

G.I.-30 SEPT. 1976

REMARKS: _____

**FOUNDATION
INVESTIGATION
REPORT**

CONTRACT NO. 99-29

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Foundation Investigation Report

for

GWP 203-86-02

Highway 417/Maitland Avenue Bridge Rehabilitation

District 42, Ottawa

INTRODUCTION

This Foundation Investigation Report was prepared as part of the Highway 417/Maitland Avenue Bridge Rehabilitation project (GWP 203-86-02, Agreement No. 9740-7411-4256). The report presents the results of the Foundation Investigation for:

- 1) Earth retaining structures beneath the Maitland Avenue Bridge; and
- 2) Foundations for overhead signs.

SITE DESCRIPTION AND GEOLOGY

GWP 203-86-02 is located along a 1.3 km long section of Highway 417 centered around the Maitland Avenue interchange, within the City of Ottawa, Regional Municipality of Ottawa-Carleton (RMOC). The site location is shown on the Key Plan (Drawing No. 11099-1).

This section of Highway 417 is 4-lanes wide in each direction directly beneath the bridge structure with the EBLs and WBLs separated by a concrete barrier.

The existing Maitland Avenue Bridge is a two span continuous steel girder bridge with composite concrete deck. The spans are each approximately 35 m in length. The height of the existing embankments is approximately 4.75 m. The existing bridge abutments are supported on piles, end bearing on bedrock. The front row of piles are battered toward Hwy 417. The foreslopes of both the north and south abutments are at a 2H:1V grade, are protected by stone paving, and extend down to the roadway shoulders.

Drainage along the sections of Hwy 417 immediately east and west of the Maitland Avenue Bridge is provided by highway ditches. Small corrugated steel pipe (CSP) culverts currently link the ditches within the section beneath the bridge structure.



This project lies within the physiographic region known as the Ottawa Valley Clay Plains which is interrupted by ridges of rock and sand.

The native surficial materials in the vicinity of the Maitland Avenue Bridge are Champlain Sea deposits, consisting of silt and clay underlying erosional terraces. Bedrock within this area generally consists of limestone of the Ottawa Formation.

INVESTIGATION PROCEDURE

Field Investigation

The subsurface conditions were investigated through a borehole drilling investigation and laboratory testing.

Prior to drilling the boreholes, their locations were laid out by Jacques Whitford staff and the appropriate utility agencies were contacted to ensure that the site was clear of buried utilities.

Due to the high traffic volumes on Highway 417, the drilling investigation was carried out at night within full lane and ramp closures. The boreholes along the eastbound and westbound lanes were drilled on the nights of August 26th and 27th, respectively. The lane and ramp closures were carried out by Beacon Lite Ltd., in accordance with a traffic control plan submitted to and approved by Mr. John Blaikie of MTO.

Portable light stands were used to provide adequate lighting for the drill crews.

The subsurface conditions along the retaining wall alignment and at the proposed location for the overhead sign foundations were investigated by a total of four (4) boreholes, designated as 98-1 through 98-4. Due to site access restrictions (concrete barriers, ditches and steep slopes), one borehole was put down along both the north and south sides of Hwy 417, between the overhead signs and retaining wall alignments, using portable electrically powered equipment. The remaining two boreholes were put down at the base of the slopes in front of the retaining wall alignments using a truck mounted CME 55 drill rig. The borehole locations are shown on Drawing No. 11099-2, attached.

The boreholes were advanced to refusal on inferred bedrock. Split spoon samples were collected at regular 0.76 m intervals while carrying out Standard Penetration Testing (SPT) (ASTM D1586) and the recovered soil samples were identified in the field by our personnel. The SPT carried out in the boreholes put down with the portable equipment utilized a 20.4 kg hammer with a 0.76 m drop as opposed to a standard 63.5 kg hammer with a 0.76 m drop. The N-values presented on these Borehole Records have been corrected by reducing the field N-value by a factor of 3 to reflect the difference in energy delivered by the hammer



during the testing. In-situ shear vane testing was attempted at several locations within the cohesive soil deposits, however, at all locations tested, the undrained shear strength of the soil exceeded the field vane capacity of 150 kPa.

The subsurface conditions are described in detail in the Borehole Records presented in Appendix 1. Geotechnical cross sections are shown on Drawing No 11099-2.

All soil samples recovered during the SPT were stored in moisture proof containers and were returned to our laboratory for detailed classification and testing.

Standpipes were installed within three of the boreholes prior to backfilling. The boreholes were backfilled by replacing (and tamping in layers) the augered material.

The field information is supplemented by soil and bedrock information contained on the Borehole Records from the foundation investigation carried out for the Maitland Avenue Bridge construction (1958). These Borehole Records include stratigraphic descriptions of the overburden soils as well as bedrock.

The borehole locations and elevations were surveyed by McCormick Rankin Corporation's (MRC) survey crew, using a geodetic datum.

Laboratory Testing

All samples returned to the laboratory were subjected to detailed visual classification by a geotechnical engineer. Selected samples were tested for moisture content, grain size distribution and Atterberg Limits. One representative soil sample from each of the retaining wall locations was submitted for pH, sulphate and chloride testing to assess the potential for corrosion of buried steel and the potential for sulphate attack on buried concrete. All soil samples will be stored for a period of one year after issuance of the final report. Unless otherwise directed, the stored samples will be disposed of after this period.

SUBSURFACE CONDITIONS

Subsurface Profile

The subsurface conditions observed in the boreholes are presented in detail on the Borehole Records provided in Appendix 2. The Borehole Records from DWG. No. D 4158-3, produced for the Maitland Avenue Bridge construction (W.P. 930-58) have been reproduced and are also included in Appendix 2. An explanation of the symbols and terms used to describe the Borehole Records is also provided.

Stratigraphic profiles are provided in Drawing No 11099-2. The subsurface conditions observed at the site are generally consistent from borehole to borehole and are described in the following sections.

