

DOCUMENT MICROFILMING IDENTIFICATION

GEOCRES No. 3165-139

DIST. 9 REGION

W.P. No. 85-84-01

CONT. No. 86-62

W. O. No.

STR. SITE No. 3-73

HWY. No. 417

LOCATION Rideau River (Hurdman's)
Bridge Widening

No of PAGES - 1

=====

OVERSIZE DRAWINGS TO BE INCLUDED WITH THIS REPORT.

REMARKS:

METRIC

DIMENSIONS ARE IN METRES
AND/OR MILLIMETRES
UNLESS OTHERWISE SHOWN

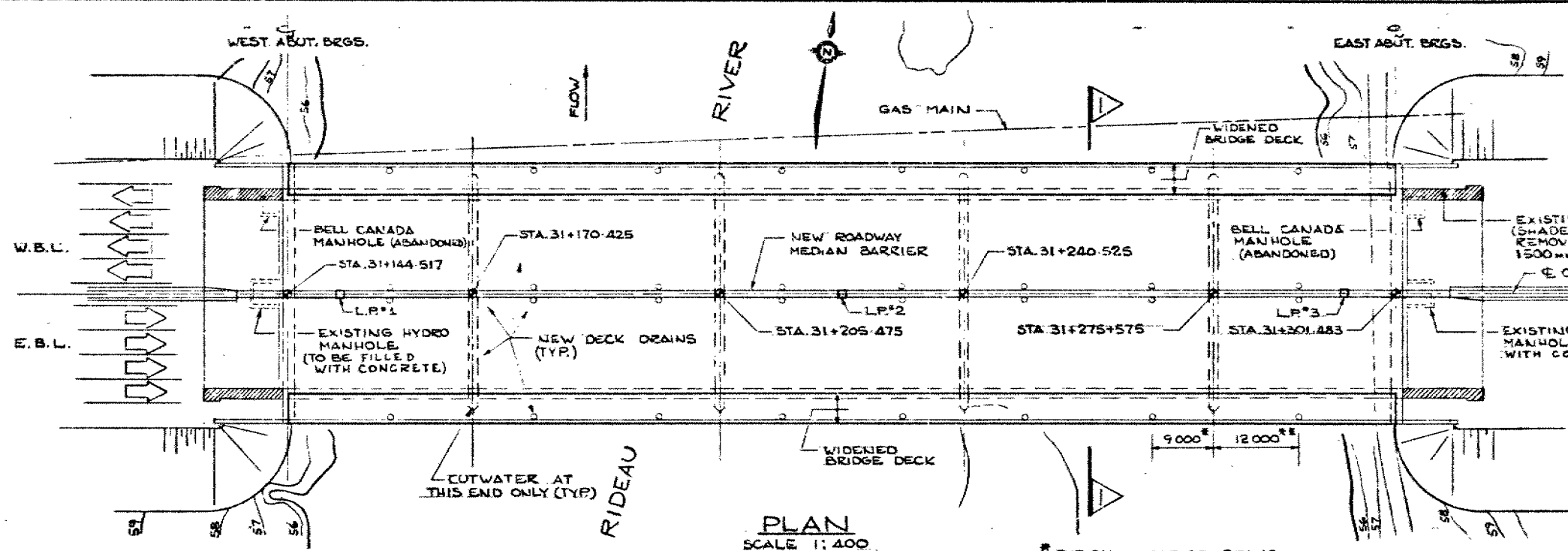
DIST. 9

CONT No

WP No 65-84-01

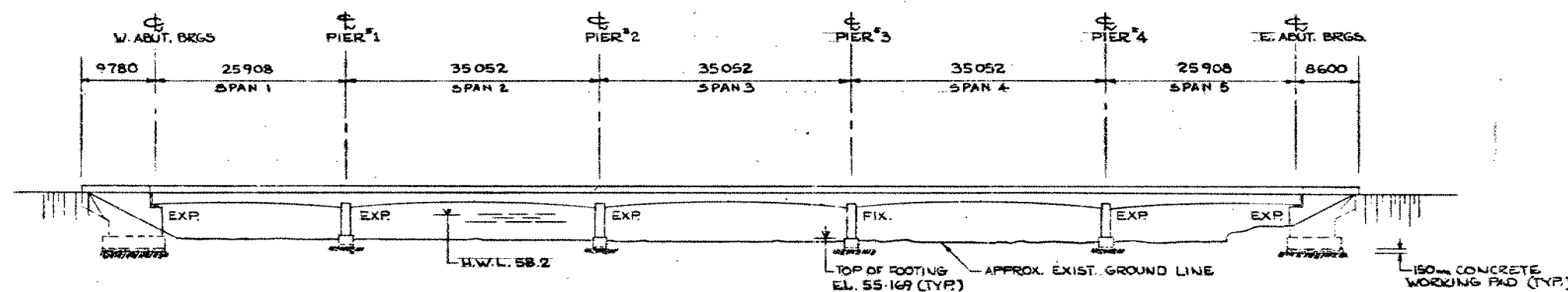
RIDEAU RIVER (HURDMAN)
BRIDGE WIDENING
GENERAL ARRANGEMENT

SHEET

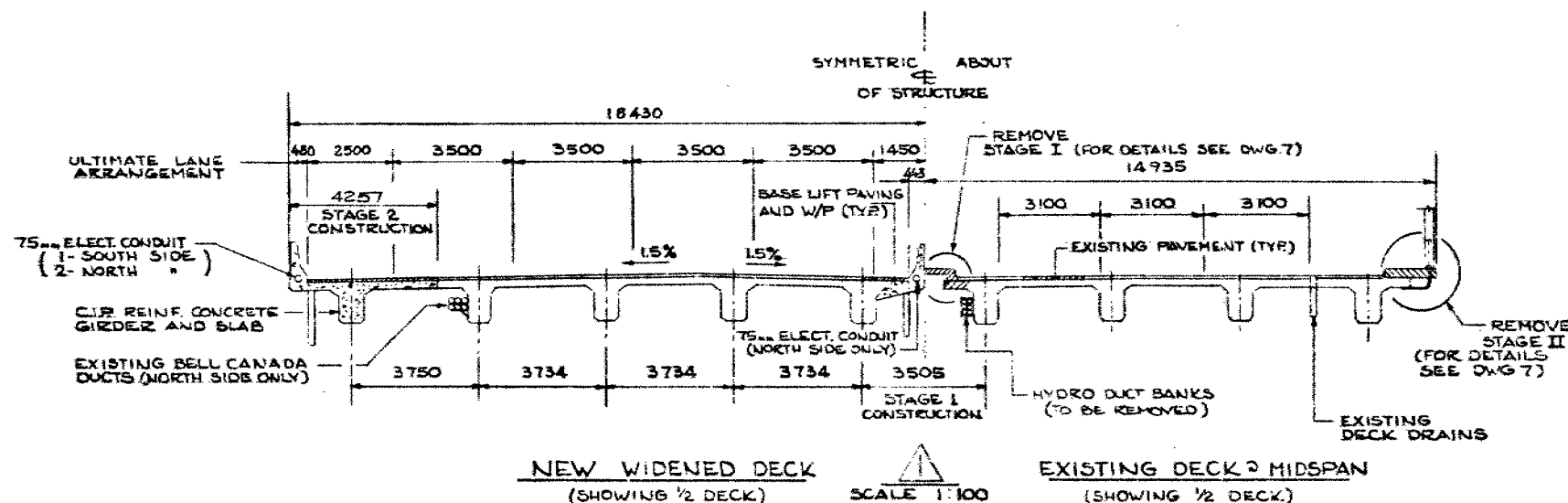


PLAN
SCALE 1:400

NO.	STATION
LP#1	31+152.000
LP#2	31+223.000
LP#3	31+294.000



ELEVATION
SCALE 1:400



SCALE 1:100

LIST OF DRAWINGS

1. GENERAL ARRANGEMENT
2. BORE HOLE LOCATIONS & SOIL STRATA
3. PIER LAYOUT & REINFORCING
4. EAST ABUTMENT
5. WEST ABUTMENT
6. DECK DETAILS
7. DECK REINFORCING
8. GIRDER REINFORCING
9. EXTERIOR BARRIER WALL
10. MEDIAN BARRIER WALL
11. APPROACH TREATMENT IN MEDIAN
12. STANDARD DETAILS
13. QUANTITIES - STRUCTURE
- 14.
- 15.

CONSTRUCTION NOTES

1. CONTRACTOR TO VERIFY LOCATION OF GAS MAIN IN RIVER BED AND TO TAKE PRECAUTION NOT TO DISTURB SAME.
2. ALL DIMENSIONS AND ELEVATIONS REQUIRED FOR THE STRUCTURE WIDENING MUST BE CHECKED IN THE FIELD BY THE CONTRACTOR.
3. TOP COURSE PAVING, EXP. JT. INSTALLATION AND APPROACH SLAB RECONSTRUCTION ARE NOT PART OF THIS CONTRACT.
4. BELL CANADA DUCTS ARE TO REMAIN UNDISTURBED



