FOUNDATION INVESTIGATION REPORT
RIVERSIDE DRIVE UNDERPASS REHABILITATION
HIGHWAY 417 EXPANSION FROM VANIER PARKWAY TO O.R. 174
OTTAWA, ONTARIO

G.W.P. 4320-06-00, SITE No. 3-069

Geocres Number: 31G5-241

Report to

McCormick Rankin

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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 of the existing underpass structure which carries Riverside Drive/ Vanier Parkway over Highway 417 in the City of Ottawa, Ontario. This investigation also covered the proposed staging area for this structure. This investigation is part of the Highway 417 Widening 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, records of boreholes, 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-0007.

2 SITE DESCRIPTION

The Riverside Drive Underpass is located at Exit 117 of Highway 417 approximately 4.5 km east of the Ottawa city centre. Riverside Drive/ Vanier Parkway stretches northwards across Highway 417 and links into Riverside Drive to the south. The underpass is approximately 400 m east of the Rideau River and is located within a landscaped area of sparse trees and shrubs.

The underpass is a two-span structure supported by a pier and two abutments with substructures founded on bedrock. The approach embankments are approximately 6.5 m high. The underpass

spans approximately 55.9 m across Highway 417 connecting Coventry Road (Regional Road 50) at the north to Industrial Avenue (Regional Road 30) at the south.

The staging area for the remediation works of the Riverside Drive Underpass is located north-west of the underpass in a grassland area just north of the North-West Ramp at Exit 117 of Highway 417.

The site 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.

A photograph in Appendix C shows the underpass structure. No stability or performance issues were noted on the roadways and existing slopes adjacent to the abutments with the exception of pavement cracking at the edges of the approach slabs on Riverside Drive/ Vanier Parkway.

3 SITE INVESTIGATION AND FIELD TESTING

The site investigation and field testing for this project was carried out during July 15 to July 26, 2011 at the location of the underpass and during August 12 to August 13, 2011 at the staging area.

A total of eight boreholes were drilled and sampled. Five boreholes drilled at the underpass structure were numbered VP-01, VP-02, VP-03, VP-04A and VP-04B. Borehole VP-01 was drilled on the southbound lane of the existing north approach while borehole VP-03 was drilled on the northbound lane of the existing south approach. Borehole VP-02 was drilled to the west of the pier and boreholes VP-04A and VP-04B were drilled to the east of the pier, on the pavement of Highway 417. VP-04A was terminated above the bedrock and repositioned to VP-04B to avoid water from rock coring from disrupting passing vehicles on the highway. The three boreholes drilled within the staging area were numbered STG-10, STG-11 and STG-12.

Details of the borehole depths and elevations are summarised in Table 3.1.

Table 3.1 – Borehole Termination Depths and Ground Elevations

Structure Element	Borehole Number	Ground Elevation	BH Termination Elevation	BH Termination Depth (m)
North Approach	VP-01	65.9	58.1	7.8
Pier	VP-02	59.2	54.2	5.0
South Approach	VP-03	65.8	57.8	7.9
Pier	VP-04A	60.1	56.7	3.4
Pier	VP-04B	59.3	54.3	5.0
Staging Area	STG-10	61.1	54.7	6.4
Staging Area	STG-11	61.3	55.2	6.1
Staging Area	STG-12	61.8	55.1	6.7

The approximate locations of the boreholes are shown on the attached Borehole Locations and Soil Strata Drawing in Appendix D.

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 for boreholes drilled on Riverside Drive/ Vanier Parkway and City of Ottawa consent was obtained for the boreholes drilled in the proposed staging area (a grassland north of the North-West Ramp of Highway 417).

The drilling was carried out using a CME 55 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). 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 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 in the open boreholes were recorded during the drilling operations. Standpipe piezometers consisting of 19mm diameter PVC pipe with slotted screen were installed in boreholes VP-04A and STG-12. The installation details of the piezometers are summarised in Table 3.2. Following the final water level reading, the piezometer would 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 to a depth approximately 0.15 m below ground level and then asphalt cold patch to surface.

Table 3.2 – Piezometer Installation Details

Borehole	Tip Position		Installation Details
	Depth	Elevation	
VP-04A	3.4	56.7	Sand filter from 3.4 to 1.5 m, bentonite holeplug and cuttings from 1.5 to 0.15 m, then asphalt cold path to surface.
STG-12	6.7	55.1	Sand filter from 6.7 to 4.9 m, bentonite holeplug and cuttings from 4.9 to ground surface.

4 LABORATORY TESTING

All recovered soil samples were subjected to Visual Identification (VI) 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 conducted on selected portion of the rock cores. The UCS values of the rock were assessed from the point load data and these values are reported on the borehole logs.

5 DESCRIPTION OF SUBSURFACE CONDITIONS

Reference is made to the Record of Borehole sheets included in Appendix A, and 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 Record of Borehole Sheets governs any interpretation of the site conditions.

The stratigraphy encountered at the underpass typically consists of a pavement structure overlying gravelly sand and sand fill, underlain by silty sand till with shale at depth. At the staging area, the stratigraphy comprises topsoil overlying clayey silt, gravelly sand and sand fill. Underlying the fill is silty sand till and shale bedrock was encountered below the till.

More detailed descriptions of the individual strata encountered at the existing underpass site and the staging area are presented below.

5.1 Underpass Site (Boreholes VP-01 to VP-04B)

5.1.1 Asphalt

Asphalt was encountered in all five boreholes drilled on Highway 417 and Riverside Drive/ Vanier Parkway. The asphalt layer was approximately 150 mm to 200 mm thick.

5.1.2 Gravelly Sand / Sand Fill

Sand fill was encountered below the asphalt layer in all boreholes. In Boreholes VP-01 and VP-03 at the approach embankments, the fill consists of brown sand with some silt and trace to some clay and gravel. In Boreholes VP-02, VP-04A and VP-04B at the central pier, the fill comprises brown sand to gravelly sand with trace to some silt. Occasional cobbles were noted in the fill.

The thickness of the fill varies between 1.2 and 1.5 m at the pier, 3.8 m at the south approach and 4.8 m at the north approach. Details are provided in Table 5.1.

SPT 'N' values recorded in the cohesionless fill ranged from 10 blows/ 0.3 m penetration to 49 blows/ 0.3 m penetration, indicating a compact to very dense relative density. The moisture content of the fill ranged from 1% to 13%.

Table 5.1 – Fill Thickness Encountered in Boreholes

Underpass Elements	Borehole	Top Boundary of Fill (Elev.)	Base Boundary of Fill (Elev.)	Thickness of Fill (m)
Abutments/ Approach Embankments	VP-01	65.7	60.9	4.8
	VP-03	65.6	61.8	3.8
Pier	VP-02	59.0	57.8	1.2
	VP-04A	59.9	58.7	1.2
	VP-04B	59.1	57.6	1.5

Grain size distribution analyses were carried out on samples of the fill from the pier and each approach. The results of these tests are presented in Figure B1 of Appendix B, and summarized below:

	Approach	Pier
Gravel %	1 to 2	21
Sand %	82 to 88	58
Silt and Clay %	10 to 17	21

5.1.3 Clayey Silt

Grey clayey silt containing some sand was encountered locally in borehole VP-01, below the fill. The thickness of the silt layer is 1.1 m. The base of the silt layer is at 6.1 m depth (Elev. 59.8).

An SPT 'N' value of 14 blows/ 0.3 m penetration was recorded at the boundary of the fill and the native clayey silt layer, indicating a stiff consistency of the clayey silt layer.

5.1.4 Silty Sand Till

Brown to dark grey silty sand till containing some silt, clay and gravel was encountered in four of the five boreholes. No till was encountered in Borehole VP-04B.

The thickness of the silty sand till varies from 0.4 to greater than 3.9 m. Boreholes VP-01 and VP-03 were terminated in the till.

SPT 'N' values recorded in the silty sand till typically ranged from 26 blows/ 0.3 m penetration to 50 blows/ 0.075 m penetration, indicating a compact to very dense relative density. Lower SPT 'N' values were recorded in the silty sand till encountered in Borehole VP-04A, ranging from 8 to 10 blows/ 0.3 m penetration, indicating a loose condition. The moisture content of the till ranged from 5% to 26%.