Embankment Fill

The embankment fill in the vicinity of the proposed retaining walls consists primarily of brown, sand, some silt, trace organics (rootlings) and occasional clayey pockets. Some areas of fill consisting of silty sand and clay, some gravel were also encountered. Typical "N" values obtained during Standard Penetration Testing ranged from 3 to 6, indicating a loose material. The thickness of the embankment fill varies significantly due to the 2H:1V foreslopes. The base of the embankment fill varies from elevation 80.8 m to 82.1 m

Clay

The fill is underlain by a deposit of high plasticity clay. The thickness of the clay deposit varies from in Boreholes 98-1 through 98-4 varied from 1.1 m to 3.0 m. The elevation at the based of the clay varied from 78.5 m to 80.1 m. The clay was brown to greyish brown in colour. The moisture contents of seven samples tested ranged from 29 % to 60 %. Atterberg Limit testing carried out on one representative sample of the clay indicated a Liquid Limit of 60 % and a Plastic Limit of 22 %, indicating an inorganic clay of high plasticity (CH). A hydrometer analysis indicated that 42 % of the clay had a grain size between 5 and 75 microns, indicating a moderate susceptibility to frost heaving (MSFH).

Standard Penetration Test "N" values within the clay varied from 9 to 3, and generally decreased with depth. In-situ shear vane testing was attempted at several locations within the clay deposit, however, at all locations tested, the undrained shear strength of the soil exceeded the field vane capacity of 150 kPa, indicating that the consistency of the clay was very stiff to hard. A thin layer of soft silty clay was identified in one borehole (Borehole No. 5 - located at the eastern centre pier) during the 1958 foundation investigation for the original bridge structure.

Heterogeneous Mixture of Sand, Silt and Gravel (Glacial Till)

A glacial till deposit consisting of a heterogeneous mixture of sand, silt and gravel was encountered beneath the clay deposit in each of the boreholes. The deeper portion of the till deposit in Borehole 98-4 was clayey. At all borehole locations, the glacial till extended to bedrock. Standard Penetration Test "N" values varied from 4 to 23. Refusal to penetration of the split spoon sampler was encountered within the Till deposit in Borehole No. 1. The results of the Standard Penetration Tests indicate that the glacial till is generally in a loose to compact state with some areas of dense till. A grain size distribution analysis carried out on a sample of the till indicated that it contained 25 % gravel, 42 % sand and 33 % silt and clay particles. The moisture contents of five samples tested ranged from 10 % to 29 %



Bedrock

Auger refusal on inferred bedrock was encountered in Boreholes 98-1 through 98-4. Bedrock coring was not carried out during the current investigation. Bedrock coring was carried out for the 1958 geotechnical investigation for the Maitland Avenue Bridge structure. The bedrock elevation at these ten borehole locations varied from 77.1 m to 79.3 m.

The records for Borehole Nos 1 through 6 indicate that bedrock consists of limestone with typical bedding thicknesses ranging from 2 to 3 inches (50 mm to 75 mm). No record of Rock Quality Designation (RQD) or unconfined compressive strength was available.

Groundwater

Groundwater levels were measured in the standpipes on September 17, 1998, approximately three weeks after the boreholes were drilled. The groundwater levels measured in the standpipes varied from elevation 79.2 m to 80.0 m, (approximately 2 m below the finished grade of Hwy 417). Fluctuations in the groundwater level due to seasonal variations or in response to a particular precipitation event should be anticipated.



CLOSURE

Cont. 99-29

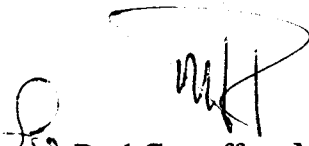
A soil investigation is a limited sampling of a site. The conclusions given herein are based on information gathered at the specific borehole locations and can only be extrapolated to an undefined limited area around these locations. The extent of the limited area depends on the soil and groundwater conditions, as well as the history of the site reflecting natural, construction, and other activities. Should any conditions at the site be encountered which differ from those at the borehole locations, we request that we be notified immediately in order to assess the additional information.

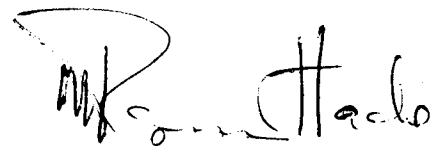
The drilling equipment used was owned and operated by Marathon Drilling Company Ltd.

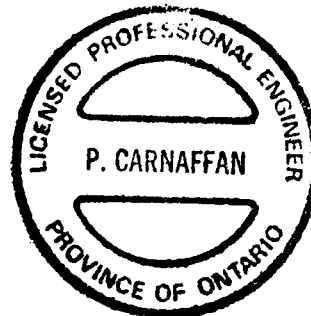
We trust the information presented herein meets your present requirements. Should you have any questions or require additional information, please do not hesitate to contact us.

