THURBER 1201A.GPJ 5/10/12

Date May 2012
W.P.# 4091-07-00

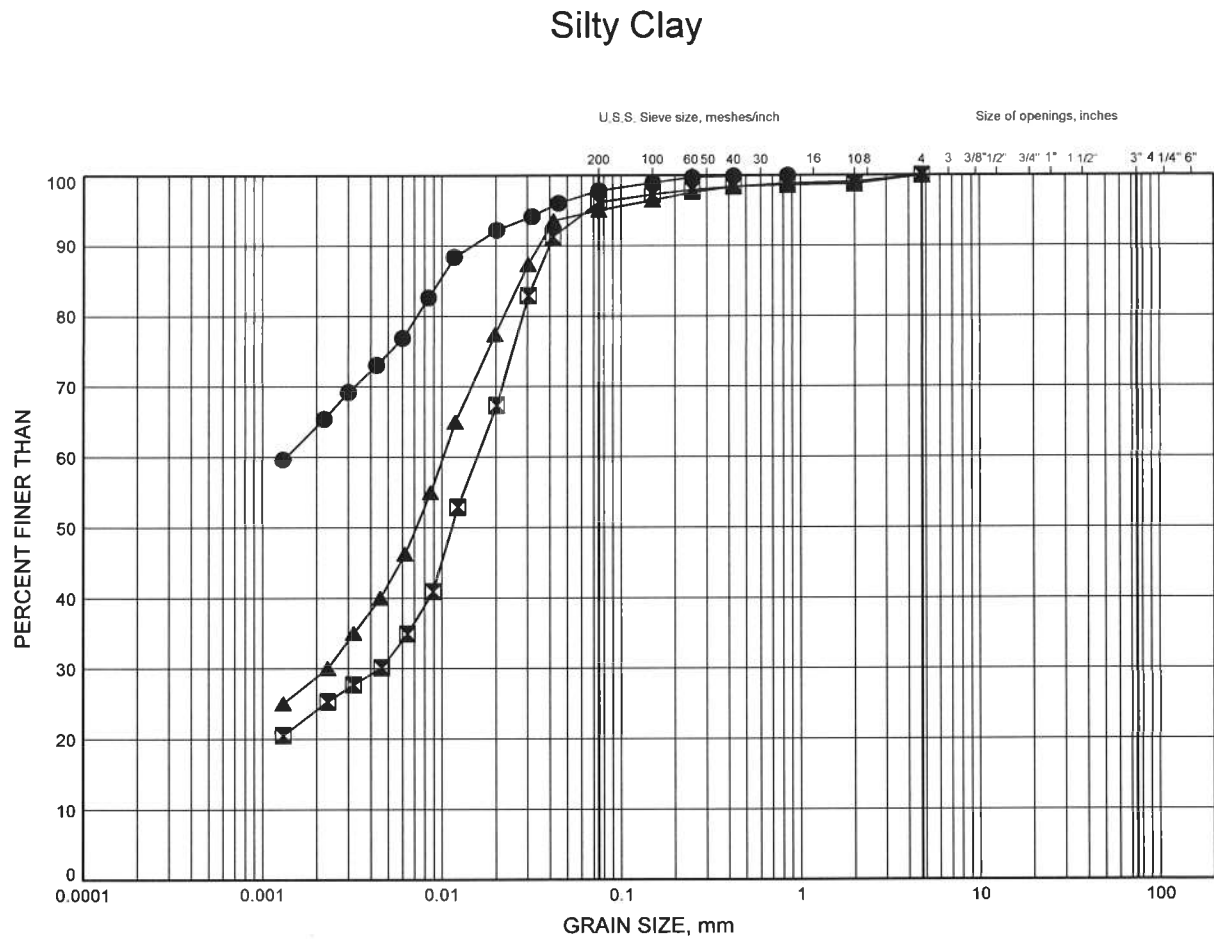


Prep'd MFA
Chkd. LRB

Highway 417 Ottawa: Nicholas to Vanier

GRAIN SIZE DISTRIBUTION

FIGURE B2



SILT and CLAY	FINE	MEDIUM	COARSE	FINE	COARSE	COBBLE SIZE
FINE GRAINED	SAND			GRAVEL		

LEGEND

SYMBOL	BOREHOLE	DEPTH (m)	ELEV. (m)
●	LSER-01	4.88	54.12
⊠	LSER-02	6.40	52.94
▲	LSER-04	4.88	55.05

Date May 2012
W.P.# 4091-07-00

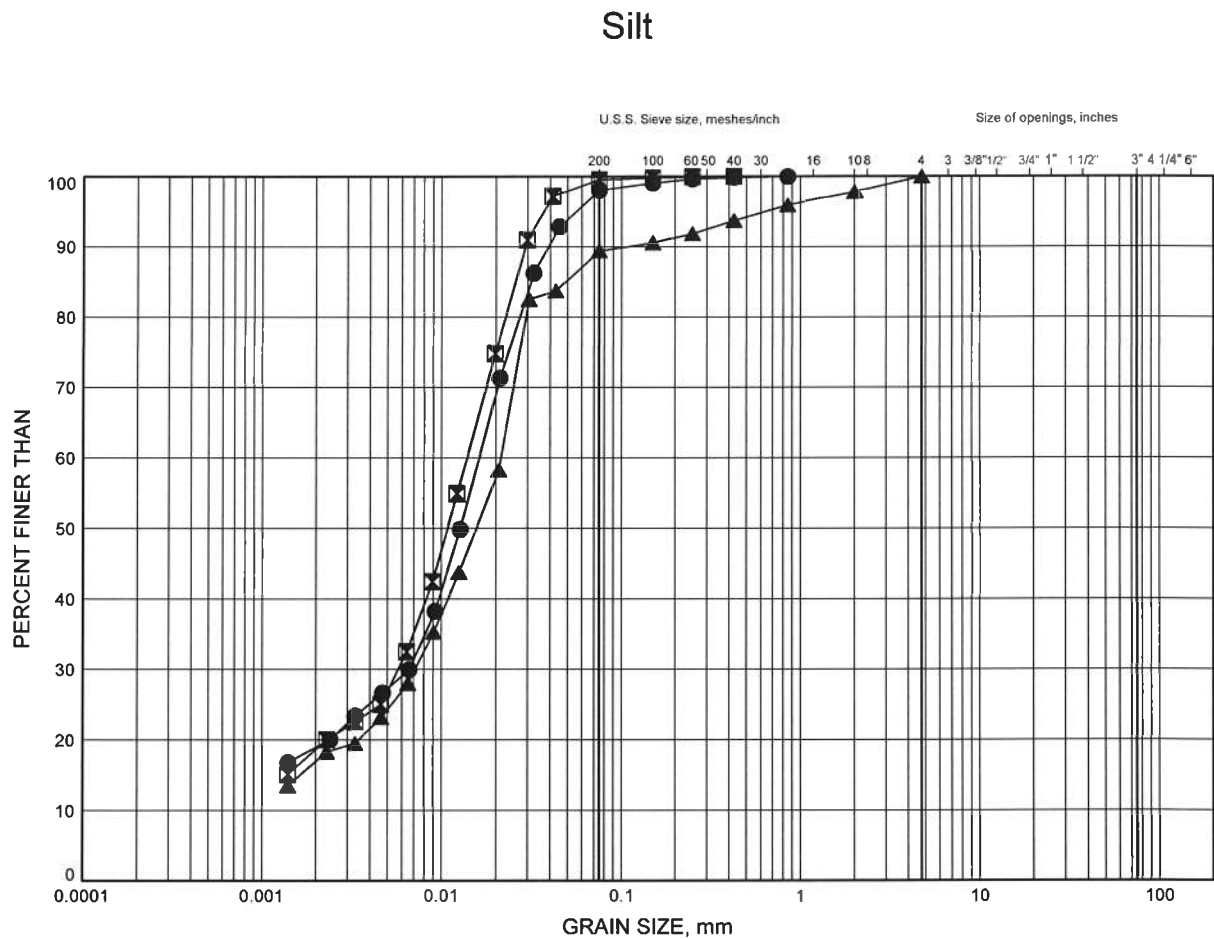


Prep'd MFA
Chkd. LRB

Highway 417 Ottawa: Nicholas to Vanier

GRAIN SIZE DISTRIBUTION

FIGURE B3



SILT and CLAY	FINE	MEDIUM	COARSE	FINE	COARSE	COBBLE SIZE
FINE GRAINED	SAND			GRAVEL		

LEGEND

SYMBOL	BOREHOLE	DEPTH (m)	ELEV. (m)
●	LSER-01	7.92	51.08
■	LSER-03	6.40	53.31
▲	LSER-04	6.40	53.53

GRAIN SIZE DISTRIBUTION - THURBER 1201A.GPJ 5/11/12

Date May 2012
W.P.# 4091-07-00



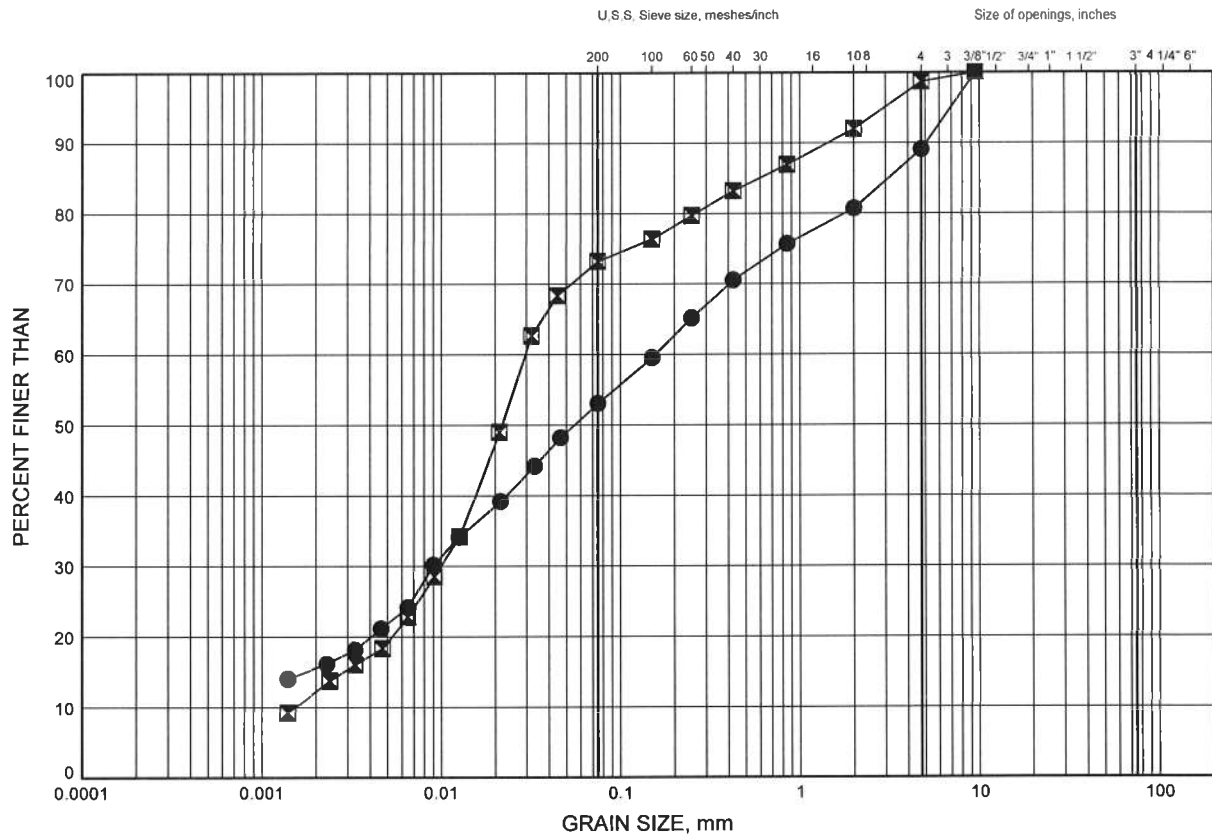
Prep'd MFA
Chkd. LRB

Highway 417 Ottawa: Nicholas to Vanier

GRAIN SIZE DISTRIBUTION

FIGURE B4

Sandy Silt to Silty Sand Till



SILT and CLAY	FINE	MEDIUM	COARSE	FINE	COARSE	COBBLE SIZE
FINE GRAINED	SAND			GRAVEL		

LEGEND

SYMBOL	BOREHOLE	DEPTH (m)	ELEV. (m)
●	LSER-01	9.45	49.55
⊠	LSER-03	9.45	50.27

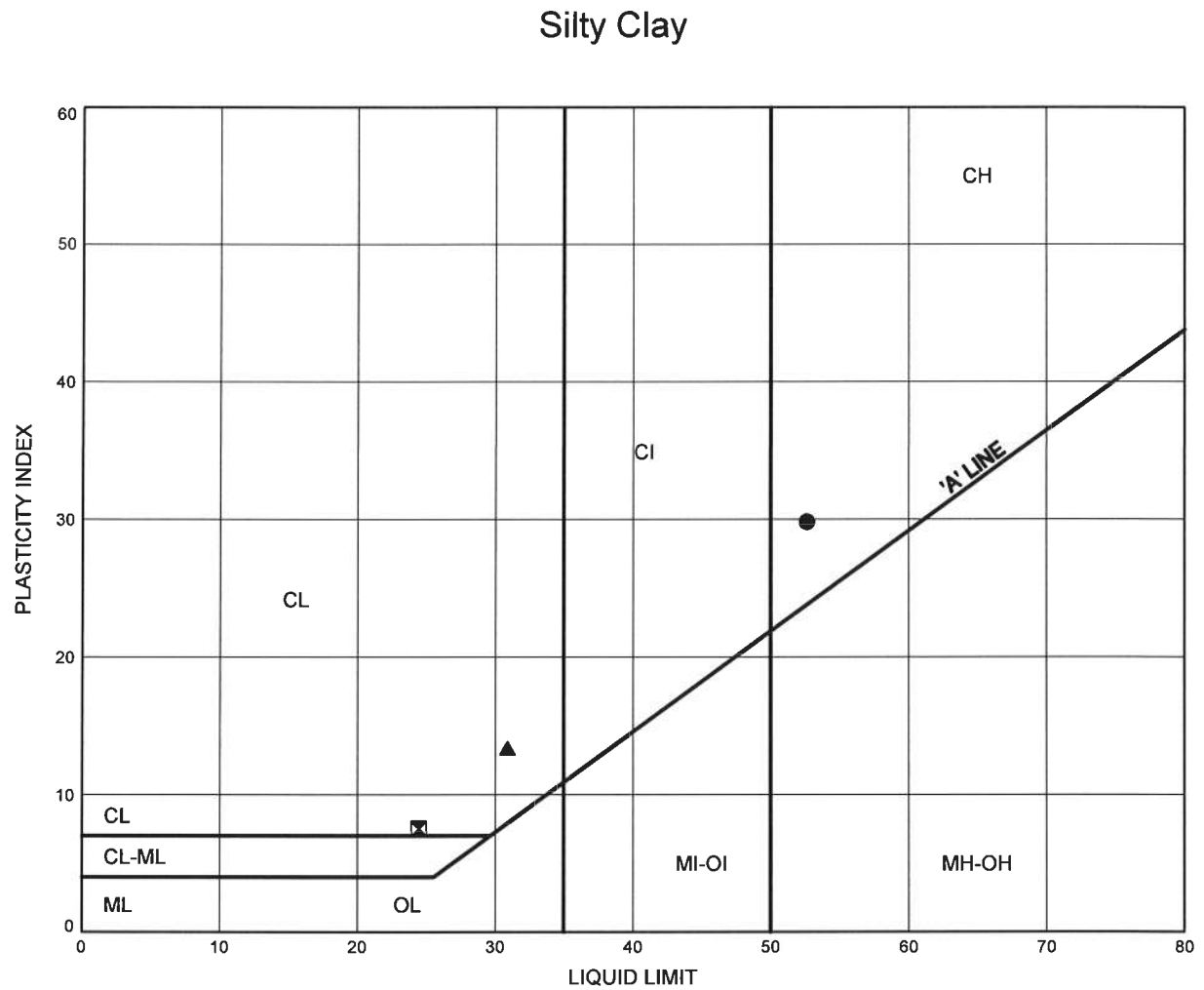
Date May 2012
W.P.# 4091-07-00



Prep'd MFA
Chkd. LRB

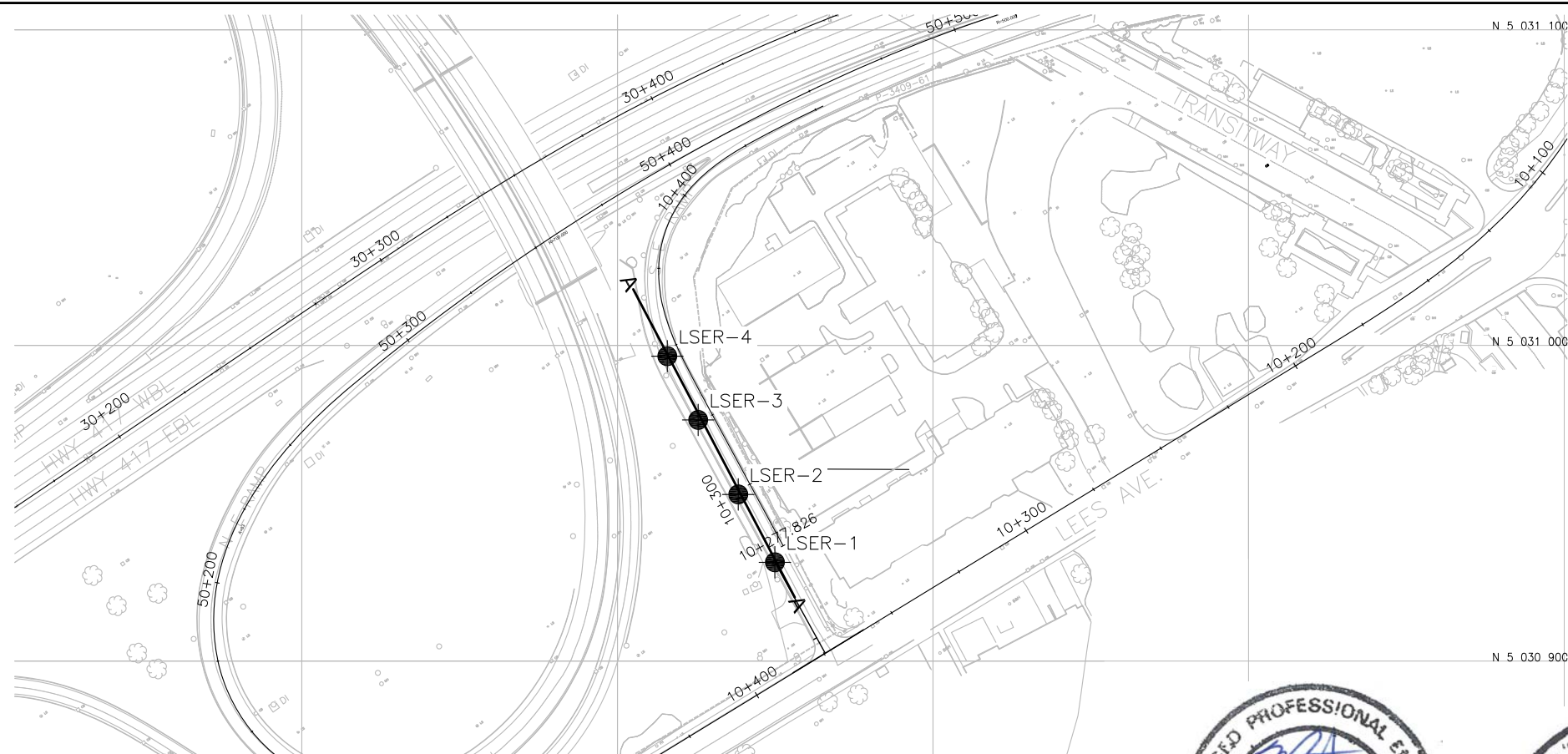
Highway 417 Ottawa: Nicholas to Vanier
ATTERBERG LIMITS TEST RESULTS

FIGURE B5



LEGEND

SYMBOL	BOREHOLE	DEPTH (m)	ELEV. (m)
●	LSER-01	4.88	54.12
⊠	LSER-02	6.40	52.94
▲	LSER-04	4.88	55.05



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

CONT	No
WP	No

HIGHWAY 417
LEES AVENUE S-E RAMP
BOREHOLE LOCATIONS & SOIL STRATA








THURBER ENGINEERING LTD.



KEYPLAN

LEGEND

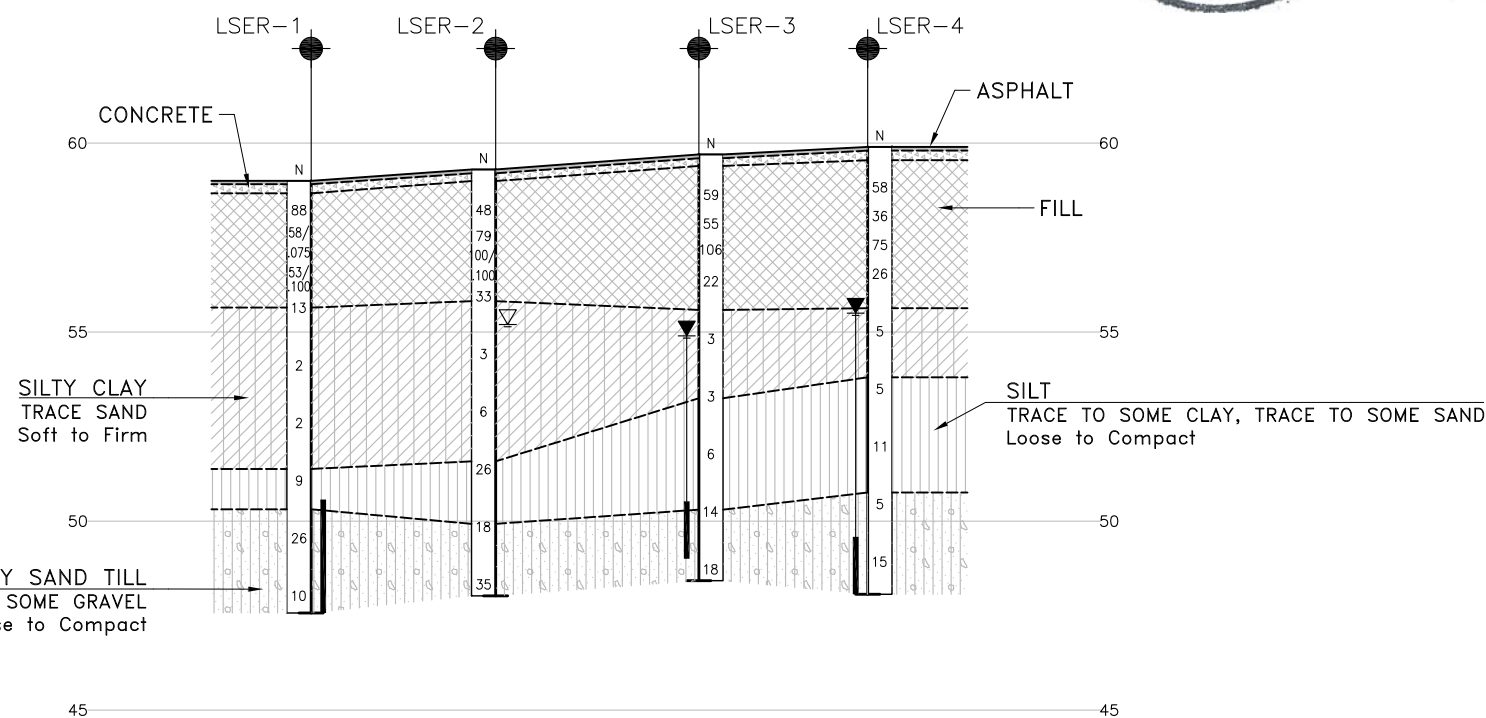
	Borehole
	Borehole and Cone
N	Blows /0.3m (Std Pen Test, 475J/blow)
CONE	Blows /0.3m (60° Cone, 475J/blow)
PH	Pressure, Hydraulic
	Water Level
	Head Artesian Water
	Piezometer
90%	Rock Quality Designation (RQD)
A/R	Auger Refusal

[illegible]

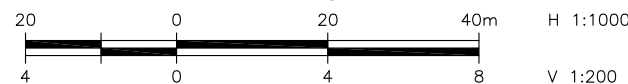
-NOTES-

- 1) The boundaries between soil strata have been established only at Borehole locations. Between Boreholes the boundaries are assumed from geological evidence.
- 2) This drawing is for subsurface information only. Surface details and features are for conceptual illustration.