Grain size distribution analyses were carried out on three samples of the silty sand till. One sample was taken from each approach embankment and pier. The results are plotted in Figure B2 of Appendix B and summarized below:

Gravel %	1 to 12
Sand %	44 to 55
Silt %	23 to 41
Clay %	12 to 17

Glacial till inherently contains cobbles and boulders.

5.1.5 Shale Bedrock

Grey, slightly weathered to fresh, laminated shale was proven by coring in Boreholes VP-02 and VP-04B, located at the pier. The shale was observed to have thin hard limestone interbeds throughout.

In Borehole VP-04A, no coring was carried out due to site constraints. The borehole was terminated when the auger could not advance further after encountering a hard stratum. It is probable that the hard stratum encountered was shale bedrock. Comparison between the level at which augering started to be difficult in Borehole VP-04A with the shale surface elevation in Boreholes VP-02 and VP-04B, suggests that the hard stratum encountered in Borehole VP-04A is probably shale.

The depths and elevations at which bedrock was encountered are summarized in Table 5.2.

Table 5.2 – Depths and Elevations of Bedrock Surface at Pier

Underpass Element	Borehole	Bedrock Surface	
		Depth (m)	Elevation (m)
Pier	VP-02	1.8	57.4
	VP-04A	2.9	57.2
	VP-04B	1.7	57.6

Total Core Recovery (TCR) in the bedrock was between 95 and 100%, indicating good core recovery. The Rock Quality Designation (RQD) values ranged from 26 to 100%, indicating poor to excellent rock quality. The Fracture Index (FI) of the rock, expressed as fractures per 0.3 m of core, ranged from 0 to greater than 10.

Average unconfined compression strength (UCS) of the shale, interpreted from point load tests conducted on intact cores, ranged from 10 to 22 MPa, which indicates a weak rock.

5.1.6 Water Levels

No groundwater was encountered during borehole installation. A standpipe piezometer was installed in borehole VP-04A within the silty sand till. The water levels measured in the piezometer were as follows:.

Table 5.3 – Groundwater Depths and Elevations

Borehole	Date of Reading	Water Level	
		Depth (m)	Elevation
VP-04A	26-Jul-11	Dry	-
	18-Aug-11	Dry	-
	20-Sep-11	3.0	57.1
	12-Oct-11	3.0	57.1

It should be noted that ground water level is susceptible to seasonal fluctuations. In particular, the groundwater level may be at a higher elevation after the spring snowmelt or after periods of heavy rainfall.

5.2 Staging Area (Boreholes STG-10, STG-11 and STG-12)

5.2.1 Topsoil

The staging area is located in a grassland northwest of the underpass. Approximately 50mm of topsoil was encountered in all three boreholes (STG-10, STG-11 and STG-12).

5.2.2 Clayey Silt/ Sand Fill

The upper layer of the fill encountered below the topsoil is typically brown clayey silt with sand, trace of gravel and occasional rootlets. Below the clayey silt fill, the fill comprises sand with trace of gravel and clay, and gravelly sand.

The thickness of the fill varies between 1.3 and 2.8 m and details are provided in Table 5.4.

Table 5.4 – Fill Thickness Encountered in Boreholes

Location	Borehole	Top Boundary of Fill (Elev.)	Base Boundary of Fill (Elev.)	Thickness of Fill (m)
Staging Area	STG-10	61.0	59.6	1.4
	STG-11	61.2	59.9	1.3
	STG-12	61.7	58.9	2.8

SPT 'N' values recorded in the clayey silt fill ranged from 14 to 38 blows/ 0.3 m penetration indicating a stiff to hard consistency. In the gravelly sand and sand fill layer, SPT 'N' values ranged from 19 to 54 blows/ 0.3 m penetration, indicating a compact to dense relative density.

The moisture content of the clayey silt fill ranged from 6% to 19%. The moisture content in the gravelly sand and sand fill ranged from 4% to 9%.

A grain size distribution analysis was carried out on one sample of the sand fill from Borehole STG-12. The results of this test are presented in Figure B3 of Appendix B, and summarized below:

Gravel %	3
Sand %	85
Silt %	10
Clay %	2

5.2.3 Silty Sand Till

Dark grey silty sand till containing trace to some gravel and trace of clay was encountered below the fill in all three boreholes. The thickness of the silty sand till varies between 0.8 and 1.9 m. The base of the silty sand till layer ranges from 2.4 to 3.7 m (Elev. 57.7 to 58.9).

SPT 'N' values recorded in the silty sand till ranged from 12 blows/ 0.3 m penetration to 50 blows / 0.15 m penetration, indicating a compact to very dense relative density. The upper part of the till is typically compact becoming dense with depth.

The moisture content of the till ranged from 8% to 19%.

Grain size distribution analyses were carried out on two samples of the silty sand till. The results are plotted in Figure B4 of Appendix B and summarised below:

Gravel%	4 to 11
Sand%	52 to 55
Silt%	31
Clay%	6 to 10

Glacial till inherently contains cobbles and boulders.

5.2.4 Shale Bedrock

Grey and black, fresh, thinly bedded shale was proven in Boreholes STG-10, STG-11 and STG-12. The depths and elevations at which bedrock was encountered are summarized in Table 5.5.

Table 5.5 – Depths and Elevations of Bedrock Surface at Staging Area

Location	Borehole	Bedrock Surface	
		Depth (m)	Elevation (m)
Staging area	STG-10	3.4	57.7
	STG-11	2.4	58.9
	STG-12	3.7	58.1

The shale was observed to have very thin hard limestone interbeds throughout. Horizontal joints were encountered in the shale at depths of 3.4 to 4.5 m and 5.8 to 5.9 m below ground surface. Vertical joints were encountered in borehole STG-12 at depths of 4.6 to 5.2 m. In Boreholes STG-11 and STG-12, zones of highly broken shale were encountered at depths of 3.1 to 3.4 m, 4.3 to 4.6 m and 5.8 to 5.9 m.

Total Core Recovery (TCR) in the bedrock was 100%, indicating good core recovery. The Rock Quality Designation (RQD) values ranged from 75 to 100%, indicating good to excellent rock quality. The Fracture Index (FI) of the rock, expressed as fractures per 0.3 m of core, ranged from 0 to greater than 10.

The average unconfined compression strength (UCS) of the shale was interpreted from point load tests conducted on intact cores. The UCS values ranged from 18 to 23 MPa, with an average of 21 MPa, indicating a weak rock.

5.2.5 Water Levels

A standpipe piezometer was installed in borehole STG-12 within the shale. The groundwater depths and elevations measured in the piezometer are shown in Table 5.6.

Table 5.6 – Groundwater Depths and Elevations

Borehole	Date of Reading	Water Level	
		Depth	Elevation
STG-12	02-Sep-11	4.0	57.8
	20-Sep-11	3.9	57.9
	12-Oct-11	4.9	56.9

It should be noted that ground water level is susceptible to seasonal fluctuations. In particular, the groundwater level may be at a higher elevation after the spring snowmelt or after periods of heavy rainfall.

6 MISCELLANEOUS

Borehole locations were selected and established in the field by Thurber Engineering Ltd. Surveyors from MMM Group provided co-ordinates and the ground surface elevations at the boreholes drilled.

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 a truck mounted CME 55 drill rig and conducted the drilling, sampling and in-situ testing operations.

The field investigation was supervised by Mr. Luke Gilarski, E.I.T. of Thurber.

Routine laboratory testing was carried out by Thurber Engineering Ltd.

Overall planning and supervision of the field program was conducted by Ms. Lindsey Blaine, E.I.T. Interpretation of the data and preparation of the report were carried out by Ms. Mei Cheong, M.Phil.