Yours very truly,

JACQUES, WHITFORD LIMITED

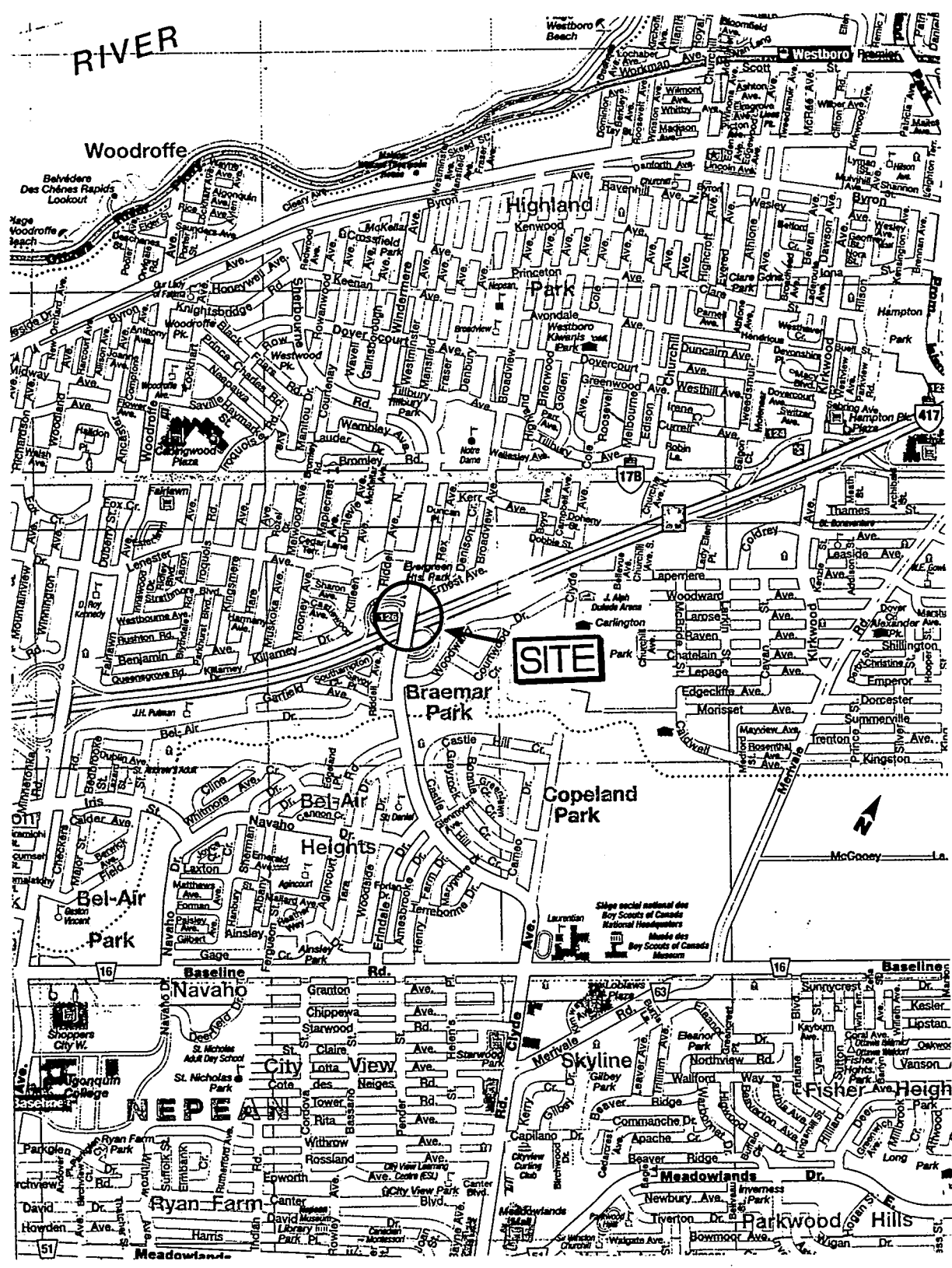

Paul Carnaffan, M.Eng., P.Eng.


J.G.A. Raymond Haché, M.Sc., P.Eng.



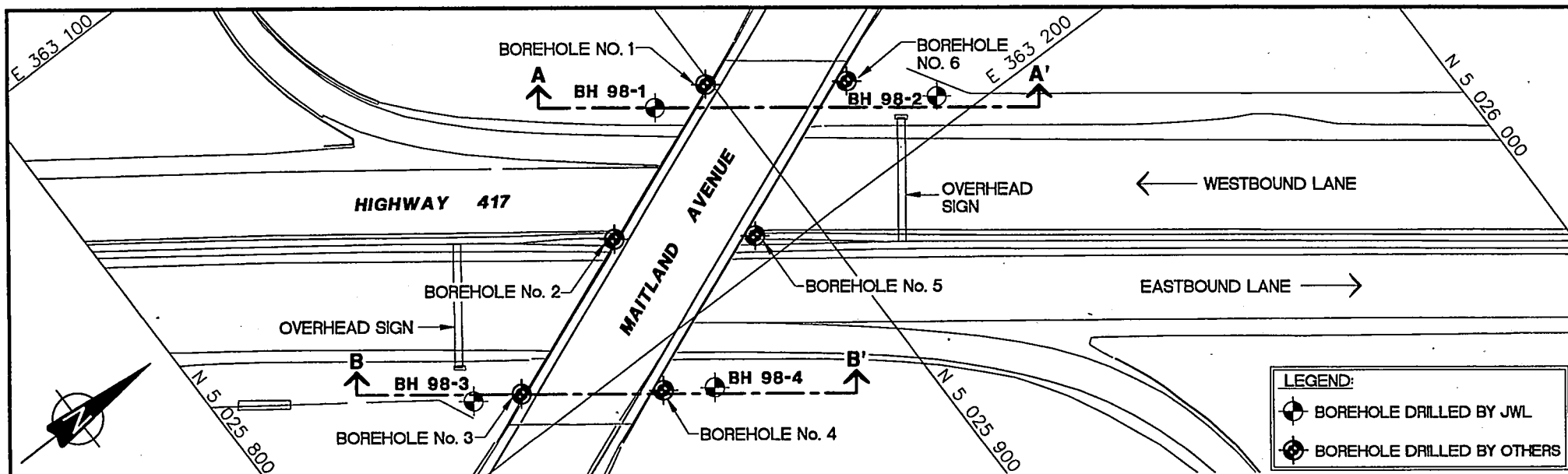
P:\1998\10000\11099\foundation\foundTRY.rep.mar29.wpd