GEOCRES No. 31G5-250



PROFILE ALONG A-A



REVISIONS										
	DATE	BY								
DESIGN	LRB	CHK	MRA	CODE		LOAD		DATE	AUG. 2012	
DRAWN	MFA/AN	CHK	PKC	SITE		STRUCT	DWG	1		

Appendix C

Lees Avenue (North) at Robinson Avenue

Boreholes LE-08 and LE-09

RECORD OF BOREHOLE No LE-08

1 OF 2

METRIC

W.P. 4091-07-00 LOCATION N 5 031 173 5 E 369 820 5 Lees Avenue ORIGINATED BY RK/ES
 HWY 417 BOREHOLE TYPE Hollow Stem Augers COMPILED BY AN
 DATUM Geodetic DATE 2012.03.12 - 2012.03.22 CHECKED BY LRB

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					
60.7								20 40 60 80 100		PLASTIC LIMIT	NATURAL MOISTURE CONTENT	LIQUID LIMIT	
0.0	ASPHALT: (100mm)									w _p	w	w _L	
0.1	SAND, medium grained												
60.2	Brown												
0.5	Moist (FILL)												
	SAND and GRAVEL, some silt		1	SS	87/ 0.275								
	Very Dense to Dense												
	Dark Brown												
	Moist (FILL)		2	SS	30								
58.5													
2.2	SAND, some gravel to gravelly, some silt to silty, occasional cobble		3	SS	51								16 54 23 7
	Very Dense												
	Dark Brown		4	SS	51								
	Moist												
56.0													
4.7	SAND, fine to medium grained, trace gravel, trace silt, trace clay		5	SS	80								
	Very Dense to Compact												
	Brown												
	Damp to Moist												
	Grey		6	SS	75								
	Wet												
			7	SS	25								0 90 10 (SI+CL)
51.9													
8.8	Silty SAND, occasional shale fragments		8	SS	148/ 0.275								
	Very Dense												
	Dark Grey												
51.1	Moist (TILL)												
9.6													
	END OF BOREHOLE AT 9.6m UPON												

Continued Next Page

+ 3, x 3: Numbers refer to Sensitivity 20 15 10 5 0 (%) STRAIN AT FAILURE

RECORD OF BOREHOLE No LE-08

2 OF 2

METRIC

W.P. 4091-07-00 LOCATION N 5 031 173.5 E 369 820.5 Lees Avenue ORIGINATED BY RK/ES
 HWY 417 BOREHOLE TYPE Hollow Stem Augers COMPILED BY AN
 DATUM Geodetic DATE 2012 03 12 - 2012 03 22 CHECKED BY LRB

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			20 40 60 80 100	20 40 60 80 100	w _p w w _L				
	Continued From Previous Page													
	PROBABLE BEDROCK. Piezometer installation consists of 19mm diameter Schedule 40 PVC pipe with a 1.52m slotted screen. WATER LEVEL READINGS: DATE DEPTH (m) ELEV. (m) Mar 23/12 1.1 59.6													

ONTMT4S 1201A.GPJ 5/15/12

RECORD OF BOREHOLE No LE-09

1 OF 2

METRIC

W.P. 4091-07-00 LOCATION N 5 031 173.0 E 369 843.4 Lees Avenue ORIGINATED BY ES
HWY 417 BOREHOLE TYPE Hollow Stem Augers/Casing COMPILED BY AN
DATUM Geodetic DATE 2012.03.13 - 2012.03.13 CHECKED BY LRB

SOIL PROFILE			SAMPLES			GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT		PLASTIC LIMIT NATURAL MOISTURE CONTENT LIQUID LIMIT			UNIT WEIGHT γ kN/m ³	REMARKS & GRAIN SIZE DISTRIBUTION (%)
ELEV DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE	"N" VALUES			SHEAR STRENGTH kPa		WATER CONTENT (%)				
								20 40 60 80 100						
								○ UNCONFINED + FIELD VANE						
								● QUICK TRIAXIAL x LAB VANE						
								20 40 60 80 100						
60.5	ASPHALT: (50mm)													
59.4	SAND, trace gravel, trace silt Compact Brown Damp (FILL)		1	GS										
1.1	Silty SAND, some clay, trace gravel Compact to Very Dense Brown Moist (FILL)		1	SS	15									8 50 28 14
			2	SS	19									
58.3	Cobbles													
2.2	Gravelly SAND, some silt Very Dense Brown Moist Auger refusal at 2.9m, switch to casing and coring Occasional cobbles and boulders from 2.9m to 4.5m No recovery		3	SS	50/ 0.150									
			4	SS	100/ 0.0									
54.4														
6.1	SAND and GRAVEL, occasional cobbles Very Dense Grey Wet		5	SS	95									
			6	SS	55/ 0.150									
52.0														
8.5	Sandy SILT, trace clay, trace gravel Very Dense Grey Moist		7	SS	50/ 0.100									4 18 74 4
50.8														
50.7	SHALE, weathered, grey		8	SS	100/ 0.075									
50.7														
9.8														

Continued Next Page

+³ X³: Numbers refer to
Sensitivity

20
15
10

(%) STRAIN AT FAILURE

ONTMT4S 1201A.GPJ 5/15/12

RECORD OF BOREHOLE No LE-09

2 OF 2

METRIC

W.P. 4091-07-00 LOCATION N 5 031 173.0 E 369 843.4 Lees Avenue ORIGINATED BY ES
HWY 417 BOREHOLE TYPE Hollow Stem Augers/Casing COMPILED BY AN
DATUM Geodetic DATE 2012.03.13 - 2012.03.13 CHECKED BY LRB

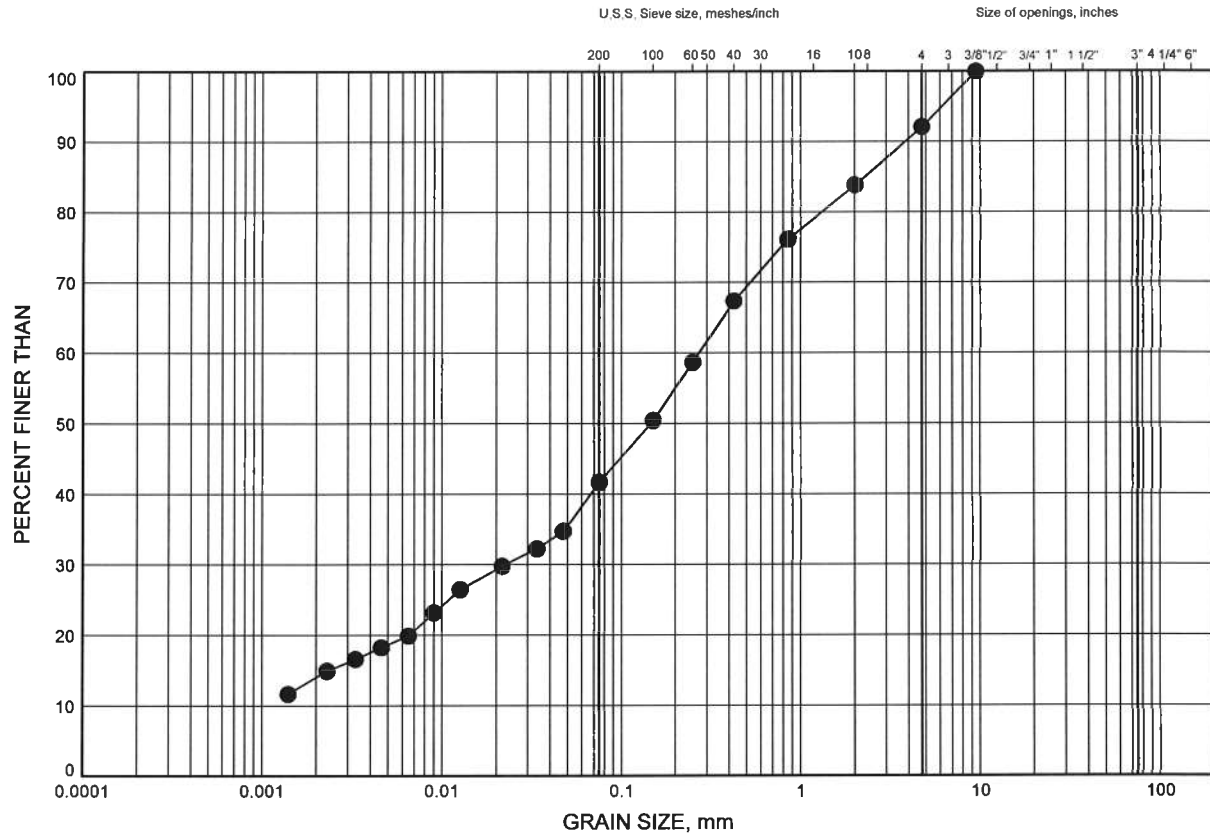
SOIL PROFILE		SAMPLES			GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT					PLASTIC LIMIT NATURAL MOISTURE CONTENT LIQUID LIMIT			UNIT WEIGHT γ kN/m ³	REMARKS & GRAIN SIZE DISTRIBUTION (%) GR SA SI CL
ELEV DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE			"N" VALUES	SHEAR STRENGTH kPa					WATER CONTENT (%)			
							20	40	60	80	100	W _p	W	W _L		
	Continued From Previous Page															
	END OF BOREHOLE AT 9.8m UPON PROBABLE BEDROCK. Piezometer installation consists of 19mm diameter Schedule 40 PVC pipe with a 1.52m slotted screen.															
	WATER LEVEL READINGS: DATE DEPTH (m) ELEV. (m) Mar.23/12 1.0 59.5															

ONTMT4S 1201A.GPJ 5/15/12

Highway 417 Ottawa: Nicholas Street to OR 174
GRAIN SIZE DISTRIBUTION

FIGURE C1

SILTY SAND FILL



SILT and CLAY	FINE	MEDIUM	COARSE	FINE	COARSE	COBBLE SIZE
FINE GRAINED	SAND			GRAVEL		

LEGEND

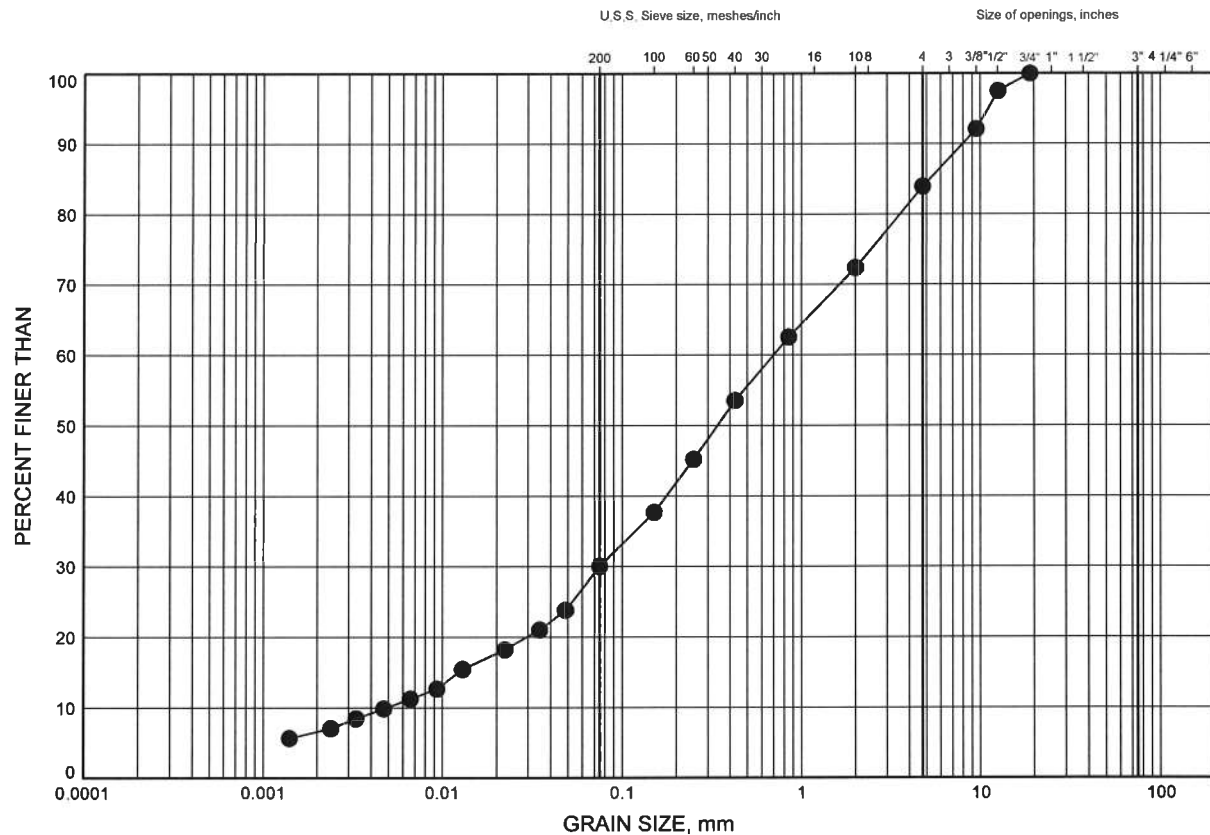
SYMBOL	BOREHOLE	DEPTH (m)	ELEV. (m)
●	LE-09	1.07	59.43

Highway 417 Ottawa: Nicholas Street to OR 174

GRAIN SIZE DISTRIBUTION

FIGURE C2

SILTY SAND



SILT and CLAY	FINE	MEDIUM	COARSE	FINE	COARSE	COBBLE SIZE
FINE GRAINED	SAND			GRAVEL		

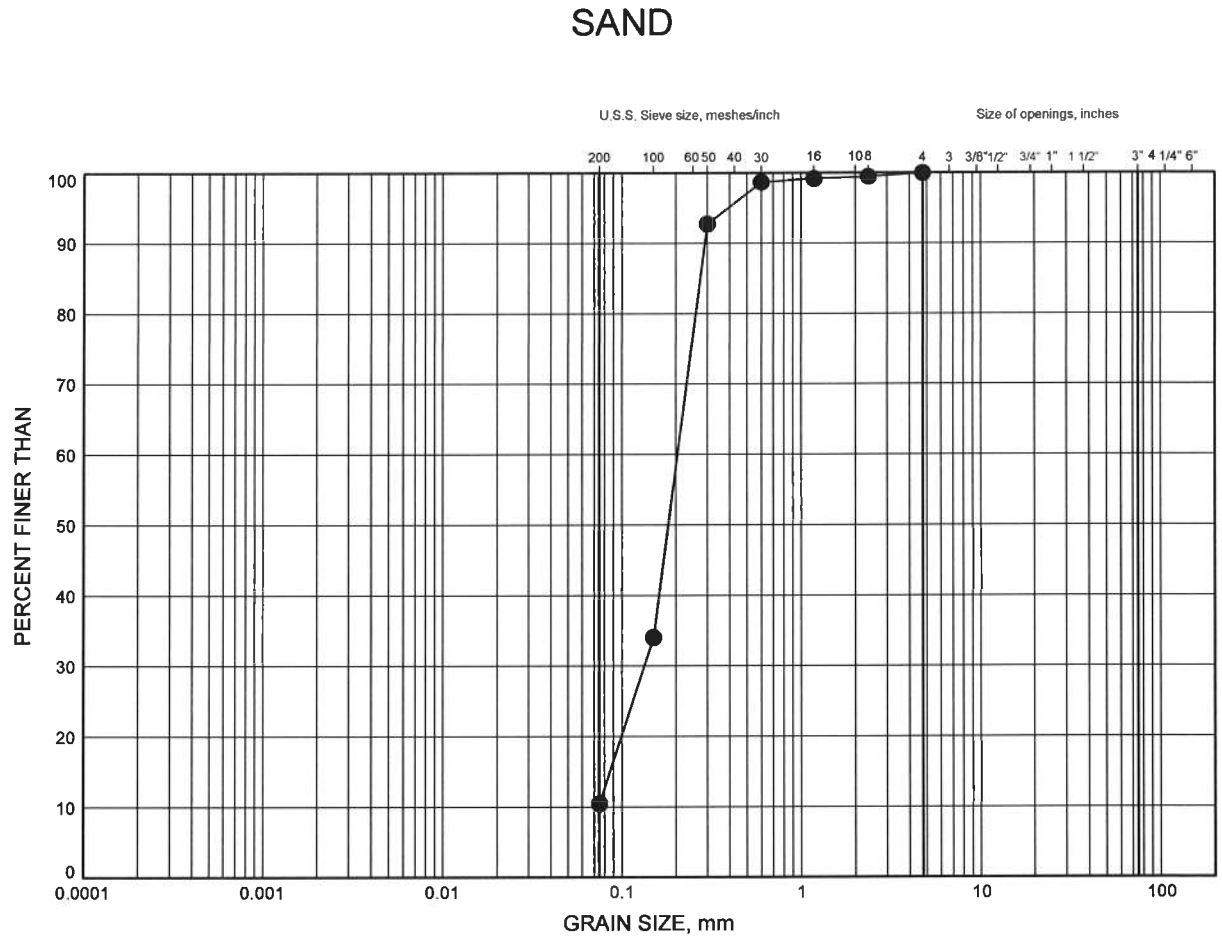
LEGEND

SYMBOL	BOREHOLE	DEPTH (m)	ELEV. (m)
●	LE-08	2.59	58.11

Highway 417 Ottawa: Nicholas Street to OR 174

GRAIN SIZE DISTRIBUTION

FIGURE C3



SILT and CLAY	FINE	MEDIUM	COARSE	FINE	COARSE	COBBLE SIZE
FINE GRAINED	SAND			GRAVEL		

LEGEND

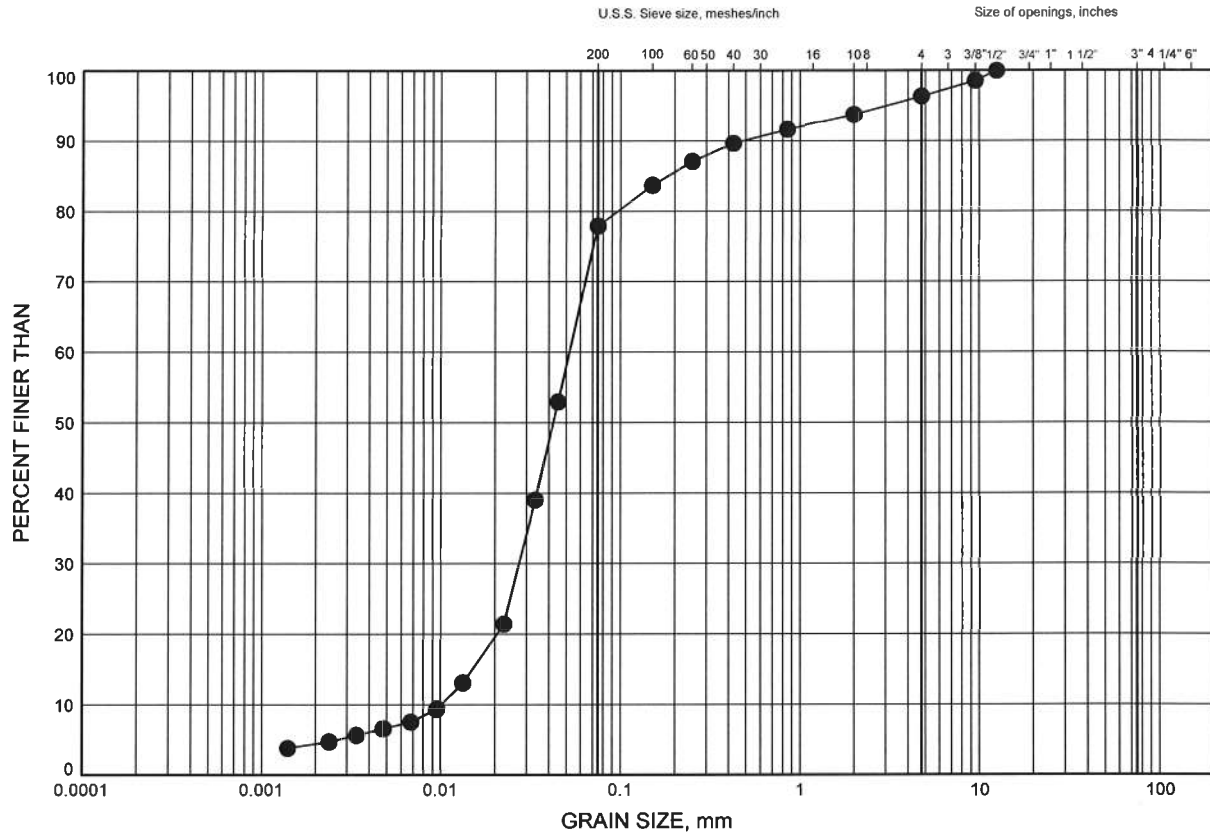
SYMBOL	BOREHOLE	DEPTH (m)	ELEV. (m)
●	LE-08	7.92	52.78

Highway 417 Ottawa: Nicholas Street to OR 174

GRAIN SIZE DISTRIBUTION

FIGURE C4

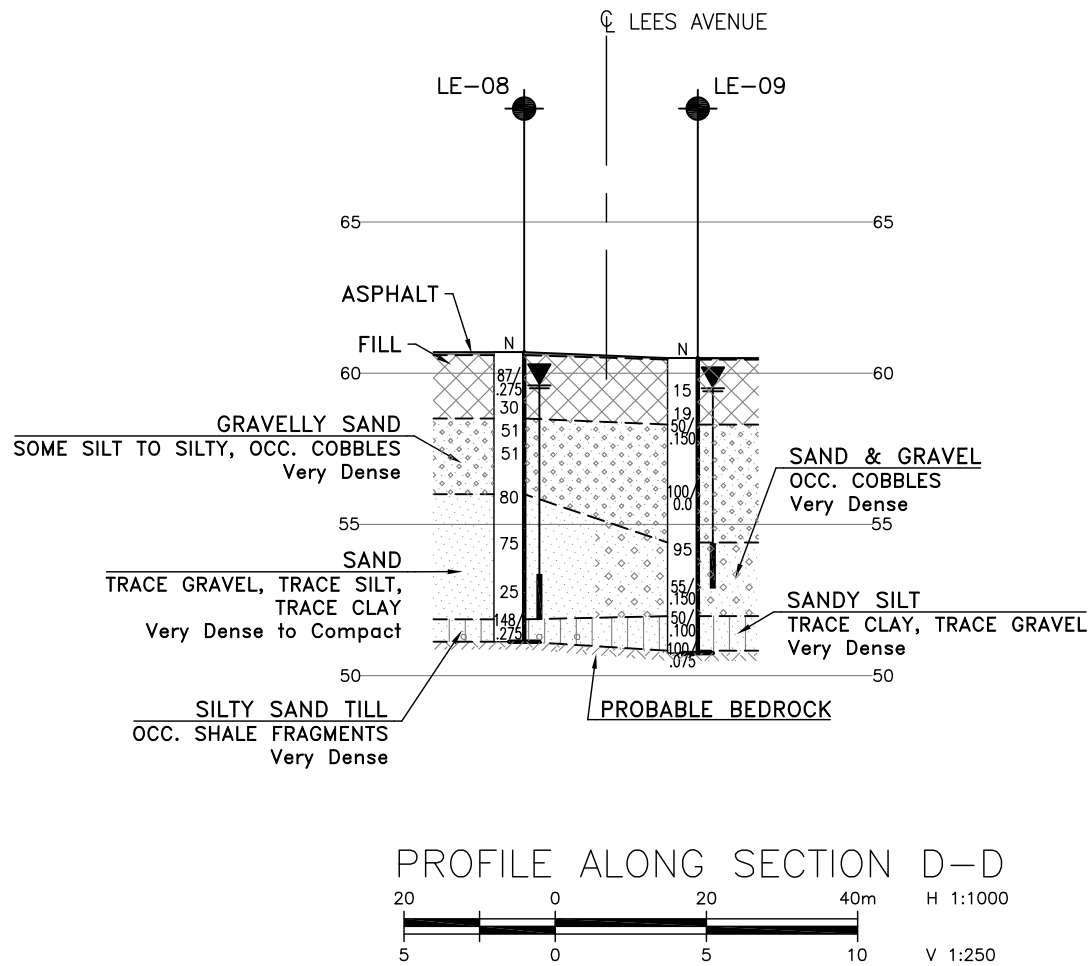
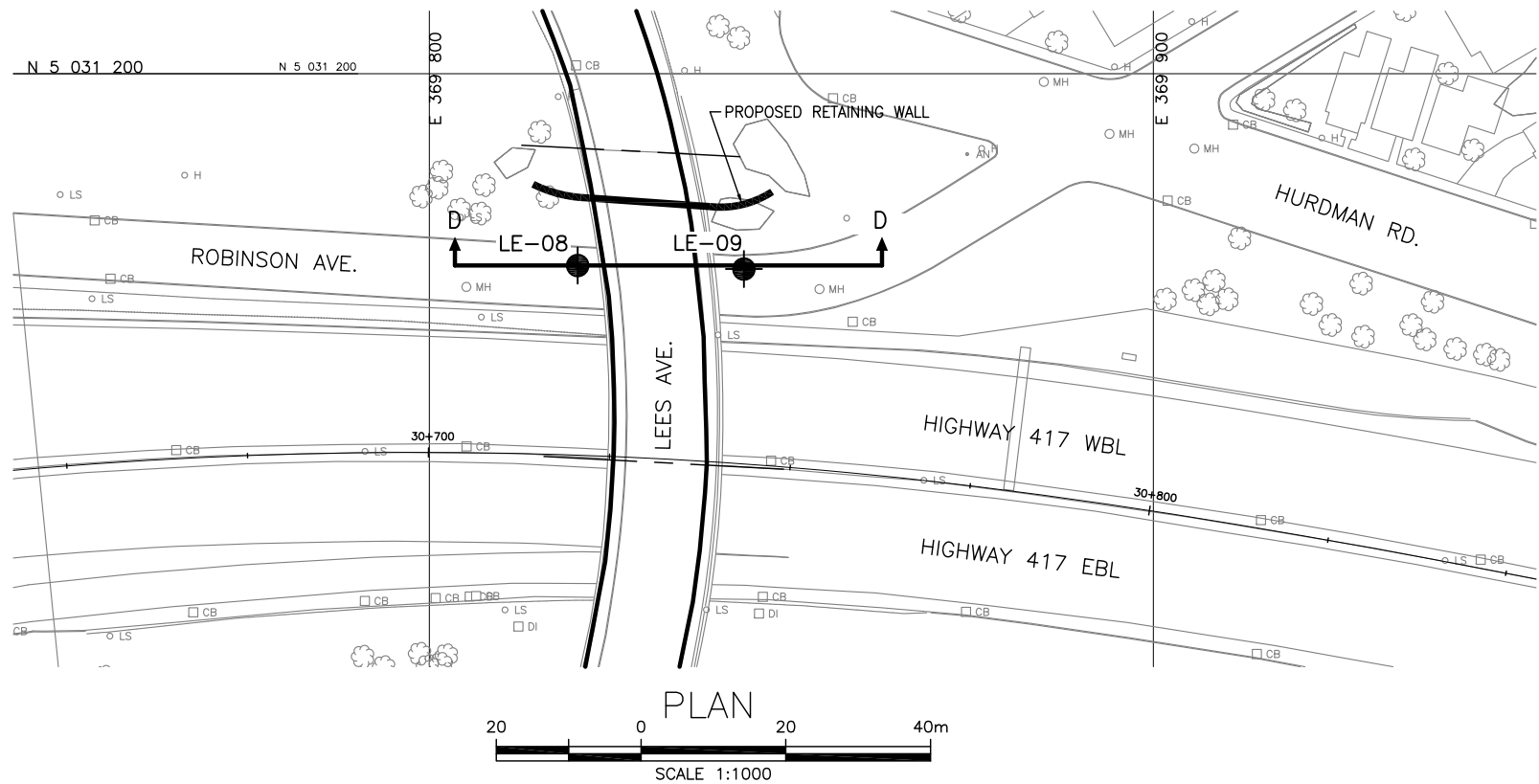
SANDY SILT



SILT and CLAY	FINE	MEDIUM	COARSE	FINE	COARSE	COBBLE SIZE
FINE GRAINED	SAND			GRAVEL		

LEGEND

SYMBOL	BOREHOLE	DEPTH (m)	ELEV. (m)
●	LE-09	9.27	51.23



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

CONT No
WP No 4091-07-00

HIGHWAY 417
LEES AVE (NORTH) AT ROBINSON AVE
BOREHOLE LOCATIONS AND SOIL STRATA



KEYPLAN

LEGEND

	Borehole
	Borehole and Cone
N	Blows /0.3m (Std Pen Test, 475J/blow)
CONE	Blows /0.3m (60' Cone, 475J/blow)
PH	Pressure, Hydraulic
	Water Level
	Head Artesian Water
	Piezometer
90%	Rock Quality Designation (RQD)
A/R	Auger Refusal

NO	ELEVATION	NORTHING	EASTING
LE-08	60.7	5 031 173.5	369 820.5
LE-09	60.5	5 031 173.0	369 843.4

-NOTES-

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

GEOCRES No. 31G5-250

REVISIONS		DATE				BY		DESCRIPTION	
DESIGN	MC	CHK	MRA	CODE	LOAD	DATE	AUG. 2012		
DRAWN	AN	CHK	SITE	STRUCT	DWG	1			

Appendix D

Lees Avenue (North) Noise Barrier

Boreholes 12N-01 & 02, 13N-01, 14N-01 to 03, NB8-01

RECORD OF BOREHOLE No 12N-01

1 OF 1

METRIC

W.P. 4091-07-00 LOCATION N 5 031 163 6 E 369 769 5 ORIGINATED BY RK
HWY 417 BOREHOLE TYPE Hollow Stem Augers - CME-75 COMPILED BY AN
DATUM Geodetic DATE 2011.08.22 - 2011.08.22 CHECKED BY LRB

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								
61.0								20	40	60	80	100				
0.0	ASPHALT: (175mm)															
0.2	SAND and GRAVEL to SAND, some gravel Very Dense Brown Dry to Damp (FILL)		1	SS	100/ 0.280											
59.0	Trace rootlets		2	SS	100/ 0.280											
2.0	SAND, medium grained, trace gravel, trace silt Very Dense Brown Damp		3	SS	56											7 85 8 (SI+CL)
			4	SS	57											
			5	SS	71											

+³, X³; Numbers refer to
Sensitivity

20
15
10

(%) STRAIN AT FAILURE

RECORD OF BOREHOLE No 12N-02

1 OF 1

METRIC

W.P. 4091-07-00 LOCATION N 5 031 158.6 E 369 879.9 ORIGINATED BY RK
 HWY 417 BOREHOLE TYPE Hollow Stem Augers - CME-75 COMPILED BY AN
 DATUM Geodetic DATE 2011.08.22 - 2011.08.22 CHECKED BY LRB

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		
60.9														
0.0	ASPHALT: (175mm)													
0.2	SAND, medium grained, trace to some gravel Dense to Compact Brown Damp (FILL)		1	SS	48		60							
			2	SS	18		59							
58.6														
2.3	SAND and GRAVEL, some silt Very Dense to Dense Greyish Brown Damp		3	SS	65		58							
			4	SS	31		57							
56.3	No recovery		5	SS	100/									
4.6	END OF BOREHOLE AT 4.6m UPON AUGER REFUSAL. WATER LEVEL AT 3.7m UPON COMPLETION. Piezometer installation consists of 19mm diameter Schedule 40 PVC pipe with a 1.52m slotted screen. WATER LEVEL READINGS: DATE DEPTH (m) ELEV. (m) Oct. 12/11 Plugged at 3.0m				0.025									40 44 16 (SI+CL)

+³, ×³: Numbers refer to
Sensitivity

20
15
10

(%) STRAIN AT FAILURE

RECORD OF BOREHOLE No 13N-01

1 OF 1

METRIC

W.P. 4091-07-00 LOCATION N 5 031 135.7 E 369 994.1 ORIGINATED BY RK
 HWY 417 BOREHOLE TYPE Hollow Stem Augers - CME-55 COMPILED BY AN
 DATUM Geodetic DATE 2011.08.23 - 2011.08.23 CHECKED BY LRB

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 (%)				
60.4								20 40 60 80 100						
0.0	ASPHALT: (175mm)							20 40 60 80 100						
0.2	SAND, gravelly to trace gravel Very Dense Brown Damp (FILL)		1	SS	63		60							
58.9							59							
1.5	Silty SAND, some gravel, trace clay Dense to Loose Brown Moist to Wet (TILL)		2	SS	42		58							
			3	SS	14		57							6 56 30 8
			4	SS	11		56							
			5	SS	9		55							
53.9			6	SS	64/ 0.23		54							
6.5	END OF BOREHOLE AT 6.5m. Piezometer installation consists of 19mm diameter Schedule 40 PVC pipe with a 1.52m slotted screen. WATER LEVEL READINGS: DATE DEPTH (m) ELEV. (m) Oct. 12/11 Plugged at 1.5m													


















ONTMT4S 1201A.GPJ 4/23/12

RECORD OF BOREHOLE No 14N-01

1 OF 1

METRIC

W.P. 4091-07-00 LOCATION N 5 031 124.5 E 370 108.6 ORIGINATED BY GA
 HWY 417 BOREHOLE TYPE Hollow Stem Augers - CME-55 COMPILED BY AN
 DATUM Geodetic DATE 2011.08.15 - 2011.08.15 CHECKED BY LRB

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									WATER CONTENT (%)		
								○ UNCONFINED	+ FIELD VANE	● QUICK TRIAXIAL	× LAB VANE								
60.4							20	40	60	80	100	20	40	60					
0.0	TOPSOIL: (50mm)		1	SS	22														
59.6	SAND, some silt, trace gravel, occasional rootlets Compact Brown																		
0.8	Dry (FILL)		2	SS	29														
58.9	Silty SAND, trace gravel, trace clay Compact Brown to Grey																		
1.5	Dry to Damp (FILL)		3	SS	30											7 55 29 9			
	Silty SAND, some clay, trace gravel Compact to Dense Brown to Grey Moist to Wet (TILL)																		
			4	SS	13														
	Poor recovery																		
			5	SS	10														
																			
																			
			6	SS	32											9 43 38 10			
																			
																			
																			
			7	SS	23														
53.7																			
6.7	END OF BOREHOLE AT 6.7m. BOREHOLE OPEN TO 6.7m AND DRY UPON COMPLETION. BOREHOLE BACKFILLED WITH BENTONITE HOLEPLUG AND CUTTINGS TO SURFACE.																		