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

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19 Jan 2012

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Review Principal

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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

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

$\overline{\blacktriangledown}$ Water Level

C_{pen} 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

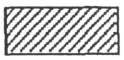
MAJOR DIVISIONS		GROUP SYMBOL	TYPICAL DESCRIPTION
COARSE GRAINED SOILS	GRAVEL AND GRAVELLY SOILS	GW	Well-graded gravels or gravel-sand mixtures, little or no fines.
		GP	Poorly-graded gravels or gravel-sand mixtures, little or no fines.
		GM	Silty gravels, gravel-sand-silt mixtures.
		GC	Clayey gravels, 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	Peat and other highly organic soils.
CLAY SHALE			
SANDSTONE			
SILTSTONE			
CLAYSTONE			
COAL			

EXPLANATION OF ROCK LOGGING TERMS

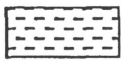
ROCK WEATHERING CLASSIFICATION

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

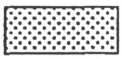
SYMBOLS



CLAYSTONE



SILTSTONE



SANDSTONE

COAL

Bedrock (general)

DISCONTINUITY SPACING

Bedding	Bedding Plane Spacing
Very thickly bedded	Greater than 2m
Thickly bedded	0.6 to 2m
Medium bedded	0.2 to 0.6m
Thinly bedded	60mm to 0.2m
Very thinly bedded	20 to 60mm
Laminated	6 to 20mm
Thinly Laminated	Less than 6mm

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.

STRENGTH CLASSIFICATION

Rock Strength	Approximate Uniaxial Compressive Strength (MPa)	(psi)	Field Estimation of Hardness*
Extremely Strong	Greater than 250	Greater than 36,000	Specimen can only be chipped with a geological hammer
Very Strong	100-250	15,000 to 36,000	Requires many blows of geological hammer to break
Strong	50-100	7,500 to 15,000	Requires more than one blow of geological hammer to break
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

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Ministry of Transportation
Ontario

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RECORD OF BOREHOLE No VP-01 1 OF 1 METRIC

W.P. 4320-06-00 LOCATION N 5 031 232.8 E 370 799.2 Vanier Parkway ORIGINATED BY LPG

HWY 417 BOREHOLE TYPE Hollow Stem Augers - CME 55 COMPILED BY AN

DATUM Geodetic DATE 2011.07.15 - 2011.07.15 CHECKED BY LRB

SOIL PROFILE			SAMPLES			GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT 20 40 60 80 100 / SHEAR STRENGTH kPa: o UNCONFINED, + FIELD VANE, ● QUICK TRIAXIAL, × LAB VANE (20 40 60 80 100)	PLASTIC LIMIT w_P / NATURAL MOISTURE CONTENT w / LIQUID LIMIT w_L — WATER CONTENT (%) 20 40 60	UNIT WEIGHT γ kN/m^3	REMARKS & GRAIN SIZE DISTRIBUTION (%)
ELEV / DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE	"N" VALUES						GR SA SI CL
65.9											
0.0	**ASPHALT:** (150mm)										
0.2	**SAND**, some silt, some gravel Grey Moist (FILL)		1	AS					o		
65.1							65				
0.8	**SAND**, some silt and clay, trace gravel Dense to Compact Brown Moist (FILL)		2	SS	49				o		2 88 10 (SI+CL)
			3	SS	40		64		o		
			4	SS	31				o		
			5	SS	19		63		o		
							62				
60.9			6	SS	14		61		o		
5.0	Clayey **SILT**, some sand Grey Moist										
59.8							60				
6.1	Silty **SAND**, some clay, trace gravel Compact to Very Dense Brown Moist (TILL)		7	SS	26					o	1 44 41 14
							59				
58.1	Shale fragments		8	SS	100/				o		
7.8	END OF BOREHOLE AT 7.8m. BOREHOLE BACKFILLED WITH BENTONITE HOLEPLUG AND CUTTINGS TO 0.1m, THEN COLD PATCH TO SURFACE.				0.025						

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

20 / 15 5 / 10 (%) STRAIN AT FAILURE

ONTMT4S 1201B.GPJ 10/26/11

Ministry of Transportation
Ontario

RECORD OF BOREHOLE No VP-02 1 OF 1 METRIC

W.P. 4320-06-00 LOCATION N 5 031 194.4 E 370 794.2 Vanier Parkway ORIGINATED BY LPG

HWY 417 BOREHOLE TYPE Hollow Stem Augers - CME 55 COMPILED BY AN

DATUM Geodetic DATE 2011.07.26 - 2011.07.26 CHECKED BY LRB

ELEV / DEPTH	DESCRIPTION	STRAT PLOT	SAMPLES NUMBER	SAMPLES TYPE	SAMPLES "N" VALUES	GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT 20 40 60 80 100	SHEAR STRENGTH kPa ○ UNCONFINED ● QUICK TRIAXIAL + FIELD VANE × LAB VANE 20 40 60 80 100	PLASTIC LIMIT w_P / NATURAL MOISTURE CONTENT w / LIQUID LIMIT w_L WATER CONTENT (%) 20 40 60	UNIT WEIGHT γ kN/m^3	REMARKS & GRAIN SIZE DISTRIBUTION (%) GR SA SI CL
59.2												
0.0	**ASPHALT:** (200mm)						59					
0.2	Gravelly **SAND**, some silt, trace clay Dense Grey to Brown Moist (FILL)		1	AS						○		
57.8			2	SS	38		58			○		21 58 17 4
1.4	Silty **SAND**, trace gravel Very Dense Dark Grey Moist (TILL)		3	SS	50/					○		
57.4					0.075						FI	
1.8	**SHALE**, slightly weathered to fresh, laminated, grey, 10 mm thick limestone interbeds throughout		1	RUN			57				5 2 3	RUN #1 TCR=95% SCR=95% RQD=95% UCS=17MPa (Average)
			2	RUN			56				>5 >10 3 1 2	RUN #2 TCR=100% SCR=78% RQD=57% UCS=16MPa (Average)
			3	RUN			55				0 0	RUN #3 TCR=100% SCR=100% RQD=100% UCS=22MPa (Average)
54.2												
5.0	END OF BOREHOLE AT 5.0m. BOREHOLE BACKFILLED WITH BENTONITE HOLEPLUG AND CUTTINGS TO 0.15m, THEN ASPHALT COLD PATCH TO SURFACE.											

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

$\frac{20}{15 \oplus 5}$ (%) STRAIN AT FAILURE

ONTMT4S 1201B.GPJ 10/12/11

Ministry of Transportation
Ontario

RECORD OF BOREHOLE No VP-03 1 OF 1 METRIC

W.P. 4320-06-00 LOCATION N 5 031 160.4 E 370 817.7 Vanier Parkway ORIGINATED BY LPG

HWY 417 BOREHOLE TYPE Hollow Stem Augers - CME 55 COMPILED BY AN

DATUM Geodetic DATE 2011.07.15 - 2011.07.15 CHECKED BY LRB

ELEV / DEPTH	DESCRIPTION	STRAT PLOT	SAMPLES NUMBER	SAMPLES TYPE	SAMPLES "N" VALUES	GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT 20 40 60 80 100	SHEAR STRENGTH kPa: ○ UNCONFINED + FIELD VANE ● QUICK TRIAXIAL × LAB VANE 20 40 60 80 100	PLASTIC LIMIT w_P / NATURAL MOISTURE CONTENT w / LIQUID LIMIT w_L WATER CONTENT (%) 20 40 60	UNIT WEIGHT γ kN/m^3	REMARKS & GRAIN SIZE DISTRIBUTION (%) GR SA SI CL
65.8												
0.0	**ASPHALT:** (150mm)											
0.2	**SAND**, some silt, trace gravel, trace clay Brown Moist (FILL) Dense to Compact		1	AS			65		○			
			2	SS	44				○			
			3	SS	25		64		○			
			4	SS	27		63		○			1 82 14 3
			5	SS	10				○			
61.8							62					
4.0	Silty **SAND**, some clay, some gravel Dense to Very Dense Brown to Grey Moist (TILL)		6	SS	36		61		○			12 48 23 17
			7	SS	35		60		○			
							59					
57.8			8	SS	100/0.175		58		○			
7.9	END OF BOREHOLE AT 7.9m. BOREHOLE BACKFILLED WITH BENTONITE HOLEPLUG AND CUTTINGS TO 0.15m, THEN ASPHALT TO SURFACE.											