DRAWING NOT TO BE SCALED
100 mm ON ORIGINAL DRAWING

REVISION	DATE	BY	DESCRIPTION	DATE	BY
DESIGN		CHECK	LOADING		
DRAWING		CHECK	SITE No		DWG

METRIC

DIMENSIONS ARE IN METRES
AND/OR MILLIMETRES
UNLESS OTHERWISE SHOWN

CONT No
WP No 95-84-01

RIEUAU RIVER (HURDMAN)
BRIDGE WIDENING
PIER LAYOUT & REINFORCING

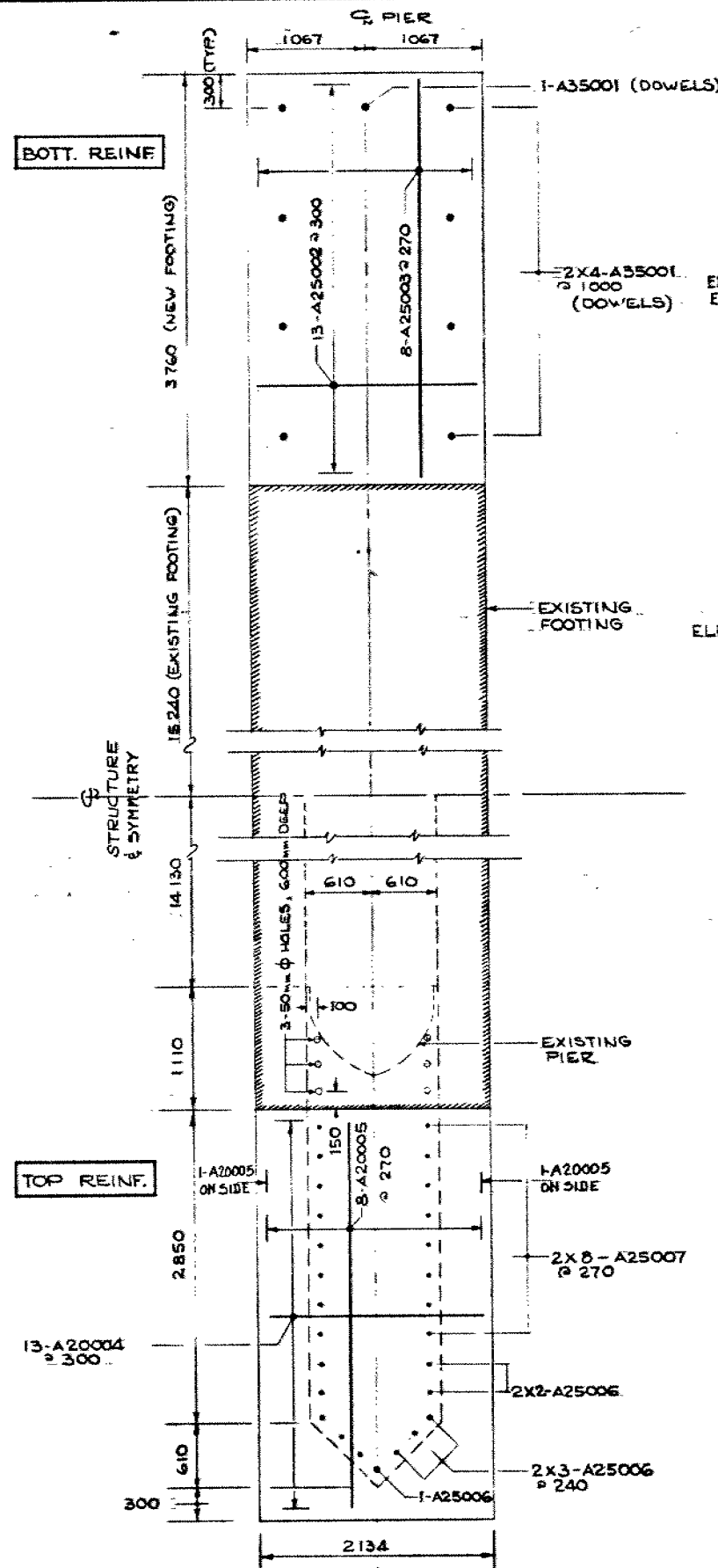
SHEET

NOTES

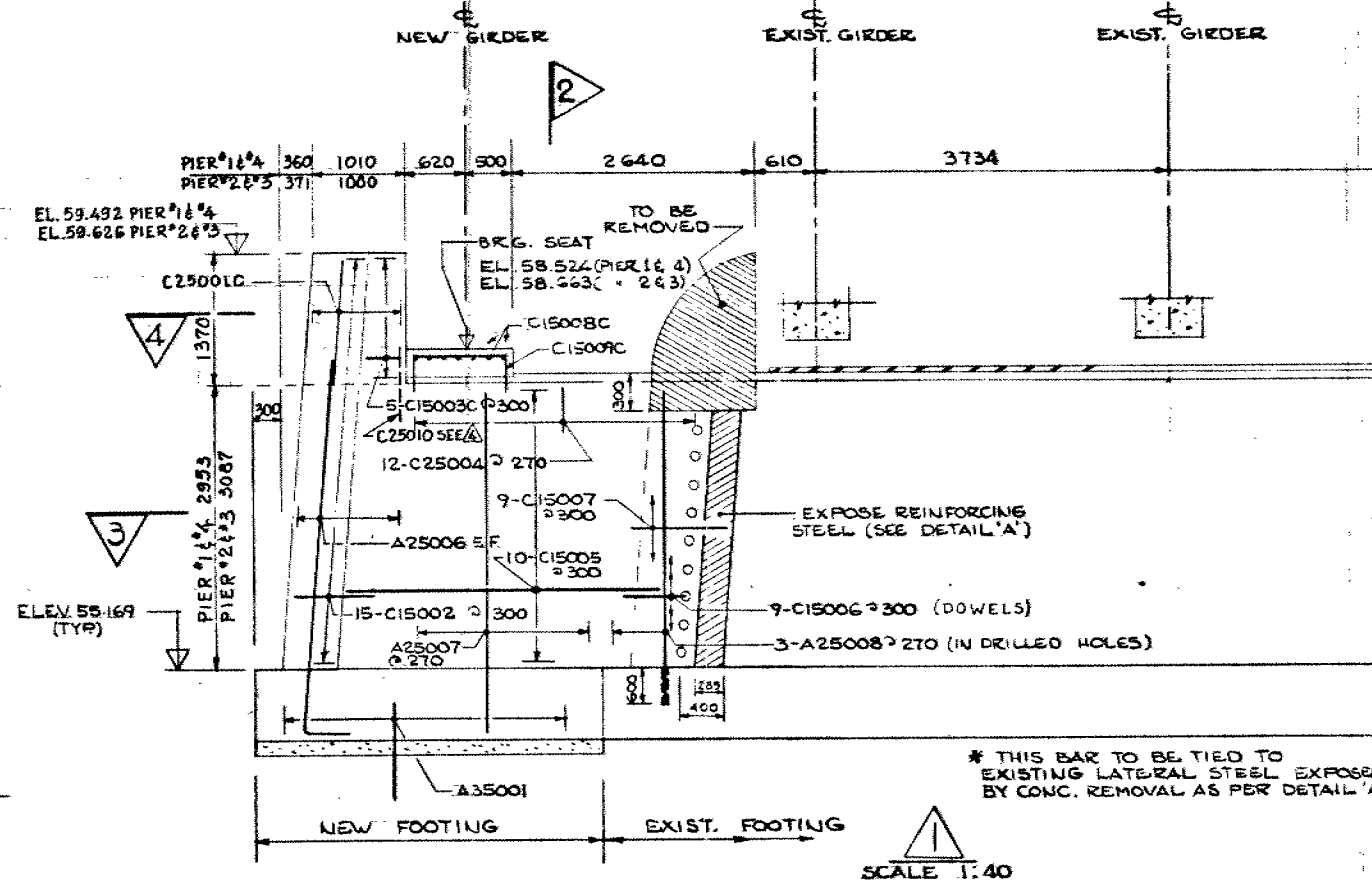
- ALL DIMENSIONS AND ELEVATIONS REQUIRED FOR SUBSTRUCTURE WORK ARE TO BE CONFIRMED IN FIELD BY CONTRACTOR.
- SEE DRAWING NO. 1 FOR WORK DESCRIPTION AND STAGING.
- DIMENSIONS AND REINFORCING SIMILAR FOR ALL PIERS, NORTH & SOUTH SIDE WIDENINGS, EXCEPT AS NOTED.
- MASS CONCRETE TO BE PLACED OVER NEWLY EXPOSED BEDROCK WITHIN 12 HOURS OF COMPLETION OF FOOTING EXCAVATION.
- TOP OF EXISTING PIERS TO BE REMOVED 300 mm BELOW EXISTING BEARING SEATS (FULLY SHADED AREA). REINFORCING STEEL IN PIERS BELOW BEARING SEAT LEVEL TO BE RETAINED AND CLEANED BEFORE PLACING NEW CONCRETE. THE SURFACE OF EXPOSED CONCRETE AT CONSTRUCTION JOINTS TO BE SAND-BLASTED AND COATED WITH NEAT CEMENT PASTE.
- REMOVE CONCRETE TO EXPOSE REINFORCING STEEL ON VERTICAL FACE OF PIERS AS SHOWN IN DETAIL 'A'. TREAT EXISTING CONCRETE SURFACES AS DESCRIBED ABOVE.
- ALL DOWEL HOLES TO BE FILLED WITH NON-SHRINK GROUT AFTER REINFORCEMENT POSITIONED.
- E.F. DENOTES EACH FACE

BOTT. REINF.

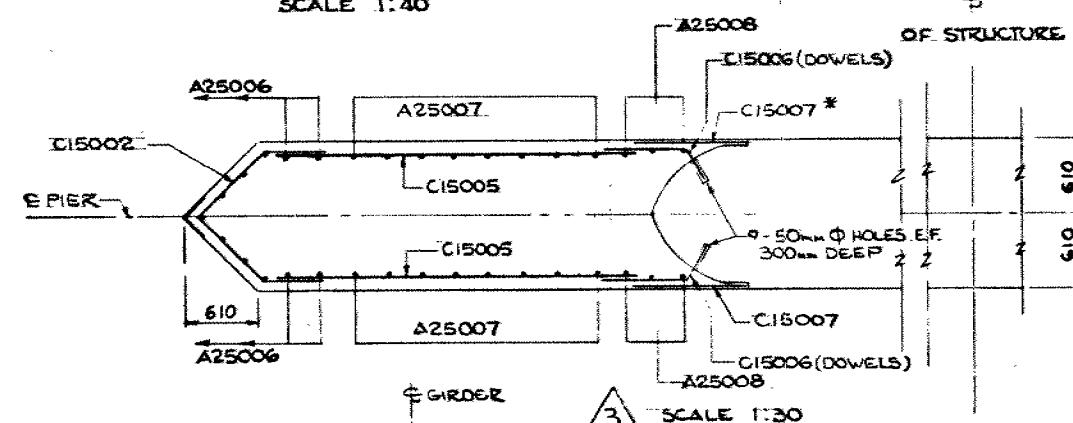
TOP REINF.



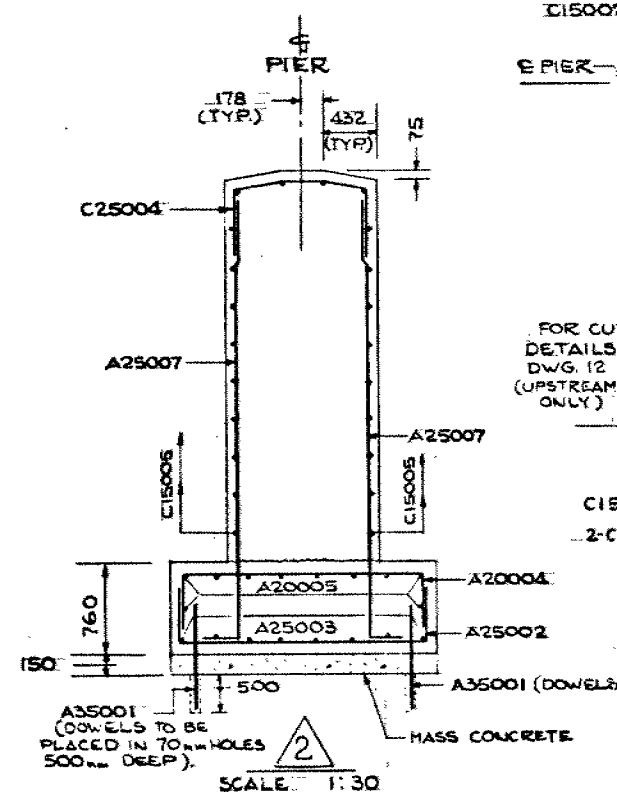
PLAN OF PIER FOOTING
SCALE 1:30



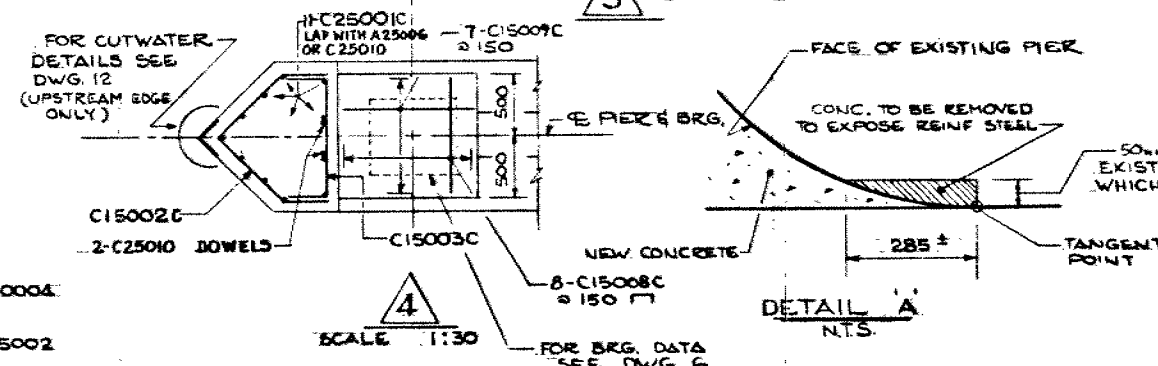
SCALE 1:40



SCALE 1:30



SCALE 1:30



SCALE 1:30



DRAWING NOT TO BE SCALED
100 mm ON ORIGINAL DRAWING

REVISIONS	DATE	BY	DESCRIPTION	DATE	BY
DESIGN		C.S.	LOADING		
DRAWING		C.S.	SITE No.		

FOUNDATION INVESTIGATION REPORT

CONTRACT NO 86-62



Ministry of
Transportation and
Communications

I N D E X

<u>Page Number</u>	<u>Description</u>
1	Index
2	Abbreviations and Symbols
3-24	Foundation Investigation Report for Rideau River Bridge Widening W. P. 85-84-01, Site: 3-73 Highway #417, District #9, Ottawa

NOTE: For the purpose of this contract this report supercedes all other foundation reports prepared by or for the Ministry in connection with the above-noted project.

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

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

SOILS ARE DESCRIBED BY THEIR COMPOSITION AND CONSISTENCY OR DENSENESS.

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

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

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

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

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

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

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

RQD (%)	0 - 25	25 - 50	50 - 75	75 - 90	90 - 100
	VERY POOR	POOR	FAIR	GOOD	EXCELLENT

JOINTING AND BEDDING:

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

ABBREVIATIONS AND SYMBOLS

FIELD SAMPLING

SS	SPLIT SPOON	TP	THINWALL PISTON
WS	WASH SAMPLE	OS	OSTERBERG SAMPLE
ST	SLOTTED TUBE SAMPLE	RC	ROCK CORE
BS	BLOCK SAMPLE	PH	TW ADVANCED HYDRAULICALLY
CS	CHUNK SAMPLE	PM	TW ADVANCED MANUALLY
TW	THINWALL OPEN	FS	FOIL SAMPLE

STRESS AND STRAIN

u_w	kPa	PORE WATER PRESSURE
r_u	1	PORE PRESSURE RATIO
σ	kPa	TOTAL NORMAL STRESS
σ'	kPa	EFFECTIVE NORMAL STRESS
τ	kPa	SHEAR STRESS
$\sigma_1, \sigma_2, \sigma_3$	kPa	PRINCIPAL STRESSES
ϵ	%	LINEAR STRAIN
$\epsilon_1, \epsilon_2, \epsilon_3$	%	PRINCIPAL STRAINS
E	kPa	MODULUS OF LINEAR DEFORMATION
G	kPa	MODULUS OF SHEAR DEFORMATION
μ	1	COEFFICIENT OF FRICTION

MECHANICAL PROPERTIES OF SOIL

m_v	kPa ⁻¹	COEFFICIENT OF VOLUME CHANGE
C_c	1	COMPRESSION INDEX
C_s	1	SWELLING INDEX
C_α	1	RATE OF SECONDARY CONSOLIDATION
c_v	m ² /s	COEFFICIENT OF CONSOLIDATION
H	m	DRAINAGE PATH
T_v	1	TIME FACTOR
U	%	DEGREE OF CONSOLIDATION
σ'_{vo}	kPa	EFFECTIVE OVERBURDEN PRESSURE
σ'_p	kPa	PRECONSOLIDATION PRESSURE
τ_f	kPa	SHEAR STRENGTH
c'	kPa	EFFECTIVE COHESION INTERCEPT
ϕ'	-°	EFFECTIVE ANGLE OF INTERNAL FRICTION
c_u	kPa	APPARENT COHESION INTERCEPT
ϕ_u	-°	APPARENT ANGLE OF INTERNAL FRICTION
τ_R	kPa	RESIDUAL SHEAR STRENGTH
τ_r	kPa	REMOULDED SHEAR STRENGTH
S_f	1	SENSITIVITY = $\frac{c_u}{\tau_r}$

PHYSICAL PROPERTIES OF SOIL

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

FOUNDATION INVESTIGATION REPORT

For

Rideau River Bridge Widening

W.P. 85-84-01, Site 3-73

Hwy. 417, District 9, OttawaINTRODUCTION

This report summarizes the factual information obtained from a foundation investigation carried out at the above-mentioned site between 84 11 21 and 84 11 29. The fieldwork consisted of 12 sampled boreholes ranging in depth from 1.9 to 4.4 m below the ground or water surface. The boreholes were advanced by means of hollow or solid stem augers on land and wash boring techniques on the river.