ONTMT4S 1201A.GPJ 4/23/12

RECORD OF BOREHOLE No 14N-02

1 OF 1

METRIC

W.P. 4091-07-00 LOCATION N 5 031 120.1 E 370 121.9 ORIGINATED BY RK
 HWY 417 BOREHOLE TYPE Hollow Stem Augers COMPILED BY AN
 DATUM Geodetic DATE 2011.08.23 - 2011.08.23 CHECKED BY LRB

SOIL PROFILE			SAMPLES			GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT			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 (%)				
60.1						20 40 60 80 100	20 40 60					
0.0	ASPHALT: (175mm)											
0.2	SAND, some gravel Very Dense Brown Dry (FILL)		1	SS	100/ 0.280							
58.6												
1.5	Silty SAND, some gravel Very Dense Brown Moist (FILL)		2	SS	67/ 0.280							
58.0												
2.1	Augers grinding											
	SAND and GRAVEL, some silt, shale fragments Dense Brown		3	SS	38							
57.1												
3.0	Moist to Wet Hydrocarbon odour		4	SS	15							
	Silty SAND, some gravel, trace clay Compact to Very Dense Brown Wet (TILL)											
			5	SS	57							
			6	SS	36							
53.4												
6.7	END OF BOREHOLE AT 6.7m. WATER LEVEL AT 3.9m UPON COMPLETION. Piezometer installation consists of 19mm diameter Schedule 40 PVC pipe with a 1.52m slotted screen. WATER LEVEL READINGS: DATE DEPTH (m) ELEV. (m) Oct.12/11 2.5 57.6											

+³, ×³: Numbers refer to
Sensitivity

20
15 5
10
(%) STRAIN AT FAILURE

METRIC

[illegible]

+³, ×³: Numbers refer to Sensitivity

RECORD OF BOREHOLE No NB8-01

1 OF 1

METRIC

W.P. 4091-07-00 LOCATION N 5 031 154.6 E 369 929.6 ORIGINATED BY GA
HWY 417 BOREHOLE TYPE Hollow Stem Augers - CME-55 COMPILED BY AN
DATUM Geodetic DATE 2011.08.16 - 2011.08.16 CHECKED BY LRB

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									WATER CONTENT (%)		
								○ UNCONFINED + FIELD VANE ● QUICK TRIAXIAL × LAB VANE											
61.1							20	40	60	80	100	20	40	60					
0.0	TOPSOIL: (50mm)																		
	SAND, some silt, some gravel, trace clay, occasional rootlets Dense to Compact Brown/Black Dry (FILL) Poor recovery		1	SS	38							○							
			2	SS	28							○							
			3	SS	16							○				12 61 20 7			
	Poor recovery		4	SS	13							○							
58.1																			
3.0	Silty SAND, some clay, some gravel Compact to Very Dense Grey/Black Damp (TILL)		5	SS	50/ 0.150							○				13 48 29 10			
			6	SS	26							○							
			7	SS	50/ 0.150							○							
54.9																			
6.2	END OF BOREHOLE AT 6.2m. BOREHOLE OPEN TO 6.2m AND DRY UPON COMPLETION. BOREHOLE BACKFILLED WITH BENTONITE HOLEPLUG AND CUTTINGS TO SURFACE.				0.150														

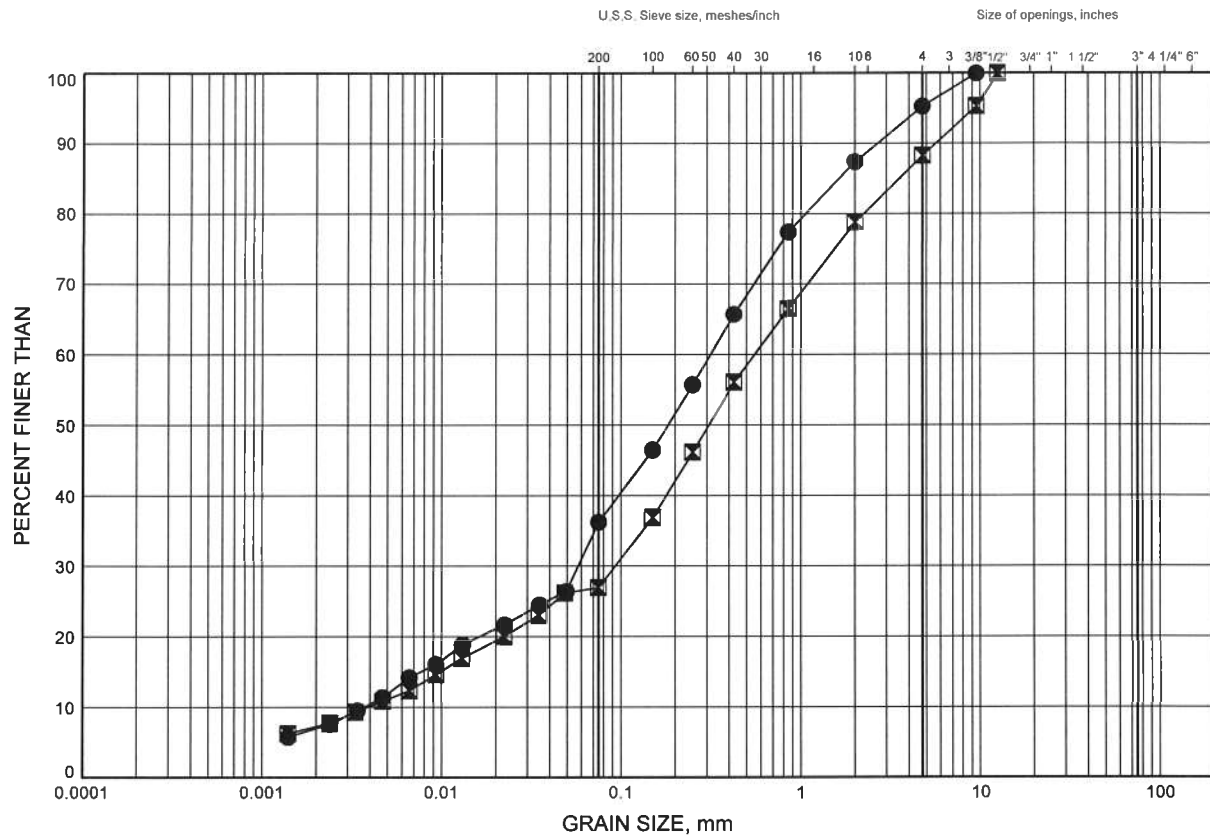
ONTMT4S 1201A.GPJ 4/23/12

Highway 417 Ottawa: Nicholas to Vanier

GRAIN SIZE DISTRIBUTION

FIGURE D1

SILTY SAND FILL



SILT and CLAY	FINE	MEDIUM	COARSE	FINE	COARSE	COBBLE SIZE
FINE GRAINED	SAND			GRAVEL		

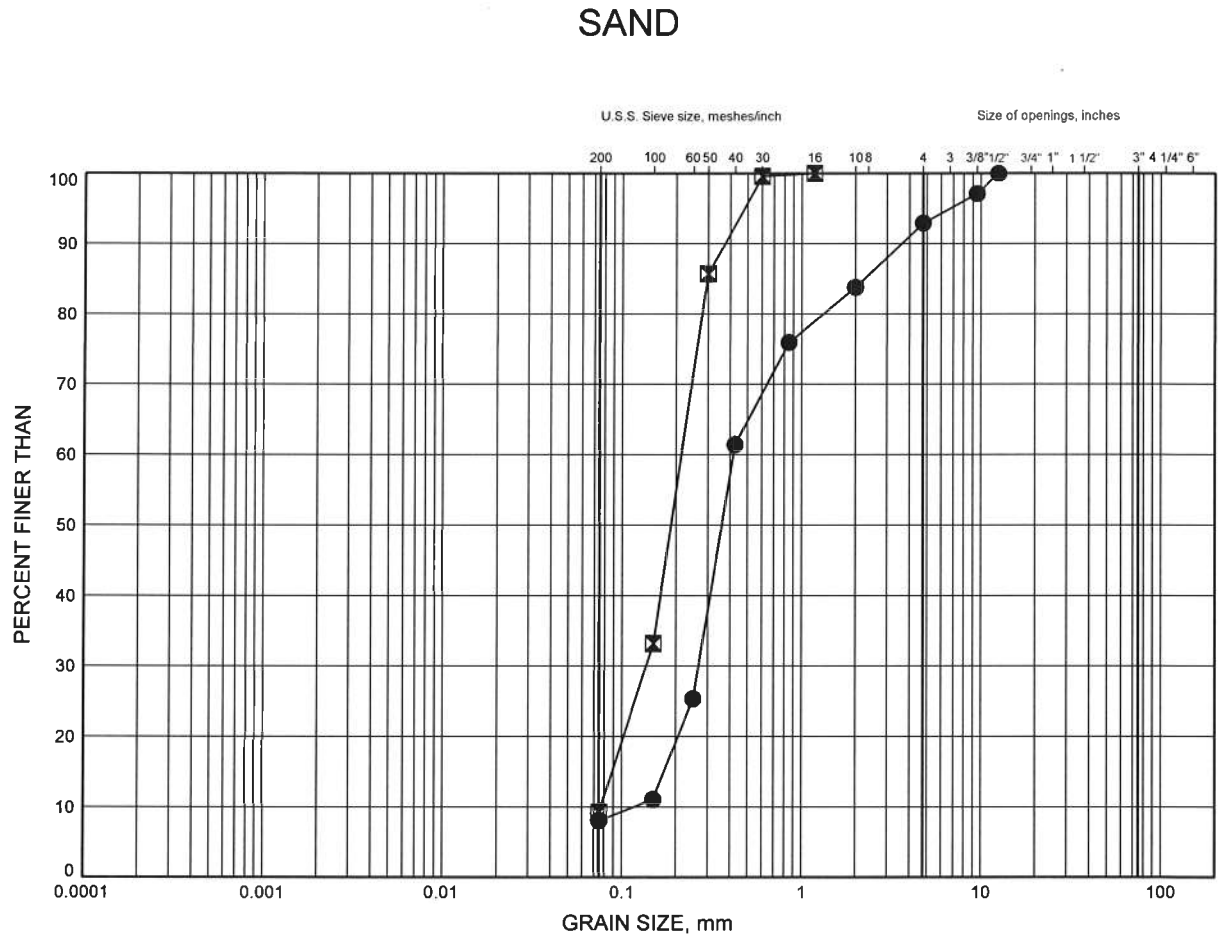
LEGEND

SYMBOL	BOREHOLE	DEPTH (m)	ELEV. (m)
●	14N-03	1.78	58.42
■	NB8-01	1.83	59.27

Highway 417 Ottawa: Nicholas Street to OR 174

GRAIN SIZE DISTRIBUTION

FIGURE D2



SILT and CLAY	FINE	MEDIUM	COARSE	FINE	COARSE	COBBLE SIZE
FINE GRAINED	SAND			GRAVEL		

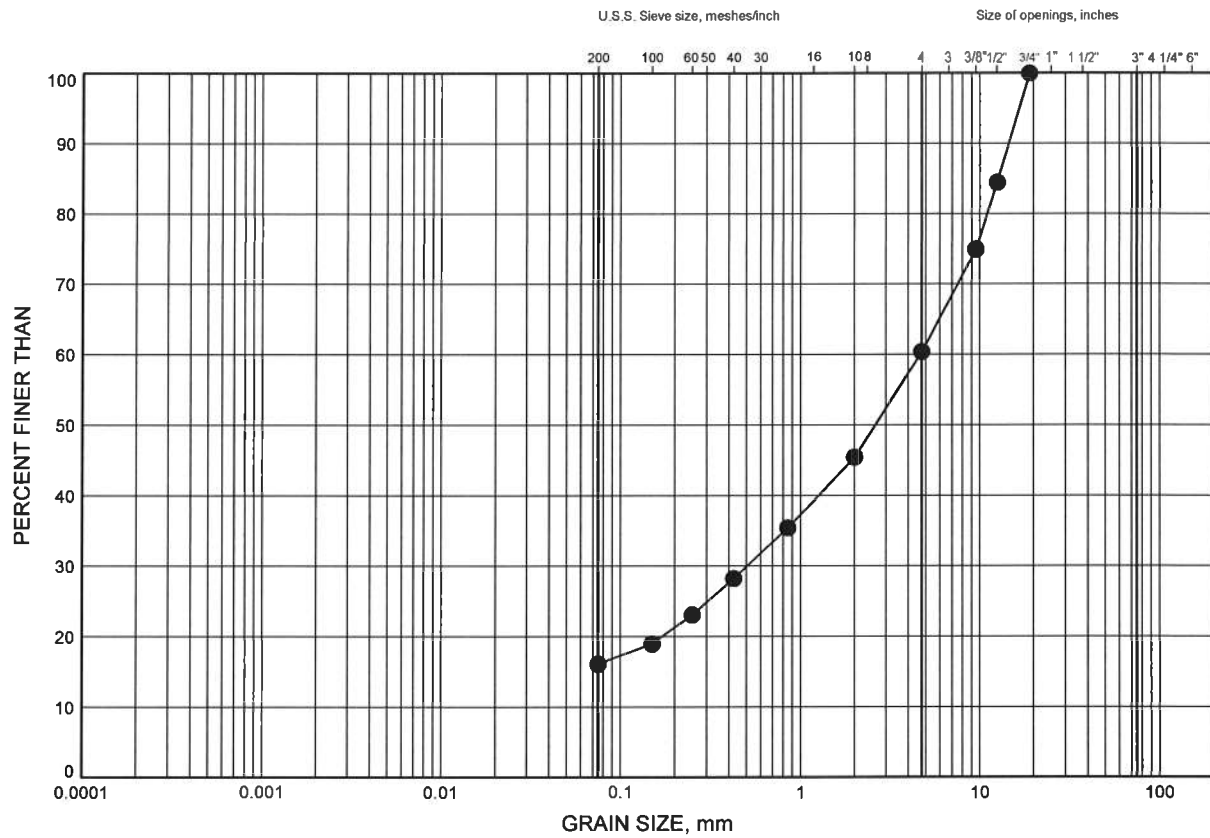
LEGEND

SYMBOL	BOREHOLE	DEPTH (m)	ELEV. (m)
●	12N-01	2.59	58.42
⊠	12N-01	6.40	54.61

Highway 417 Ottawa: Nicholas Street to OR 174 GRAIN SIZE DISTRIBUTION

FIGURE D3

SAND & GRAVEL



SILT and CLAY	FINE	MEDIUM	COARSE	FINE	COARSE	COBBLE SIZE
FINE GRAINED	SAND			GRAVEL		

LEGEND

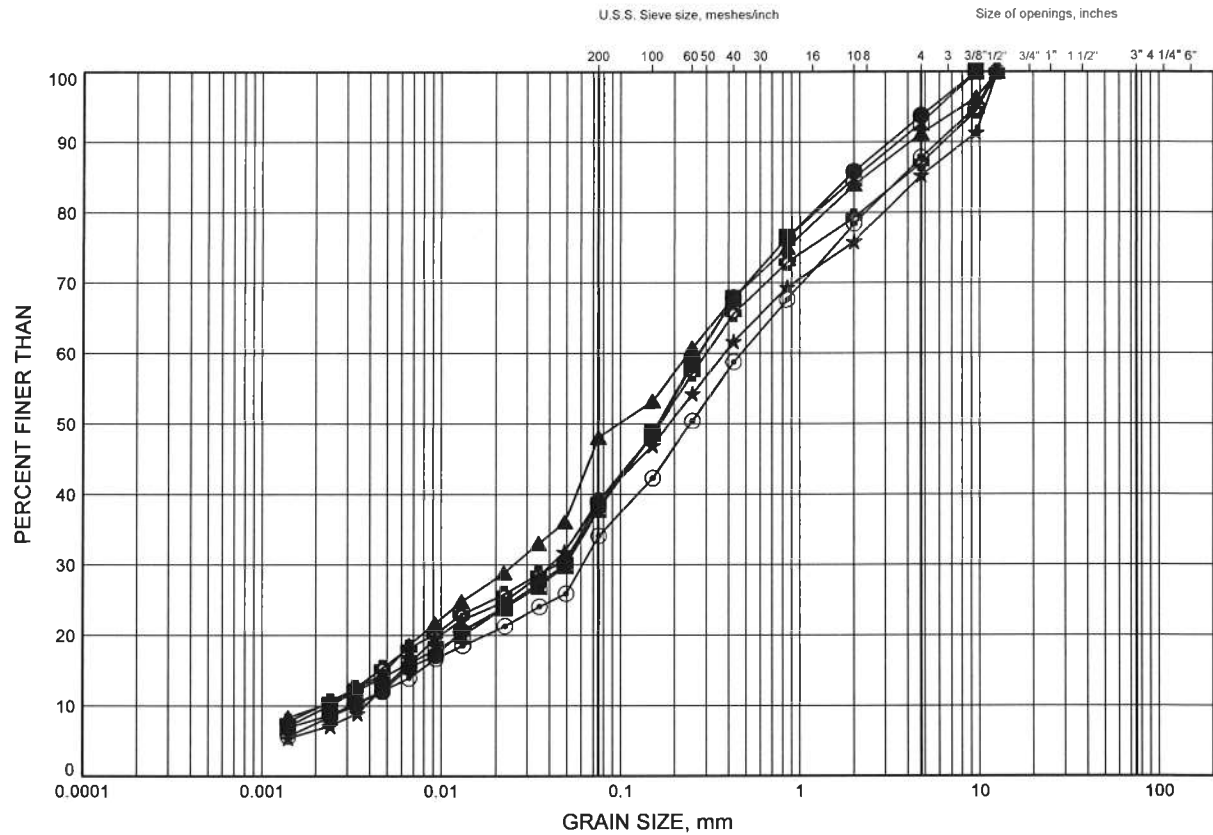
SYMBOL	BOREHOLE	DEPTH (m)	ELEV. (m)
●	12N-02	3.35	57.57

Highway 417 Ottawa: Nicholas to Vanier

GRAIN SIZE DISTRIBUTION

FIGURE D4

SILTY SAND TILL



SILT and CLAY	FINE	MEDIUM	COARSE	FINE	COARSE	COBBLE SIZE
FINE GRAINED	SAND			GRAVEL		

LEGEND

SYMBOL	BOREHOLE	DEPTH (m)	ELEV. (m)
●	13N-01	2.59	57.81
⊠	14N-01	1.83	58.57
▲	14N-01	4.88	55.52
★	14N-02	4.88	55.22
⊙	14N-03	3.35	56.85
⊕	NB8-01	3.35	57.75

Date May 2012

W.P.# 4091-07-00



Prep'd MFA

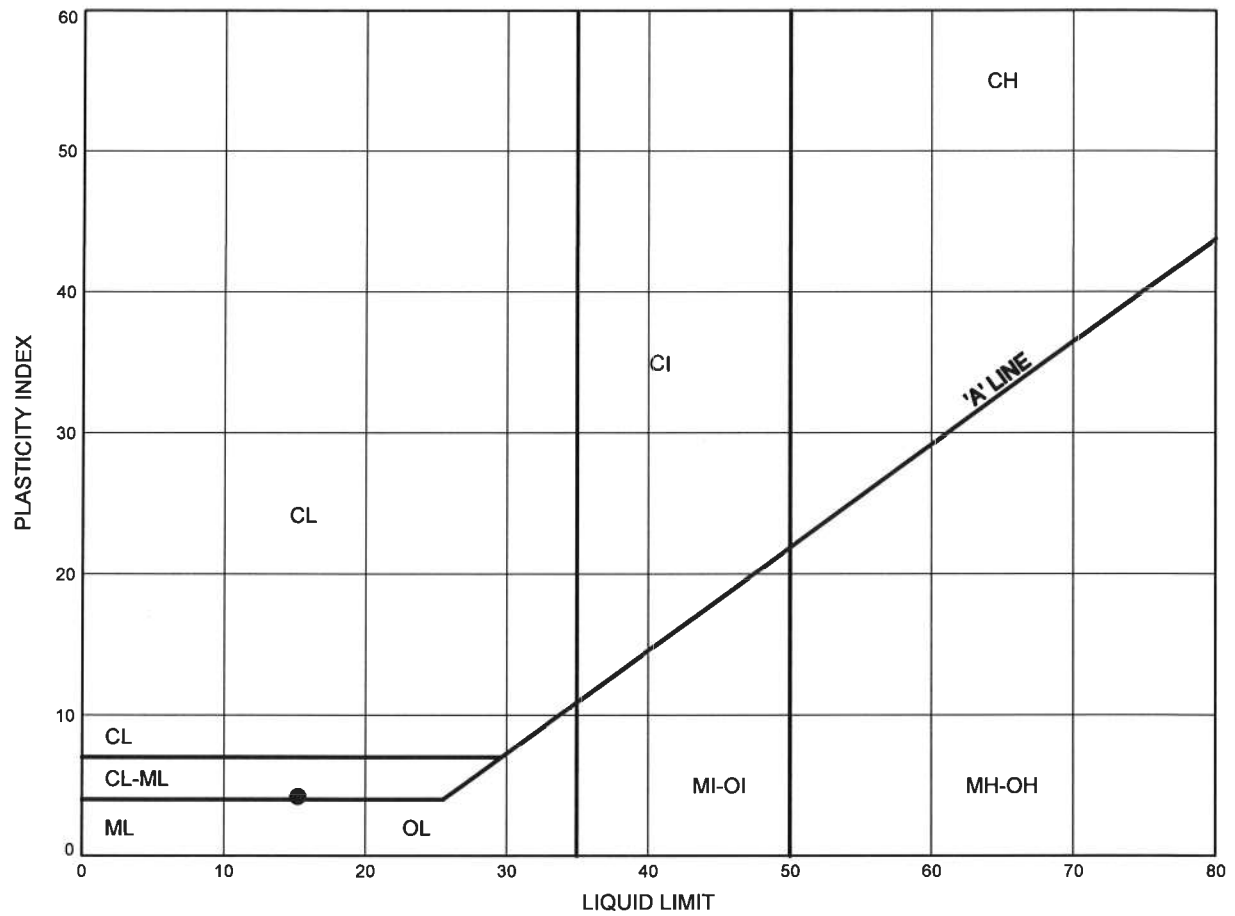
Chkd. LRB

Highway 417 Ottawa: Nicholas Street to OR 174

ATTERBERG LIMITS TEST RESULTS

FIGURE D5

SILTY SAND TILL



SYMBOL	BH	DEPTH (m)	ELEV. (m)
●	14N-01	4.88	55.52

Date April 2012
Project 4091-07-00



Prep'd AN
Chkd. LRB

METRIC

DIMENSIONS ARE IN METRES
AND/OR MILLIMETRES
UNLESS OTHERWISE SHOWNCONT No
WP No 4091-07-00HIGHWAY 417
NOISE BARRIER
LEES AVENUE (NORTH)
BOREHOLE LOCATIONS AND SOIL STRATA

THURBER ENGINEERING LTD.



KEYPLAN

LEGEND

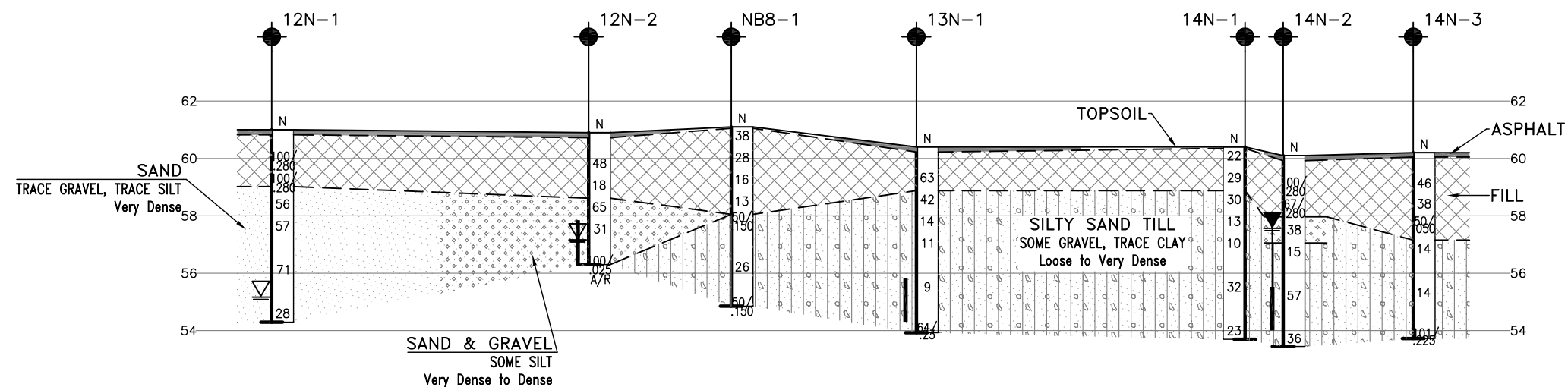
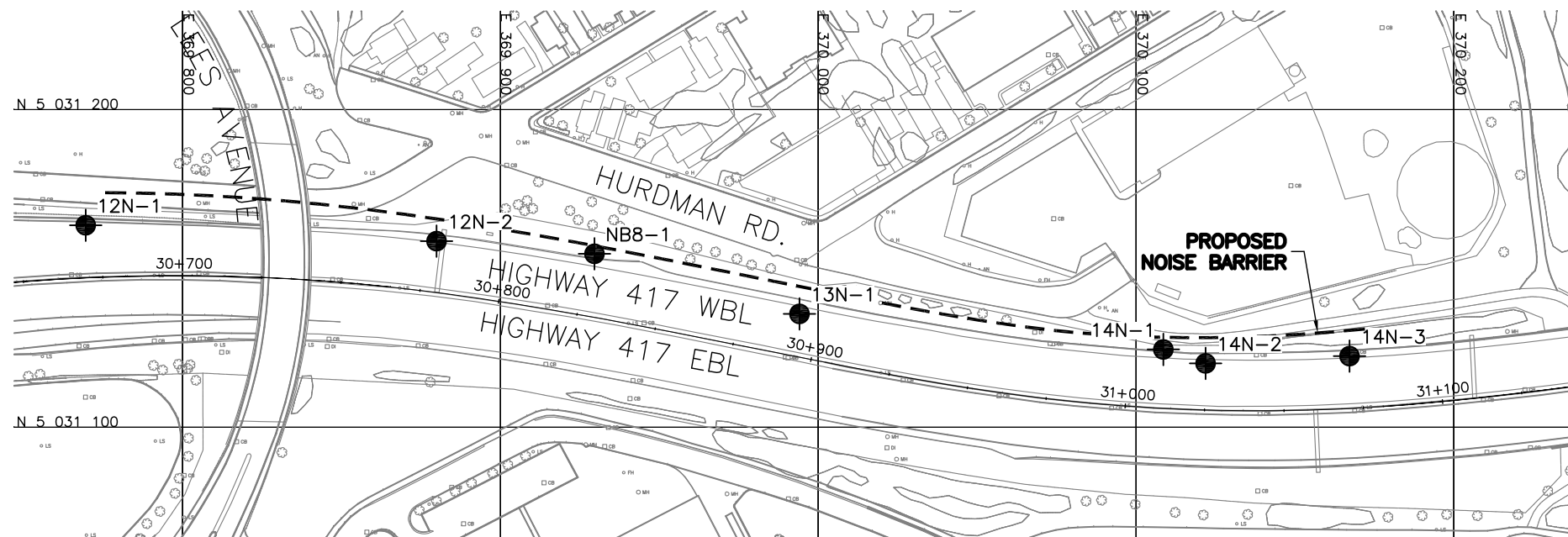
	Borehole
	Borehole and Cone
N	Blows /0.3m (Std Pen Test, 475J/blow)
CONE	Blows /0.3m (60° Cone, 475J/blow)
PH	Pressure, Hydraulic
	Water Level
	Head Artesian Water
	Piezometer
90%	Rock Quality Designation (RQD)
A/R	Auger Refusal

