

FOUNDATION INVESTIGATION REPORT
ST. LAURENT BLVD. OVERPASS REHABILITATION AND WIDENING
HIGHWAY 417 EXPANSION FROM VANIER PARKWAY TO O.R.174
OTTAWA, ONTARIO

G.W.P. 4320-06-00, SITE No. 3-072

Geocres Number: 31G5-243

Report to

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PART 1: FACTUAL INFORMATION

1 INTRODUCTION

This report presents the factual findings obtained from a foundation investigation conducted for the proposed rehabilitation and widening of the existing St. Laurent Blvd. Overpass in Ottawa, Ontario. This structure rehabilitation and widening is part of the Highway 417 Expansion project, from Vanier Parkway to O.R.174.

The purpose of this investigation was to explore the subsurface conditions at the site and, based on the data obtained, to provide a borehole location plan, record of borehole sheets, stratigraphic profile and cross-sections, laboratory test results and a written description of the subsurface conditions. A model of the subsurface conditions 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-00007.

2 SITE DESCRIPTION

The St. Laurent Blvd. Overpass structure is located on Highway 417 approximately 6 km east of Ottawa city centre. The structure is a 2 span bridge with a total length of approximately 38 m which crosses St. Laurent Blvd., a 6 lane roadway. The deck is approximately 46 m wide and carries 6 main lanes of traffic for Highway 417 as well as two on-ramp lanes (N-E Ramp and S-W Ramp). The pier and abutments are supported on spread footings founded on shale bedrock. Approach embankments on either side of the bridge are approximately 6.0 m high.

Land use surrounding the site is primarily commercial/industrial to the northeast and southeast, and retail (shopping centre) to the northwest. To the southwest, the lands adjacent to the site are undeveloped and further west the lands consist of residential developments.

The site lies within the Ottawa Valley Clay Plains physiographic region, which comprises a clay plain interrupted by ridges of sand or rock. At the specific overpass site however, the general stratigraphy comprises fill underlain by sand and glacial silty sand till overlying bedrock at relatively shallow depth. The bedrock consists of the Carlsbad Formation, comprising dark grey shale interbedded with calcareous siltstone and limestone. The Billings Formation lies adjacent to the north end of the structure.

Photographs in Appendix C show the general nature of the site. No stability or performance issues were noted on the roadways and existing slopes adjacent to the abutments.

3 SITE INVESTIGATION AND FIELD TESTING

The site investigation and field testing for this project were carried out during the period of July 11 to September 12, 2011 and consisted of drilling and sampling ten boreholes at the existing structure (Boreholes SLB-01 to SLB-10). Boreholes SLB-01, SLB-05, SLB-06, and SLB-10 were drilled on the shoulders of Highway 417 while Boreholes SLB-02 to SLB-04 and SLB-07 to SLB-09 were drilled along St. Laurent Blvd. The locations, termination depths and elevations of the ten boreholes drilled at this site are listed in Table 3.1, below.

Table 3.1 – Borehole Details

Location	Borehole	Ground Elevation (m)	Termination Elevation (m)	Termination Depth (m)
West Approach	SLB-01	72.8	60.9	11.9
	SLB-06	72.6	60.4	12.2
West Abutment	SLB-02	66.6	60.3	6.3
	SLB-07	67.0	60.0	7.0
Pier	SLB-03	67.3	61.2	6.1
	SLB-08	67.0	61.4	5.6
East Abutment	SLB-04	66.9	61.2	5.7
	SLB-09	67.0	60.6	6.4
East Approach	SLB-05	73.1	61.2	11.9
	SLB-10	73.1	60.9	12.2

The locations of the boreholes are shown on the attached Borehole Locations and Soil Strata Drawing in Appendix D. A list of the borehole coordinates and elevations is included on this drawing.

The borehole locations were marked in the field and utility clearances were obtained prior to commencement of drilling operations. A road cut permit was obtained from the City of Ottawa

for boreholes drilled within the St. Laurent Blvd. right-of-way. An MTO encroachment permit was obtained for boreholes on Highway 417.

Both a CME 75 and CME 55 truck-mounted drill rig were used for the boreholes drilled at this site. 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). A minimum 3m length of rock core was recovered from each borehole. All rock cores were logged in the field, and the Total Core Recovery (TCR), Solid Core Recovery (SCR), Rock Quality Designation (RQD) and Fracture Index (FI) were determined for each core run.

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.

Groundwater conditions were not recorded in the open boreholes during drilling operations since water was introduced into the borehole during coring and was not representative of groundwater conditions on site. Standpipe piezometers, consisting of 19 mm PVC pipe with a slotted screen, were installed in six boreholes at this site. The completion 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. Upon completion of drilling, boreholes without a piezometer installation were backfilled with a mixture of bentonite holeplug and cuttings then asphalt cold patch at the surface, where appropriate.

Table 3.2 – Piezometer Completion Details

Location	Borehole	Tip Position (m)		Completion Details
		Depth	Elev.	
West Approach	SLB-06	12.2	60.4	Sand filter from 12.2 to 7.3 m, bentonite holeplug from 7.3 to 6.7 m, cuttings and bentonite mixture from 6.7 to 0.6 m, then asphalt cold patch to surface. Flushmount casing protector installed at surface.
West Abutment	SLB-07	4.9	62.1	Sand filter from 7.0 to 1.2 m, bentonite holeplug from 1.2 to 0.3 m, then cuttings to surface. Flushmount casing protector installed at surface.
Pier	SLB-08	4.6	62.4	Sand filter from 5.6 to 1.2 m, bentonite holeplug from 1.2 to 0.3 m, then cuttings to surface with 50 mm asphalt patch. Flushmount casing protector installed at surface.
East Abutment	SLB-04	4.6	62.3	Sand filter from 5.7 to 1.2 m, bentonite holeplug from 1.2 to 0.3 m, then cuttings to surface. Flushmount casing protector installed at surface.
East Approach	SLB-05	10.4	62.7	Sand filter from 11.9 to 6.7 m, bentonite holeplug from 6.7 to 5.8 m, cuttings and bentonite mixture from 5.8 m to 0.1 m, then asphalt cold patch to surface. Flushmount casing protector installed at surface.
	SLB-10	10.7	62.4	Sand filter from 12.2 to 7.0 m, bentonite holeplug from 7.0 to 6.1 m, cuttings and bentonite mixture from 6.1 to 0.3 m, then sand to surface with 100 mm asphalt cold patch. Flushmount casing protector installed at surface.

4 LABORATORY TESTING

All recovered soil samples were subjected to Visual Identification and moisture content determinations. Selected samples were also subjected to grain size distribution analyses (sieve and hydrometer) and Atterberg Limits testing, where appropriate. The results of this testing program are summarized on the Record of Borehole sheets included in Appendix A and on the figures presented in Appendix B.

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 (as average per core run).

5 DESCRIPTION OF SUBSURFACE CONDITIONS

Reference is made to the Record of Borehole sheets in Appendix A and to the Borehole Locations and Soil Strata Drawings in Appendix D. An overall description of the stratigraphy based on the conditions encountered in the boreholes is given in the following paragraphs. However, the factual data presented in the borehole logs takes precedence over this general description and should be used for interpretation of the site conditions.

In general terms, the stratigraphy encountered in the boreholes drilled on the shoulders of Highway 417 consists of pavement structure overlying silty clay fill, underlain by silty sand till which in turn is underlain by shale bedrock. The stratigraphy encountered in the boreholes drilled along St. Laurent Blvd generally consists of pavement structure overlying silt and sand fill, underlain by a sand layer in the west and underlain by silty sand till in the east. Shale bedrock was also encountered below the overburden deposits in the boreholes drilled along St. Laurent Blvd.

More detailed descriptions of the individual strata encountered at the existing bridge site are presented below.

5.1 Pavement Structure

5.1.1 Highway 417

In Boreholes SLB-01, SLB-05, SLB-06, and SLB-10 drilled on the shoulders of Highway 417 at the approaches to the overpass, the pavement structure consists of 150 mm to 225 mm of asphalt overlying 0.6 m to 1.9 m of granular fill.

The granular fill is brown to dark grey and varies from sand containing some gravel and some silt, to sand and gravel. The lower boundary of the granular fill was encountered at depths ranging from 0.8 m to 2.1 m (Elevations 72.0 to 70.5).

SPT 'N' values recorded in the granular fill ranged from 21 to 68 blows for 0.3 m penetration, indicating a compact to very dense relative density.

Moisture contents of 1 to 7% were measured in the granular fill.

5.1.2 St. Laurent Boulevard

In Boreholes SLB-03 and SLB-08 drilled on the left shoulder of northbound St. Laurent Blvd., the pavement structure consists of 50 mm of asphalt overlying 700 mm of brown to grey sand containing some gravel and trace silt.

Moisture contents of samples of the sand fill were 2% and 3%.

5.2 Fill

5.2.1 Silty Clay Fill

Cohesive embankment fill was encountered below the pavement structure in the boreholes drilled on the shoulders of Highway 417 (SLB-01, SLB-05, SLB-06, and SLB-10). The cohesive fill consists of greenish brown to grey silty clay containing trace to some sand.

The thickness of the silty clay fill ranged from 4.3 to 6.5 m with a lower boundary at a depth of 6.1 to 7.3 m (Elevations 67.0 to 65.5 m).

SPT 'N' values recorded in the cohesive fill typically ranged from 5 to 13 blows for 0.3 m penetration, indicating a firm to stiff consistency. A higher SPT 'N' value of 17 blows for 0.3 m penetration was recorded in Borehole SLB-10 at a depth of 6.5 m, where occasional gravelly sand seams were observed in the silty clay fill.

The moisture contents of the silty clay fill samples typically ranged from 39 to 51%, with two lower moisture contents (16% and 27%) measured in Borehole SLB-01.

Grain size distribution analyses were carried out on four samples of the silty clay fill. The results of these tests are plotted on Figure B1, Appendix B, and are summarized below.

Gravel %	0
Sand %	1 to 13
Silt %	20 to 23
Clay %	64 to 77

Atterberg Limits tests were also carried out on four samples of the cohesive fill. The results of the Atterberg Limits tests are plotted on Figure B4, Appendix B, and are summarized below.

Plastic Limit %	25 to 27
Liquid Limit %	67 to 74
Plasticity Index %	43 to 48

The results of the Atterberg Limits tests indicate that the silty clay fill has high plasticity with a group symbol of CH.