Bedrock was proven in all the boreholes by obtaining up to 2.7 m of rock core.

SITE DESCRIPTION AND GEOLOGY

The site is located at the existing Hwy. 417 (Hurdman) bridge over the Rideau River in the eastern end of the City of Ottawa in the Regional Municipality of Ottawa-Carleton. Land use in the vicinity of the site is predominantly recreational and institutional.

Topography across the site is generally flat. The Rideau River flows in a northerly direction and is approximately 150 m wide at this site. The river is relatively shallow at this location and varies from 0.3 to 1.3 m deep. A small shallow island is located just south of existing pier 3.

The site lies on the Ottawa Valley Clay Plain and is characterized by silty clay deposits. This silty clay is underlain by black shale of the Billings formation.

SUBSURFACE CONDITIONS

General

The subsurface conditions across the site are quite uniform. A surficial deposit of a heterogeneous mixture of silty clay, sand with shale fragments was encountered on the river banks and on the island. This cohesive deposit varies in thickness from 0.9 to 2.3 m and is underlain by shale bedrock which is generally highly to moderately weathered in the upper 0.5 m.

The borings located in the Rideau River were carried out in water depths ranging from 0.2 to 0.5 m. The river bottom is strewn with boulders ranging in size from 15 to 50 cm. Shale bedrock was encountered underlying the boulders and was proven to a depth of 2.7 m.

The boundaries between the soil types, insitu and laboratory test results, and ground water levels, are shown on the attached Record of Borehole Sheets. The locations and elevations of the borings, along with 6 estimated stratigraphical sections based on borehole data, are shown on Drawing No. 2 of the contract drawings.

The subsoils encountered are described in the following paragraphs.

Heterogeneous Mixture of Silty Clay, Sand with Shale Fragments

This generally cohesive deposit was encountered at the abutments and on the island near BH 5. The thickness of this stratum is 0.9 m at BH 5, and varies from 1.2 to 2.3 m at the abutments.

Atterberg limits tests were carried out on 3 samples from this stratum indicating the deposit is generally a silty clay of low plasticity (CL zone) with occasional localized pockets of organic silt of low plasticity (OL zone). The results of these tests are plotted on Fig. 1. Natural water content of this material varied between 10 and 21%.

Results of grain size distribution tests conducted on 3 samples of this material are plotted on Fig. 2 and can be summarized as follows:

	<u>Range</u>
Gravel	36-41%
Sand	37-44%
Silt	11-18%
Clay	4- 7%

Based on this information, this stratum can be described as a heterogeneous mixture of silty clay, sand with shale fragments. The silt and clay act as a binder in this heterogeneous soil mixture.

Organic tests carried out on samples of the localized organic silt pockets indicate the organic content varies from 2 to 6%.

Based on the interpretation of Standard Penetration test 'N' values ranging from 4 to 22, the consistency of this generally cohesive deposit is assessed to be firm to very stiff.

Shale Bedrock

Bedrock at the site was proven in all boreholes by obtaining up to 2.7 m of BX rock core.

Bedrock was encountered 1.2 to 2.3 m below the ground surface at the abutments and up to 0.5 m below the water surface at the existing pier locations. The bedrock within the river channel is generally overlain by boulders varying in size from 0.2 to 0.5 m. These depths correspond to a bedrock elevation ranging from 54.5 to 54.9 m.

Bedrock at this location consists of black shale of the Ordovician Period. The upper 0.2 to 0.6 m zone is in a highly to slightly weathered state. In 3 boreholes, it was possible to drive a split-spoon through the highly weathered zone. The bedrock becomes less weathered with depth (see borehole logs), with the unweathered zone being encountered at an elevation ranging from 54.2 to 54.6 m.

The thinly and horizontally bedded shale of the Billings Formation may, in some instances, be susceptible to slaking and degradation when exposed to the atmosphere. Consequently, the bottom of an excavation in this type of shale may experience heaving if the excavation is kept open for a considerable length of time.

The core recovery attained in the boreholes ranged from 52 to 100%. Borehole 1, sample RC-4 yielded 0% recovery, however, this unrealistic value can be attributed to mechanical problems experienced during the coring process.

Based on rock quality designation (RQD) values ranging from 0 to 100%, the quality of the bedrock is assessed to range from very poor in the weathered zones to excellent in the unweathered zones.

For a detailed description of the bedrock, see Description of Rock Core in the Appendix.

Groundwater

The groundwater levels recorded at elevation 55.3 m generally correspond to the river level. The groundwater level at the river banks is probably controlled by the river level.



A handwritten signature in black ink, appearing to read "L. R. Politano", written over a horizontal line.

L. Politano, P. Eng.
Project Foundations Engineer

A handwritten signature in black ink, appearing to read "M. Devata", written over a horizontal line.

M. Devata, P. Eng.
Chief Foundations Engineer (East)

APPENDIX

RECORD OF BOREHOLE No 1


METRIC



W P 85-84-01 LOCATION Sta. 31 + 301.0; O/S 22.0 m Rt. 4 Hwy. 417 ORIGINATED BY HS
 DIST 9 HWY 417 BOREHOLE TYPE Solid Stem Auger & BX Rock Core COMPILED BY DT
 DATUM Geodetic DATE 84 11 23 CHECKED BY CP

SOIL PROFILE			SAMPLES			GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT					UNIT WEIGHT γ	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																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																												
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RECORD OF BOREHOLE No 2

METRIC

W P 85-84-01 LOCATION Sta. 31 + 297.0; O/S 17.5 m Lt. ϵ Hwy. 417 ORIGINATED BY HS
 DIST 9 HWY 417 BOREHOLE TYPE Hollow Stem Auger, BX Rock Core COMPILED BY DT
 DATUM Geodetic DATE 84 11 23 CHECKED BY 

SOIL PROFILE			SAMPLES			GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT					PLASTIC LIMIT W _p	NATURAL MOISTURE CONTENT W	LIQUID LIMIT W _L	UNIT WEIGHT γ	REMARKS & GRAIN SIZE DISTRIBUTION (%)
ELEV DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE	'N' VALUES			20	40	60	80	100					
57.0	Ground Surface																
0.0	Heterogeneous Mixture of Silty Clay, Sand with Shale Fragments		1	SS	22	* 10 cm	56									3%	36 42 17 5
	Very Stiff																
	Stiff		2	SS	11												
54.8			3	SS	50		55										
2.2	Slightly Weathered Unweathered		4	BX RC	REC 93%		54										RQD = 70%
	Black Shale Bedrock																
			5	BX RC	REC 91%		53										RQD = 26%
52.6																	
4.4	End of Borehole																
	* Water Level Not Established																
	** Org.M. indicates percentage of organic matter by weight																



RECORD OF BOREHOLE No 3

METRIC

W P 85-84-01 LOCATION Sta. 31 + 275.4; O/S 18.3 m Rt. Q Hwy. 417 ORIGINATED BY DT
DIST 9 HWY 417 BOREHOLE TYPE BX Rock Core COMPILED BY DT
DATUM Geodetic DATE 84 11 27 CHECKED BY [Signature]





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 Y	REMARKS & GRAIN SIZE DISTRIBUTION (%)
ELEV DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE	'N' VALUES			20	40	60	80	100					
55.3	Water Surface																GR SA SI CL
0.0	Water						55										
54.8	River Bottom Boulder Strewn																
0.5	Black Shale Bedrock Unweathered		1	BX RC	REC 100%												RQD = 19%
			2	BX RC	REC 96%		54										RQD = 93%
			3	BX RC	REC 100%												RQD = 100%
53.2																	
2.1	End of Borehole																



RECORD OF BOREHOLE No 4

METRIC

W P 85-84-01 LOCATION Sta. 31 + 275.4; O/S 18.0 m Lt. E Hwy. 417 ORIGINATED BY DT
DIST 9 HWY 417 BOREHOLE TYPE 37 mm Dia. Rock Core COMPILED BY DT
DATUM Geodetic DATE 84 11 28 CHECKED BY [Signature]




SOIL PROFILE			SAMPLES			GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT 						PLASTIC LIMIT W _p	NATURAL MOISTURE CONTENT W	LIQUID LIMIT W _L	UNIT WEIGHT γ	REMARKS & GRAIN SIZE DISTRIBUTION (%) GR SA SI CL
ELEV DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE	'N' VALUES			SHEAR STRENGTH										
								○ UNCONFINED + FIELD VANE ● QUICK TRIAXIAL x LAB VANE										
55.3	Water Surface																	
0.0	River Bottom						55											
55.0	Boulders Quartzite		1	RC	REC 71%												RQD = 0%	
0.5	Black Shale Bedrock Unweathered		2	RC	REC 93%												RQD = 0%	
			3	RC	REC 96%		54											RQD = 96%
53.2																		
2.1	End of Borehole																	



RECORD OF BOREHOLE No 5

METRIC

W P 85-84-01 LOCATION Sta. 31 + 240.0; O/S 17.5 m Rt. E Hwy. 417 ORIGINATED BY DT
DIST 9 HWY 417 BOREHOLE TYPE Hollow Stem Auger, BX Rock Core COMPILED BY DT
DATUM Geodetic DATE 84 11 27 CHECKED BY [Signature]



SOIL PROFILE			SAMPLES			GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT 					PLASTIC LIMIT W _p	NATURAL MOISTURE CONTENT W	LIQUID LIMIT W _L	UNIT WEIGHT γ	REMARKS & GRAIN SIZE DISTRIBUTION (%)		
ELEV DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE	'N' VALUES														
								SHEAR STRENGTH ○ UNCONFINED + FIELD VANE ● QUICK TRIAXIAL x LAB VANE											
WATER CONTENT (%)																			
55.5	Ground Surface															Org M.**	GR SA SI CL		
0.0	Heterogeneous Mixture of Silty Clay, Sand with Shale Fragments Very Stiff <u>Highly Weathered</u> <u>Slightly Weathered</u> <u>Unweathered</u> Black Shale Bedrock					 13 cm	55									3%			
54.6			1	SS	50													RQD = 0%	
0.9			2	BX RC	REC 56%														RQD = 69%
			3	BX RC	REC 93%														
			4	BX RC	REC 100%		53										RQD = 93%		
51.9							52												
3.6	End of Borehole																		
** Org.M. indicates percentage of organic matter by weight.																			