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

$\frac{20}{15 \oplus 5}$ (%) STRAIN AT FAILURE

ONTMT4S 1201B.GPJ 10/12/11

Ministry of Transportation
Ontario

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

W.P. 4320-06-00 LOCATION N 5 031 208.9 E 370 823.2 Vanier Parkway ORIGINATED BY LPG

HWY 417 BOREHOLE TYPE Hollow Stem Augers - CME 55 COMPILED BY AN

DATUM Geodetic DATE 2011.07.25 - 2011.07.25 CHECKED BY LRB

ELEV / DEPTH	DESCRIPTION	STRAT PLOT	SAMPLES: NUMBER	SAMPLES: TYPE	SAMPLES: "N" VALUES	GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT (20 40 60 80 100) / SHEAR STRENGTH kPa (○ UNCONFINED + FIELD VANE ● QUICK TRIAXIAL × LAB VANE) (20 40 60 80 100)	PLASTIC LIMIT w_P / NATURAL MOISTURE CONTENT w / LIQUID LIMIT w_L / WATER CONTENT (%) (20 40 60)	UNIT WEIGHT γ kN/m^3	REMARKS & GRAIN SIZE DISTRIBUTION (%) GR SA SI CL
60.1											
0.0	**ASPHALT:** (150mm)						60				
0.2	Gravelly **SAND**, some silt Brown Moist (FILL)		1	AS					○		
59.3							59		○		
0.8	**SAND**, some silt Compact Brown Moist (FILL)		2	SS	26						
58.7							58		○		
1.4	Silty **SAND**, some clay, trace gravel Loose to Very Dense Brown Moist to Wet (TILL)		3	SS	10				○		
			4	SS	8				○		4 55 29 12
57.2							57				
2.9	Probable **SHALE/BEDROCK**, difficult augering		~~5~~	~~SS~~	~~50/ 0.00~~						
56.7											
3.4	END OF BOREHOLE AT 3.4m. Piezometer installation consists of 19mm diameter Schedule 40 PVC pipe with a 1.52m slotted screen. WATER LEVEL READINGS: DATE DEPTH (m) ELEV. (m) 07/26/2011 DRY 08/18/2011 DRY 09/20/2011 3.0 57.1 10/12/2011 3.0 57.1										

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

$15\frac{20}{10}5$ (%) STRAIN AT FAILURE

ONTMT4S 1201B.GPJ 10/31/11

Ministry of Transportation
Ontario

THURBER

RECORD OF BOREHOLE No VP-04B 1 OF 1 METRIC

W.P. 4320-06-00 LOCATION N 5 031 203.0 E 370 821.5 Vanier Parkway ORIGINATED BY LPG

HWY 417 BOREHOLE TYPE Hollow Stem Augers - CME 55 COMPILED BY AN

DATUM Geodetic DATE 2011.07.26 - 2011.07.26 CHECKED BY LRB

ELEV / DEPTH	DESCRIPTION	STRAT PLOT	SAMPLES NUMBER	SAMPLES TYPE	SAMPLES "N" VALUES	GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT 20 40 60 80 100	SHEAR STRENGTH kPa ○ UNCONFINED ● QUICK TRIAXIAL + FIELD VANE × LAB VANE 20 40 60 80 100	PLASTIC LIMIT w_P NATURAL MOISTURE CONTENT w LIQUID LIMIT w_L WATER CONTENT (%) 20 40 60	UNIT WEIGHT γ kN/m³	REMARKS & GRAIN SIZE DISTRIBUTION (%) GR SA SI CL
59.3												
0.0	**ASPHALT:** (200mm)											
0.2	Gravelly **SAND**, some silt Brown Moist (FILL)		1	AS			59			○		
58.5												
0.8	**SAND**, some gravel, trace silt Compact to Very Dense Brown (FILL) Cobble at 1.3 m		2	SS	19		58			○		
57.6			3	SS	50/					○		
1.7	**SHALE**, slightly weathered to fresh, laminated, grey, very thin limestone interbeds throughout		1	RUN	0.05		57				FI 1 5 4	RUN #1 TCR=100% SCR=83% RQD=52% UCS=10MPa (Average)
			2	RUN			56				0 0 0 0	RUN #2 TCR=100% SCR=100% RQD=100% UCS=15MPa (Average)
54.3			3	RUN			55				4 >5	RUN #3 TCR=100% SCR=96% RQD=26% UCS=19MPa (Average)
5.0	END OF BOREHOLE AT 5.0m. BOREHOLE BACKFILLED WITH BENTONITE HOLEPLUG AND CUTTINGS TO 0.15m, THEN ASPHALT COLD PATCH TO SURFACE.											

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

$15 \oplus \begin{matrix}20\\10\end{matrix} 5$ (%) STRAIN AT FAILURE

ONTMT4S 1201B.GPJ 10/26/11

Ministry of Transportation
Ontario

THURBER

RECORD OF BOREHOLE No STG-10 1 OF 1 METRIC

W.P. 4320-06-00 LOCATION N 5 031 238.4 E 370 668.1 Vanier Parkway Staging Area ORIGINATED BY GA

HWY 417 BOREHOLE TYPE Hollow Stem Augers/NQ Coring COMPILED BY AN

DATUM Geodetic DATE 2011.08.12 - 2011.08.13 CHECKED BY LRB

ELEV / DEPTH	DESCRIPTION	STRAT PLOT	SAMPLES NUMBER	SAMPLES TYPE	SAMPLES "N" VALUES	GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT 20 40 60 80 100 / SHEAR STRENGTH kPa: o UNCONFINED, + FIELD VANE, ● QUICK TRIAXIAL, × LAB VANE (20 40 60 80 100)	PLASTIC LIMIT w_P / NATURAL MOISTURE CONTENT w / LIQUID LIMIT w_L — WATER CONTENT (%) 20 40 60	UNIT WEIGHT γ kN/m^3	REMARKS & GRAIN SIZE DISTRIBUTION (%) GR SA SI CL
0.0 / 0.1	**TOPSOIL:** (50mm)						61				
	Clayey **SILT**, with sand, trace gravel, occasional rootlets Hard to Stiff Brown (FILL)		1	SS	38			o			
			2	SS	14		60		o		
59.6 / 1.5	Silty **SAND**, some gravel, trace clay Compact to Very Dense Dark Grey Dry (TILL)		3	SS	12				o		11 52 31 6
			4	SS	60		59		o		
57.7 / 3.4	**SHALE**, fresh, thinly bedded, grey and black, very thin limestone interbeds throughout Horizontal joints at 3.4m, 3.5m, 3.6m and 4.3m		5	SS	50/ 0.150	▽	58		o	FI 3 0 0 1 0	RUN #1 TCR=100% SCR=93% RQD=80% UCS=19MPa (Average)
			1	RUN			57			0 0 0 0	RUN #2 TCR=100% SCR=100% RQD=100% UCS=18MPa (Average)
			2	RUN			56			0 0 0	
54.7 / 6.4	END OF BOREHOLE AT 6.4m. BOREHOLE OPEN TO 6.4m AND WATER LEVEL AT 3.1m UPON COMPLETION. BOREHOLE BACKFILLED WITH BENTONITE HOLEPLUG AND CUTTINGS TO SURFACE.						55			0	

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

20 / 15 ⊕ 5 / 10 (%) STRAIN AT FAILURE

ONTMT4S 1201B.GPJ 10/26/11

Ministry of Transportation
Ontario

RECORD OF BOREHOLE No STG-11 1 OF 1 METRIC

W.P. 4320-06-00 LOCATION N 5 031 296.9 E 370 705.5 Vanier Parkway Staging Area ORIGINATED BY GA