5.2.2 Sand Fill

Granular fill consisting primarily of sand was encountered at the surface in Boreholes SLB-02, SLB-04, and SLB-09, below the pavement structure in Boreholes SLB-03 and SLB-08, and below silt fill encountered at surface in Borehole SLB-07. The sand fill is grey to black and contains trace gravel to gravelly, trace to some silt, trace clay, and occasional cobbles. An obstruction was encountered at 1.5 m depth in Borehole SLB-04.

The thickness of the sand fill ranged from 0.8 m to 2.1 m with a lower boundary at a depth of 0.8 m to 3.2 m (Elevations 66.2 to 63.8).

SPT 'N' values measured in the sand fill generally ranged from 13 to 66 blows for 0.3 m penetration, indicating a compact to very dense relative density. Higher SPT 'N' values of 50 blows/ 0.025 m and 68 blows/ 0.275 m were measured in Boreholes SLB-07 and SLB-08, respectively, just above bedrock. An 'N' value of 7 (loose) was obtained in a gravelly sand layer in Borehole SLB-02.

Moisture contents of samples of the sand fill generally ranged from 2% to 15%. A higher moisture content of 41% was measured in Borehole SLB-07 at a depth of 3.2 m, just above bedrock.

Grain size distribution analyses were carried out on four samples of the sand fill. The results of these tests are plotted on Figure B2, Appendix B, and are summarized below.

Gravel %	6 to 23
Sand %	52 to 80
Silt %	11 to 18
Clay %	3 to 7

5.2.3 Silt Fill

Silt fill was encountered at the surface in Borehole SLB-07 and below gravelly sand fill in Borehole SLB-09. The silt fill is dark grey to brown/black and contains some sand, trace to some clay, trace gravel, some organics, shale fragments, glass and wood fragments.

The silt fill was 1.5 m thick in both boreholes, with a lower boundary at a depth of 1.5 m in Borehole SLB-07 and 2.3 m in Borehole SLB-09 (Elevations 65.5 and 64.7).

SPT 'N' values recorded in the silt fill ranged from 22 to 39 blows for 0.3 m penetration, indicating a compact to dense condition. Samples of the silt fill had measured moisture contents of 4% to 19%.

5.3 Sand

Native sand was encountered below the sand fill in Boreholes SLB-02 and SLB-03. The sand is brown to black, fine grained and contains trace gravel, clay and shale fragments.

The sand was 0.7 m thick in Borehole SLB-02, with a lower boundary at a depth of 2.8 m (Elevation 63.8). In Borehole SLB-03 the sand was 0.4 m thick, with a lower boundary at a depth of 2.7 m (Elevation 64.6).

SPT 'N' values recorded in the native sand ranged from 9 to 31 blows for 0.3 m penetration, indicating a loose to dense condition.

Moisture contents of the sand samples were 6% and 14%.

5.4 Silty Sand Till

Silty sand till was encountered below silty clay fill in Boreholes SLB-01, SLB-05, SLB-06, and SLB-10 and below the sand/silt fill in Boreholes SLB-04 and SLB-09 (both located at the east abutment). The silty sand till is dark brown to black and contains trace to some clay and trace to some gravel.

The thickness of the silty sand till ranged from 1.5 m to 2.8 m in the approach boreholes (SLB-01, SLB-05, SLB-06, and SLB-10) and 0.5 m to 1.1 m in the boreholes at the east abutment (SLB-04 and SLB-09, respectively). The depth to the base of the silty sand till ranged from 8.8 m to 9.2 m (Elevations 64.3 to 63.4) at the approaches, and 2.6 m to 3.4 m (Elevations 64.3 and 63.6) at the east abutment.

SPT 'N' values recorded in the silty sand till typically ranged from 14 to 49 blows for 0.3 m penetration, indicating a compact to dense relative density. An SPT 'N' value of 5 blows for 0.3 m penetration, indicating a loose condition, was recorded in Borehole SLB-09 at 2.5 m depth. SPT 'N' values of 78 and 76 blows for less than 0.3 m penetration, indicating a very dense condition, were recorded in Borehole SLB-04 and SLB-09 directly above bedrock and therefore these 'N' values are likely a result of spoon refusal on bedrock. Difficult augering or auger grinding was encountered in the till in Boreholes SLB-01 and SLB-06.

The moisture content of samples of the silty sand till ranged from 9 to 28%.

Grain size distribution analyses were carried out on six samples of the silty sand till. The results of these tests are plotted on Figure B3, Appendix B, and are summarized below.

Gravel %	4 to 15
Sand %	46 to 54
Silt %	23 to 35
Clay %	7 to 15

For one sample of the silty sand till, the clay content was sufficient to allow for Atterberg Limits testing. The results of this test are plotted on Figure B5, Appendix B, and are summarized below.

Plastic Limit %	14
Liquid Limit %	22
Plasticity Index %	8

The results of this test indicate that the silty sand till has zones of low plasticity, with a group symbol of CL.

Glacial tills are known to contain cobbles, boulders and bedrock slabs.

5.5 Shale Bedrock

Bedrock was encountered below the silty sand till in the approach boreholes (SLB-01, SLB-05, SLB-06, and SLB-10) and the boreholes at the east abutment (SLB-04 and SLB-09), and below either sand or fill in the boreholes at the west abutment and pier. Bedrock was proved by coring in all boreholes drilled at this site. The depths and elevations at which bedrock was encountered are summarized in Table 5.1.

Table 5.1 – Depths and Elevations of Bedrock Surface

Location	Borehole	Bedrock Surface	
		Depth (m)	Elevation (m)
West Approach	SLB-01	8.8	64.0
	SLB-06	9.2	63.4
West Abutment	SLB-02	2.8	63.8
	SLB-07	3.2	63.8
Pier	SLB-03	2.7	64.6
	SLB-08	2.8	64.2
East Abutment	SLB-04	2.6	64.3
	SLB-09	3.4	63.6
East Approach	SLB-05	8.8	64.3
	SLB-10	9.1	64.0

The bedrock was described as laminated grey shale and typically contains hard limestone interbeds up to 50 mm in thickness. The shale was generally described as slightly weathered to fresh. Occasional vertical fractures, rubbles zones, and clay seams were observed in the bedrock cores. Total Core Recovery (TCR) in the bedrock ranged from 73 % to 100%. The RQD values ranged from 0 to 100%, indicating a widely variable rock quality ranging from very poor to excellent. RQD values typically ranged from 32 to 71%, which is indicative of poor to fair 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 6 to 25 MPa, indicating a weak rock strength classification. Higher rock strengths may be obtained in the hard limestone interbeds.

5.6 Groundwater Levels

Groundwater was not recorded in the boreholes during drilling. Water was added into the boreholes as part of the rock coring operations and therefore natural groundwater levels were not measured in the bedrock.

Standpipe piezometers were installed in six boreholes at this site upon completion of drilling. The groundwater depths and elevations measured in the piezometers are summarized in Table 5.2.

Table 5.2 – Groundwater Depths and Elevations

Location	Borehole	Date	Water Level	
			Depth (m)	Elevation (m)
West Approach	SLB-06	20-Sept-2011	8.8	63.8
		12-Oct-2011	8.6	64.0
West Abutment	SLB-07	21-Jul-2011	2.1	64.9
		26-Jul-2011	2.2	64.8
		18-Aug-2011	2.2	64.8
		2-Sep-2011	2.4	64.6
		8-Sep-2011	3.4	63.6
		20-Sep-2011	2.4	64.6
		12-Oct-2011	2.8	64.2
Pier	SLB-08	21-Jul-2011	3.0	64.0
		26-Jul-2011	3.0	64.0
		18-Aug-2011	3.0	64.0
		8-Sep-2011	3.4	63.6
		20-Sep-2011	3.2	63.8
		12-Oct-2011	2.9	64.1
East Abutment	SLB-04	21-Jul-2011	2.3	64.6
		26-Jul-2011	2.3	64.6
		18-Aug-2011	2.3	64.6
		8-Sep-2011	3.4	63.5
		20-Sep-2011	2.4	64.5
		12-Oct-2011	1.7	65.2
East Approach	SLB-05	20-Sep-2011	8.6	64.5
		12-Oct-2011	7.7	65.4
	SLB-10	20-Sep-2011	8.5	64.6
		12-Oct-2011	8.7	64.4

The groundwater level at the approach embankments ranged from 7.7 to 8.8 m below ground surface (Elevation 65.4 to 63.8). Groundwater measured along St. Laurent Blvd. was at depths of 1.7 to 3.4 m (Elevation 65.2 to 63.5).

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 borehole locations after completion of the site investigation.

Eastern Ontario Diamond Drilling Ltd. from Hawkesbury, Ontario supplied both a CME 75 and CME 55 truck mounted drill rig for this site and conducted the drilling, sampling and in-situ testing operations.

The field investigation was supervised by 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.

Interpretation of the field data and preparation of the report were carried out by Ms Lindsey Blaine, E.I.T.

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

Thurber Engineering Ltd.