NO	ELEVATION	NORTHING	EASTING
12N-1	61.0	5 031 163.6	369 769.5
12N-2	60.9	5 031 158.6	369 879.9
NB8-1	61.1	5 031 154.6	369 929.6
13N-1	60.4	5 031 135.7	369 994.1
14N-1	60.4	5 031 124.5	370 108.6
14N-2	60.1	5 031 120.1	370 121.9
14N-3	60.2	5 031 122.4	370 167.2

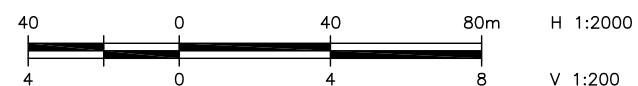
-NOTES-

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

GEOCRES No. 31G5-250



PROFILE ALONG HWY. 417 WBL



REVISIONS	DATE	BY	DESCRIPTION
DESIGN MC	CHK MC	CODE	LOAD
DRAWN AN	CHK PKC	SITE	STRUCT
			DWG 1

Appendix E

Canadian Tire Parking Lot – Riverside Drive to Belfast Road (North)

Boreholes 15N-01, CTW-1 & 2, OHS-07L

RECORD OF BOREHOLE No 15N-01

1 OF 1

METRIC

W.P. 4320-06-00 LOCATION N 5 031 400 9 E 371 304 1 ORIGINATED BY LPG
HWY 417 BOREHOLE TYPE Hollow Stem Augers COMPILED BY AN
DATUM Geodetic DATE 2011.07.25 - 2011.07.25 CHECKED BY LRB

SOIL PROFILE			SAMPLES			GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT			UNIT WEIGHT γ kN/m ³	REMARKS & GRAIN SIZE DISTRIBUTION (%) GR SA SI CL								
ELEV DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE	"N" VALUES			SHEAR STRENGTH kPa ○ UNCONFINED + FIELD VANE ● QUICK TRIAXIAL x LAB VANE					WATER CONTENT (%) w _p w w _L							
61.1								20	40	60	80	100								
0.0	ASPHALT: (200mm)						61													
0.2	Gravelly SAND, some silt Brown Moist (FILL)		1	AS																
60.3																				
0.8	Sandy SILT, some clay, trace gravel Compact to Very Dense Brown to Grey Moist (TILL)		2	SS	45		60													
			3	SS	64/ 0.275														0 24 59 17	
			4	SS	27		59													
			5	SS	19		58													
	Difficult augering from 4.0m						57													
56.5	Shale fragments		6	SS	50/ 0.00															
4.6	END OF BOREHOLE AT 4.6m ON PROBABLE BEDROCK. Piezometer installation consists of 19mm diameter Schedule 40 PVC pipe with a 3.05m slotted screen. WATER LEVEL READINGS: DATE DEPTH (m) ELEV. (m) Jul. 26/11 3.5 57.6 Aug. 18/11 3.5 57.6 Oct. 12/11 2.7 58.4																			

+³ ×³: Numbers refer to
Sensitivity

20
15
10
(%) STRAIN AT FAILURE

METRIC

ELEV DEPTH	SOIL PROFILE		SAMPLES		DYNAMIC CONE PENETRATION RESISTANCE PLOT	PLASTIC LIMIT NATURAL MOISTURE CONTENT LIQUID LIMIT	UNIT WEIGHT	REMARKS & GRAIN SIZE DISTRIBUTION (%)
	DESCRIPTION	STRAT PLOT	NUMBER TYPE "N" VALUES	GROUND WATER CONDITIONS	WATER CONTENT (%) <div style="font-size: small;">○ UNCONFINED + FIELD VANE ● QUICK TRIAXIAL × LAB VANE</div>	w p w L	kN/m³ γ	GR SA SI C
61.0								
0.0	ASPHALT: (100mm)	[Pattern]						
0.1	SAND, some silt, trace gravel Compact Brown Dry (FILL)	[Pattern]	1 SS 18					
60.3								
0.7	Silty SAND, some clay, trace gravel Compact Dark Grey (FILL)	[Pattern]	2 SS 12					0 53 31 1
			3 SS 27					
58.7								
2.3	Silty SAND, some clay, trace gravel Compact Dark Grey Dry (TILL) Wet	[Pattern]	4 SS 29					
			5 SS 16					
			6 SS 13					7 55 24 1
54.9								
6.1	SHALE, fresh, thinly bedded, grey	[Pattern]	7 SS 50/ 0.150					
	Cored from 7.0m							RUN #1 TCR=95% SCR=90% RQD=87% UCS=19MPa (average)
	Horizontal joint at 7.0m, 7.1m, 7.2m, 7.3m		1 RUN				F I 3 1 2	
	Sub-horizontal joint at 7.6m		2 RUN				0 0 0 0 0 0	RUN #2 TCR=100% SCR=100% RQD=100% UCS=21MPa (average)

(%) STRAIN AT FAILURE

ONTMT4S 1201B.GPJ 5/15/12

RECORD OF BOREHOLE No CTW-1

2 OF 2

METRIC

W.P. 4320-06-00 LOCATION N 5 031 386.6 E 371 185.5 ORIGINATED BY GA
 HWY 417 BOREHOLE TYPE Hollow Stem Augers/NQ Coring COMPILED BY AN
 DATUM Geodetic DATE 2012.05.02 - 2012.05.02 CHECKED BY LRB

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									
							20	40	60	80	100	W _p	W	W _L			
50.9	Continued From Previous Page	✓					51										
10.1	END OF BOREHOLE AT 10.1m. BOREHOLE OPEN AND DRY PRIOR TO CORING. Piezometer installation consists of 19mm diameter Schedule 40 PVC pipe with a 1.52m slotted screen. WATER LEVEL READINGS: DATE DEPTH (m) ELEV. (m) May03/ 12 0.3 60.7																

RECORD OF BOREHOLE No CTW-2

1 OF 1

METRIC

W.P. 4320-06-00 LOCATION N 5 031 395.1 E 371 258.6 ORIGINATED BY GA
 HWY 417 BOREHOLE TYPE Hollow Stem Augers/NQ Coring COMPILED BY AN
 DATUM Geodetic DATE 2012.05.02 - 2012.05.03 CHECKED BY LRB

SOIL PROFILE			SAMPLES			GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT			UNIT WEIGHT γ kN/m ³	REMARKS & GRAIN SIZE DISTRIBUTION (%) GR SA SI CL					
ELEV DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE	"N" VALUES			SHEAR STRENGTH kPa ○ UNCONFINED + FIELD VANE ● QUICK TRIAXIAL × LAB VANE					WATER CONTENT (%) W _p W W _L				
61.0							20	40	60	80	100						
0.0	ASPHALT: (100mm)																
0.1	SAND, some silt, trace gravel Compact Brown		1	SS	22												
60.4	Dry (FILL)																
0.6	Sandy SILT, some clay to clayey, trace gravel Compact to Loose Grey (TILL)		2	SS	21												
			3	SS	24											1	26 51 22
			4	SS	14												
			5	SS	7												
56.9																	
4.1	SHALE, fresh, thinly bedded, grey, occasional limestone interbeds																
	Limestone interbed at 4.3m, 4.5m, 4.7m, 5.1m, 5.4m, 5.6m		1	RUN													RUN #1 TCR=93% SCR=87% RQD=87% UCS=20MPa (average)
	Horizontal joint at 4.3m, 4.4m																
	Highly broken zone at 4.9m, 5.0m																
	Limestone interbed at 6.0m, 6.2m, 6.3m, 6.8m, 6.9m		2	RUN													RUN #2 TCR=100% SCR=100% RQD=100% UCS=15MPa (average)
53.9																	
7.1	END OF BOREHOLE AT 7.1m. BOREHOLE OPEN AND DRY PRIOR TO CORING. BOREHOLE BACKFILLED WITH BENTONITE HOLEPLUG FROM 7.0m TO 0.3m, CONCRETE FROM 0.3m TO 0.15m, THEN ASPHALT TO SURFACE.																

ONTMT4S 1201B.GPJ 5/15/12

RECORD OF BOREHOLE No OHS-07L

1 OF 1

METRIC

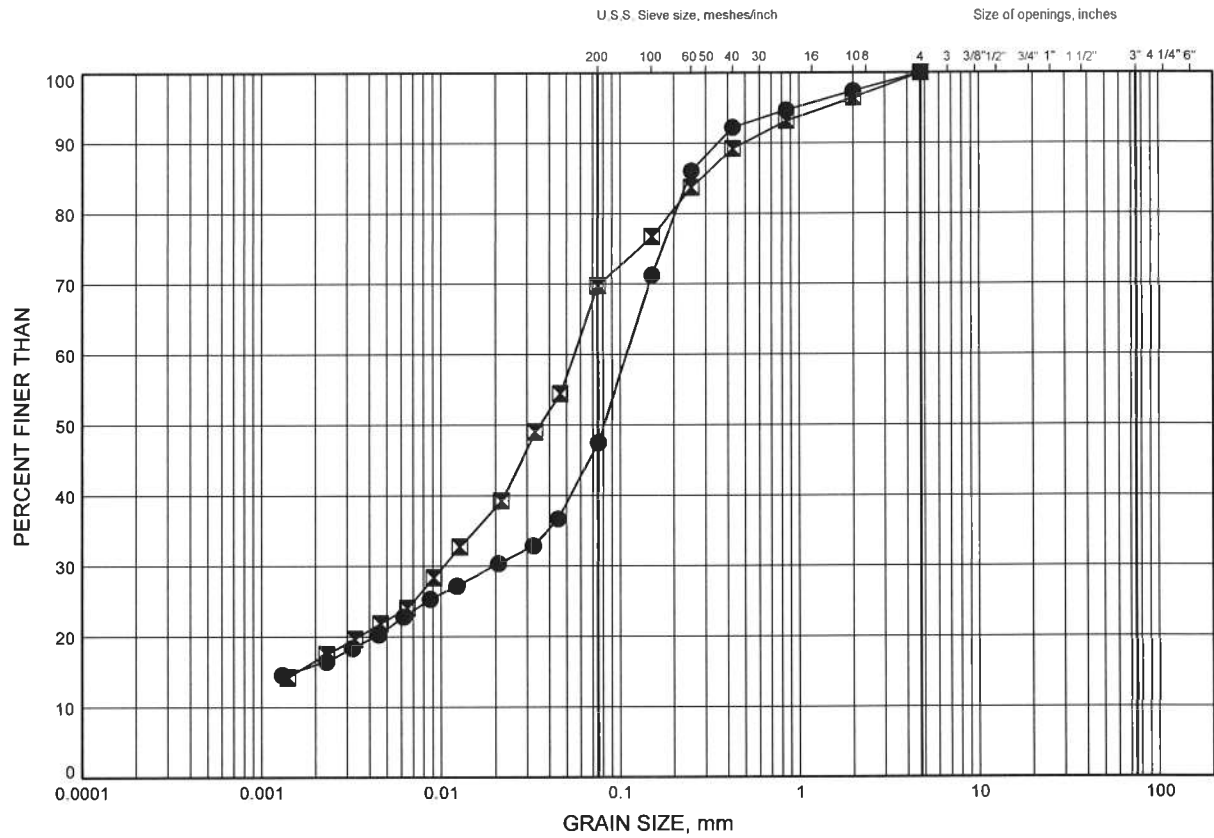
W.P. 4320-06-00 LOCATION N 5 031 391.4 E 371 216.4 ORIGINATED BY RK
 HWY 417 BOREHOLE TYPE Hollow Stem Augers COMPILED BY AN
 DATUM Geodetic DATE 2012 03 14 - 2012 03 14 CHECKED BY LRB

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					
60.9								20 40 60 80 100					
0.0	ASPHALT: (150mm)												
0.2	Gravelly SAND Brown Moist (FILL)												
59.8			1	SS	10		60						
1.1	Clayey SILT, some sand, some gravel Stiff Dark Grey (FILL)												
59.4			2	SS	38		59						0 30 53 17
1.5	Sandy SILT, some clay Dense to Compact Dark Grey Damp (FILL)												
			3	SS	13								
58.0							58						
2.9	Sandy SILT, some clay, trace gravel Compact Dark Grey Damp to Moist (TILL)		4	SS	20								
							57						
			5	SS	14		56						
54.8							55						
6.1	END OF BOREHOLE AT 6.1m. Piezometer installation consists of 19mm diameter Schedule 40 PVC pipe with a 1.52m slotted screen. WATER LEVEL READINGS: DATE DEPTH (m) ELEV. (m) Mar 22/12 2.2 58.7		6	SS	50/ 150								

Highway 417 Ottawa: Vanier to OR 174 GRAIN SIZE DISTRIBUTION

FIGURE E1

Sandy Silt to Silty Sand Fill



SILT and CLAY	FINE	MEDIUM	COARSE	FINE	COARSE	COBBLE SIZE
FINE GRAINED	SAND			GRAVEL		

LEGEND

SYMBOL	BOREHOLE	DEPTH (m)	ELEV. (m)
●	CTW-1	1.07	59.93
⊠	OHS-07L	1.83	59.07

Date May 2012
W.P.# 4320-06-00

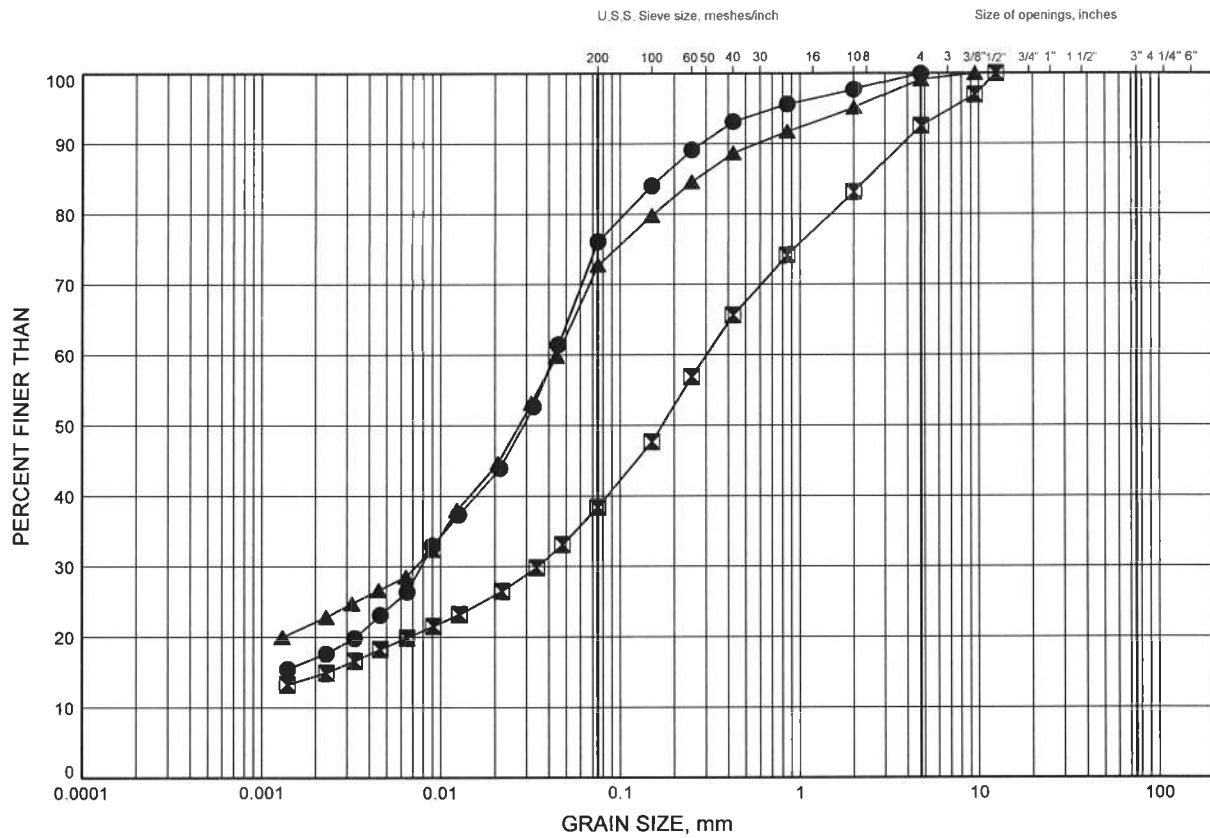


Prep'd MFA
Chkd. LRB

Highway 417 Ottawa: Vanier to OR 174 GRAIN SIZE DISTRIBUTION

FIGURE E2

Sandy Silt to Silty Sand Till



SILT and CLAY	FINE	MEDIUM	COARSE	FINE	COARSE	COBBLE SIZE
FINE GRAINED	SAND			GRAVEL		

LEGEND

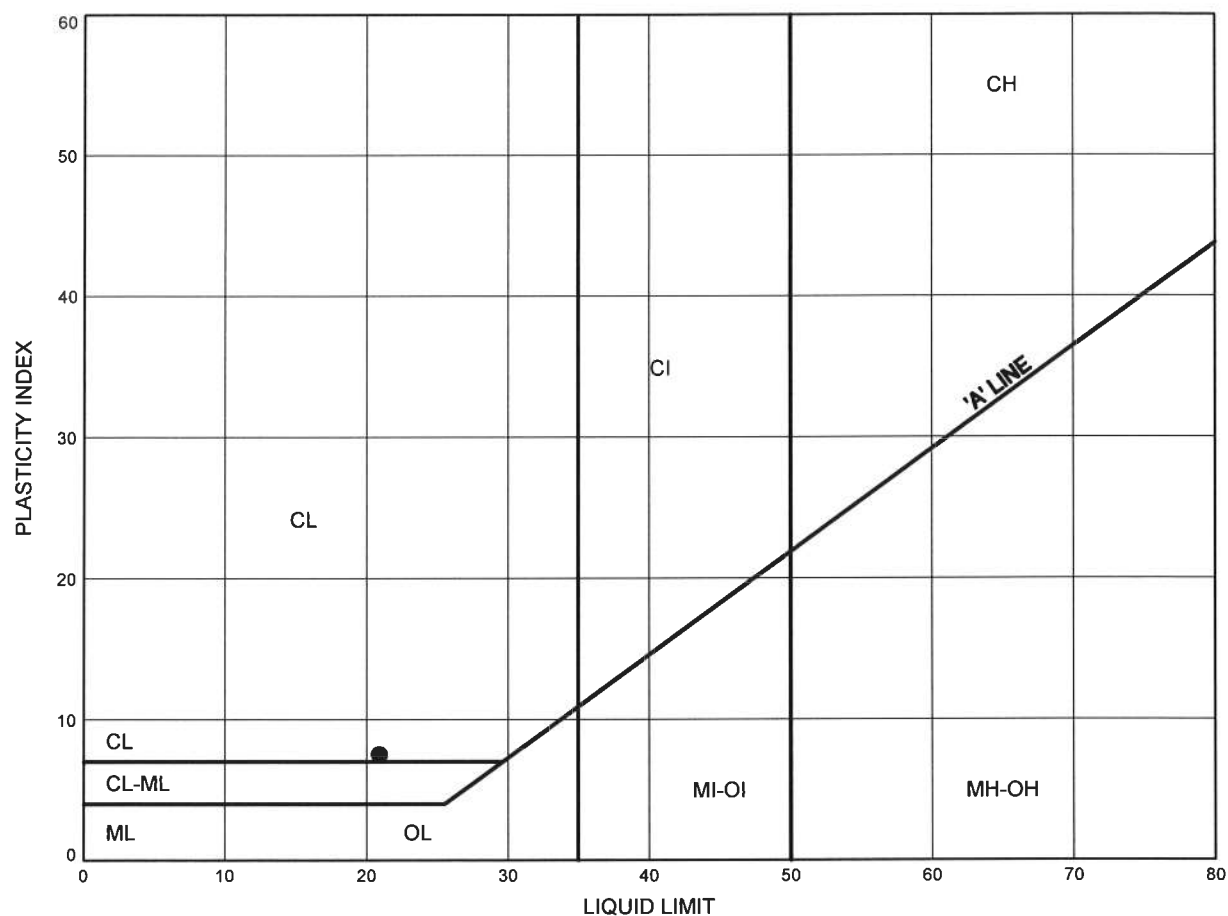
SYMBOL	BOREHOLE	DEPTH (m)	ELEV. (m)
●	15N-01	1.74	59.36
■	CTW-1	4.88	56.12
▲	CTW-2	1.83	59.17

Highway 417 Ottawa: Vanier to OR 174

ATTERBERG LIMITS TEST RESULTS

FIGURE E3

Sandy Silt Fill



LEGEND

SYMBOL	BOREHOLE	DEPTH (m)	ELEV. (m)
●	OHS-07L	1.83	59.07

Date May 2012

W.P.# 4320-06-00



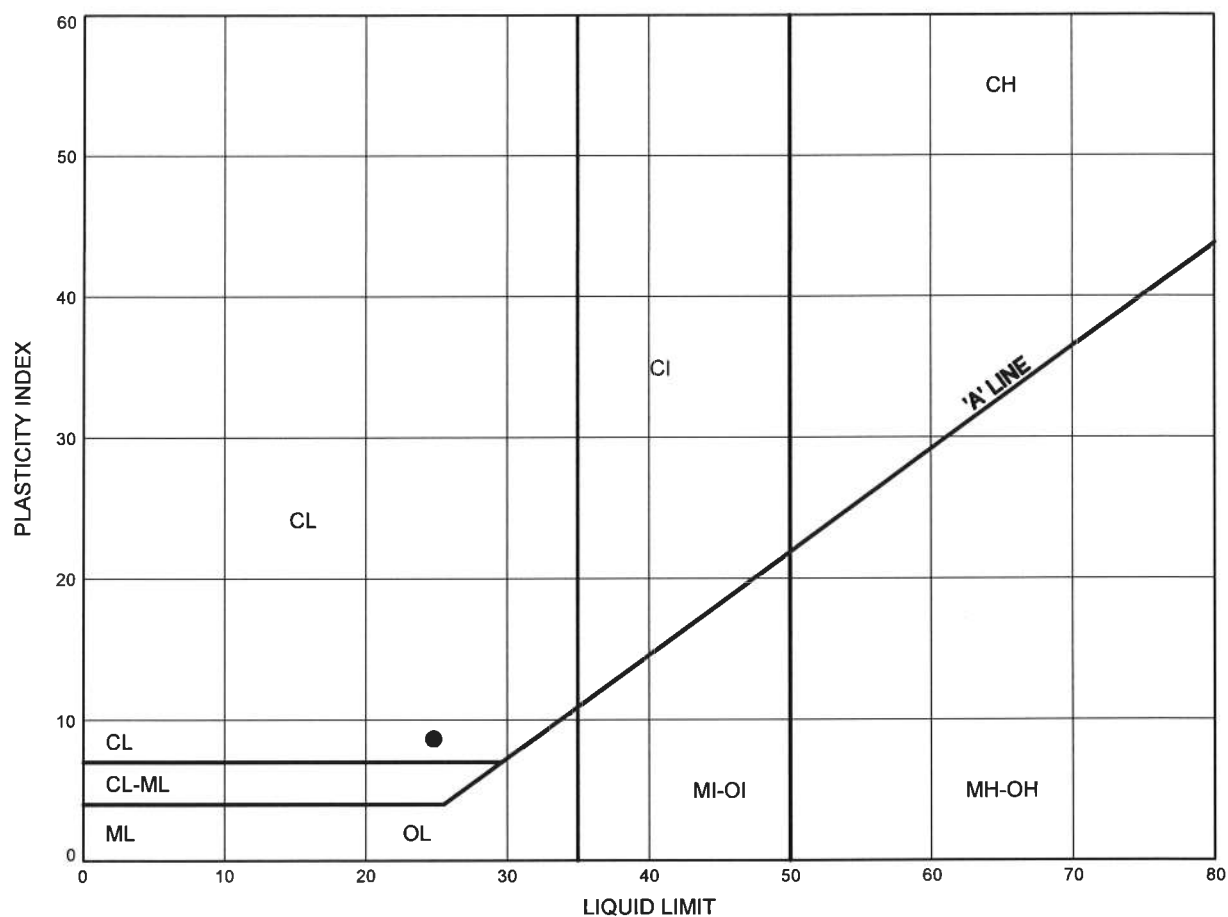
Prep'd MFA

Chkd. LRB

Highway 417 Ottawa: Vanier to OR 174 ATTERBERG LIMITS TEST RESULTS

FIGURE E4

Sandy Silt Till



LEGEND

SYMBOL	BOREHOLE	DEPTH (m)	ELEV. (m)
●	15N-01	1.74	59.36

Date May 2012
W.P.# 4320-06-00



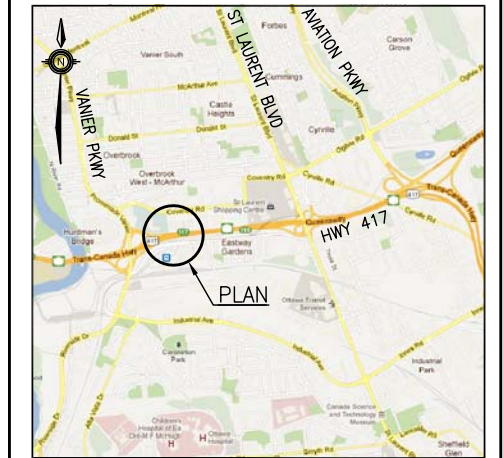
Prep'd MFA
Chkd. LRB

METRIC

DIMENSIONS ARE IN METRES
AND/OR MILLIMETRES
UNLESS OTHERWISE SHOWN






CONT No
WP No 4320-06-00

HIGHWAY 417 CANADIAN TIRE WALL VANIER TO BELFAST NORTH BOREHOLE LOCATIONS AND SOIL STRATA	
--	--



KEYPLAN

LEGEND

- | | |
|---|---------------------------------------|
|  | Borehole |
|  | Borehole and Cone |
| N | Blows /0.3m (Std Pen Test, 475J/blow) |
| CONE | Blows /0.3m (60° Cone, 475J/blow) |
| PH | Pressure, Hydraulic |
|  | Water Level |
|  | Head Artesian Water |
|  | Piezometer |
| 90% | Rock Quality Designation (RQD) |
| A/R | Auger Refusal |

NO	ELEVATION	NORTHING	EASTING
CTW-1	61.0	5 031 386.6	371 185.5
CTW-2	61.0	5 031 395.1	371 258.6
15N-01	61.1	5 031 400.9	371 304.1
OHS-07L	60.9	5 031 391.4	371 216.4

-NOTES-

- 1) The boundaries between soil strata have been established only at Borehole locations. Between Boreholes the boundaries are assumed from geological evidence.
- 2) This drawing is for subsurface information only. Surface details and features are for conceptual illustration.

GEOCRES No. 31G5-250



SANDY SILT TO SILTY SAND TILL
SOME CLAY TO CLAYEY, TRACE GRAVEL
Very Dense to Loose

PROFILE

H 1:1000

V 1:200

REVISIONS										
	DATE	BY	DESCRIPTION							
DESIGN	LRB	CHK	MRA	CODE	LOAD			DATE	AUG. 2012	
DRAWN	MFA	CHK	PKC	SITE	STRUCT			DWG	1	

Appendix F

Belfast Road (North) - Wall 15N

Boreholes 15N-01 to 15N-12

RECORD OF BOREHOLE No 15N-01

1 OF 1

METRIC

W.P. 4320-06-00 LOCATION N 5 031 400.9 E 371 304.1 ORIGINATED BY LPG
 HWY 417 BOREHOLE TYPE Hollow Stem Augers COMPILED BY AN
 DATUM Geodetic DATE 2011.07.25 - 2011.07.25 CHECKED BY LRB

SOIL PROFILE			SAMPLES			GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT			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 (%)				
61.1							20 40 60 80 100	PLASTIC LIMIT w _p	NATURAL MOISTURE CONTENT w	LIQUID LIMIT w _L		
0.0	ASPHALT: (200mm)											
0.2	Gravelly SAND, some silt Brown Moist (FILL)		1	AS								
60.3												
0.8	Sandy SILT, some clay, trace gravel Compact to Very Dense Brown to Grey Moist (TILL)		2	SS	45							
			3	SS	64/ 0.275							
			4	SS	27							
			5	SS	19							
	Difficult augering from 4.0m											
56.5	Shale fragments		6	SS	50/ 0.00							
4.6	END OF BOREHOLE AT 4.6m ON PROBABLE BEDROCK. Piezometer installation consists of 19mm diameter Schedule 40 PVC pipe with a 3.05m slotted screen. WATER LEVEL READINGS: DATE DEPTH (m) ELEV. (m) Jul. 26/11 3.5 57.6 Aug. 18/11 3.5 57.6 Oct. 12/11 2.7 58.4											

RECORD OF BOREHOLE No 15N-02

1 OF 1

METRIC

W.P. 4320-06-00 LOCATION N 5 031 408.5 E 371 370.3 ORIGINATED BY LPG
 HWY 417 BOREHOLE TYPE Hollow Stem Augers COMPILED BY AN
 DATUM Geodetic DATE 2011.07.25 - 2011.07.25 CHECKED BY LRB

SOIL PROFILE			SAMPLES			GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT			PLASTIC LIMIT w _p	NATURAL MOISTURE CONTENT w	LIQUID LIMIT w _L	UNIT WEIGHT γ kN/m ³	REMARKS & GRAIN SIZE DISTRIBUTION (%) GR SA SI CL
ELEV DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE	"N" VALUES			SHEAR STRENGTH kPa ○ UNCONFINED + FIELD VANE ● QUICK TRIAXIAL × LAB VANE							
61.5								20 40 60 80 100							
0.0	ASPHALT: (200mm)														
0.2	Gravelly SAND, some silt Brown Moist (FILL)		1	AS			61								
60.7															
0.8	Sandy SILT, trace gravel, trace clay Very Dense to Dense Brown Moist to Wet (FILL)		2	SS	56		60								2 25 70 3
			3	SS	33										
59.3															
2.2	Sandy, Clayey SILT, trace gravel Compact to Very Dense Brown to Grey Moist (TILL)		4	SS	17		59								
			5	SS	30		58								1 29 48 22
	Shale fragments at 4.6m Difficult augering		6	SS	50/ 0.075		57								
			7	SS	93/ 0.250		56								
55.8															
5.7	END OF BOREHOLE AT 5.7m ON PROBABLE BEDROCK. BOREHOLE BACKFILLED WITH CUTTINGS AND BENTONITE HOLEPLUG TO 0.2m, THEN ASPHALT COLD PATCH TO SURFACE.														