RECORD OF BOREHOLE No 6

METRIC

W P 85-84-01 LOCATION Sta. 31 + 240.0; O/S 15.8 m Lt. E Hwy. 417 ORIGINATED BY DT
DIST 9 HWY 417 BOREHOLE TYPE BX Rock Core COMPILED BY DT
DATUM Geodetic DATE 84 11 26 CHECKED BY [Signature]

SOIL PROFILE			SAMPLES			GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT 						PLASTIC LIMIT W _p	NATURAL MOISTURE CONTENT W	LIQUID LIMIT W _L	UNIT WEIGHT γ	REMARKS & GRAIN SIZE DISTRIBUTION (%) GR SA SI CL				
ELEV DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE	'N' VALUES			SHEAR STRENGTH											WATER CONTENT (%)			
								○ UNCONFINED + FIELD VANE ● QUICK TRIAXIAL x LAB VANE														
55.3	Water Surface																					
55.1	River Bottom						55															
54.8	Boulders																					
0.5	Highly Weathered Unweathered		1	BX RC	REC 68%			54										RQD = 36%				
	Black Shale Bedrock		2	BX RC	REC 81%														RQD = 40%			
		3	BX RC	REC 92%		53											RQD = 92%					
52.3																						
3.0	End of Borehole																					



RECORD OF BOREHOLE No 7

METRIC

W P 85-84-01 LOCATION Sta. 31 + 225.0; O/S 18.3 m Rt. 417 ORIGINATED BY DT
DIST 9 HWY 417 BOREHOLE TYPE 37 mm Dia. Rock Core COMPILED BY DT
DATUM Geodetic DATE 84 11 29 CHECKED BY [Signature]

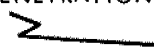

SOIL PROFILE			SAMPLES			GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT					PLASTIC LIMIT W _p	NATURAL MOISTURE CONTENT W	LIQUID LIMIT W _L	UNIT WEIGHT γ	REMARKS & GRAIN SIZE DISTRIBUTION (%) GR SA SI CL
ELEV DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE	'N' VALUES			20	40	60	80	100					
55.3	Water Surface																
0.0	Water						55										
54.8	River Bottom																
0.5	Boulder Strewn																
	Slightly Weathered		1	BX	REC												RQD = 39%
	Unweathered			RC	89%												
	Black Shale Bedrock		2	BX	REC		54										RQD = 95%
				RC	100%												
53.4			3	BX	REC												RQD = 100%
				RC	100%												
1.9	End of Borehole																



RECORD OF BOREHOLE No 8

METRIC

W P 85-84-01 LOCATION Sta. 31 + 225.0; O/S 16.2 m Lt. & Hwy. 417 ORIGINATED BY DT
DIST 9 HWY 417 BOREHOLE TYPE BX Rock Core COMPILED BY DT
DATUM Geodetic DATE 84 11 26 CHECKED BY [Signature]


SOIL PROFILE			SAMPLES			GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT 					PLASTIC LIMIT W _p	NATURAL MOISTURE CONTENT W	LIQUID LIMIT W _L	UNIT WEIGHT γ	REMARKS & GRAIN SIZE DISTRIBUTION (%) GR SA SI CL			
ELEV DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE	'N' VALUES			SHEAR STRENGTH										WATER CONTENT (%)		
								○ UNCONFINED	+ FIELD VANE	● QUICK TRIAXIAL	x LAB VANE									
55.3	Water Surface																			
55.1	River Bottom						55													
54.8	Boulders																			
0.5	Highly Weathered Unweathered		1	BX RC	REC 52%				54											RQD = 39%
	Black Shale Bedrock		2	BX RC	REC 85%															RQD = 34%
52.6							53													
2.7	End of Borehole																			



RECORD OF BOREHOLE No 9

METRIC

W P 85-84-01 LOCATION Sta. 31 + 172.2; O/S 16.6 m Rt. \mathcal{C} Hwy. 417 ORIGINATED BY DT
DIST 9 HWY 417 BOREHOLE TYPE BX Rock Core COMPILED BY DT
DATUM Geodetic DATE 84 11 26 CHECKED BY [Signature]

SOIL PROFILE			SAMPLES			GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT 					PLASTIC LIMIT W _p	NATURAL MOISTURE CONTENT W	LIQUID LIMIT W _L	UNIT WEIGHT γ	REMARKS & GRAIN SIZE DISTRIBUTION (%) GR SA SI CL
ELEV DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE	'N' VALUES			20	40	60	80	100					
55.3	Water Surface																
0.0	River Bottom																
55.0	Boulders						55										
0.4	Slightly Weathered		1	BX RC	REC 75%												RQD = 0%
	Unweathered		2	BX RC	REC 91%		54										RQD = 79%
	Black Shale Bedrock		3	BX RC	REC 85%		53										RQD = 83%
52.2																	
3.1	End of Borehole																



RECORD OF BOREHOLE No 10

METRIC

W P 85-84-01 LOCATION Sta. 31 + 172.0; O/S 16.4 m Lt. 4 Hwy. 417 ORIGINATED BY DT
DIST 9 HWY 417 BOREHOLE TYPE Hollow Stem Auger, BX Rock Core COMPILED BY DT
DATUM Geodetic DATE 84 11 23 CHECKED BY [Signature]

SOIL PROFILE			SAMPLES			GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT					UNIT WEIGHT γ	REMARKS & GRAIN SIZE DISTRIBUTION (%) GR SA SI CL
ELEV DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE	'N' VALUES			SHEAR STRENGTH						
								○ UNCONFINED + FIELD VANE ● QUICK TRIAXIAL x LAB VANE						
								WATER CONTENT (%) 						
55.3	Water Surface													
55.1	River Bottom						55							
0.2	Boulders													
54.5	Limestone Boulders		1	BX RC	REC 91%									
0.8	Black Shale Bedrock Unweathered		2	BX RC	REC 100%			54						
53.2														RQD = 64%
2.1	End of Borehole													



RECORD OF BOREHOLE No 11

METRIC

W P 85-84-01 LOCATION Sta. 31 + 144.2; O/S 19.2 m Rt. 417 ORIGINATED BY DT
DIST 9 HWY 417 BOREHOLE TYPE Hollow Stem Auger, BX Rock Core COMPILED BY DT
DATUM Geodetic DATE 84 11 23 CHECKED BY [Signature]

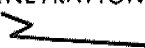



SOIL PROFILE			SAMPLES			GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT					PLASTIC LIMIT W _p	NATURAL MOISTURE CONTENT W	LIQUID LIMIT W _L	UNIT WEIGHT γ	REMARKS & GRAIN SIZE DISTRIBUTION (%)
ELEV DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE	'N' VALUES			20	40	60	80	100					
56.3	Ground Surface																
0.0	Heterogeneous Mixture Of Silty Clay, Sand with Shale Fragments Firm		1	SS	4	 8 cm	56									7%	
54.6			2	SS	100/		55										
1.7	Moderately Weathered Unweathered Black Shale Bedrock		3	BX RC	REC 77%		54										RQD = 46%
			4	BX RC	REC 86%												RQD = 28%
			5	BX RC	REC 100%		53										RQD = 63%
52.6	End of Borehole																
3.7	* Org.M. indicates percentage of organic matter by weight																



RECORD OF BOREHOLE No 12

METRIC

W P 85-84-01 LOCATION Sta. 31 + 146.0: O/S 16.3 m Lt. 4 Hwy. 417 ORIGINATED BY DT
DIST 9 HWY 417 BOREHOLE TYPE Hollow Stem Auger, BX Rock Core COMPILED BY DT
DATUM Geodetic DATE 84 11 23 CHECKED BY [Signature]

SOIL PROFILE			SAMPLES			GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT 					PLASTIC LIMIT W _p	NATURAL MOISTURE CONTENT W	LIQUID LIMIT W _L	UNIT WEIGHT γ	REMARKS & GRAIN SIZE DISTRIBUTION (%) GR SA SI CL			
ELEV DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE	'N' VALUES			SHEAR STRENGTH										WATER CONTENT (%)		
								○ UNCONFINED	+ FIELD VANE	● QUICK TRIAXIAL	x LAB VANE									
56.0	Ground Surface																			
0.0	Heterogeneous Mixture of Silty Clay, Sand with Shale Fragments Stiff					 5 cm	55										41 44 11 4			
54.8			1	SS	9															
1.2	Moderately Weathered Unweathered		2	SS	50			54												RQD = 41%
			3	BX RC	REC 65%														RQD = 77%	
			4	BX RC	REC 97%														RQD = 50%	
52.6	Black Shale Bedrock		5	BX RC	REC 88%	53														
3.4	End of Borehole																			

DESCRIPTION OF ROCK CORE - W.P. 85-84-01

20

BOREHOLE NUMBER				CORE DESCRIPTION	
	DEPTH (m)	% CR *	% RQD *	DEPTH (m)	DESCRIPTION
1	2.3 - 2.6	0	0	2.3 - 2.6	No core recovered; assumed highly weathered shale
	2.6 - 3.9	92	53	2.6 - 2.7	Shale, black, moderately weathered, very closely spaced joints
				2.7 - 3.9	Shale, black, unweathered, moderately spaced joints
2	2.2 - 3.3	93	70	2.2 - 2.4	Shale, black, slightly weathered, very closely spaced joints
	3.3 - 4.4	91	26	2.4 - 4.4	Shale, black, unweathered with near-vertical joint from 3.9 to 4.4 m
3	0.5 - 1.0	100	19	0.5 - 0.9	Shale, black, unweathered, very closely spaced joints
	1.0 - 1.7	96	93	0.9 - 2.1	Shale, black, unweathered, moderately spaced joints
	1.7 - 2.1	100	100		
4	0.4 - 0.5	71	0	0.4 - 0.5	Boulders (quartzite)
	0.5 - 0.9	93	0	0.5 - 0.9	Shale, black, unweathered, very closely spaced joints
	0.9 - 2.1	96	96	0.9 - 2.1	Shale, black, unweathered, moderately spaced joints
5	0.9 - 1.2	56	0	0.6 - 0.9	Split spoon sample - Shale, black, highly weathered
	1.2 - 2.2	93	69	0.9 - 1.2	Shale, black, slightly weathered, very closely spaced joints; core loss zone
	2.2 - 3.6	100	93	1.2 - 3.6	Shale, black, unweathered, moderately spaced joints, clay zone (3 cm thick) at 3.63 to 3.65

* CR = CORE RECOVERY ; RQD = ROCK QUALITY DESIGNATION

DESCRIPTION OF ROCK CORE - W.P. 85-84-01

21

BOREHOLE NUMBER				CORE DESCRIPTION	
	DEPTH (m)	% CR *	% RQD *	DEPTH (m)	DESCRIPTION
6	0.5 - 1.2	68	36	0.5 - 0.8	Shale, black, highly weathered; core loss assumed at top of run
	1.2 - 2.4	81	40		
	2.4 - 3.0	92	92	0.8 - 3.0	Shale, black, unweathered, closely spaced joints, with some very closely spaced zones
7	0.5 - 0.9	89	39	0.5 - 0.7	Shale, black, slightly weathered, very closely spaced joints
	0.9 - 1.5	100	95		
	1.5 - 1.9	100	100	0.7 - 1.9	Shale, black, unweathered, moderately spaced joints
8	0.5 - 1.3	52	39	0.5 - 1.0	Shale, black, highly weathered; core loss zone
	1.3 - 2.7	85	34	1.0 - 2.7	Shale, black, unweathered, closely spaced joints with near-vertical joint from 1.9 to 2.5 m
9	0.4 - 0.7	75	0	0.4 - 0.6	Shale, black, slightly weathered, very closely spaced joints
	0.7 - 1.5	91	79		
	1.5 - 3.1	85	83	0.6 - 3.1	Shale, black, unweathered, moderately spaced joints
10	0.6 - 1.2	91	42	0.6 - 0.8	Boulders (limestone)
	1.2 - 2.1	100	64	0.8 - 2.1	Shale, black, unweathered, closely to moderately spaced joints

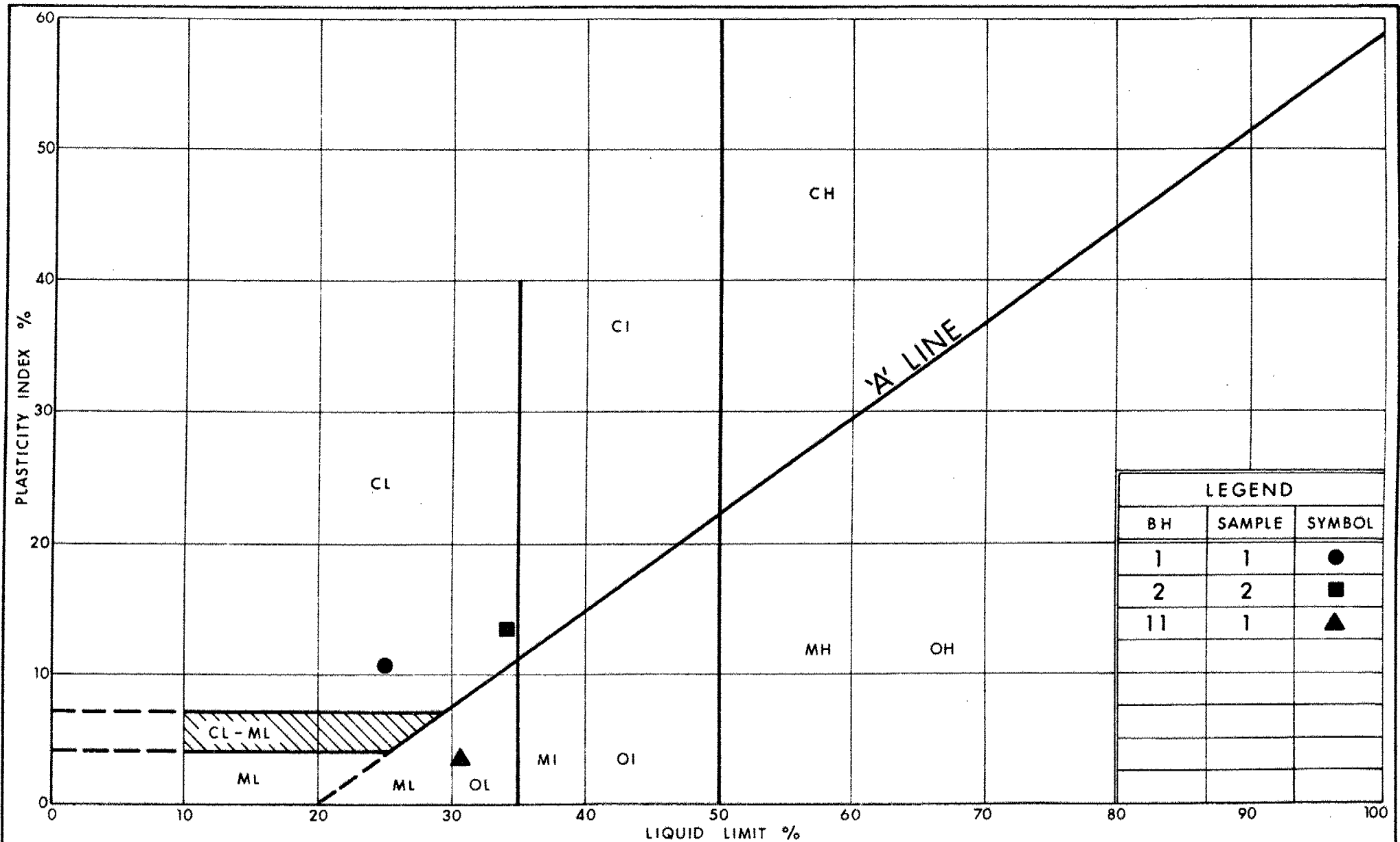
* CR = CORE RECOVERY ; RQD = ROCK QUALITY DESIGNATION