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Appendix A

Record of Borehole Sheets

SYMBOLS, ABBREVIATIONS AND TERMS USED ON RECORDS OF BOREHOLES

1. TEXTURAL CLASSIFICATION OF SOILS

CLASSIFICATION	PARTICLE SIZE	VISUAL IDENTIFICATION
Boulders	Greater than 200mm	same
Cobbles	75 to 200mm	same
Gravel	4.75 to 75mm	5 to 75mm
Sand	0.075 to 4.75mm	Not visible particles to 5mm
Silt	0.002 to 0.075mm	Non-plastic particles, not visible to the naked eye
Clay	Less than 0.002mm	Plastic particles, not visible to the naked eye

2. COARSE GRAIN SOIL DESCRIPTION (50% greater than 0.075mm)

TERMINOLOGY	PROPORTION
Trace or Occasional	Less than 10%
Some	10 to 20%
Adjective (e.g. silty or sandy)	20 to 35%
And (e.g. sand and gravel)	35 to 50%

3. TERMS DESCRIBING CONSISTENCY (COHESIVE SOILS ONLY)

DESCRIPTIVE TERM	UNDRAINED SHEAR STRENGTH (kPa)	APPROXIMATE SPT ⁽¹⁾ 'N' VALUE
Very Soft	12 or less	Less than 2
Soft	12 to 25	2 to 4
Firm	25 to 50	4 to 8
Stiff	50 to 100	8 to 15
Very Stiff	100 to 200	15 to 30
Hard	Greater than 200	Greater than 30

NOTE: Hierarchy of Soil Strength Prediction

- 1) Laboratory Triaxial Testing
- 2) Field Insitu Vane Testing
- 3) Laboratory Vane Testing
- 4) SPT value
- 5) Pocket Penetrometer



4. TERMS DESCRIBING DENSITY (COHESIONLESS SOILS ONLY)

DESCRIPTIVE TERM	SPT "N" VALUE
Very Loose	Less than 4
Loose	4 to 10
Compact	10 to 30
Dense	30 to 50
Very Dense	Greater than 50

5. LEGEND FOR RECORDS OF BOREHOLES

SYMBOLS AND ABBREVIATIONS FOR SAMPLE TYPE	SS Split Spoon Sample	WS Wash Sample	AS Auger (Grab) Sample
	TW Thin Wall Shelby Tube Sample	TP Thin Wall Piston Sample	
	PH Sampler Advanced by Hydraulic Pressure	PM Sampler Advanced by Manual Pressure	
	WH Sampler Advanced by Self Static Weight	RC Rock Core	SC Soil Core

$$\text{Sensitivity} = \frac{\text{Undisturbed Shear Strength}}{\text{Remoulded Shear Strength}}$$



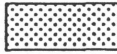


 Water Level
 Shear Strength Determination by Pocket Penetrometer

- (1) SPT 'N' Value Standard Penetration Test 'N' Value – refers to the number of blows from a 63.5kg hammer free falling a height of 0.76m to advance a standard 50 mm outside diameter split spoon sampler for 0.3 m depth into undisturbed ground.
- (2) DCPT Dynamic Cone Penetration Test – Continuous penetration of a 50 mm outside diameter, 60° conical steel point attached to "A" size rods driven by a 63.5 kg hammer free falling a height of 0.76 m. The resistance to cone penetration is the number of hammer blows required for each 0.3 m advance of the conical point into undisturbed ground.

UNIFIED SOILS CLASSIFICATION

MAJOR DIVISIONS		GROUP SYMBOL	TYPICAL DESCRIPTION
COARSE GRAINED SOILS	GRAVEL AND GRAVELLY SOILS	GW	Well-graded gravels or gravel-sand mixtures, little or no fines.
		GP	Poorly-graded gravels or gravel-sand mixtures, little or no fines.
		GM	Silty gravels, gravel-sand-silt mixtures.
		GC	Clayey gravels, gravel-sand-clay mixtures.
	SAND AND SANDY SOILS	SW	Well-graded sands or gravelly sands, little or no fines.
		SP	Poorly-graded sands or gravelly sands, little or no fines.
		SM	Silty sands, sand-silt mixtures.
		SC	Clayey sands, sand-clay mixtures.
FINE GRAINED SOILS	SILTS AND CLAYS $W_L < 50\%$	ML	Inorganic silts and very fine sands, rock flour, silty or clayey fine sands or clayey silts with slight plasticity.
		CL	Inorganic clays of low to medium plasticity, gravelly clays, sandy clays, silty clays, lean clays. ($W_L < 30\%$).
		CI	Inorganic clays of medium plasticity, silty clays. ($30\% < W_L < 50\%$).
		OL	Organic silts and organic silty-clays of low plasticity.
	SILTS AND CLAYS $W_L > 50\%$	MH	Inorganic silts, micaceous or diatomaceous fine sandy or silty soils, elastic silts.
		CH	Inorganic clays of high plasticity, fat clays.
		OH	Organic clays of medium to high plasticity, organic silts.
	HIGHLY ORGANIC SOILS		Pt
CLAY SHALE			
SANDSTONE			
SILTSTONE			
CLAYSTONE			
COAL			

EXPLANATION OF ROCK LOGGING TERMS

ROCK WEATHERING CLASSIFICATION		SYMBOLS	
Fresh (FR)	No visible signs of weathering.		
Fresh Jointed (FJ)	Weathering limited to the surface of major discontinuities.		CLAYSTONE
Slightly Weathered (SW)	Penetrative weathering developed on open discontinuity surfaces, but only slight weathering of rock material.		SILTSTONE
Moderately Weathered (MW)	Weathering extends throughout the rock mass, but the rock material is not friable.		SANDSTONE
Highly Weathered (HW)	Weathering extends throughout the rock mass and the rock is partly friable.		COAL
Completely Weathered (CW)	Rock is wholly decomposed and in a friable condition, but the rock texture and structure are preserved.		Bedrock (general)

DISCONTINUITY SPACING		STRENGTH CLASSIFICATION			
Bedding	Bedding Plane Spacing	Rock Strength	Approximate Uniaxial Compressive Strength		Field Estimation of Hardness*
			(MPa)	(psi)	
Very thickly bedded	Greater than 2m	Extremely Strong	Greater than 250	Greater than 36,000	Specimen can only be chipped with a geological hammer
Thickly bedded	0.6 to 2m				
Medium bedded	0.2 to 0.6m	Very Strong	100-250	15,000 to 36,000	Requires many blows of geological hammer to break
Thinly bedded	60mm to 0.2m				
Very thinly bedded	20 to 60mm	Strong	50-100	7,500 to 15,000	Requires more than one blow of geological hammer to break
Laminated	6 to 20mm				
Thinly Laminated	Less than 6mm	Medium Strong	25.0 to 50.0	3,500 to 7,500	Breaks under single blow of geological hammer.
		Weak	5.0 to 25.0	750 to 3,500	Can be peeled by a pocket knife with difficulty
		Very Weak	1.0 to 5.0	150 to 750	Can be peeled by a pocket knife, crumbles under firm blows of geological pick.
		Extremely Weak (Rock)	0.25 to 1.0	35 to 150	Indented by thumbnail

TERMS	
Total Core Recovery: (TCR)	Core recovered as a percentage of total core run length.
Solid Core Recovery: (SCR)	Percent Ratio of solid core of full cylindrical shape recovered. Expressed with respect to the total length of core run.
Rock Quality Designation: (RQD)	Total length of sound core recovered in pieces 0.1m in length or larger as a percentage of total core run length.
Uniaxial Compressive Strength (UCS)	Axial stress required to break the specimen
Fracture Index: (FI)	Frequency of natural fractures per 0.3m of core run.

RECORD OF BOREHOLE No SLB-01

1 OF 2

METRIC

W.P. 4320-06-00 LOCATION N 5 031 492.2 E 372 449.1 ORIGINATED BY LPG
HWY 417 BOREHOLE TYPE Hollow Stem Augers/NQ Coring COMPILED BY AN
DATUM Geodetic DATE 2011.09.12 - 2011.09.12 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							WATER CONTENT (%)	
								○ UNCONFINED ● QUICK TRIAXIAL	+ FIELD VANE × LAB VANE							
72.8							20 40 60 80 100		20 40 60							
0.0	ASPHALT: (150mm)															
0.2	SAND, some gravel, some silt Brown Moist (FILL)		1	AS												
72.0																
0.8	Silty CLAY, some sand, trace gravel Firm to Stiff Greenish Brown to Grey Moist (FILL)		2	SS	7											
			3	SS	11									0 13 23 64		
			4	SS	10											
			5	SS	11											
			6	SS	13											
			7	SS	10											
65.5																
7.3	Silty SAND, some clay, trace gravel Compact Dark Grey Wet (TILL)		8	SS	27									4 52 31 13		
	Difficult augering at 8.5m															
64.0																
8.8	SHALE, slightly weathered to fresh, laminated, blue-grey, very thin limestone interbeds through out Limestone (25mm) at 9.3m		1	RUN										RUN #1 TCR=100% SCR=100% RQD=100% UCS=17MPa (Average)		
				</												

Continued Next Page

+³, ×³: Numbers refer to
Sensitivity

20
15 5
10 (%) STRAIN AT FAILURE

RECORD OF BOREHOLE No SLB-01

2 OF 2

METRIC

W.P. 4320-06-00 LOCATION N 5 031 492.2 E 372 449.1 ORIGINATED BY LPG
HWY 417 BOREHOLE TYPE Hollow Stem Augers/NQ Coring COMPILED BY AN
DATUM Geodetic DATE 2011.09.12 - 2011.09.12 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	20 40 60	W P W W L						
	Continued From Previous Page																
60.9			2	RUN			62									RUN #2 TCR=100% SCR=100% RQD=100% UCS=11MPa (Average)	
11.9	END OF BOREHOLE AT 11.9m. BOREHOLE BACKFILLED WITH BENTONITE HOLEPLUG AND CUTTINGS TO 0.1m THEN ASPHALT COLD PATCH TO SURFACE.						61										

RECORD OF BOREHOLE No SLB-02

1 OF 1

METRIC

W.P. 4320-06-00 LOCATION N 5 031 481.8 E 372 476.8 ORIGINATED BY LPG
HWY 417 BOREHOLE TYPE Hollow Stem Augers/NQ Coring COMPILED BY AN
DATUM Geodetic DATE 2011.07.13 - 2011.07.13 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 (%) GR SA SI CL		
ELEV DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE	"N" VALUES			SHEAR STRENGTH kPa								
66.6							20 40 60 80 100	PLASTIC LIMIT NATURAL MOISTURE CONTENT LIQUID LIMIT								
								w _p w w _L								
								WATER CONTENT (%)								
								○ UNCONFINED + FIELD VANE								
								● QUICK TRIAXIAL × LAB VANE								
								20 40 60 80 100								
								20 40 60								
0.0	SAND , some gravel to gravelly, some silt, trace clay Dense Dark Grey Moist (FILL) Occasional cobbles		1	AS			66						○			23 52 18 7
			2	SS	50								○			
65.1																
1.5	Gravelly SAND , trace silt, trace clay Loose Black Moist (FILL)		3	SS	7		65						○			
64.5																
2.1	SAND , trace gravel, trace clay, shale fragments Dense Black Moist		4	SS	31		64						○			
63.8																
2.8	SHALE , slightly weathered, laminated, grey, frequent very thin limestone interbeds Clay seam (25mm) Clay seam (25mm)		1	RUN			63									RUN #1 TCR=83% SCR=56% RQD=52% UCS=16MPa (Average)
			2	RUN			62									RUN #2 TCR=97% SCR=73% RQD=45% UCS=15MPa (Average)
			3	RUN			61									RUN #3 TCR=93% SCR=93% RQD=93% UCS=14MPa (Average)
60.3																
6.3	END OF BOREHOLE AT 6.3m. BOREHOLE BACKFILLED WITH BENTONITE HOLEPLUG AND CUTTINGS TO 0.3m, THEN CUTTINGS TO SURFACE.															