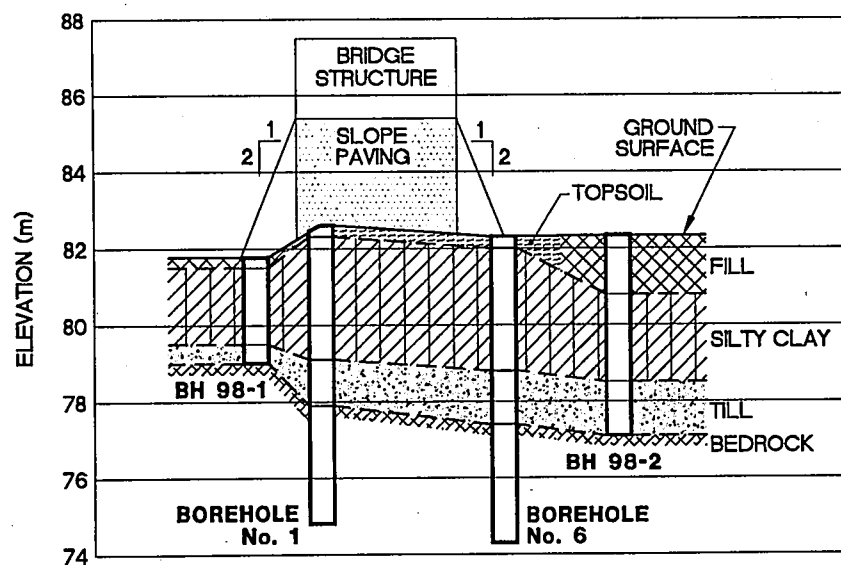


KEY PLAN
1: 25 000

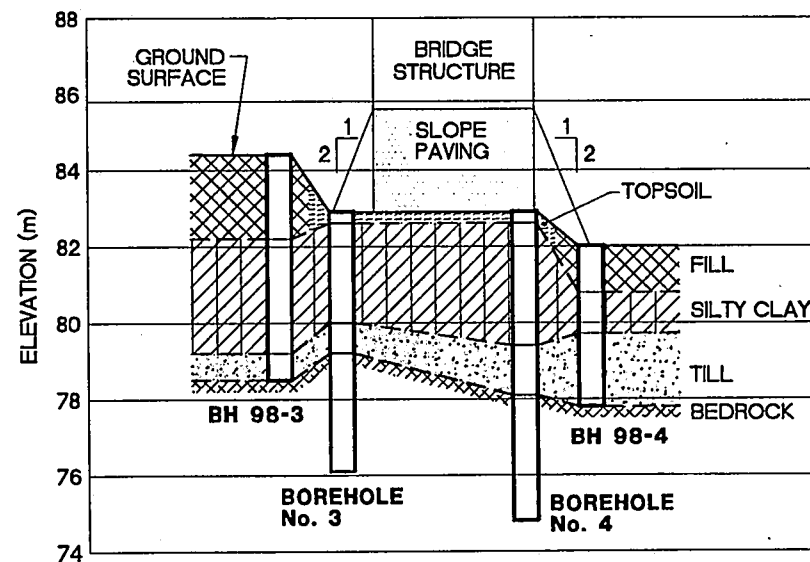




PLAN VIEW
1:1000



CROSS-SECTION A-A'



CROSS-SECTION B-B'

Cont. 99-29

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McCORMICK RANKIN CORPORATION
GWP 203-86-02
HIGHWAY 417/MAITLAND AVENUE BRIDGE REHABILITATION
BOREHOLE LOCATION AND CROSS-SECTION PLANS

OTTAWA,

ONTARIO

Scale: 1:1000 HORIZ.
1:200 VERT.

Date: 98/11/04

Drawing No.: 11099-2

Dwn. by: GBB

Appd.:



Jacques
Whitford

EXPLANATION OF TERMS USED IN REPORT

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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						

CON7. 99-29

RECORD OF BOREHOLE No 98-1

1 OF 1

METRIC

W.P. 203-86-02 LOCATION Hwy 417 WBL at Maitland Avenue ORIGINATED BY LP
DIST 429 HWY 417 BOREHOLE TYPE Hollow Stem Augers COMPILED BY PC
DATUM Geodetic DATE 98.08.27 & 98.08.28 CHECKED BY *[Signature]*

SOIL PROFILE			SAMPLES			GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT					UNIT WEIGHT γ kN/m ³	REMARKS & GRAIN SIZE DISTRIBUTION (%) GR SA SI CL
ELEV DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE	"N" VALUES			20 40 60 80 100	20 40 60 80 100	20 40 60 80 100	20 40 60 80 100	20 40 60 80 100		
82.3 0.0	Brown, silty sand, trace organics: FILL		1	SS	5		82							
81.6 0.8	Brown, silty clay, some gravel, trace organics: FILL		2	SS	8		81							
80.8 1.5	Very stiff, brown, SILTY CLAY, occasional sand seams		3	SS	7		80							
79.3 3.0	Stiff		4	SS	4		79							
78.5 3.8	Loose to compact, grey, silty sand with gravel, trace clay: TILL		5	SS	3		78							
77.1 5.2	End of Borehole		6	SS	7									
	Auger Refusal on Inferred Bedrock		7	SS	16									
	- standpipe installed													
	- standard penetration tests carried out using 45 lb hammer and 30 inch freefall													
	max. field vane capacity was 150 kPa which was exceeded by soil resistance.													