HWY 417 BOREHOLE TYPE Hollow Stem Augers/NQ Coring COMPILED BY AN

DATUM Geodetic DATE 2011.08.13 - 2011.08.13 CHECKED BY LRB

ELEV / DEPTH	DESCRIPTION	STRAT PLOT	SAMPLES NUMBER	SAMPLES TYPE	SAMPLES "N" VALUES	GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT (20 40 60 80 100) / SHEAR STRENGTH kPa (○ UNCONFINED, ● QUICK TRIAXIAL, + FIELD VANE, × LAB VANE) (20 40 60 80 100)	PLASTIC LIMIT w_P / NATURAL MOISTURE CONTENT w / LIQUID LIMIT w_L — WATER CONTENT (%) (20 40 60)	UNIT WEIGHT γ kN/m^3	REMARKS & GRAIN SIZE DISTRIBUTION (%) GR SA SI CL
61.3											
0.0	**TOPSOIL:** (50mm)										
0.1	Clayey **SILT**, with sand, trace gravel, occasional rootlets		1	SS	14		61	○	○		
60.7	Stiff										
0.6	Brown										
	(FILL)		2	SS	54				○		
	Gravelly **SAND**										
59.9	Very Dense						60				
1.4	Brown										
	Dry										
	(FILL)		3	SS	22				○		4 55 31 10
	Silty **SAND**, trace clay, trace gravel										
	Compact										
	Dark Grey										
	Dry										
58.9	(TILL)					▽	59				
2.4	Augered from 2.3m to 3.1m		4	SS	50/ 0.0						
	SHALE, fresh, thinly bedded, grey and black, very thin limestone interbeds throughout									FI	
	Highly broken zone from 3.1m to 3.4m						58			>10	RUN #1 TCR=100% SCR=87% RQD=75% UCS=23MPa (Average)
	Horizontal joints at 3.4m, 4.1m, and 4.2m		1	RUN						0	
										0	
										2	
							57			0	
										0	RUN #2 TCR=100% SCR=100% RQD=100% UCS=23MPa (Average)
			2	RUN						0	
							56			0	
										0	
55.2										0	
6.1	END OF BOREHOLE AT 6.1m. BOREHOLE OPEN TO 6.1m AND WATER LEVEL AT 2.4m UPON COMPLETION. BOREHOLE BACKFILLED WITH BENTONITE HOLEPLUG AND CUTTINGS TO SURFACE.										

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

$\frac{20}{15 \oplus 5}$ (%) STRAIN AT FAILURE
10

ONTMT4S 1201B.GPJ 10/12/11

Ministry of Transportation
Ontario

THURBER

RECORD OF BOREHOLE No STG-12 1 OF 1 METRIC

W.P. 4320-06-00 LOCATION N 5 031 352.9 E 370 733.3 Vanier Parkway Staging Area ORIGINATED BY GA

HWY 417 BOREHOLE TYPE Hollow Stem Augers/NQ Coring COMPILED BY AN

DATUM Geodetic DATE 2011.08.13 - 2011.08.13 CHECKED BY LRB

ELEV / DEPTH	DESCRIPTION	STRAT PLOT	SAMPLES NUMBER	SAMPLES TYPE	SAMPLES "N" VALUES	GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT (20 40 60 80 100) / SHEAR STRENGTH kPa (○ UNCONFINED + FIELD VANE ● QUICK TRIAXIAL × LAB VANE) (20 40 60 80 100)	PLASTIC LIMIT w_P / NATURAL MOISTURE CONTENT w / LIQUID LIMIT w_L WATER CONTENT (%) (20 40 60)	UNIT WEIGHT γ kN/m^3	REMARKS & GRAIN SIZE DISTRIBUTION (%) GR SA SI CL
61.8											
0.0 / 0.1	**TOPSOIL:** (50mm)										
	Clayey **SILT**, with sand, trace gravel, occasional rootlets Stiff Brown		1	SS	15				○		
61.0 / 0.8	(FILL)						61				
	SAND, some silt, trace gravel, trace clay Dense to Compact Brown Dry (FILL)		2	SS	50				○		3 85 10 2
			3	SS	26		60		○		
58.9			4	SS	19				○		
2.9	Silty **SAND**, trace clay, trace gravel Very Dense Dark Grey Dry		5	SS	67		59		○		
58.1	(TILL)										
3.7	Augered from 3.5m to 3.7m						58				
	SHALE, fresh, thinly bedded, grey and black, very thin limestone interbeds throughout Horizontal joints at 4.3m, 4.4m, and 4.5m Highly broken zone from 4.3m to 4.4m and 4.5m to 4.6m Vertical joint from 4.6m to 5.2m		1	RUN			57			FI 0 0 >5 0 0	RUN #1 TCR=100% SCR=93% RQD=80% UCS=22MPa (Average)
	Highly broken zone from 5.8m to 5.9m Horizontal joints at 5.8m and 5.9m		2	RUN			56			0 1 >10 0 0	RUN #2 TCR=100% SCR=92% RQD=83% UCS=21MPa (Average)
55.1											
6.7	END OF BOREHOLE AT 6.7m. BOREHOLE OPEN TO 6.7m AND WATER LEVEL AT 2.7m 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)
Sep.02/ 11	4.0	57.8
Sep.20/ 11	3.9	57.9
Oct.12/ 11	4.9	56.9