+ 3, x 3: Numbers refer to
Sensitivity

20
15 5
10 (%) STRAIN AT FAILURE

RECORD OF BOREHOLE No SLB-03

1 OF 1

METRIC

W.P. 4320-06-00 LOCATION N 5 031 489.1 E 372 499.2 ORIGINATED BY LPG
 HWY 417 BOREHOLE TYPE Hollow Stem Augers/NQ Coring COMPILED BY AN
 DATUM Geodetic DATE 2011.07.11 - 2011.07.11 CHECKED BY LRB

SOIL PROFILE			SAMPLES			GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT				UNIT WEIGHT 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 (%)					
67.3													
66.6	ASPHALT: (50mm)		1	AS									
66.6	SAND, medium to coarse grained, some gravel Brown Moist (FILL)		2	SS	66								
65.0	SAND, medium to coarse grained, some silt, trace gravel Very Dense to Compact Grey Moist (FILL)		3	SS	16								6 80 11 3
64.6	SAND, trace gravel Loose Brown Wet		4	SS	9								
61.2	SHALE, slightly weathered, laminated, grey to black, very thin limestone interbeds through out		1	RUN									RUN #1 TCR=80% SCR=47% RQD=32% UCS=12MPa (Average)
61.2	Clay seam at 3.9m		2	RUN									RUN #2 TCR=100% SCR=78% RQD=32% UCS=19MPa (Average)
61.2	Vertical fracture (300mm)												
6.1	END OF BOREHOLE AT 6.1m. BOREHOLE BACKFILLED WITH BENTONITE HOLEPLUG AND CUTTINGS TO 0.05m, THEN ASPHALT COLD PATCH TO SURFACE.												

+ 3, x 3: Numbers refer to
Sensitivity

20
15 5
10 (%) STRAIN AT FAILURE

RECORD OF BOREHOLE No SLB-04

1 OF 1

METRIC

W.P. 4320-06-00 LOCATION N 5 031 489.8 E 372 512.0 ORIGINATED BY LPG
 HWY 417 BOREHOLE TYPE Hollow Stem Augers/NQ Coring COMPILED BY AN
 DATUM Geodetic DATE 2011.07.12 - 2011.07.12 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								
66.9								20 40 60 80 100								
0.0	SAND , some gravel to gravelly, some silt Dense Brown Moist (FILL) Obstruction encountered at 1.49m (possibly concrete)		1	AS												
			2	SS	39											
65.4																
1.5	Gravelly SAND , trace silt Compact Black Moist to Wet (FILL)		3	SS	15											
64.8																
2.1	Silty SAND , trace clay, trace gravel Very Dense Black Moist (TILL)		4	SS	78/											
64.3																
2.6	SHALE , slightly weathered, laminated, dark grey, thin limestone interbeds through out, highly fractured		1	RUN												RUN #1 TCR=100% SCR=72% RQD=15% UCS=15MPa (Average)
			2	RUN												RUN #2 TCR=100% SCR=90% RQD=28% UCS=6MPa (Average)
61.2																
5.7	END OF BOREHOLE AT 5.7m. 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.21/ 11 2.3 64.6 Jul.26/ 11 2.3 64.6 Aug.18/ 11 2.3 64.6 Sep.08/ 11 3.4 63.5 Sep.20/ 11 2.4 64.5 Oct.12/ 11 1.7 65.2															

RECORD OF BOREHOLE No SLB-05

1 OF 2

METRIC

W.P. 4320-06-00 LOCATION N 5 031 499.7 E 372 532.8 ORIGINATED BY LPG
 HWY 417 BOREHOLE TYPE Hollow Stem Augers/NQ Coring COMPILED BY AN
 DATUM Geodetic DATE 2011.09.11 - 2011.09.11 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						
73.1								20 40 60 80 100						
0.0	ASPHALT: (200mm)						73							
0.2	SAND, some gravel, some silt Dark Grey Moist (FILL)		1	AS										
72.3														
0.8	Gravelly SAND Compact Dark Grey Moist (FILL)		2	SS	24		72							
71.6														
1.5	Silty CLAY, trace sand, trace gravel Firm to Stiff Greenish Brown to Grey Moist (FILL)		3	SS	12		71							
			4	SS	7		70							
			5	SS	12		69							
			6	SS	9		68							
67.0														
6.1	Silty SAND, some clay, trace gravel Dense Dark Grey Moist (TILL)		7	SS	49		67							
			8	SS	38		66							
64.3														
8.8	SHALE, slightly weathered, laminated, grey, occasional vertical fractures, very thin limestone interbeds through out		1	RUN			64							

Continued Next Page

+ 3 x 3: Numbers refer to
Sensitivity

20
15
10

(%) STRAIN AT FAILURE

ONTMT4S 1201B.GPJ 12/20/11

RECORD OF BOREHOLE No SLB-05

2 OF 2

METRIC

W.P. 4320-06-00 LOCATION N 5 031 499.7 E 372 532.8 ORIGINATED BY LPG
HWY 417 BOREHOLE TYPE Hollow Stem Augers/NQ Coring COMPILED BY AN
DATUM Geodetic DATE 2011.09.11 - 2011.09.11 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 Y 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					
	Continued From Previous Page																
61.2			2	RUN													
11.9	<p>END OF BOREHOLE AT 11.9m. Piezometer installation consists of 19mm diameter Schedule 40 PVC pipe with a 3.0m slotted screen.</p> <p>WATER LEVEL READINGS: DATE DEPTH (m) ELEV. (m) Sep.20/ 11 8.6 64.5 Oct.12/ 11 7.7 65.4</p>																

RECORD OF BOREHOLE No SLB-06

1 OF 2

METRIC

W.P. 4320-06-00 LOCATION N 5 031 527.5 E 372 446.0 ORIGINATED BY RK
 HWY 417 BOREHOLE TYPE Hollow Stem Augers/NQ Coring COMPILED BY AN
 DATUM Geodetic DATE 2011.08.27 - 2011.08.27 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							
72.6								20 40 60 80 100							
0.0	ASPHALT: (225mm)							20 40 60 80 100							
0.2	SAND and GRAVEL Dense to Compact Brown Dry (FILL)		1	SS	43		72								
			2	SS	21		71								
70.5															
2.1	Silty CLAY, some sand Firm Grey Damp (FILL)		3	SS	7		70								
			4	SS	5		69								0 10 20 70
							68								
			5	SS	7		67								
66.2															
6.4	Silty SAND, some clay, trace gravel Dense to Compact Dark Grey Moist (TILL)		6	SS	42		66								
							65								10 46 29 15
	Auger grinding		7	SS	14		64								
63.4															
9.2	SHALE, slightly weathered to fresh, thinly laminated, dark grey Rubble zone (100mm)						63								
	Rubble zone (150mm)		1	RUN											RUN #1 TCR=85% SCR=57% RQD=37% UCS=12MPa (Average)

Continued Next Page

+ 3, x 3: Numbers refer to
Sensitivity

20
15
10

(%) STRAIN AT FAILURE

METRIC

DATUM Geodetic DATE 2011.08.27 - 2011.08.27 CHECKED BY LRB

[illegible]

(%) STRAIN AT FAILURE

RECORD OF BOREHOLE No SLB-07

1 OF 1

METRIC

W.P. 4320-06-00 LOCATION N 5 031 535.9 E 372 462.9 ORIGINATED BY LPG
HWY 417 BOREHOLE TYPE Hollow Stem Augers/NQ Coring COMPILED BY AN
DATUM Geodetic DATE 2011.07.13 - 2011.07.13 CHECKED BY LRB

SOIL PROFILE			SAMPLES			GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT					UNIT WEIGHT 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								
67.0							20 40 60 80 100	PLASTIC LIMIT NATURAL MOISTURE CONTENT LIQUID LIMIT w _p w w _L								
0.0	SILT, some sand, trace to some clay, trace gravel, some organics, shale fragments Dense Dark Grey Moist (FILL)		1	AS												
			2	SS	35											
65.5																
1.5	SAND, some silt, some gravel, shale fragments Compact Black Moist (FILL) Trace organics		3	SS	13										19 62 16 3	
			4	SS	13											
63.8	Weathered shale	5	SS	50/												
3.2	SHALE, slightly weathered, laminated, grey, very thin limestone interbeds through out		1	RUN	0.025									FI	RUN #1 TCR=97% SCR=80% RQD=44% UCS=14MPa (Average)	
															>10	
															1	
															2	
															>5	RUN #2 TCR=100% SCR=88% RQD=82% UCS=13MPa (Average)
															2	
	Calcite infilled sub-vertical fracture from 4.9m to 5.3m		2	RUN											0	
															1	
	50mm thick clay seam at 6.1m and 6.3m														>5	RUN #3 TCR=100% SCR=77% RQD=71% UCS=12MPa (Average)
	100mm thick clay seam at 6.5m	3	RUN											0		
														3		
60.0														3		
														2		
7.0	END OF BOREHOLE AT 7.0m. 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.21/ 11 2.1 64.9 Jul.26/ 11 2.2 64.8 Aug.18/ 11 2.2 64.8 Sep.02/ 11 2.4 64.6 Sep.08/ 11 3.4 63.6 Sep.20/ 11 2.4 64.6 Oct.12/ 11 2.8 64.2															

ONTMT4S 1201B.GPJ 12/20/11

RECORD OF BOREHOLE No SLB-08

1 OF 1

METRIC

W.P. 4320-06-00 LOCATION N 5 031 539.2 E 372 478.9 ORIGINATED BY LPG
HWY 417 BOREHOLE TYPE Hollow Stem Augers/NQ Coring COMPILED BY AN
DATUM Geodetic DATE 2011.07.14 - 2011.07.14 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 (%)		
ELEV DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE	"N" VALUES			SHEAR STRENGTH kPa ○ UNCONFINED + FIELD VANE ● QUICK TRIAXIAL × LAB VANE								WATER CONTENT (%)	
67.0								20	40	60	80	100					
66.3	ASPHALT: (50mm)		1	AS													
66.3	SAND, some gravel, trace silt Grey Moist (FILL)																
64.2	SAND, trace to some gravel, some silt Dense to Very Dense Grey Moist (FILL)		2	SS	66												
			3	SS	42												
	Shale fragments		4	SS	68/ 0.275												
64.2																	
2.8	SHALE, slightly weathered to fresh, laminated, grey, very thin limestone interbeds through out		1	RUN													
</																	