DESCRIPTION OF ROCK CORE - W.P. 85-84-01

22

BOREHOLE NUMBER				CORE DESCRIPTION	
	DEPTH (m)	% CR *	% RQD *	DEPTH (m)	DESCRIPTION
11	1.9 - 2.3	77	46	1.9 - 2.0	Shale, black, moderately weathered, very closely spaced joints
	2.3 - 2.8	86	28	2.0 - 3.7	Shale, black, unweathered, closely to moderately spaced joints, with near-vertical joint from 2.8 to 3.1 m
	2.8 - 3.7	100	63		
12	1.5 - 1.9	65	41	1.5 - 1.8	Shale, black, moderately weathered, very closely spaced joints
	1.9 - 2.8	97	77	1.8 - 3.4	Shale, black, unweathered, moderately spaced joints, with near-vertical joint from 3.2 to 3.3 m
	2.8 - 3.4	88	50		

* CR = CORE RECOVERY ; RQD = ROCK QUALITY DESIGNATION



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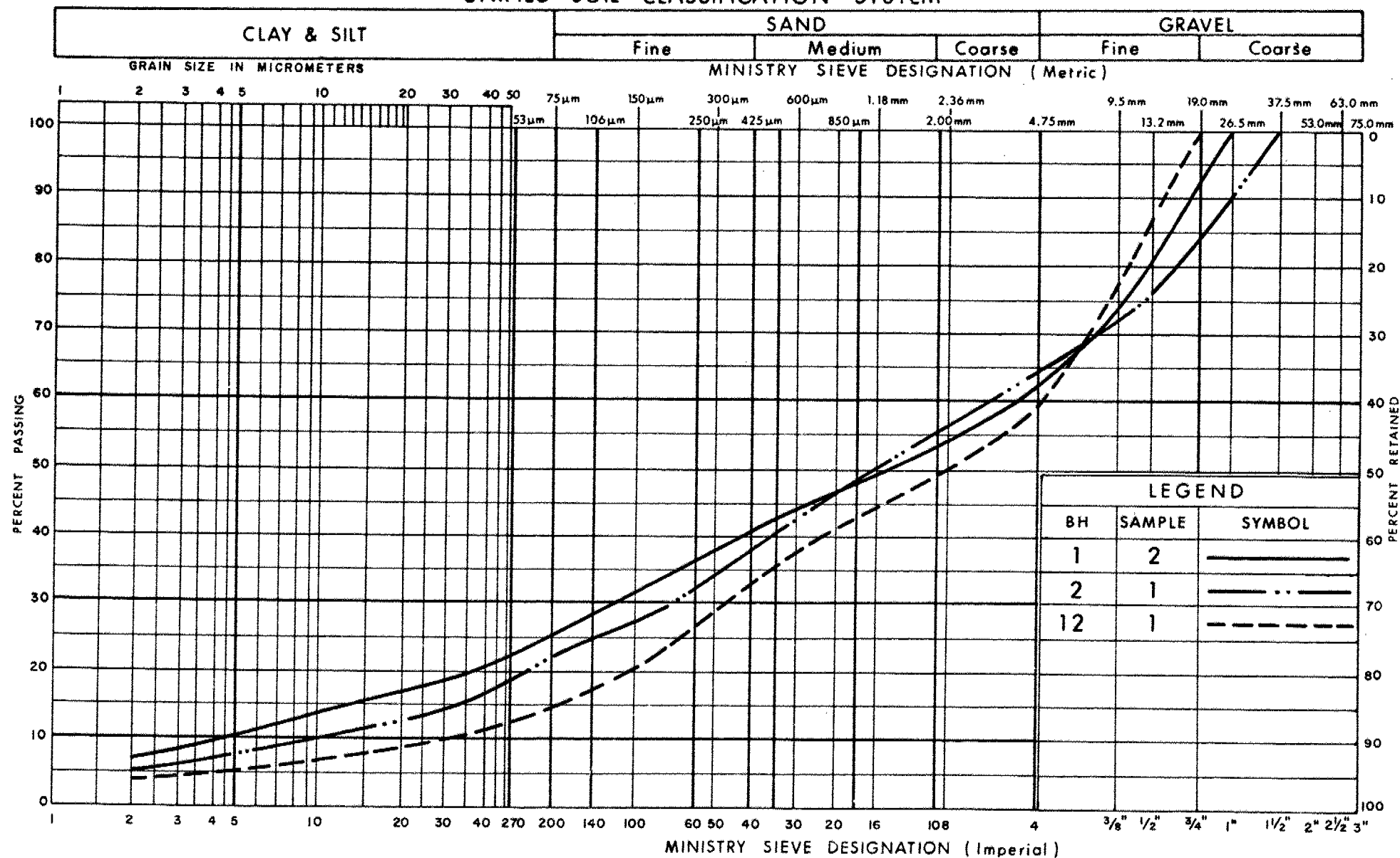
Ontario

PLASTICITY CHART
HET MIXTURE OF
SILTY CLAY, SAND WITH SHALE FRAGMENTS

FIG No 1

W P 85-84-01

UNIFIED SOIL CLASSIFICATION SYSTEM



Ministry of
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Communications

GRAIN SIZE DISTRIBUTION
HET MIXTURE OF
SILTY CLAY, SAND WITH SHALE FRAGMENTS

FIG No 2

W P 85-84-01



ENGINEERING MATERIALS OFFICE
FOUNDATION DESIGN SECTION

WP 85-84-01

DIST 9

HWY 417

STR SITE 3-73

Rideau River Bridge Widening

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FOUNDATION INVESTIGATION REPORT

For

Rideau River Bridge Widening

W.P. 85-84-01, Site 3-73

Hwy. 417, District 9, Ottawa

INTRODUCTION

This report summarizes the factual information obtained from a foundation investigation carried out at the above-mentioned site between 84 11 21 and 84 11 29. The fieldwork consisted of 12 sampled boreholes ranging in depth from 1.9 to 4.4 m below the ground or water surface. The boreholes were advanced by means of hollow or solid stem augers on land and wash boring techniques on the river.

Bedrock was proven in all the boreholes by obtaining up to 2.7 m of rock core.

SITE DESCRIPTION AND GEOLOGY

The site is located at the existing Hwy. 417 (Hurdman) bridge over the Rideau River in the eastern end of the City of Ottawa in the Regional Municipality of Ottawa-Carleton. Land use in the vicinity of the site is predominantly recreational and institutional.

Topography across the site is generally flat. The Rideau River flows in a northerly direction and is approximately 150 m wide at this site. The river is relatively shallow at this location and varies from 0.3 to 1.3 m deep. A small shallow island is located just south of existing pier 3.

The site lies on the Ottawa Valley Clay Plain and is characterized by silty clay deposits. This silty clay is underlain by black shale of the Billings formation.

SUBSURFACE CONDITIONS

General

The subsurface conditions across the site are quite uniform. A surficial deposit of a heterogeneous mixture of silty clay, sand with shale fragments was encountered on the river banks and on the island. This cohesive deposit varies in thickness from 0.9 to 2.3 m and is underlain by shale bedrock which is generally highly to moderately weathered in the upper 0.5 m.

The borings located in the Rideau River were carried out in water depths ranging from 0.2 to 0.5 m. The river bottom is strewn with boulders ranging in size from 15 to 50 cm. Shale bedrock was encountered underlying the boulders and was proven to a depth of 2.7 m.

The boundaries between the soil types, insitu and laboratory test results, and ground water levels, are shown on the attached Record of Borehole Sheets. The locations and elevations of the borings, along with 6 estimated stratigraphical sections based on borehole data, are shown on Drawings 858401A & B.

The subsoils encountered are described in the following paragraphs.

Heterogeneous Mixture of Silty Clay, Sand with Shale Fragments

This generally cohesive deposit was encountered at the abutments and on the island near BH 5. The thickness of this stratum is 0.9 m at BH 5, and varies from 1.2 to 2.3 m at the abutments.

Atterberg limits tests were carried out on 3 samples from this stratum indicating the deposit is generally a silty clay of low plasticity (CL zone) with occasional localized pockets of organic silt of low plasticity (OL zone). The results of these tests are plotted on Fig. 1. Natural water content of this material varied between 10 and 21%.

Results of grain size distribution tests conducted on 3 samples of this material are plotted on Fig. 2 and can be summarized as follows:

	Range
Gravel	36 - 41%
Sand	37 - 44%
Silt	11 - 18%
Clay	4 - 7%

Based on this information, this stratum can be described as a heterogeneous mixture of silty clay, sand with shale fragments. The silt and clay act as a binder in this heterogeneous soil mixture.

Organic tests carried out on samples of the localized organic silt pockets indicate the organic content varies from 2 to 6%.

Based on the interpretation of Standard Penetration test 'N' values ranging from 4 to 22, the consistency of this generally cohesive deposit is assessed to be firm to very stiff.

Shale Bedrock

Bedrock at the site was proven in all boreholes by obtaining up to 2.7 m of BX rock core.

Bedrock was encountered 1.2 to 2.3 m below the ground surface at the abutments and up to 0.5 m below the water surface at the existing pier locations. The bedrock within the river channel is generally overlain by boulders varying in size from 0.2 to 0.5 m. These depths correspond to a bedrock elevation ranging from 54.5 to 54.9 m.

Bedrock at this location consists of black shale of the Ordovician Period. The upper 0.2 to 0.6 m zone is in a highly to slightly weathered state. In 3 boreholes, it was possible to drive a split-spoon through the highly weathered zone. The bedrock becomes less weathered with depth (see borehole logs), with the unweathered zone being encountered at an elevation ranging from 54.2 to 54.6 m.

The thinly and horizontally bedded shale of the Billings Formation may, in some instances, be susceptible to slaking and degradation when exposed to the atmosphere. Consequently, the bottom of an excavation in this type of shale may experience heaving if the excavation is kept open for a considerable length of time.

The core recovery attained in the boreholes ranged from 52 to 100%. Borehole 1, sample RC-4 yielded 0% recovery, however, this unrealistic value can be attributed to mechanical problems experienced during the coring process.

Based on rock quality designation (RQD) values ranging from 0 to 100%, the quality of the bedrock is assessed to range from very poor in the weathered zones to excellent in the unweathered zones.

For a detailed description of the bedrock, see Description of Rock Core in the Appendix.

Groundwater

The groundwater levels recorded at elevation 55.3 m generally correspond to the river level. The groundwater level at the river banks is probably controlled by the river level.

DISCUSSION AND RECOMMENDATIONS

General

The existing Hwy. 417 Rideau River structure (Hurdman Bridge) is five spans constructed of reinforced concrete with 25.9 m end spans and 35± m interior spans. The total span of the bridge is 156.9± m. There are presently six lanes of high speed traffic on the 29.7 m wide structure.

The Ministry intends to widen this structure on both sides to allow for one extra traffic lane in each direction. The proposed widening of the structure is to be carried out in isolation from the proposed rehabilitation work to be completed on the existing bridge.

The subsurface conditions generally consist of a shallow deposit of a heterogeneous mixture of silty clay, sand with shale fragments. This surficial deposit was encountered only at the river banks and on the island (BH 5). Underlying this stratum at the abutments, and underlying boulders within the river channel, is black shale bedrock which varies in elevation from 54.4 to 54.9 m.