$\times^3 \times^3$ Numbers refer to Sensitivity 20 15 10 5 (%) STRAIN AT FAILURE




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RECORD OF BOREHOLE No 98-2

1 OF 1

METRIC

W.P. 203-86-02 LOCATION Hwy 417 WBL at Maitland Avenue ORIGINATED BY LP
DIST 429 HWY 417 BOREHOLE TYPE Hollow Stem Augers COMPILED BY PC
DATUM Geodetic DATE 98.08.27 & 98.08.28 CHECKED BY MJP

SOIL PROFILE			SAMPLES			GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT					UNIT WEIGHT γ kN/m ³	REMARKS & GRAIN SIZE DISTRIBUTION (%) GR SA SI CL
ELEV DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE	"N" VALUES			SHEAR STRENGTH kPa						
								20 40 60 80 100						
81.8														
0.0	Dark brown, silty sand: FILL		1	SS	3									
81.5														
0.3	Very stiff, brown, SILTY CLAY		2	SS	9									
			3	SS	7									
79.5														
2.3	Compact, brown, silty sand, some gravel, trace clay: TILL		4	SS		*REF								
79.0														
2.8	End of Borehole													
	Auger Refusal on Inferred Bedrock													
	- max. field vane capacity was 150 kPa which was exceeded by soil resistance.													
	*REF = split spoon refusal													









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RECORD OF BOREHOLE No 98-3

1 OF 1

METRIC

W.P. 203-86-02 LOCATION Hwy 417 EBL at Maitland Avenue ORIGINATED BY LP
DIST 429 HWY 417 BOREHOLE TYPE Hollow Stem Augers COMPILED BY PC
DATUM Geodetic DATE 98.08.26 & 98.08.27 CHECKED BY *MLP*

SOIL PROFILE			SAMPLES			GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT					UNIT WEIGHT γ kN/m ³	REMARKS & GRAIN SIZE DISTRIBUTION (%) GR SA SI CL					
ELEV DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE	"N" VALUES			20 40 60 80 100											
								SHEAR STRENGTH kPa							PLASTIC LIMIT NATURAL MOISTURE CONTENT LIQUID LIMIT				
								○ UNCONFINED × FIELD VANE ● QUICK TRIAXIAL × LAB VANE							W P W W L				
							20 40 60 80 100					WATER CONTENT (%) 10 20 30							
84.4																			
0.0	Brown, sand, some silt, trace organics, clayey pockets: FILL		1	SS	6														
			2	SS	3														
			3	SS	6														
82.1																			
2.3	Very stiff, brown, SILTY CLAY, occasional sand seams		4	SS	8														
			5	SS	6														
80.6																			
3.8	stiff		6	SS	3								44.20						
			7	SS	5								59.90						
79.2																			
5.3	Loose, brown, clayey sand, some silt, trace gravel: TILL		8	SS	7														
78.5																			
5.9	End of Borehole																		
	Auger Refusal on Inferred Bedrock																		
	- max. field vane capacity was 150 kPa which was exceeded by soil resistance.																		

RECORD OF BOREHOLE No 98-4

1 OF 1

METRIC

W.P. 203-86-02 LOCATION Hwy 417 EBL at Maitland Avenue ORIGINATED BY LP
DIST 429 HWY 417 BOREHOLE TYPE Hollow Stem Augers COMPILED BY PC
DATUM Geodetic DATE 98.08.26 & 98.08.27 CHECKED BY *WHA*

SOIL PROFILE			SAMPLES			GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT					UNIT WEIGHT γ kN/m ³	REMARKS & GRAIN SIZE DISTRIBUTION (%)
ELEV DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE	"N" VALUES			20 40 60 80 100	20 40 60 80 100	20 40 60 80 100	20 40 60 80 100	20 40 60 80 100		
82.0 0.0	Brown, silty sand: FILL		1	SS	16		82							
80.8			2	SS	5		81							
1.2	Very stiff to stiff, brown, SILTY CLAY		3	SS	4		80					60.1		
79.7														
2.3	Loose, brown-grey, silty sand with gravel, trace clay: TILL		4	SS	8		79							
79.0														
3.1	Grey, silty clay, som gravel: TILL		5	SS	4									
77.8			6	SS		*REF	78							
4.2	End of Borehole													
	Auger Refusal on Inferred Bedrock													
	- standpipe installed													
	- standard penetartion tests carried out using 45 lb hammer and 30 inch freefall													
	*REF = split spoon refusal													

RECORD OF BOREHOLE No 1										1 OF 1	METRIC		
W.P. 930-58		LOCATION Bridge No. 3 at Maitland Avenue				ORIGINATED BY MTO							
DIST 9 HWY 417		BOREHOLE TYPE				COMPILED BY MTO							
DATUM Geodetic		DATE 58.05.09 & 58.05.12				CHECKED BY							
SOIL PROFILE			SAMPLES			GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT				UNIT WEIGHT γ kN/m ³	REMARKS & GRAIN SIZE DISTRIBUTION (%) GR SA SI CL
ELEV DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE	"N" VALUES			SHEAR STRENGTH kPa ○ UNCONFINED × FIELD VANE ● QUICK TRIAXIAL × LAB VANE					
82.6 0.0 82.3	TOP SOIL												
0.3 80.8	HARD, FISSURED, SILTY, BROWNISH GREY CLAY		1	SS	23								
1.9 79.1	VERY STIFF, FISSURED, SILTY, BROWNISH GREY CLAY		2	SS	14								
			3	SS	10								
			4	SS	13								
3.5 77.9	DENSE SANDY TILL		5	SS	150 / 225 mm								
			6	SS	65 75 mm								
4.7 77.3	LIMESTONE (drilled)		7	RC									REC = 71%
5.3 76.6	LIMESTONE (drilled) bedding thickness 2.5"		8	RC									REC = 89%
6.0 75.4	LIMESTONE (drilled) bedding thickness 3"		9	RC									REC = 96%
7.2 74.8	LIMESTONE (drilled) bedding thickness 2"		10	RC									REC = 87%
7.8	BOTTOM OF HOLE												
Record of Borehole reproduced from Dwg No. D 4158-3													