METRIC

+³, ×³: Numbers refer to Sensitivity

RECORD OF BOREHOLE No SLB-10

1 OF 2

METRIC

W.P. 4320-06-00 LOCATION N 5 031 532.6 E 372 523.3 ORIGINATED BY RK
HWY 417 BOREHOLE TYPE Hollow Stem Augers/NQ Coring COMPILED BY AN
DATUM Geodetic DATE 2011.09.09 - 2011.09.09 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			20 40 60 80 100	PLASTIC LIMIT w _p	NATURAL MOISTURE CONTENT w	LIQUID LIMIT w _L	
73.1												
0.0	ASPHALT: (175mm)						73					
0.2	SAND and GRAVEL Very Dense to Compact Brown Dry (FILL)		1	SS	68		72					
			2	SS	22							
71.0							71					
2.1	Silty CLAY, trace sand Firm to Very Stiff Grey (FILL)		3	SS	6							
			4	SS	7		70					
			5	SS	10		69					
			6	SS	17		68					
	Occasional gravelly sand seams						67					
65.8							66					
7.3	Silty SAND, some clay, trace to some gravel Dense Dark Brown Moist (TILL)		7	SS	39		65					
64.0							64					
9.1	SHALE, fresh, thinly laminated, horizontal, vertical and subvertical jointed, frequent rubble zone, dark grey											
			1	RUN								

Continued Next Page

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

RECORD OF BOREHOLE No SLB-10

2 OF 2

METRIC

W.P. 4320-06-00 LOCATION N 5 031 532.6 E 372 523.3 ORIGINATED BY RK
 HWY 417 BOREHOLE TYPE Hollow Stem Augers/NQ Coring COMPILED BY AN
 DATUM Geodetic DATE 2011.09.09 - 2011.09.09 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			20	40	60	80	100					
Continued From Previous Page																	
60.9	Clay seam (50mm)		2	RUN												RUN #2 TCR=100% SCR=95% RQD=14% UCS=21MPa (Average)	
12.2	END OF BOREHOLE AT 12.2m. Piezometer installation consists of 19mm diameter Schedule 40 PVC pipe with a 3.0m slotted screen. WATER LEVEL READINGS: DATE DEPTH (m) ELEV. (m) Sep.20/ 11 8.5 64.6 Oct.12/ 11 8.7 64.4																

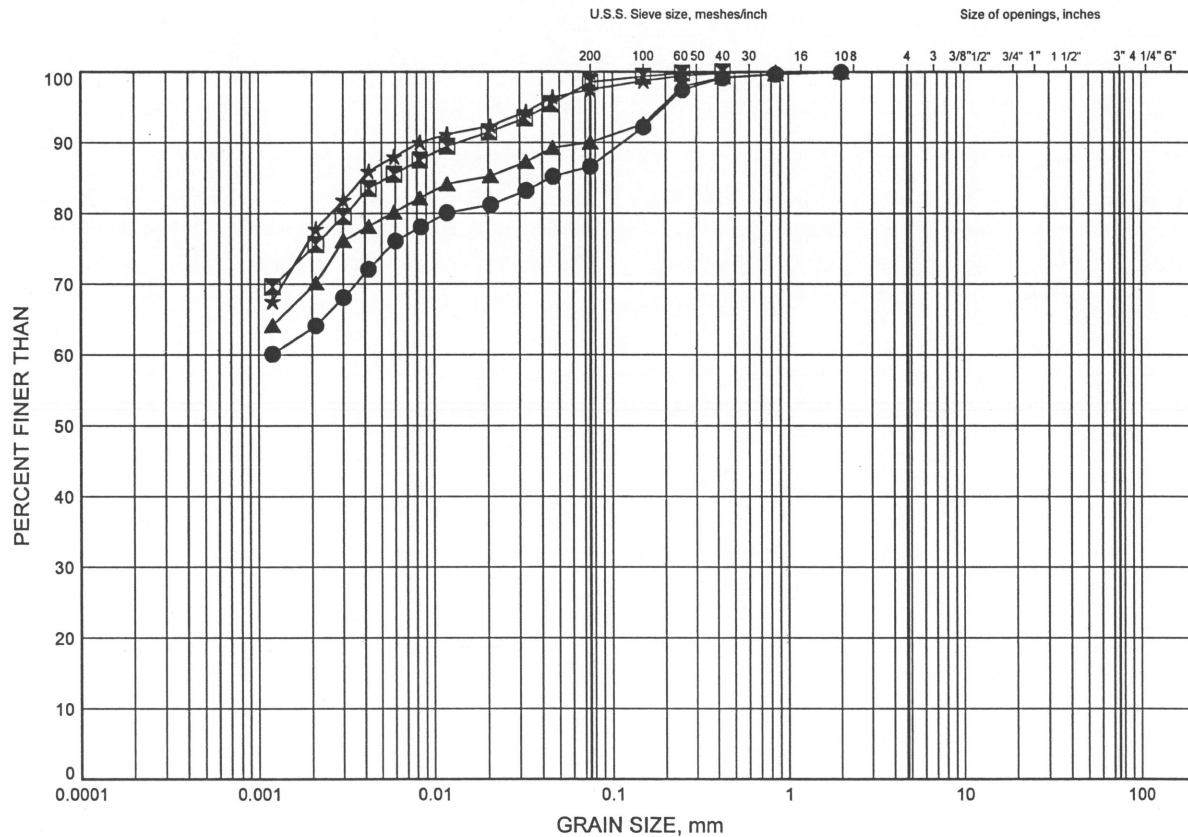
Appendix B

Laboratory Test Results

Highway 417 Ottawa: Vanier to OR 174 GRAIN SIZE DISTRIBUTION

FIGURE B1

SILTY CLAY FILL



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

LEGEND

SYMBOL	BOREHOLE	DEPTH (m)	ELEV. (m)
●	SLB-01	1.83	70.92
■	SLB-05	4.88	68.17
▲	SLB-06	3.35	69.21
★	SLB-10	4.88	68.18

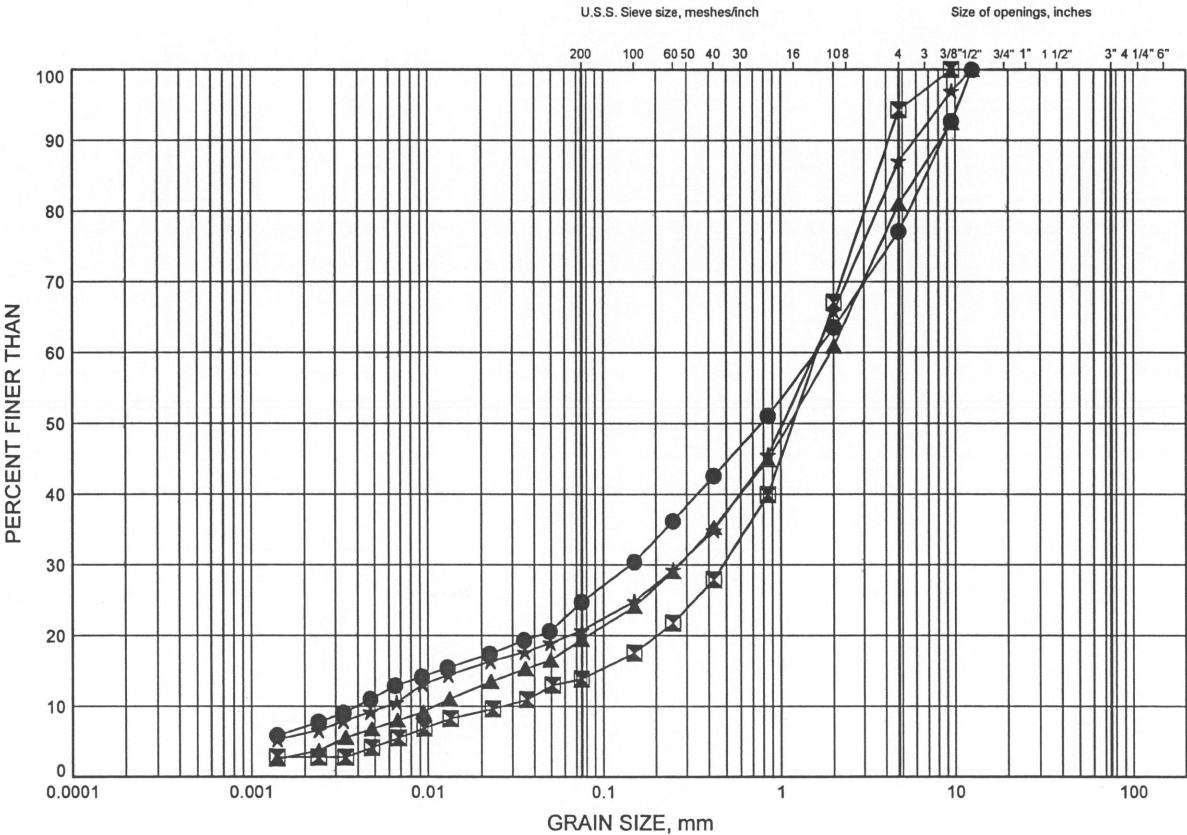


W.P.# .4320-06-00.....
Prepared By .AN.....
Checked By .LRB.....