METRIC

[illegible]

RECORD OF BOREHOLE No 15N-04

1 OF 1

METRIC

W.P. 4320-06-00 LOCATION N 5 031 423.0 E 371 508.4 ORIGINATED BY LPG
 HWY 417 BOREHOLE TYPE Hollow Stem Augers COMPILED BY AN
 DATUM Geodetic DATE 2011.07.23 - 2011.07.23 CHECKED BY LRB

SOIL PROFILE			SAMPLES			GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT			UNIT WEIGHT γ kN/m ³	REMARKS & GRAIN SIZE DISTRIBUTION (%) GR SA SI CL								
ELEV DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE	"N" VALUES			SHEAR STRENGTH kPa ○ UNCONFINED + FIELD VANE ● QUICK TRIAXIAL × LAB VANE					WATER CONTENT (%) w _p w w _L							
62.3								20	40	60	80	100								
0.0	ASPHALT: (200mm)																			
0.2	Gravelly SAND, some silt		1	AS			62													
61.5	Brown Moist (FILL)																			
0.8	Silty SAND, trace gravel Compact to Dense Brown Moist (FILL)		2	SS	17			61												
			3	SS	41															
60.1							60													
2.2	Silty SAND, trace gravel, trace clay, trace shale fragments Very Dense Dark Grey Moist (TILL)		4	SS	58															
			5	SS	50/ 0.15		59													
	Difficult augering at 4.1m						58													
57.7																				
54.6	SHALE, slightly weathered		6	SS	50/															
4.7	END OF BOREHOLE AT 4.7m. BOREHOLE BACKFILLED WITH BENTONITE HOLEPLUG AND CUTTINGS TO 0.15m, THEN ASPHALT COLD PATCH TO SURFACE.				0.075															

+ 3, x 3: Numbers refer to
Sensitivity

20
15
10

(%) STRAIN AT FAILURE

METRIC

SOIL PROFILE			SAMPLES		GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT		SHEAR STRENGTH kPa		WATER CONTENT (%)		UNIT WEIGHT γ kN/m ³	REMARKS & GRAIN SIZE DISTRIBUTION (%)
ELEV DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	"N" VALUES			20 40 60 80 100	20 40 60 80 100	W _P W W _L	GR SA SI CL				
62.8 0.0	ASPHALT: (200mm)													
0.2	Gravelly SAND, some silt Brown Moist (FILL)		1	AS										
62.0 0.8	Silty SAND, some gravel, trace clay, occasional cobbles Dense Brown Moist (FILL)		2	SS 36										
			3	SS 47										
60.6 2.2	Silty SAND, trace gravel Very Dense Dark Grey Moist to Wet (TILL)		4	SS 64										
			5	SS 50/ 0.075										
			6	SS 50/ 0.025										
57.4 5.4	SHALE, slightly weathered		7	SS 50/ 0.025										
END OF BOREHOLE AT 5.4m. Piezometer installation consists of 19mm diameter Schedule 40 PVC pipe with a 1.52m slotted screen. WATER LEVEL READINGS: DATE DEPTH (m) ELEV. (m) July 26/ 11 2.9 59.9 Aug. 18/ 11 3.0 59.8 Oct. 12/ 11 3.2 59.6														



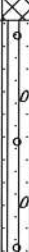



+³, ×³: Numbers refer to Sensitivity

RECORD OF BOREHOLE No 15N-06

1 OF 1

METRIC

W.P. 4320-06-00 LOCATION N 5 031 437.9 E 371 639.5 ORIGINATED BY LPG
HWY 417 BOREHOLE TYPE Hollow Stern Augers COMPILED BY AN
DATUM Geodetic DATE 2011.07.23 - 2011.07.23 CHECKED BY LRB

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										
63.7								20	40	60	80	100						
0.0	ASPHALT: (200mm)																	
0.2	Gravelly SAND, some silt		1	AS			63											
62.9	Brown Moist (FILL)																	
0.8	Sandy SILT, trace gravel		2	SS	44													
62.3	Dense Brown Moist (FILL)																	
1.4	Sandy SILT, trace clay, trace gravel		3	SS	35		62											
	Dense to Very Dense																	
	Brown																	
	Moist (TILL)																	
			4	SS	85/ 0.250		61											
60.7			5	SS	88		60											
3.0	Silty SAND, trace gravel																	
	Very Dense																	
	Dark Grey																	
	Moist (TILL)																	
59.1			6	SS	60/ 0.025													
58.9	SHALE, slightly weathered																	
4.6	END OF BOREHOLE AT 4.6m. BOREHOLE BACKFILLED WITH CUTTINGS AND BENTONITE HOLEPLUG TO 0.15m, THEN ASPHALT COLD PATCH TO SURFACE.																	

+ ³, X ³: Numbers refer to
Sensitivity

20
15
10

(%) STRAIN AT FAILURE

RECORD OF BOREHOLE No 15N-07

1 OF 1

METRIC

W.P. 4320-06-00 LOCATION N 5 031 446.5 E 371 715.3 ORIGINATED BY LPG
 HWY 417 BOREHOLE TYPE Hollow Stem Augers/NQ Coring COMPILED BY AN
 DATUM Geodetic DATE 2011.07.22 - 2011.07.22 CHECKED BY LRB

SOIL PROFILE			SAMPLES			GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT				UNIT WEIGHT γ kN/m ³	REMARKS & GRAIN SIZE DISTRIBUTION (%) GR SA SI CL			
ELEV DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE	"N" VALUES			SHEAR STRENGTH kPa								
								○ UNCONFINED + FIELD VANE ● QUICK TRIAXIAL × LAB VANE								
64.5							20	40	60	80	100	PLASTIC LIMIT	NATURAL MOISTURE CONTENT	LIQUID LIMIT		
0.0	ASPHALT: (200mm)											w _P	w	w _L		
0.2	Gravelly SAND, some silt Brown Moist (FILL)		1	AS												
63.6																
0.9	Silty SAND, trace gravel, trace clay, occasional shale fragments Dense to Very Dense Dark Grey Moist (TILL)		2	SS	32											
			3	SS	52											
			4	SS	45											
61.5																
3.0	SHALE, slightly weathered to fresh, laminated, very thin limestone interbeds through out, grey Highly fractured		1	RUN											FI >10 >10 >10 >10	
			2	RUN											RUN #2 TCR=100% SCR=90% RQD=67% UCS=12MPa (Average)	
			3	RUN											RUN #3 TCR=100% SCR=100% RQD=100% UCS=14MPa (Average)	
58.1																
6.4	END OF BOREHOLE AT 6.4m. Piezometer installation consists of 19mm diameter Schedule 40 PVC pipe with a 3.0m slotted screen. WATER LEVEL READINGS: DATE DEPTH (m) ELEV. (m) July26/ 11 3.6 60.9 Aug.18/ 11 3.5 61.0 Oct.12/ 11 4.0 60.5															

+ 3, x 3 : Numbers refer to
Sensitivity 20
15 5
10 (%) STRAIN AT FAILURE

RECORD OF BOREHOLE No 15N-08

1 OF 1

METRIC

W.P. 4320-06-00 LOCATION N 5 031 454.8 E 371 789.9 ORIGINATED BY LPG
 HWY 417 BOREHOLE TYPE Hollow Stem Augers/NQ Coring COMPILED BY AN
 DATUM Geodetic DATE 2011.07.19 - 2011.07.19 CHECKED BY LRB

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 (%)				
65.4								20	40	60	80	100		
0.0	ASPHALT: (150mm)													
0.2	Gravelly SAND, some silt Brown Moist (FILL)		1	AS			65							
64.6														
0.8	Sandy SILT, shale fragments Very Dense Grey Moist (TILL)		2	SS	58		64						FI	
64.0													>10	
1.4	SHALE, slightly weathered, laminated, very thin limestone interbeds through out, grey Highly fractured		1	RUN			63						>20	
													>20	
							62						>20	
			2	RUN									3	
													0	
													1	
													>5	
													3	
61.0							61						>10	
4.4	END OF BOREHOLE AT 4.4m. BOREHOLE BACKFILLED WITH CUTTINGS AND BENTONITE HOLEPLUG TO 0.1m, THEN ASPHALT COLD PATCH TO SURFACE.													

+³, ×³: Numbers refer to
Sensitivity

20
15 5
10
(%) STRAIN AT FAILURE

RECORD OF BOREHOLE No 15N-09

1 OF 1

METRIC

W.P. 4320-06-00 LOCATION N 5 031 463.0 E 371 862.8 ORIGINATED BY LPG
HWY 417 BOREHOLE TYPE Hollow Stem Augers/NQ Coring COMPILED BY AN
DATUM Geodetic DATE 2011.07.19 - 2011.07.19 CHECKED BY LRB

SOIL PROFILE			SAMPLES			GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT				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 (%)					
								○ UNCONFINED	+ FIELD VANE	● QUICK TRIAXIAL	× LAB VANE			w _p	w	w _L			
66.2								20	40	60	80	100							
0.0																			
65.9		ASPHALT: (250mm)																	
0.3		Gravelly SAND, some silt, trace clay Brown Moist Moist to Wet (FILL)		1	AS														
65.1				2	SS	62/ 0.225													
1.1		SHALE, fresh, laminated, very thin limestone interbeds through out, grey Moderately fractured, horizontally bedded		1	RUN														
				2	RUN														
61.9																			
4.3		END OF BOREHOLE AT 4.3m. Piezometer installation consists of 19mm diameter Schedule 40 PVC pipe with a 2.1m slotted screen. WATER LEVEL READINGS: DATE DEPTH (m) ELEV. (m) July26/ 11 2.2 64.0 Aug.18/ 11 2.2 64.0 Oct.12/ 11 2.5 63.5																	

RECORD OF BOREHOLE No 15N-11

1 OF 1

METRIC

W.P. 4320-06-00 LOCATION N 5 031 481.3 E 372 014.7 ORIGINATED BY LPG
 HWY 417 BOREHOLE TYPE Hollow Stem Augers/NQ Coring COMPILED BY AN
 DATUM Geodetic DATE 2011.07.19 - 2011.07.19 CHECKED BY LRB

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 (%)				
								○ UNCONFINED + FIELD VANE ● QUICK TRIAXIAL × LAB VANE							
67.9							20 40 60 80 100								
0.0	ASPHALT: (150mm)														
0.2	SAND, some gravel, some silt Brown Moist (FILL)		1	AS											
67.1															
0.8	Silty SAND, trace gravel, trace clay Very Dense Brown Moist (TILL)		2	SS	75										
			3	SS	50/ 0.075									4 62 27 6	
65.6															
2.3	SHALE, fresh, laminated, very thin limestone interbeds through out, grey		4	SS	50/ 0.00										
			1	RUN											
			2	RUN											
	Highly fractured zone from 5.0m to 5.3m														
62.3															
5.6	END OF BOREHOLE AT 5.6m. Piezometer installation consists of 19mm diameter Schedule 40 PVC pipe with a 3.0m slotted screen. WATER LEVEL READINGS: DATE DEPTH (m) ELEV. (m) July 26/ 11 4.1 63.8 Aug. 18/ 11 4.1 63.8 Oct. 12/ 11 4.2 63.7														

RECORD OF BOREHOLE No 15N-12

1 OF 1

METRIC

W.P. 4320-06-00 LOCATION N 5 031 493.3 E 372 089.6 ORIGINATED BY LPG
HWY 417 BOREHOLE TYPE Hollow Stem Augers/NQ Coring COMPILED BY AN
DATUM Geodetic DATE 2011.07.22 - 2011.07.22 CHECKED BY LRB

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								WATER CONTENT (%)		
								○ UNCONFINED	+ FIELD VANE	● QUICK TRIAXIAL						× LAB VANE		
68.7							20	40	60	80	100							
0.0	ASPHALT: (150mm)																	
0.2	SAND, some gravel, some silt Grey Moist (FILL)		1	AS														
67.9																		
0.8	Gravelly SAND, shale fragments Dense Brown Moist (FILL)		2	SS	42													
67.2																		
1.5	Sandy SILT, trace gravel Very Dense (TILL)		3	SS	50/ 0.100													
			1	RUN														
66.0																		
2.7	SHALE, slightly weathered to fresh, laminated, very thin limestone interbeds through out, grey Highly fractured zone from 3.3m to 3.8m 25mm thick limestone interbed at 3.9m Limestone interbeds: 50mm at 4.3m 50mm at 5.1m 75mm at 5.5m		2	RUN														
			3	RUN														
62.9																		
5.8	END OF BOREHOLE AT 5.8m. BOREHOLE BACKFILLED WITH CUTTINGS AND BENTONITE HOLEPLUG TO 0.15m, THEN ASPHALT COLD PATCH TO SURFACE.																	

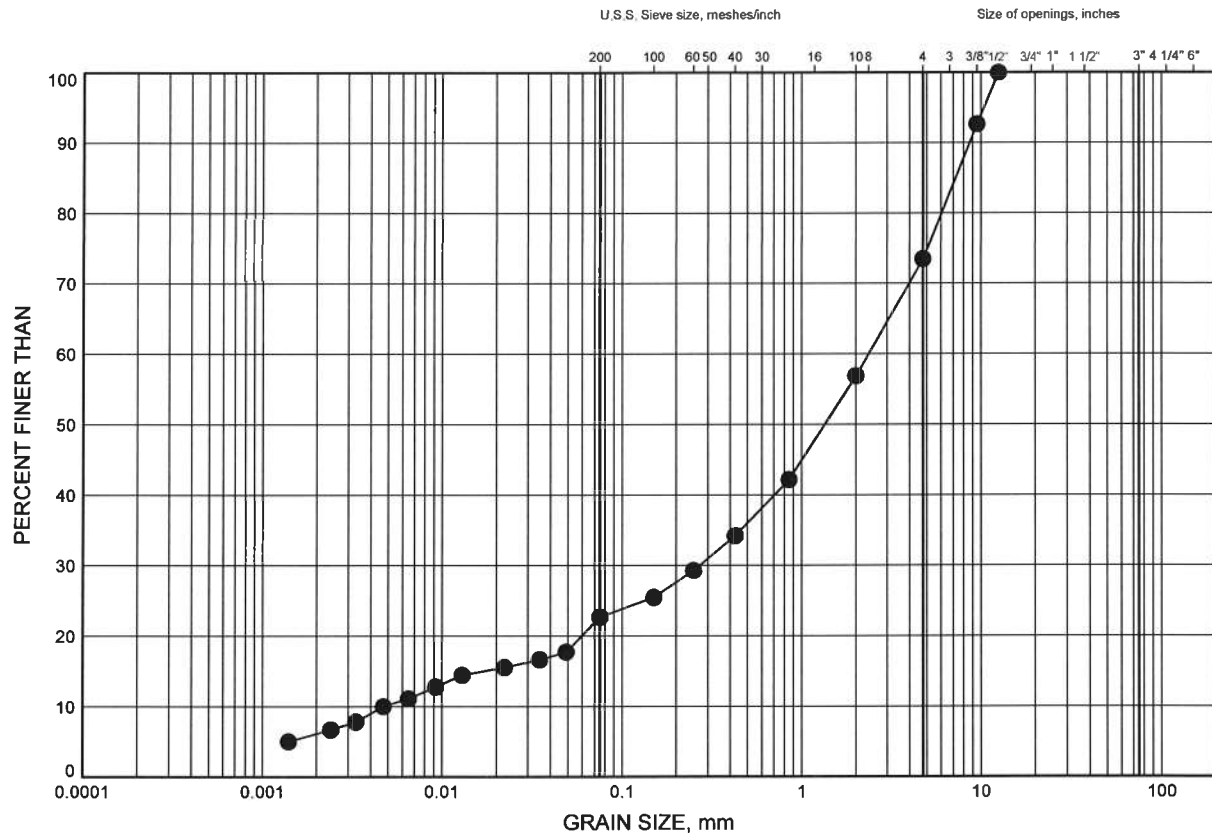
+³ X³: Numbers refer to Sensitivity 20 15 10 5 0 (%) STRAIN AT FAILURE

Highway 417 Ottawa: Nicholas Street to OR 174

GRAIN SIZE DISTRIBUTION

FIGURE F1

GRAVELLY SAND FILL



SILT and CLAY	FINE	MEDIUM	COARSE	FINE	COARSE	COBBLE SIZE
FINE GRAINED	SAND			GRAVEL		

LEGEND

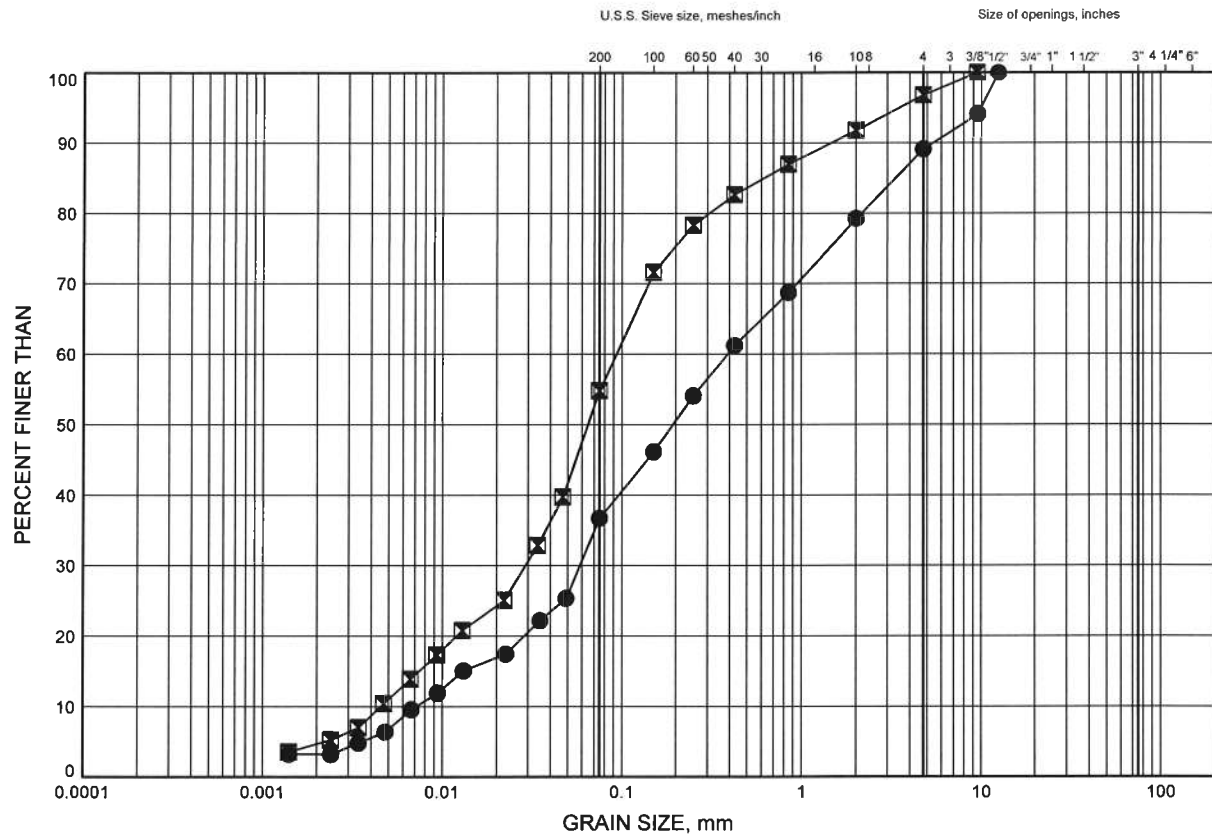
SYMBOL	BOREHOLE	DEPTH (m)	ELEV. (m)
●	15N-09	0.46	65.74

Highway 417 Ottawa: Nicholas Street to OR 174

GRAIN SIZE DISTRIBUTION

FIGURE F2

SANDY SILT to SILTY SAND FILL



SILT and CLAY	FINE	MEDIUM	COARSE	FINE	COARSE	COBBLE SIZE
FINE GRAINED	SAND			GRAVEL		

LEGEND

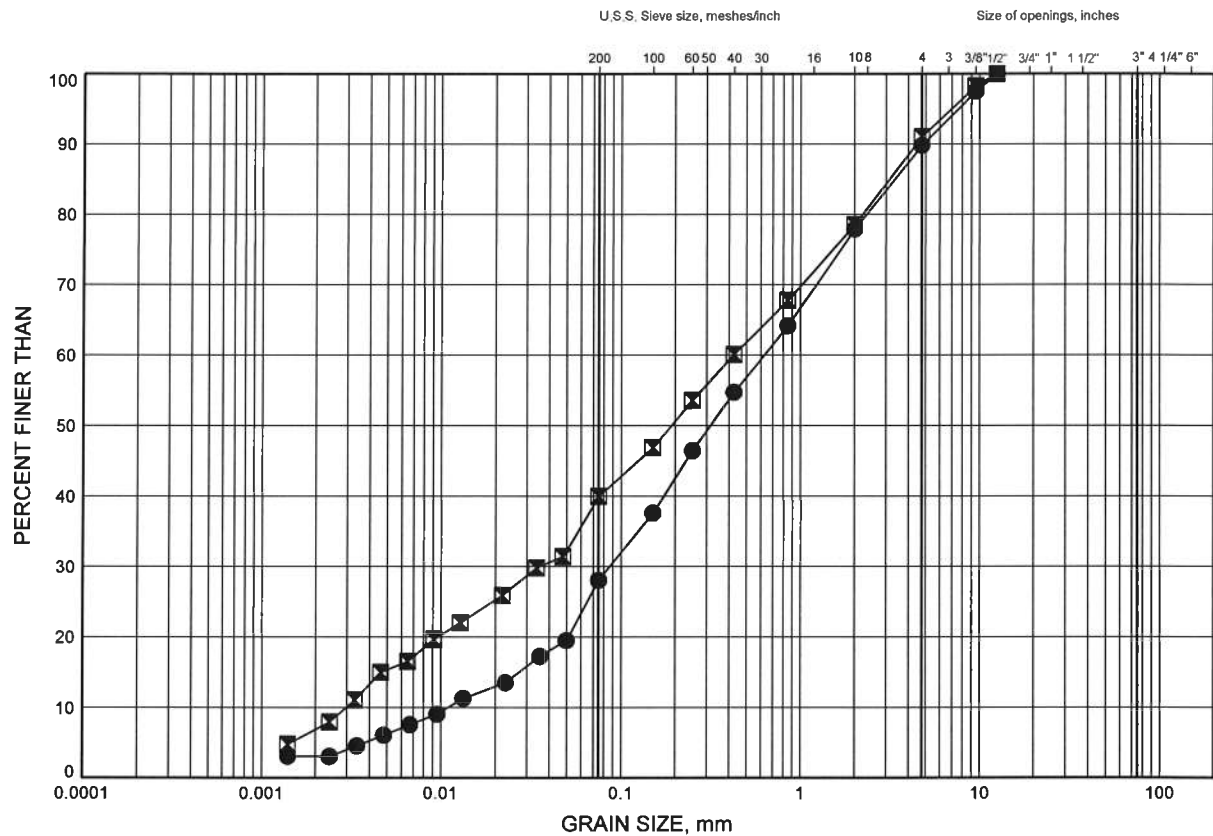
SYMBOL	BOREHOLE	DEPTH (m)	ELEV. (m)
●	15N-05	1.83	60.94
⊠	15N-06	1.07	62.63

Highway 417 Ottawa: Nicholas Street to OR 174

GRAIN SIZE DISTRIBUTION

FIGURE F3

SILTY SAND TILL



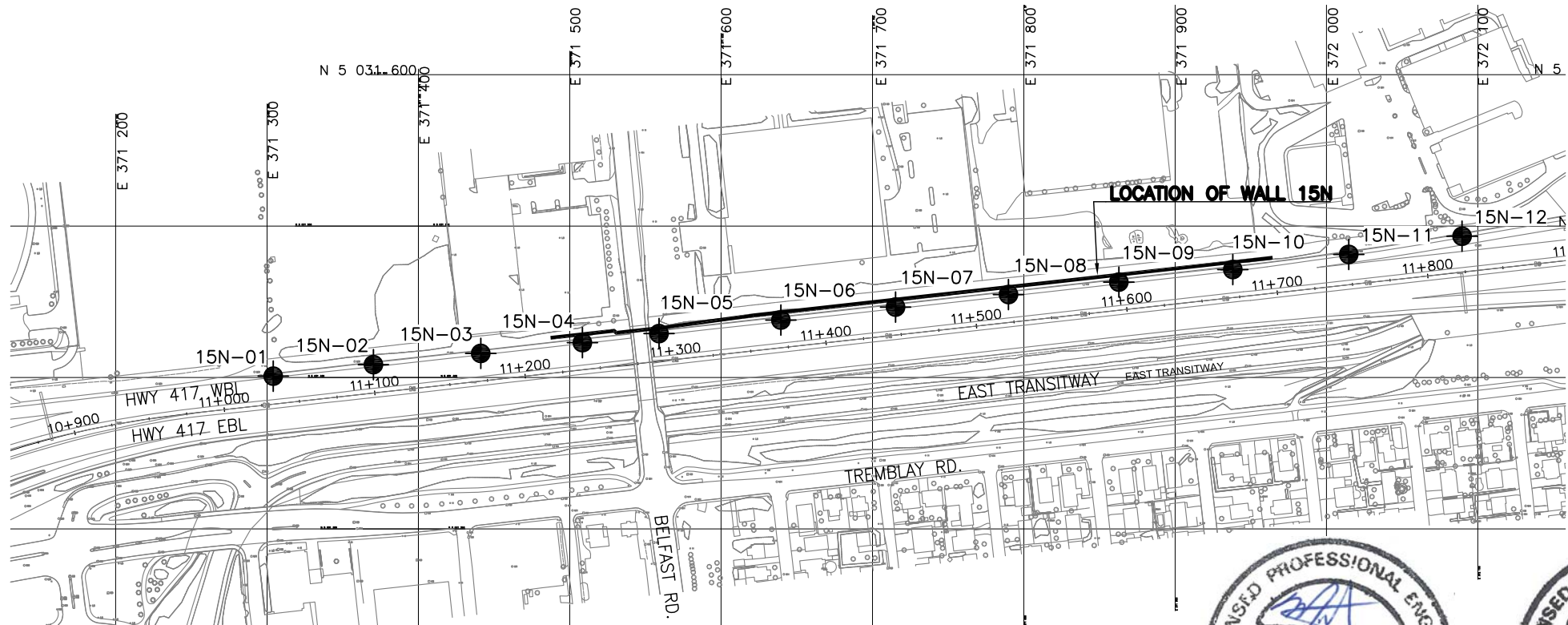
SILT and CLAY	FINE	MEDIUM	COARSE	FINE	COARSE	COBBLE SIZE
FINE GRAINED	SAND			GRAVEL		

LEGEND

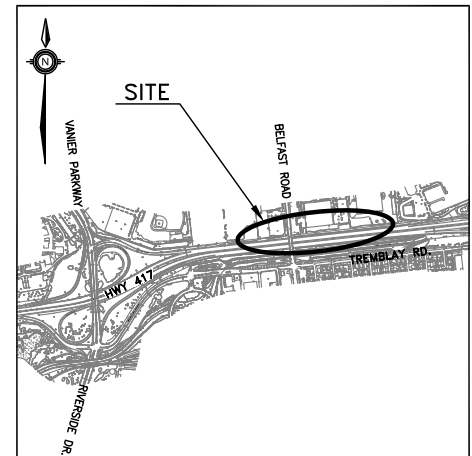
SYMBOL	BOREHOLE	DEPTH (m)	ELEV. (m)
●	15N-04	2.59	59.68
■	15N-07	2.59	61.95