The following paragraphs outline our recommendations pertaining to the design and construction of the structure foundations and related earthworks.

Structure Foundations

The abutments and piers may be founded on spread footings located within the shale bedrock. The spread footing may be founded either in the weathered or unweathered bedrock with elevations and the applicable bearing capacities listed below.

STRUCTURE COMPONENT	FOUNDING ELEV.(m)	BEDROCK CONDITION	BH.	LOADINGS	
				U.L.S. (kPa)	S.L.S. II (kPa)
West Abutment	54.4	moderately weathered	11,12	800	500
	54.2	unweathered		1500	-
Pier 1	54.4	unweathered	9,10	1500	-
Pier 2	54.7	highly weathered	7,8	700	400
	54.3	unweathered		1500	-
Pier 3	54.5	slightly weathered	5,6	800	500
	54.3	unweathered		1500	-
Pier 4	54.4	unweathered	3,4	1500	-
East Abutment	54.9	highly weathered	1,2	700	400
	54.4	unweathered		1500	-

In situations where the unweathered shale is used as the founding stratum, S.L.S. Type II loadings do not apply as the unweathered bedrock is considered to be unyielding.

If excavations are extended into unweathered shale at piers 2, 3 and the west abutment there is a possibility of undermining the existing footings which are founded at approximately elevation 54.4 m. The integrity of bedrock under the original footings should be maintained during construction.

General Foundation Requirements

1. A lean concrete working pad should be placed over the exposed shale bedrock within 12 hours of completion of the footing excavations. This is required since the shale bedrock is susceptible to slaking and possible heaving and degradation when exposed to the atmosphere. In view of this it is recommended that all excavation bases be protected with a 150 mm concrete working pad after the excavation is opened.

2. The following unfactored friction coefficient may be used for design of sliding between the base of the footing and the founding shale.

Weathered Shale	$\tan 18^\circ$
Unweathered Shale	$\tan 24^\circ$

3. All footing elements should be provided with a minimum of 1.8 m earth cover for frost protection purposes, since shales are susceptible to freezing actions.
4. The abutments should be backfilled with a free draining granular material as per SP 121 and earth pressures against the abutment wall should be computed as per Subsection 6.6.1.2 of the O.H.B.D.C. Manual. The soil properties to be used in earth pressure calculations are as follows:

	ϕ	(kN/m ³)
Granular 'A'	35°	22
Granular 'B'	30°	21

5. The abutment footings founded on bedrock should be assumed to be unyielding and therefore should be designed for the at rest (K_0) condition.

6. Dewatering at the pier locations will be required, as all footing excavations are within the river. Dewatering of the east abutment footing excavations is not anticipated as the footing will be founded within shale bedrock in the river banks. Some local seepage through the excavated cut slopes can be anticipated and can be controlled by pumping from sumps. Local sloughing of the cut slopes may occur where pockets of less cohesive soils are encountered.

The above recommendations will also be applicable to the west abutment provided construction is carried out at low river water levels. If the river level is high a dewatering scheme will be required to prevent water from flowing into the excavation.

7. All embankment widenings should be keyed into the existing fills as per DD-414.

Slope Stability and Settlement

No stability problems are anticipated, if fills at the abutments are constructed with standard 2:1 slopes.

Settlements are expected to be less than 25 mm for the widened approach embankments.

MISCELLANEOUS

The fieldwork for this investigation was carried out under the supervision of Mr. D. Thanasse, Student Engineer and Mr. H. Sturm, Project Foundations Engineer, utilizing equipment owned and operated by Marathon Drilling Co. Ltd., Ottawa. This report was written by Mr. D. Thanasse under the supervision of Mr. H. Sturm, and reviewed by Mr. M. Devata, Chief Foundations Engineer.



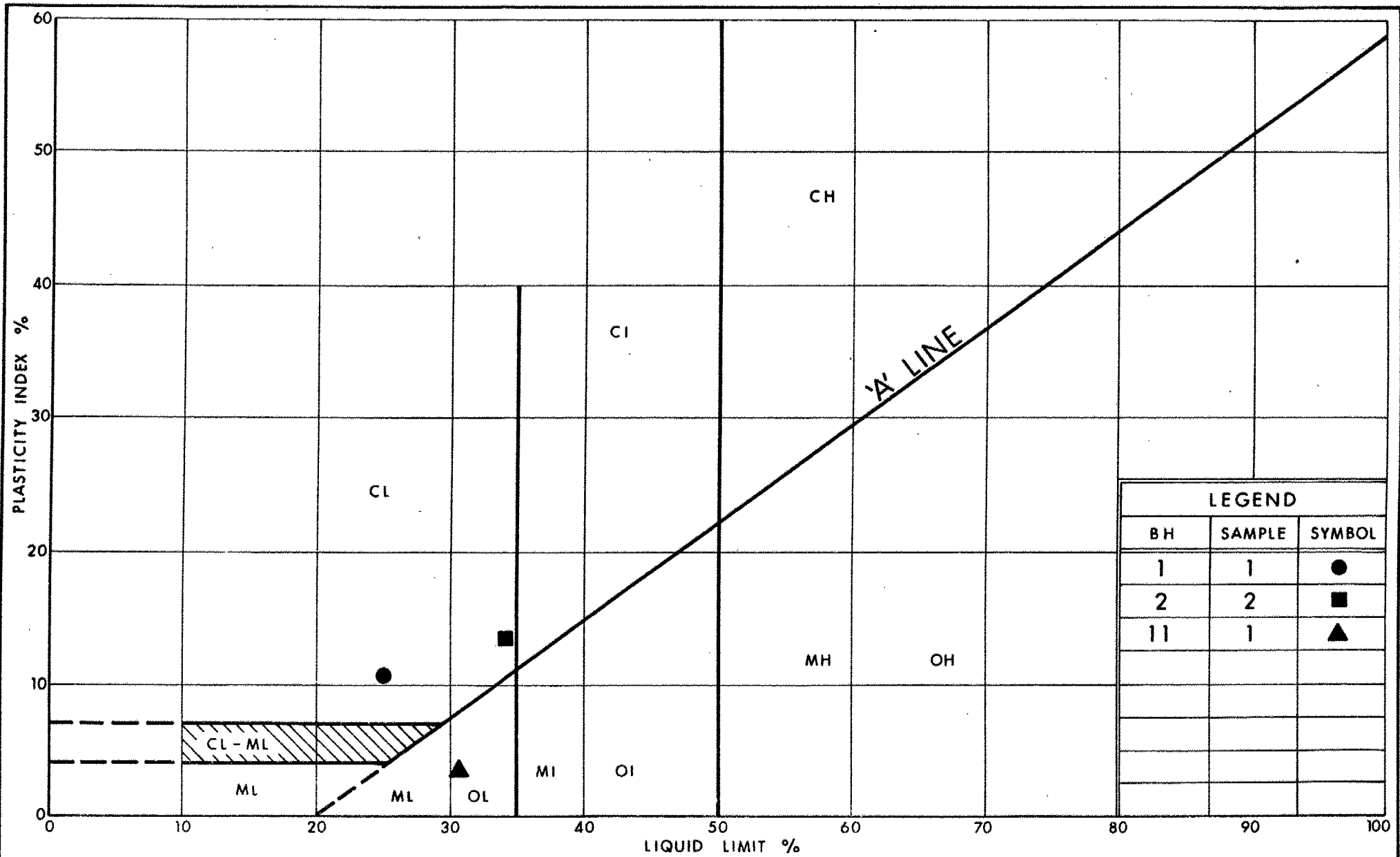
A handwritten signature in dark ink, appearing to read "H. Sturm".

H. Sturm, P.Eng.
Project Foundations Engineer

A handwritten signature in dark ink, appearing to read "M. Devata".

M. Devata, P.Eng.
Chief Foundations Engineer (East)

A P P E N D I X



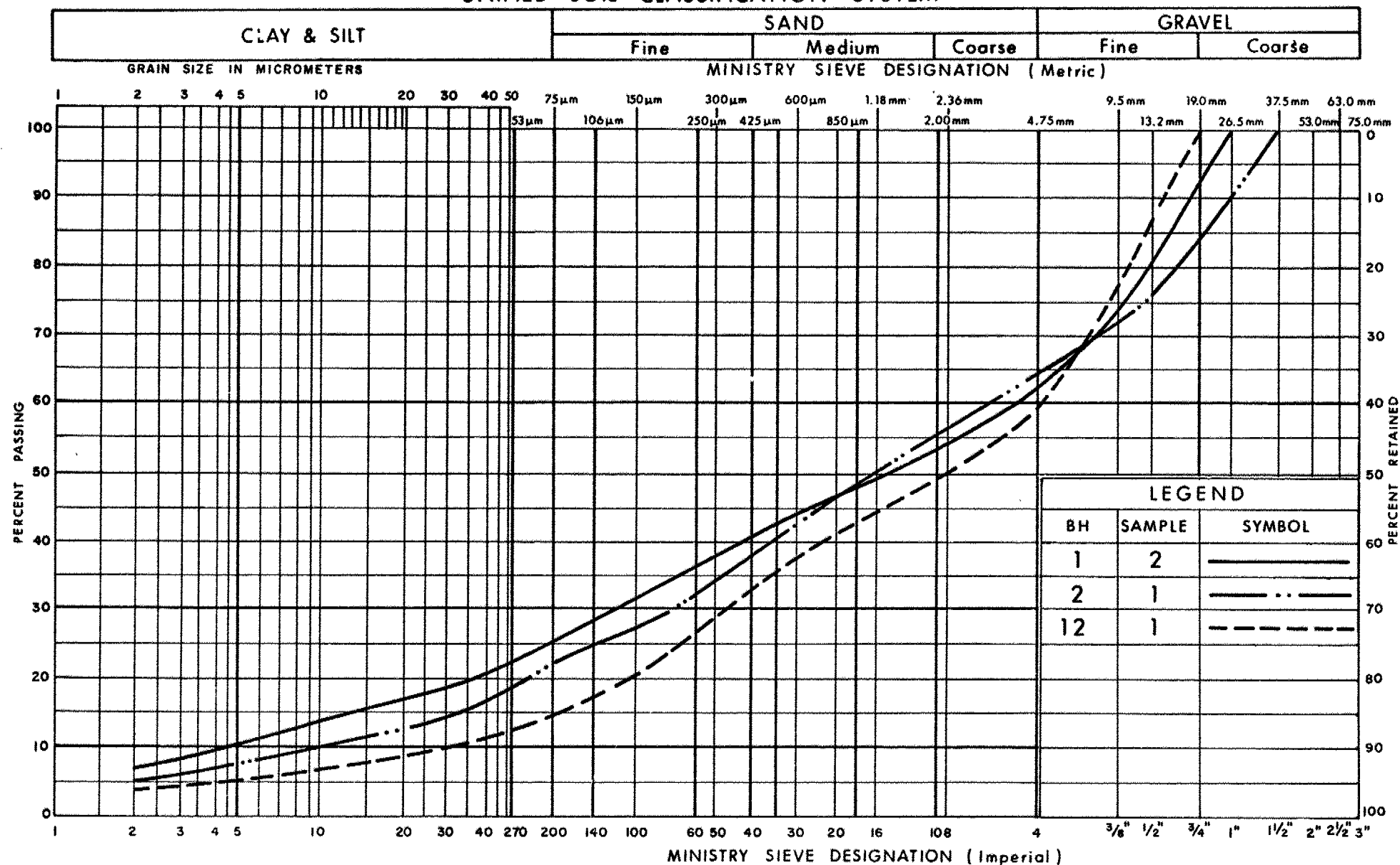
Ministry of
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PLASTICITY CHART HET MIXTURE OF SILTY CLAY, SAND WITH SHALE FRAGMENTS

FIG No 1

W P 85-84-01

UNIFIED SOIL CLASSIFICATION SYSTEM



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GRAIN SIZE DISTRIBUTION

HET MIXTURE OF

SILTY CLAY, SAND WITH SHALE FRAGMENTS

FIG No 2




W P 85-84-01



RECORD OF BOREHOLE No 1

METRIC

W P 85-84-01 LOCATION Sta. 31 + 301.0; O/S 22.0 m Rt. 417 ORIGINATED BY HS
DIST 9 HWY 417 BOREHOLE TYPE Solid Stem Auger & BX Rock Core COMPILED BY DT
DATUM Geodetic DATE 84 11 23 CHECKED BY CP

SOIL PROFILE			SAMPLES			GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT 					PLASTIC LIMIT W _p	NATURAL MOISTURE CONTENT W	LIQUID LIMIT W _L	UNIT WEIGHT γ	REMARKS & GRAIN SIZE DISTRIBUTION (%) GR SA SI CL		
ELEV DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE	'N' VALUES			SHEAR STRENGTH										WATER CONTENT (%)	
								○ UNCONFINED	+ FIELD VANE										
								● QUICK TRIAXIAL	x LAB VANE										
57.2	Ground Surface																		
0.0	Heterogeneous Mixture of Silty Clay, Sand with Shale Fragments Stiff Firm					* 10 cm REC										38 37 18 7			
			1	SS	10														
			2	SS	7														
54.9	3	SS	100																
2.3	Highly Weathered Moderately Weathered Unweathered Black Shale Bedrock		4	RC	0%												RQD = 0%		
			5	BX RC	REC 92%											RQD = 53%			
53.3																			
3.9	End of Borehole * Water Level Not Established																		