Highway 417 Ottawa: Vanier to OR 174 GRAIN SIZE DISTRIBUTION

FIGURE B2

SAND FILL



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

LEGEND

SYMBOL	BOREHOLE	DEPTH (m)	ELEV. (m)
●	SLB-02	0.30	66.32
⊠	SLB-03	1.83	65.51
▲	SLB-07	1.83	65.19
★	SLB-08	1.07	65.95

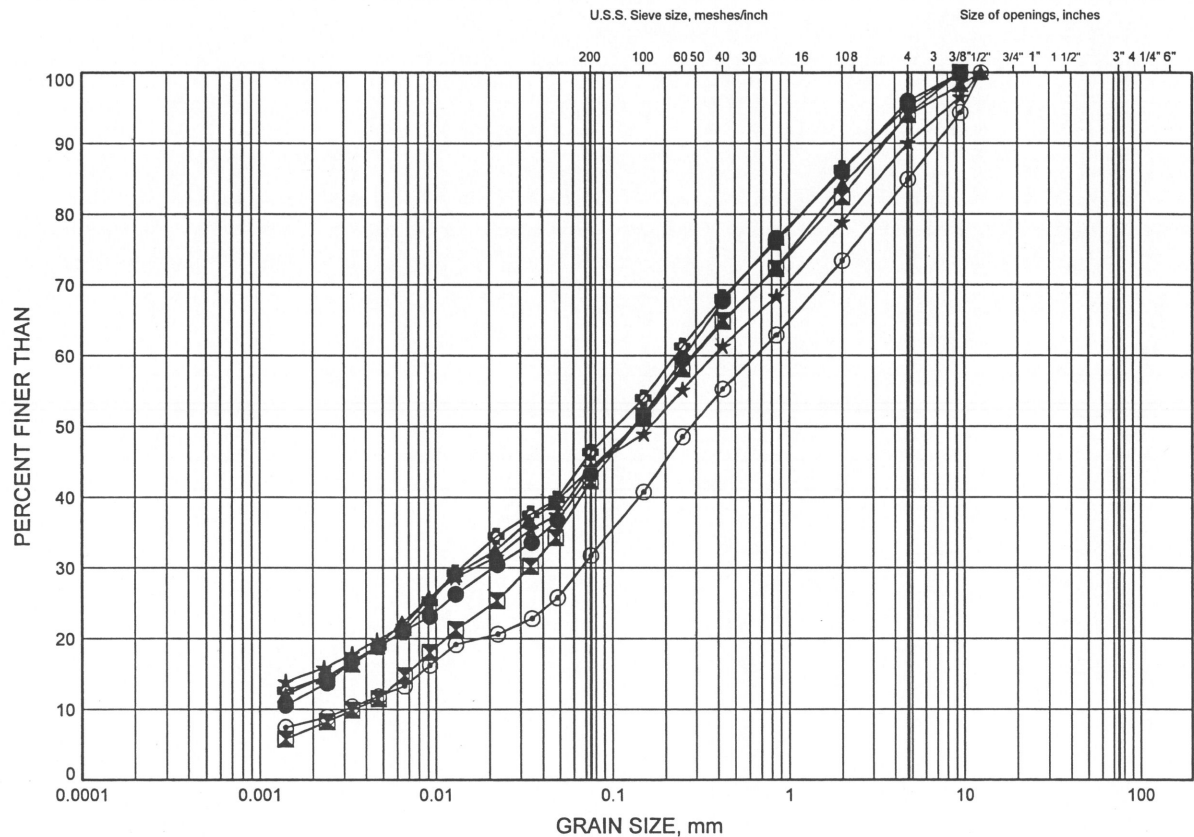


W.P.# 4320-06-00.....
Prepared By AN.....
Checked By LRB.....

Highway 417 Ottawa: Vanier to OR 174 GRAIN SIZE DISTRIBUTION

FIGURE B3

SILTY SAND TILL



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

LEGEND

SYMBOL	BOREHOLE	DEPTH (m)	ELEV. (m)
●	SLB-01	7.92	64.82
⊠	SLB-04	2.59	64.32
▲	SLB-05	7.92	65.12
★	SLB-06	7.92	64.63
⊙	SLB-09	2.59	64.41
⊗	SLB-10	7.92	65.13

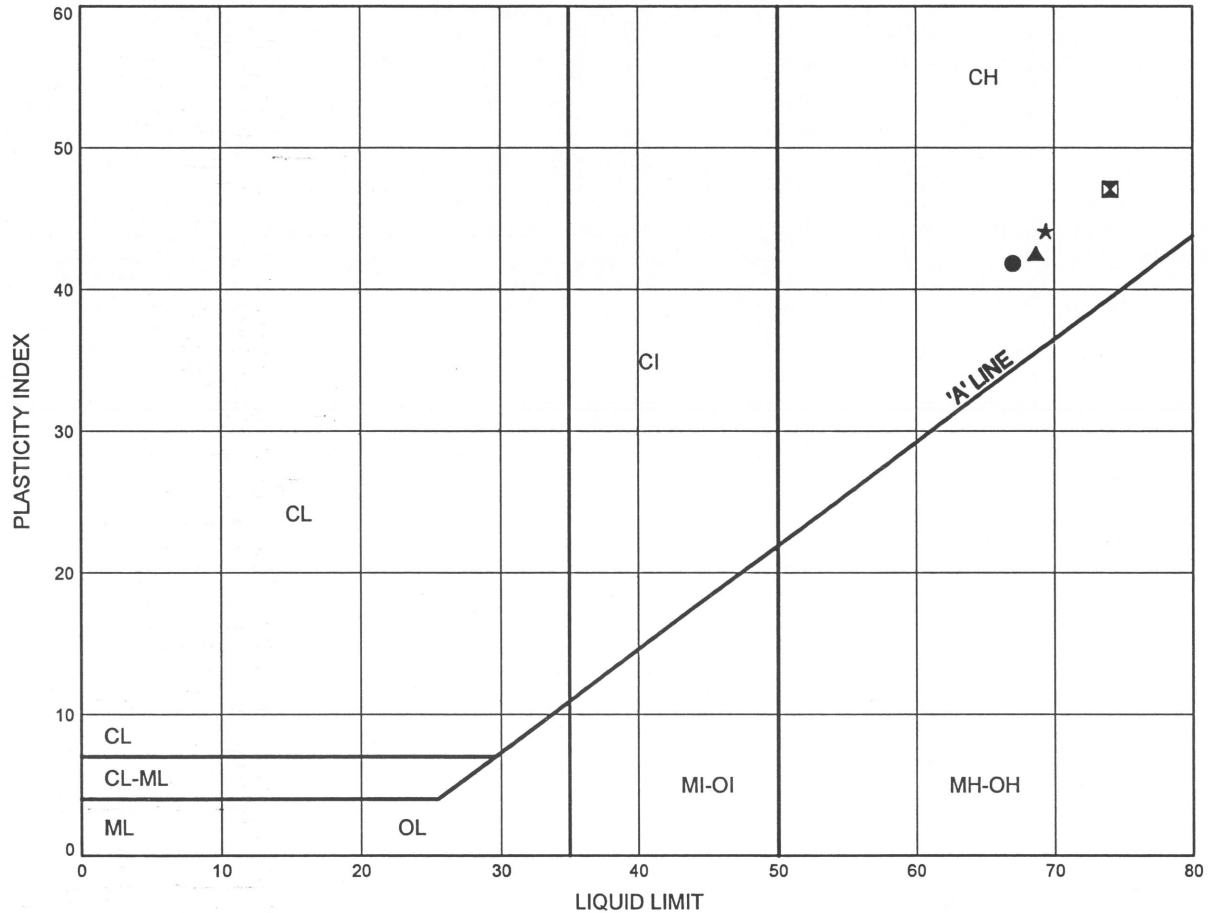


W.P.# .4320-06-00.....
Prepared By .AN.....
Checked By .LRB.....

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

FIGURE B4

SILTY CLAY FILL



SYMBOL	BH	DEPTH (m)	ELEV. (m)
●	SLB-01	1.83	70.92
⊠	SLB-05	4.88	68.17
▲	SLB-06	3.35	69.21
★	SLB-10	4.88	68.18

Date November 2011
 Project 4320-06-00

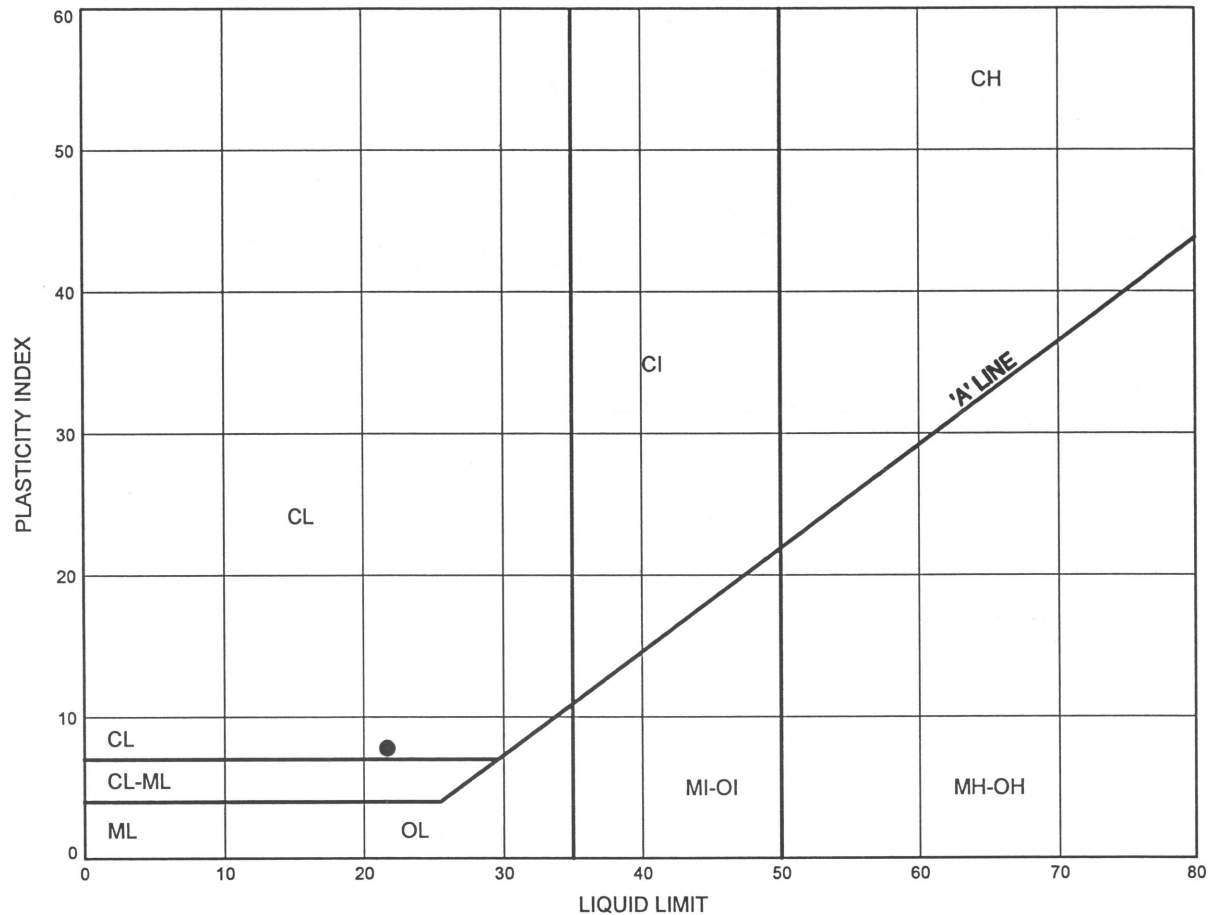


Prep'd AN
 Chkd. LRB

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

FIGURE B5

SILTY SAND TILL



SYMBOL	BH	DEPTH (m)	ELEV. (m)
●	SLB-05	7.92	65.12



Date November 2011
 Project 4320-06-00

Prep'd AN
 Chkd. LRB

Appendix C

Site Photographs

St. Laurent Blvd. Overpass Rehabilitation and Widening
Highway 417 – Ottawa, Ontario