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

20 / 15 ⊕ 5 / 10 (%) STRAIN AT FAILURE

ONTMT4S 1201B.GPJ 10/26/11

Appendix B

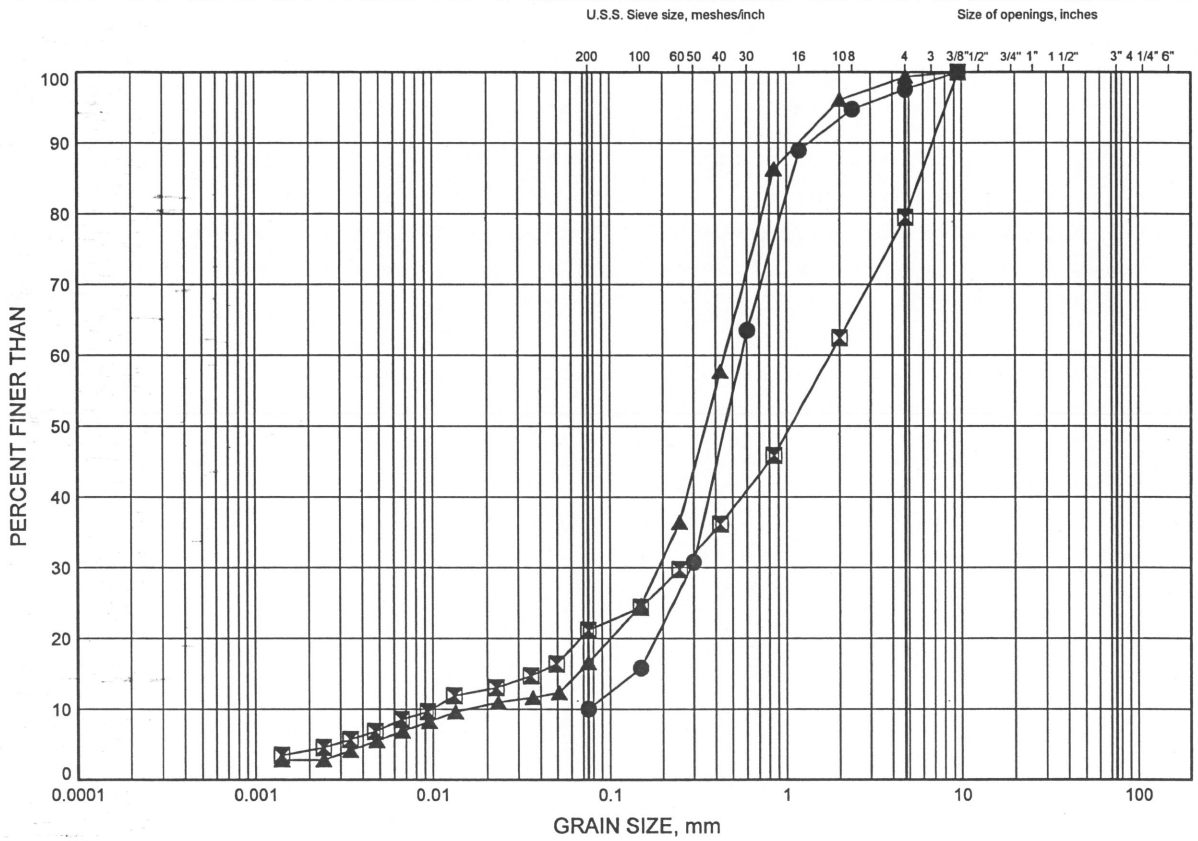
Laboratory Test Results

Highway 417 Ottawa: Vanier to OR 174

GRAIN SIZE DISTRIBUTION

FIGURE B1

SAND to GRAVELLY SAND FILL



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

LEGEND

SYMBOL	BOREHOLE	DEPTH (m)	ELEV. (m)
●	VP-01	1.07	64.83
⊠	VP-02	1.07	58.12
▲	VP-03	2.59	63.20

W.P.# 4320-06-00
Prepared By MFC
Checked By MA

THURBER

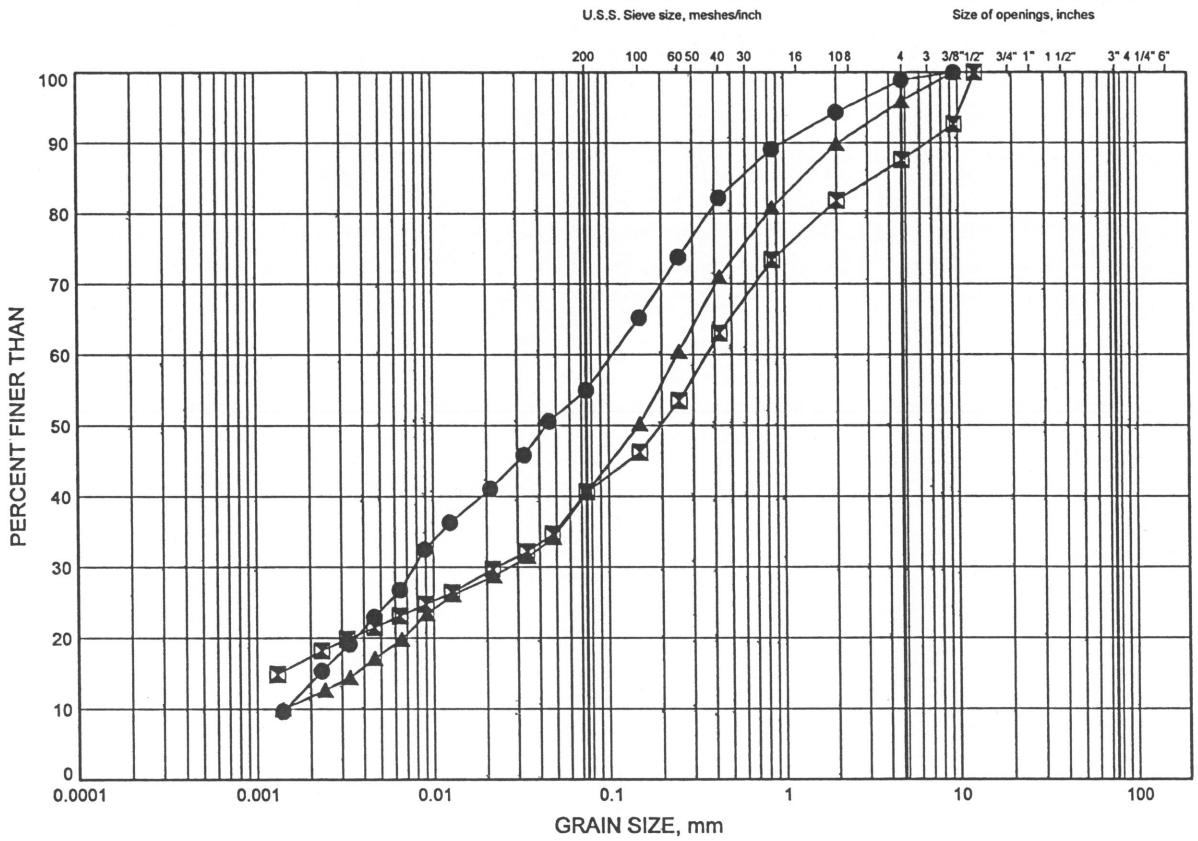
GRAIN SIZE DISTRIBUTION - THURBER 1201B.GPJ 12/13/11

Highway 417 Ottawa: Vanier to OR 174

GRAIN SIZE DISTRIBUTION

FIGURE B2

SILTY SAND TILL AT UNDERPASS



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

LEGEND

SYMBOL	BOREHOLE	DEPTH (m)	ELEV. (m)
●	VP-01	6.40	59.47
⊠	VP-03	4.88	60.91
▲	VP-04A	2.59	57.52

W.P.# 4320-06-00
Prepared By MFA
Checked By MC

THURBER

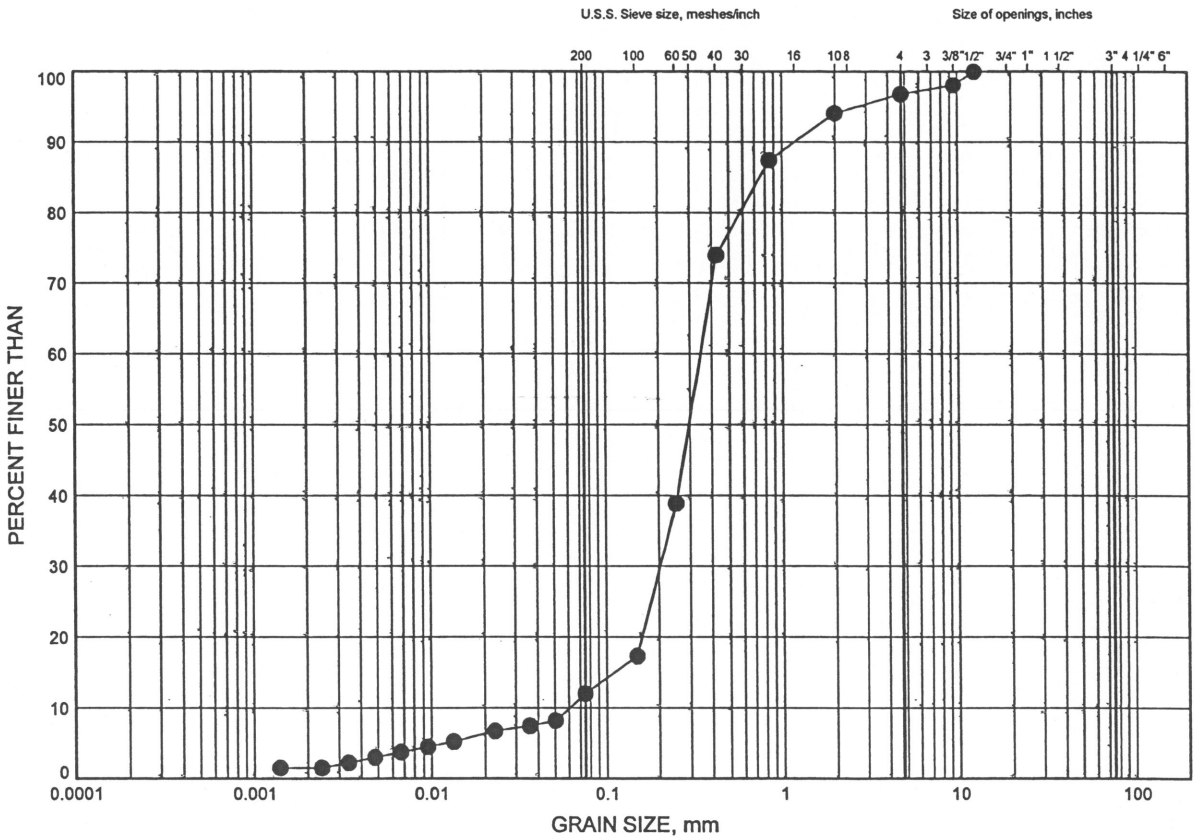
GRAIN SIZE DISTRIBUTION - THURBER 1201B.GPJ 10/12/11