W.P.# 4320-06-00
 Prepared By AN
 Checked By LRB



PLAN



KEYPLAN

LEGEND

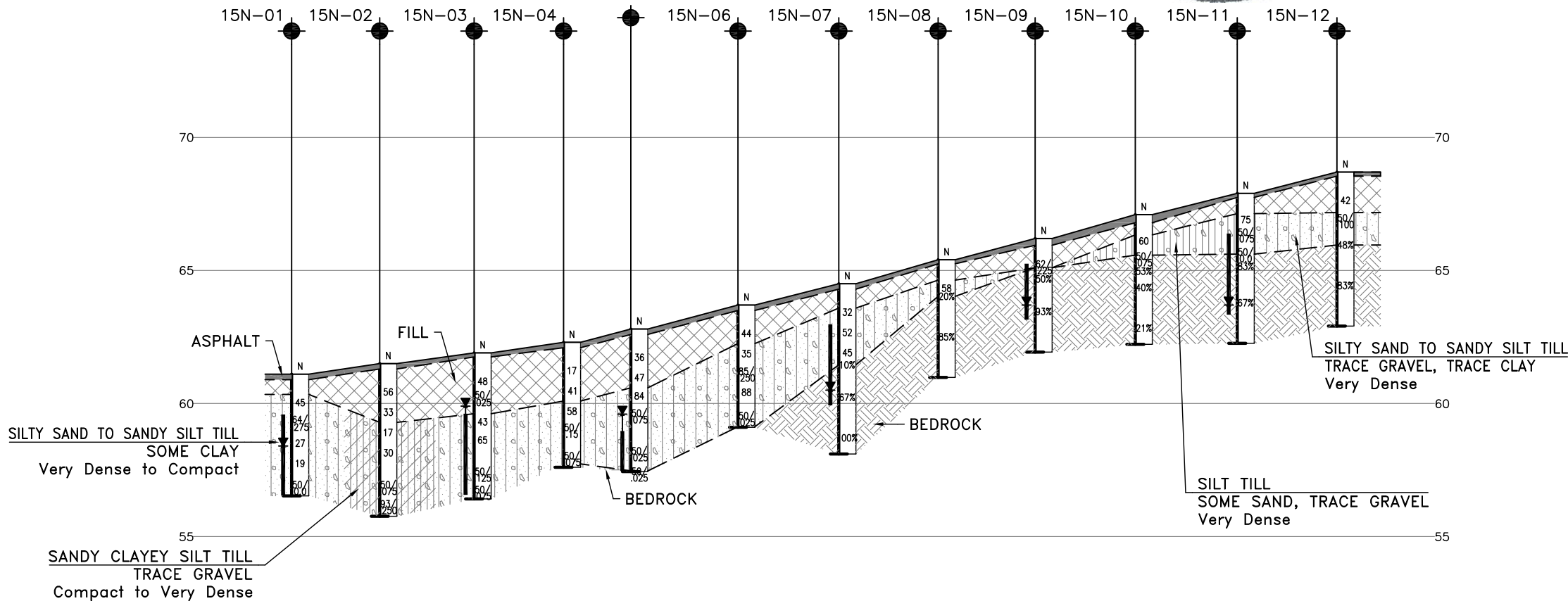
- Borehole
- Borehole and Cone
- N Blows /0.3m (Std Pen Test, 475J/blow)
- CONE Blows /0.3m (60° Cone, 475J/blow)
- PH Pressure, Hydraulic
- Water Level
- Head Artesian Water
- Piezometer
- 90% Rock Quality Designation (RQD)
- A/R Auger Refusal

NO	ELEVATION	NORTHING	EASTING
15N-01	61.1	5 031 400.9	371 304.1
15N-02	61.5	5 031 408.5	371 370.3
15N-03	61.9	5 031 415.9	371 441.2
15N-04	62.3	5 031 423.0	371 508.4
15N-05	62.8	5 031 429.0	371 559.0
15N-06	63.7	5 031 437.9	371 639.5
15N-07	64.5	5 031 446.5	371 715.3
15N-08	65.4	5 031 454.8	371 789.9
15N-09	66.2	5 031 463.0	371 862.8
15N-10	67.1	5 031 471.3	371 938.1
15N-11	67.9	5 031 481.3	372 014.7
15N-12	68.7	5 031 493.3	372 089.6

NOTES

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

GEOCRES No. 31G5-250



PROFILE

HOR. 1:4000

VER. 1:200


REVISIONS	DATE	BY	DESCRIPTION
DESIGN	LRB	CHK	LRB
DRAWN	AN	CHK	PKC
LOAD	DATE	AUG. 2012	
STRUCT	DWG	1	

Appendix G

Belfast Road (South) - Wall 23S

Boreholes 23S-01 to 23S-09

METRIC

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				W _p W W _L		
61.9							SHEAR STRENGTH kPa ○ UNCONFINED + FIELD VANE ● QUICK TRIAXIAL × LAB VANE	WATER CONTENT (%) 20 40 60		GR SA SI C	

[illegible]

ONTMT4S 1201B.GPJ 5/14/12

+ 3, × 3 Numbers refer to Sensitivity

RECORD OF BOREHOLE No 23S-02

1 OF 1

METRIC

W.P. 4320-06-00 LOCATION N 5 031 390.0 E 371 540.9 ORIGINATED BY LPG
 HWY 417 BOREHOLE TYPE Hollow Stem Augers/NQ Coring COMPILED BY AN
 DATUM Geodetic DATE 2011.07.22 - 2011.07.22 CHECKED BY LRB

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					
62.5								20 40 60 80 100					
0.0	ASPHALT: (200mm)												
0.2	SAND, some gravel, some silt Brown Moist (FILL)		1	AS			62						
61.7													
0.8	Silty SAND, some gravel, trace clay Compact Brown Moist (FILL)		2	SS	16								
61.1													
1.4	Silty SAND, some gravel, trace clay Very Dense Dark Grey Moist (TILL)		3	SS	50/ 0.05		61						
			4	SS	62		60						10 56 30 4
			5	SS	50/ 0.025		59						
	Difficult augering at 4.1m												
57.9							58					FI	
4.6	SHALE, slightly weathered, laminated, very thin limestone interbeds through out, grey Highly fractured, occasional calcite infilling, sub-horizontal fractures		1	RUN			57					>10 >10 >10	RUN #1 TCR=100% SCR=42% RQD=0%
	25mm thick limestone interbeds at 6.0m, 6.2m and 6.3m		2	RUN			56					1 2 >5 >5	RUN #2 TCR=100% SCR=87% RQD=67% UCS=19.4MPa (Average)
55.2													
7.3	END OF BOREHOLE AT 7.3m. Piezometer installation consists of 19mm diameter Schedule 40 PVC pipe with a 3.0m slotted screen.												
	WATER LEVEL READINGS: DATE DEPTH (m) ELEV. (m) Jul. 26/ 11 2.8 59.7 Aug. 18/ 11 2.8 59.7 Oct. 12/ 11 3.9 58.6												

ONTTMT4S 1201B.GPJ 5/14/12

+³ ×³: Numbers refer to
Sensitivity 20
15 10 5 10 (%) STRAIN AT FAILURE

RECORD OF BOREHOLE No 23S-03

1 OF 1

METRIC

W.P. 4320-06-00 LOCATION N 5 031 398.2 E 371 615.1 ORIGINATED BY LPG
HWY 417 BOREHOLE TYPE Hollow Stem Augers/NQ Coring COMPILED BY AN
DATUM Geodetic DATE 2011.07.18 - 2011.07.18 CHECKED BY LRB

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												
63.2								20	40	60	80	100								
0.0	ASPHALT: (300mm)						63													
62.9																				
0.3	SAND, some gravel, some silt Brown Moist (FILL)		1	AS																
62.4																				
0.8	Silty SAND, some clay, trace gravel Dense to Very Dense Dark Grey Moist (TILL)		2	SS	34		62													
			3	SS	50															
			4	SS	50/ 0.075		61													
			5	SS	61		60													
							59													
	Shale fragments from 5.0m to 5.8m		6	SS	70/ 0.275															
	Highly fractured Alternating layers of shale and till		1	RUN			58													
57.4																				
5.8	SHALE, slightly weathered, laminated, grey, frequent limestone interbeds, sub-horizontal bedding		2	RUN			57													
	Highly fractured																			
							56													
			3	RUN			55													
54.4																				
8.8	END OF BOREHOLE AT 8.8m. BOREHOLE BACKFILLED WITH BENTONITE HOLEPLUG AND CUTTINGS TO 0.15m, THEN ASPHALT COLD PATCH TO SURFACE.																			

ONTMT4S 1201B GPJ 4/23/12

+ 3, x 3; Numbers refer to
Sensitivity 20
15 5
10 (%) STRAIN AT FAILURE

METRIC

+³, ×³: Numbers refer to Sensitivity

RECORD OF BOREHOLE No 23S-05

1 OF 1

METRIC

W.P. 4320-06-00 LOCATION N 5 031 414.1 E 371 756.2 ORIGINATED BY LPG
HWY 417 BOREHOLE TYPE Hollow Stem Augers/NQ Coring COMPILED BY AN
DATUM Geodetic DATE 2011.07.20 - 2011.07.20 CHECKED BY LRB

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 (%)
64.9								20	40	60	80	100					
0.0 64.6	ASPHALT: (250mm)																
0.3	Gravelly SAND, some silt Brown Moist (FILL)		1	AS													
64.0																	
0.9	Silty SAND, some clay, trace gravel Dense to Very Dense Dark Grey Moist (TILL) Hydrocarbon smell		2	SS	35												
			3	SS	77												
			4	SS	89/ 0.180												
62.2																	
2.7	SHALE, slightly weathered, sub-horizontally laminated, very thin limestone interbeds through out, grey Limestone interbeds: 75mm at 3.0m 25mm at 3.1m 25mm at 3.4m Highly fractured		1	RUN													
							</										

+³, ×³: Numbers refer to
Sensitivity

20
15
10

(%) STRAIN AT FAILURE

METRIC

SOIL PROFILE						SAMPLES
ELEV DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE	"N" VALUES	
65.8						
0.0	ASPHALT: (150mm)	[Pattern]				
0.2	SAND, some gravel, some silt	[Pattern]	1	AS		
65.0	Brown Moist (FILL)	[Pattern]				
0.8	Silly SAND, some clay, trace gravel	[Pattern]	2	SS	84/ 0-020	
64.6	Very Dense Brown Moist (TILL)	[Pattern]				
1.2	SHALE, slightly weathered, laminated, very thin limestone interbeds through out, grey	[Pattern]	1	RUN		
	Highly fractured	[Pattern]				
		[Pattern]	2	RUN		
61.5						
4.3	END OF BOREHOLE AT 4.3m. Piezometer installation consists of 19mm diameter Schedule 40 PVC pipe with a 1.8m slotted screen.					
WATER LEVEL READINGS:						
DATE	DEPTH (m)	ELEV. (m)				
July 21/ 11	3.0	62.8				
July 26/ 11	3.1	62.7				
Aug. 18/ 11	3.1	62.7				
Oct. 12/ 11	3.2	62.6				

METRIC

[illegible]

+³, ×³: Numbers refer to Sensitivity

RECORD OF BOREHOLE No 23S-08

1 OF 1

METRIC

W.P. 4320-06-00 LOCATION N 5 031 437.5 E 371 979.4 ORIGINATED BY LPG
 HWY 417 BOREHOLE TYPE Hollow Stem Augers/NQ Coring COMPILED BY AN
 DATUM Geodetic DATE 2011.07.20 - 2011.07.20 CHECKED BY LRB

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									
67.4								20	40	60	80	100					
0.0	ASPHALT: (150mm)																
0.2	Gravelly SAND, some silt Brown Moist (FILL)		1	AS			67										
66.6																	
0.8	Silty SAND, trace gravel, shale fragments Compact Grey Moist (TILL)		2	SS	26		66								FI		
66.2															>10		
1.2	SHALE, slightly weathered, laminated, grey Highly fractured from 1.2m to 1.9m		1	RUN			65								>10	RUN #1 TCR=100% SCR=63% RQD=45% UCS=21MPa (Average)	
															1		
															0		
															>10	RUN #2 TCR=100% SCR=40% RQD=33% UCS=25MPa (Average)	
															>10		
			2	RUN			64								>10		
															3		
63.1															>10		
4.3	END OF BOREHOLE AT 4.3m. Piezometer installation consists of 19mm diameter Schedule 40 PVC pipe with a 1.8m slotted screen. WATER LEVEL READINGS: DATE DEPTH (m) ELEV. (m) Jul. 21/ 11 2.8 64.6 Jul. 26/ 11 2.8 64.6 Aug. 18/ 11 2.8 64.6 Oct. 12/ 11 2.8 64.6																

+ 3, x 3: Numbers refer to
Sensitivity 20
15 5
10 (%) STRAIN AT FAILURE

RECORD OF BOREHOLE No 23S-09

1 OF 1

METRIC

W.P. 4320-06-00 LOCATION N 5 031 443.4 E 372 055.2 ORIGINATED BY LPG
HWY 417 BOREHOLE TYPE Hollow Stem Augers/NQ Coring COMPILED BY AN
DATUM Geodetic DATE 2011.07.21 - 2011.07.21 CHECKED BY LRB

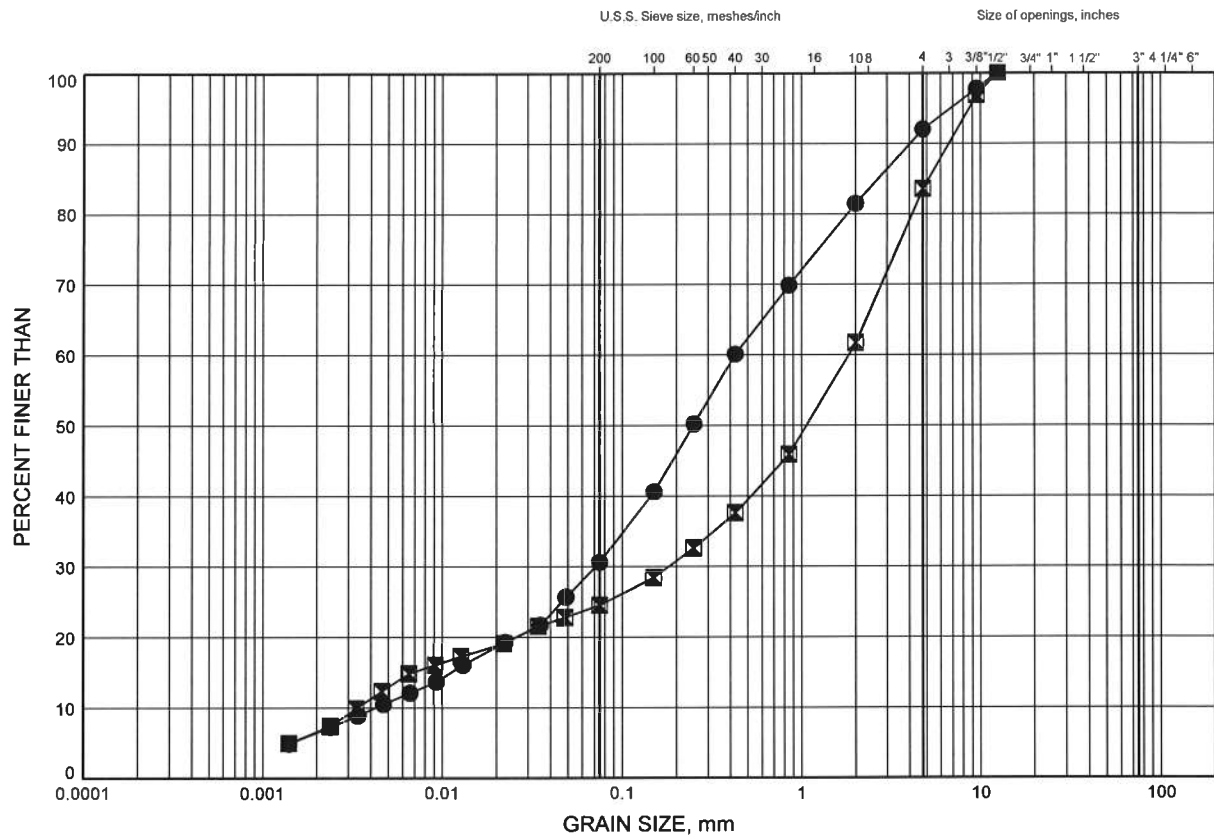
SOIL PROFILE			SAMPLES			GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT			UNIT WEIGHT γ kN/m ³	REMARKS & GRAIN SIZE DISTRIBUTION (%)	
ELEV DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE	"N" VALUES			SHEAR STRENGTH kPa					
68.2								20 40 60 80 100					
0.0	ASPHALT: (200mm)						68						
0.2	Gravelly SAND, some silt		1	AS									
67.4	Brown Moist (FILL)												
0.8	Silty SAND, some gravel, trace clay		2	SS	44		67						19 59 16 5
	Very Dense Brown Moist (TILL)												
66.2			3	SS	56/ 0.280								
2.0	SHALE, highly weathered						66						
	Started coring at 2.7m Slightly weathered to fresh, laminated, very thin limestone interbeds through out												
			1	RUN			65						RUN #1 TCR=100% SCR=82% RQD=13% UCS=7MPa (Average)
	Vertical fractures from 4.2m to 5.1m						64						
	Limestone interbeds: 25mm at 5.4m 50mm at 5.5m 25mm at 5.6m		2	RUN			63						RUN #2 TCR=100% SCR=97% RQD=43% UCS=18MPa (Average)
62.4													
5.8	END OF BOREHOLE AT 5.8m. BOREHOLE BACKFILLED WITH BENTONITE HOLEPLUG AND CUTTINGS TO 0.15m, THEN ASPHALT COLD PATCH TO SURFACE.												

+³, ×³: Numbers refer to
Sensitivity 20
15 5
10 (%) STRAIN AT FAILURE

Highway 417 Ottawa: Vanier to OR 174 GRAIN SIZE DISTRIBUTION

FIGURE G1

SILTY SAND to SAND FILL



SILT and CLAY	FINE	MEDIUM	COARSE	FINE	COARSE	COBBLE SIZE
FINE GRAINED	SAND			GRAVEL		

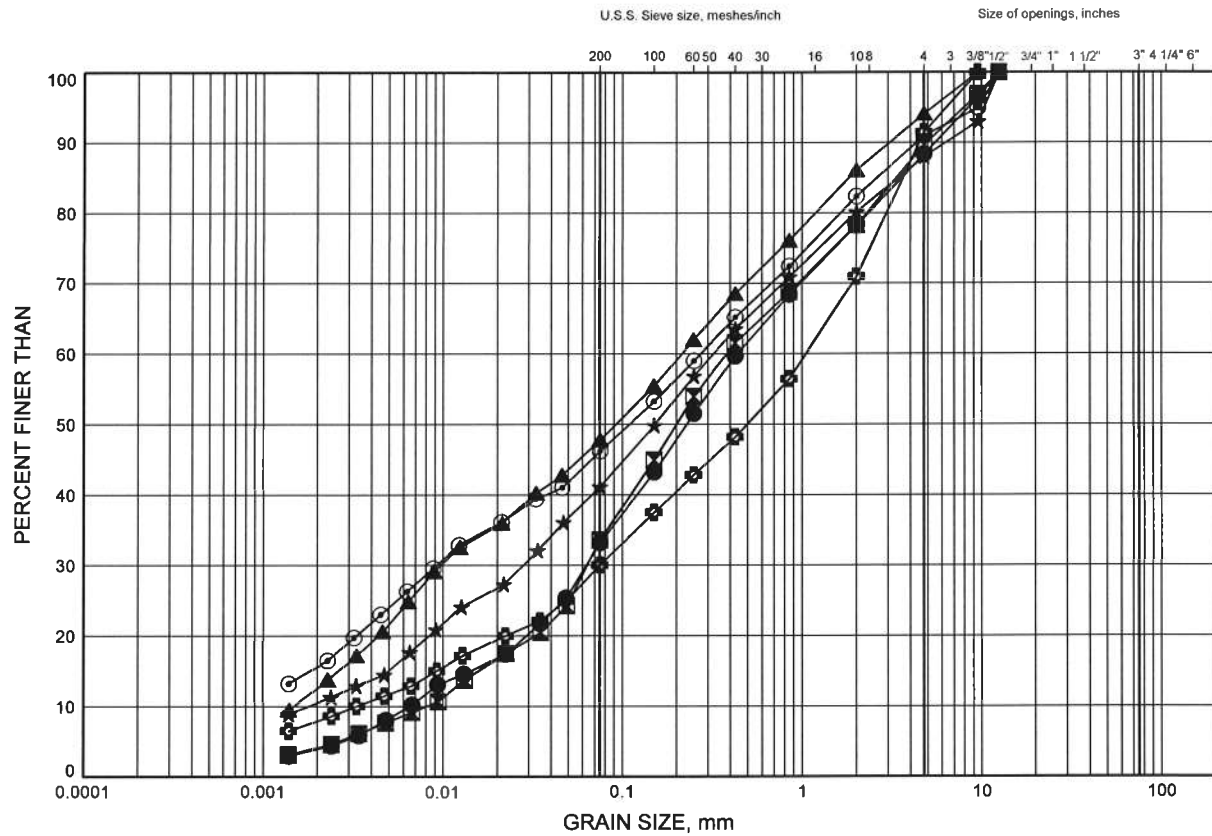
LEGEND

SYMBOL	BOREHOLE	DEPTH (m)	ELEV. (m)
●	23S-01	1.83	60.07
⊠	23S-06	0.46	65.34

Highway 417 Ottawa: Vanier to OR 174 GRAIN SIZE DISTRIBUTION

FIGURE G2

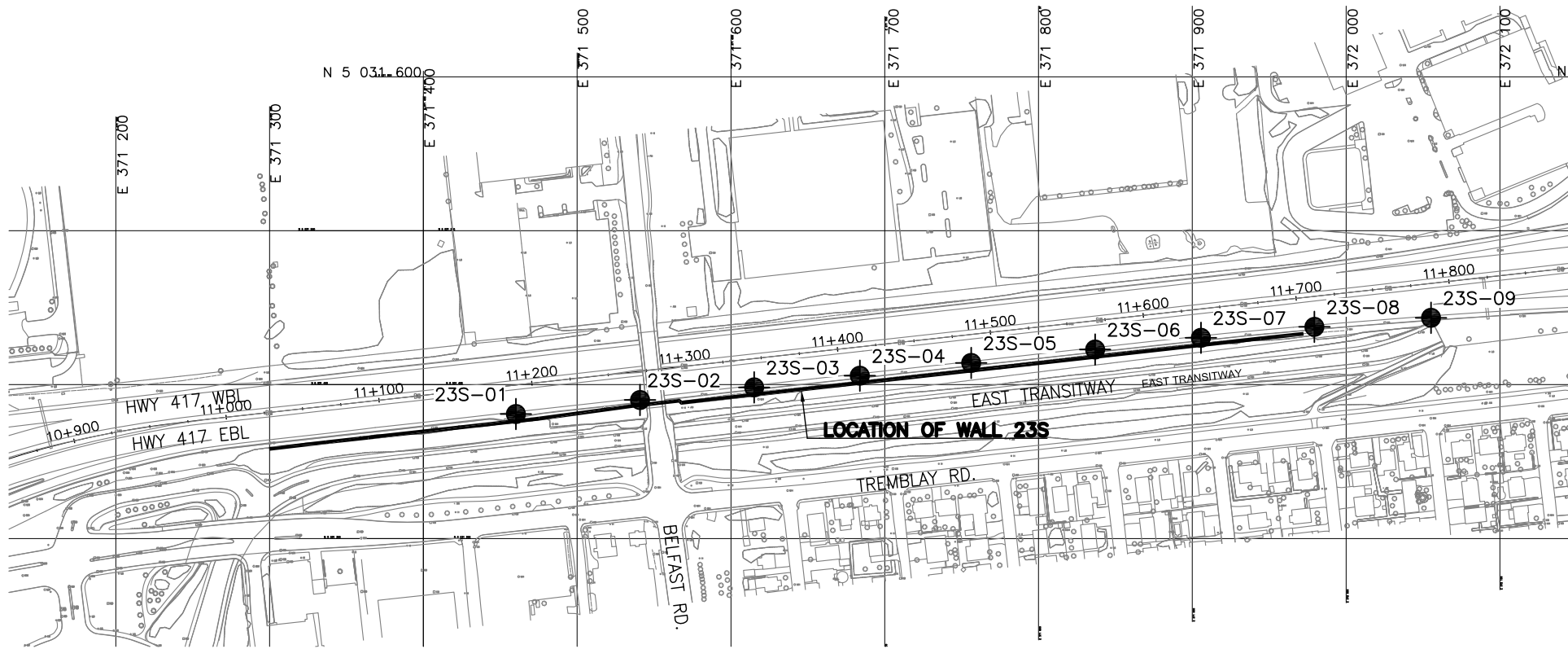
SILTY SAND TILL



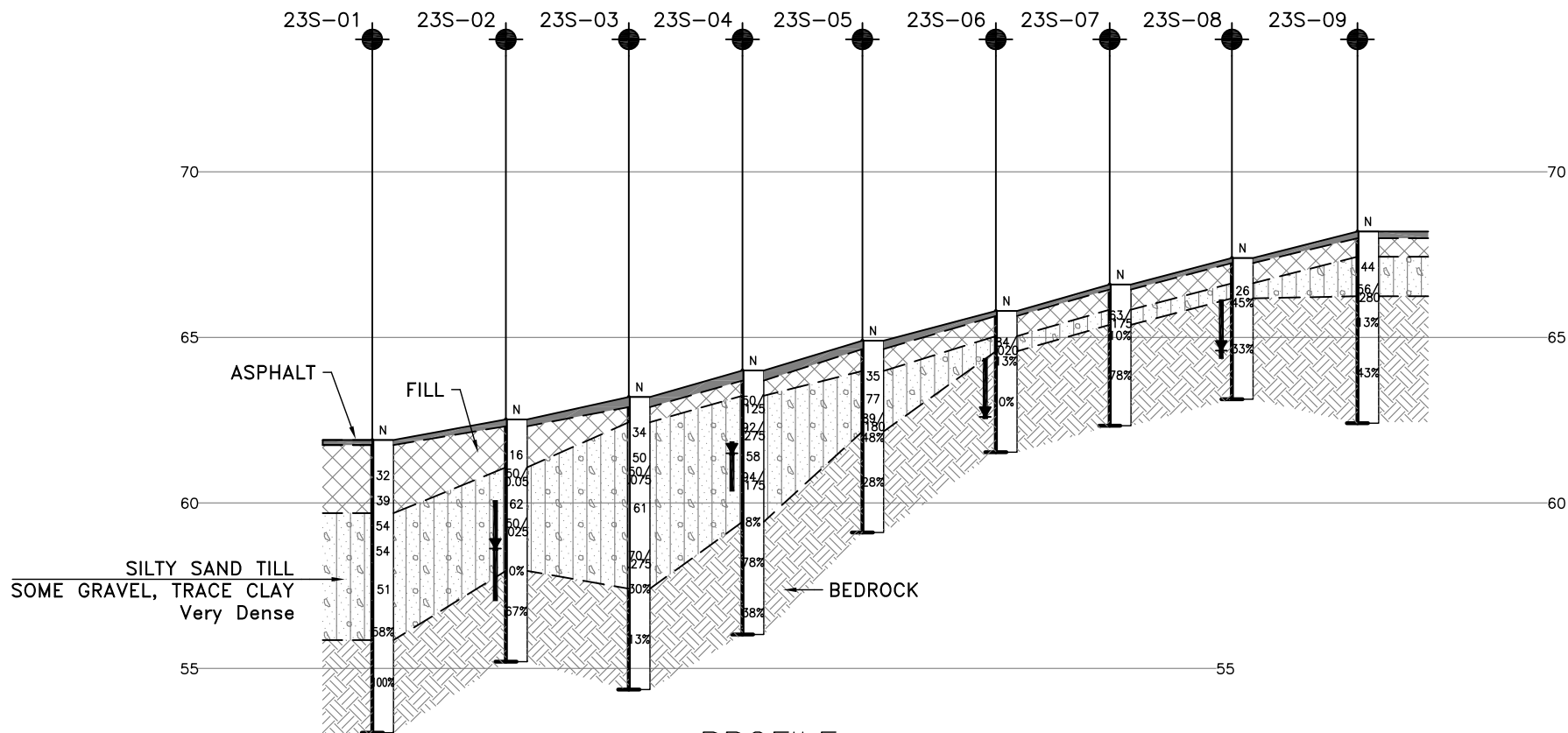
SILT and CLAY	FINE	MEDIUM	COARSE	FINE	COARSE	COBBLE SIZE
FINE GRAINED	SAND			GRAVEL		

LEGEND

SYMBOL	BOREHOLE	DEPTH (m)	ELEV. (m)
●	23S-01	3.35	58.55
⊠	23S-02	2.55	59.96
▲	23S-03	1.83	61.37
★	23S-04	1.71	62.29
⊙	23S-05	1.75	63.15
⊕	23S-07	0.95	65.65



PLAN
SCALE 1:4000



PROFILE
HOR. 1:4000
VER. 1:200

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

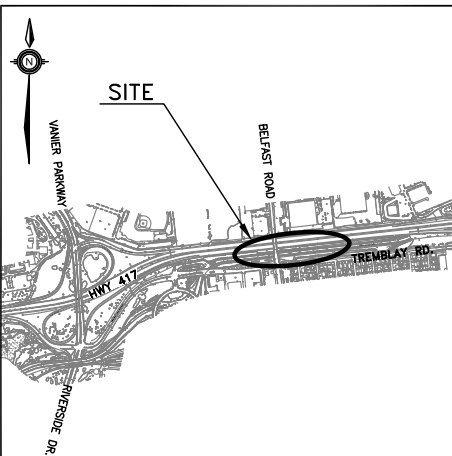


CONT No
WP No 4320-06-00

HIGHWAY 417
BELFAST ROAD (SOUTH)
RETAINING WALL 23S
BOREHOLE LOCATIONS AND SOIL STRATA



THURBER ENGINEERING LTD.