Photograph 1: Looking east on north side of St. Laurent Blvd. Overpass



Photograph 2: Looking south under St. Laurent Blvd. Overpass

St. Laurent Blvd. Overpass Rehabilitation and Widening
Highway 417 – Ottawa, Ontario



Photograph 3 : Southwest abutment

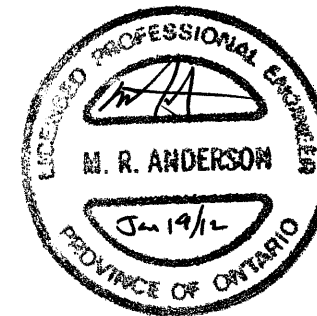
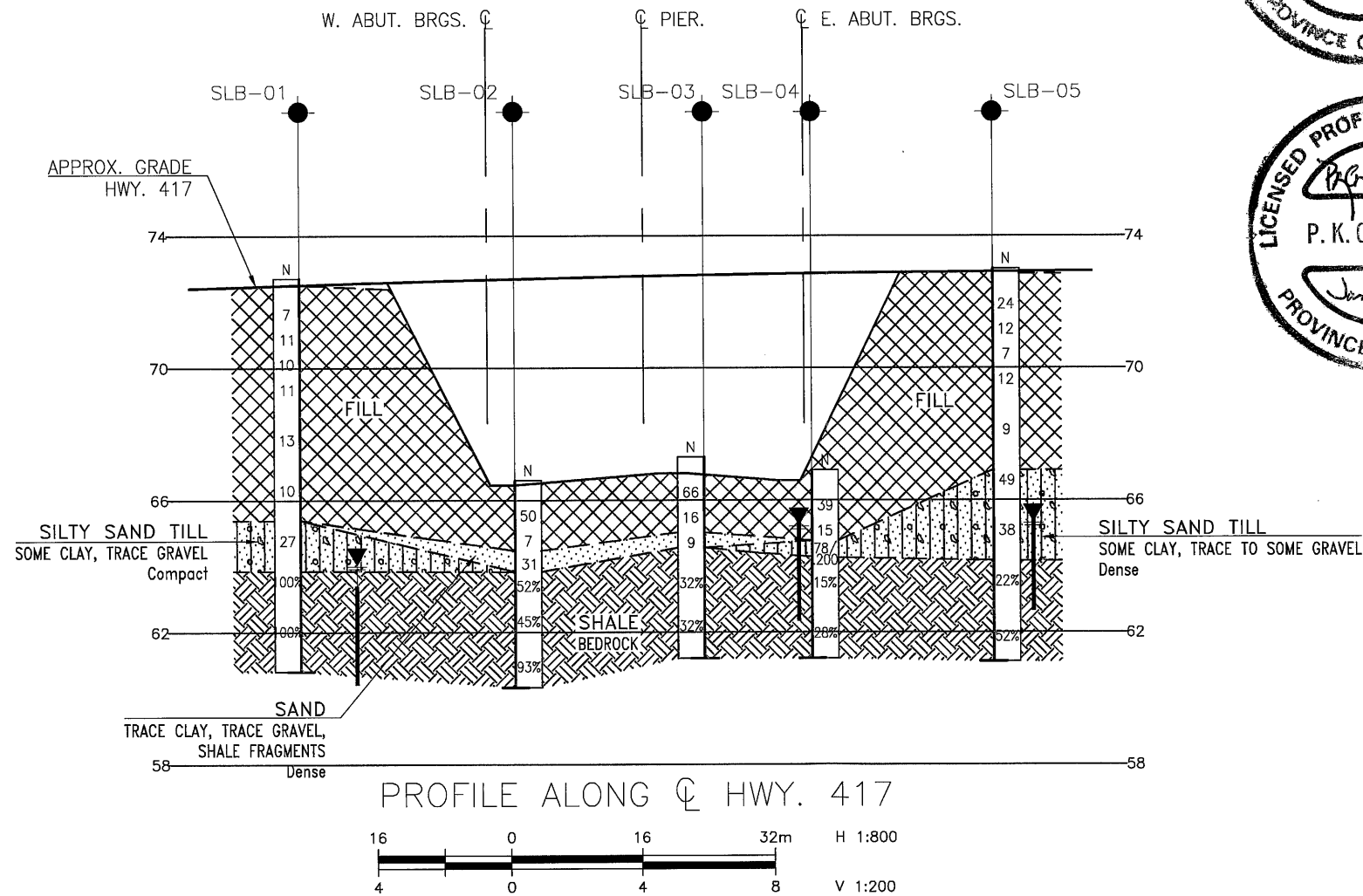
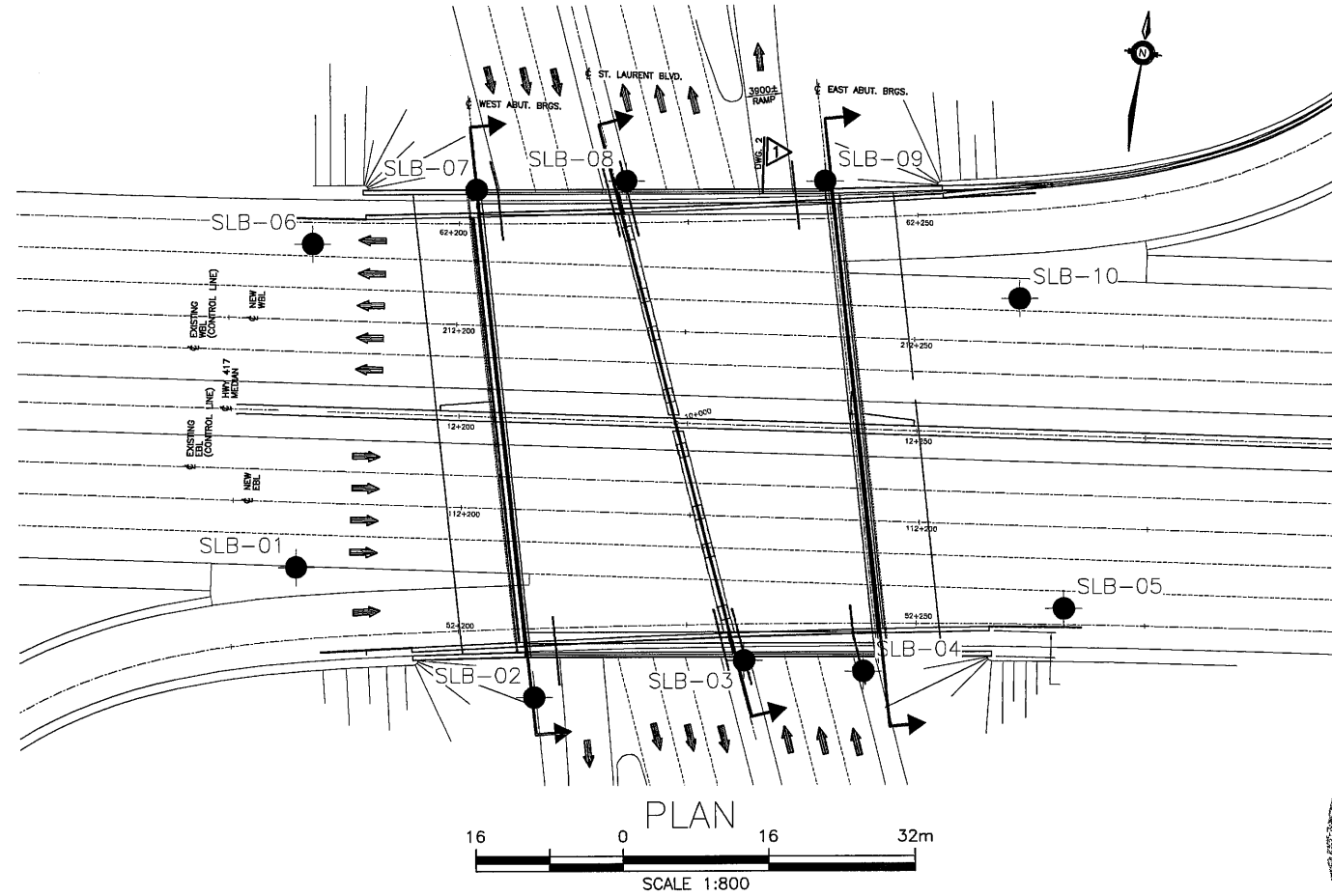


Photograph 4 : Northeast abutment

Appendix D

Drawing

Borehole Locations and Soil Strata



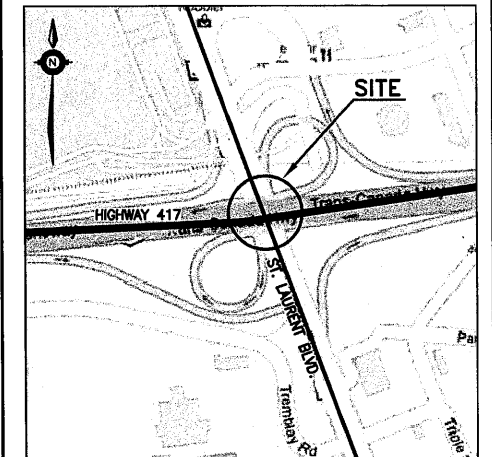
METRIC
DIMENSIONS ARE IN METRES
AND/OR MILLIMETRES
UNLESS OTHERWISE SHOWN

CONT No
WP No 4320-06-00

ST. LAURENT BLVD.
OVERPASS
BOREHOLE LOCATIONS AND SOIL STRATA

MRC McCORMICK RANKIN
CORPORATION

THURBER ENGINEERING LTD.