Highway 417 Ottawa: Vanier to OR 174

GRAIN SIZE DISTRIBUTION

FIGURE B3

SAND FILL AT STAGING AREA



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

LEGEND

SYMBOL	BOREHOLE	DEPTH (m)	ELEV. (m)
●	STG-12	1.07	60.71

W.P.# 4320-06-00
Prepared By MFA
Checked By MC

THURBER

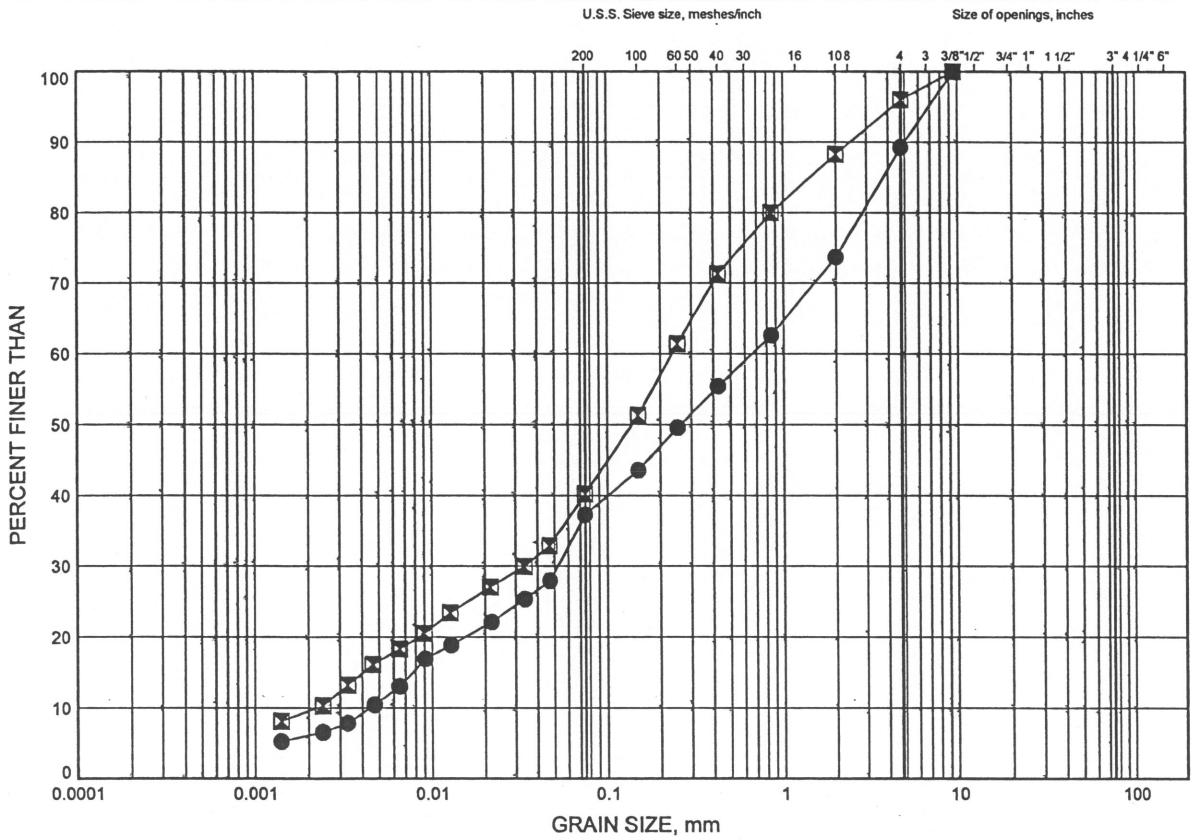
GRAIN SIZE DISTRIBUTION - THURBER 1201B.GPJ 10/12/11