KEYPLAN

LEGEND

- Borehole
- Borehole and Cone
- N Blows /0.3m (Std Pen Test, 475J/blow)
- CONE Blows /0.3m (60° Cone, 475J/blow)
- PH Pressure, Hydraulic
- Water Level
- Head Artesian Water
- Piezometer
- 90% Rock Quality Designation (RQD)
- A/R Auger Refusal

NO	ELEVATION	NORTHING	EASTING
23S-01	61.9	5 031 380.9	371 460.2
23S-02	62.5	5 031 390.0	371 540.9
23S-03	63.2	5 031 398.2	371 615.1
23S-04	64.0	5 031 405.8	371 683.8
23S-05	64.9	5 031 414.1	371 756.2
23S-06	65.8	5 031 422.8	371 836.8
23S-07	66.6	5 031 430.4	371 905.6
23S-08	67.4	5 031 437.5	371 979.4
23S-09	68.2	5 031 443.4	372 055.2

-NOTES-

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

GEOCRES No. 31G5-250

REVISIONS	DATE	BY	DESCRIPTION
DESIGN	LRB	CHK	LRB
DRAWN	AN	CHK	PKC
LOAD	DATE	AUG. 2012	
STRUCT	DWG	1	

Appendix H

St. Laurent Boulevard N-W Ramp - Wall 16N

Boreholes 16N-1 to 16N-3

METRIC

[illegible]

20
15 10 5 0
(%) STRAIN AT FAILURE

ONTMT4S 1201B.GPJ 4/23/12

RECORD OF BOREHOLE No 16N-1

2 OF 2

METRIC

W.P. 4320-06-00 LOCATION N 5 031 515.2 E 372 266.7 ORIGINATED BY LPG
 HWY 417 BOREHOLE TYPE Hollow Stem Augers/NQ Coring COMPILED BY AN
 DATUM Geodetic DATE 2011.08.18 - 2011.08.18 CHECKED BY LRB

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	20	40	60			
	Continued From Previous Page																
	Sep. 20/11 5.2 64.7																
	Oct. 12/11 5.8 64.1																

RECORD OF BOREHOLE No 16N-2

1 OF 1

METRIC

W.P. 4320-06-00 LOCATION N 5 031 524.5 E 372 330.2 ORIGINATED BY LPG
HWY 417 BOREHOLE TYPE Hollow Stem Augers/NQ Coring COMPILED BY AN
DATUM Geodetic DATE 2011.08.17 - 2011.08.17 CHECKED BY LRB

SOIL PROFILE			SAMPLES			GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT		PLASTIC LIMIT NATURAL MOISTURE CONTENT LIQUID LIMIT			UNIT WEIGHT kN/m ³	REMARKS & GRAIN SIZE DISTRIBUTION (%)
ELEV DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE	"N" VALUES			SHEAR STRENGTH kPa		WATER CONTENT (%)				
69.3							20 40 60 80 100							
0.0							20 40 60 80 100							
0.1	ASPHALT: (100mm)						20 40 60 80 100							
	Gravelly SAND, some silt Dense to Very Dense Brown Moist (FILL)		1	AS										
			2	SS	50/ 0.125									
			3	SS	30									
67.0														
2.3	SAND, some silt, some gravel Compact Brown Moist (FILL)		4	SS	21									
66.3														
3.0	Silty SAND, trace gravel, trace clay Compact Brown Wet		5	SS	11									
64.7														
4.6	Sandy SILT, some clay, trace gravel Dense Brown Moist to Wet (TILL)		6	SS	45									
63.5														
5.8	SHALE, fresh, laminated, grey, very thin limestone interbeds through out		1	RUN										
			2	RUN										
60.5														
8.8	END OF BOREHOLE AT 8.8m. BOREHOLE BACKFILLED WITH BENTONITE HOLEPLUG AND CUTTINGS TO 0.1m, THEN ASPHALT COLD PATCH TO SURFACE.													

ONTMT4S 1201B.GPJ 4/23/12

+³, x³: Numbers refer to
Sensitivity

20
15
10

(%) STRAIN AT FAILURE

RECORD OF BOREHOLE No 16N-3

1 OF 1

METRIC

W.P. 4320-06-00 LOCATION N 5 031 533.0 E 372 394.4 ORIGINATED BY LPG
HWY 417 BOREHOLE TYPE Hollow Stem Augers/NQ Coring COMPILED BY AN
DATUM Geodetic DATE 2011.08.17 - 2011.08.17 CHECKED BY LRB

SOIL PROFILE			SAMPLES			GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT		PLASTIC NATURAL LIQUID LIMIT MOISTURE CONTENT LIMIT			UNIT WEIGHT γ kN/m ³	REMARKS & GRAIN SIZE DISTRIBUTION (%)
ELEV DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE	"N" VALUES			SHEAR STRENGTH kPa		WATER CONTENT (%)				
								20 40 60 80 100						
								○ UNCONFINED + FIELD VANE						
								● QUICK TRIAXIAL × LAB VANE						
								20 40 60 80 100		20 40 60				
68.5														
0.0	ASPHALT: (150mm)													
0.2	Gravelly SAND, some silt Dense Brown Moist (FILL)		1	AS			68							
			2	SS	39									
67.0							67							
1.5	Silty SAND, trace gravel Dense Brown Moist		3	SS	39									
66.2														
2.3	Clayey SILT and SAND Stiff Grey (TILL)		4	SS	14		66							0 26 53 21
65.5														
3.0	Silty SAND, trace clay, trace gravel Compact to Very Dense Dark Grey Moist (TILL)		5	SS	24		65							3 54 38 5
			6	SS	50/ 0.100		64						F1	
63.6														RUN #1 TCR=77% SCR=46% RQD=25% UCS=18MPa (Average)
4.9	SHALE, slightly weathered to fresh, laminated, grey, with clay infilled fractures, very thin limestone interbeds through out Limestone interbed (75mm) at 5.2m		1	RUN			63						>10 2	
													>5	
			2	RUN			62						>6 3	RUN #2 TCR=100% SCR=83% RQD=52% UCS=34MPa (Average)
													3	
													0	
													5	
			3	RUN			61						3	RUN #3 TCR=100% SCR=100% RQD=100% UCS=15MPa (Average)
													1	
													1	
60.2														
8.3	END OF BOREHOLE AT 8.3m. Piezometer installation consists of 19mm diameter Schedule 40 PVC pipe with a 1.52m slotted screen. WATER LEVEL READINGS: DATE DEPTH (m) ELEV. (m) Aug. 18/11 4.7 63.8 Sep. 20/11 3.7 64.8 Oct. 12/11 3.7 64.8													

ONTWT4S 1201B GPJ 5/14/12

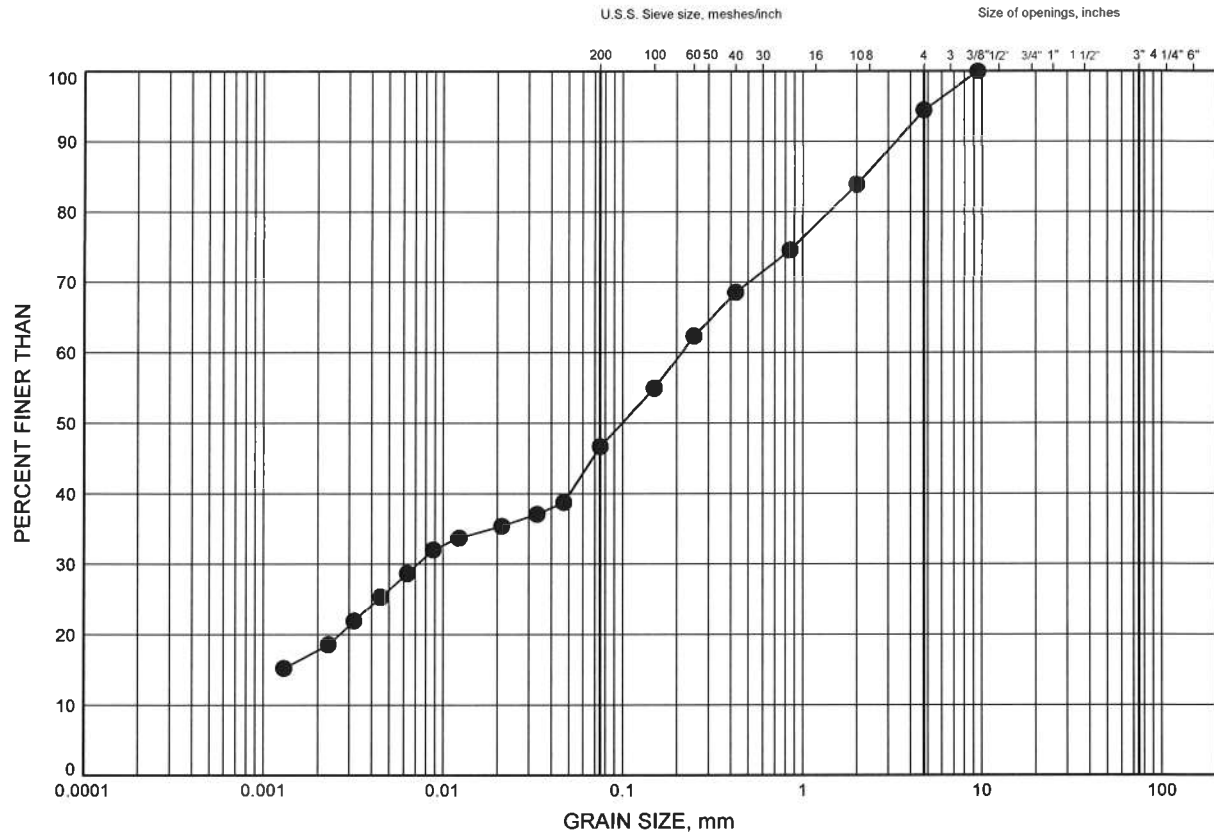
+³ ×³: Numbers refer to
Sensitivity 20
15 10 5 0
(%) STRAIN AT FAILURE

Highway 417 Ottawa: Nicholas Street to OR 174

GRAIN SIZE DISTRIBUTION

FIGURE H1

SILTY SAND FILL



SILT and CLAY	FINE	MEDIUM	COARSE	FINE	COARSE	COBBLE SIZE
FINE GRAINED	SAND			GRAVEL		

LEGEND

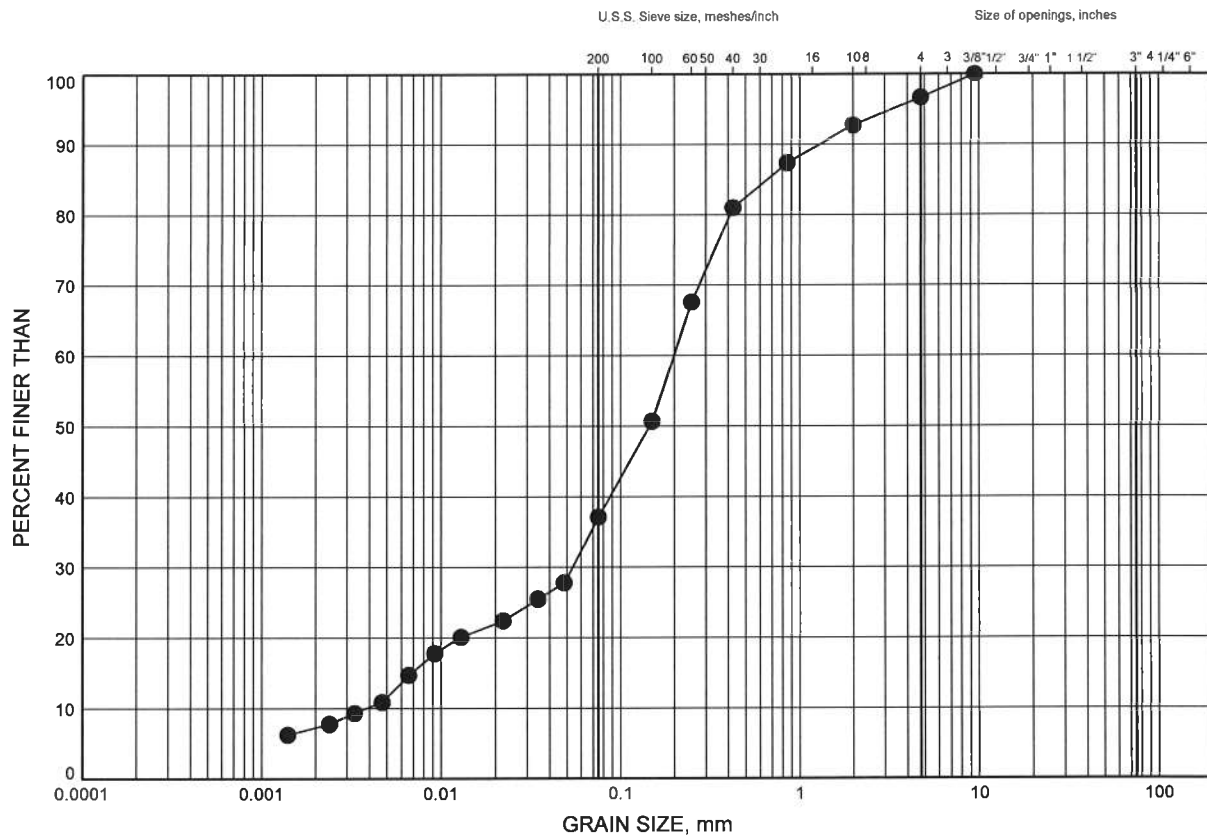
SYMBOL	BOREHOLE	DEPTH (m)	ELEV. (m)
●	16N-1	1.07	68.83

Highway 417 Ottawa: Nicholas Street to OR 174

GRAIN SIZE DISTRIBUTION

FIGURE H2

SILTY SAND



SILT and CLAY	FINE	MEDIUM	COARSE	FINE	COARSE	COBBLE SIZE
FINE GRAINED	SAND			GRAVEL		

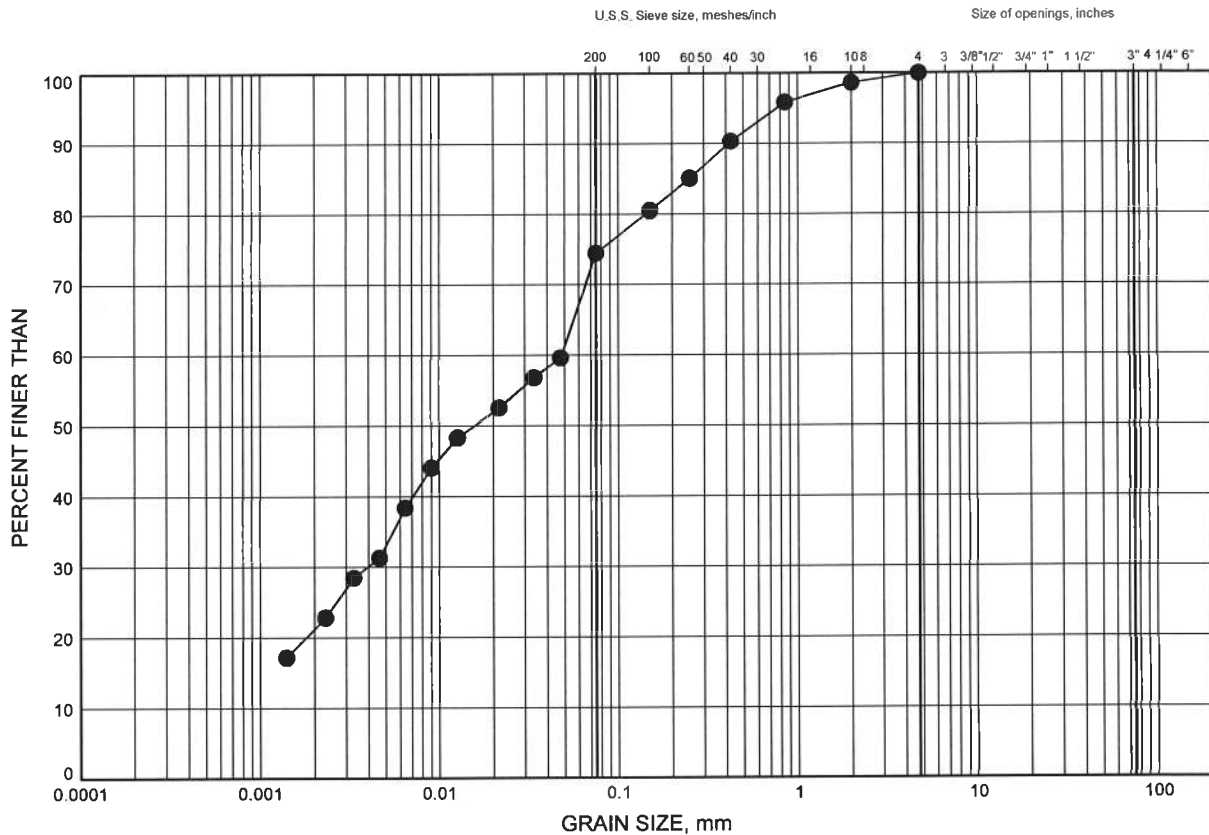
LEGEND

SYMBOL	BOREHOLE	DEPTH (m)	ELEV. (m)
●	16N-2	3.35	65.95

Highway 417 Ottawa: Nicholas Street to OR 174
GRAIN SIZE DISTRIBUTION

FIGURE H3

CLAYEY SILT & SAND TILL



SILT and CLAY	FINE	MEDIUM	COARSE	FINE	COARSE	COBBLE SIZE
FINE GRAINED	SAND			GRAVEL		

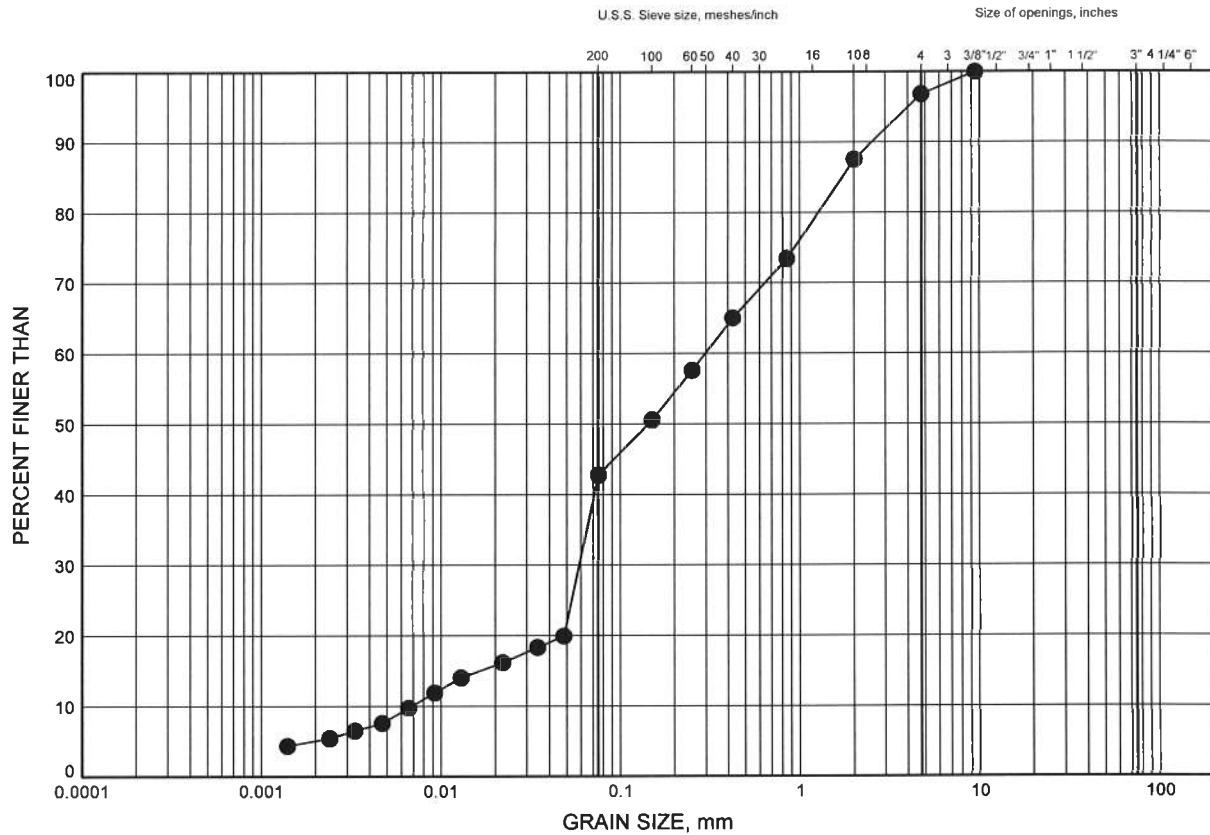
LEGEND

SYMBOL	BOREHOLE	DEPTH (m)	ELEV. (m)
●	16N-3	2.59	65.93

Highway 417 Ottawa: Vanier to OR 174 GRAIN SIZE DISTRIBUTION

FIGURE H4

SILTY SAND TILL



SILT and CLAY	FINE	MEDIUM	COARSE	FINE	COARSE	COBBLE SIZE
FINE GRAINED	SAND			GRAVEL		

LEGEND

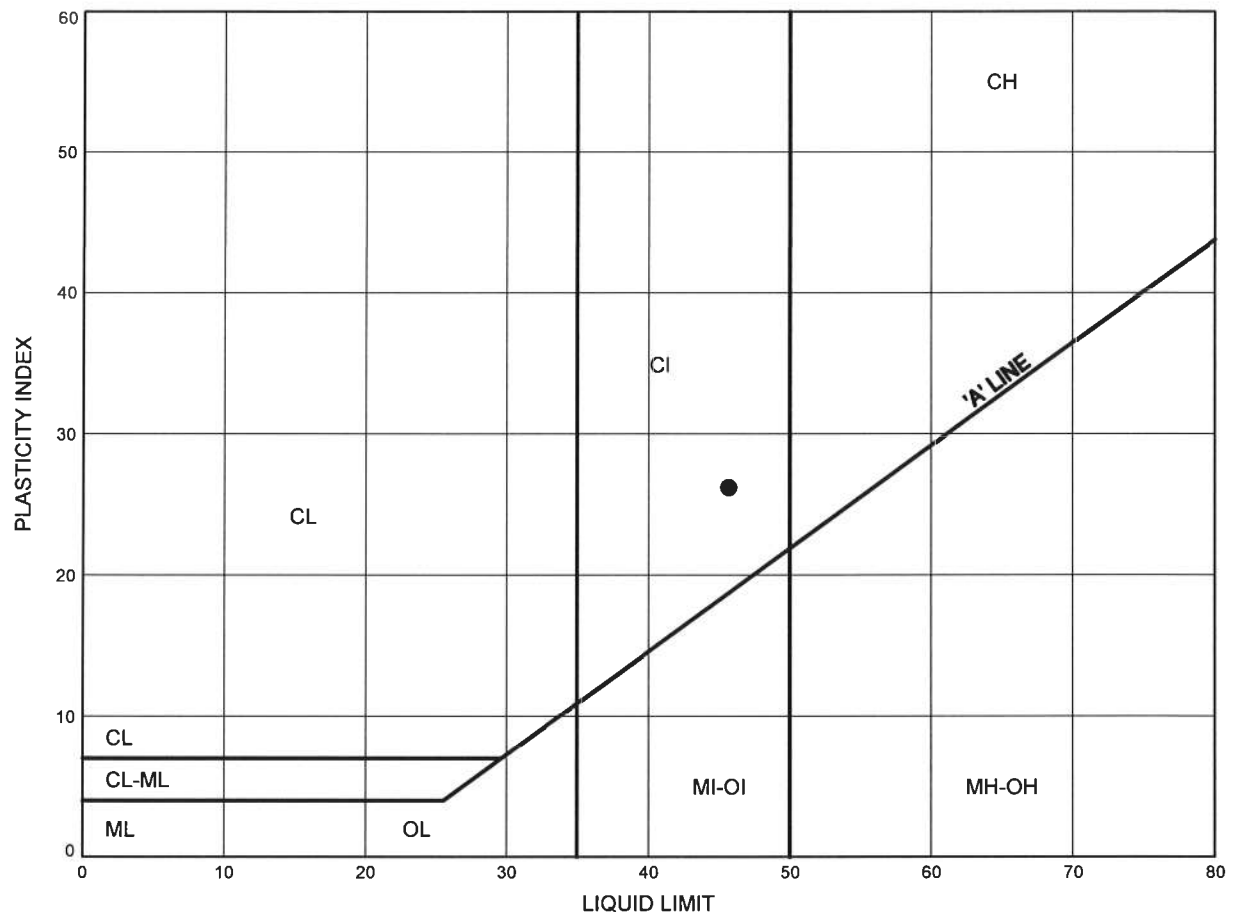
SYMBOL	BOREHOLE	DEPTH (m)	ELEV. (m)
●	16N-3	3.35	65.17

Highway 417 Ottawa: Vanier to OR 174

ATTERBERG LIMITS TEST RESULTS

FIGURE H5

CLAYEY SILT AND SAND TILL



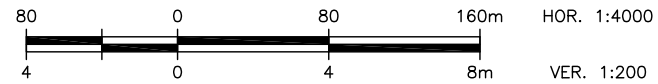
LEGEND

SYMBOL	BOREHOLE	DEPTH (m)	ELEV. (m)
●	16N-3	2.59	65.93

Date May 2012
W.P.# 4320-06-00



Prep'd MFA
Chkd. LRB



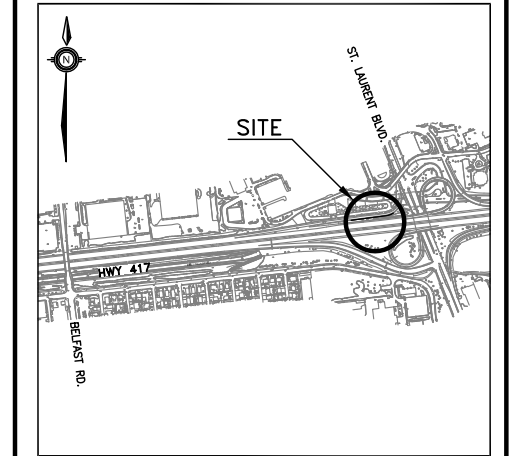
METRIC
DIMENSIONS ARE IN METRES
AND/OR MILLIMETRES
UNLESS OTHERWISE SHOWN

CONT No
WP No 4320-06-00

HIGHWAY 417
ST. LAURENT (NORTH)
RETAINING WALL 16N
BOREHOLE LOCATIONS AND SOIL STRATA








THURBER ENGINEERING LTD.



KEYPLAN

LEGEND

	Borehole
	Borehole and Cone
N	Blows /0.3m (Std Pen Test, 475J/blow)
CONE	Blows /0.3m (60° Cone, 475J/blow)
PH	Pressure, Hydraulic
	Water Level
	Head Artesian Water
	Piezometer
90%	Rock Quality Designation (RQD)
A/R	Auger Refusal

[illegible]

-NOTES-

- 1) The boundaries between soil strata have been established only at Borehole locations. Between Boreholes the boundaries are assumed from geological evidence.
- 2) This drawing is for subsurface information only. Surface details and features are for conceptual illustration.