RECORD OF BOREHOLE No 2

METRIC

W P 85-84-01 LOCATION Sta. 31 + 297.0; O/S 17.5 m Lt. 4 Hwy. 417 ORIGINATED BY HS
 DIST 9 HWY 417 BOREHOLE TYPE Hollow Stem Auger, BX Rock Core COMPILED BY DT
 DATUM Geodetic DATE 84 11 23 CHECKED BY [Signature]



SOIL PROFILE			SAMPLES			GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT					PLASTIC LIMIT W _p	NATURAL MOISTURE CONTENT W	LIQUID LIMIT W _L	UNIT WEIGHT γ	REMARKS & GRAIN SIZE DISTRIBUTION (%)
ELEV DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE	'N' VALUES			20	40	60	80	100					
57.0	Ground Surface																
0.0	Heterogeneous Mixture of Silty Clay, Sand with Shale Fragments		1	SS	22	* 10 cm	56									3%	36 42 17 5
	Very Stiff																
	Stiff		2	SS	11												
54.8			3	SS	50		55										RQD = 70%
2.2	Slightly Weathered Unweathered		4	BX RC	REC 93%		54										
	Black Shale Bedrock																
			5	BX RC	REC 91%		53										RQD = 26%
52.6																	
4.4	End of Borehole																
	* Water Level Not Established																
	** Org.M. indicates percentage of organic matter by weight																



RECORD OF BOREHOLE No 3

METRIC

W P 85-84-01 LOCATION Sta. 31 + 275.4; O/S 18.3 m Rt. ϕ Hwy. 417 ORIGINATED BY DT
DIST 9 HWY 417 BOREHOLE TYPE BX Rock Core COMPILED BY DT
DATUM Geodetic DATE 84 11 27 CHECKED BY JP.

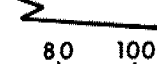



SOIL PROFILE			SAMPLES			GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT 					PLASTIC LIMIT W _p	NATURAL MOISTURE CONTENT W	LIQUID LIMIT W _L	UNIT WEIGHT γ	REMARKS & GRAIN SIZE DISTRIBUTION (%) GR SA SI CL		
ELEV DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE	'N' VALUES			SHEAR STRENGTH					WATER CONTENT (%)						
								○ UNCONFINED + FIELD VANE ● QUICK TRIAXIAL x LAB VANE					-----○-----						
55.3	Water Surface																		
0.0	Water						55												
54.8	River Bottom																		
	Boulder Strewn																		
0.5	Black Shale Bedrock		1	BX RC	REC 100%												RQD = 19%		
	Unweathered		2	BX RC	REC 96%		54									RQD = 93%			
53.2			3	BX RC	REC 100%											RQD = 100%			
2.1	End of Borehole																		



RECORD OF BOREHOLE No 4

METRIC

W P 85-84-01 LOCATION Sta. 31 + 275.4; O/S 18.0 m Lt. 4 Hwy. 417 ORIGINATED BY DT
DIST 9 HWY 417 BOREHOLE TYPE 37 mm Dia. Rock Core COMPILED BY DT
DATUM Geodetic DATE 84 11 28 CHECKED BY [Signature]

SOIL PROFILE			SAMPLES			GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT 					PLASTIC LIMIT	NATURAL MOISTURE CONTENT	LIQUID LIMIT	UNIT WEIGHT γ	REMARKS & GRAIN SIZE DISTRIBUTION (%) GR SA SI CL
ELEV DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE	'N' VALUES			SHEAR STRENGTH					W _p	W	W _L		
								○ UNCONFINED + FIELD VANE					WATER CONTENT (%)				
								● QUICK TRIAXIAL × LAB VANE									
55.3	Water Surface																
0.0	River Bottom						55										
55.0	Boulders Quartzite		1	RC	REC 71%												RQD = 0%
54.8	Black Shale Bedrock Unweathered		2	RC	REC 93%		54									RQD = 0%	
0.5			3	RC	REC 96%												RQD = 96%
53.2																	
2.1	End of Borehole																



RECORD OF BOREHOLE No 5

METRIC

W P 85-84-01 LOCATION Sta. 31 + 240.0; O/S 17.5 m Rt. 417 ORIGINATED BY DT
DIST 9 HWY 417 BOREHOLE TYPE Hollow Stem Auger, BX Rock Core COMPILED BY DT
DATUM Geodetic DATE 84 11 27 CHECKED BY [Signature]







SOIL PROFILE			SAMPLES			GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT					UNIT WEIGHT γ	REMARKS & GRAIN SIZE DISTRIBUTION (%)
ELEV DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE	'N' VALUES			20	40	60	80	100		
55.5	Ground Surface													
0.0	Heterogeneous Mixture of Silty Clay, Sand with Shale Fragments Very Stiff						55							
54.6			1	SS	50	13 cm							3%	
0.9	Highly Weathered Slightly Weathered Unweathered		2	BX RC	REC 56%									RQD = 0%
			3	BX RC	REC 93%		54							RQD = 69%
	Black Shale Bedrock		4	BX RC	REC 100%		53							RQD = 93%
51.9							52							
3.6	End of Borehole													
	** Org.M. indicates percentage of organic matter by weight.													



RECORD OF BOREHOLE No 6

METRIC

W P 85-84-01 LOCATION Sta. 31 + 240.0; O/S 15.8 m Lt. 4 Hwy. 417 ORIGINATED BY DT
DIST 9 HWY 417 BOREHOLE TYPE BX Rock Core COMPILED BY DT
DATUM Geodetic DATE 84 11 26 CHECKED BY [Signature]

SOIL PROFILE			SAMPLES			GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT 						PLASTIC LIMIT	NATURAL MOISTURE CONTENT	LIQUID LIMIT	UNIT WEIGHT γ	REMARKS & GRAIN SIZE DISTRIBUTION (%) GR SA SI CL
ELEV DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE	'N' VALUES			SHEAR STRENGTH						W _p	W	W _L		
								○ UNCONFINED + FIELD VANE ● QUICK TRIAXIAL x LAB VANE						WATER CONTENT (%)				
55.3	Water Surface																	
55.1	River Bottom																	
54.8	Boulders																	
54.5	Highly Weathered Unweathered		1	BX RC	REC 68%												RQD = 36%	
	Black Shale Bedrock		2	BX RC	REC 81%												RQD = 40%	
			3	BX RC	REC 92%												RQD = 92%	
52.3																		
3.0	End of Borehole																	



RECORD OF BOREHOLE No 7

METRIC

W P 85-84-01 LOCATION Sta. 31 + 225.0; O/S 18.3 m Rt. 417 ORIGINATED BY DT
DIST 9 HWY 417 BOREHOLE TYPE 37 mm Dia. Rock Core COMPILED BY DT
DATUM Geodetic DATE 84 11 29 CHECKED BY [Signature]

SOIL PROFILE			SAMPLES			GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT					PLASTIC LIMIT W _p	NATURAL MOISTURE CONTENT W	LIQUID LIMIT W _L	UNIT WEIGHT γ	REMARKS & GRAIN SIZE DISTRIBUTION (%) GR SA SI CL
ELEV DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE	'N' VALUES			20	40	60	80	100					
55.3	Water Surface																
0.0	Water						55										
54.8	River Bottom																
	Boulder Strewn																
0.5	Slightly Weathered		1	BX	REC												RQD = 39%
	Unweathered			RC	89%												
	Black Shale Bedrock		2	BX	REC		54										RQD = 95%
				RC	100%												
53.4			3	BX	REC												RQD = 100%
				RC	100%												
1.9	End of Borehole																



RECORD OF BOREHOLE No 8

METRIC

W P 85-84-01 LOCATION Sta. 31 + 225.0; O/S 16.2 m Lt. 4 Hwy. 417 ORIGINATED BY DT
DIST 9 HWY 417 BOREHOLE TYPE BX Rock Core COMPILED BY DT
DATUM Geodetic DATE 84 11 26 CHECKED BY [Signature]



SOIL PROFILE			SAMPLES			GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT					PLASTIC LIMIT W _p	NATURAL MOISTURE CONTENT W	LIQUID LIMIT W _L	UNIT WEIGHT γ	REMARKS & GRAIN SIZE DISTRIBUTION (%) GR SA SI CL
ELEV DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE	'N' VALUES			20	40	60	80	100					
55.3	Water Surface																
55.1	River Bottom																
54.8	Boulders						55										
0.5	Highly Weathered Unweathered		1	BX RC	REC 52%		54										RQD = 39%
	Black Shale Bedrock		2	BX RC	REC 85%		53										RQD = 34%
52.6																	
2.7	End of Borehole																



RECORD OF BOREHOLE No 9

METRIC

W P 85-84-01 LOCATION Sta. 31 + 172.2; O/S 16.6 m Rt. \angle Hwy. 417 ORIGINATED BY DT
DIST 9 HWY 417 BOREHOLE TYPE BX Rock Core COMPILED BY DT
DATUM Geodetic DATE 84 11 26 CHECKED BY SP.

SOIL PROFILE			SAMPLES			GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT 						PLASTIC LIMIT	NATURAL MOISTURE CONTENT	LIQUID LIMIT	UNIT WEIGHT γ	REMARKS & GRAIN SIZE DISTRIBUTION (%) GR SA SI CL						
ELEV DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE	'N' VALUES			SHEAR STRENGTH						W _p	W	W _L								
								○ UNCONFINED + FIELD VANE						● QUICK TRIAXIAL x LAB VANE						WATER CONTENT (%)				
55.3	Water Surface																							
0.0	River Bottom																							
55.0																								
0.4	Boulders Slightly Weathered Unweathered		1	BX RC	REC 75%		55										RQD = 0%							
			2	BX RC	REC 91%		54										RQD = 79%							
	Black Shale Bedrock		3	BX RC	REC 85%		53										RQD = 83%							
52.2																								
3.1	End of Borehole																							



RECORD OF BOREHOLE No 10

METRIC

W P 85-84-01 LOCATION Sta. 31 + 172.0; O/S 16.4 m Lt. 4 Hwy. 417 ORIGINATED BY DT
DIST 9 HWY 417 BOREHOLE TYPE Hollow Stem Auger, BX Rock Core COMPILED BY DT
DATUM Geodetic DATE 84 11 23 CHECKED BY [Signature]

SOIL PROFILE			SAMPLES			GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT						PLASTIC LIMIT W _p	NATURAL MOISTURE CONTENT W	LIQUID LIMIT W _L	UNIT WEIGHT γ	REMARKS & GRAIN SIZE DISTRIBUTION (%) GR SA SI CL
ELEV DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE	'N' VALUES			SHEAR STRENGTH										
								○ UNCONFINED		+ FIELD VANE		● QUICK TRIAXIAL		x LAB VANE		-----○-----		
55.3	Water Surface																	
55.1	River Bottom						55											
0.2	Boulders																	
54.5	Limestone Boulders		1	BX RC	REC 91%													
0.8	Black Shale Bedrock Unweathered		2	BX RC	REC 100%				54									
53.2																RQD = 64%		
2.1	End of Borehole																	



RECORD OF BOREHOLE No 11

METRIC

W P 85-84-01 LOCATION Sta. 31 + 144.2; O/S 19.2 m Rt. & Hwy. 417 ORIGINATED BY DT
DIST 9 HWY 417 BOREHOLE TYPE Hollow Stem Auger, BX Rock Core COMPILED BY DT
DATUM Geodetic DATE 84 11 23 CHECKED BY [Signature]

SOIL PROFILE			SAMPLES			GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT					UNIT WEIGHT γ Org.M.*	REMARKS & GRAIN SIZE DISTRIBUTION (%) GR SA SI CL
ELEV DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE	'N' VALUES			20	40	60	80	100		
56.3	Ground Surface													
0.0	Heterogeneous Mixture Of Silty Clay, Sand with Shale Fragments Firm		1	SS	4	 8 cm	56						7%	
54.6			2	SS	100/		55							
1.7	Moderately Weathered Unweathered Black Shale Bedrock		3	BX RC	REC 77%		54							RQD = 46%
			4	BX RC	REC 86%									RQD = 28%
			5	BX RC	REC 100%		53							RQD = 63%
52.6														
3.7	End of Borehole * Org.M. indicates percentage of organic matter by weight													



RECORD OF BOREHOLE No 12

METRIC

W P 85-84-01 LOCATION Sta. 31 + 146.0: O/S 16.3 m Lt. 4 Hwy. 417 ORIGINATED BY DT
DIST 9 HWY 417 BOREHOLE TYPE Hollow Stem Auger, BX Rock Core COMPILED BY DT
DATUM Geodetic DATE 84 11 23 CHECKED BY [Signature]