Highway 417 Ottawa: Vanier to OR 174

GRAIN SIZE DISTRIBUTION

FIGURE B4

SILTY SAND TILL AT STAGING AREA



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

LEGEND

SYMBOL	BOREHOLE	DEPTH (m)	ELEV. (m)
●	STG-10	1.83	59.24
⊠	STG-11	1.83	59.46

W.P.# 4320-06-00
Prepared By MFA
Checked By MC

THURBER

GRAIN SIZE DISTRIBUTION - THURBER 1201B.GPJ 10/12/11

Appendix C

Site Photographs

Photograph 1 – Existing Riverside Drive Underpass at Highway 417

Appendix D

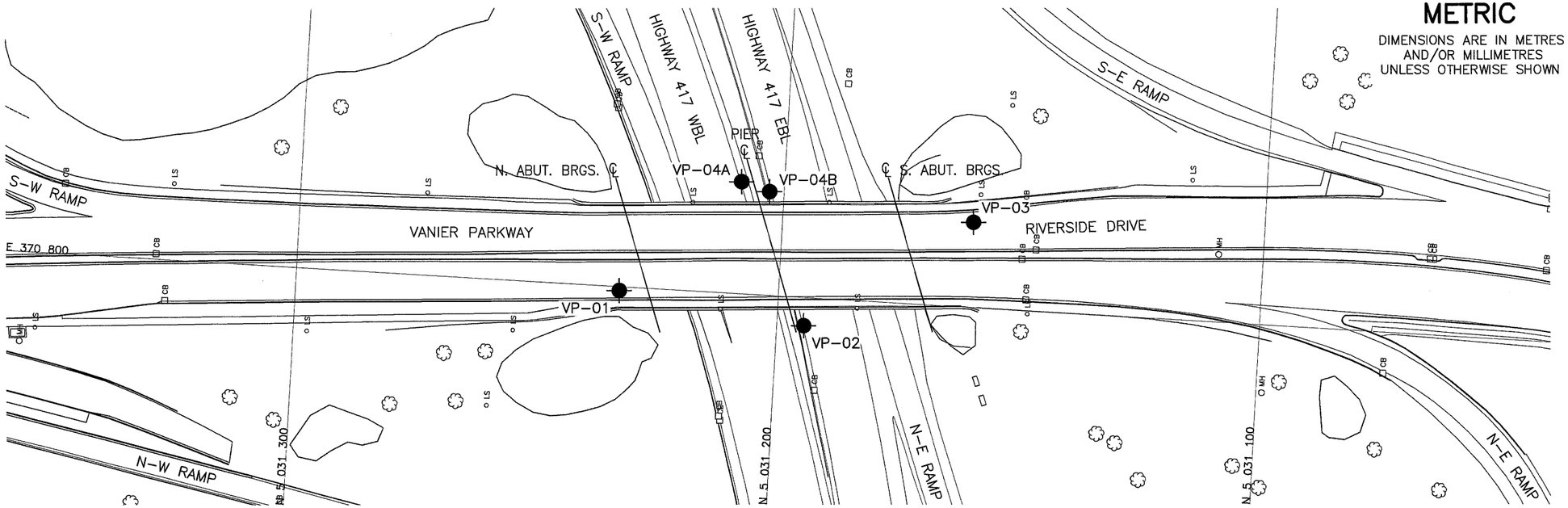
Drawing

Borehole Locations and Soil Strata

MINISTRY OF TRANSPORTATION, ONTARIO

METRIC

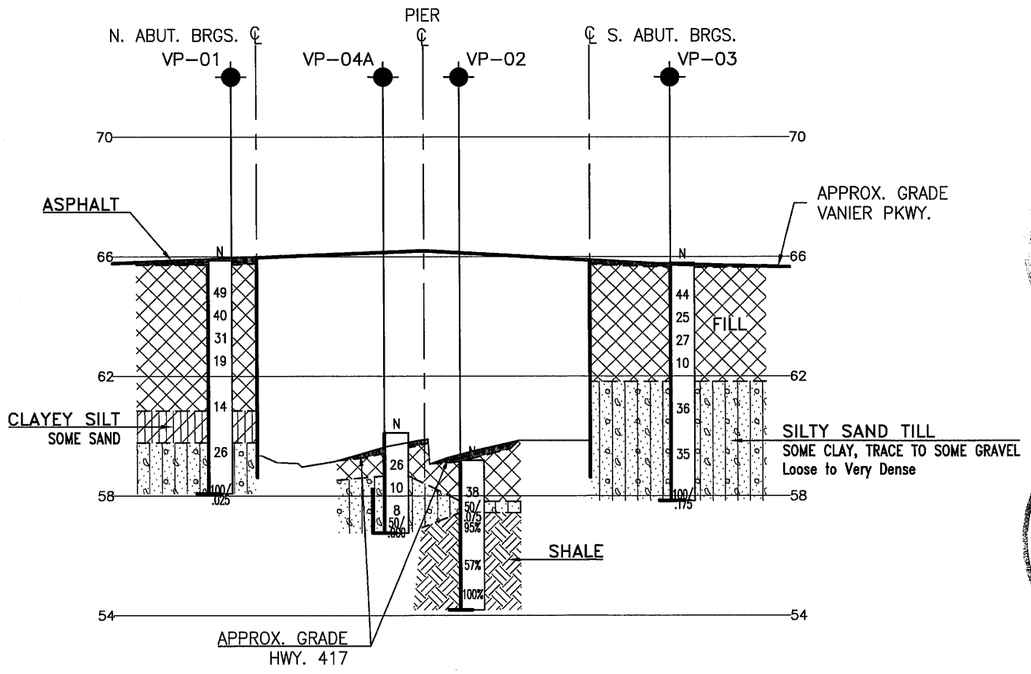
DIMENSIONS ARE IN METRES AND/OR MILLIMETRES UNLESS OTHERWISE SHOWN



PLAN

20 0 20 40m

SCALE 1:1000



PROFILE ALONG ℄ RIVERSIDE DRIVE/VANIER PARKWAY

20 0 20 40m H 1:1000

4 0 4 8 V 1:200

CONT No

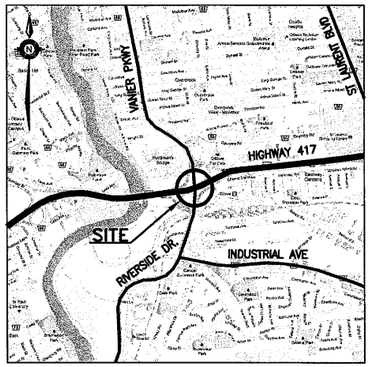
WP No 4320-06-00

HIGHWAY 417
RIVERSIDE DRIVE
UNDERPASS
BOREHOLE LOCATIONS AND SOIL STRATA

SHEET

MRC McCORMICK RANKIN CORPORATION

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
VP-01	65.9	5 031 232.8	370 799.2
VP-02	59.2	5 031 194.4	370 794.2
VP-03	65.8	5 031 160.4	370 817.7
VP-04A	60.1	5 031 208.9	370 823.2
VP-04B	59.3	5 031 203.0	370 821.5

-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. 31G5-241

LICENSED PROFESSIONAL ENGINEER M. R. ANDERSON Jan 19/12 PROVINCE OF ONTARIO

LICENSED PROFESSIONAL ENGINEER P. K. CHATTERJI Jan 19/12 PROVINCE OF ONTARIO

REVISIONS		
DATE	BY	DESCRIPTION

DESIGN	MC	CHK	MC	CODE		LOAD	DATE JAN. 2012
DRAWN	MFA	CHK	PKC	SITE		STRUCT	DWG 1

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MINISTRY OF TRANSPORTATION ONTARIO

METRIC

DIMENSIONS ARE IN METRES AND/OR MILLIMETRES UNLESS OTHERWISE SHOWN

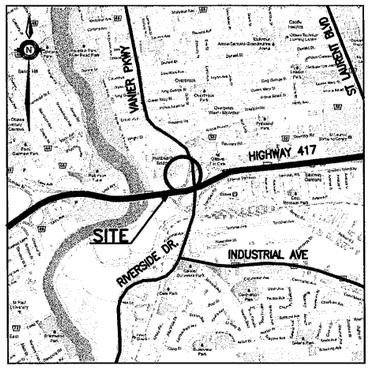
CONT No
WP No 4320-06-00

HIGHWAY 417
RIVERSIDE DRIVE
STAGING AREA
BOREHOLE LOCATION PLAN

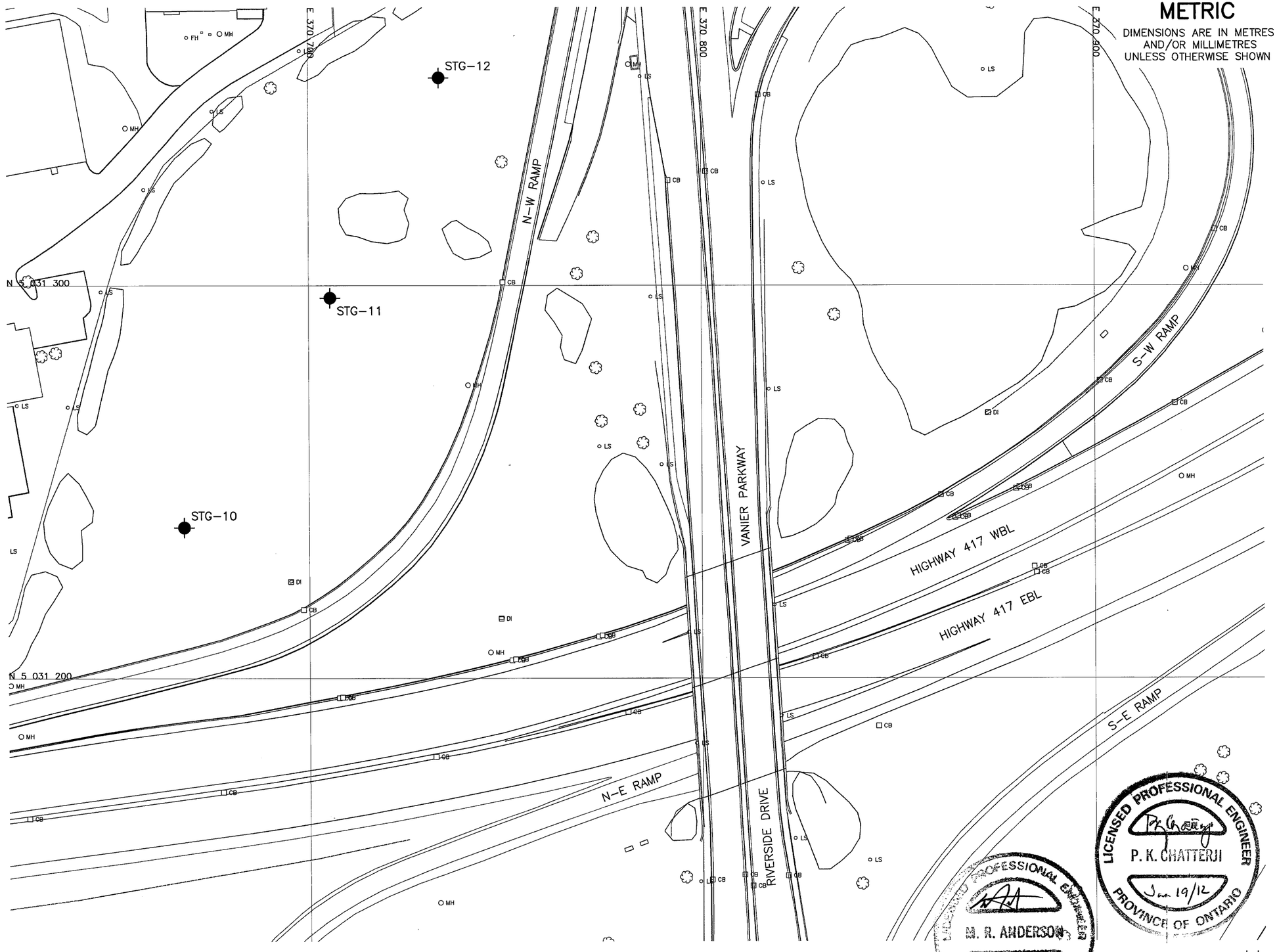
SHEET

McCORMICK RANKIN CORPORATION

THURBER ENGINEERING LTD.



KEYPLAN



PLAN

20 0 20 40m

SCALE 1:1000

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
STG-10	61.1	5 031 238.4	370 668.1
STG-11	61.3	5 031 296.9	370 705.5
STG-12	61.8	5 031 352.9	370 733.3

-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.

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