CONT. 99-29

RECORD OF BOREHOLE No 2

1 OF 1

METRIC

W.P. 930-58 LOCATION Bridge No. 3 at Maitland Avenue ORIGINATED BY MTD
DIST 9 HWY 417 BOREHOLE TYPE _____ COMPILED BY MTD
DATUM Geodetic DATE 58.05.15 & 58.05.15 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 kN/m ³	REMARKS & GRAIN SIZE DISTRIBUTION (%) GR SA SI CL
ELEV DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE	"N" VALUES			SHEAR STRENGTH kPa	20	40	60	80					
83.0	TOP SOIL																
82.7																	
0.3	HARD, FISSURED, SILTY, BROWNISH GREY CLAY		1	SS			82										
81.6																	
1.4	VERY STIFF, FISSURED, SILTY, BROWNISH GREY CLAY		2	SS			81										
80.8																	
2.2	STIFF, FISSURED, SILTY, BROWNISH GREY CLAY		3	SS													
80.1																	
2.9	LOOSE TILL		4	SS	5		80										
79.3																	
3.7	LIMESTONE (drilled) bedding thickness 2.5"		5	RC			79										REC = 93%
77.8																	
5.2	LIMESTONE (drilled) bedding thickness 3"		6	RC			77										REC = 100%
76.3																	
6.7	BOTTOM OF HOLE																

RECORD OF BOREHOLE No 3

1 OF 1

METRIC

W.P. 930-58 LOCATION Bridge No. 3 at Maitland Avenue ORIGINATED BY MTO
DIST 9 HWY 417 BOREHOLE TYPE COMPILED BY MTO
DATUM Geodetic DATE 58.05.13 & 58.05.13 CHECKED BY

SOIL PROFILE			SAMPLES			GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT					UNIT WEIGHT γ kN/m ³	REMARKS & GRAIN SIZE DISTRIBUTION (%)
ELEV DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE	"N" VALUES			20 40 60 80 100	20 40 60 80 100	20 40 60 80 100	20 40 60 80 100	20 40 60 80 100		
82.9	TOP SOIL													
82.6														
0.3	HARD, FISSURED, SILTY, BROWNISH GREY CLAY		1	SS			82							
81.6														
1.4	VERY STIFF, FISSURED, SILTY, BROWNISH GREY CLAY		2	SS			81							
80.8														
2.2	STIFF, FISSURED, SILTY, BROWNISH GREY CLAY		3	SS			80							
80.0														
2.9	LOOSE TILL		4	SS										
79.3														
3.7	LIMESTONE (drilled) bedding thickness 2"		5	RC			79							REC = 83%
78.1														
4.8	LIMESTONE (drilled) bedding thickness 2" to 3"		6	RC			78							REC = 100%
76.9														
6.0	LIMESTONE (drilled) bedding thickness 3"		7	RC			77							REC = 86%
76.1														
6.8	BOTTOM OF HOLE													

RECORD OF BOREHOLE No 4

1 OF 1

METRIC

W.P. 930-58 LOCATION Bridge No. 3 at Maitland Avenue ORIGINATED BY MTO
DIST 9 HWY 417 BOREHOLE TYPE COMPILED BY MTO
DATUM Geodetic DATE 58.05.12 & 58.05.12 CHECKED BY

SOIL PROFILE			SAMPLES			GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT					UNIT WEIGHT γ kN/m ³	REMARKS & GRAIN SIZE DISTRIBUTION (%)
ELEV DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE	"N" VALUES			20 40 60 80 100	20 40 60 80 100	20 40 60 80 100	20 40 60 80 100	20 40 60 80 100		
82.9	TOP SOIL													
82.6														
0.3	HARD, FISSURED, SILTY, BROWNISH GREY CLAY		1	SS			82							
81.5														
1.4	VERY STIFF, FISSURED, SILTY, BROWNISH GREY CLAY		2	SS			81							
80.7														
2.2	STIFF, FISSURED, SILTY, BROWNISH GREY CLAY		3	SS			80							
79.4			4	SS										
3.5	LOOSE TILL		5	SS	7		79							
78.3														
4.6	DENSE TILL						78							
78.1														
4.8	LIMESTONE (drilled) bedding thickness 2" some vertical seams		6	RC			77							REC = 81%
76.6														
6.3	LIMESTONE (drilled) bedding thickness 2"		7	RC			76							REC = 60%
76.0														
6.9	LIMESTONE (drilled) bedding thickness 2"		8	RC			75							REC = 80%
74.8														
8.1	BOTTOM OF HOLE													

CONT. 99-29

RECORD OF BOREHOLE No 5										1 OF 1		METRIC	
W.P. 930-58			LOCATION Bridge No. 3 at Maitland Avenue			ORIGINATED BY MTO							
DIST 9 HWY 417			BOREHOLE TYPE			COMPILED BY MTO							
DATUM Geodetic			DATE 58.05.14 & 58.05.14			CHECKED BY							
SOIL PROFILE			SAMPLES			GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT			UNIT WEIGHT γ kN/m ³	REMARKS & GRAIN SIZE DISTRIBUTION (%) GR SA SI CL	
ELEV DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE	"N" VALUES			SHEAR STRENGTH kPa					WATER CONTENT (%)
82.7 0.0 82.4	TOP SOIL							20 40 60 80 100	PLASTIC LIMIT W _P	NATURAL MOISTURE CONTENT W	LIQUID LIMIT W _L		
0.3	HARD, FISSURED, SILTY, BROWNISH GREY CLAY		1	SS			82						
81.3 1.4	VERY STIFF, FISSURED, SILTY, BROWNISH GREY CLAY		2	SS			81						
			3	SS			80						
79.8 2.9	STIFF, FISSURED, SILTY, BROWNISH GREY CLAY		4	SS			79						
79.0 3.7	SOFT, VERY SILTY, GREY CLAY		5	SS	1	450mm							
78.4 4.3	DENSE TILL		6	SS	23								
78.0 4.7	LIMESTONE (drilled)		8	RC		75mm	78						REC = 60%
77.5 5.2	LIMESTONE (drilled) bedding thickness 3"		9	RC			77						REC = 33%
76.6 6.1	LIMESTONE (drilled) bedding thickness 3" one 80 degree joint in core break		10	RC			76						REC = 87%
75.0 7.7	LIMESTONE (drilled) bedding thickness 3"		11	RC			75						REC = 100%
74.5 8.2	BOTTOM OF HOLE												