GEOCRES No. 31G5-250

REVISIONS									
	DATE	BY				DESCRIPTION			
DESIGN	LRB	CHK	LRB	CODE		LOAD		DATE	AUG. 2012
DRAWN	AN	CHK	PKC	SITE		STRUCT		DWG	1

Appendix I

Retaining Walls 17N, 18N, 19N, 21S, 22S, 1M

Boreholes 17N-02, 18N-1 to 3, 19N-1 & 2, 21S-01 to 03, 22S-01 & 02, 1M-01 & 02

METRIC

SOIL PROFILE			SAMPLES			GROUND WATER CONDITIONS	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		WATER CONTENT (%)			
							○ UNCONFINED ● QUICK TRIAXIAL	+ FIELD VANE x LAB VANE	W _p	W _L		
72.2												
0.0	ASPHALT: (150mm)											
0.2	SAND, some gravel, some silt Grey Moist (FILL)		1	AS								
71.4												
0.8	Gravelly SAND, some silt and clay Very Dense to Dense Grey to Brown Moist (FILL)		2	SS	50/ 0.100							
			3	SS	34							
69.9												
2.3	SAND and GRAVEL, some silt and clay Dense to Very Dense Brown Moist (FILL)		4	SS	50/ 0.125							
			5	SS	37							
			6	SS	50/ 0.075							
66.1												
6.1	SAND, some gravel Compact Brown Moist (FILL)		7	SS	21							
65.3												
6.9	CONCRETE		1	RUN								
64.1			2	RUN								
8.1	SHALE, fresh, laminated, grey, very thin limestone interbeds throughout											
	Clay infill at 8.8m		3	RUN								

+³, ×³: Numbers refer to Sensitivity

ONTMT4S 1201B.GPJ 5/1/12

RECORD OF BOREHOLE No 17N-02

2 OF 2

METRIC

W.P. 4320-06-00 LOCATION N 5 031 557.5 E 372 555.7 ORIGINATED BY LPG
HWY 417 BOREHOLE TYPE Hollow Stem Augers/NQ Coring COMPILED BY AN
DATUM Geodetic DATE 2011.09.13 - 2011.09.13 CHECKED BY LRB

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		
	Continued From Previous Page															
61.0			4	RUN		62										0
11.2	END OF BOREHOLE AT 11.2m. BOREHOLE BACKFILLED WITH BENTONITE HOLEPLUG AND CUTTINGS TO 0.1m, THEN ASPHALT COLD PATCH TO SURFACE.					61										3
																1
																0

+³, ×³: Numbers refer to Sensitivity 20 15 10 5 0 (%) STRAIN AT FAILURE

RECORD OF BOREHOLE No 18N-1

1 OF 1

METRIC

W.P. 4320-06-00 LOCATION N 5 031 575.3 E 372 757.8 ORIGINATED BY LPG
 HWY 417 BOREHOLE TYPE Hollow Stem Augers COMPILED BY AN
 DATUM Geodetic DATE 2011.09.13 - 2011.09.13 CHECKED BY LRB

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 (%)				
								○ UNCONFINED + FIELD VANE ● QUICK TRIAXIAL × LAB VANE						
71.7							20 40 60 80 100							
0.0	ASPHALT: (150mm)													
0.2	Gravelly SAND, some silt Brown Moist (FILL)		1	AS										
70.9														
0.8	Clayey SILT, some sand Stiff Brown Moist (FILL)		2	SS	8									
70.2														
1.5	Silty CLAY, some sand Stiff Brown Moist		3	SS	15									0 22 36 42
69.4														
2.3	SILT, some sand, some clay Compact Brown Moist		4	SS	21									
68.6														
3.1	Shale fragments		5	SS	50									
	END OF BOREHOLE AT 3.1m ON PROBABLE BEDROCK. BOREHOLE BACKFILLED WITH BENTONITE HOLEPLUG AND CUTTINGS TO 0.1m, THEN ASPHALT COLD PATCH TO SURFACE.				0.075									

RECORD OF BOREHOLE No 18N-2

1 OF 1

METRIC

W.P. 4320-06-00 LOCATION N 5 031 580.4 E 372 801.9 ORIGINATED BY GA
 HWY 417 BOREHOLE TYPE Hollow Stem Augers COMPILED BY AN
 DATUM Geodetic DATE 2011.08.14 - 2011.08.14 CHECKED BY LRB

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 (%)				
70.8								20 40 60 80 100		20 40 60				
69.8	ASPHALT: (25mm)		1	SS	18									
	Silty SAND, some clay, trace gravel Compact Grey Damp (FILL)		2	SS	17		70						2 51 35 12	
69.4														
1.4	Silty SAND, some clay, trace gravel Very Dense Brown Damp (TILL)		3	SS	125		69							
68.8														
2.0	SHALE		4	SS	50/									
68.4					0.00									
2.4	END OF BOREHOLE AT 2.4m. BOREHOLE OPEN TO 2.4m AND DRY UPON COMPLETION. BOREHOLE BACKFILLED WITH CUTTINGS TO SURFACE.													

+ 3, X 3 Numbers refer to
Sensitivity

20
15
10

(%) STRAIN AT FAILURE

RECORD OF BOREHOLE No 18N-3

1 OF 1

METRIC

W.P. 4320-06-00 LOCATION N 5 031 589.1 E 372 835.8 ORIGINATED BY GA
 HWY 417 BOREHOLE TYPE Hollow Stem Augers COMPILED BY AN
 DATUM Geodetic DATE 2011.08.14 - 2011.08.14 CHECKED BY LRB

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 (%)				
71.4								20	40	60	80	100		
70.7	ASPHALT: (25mm)		1	SS	19		71							
70.7	Gravelly SAND, some silt, some clay Compact Brown/Grey													
69.9	Damp (FILL)		2	SS	20		70							1 56 32 10
69.9	Silty SAND, some clay, trace gravel Compact Dark Grey													
69.3	Damp (FILL)		3	SS	42									
69.3	Silty SAND, some clay, trace gravel Dense Brown													
68.8	Dry (TILL)		4	SS	100/		69							
68.8	SHALE, thinly bedded, grey				0.075									
2.6	END OF BOREHOLE AT 2.6m UPON AUGER REFUSAL. BOREHOLE OPEN TO 2.6m AND DRY UPON COMPLETION. BOREHOLE BACKFILLED WITH CUTTINGS TO SURFACE.													

RECORD OF BOREHOLE No 19N-1

1 OF 1

METRIC

W.P. 4320-06-00 LOCATION N 5 031 663.0 E 373 082.0 ORIGINATED BY GA
 HWY 417 BOREHOLE TYPE Hollow Stem Augers COMPILED BY AN
 DATUM Geodetic DATE 2011.08.14 - 2011.08.14 CHECKED BY LRB

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		
69.8	TOPSOIL: (25mm)		1	SS	14									
69.1	Silty SAND , some clay, trace gravel, occasional rootlets Compact Grey Damp		2	SS	50/ 0.150		69							5 44 39 11
0.7	Silty SAND , some clay, trace gravel Very Dense Grey Dry (TILL)		3	SS	70		68							
67.7														
2.1	SHALE													
67.4														
2.4	END OF BOREHOLE AT 2.4m UPON AUGER REFUSAL. BOREHOLE OPEN TO 2.4m AND DRY UPON COMPLETION. BOREHOLE BACKFILLED WITH CUTTINGS TO SURFACE.													

+³, X³: Numbers refer to
Sensitivity

20
15 5
10 (%) STRAIN AT FAILURE

RECORD OF BOREHOLE No 19N-2

1 OF 1

METRIC

W.P. 4320-06-00 LOCATION N 5 031 673.0 E 373 106.8 ORIGINATED BY GA
HWY 417 BOREHOLE TYPE Hollow Stem Augers COMPILED BY AN
DATUM Geodetic DATE 2011.08.13 - 2011.08.13 CHECKED BY LRB

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		
69.4														
0.0	TOPSOIL: (50mm)													
	Silty SAND, some clay, trace gravel, occasional rootlets Compact to Very Dense Brown to Grey Damp (TILL)		1	SS	24		69							
68.1			2	SS	64									1 49 38 12
1.3 67.8	SHALE, fresh, thinly bedded, grey		3	SS	100/		68							
1.6	END OF BOREHOLE AT 1.6m. BOREHOLE OPEN TO 1.6m AND DRY UPON COMPLETION. BOREHOLE BACKFILLED WITH CUTTINGS TO SURFACE.				0.075									

+³, ×³: Numbers refer to
Sensitivity

20
15
10
(%) STRAIN AT FAILURE

RECORD OF BOREHOLE No 21S-01

1 OF 1

METRIC

W.P. 4091-07-00 LOCATION N 5 031 116.4 E 369 877.9 ORIGINATED BY GA
HWY 417 BOREHOLE TYPE Hollow Stem Augers COMPILED BY AN
DATUM Geodetic DATE 2011.08.16 - 2011.08.16 CHECKED BY LRB


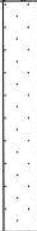

SOIL PROFILE			SAMPLES			GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT				PLASTIC LIMIT NATURAL MOISTURE CONTENT LIQUID LIMIT			UNIT WEIGHT γ kN/m ³	REMARKS & GRAIN SIZE DISTRIBUTION (%) GR SA SI CL		
ELEV DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE	"N" VALUES			SHEAR STRENGTH kPa				WATER CONTENT (%)						
								○ UNCONFINED + FIELD VANE ● QUICK TRIAXIAL × LAB VANE										
60.2							20	40	60	80	100	20	40	60				
0.0	SAND, some silt, trace gravel Dense to Compact Brown Dry (FILL)		1	SS	32													
			2	SS	43													
			3	SS	14													
			4	SS	15													
			5	SS	9													
55.9	SAND, some silt, trace gravel Compact Dark Grey Dry		6	SS	22													
4.3																		
55.0																		
5.2	END OF BOREHOLE AT 5.2m. BOREHOLE OPEN TO 5.2m AND DRY UPON COMPLETION. Piezometer installation consists of 19mm diameter Schedule 40 PVC pipe with a 1.52m slotted screen. WATER LEVEL READINGS: DATE DEPTH (m) ELEV. (m) Sep.20/11 Dry Oct.12/11 Dry																	

RECORD OF BOREHOLE No 21S-02

1 OF 1

METRIC

W.P. 4091-07-00 LOCATION N 5 031 107.9 E 369 936.3 ORIGINATED BY GA
 HWY 417 BOREHOLE TYPE Hollow Stem Augers COMPILED BY AN
 DATUM Geodetic DATE 2011.08.17 - 2011.08.17 CHECKED BY LRB

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							
60.4															
0.0	SAND , some gravel to gravelly, some silt and clay, occasional rootlets Loose to Dense Brown Dry (FILL)		1	SS	4										23 63 14 (Si+CL)
			2	SS	42										
			3	SS	7										
			4	SS	4										
57.4															
3.0	SAND , trace silt, occasional gravel Compact Brown Dry		5	SS	12										4 60 32 4
55.8															
4.6	Silty SAND , trace gravel, trace clay Dense Brown Damp (TILL)		6	SS	30										
55.2															
5.2	END OF BOREHOLE AT 5.2m. BOREHOLE OPEN TO 5.2m AND DRY UPON COMPLETION. BOREHOLE BACKFILLED WITH BENTONITE HOLEPLUG AND CUTTINGS TO SURFACE.														

RECORD OF BOREHOLE No 21S-03

1 OF 1

METRIC

W.P. 4091-07-00 LOCATION N 5 031 098.7 E 369 993.9 ORIGINATED BY GA
HWY 417 BOREHOLE TYPE Hollow Stem Augers - CME-55 COMPILED BY AN
DATUM Geodetic DATE 2011.08.17 - 2011.08.17 CHECKED BY LRB

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		
60.4														
0.0	SAND, trace to some silt, trace gravel, occasional rootlets Compact Brown Dry (FILL)		1	SS	11		60							
			2	SS	28		59							
58.9														
1.5	Silty SAND, trace gravel, trace clay Compact Brown Damp to Dry (TILL)		3	SS	16		58							
			4	SS	11		57							
57.4														
3.0	SAND, some silt, trace gravel Compact Grey Damp to Wet		5	SS	11		56							
55.2			6	SS	24									
5.2	END OF BOREHOLE AT 5.2m. BOREHOLE OPEN TO 5.2m AND DRY UPON COMPLETION. Piezometer installation consists of 19mm diameter Schedule 40 PVC pipe with a 1.52m slotted screen. WATER LEVEL READINGS: DATE DEPTH (m) ELEV. (m) Oct.12/11 Destroyed													

+ 3 x 3 Numbers refer to 20
Sensitivity 15 5
10 (%) STRAIN AT FAILURE

RECORD OF BOREHOLE No 22S-01

1 OF 1

METRIC

W.P. 4091-07-00 LOCATION N 5 031 091.9 E 370 029.5 ORIGINATED BY GA
HWY 417 BOREHOLE TYPE Hollow Stem Augers COMPILED BY AN
DATUM Geodetic DATE 2011.08.17 - 2011.08.17 CHECKED BY LRB

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		
60.7 0.0	SAND, some silt to silty, trace gravel Compact to Very Loose Brown Dry (FILL)		1	SS	14									
			2	SS	3									
			3	SS	13									
58.4 2.3	Silty SAND, trace gravel, trace clay Loose to Compact Brown to Grey Dry to Damp (TILL)		4	SS	8									
			5	SS	27									
			6	SS	25									
55.5 5.2	END OF BOREHOLE AT 5.2m. BOREHOLE OPEN AND DRY UPON COMPLETION. BOREHOLE BACKFILLED WITH BENTONITE HOLEPLUG AND CUTTINGS TO SURFACE.													

RECORD OF BOREHOLE No 22S-02

1 OF 1

METRIC

W.P. 4091-07-00 LOCATION N 5 031 081.4 E 370 082.5 ORIGINATED BY GA
HWY 417 BOREHOLE TYPE Hollow Stem Augers COMPILED BY AN
DATUM Geodetic DATE 2011.08.18 - 2011.08.18 CHECKED BY LRB

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 ○ UNCONFINED + FIELD VANE ● QUICK TRIAXIAL x LAB VANE		WATER CONTENT (%) w _p w w _L				
60.5							20 40 60 80 100							
0.0	TOPSOIL: (75mm)		1	SS	50/									
0.1	SAND, trace silt, trace gravel Very Dense Brown Dry (FILL)				0.150									
59.7			2	SS	32									
0.8	Silty SAND, trace gravel Dense to Very Dense Brown Dry (FILL)													
			3	SS	53									3 55 34 8
58.4														
2.1	Silty SAND, trace gravel, trace clay Very Dense to Very Loose Brown to Grey Dry to Wet (TILL)		4	SS	50/									
					0.150									
			5	SS	4									7 58 30 5
			6	SS	32									
55.3														
5.2	END OF BOREHOLE AT 5.2m. BOREHOLE OPEN TO 5.2m AND DRY UPON COMPLETION. Piezometer installation consists of 19mm diameter Schedule 40 PVC pipe with a 1.52m slotted screen. WATER LEVEL READINGS: DATE DEPTH (m) ELEV. (m) Sep.20/11 3.1 57.4 Oct.12/11 3.8 56.7													

RECORD OF BOREHOLE No 1M-01

1 OF 1

METRIC

W.P. 4320-06-00 LOCATION N 5 031 226.9 E 370 866.6 ORIGINATED BY RK/GA
 HWY 417 BOREHOLE TYPE Hollow Stem Augers COMPILED BY AN
 DATUM Geodetic DATE 2011.08.26 - 2011.08.26 CHECKED BY LRB

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	PLASTIC LIMIT w _p	NATURAL MOISTURE CONTENT w	LIQUID LIMIT w _L		
60.5													
0.0	ASPHALT: (100mm)												
0.1													
60.2	CONCRETE: (250mm)												
0.4	SAND, trace to some gravel Compact Brown Damp (FILL)		1	SS	28		60						
			2	SS	100/ 0.050		59						
58.2													
2.3	Sandy SILT, some gravel, with shale fragments Very Dense Dark Brown Dry (TILL)		3	SS	63		58						
57.5													
3.0	SHALE, thinly bedded, grey		4	SS	86		57						
56.5													
4.0	END OF BOREHOLE AT 4.0m UPON AUGER REFUSAL. BOREHOLE OPEN TO 4.0m AND DRY UPON COMPLETION. BOREHOLE BACKFILLED WITH BENTONITE HOLEPLUG AND CUTTINGS FROM 4.0m TO 0.3m, CONCRETE FROM 0.3m TO 0.15m THEN ASPHALT PATCH TO SURFACE.												

+ 3, X 3 Numbers refer to 20
Sensitivity 15-10 5 (%) STRAIN AT FAILURE

RECORD OF BOREHOLE No 1M-02

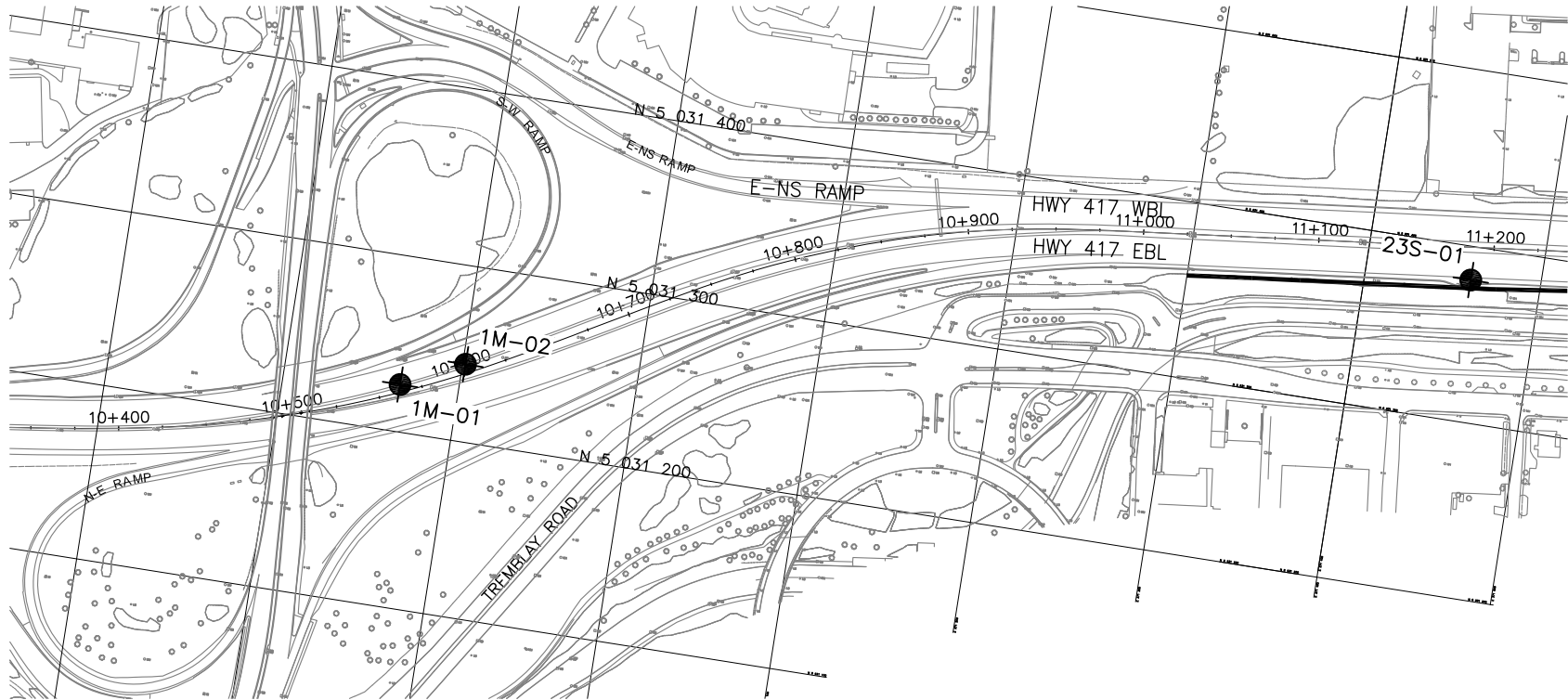
1 OF 1

METRIC

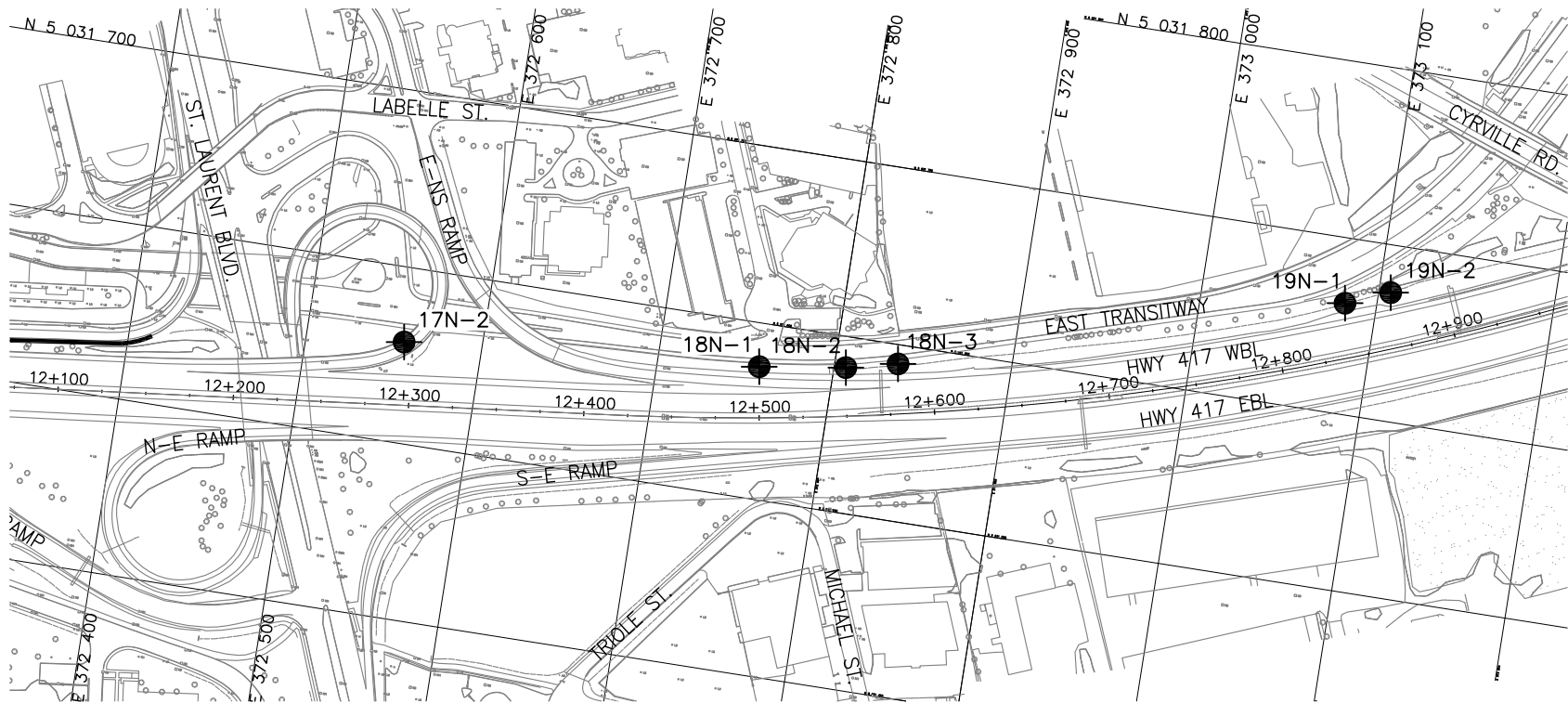
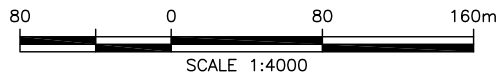
W.P. 4320-06-00 LOCATION N 5 031 244.1 E 370 901.7 ORIGINATED BY GA
 HWY 417 BOREHOLE TYPE Hollow Stem Augers COMPILED BY AN
 DATUM Geodetic DATE 2011.11.14 - 2011.11.14 CHECKED BY LRB

SOIL PROFILE			SAMPLES			GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT				PLASTIC LIMIT W _P	NATURAL MOISTURE CONTENT W	LIQUID LIMIT W _L	UNIT WEIGHT γ kN/m ³	REMARKS & GRAIN SIZE DISTRIBUTION (%) GR SA SI CL
ELEV DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE	"N" VALUES			SHEAR STRENGTH kPa ○ UNCONFINED + FIELD VANE ● QUICK TRIAXIAL × LAB VANE								
60.8	ASPHALT: (100mm)															
60.3	CONCRETE: (200mm)															
0.3	SAND and GRAVEL Compact Brown Dry (FILL)		1	SS	26											
60.1			2	SS	28											0 92 8 (SI+CL)
0.7			3	SS	20											
59.3	SAND, trace silt and clay Compact Brown Dry (FILL)		4	SS	44											15 46 26 13
1.4	Silty SAND, some gravel, some clay Compact to Dense Dark Brown to Grey Dry (TILL)															
57.8	SHALE, thinly bedded, grey		5	SS	50/											
2.9 57.6	END OF BOREHOLE AT 3.1m. BOREHOLE OPEN TO 3.1m AND DRY UPON COMPLETION. Piezometer installation consists of 19mm diameter Schedule 40 PVC pipe with a 1.52m slotted screen. WATER LEVEL READINGS: DATE DEPTH (m) ELEV. (m)				0.100											
3.1																

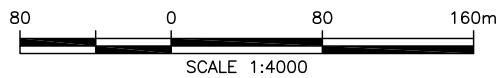
+³, ×³: Numbers refer to Sensitivity
 20
 15-10
 10 (%) STRAIN AT FAILURE



PLAN



PLAN

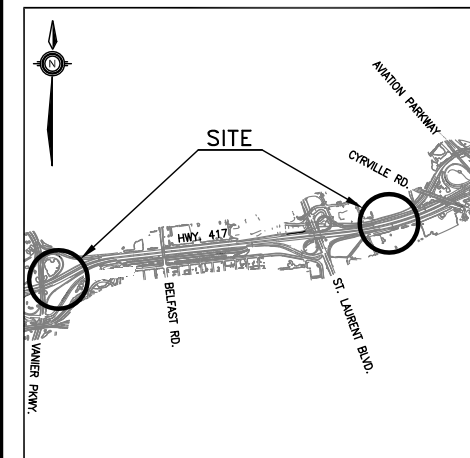


METRIC

DIMENSIONS ARE IN METRES
AND/OR MILLIMETRES
UNLESS OTHERWISE SHOWN

CONT No
WP No 4320-06-00

HIGHWAY 417
VANIER PARKWAY
TO CYRVILLE ROAD
BOREHOLE LOCATION PLAN



KEYPLAN

LEGEND

- Borehole
- Borehole and Cone
- N Blows /0.3m (Std Pen Test, 475J/blow)
- CONE Blows /0.3m (60° Cone, 475J/blow)
- PH Pressure, Hydraulic
- Water Level
- Head Artesian Water
- Piezometer
- 90% Rock Quality Designation (RQD)
- A/R Auger Refusal

NO	ELEVATION	NORTHING	EASTING
1M-01	60.5	5 031 226.9	370 866.6
1M-02	60.8	5 031 244.1	370 901.7
17N-2	72.2	5 031 557.5	372 555.7
18N-1	71.7	5 031 575.3	372 757.8
18N-2	70.8	5 031 580.4	372 801.9
18N-3	71.4	5 031 589.1	372 835.8
19N-1	69.8	5 031 663.0	373 082.0
19N-2	69.4	5 031 673.0	373 106.8

-NOTES-

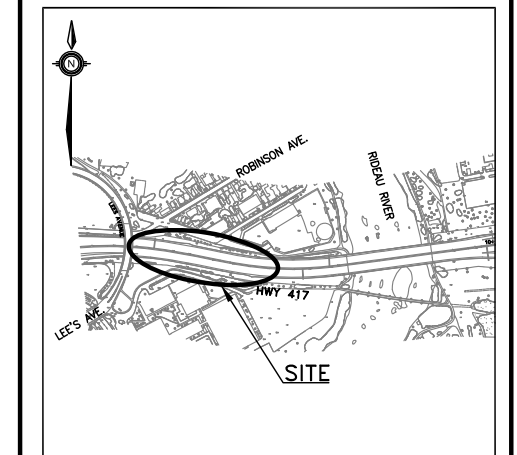
- The boundaries between soil strata have been established only at Borehole locations. Between Boreholes the boundaries are assumed from geological evidence.
- This drawing is for subsurface information only. Surface details and features are for conceptual illustration.

GEOCRES No. 31G5-250








REVISIONS	DATE	BY	DESCRIPTION
DESIGN LRB	CHK LRB	CODE	LOAD
DRAWN AN	CHK PKC	SITE	STRUCT
			DWG 1

HIGHWAY 417
LEES AVENUE TO
RIDEAU RIVER
BOREHOLE LOCATIONS PLAN



LEGEND

	Borehole
	Borehole and Cone
N	Blows /0.3m (Std Pen Test, 475J/blow)
CONE	Blows /0.3m (60° Cone, 475J/blow)
PH	Pressure, Hydraulic
	Water Level
	Head Artesian Water
	Piezometer
90%	Rock Quality Designation (RQD)
A/R	Auger Refusal

[illegible]

- 1) The boundaries between soil strata have been established only at Borehole locations. Between Boreholes the boundaries are assumed from geological evidence.
- 2) This drawing is for subsurface information only. Surface details and features are for conceptual illustration.

[illegible]