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
- W Water Level
- HA Head Artesian Water
- PZ Piezometer
- 90% Rock Quality Designation (RQD)
- A/R Auger Refusal

NO	ELEVATION	NORTHING	EASTING
SLB-01	72.8	5 031 492.2	372 449.1
SLB-02	66.6	5 031 481.8	372 476.8
SLB-03	67.3	5 031 489.1	372 499.2
SLB-04	66.9	5 031 489.8	372 512.0
SLB-05	73.1	5 031 499.7	372 532.8
SLB-06	72.6	5 031 527.5	372 446.0
SLB-07	67.0	5 031 535.9	372 462.9
SLB-08	67.0	5 031 539.2	372 478.9
SLB-09	67.0	5 031 542.3	372 500.4
SLB-10	73.1	5 031 532.6	372 523.3

NOTES

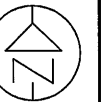
- The boundaries between soil strata have been established only at Borehole locations. Between Boreholes the boundaries are assumed from geological evidence.
- This drawing is for subsurface information only. Surface details and features are for conceptual illustration.

GEOCRES No. 31G5-243

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

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

CONT No
WP No 4320-06-00



ST. LAURENT BLVD.
OVERPASS
BOREHOLE LOCATIONS AND SOIL STRATA

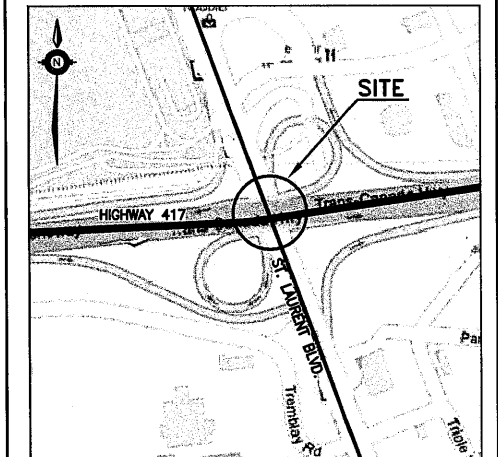
SHEET



McCORMICK RANKIN
CORPORATION



THURBER ENGINEERING LTD.



KEYPLAN

LEGEND

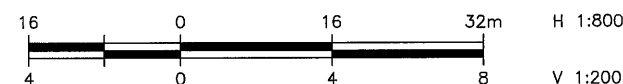
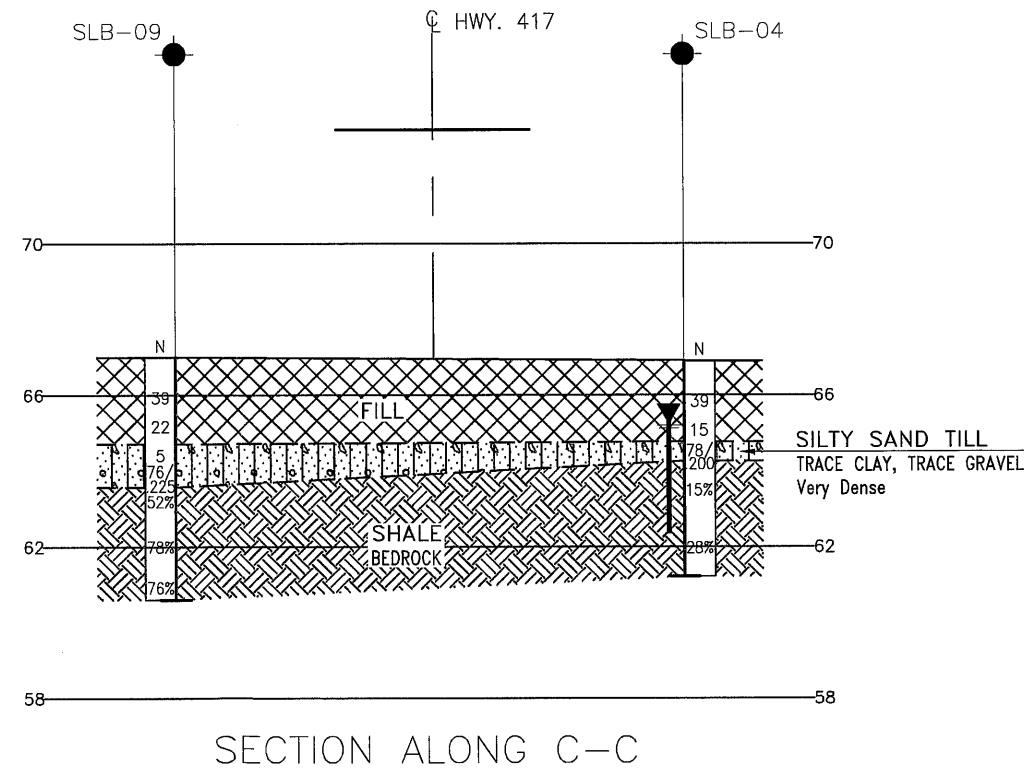
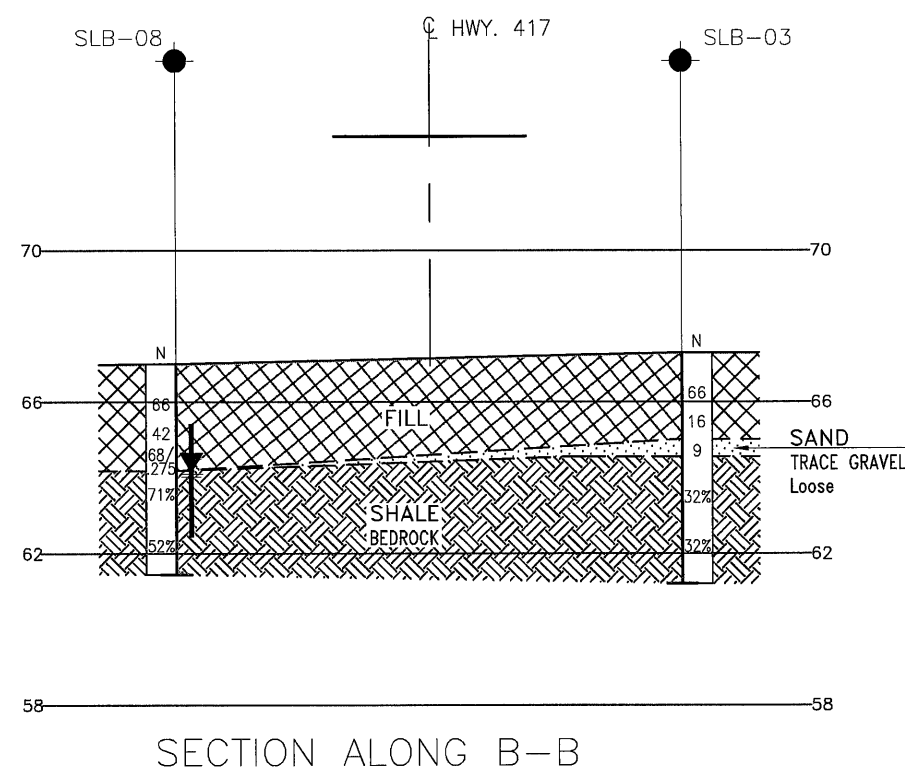
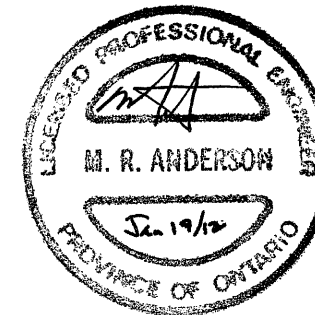
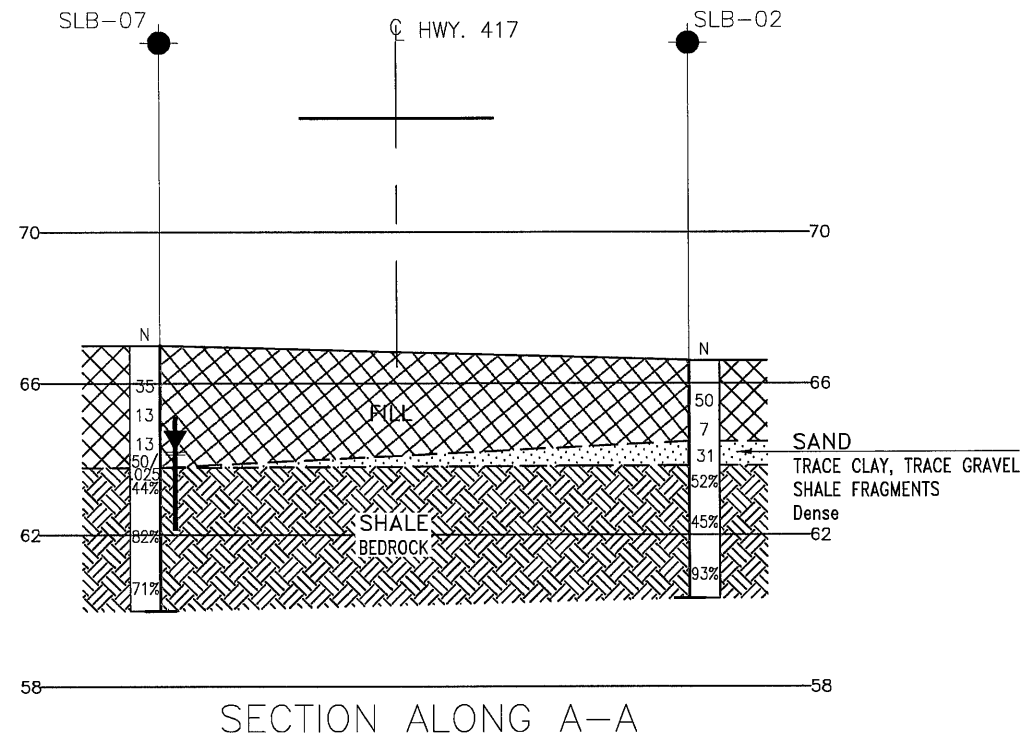
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SLB-10	73.1	5 031 532.6	372 523.3

-NOTES-

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GEOCRES No. 31G5-243



REVISIONS	DATE	BY	DESCRIPTION
DESIGN	LRB	CHK	LRB
DRAWN	AN	CHK	SITE
LOAD	STRUCT	DWG	2
DATE	JAN. 2012		