CONT. 99-29

RECORD OF BOREHOLE No 6										1 OF 1	METRIC					
W.P. 930-58		LOCATION Bridge No. 3 at Maitland Avenue				ORIGINATED BY MTO										
DIST 9 HWY 417		BOREHOLE TYPE				COMPILED BY MTO										
DATUM Geodetic		DATE 58.05.13 & 58.05.14				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 kN/m ³	REMARKS & GRAIN SIZE DISTRIBUTION (%) GR SA SI CL	
ELEV DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE	"N" VALUES			20	40	60						80
82.3	TOP SOIL															
82.0																
0.3	HARD, FISSURED, SILTY, BROWNISH GREY CLAY		1	SS												
81.0																
1.4	VERY STIFF, FISSURED, SILTY, BROWNISH GREY CLAY		2	SS												
80.2																
2.2	STIFF, FISSURED, SILTY, BROWNISH GREY CLAY		3	SS												
78.8			4	SS												
3.5	LOOSE TILL		5	SS	7											
78.2			6	SS	33	150mm										
4.1	DENSE TILL		7	SS	44	75mm										
77.4																
5.0	LIMESTONE (drilled) bedding thickness 2"		8	RC												REC = 93%
76.3																
6.0	LIMESTONE (drilled) bedding thickness 3"		9	RC												REC = 94%
74.9																
7.4	LIMESTONE (drilled) bedding thickness 3"		10	RC												REC = 95%
74.3																
8.0	BOTTOM OF HOLE															

GEOCRES No

3145-190

FOUNDATION INVESTIGATION REPORT

GWP 203-86-02

HIGHWAY 417/MAITLAND AVENUE BRIDGE REHABILITATION

DISTRICT 42, OTTAWA

MINISTRY OF TRANSPORTATION ONTARIO

SUBMITTED TO

McCORMICK RANKIN CORPORATION

BY

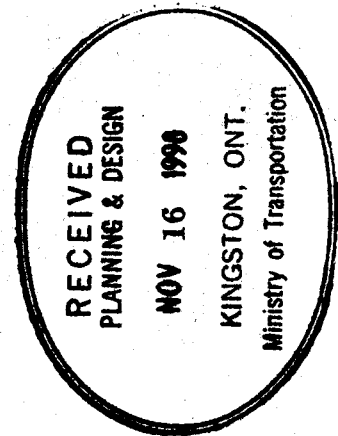
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PROJECT NO. 11099

FOUNDATION INVESTIGATION REPORT

TO

McCORMICK RANKIN CORPORATION

ON

GWP 203-86-02

HIGHWAY 417/MAITLAND AVENUE BRIDGE REHABILITATION

DISTRICT 42, OTTAWA

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November 6, 1998



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FOUNDATION INVESTIGATION REPORT

for

GWP 203-86-02

Highway 417/Maitland Avenue Bridge Rehabilitation

District 42, Ottawa

1.0 INTRODUCTION

This report presents the results of a geotechnical foundation investigation carried out as part of the Highway 417/Maitland Avenue Bridge Rehabilitation project (GWP 203-86-02, Agreement No. 9740-7411-4256). This bridge rehabilitation project includes the bridge rehabilitation work as well as pavement widenings of the Highway 417 lanes, construction of earth retaining structures beneath the bridge and relocation of two overhead sign foundations, as well as intersection improvements at the Ramp E-N/S and Maitland Avenue intersection.

This Foundation Investigation Report presents geotechnical recommendations for the design and construction of:

- 1) Earth retaining structures beneath the Maitland Avenue Bridge; and
- 2) Foundations for overhead signs.

A separate Pavement Design Report (PDR) has been prepared for the pavement widenings and the Ramp E-N/S intersection works.

The work was carried out in general accordance with Schedule 6 of the TPM proposal submission.

This report has been prepared specifically and solely for the project described herein. It contains factual information obtained from this investigation pertaining to the subsurface conditions.

2.0 SITE DESCRIPTION AND GEOLOGY

GWP 203-86-02 is located along a 1.3 km long section of Highway 417 centered around the Maitland Avenue interchange. The site location is shown on the Key Plan provided in Appendix 1 (Drawing No. 11099-1).

This section of Highway 417 is 4-lanes wide in each direction directly beneath the bridge structure with the EBLs and WBLs separated by a concrete barrier.

The existing bridge abutments are supported on piles, end bearing on bedrock. The front row of piles are battered toward Hwy 417. The foreslopes of both the north and south abutments are at a 2H:1V grade, are protected by stone paving, and extend down to the roadway shoulders.

Drainage along the sections of Hwy 417 immediately east and west of the Maitland Avenue Bridge is provided by highway ditches. Small corrugated steel pipe (CSP) culverts currently link the ditches within the section beneath the bridge structure.

This project lies within the physiographic region known as the Ottawa Valley Clay Plains which is interrupted by ridges of rock and sand.

The native surficial materials in the vicinity of the Maitland Avenue Bridge are Champlain Sea deposits, consisting of silt and clay underlying erosional terraces. Bedrock within this area generally consists of limestone of the Ottawa Formation.



3.0 PROCEDURE

3.1 Field Investigation

The site soil conditions were investigated through a borehole drilling investigation and laboratory testing.

Prior to drilling the boreholes, their locations were laid out by Jacques Whitford staff and the appropriate utility agencies were contacted to ensure that the site was clear of buried utilities.

Due to the high traffic volumes on Highway 417, the drilling investigation was carried out at night within full lane and ramp closures. The boreholes along the eastbound and westbound lanes were drilled on the nights of August 26th and 27th, respectively. The lane and ramp closures were carried out by Beacon Lite Ltd., in accordance with a traffic control plan submitted to and approved by Mr. John Blaikie of MTO.

Portable light stands were used to provide adequate lighting for the drill crews.