SOIL PROFILE			SAMPLES			GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT					PLASTIC LIMIT W _p	NATURAL MOISTURE CONTENT W	LIQUID LIMIT W _L	UNIT WEIGHT γ	REMARKS & GRAIN SIZE DISTRIBUTION (%) GR SA SI CL
ELEV DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE	'N' VALUES			20	40	60	80	100					
56.0	Ground Surface																
0.0	Heterogeneous Mixture of Silty Clay, Sand with Shale Fragments Stiff		1	SS	9	 5 cm	55										41 44 11 4
54.8			2	SS	50												RQD = 41%
1.2	Moderately Weathered Unweathered Black Shale Bedrock		3	BX RC	REC 65%												RQD = 77%
			4	BX RC	REC 97%												RQD = 50%
			5	BX RC	REC 88%												
52.6	End of Borehole																
3.4																	

DESCRIPTION OF ROCK CORE - W.P. 85-84-01

BOREHOLE NUMBER				CORE DESCRIPTION	
	DEPTH (m)	% CR *	% RQD *	DEPTH (m)	DESCRIPTION
1	2.3 - 2.6	0	0	2.3 - 2.6	No core recovered; assumed highly weathered shale
	2.6 - 3.9	92	53	2.6 - 2.7	Shale, black, moderately weathered, very closely spaced joints
				2.7 - 3.9	Shale, black, unweathered, moderately spaced joints
2	2.2 - 3.3	93	70	2.2 - 2.4	Shale, black, slightly weathered, very closely spaced joints
	3.3 - 4.4	91	26	2.4 - 4.4	Shale, black, unweathered with near-vertical joint from 3.9 to 4.4 m
3	0.5 - 1.0	100	19	0.5 - 0.9	Shale, black, unweathered, very closely spaced joints
	1.0 - 1.7	96	93	0.9 - 2.1	Shale, black, unweathered, moderately spaced joints
	1.7 - 2.1	100	100		
4	0.4 - 0.5	71	0	0.4 - 0.5	Boulders (quartzite)
	0.5 - 0.9	93	0	0.5 - 0.9	Shale, black, unweathered, very closely spaced joints
	0.9 - 2.1	96	96	0.9 - 2.1	Shale, black, unweathered, moderately spaced joints
5	0.9 - 1.2	56	0	0.6 - 0.9	Split spoon sample - Shale, black, highly weathered
	1.2 - 2.2	93	69	0.9 - 1.2	Shale, black, slightly weathered, very closely spaced joints; core loss zone
	2.2 - 3.6	100	93	1.2 - 3.6	Shale, black, unweathered, moderately spaced joints, clay zone (3 cm thick) at 3.63 to 3.65

* CR = CORE RECOVERY ; RQD = ROCK QUALITY DESIGNATION

DESCRIPTION OF ROCK CORE - W.P. 85-84-01

BOREHOLE NUMBER				CORE DESCRIPTION	
	DEPTH (m)	% CR *	% RQD *	DEPTH (m)	DESCRIPTION
6	0.5 - 1.2	68	36	0.5 - 0.8	Shale, black, highly weathered; core loss assumed at top of run
	1.2 - 2.4	81	40		
	2.4 - 3.0	92	92	0.8 - 3.0	Shale, black, unweathered, closely spaced joints, with some very closely spaced zones
7	0.5 - 0.9	89	39	0.5 - 0.7	Shale, black, slightly weathered, very closely spaced joints
	0.9 - 1.5	100	95		
	1.5 - 1.9	100	100	0.7 - 1.9	Shale, black, unweathered, moderately spaced joints
8	0.5 - 1.3	52	39	0.5 - 1.0	Shale, black, highly weathered; core loss zone
	1.3 - 2.7	85	34	1.0 - 2.7	Shale, black, unweathered, closely spaced joints with near-vertical joint from 1.9 to 2.5 m
9	0.4 - 0.7	75	0	0.4 - 0.6	Shale, black, slightly weathered, very closely spaced joints
	0.7 - 1.5	91	79		
	1.5 - 3.1	85	83	0.6 - 3.1	Shale, black, unweathered, moderately spaced joints
10	0.6 - 1.2	91	42	0.6 - 0.8	Boulders (limestone)
	1.2 - 2.1	100	64	0.8 - 2.1	Shale, black, unweathered, closely to moderately spaced joints

* CR= CORE RECOVERY ; RQD = ROCK QUALITY DESIGNATION

DESCRIPTION OF ROCK CORE - W.P. 85-84-01

BOREHOLE NUMBER				CORE DESCRIPTION	
	DEPTH (m)	% CR *	% RQD *	DEPTH (m)	DESCRIPTION
11	1.9 - 2.3	77	46	1.9 - 2.0	Shale, black, moderately weathered, very closely spaced joints
	2.3 - 2.8	86	28	2.0 - 3.7	Shale, black, unweathered, closely to moderately spaced joints, with near-vertical joint from 2.8 to 3.1 m
	2.8 - 3.7	100	63		
12	1.5 - 1.9	65	41	1.5 - 1.8	Shale, black, moderately weathered, very closely spaced joints
	1.9 - 2.8	97	77	1.8 - 3.4	Shale, black, unweathered, moderately spaced joints, with near-vertical joint from 3.2 to 3.3 m
	2.8 - 3.4	88	50		

* CR= CORE RECOVERY ; RQD= ROCK QUALITY DESIGNATION

EXPLANATION OF TERMS USED IN REPORT

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

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

SOILS ARE DESCRIBED BY THEIR COMPOSITION AND CONSISTENCY OR DENSENESS.

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

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

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

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

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

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

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

RQD (%)	0 - 25	25 - 50	50 - 75	75 - 90	90 - 100
	VERY POOR	POOR	FAIR	GOOD	EXCELLENT

JOINTING AND BEDDING:

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

ABBREVIATIONS AND SYMBOLS

FIELD SAMPLING

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

STRESS AND STRAIN

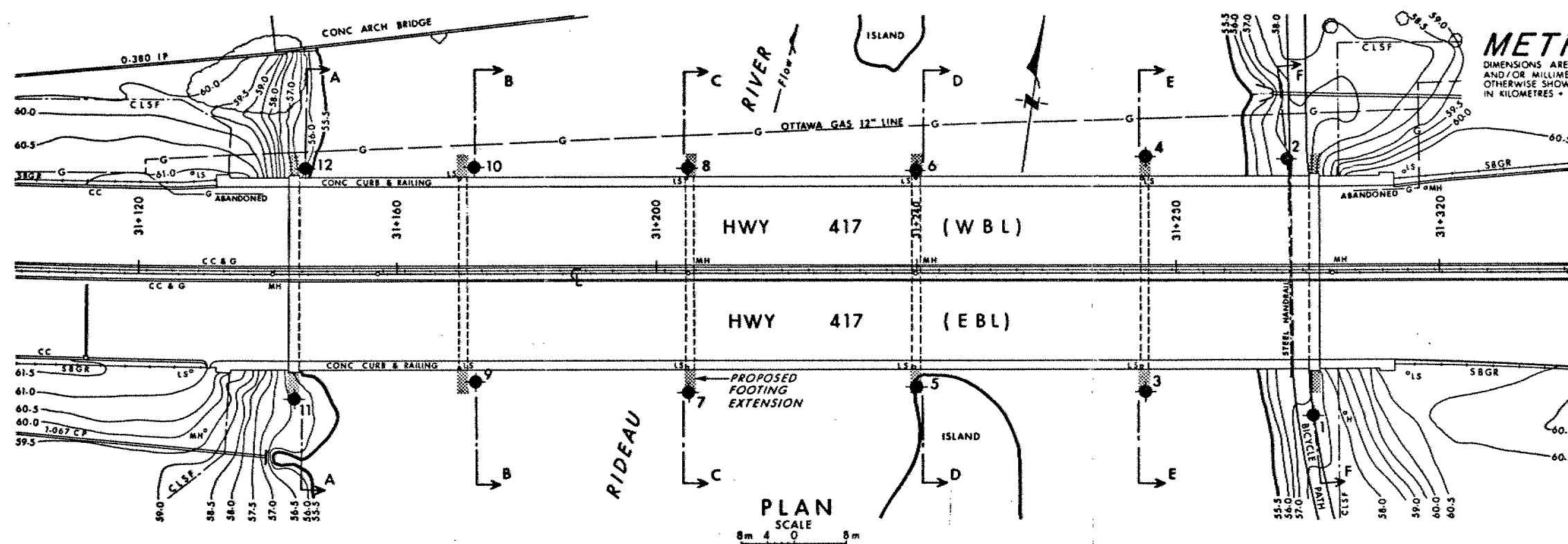
u_w	kPa	PORE WATER PRESSURE
r_u	1	PORE PRESSURE RATIO
σ	kPa	TOTAL NORMAL STRESS
σ'	kPa	EFFECTIVE NORMAL STRESS
τ	kPa	SHEAR STRESS
$\sigma_1, \sigma_2, \sigma_3$	kPa	PRINCIPAL STRESSES
ϵ	%	LINEAR STRAIN
$\epsilon_1, \epsilon_2, \epsilon_3$	%	PRINCIPAL STRAINS
E	kPa	MODULUS OF LINEAR DEFORMATION
G	kPa	MODULUS OF SHEAR DEFORMATION
μ	1	COEFFICIENT OF FRICTION

MECHANICAL PROPERTIES OF SOIL

m_v	kPa^{-1}	COEFFICIENT OF VOLUME CHANGE
C_c	1	COMPRESSION INDEX
C_s	1	SWELLING INDEX
C_α	1	RATE OF SECONDARY CONSOLIDATION
c_v	m^2/s	COEFFICIENT OF CONSOLIDATION
H	m	DRAINAGE PATH
T_v	1	TIME FACTOR
U	%	DEGREE OF CONSOLIDATION
σ'_{vo}	kPa	EFFECTIVE OVERBURDEN PRESSURE
σ'_p	kPa	PRECONSOLIDATION PRESSURE
τ_f	kPa	SHEAR STRENGTH
c'	kPa	EFFECTIVE COHESION INTERCEPT
ϕ'	-°	EFFECTIVE ANGLE OF INTERNAL FRICTION
c_u	kPa	APPARENT COHESION INTERCEPT
ϕ_u	-°	APPARENT ANGLE OF INTERNAL FRICTION
τ_R	kPa	RESIDUAL SHEAR STRENGTH
τ_r	kPa	REMOULDED SHEAR STRENGTH
S_t	1	SENSITIVITY = $\frac{c_u}{\tau_r}$

PHYSICAL PROPERTIES OF SOIL

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



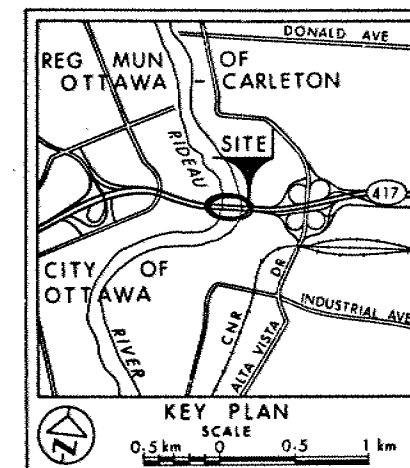
CONT No
WP No 85-84-01



RIDEAU RIVER BRIDGE

SHEET

BORE HOLE LOCATIONS & SOIL STRATA



LEGEND

- ◆ Bore Hole
- ⊕ Dynamic Cone Penetration Test (Cone)
- ◆ Bore Hole & Cone
- N Blows/0.3m (Std Pen Test, 475 J/blow)
- CONE Blows/0.3m (60° Cone, 475 J/blow)
- W.L. at time of investigation 1984 11
- W.L. Not Established in BH 1 and 2

No	ELEVATION	STATION	OFFSET
1	57.2	31+301.0	22.0m Rt
2	57.0	31+297.0	17.5m Lt
3	55.3	31+275.4	18.3m Rt
4	55.3	31+275.4	18.0m Lt
5	55.5	31+240.0	17.5m Rt
6	55.3	31+240.0	15.8m Lt
7	55.3	31+225.0	18.3m Rt
8	55.3	31+225.0	16.2m Lt
9	55.3	31+172.2	16.6m Rt
10	55.3	31+172.0	16.4m Lt
11	56.3	31+144.2	19.2m Rt
12	56.0	31+146.0	16.3m Lt

NOTE

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

NOTE: The complete foundation investigation and design report for this project and other related documents may be examined at the Engineering Materials Office, Downsview. Information contained in this report and related documents is specifically excluded in accordance with the conditions of Section 102-2 of Form 100.

REV	DATE	BY	DESCRIPTION

Geocres No 31G5-139

HWY No 417	DIST 9
SUBM/DHS	CHECKED DATE 198 01 30 SITE 3-73
DRAWN	CHECKED APPROVED DWG 858401-A