The soil conditions along the retaining wall alignment and at the proposed location for the overhead sign foundations were investigated by a total of four (4) boreholes, designated as 98-1 through 98-4. Due to site access restrictions (concrete barriers, ditches and steep slopes), one borehole was put down along both the north and south sides of Hwy 417, between the overhead signs and retaining wall alignments, using portable electrically powered equipment. The remaining two boreholes were put down at the base of the slopes in front of the retaining wall alignments using a truck mounted CME 55 drill rig. The borehole locations are shown on Drawing No. 11099-2, attached.

The boreholes were advanced to refusal on inferred bedrock. Split spoon samples were collected at regular 2½ foot intervals while carrying out Standard Penetration Testing (SPT) (ASTM D1586) and the recovered soil samples were identified in the field by our personnel. The SPT carried out in the boreholes put down with the portable equipment utilized a 45 pound hammer with a 30 inch drop as opposed to a standard 140 lb hammer with a 30 inch drop. The N-values presented on these Borehole Records have been corrected by reducing the field N-value by a factor of 3 to reflect the difference in energy delivered by the hammer during the testing. In-situ shear vane testing was attempted at several locations within the cohesive soil deposits, however, at all locations tested, the undrained shear strength of the soil exceeded the field vane capacity of 150 kPa.

The subsurface conditions are described in detail in the Borehole Records presented in Appendix 1. Geotechnical cross sections are shown on Drawing No 11099-2.



All soil samples recovered during the SPT were stored in moisture proof containers and were returned to our laboratory for detailed classification and testing.

Standpipes were installed within three of the boreholes prior to backfilling. The boreholes were backfilled by replacing (and tamping in layers) the augered material.

The field information is supplemented by soil and bedrock information contained on the Borehole Records from the foundation investigation carried out for the Maitland Avenue Bridge construction (1958). These Borehole Records include stratigraphic descriptions of the overburden soils as well as bedrock.

3.2 Survey

The borehole locations and elevations were surveyed by McCormick Rankin Corporation's (MRC) survey crew, using a geodetic datum.

3.3 Laboratory Testing

All samples returned to the laboratory were subjected to detailed visual classification by a geotechnical engineer. Selected samples were tested for moisture content, grain size distribution and Atterberg Limits. One representative soil sample from each of the retaining wall locations was submitted for pH, sulphate and chloride testing to assess the potential for corrosion of buried steel and the potential for sulphate attack on buried concrete. All soil samples will be stored for a period of one year after issuance of the final report. Unless otherwise directed, the stored samples will be disposed of after this period.



4.0 RESULTS OF THE INVESTIGATION

4.1 Subsurface Profile

The subsurface conditions observed in the boreholes are presented in detail on the Borehole Records provided in Appendix 2. The Borehole Records from DWG. No. D 4158-3, produced for the Maitland Avenue Bridge construction (W.P. 930-58) have been reproduced and are also included in Appendix 2. An explanation of the symbols and terms used to describe the Borehole Records is also provided. Stratigraphic profiles are provided in Drawing No 11099-2. The subsurface conditions observed at the site are generally consistent from borehole to borehole and are described in the following sections.

4.1.1 Embankment Fill

The embankment fill within the slopes beside the slope paving consists of silty sand with varying amounts of gravel, occasional rootlings and clayey pockets.

4.1.2 Silty Clay

The fill is underlain by a silty clay deposit which extends to elevation 78.5 m to 80.1 m. The silty clay generally has a hard to stiff consistency and is brown to greyish-brown in colour. A thin layer of soft silty clay was identified in Borehole No. 5, located at the eastern centre pier. The moisture contents of seven samples tested ranged from 29 % to 60 %. Atterberg Limit testing carried out on one representative sample of the silty clay indicated a Liquid Limit of 60 % and a Plastic Limit of 22 %. A hydrometer analysis indicated that 42 % of the silty clay had a grain size between 5 and 75 microns, indicating a moderate susceptibility to frost heaving (MSFH).

4.1.3 Glacial Till

A glacial till deposit was encountered in each of the boreholes below the silty clay. The glacial till extended to bedrock and was in a loose to dense state. A grain size distribution analysis carried out on a sample of the till indicated that it contained 25 % gravel, 42 % sand and 33 % silt and clay particles. The moisture contents of five samples tested ranged from 10 % to 29 %



4.2 Groundwater

Groundwater levels were measured in the standpipes on September 17, 1998. The measured groundwater levels varied from elevation 79.2 m to 80.0 m, (approximately 2 m below the finished grade of Hwy 417). Fluctuations in the groundwater level due to seasonal variations or in response to a particular precipitation event should be anticipated.

4.3 Bedrock

Refusal on inferred bedrock was encountered in Boreholes 98-1 through 98-4. Bedrock coring was carried out for the 1958 geotechnical investigation for the Maitland Avenue Bridge structure. The bedrock elevation at these ten borehole locations varied from 77.1 m to 79.3 m. The records for Borehole Nos 1 through 6 indicate that bedrock consists of limestone with typical bedding thicknesses ranging from 2 to 3 inches (50 mm to 75 mm).



5.0 DISCUSSION AND RECOMMENDATIONS

5.1 Proposed Development

Pavement widenings will be carried out beneath the Maitland Avenue Bridge to accommodate temporary construction detours as well as future widening of the Highway. It is understood that Highway 417 near Maitland Avenue will be widened by one lane in each direction, likely within the next 5 to 7 years.

To create space for the proposed pavement widenings, the existing slope paving and approach fill in front of both the north and south bridge abutments will be cut back and retained. The exact limits of the proposed retaining structures were not known at the time of the investigation. In addition, the existing overhead signs located just before the Maitland Avenue bridge in both the EBL and WBL will be widened. This will require moving the outside leg of each sign to a new foundation located approximately 4 m further out.

It is understood that a tieback retaining wall system, incorporating H-piles and rock anchors, is the preferred design alternative to hold back the approach fill in front of the bridge abutments. In addition, new foundations are to be constructed for support of the outside legs of the overhead signs near the Maitland Avenue Bridge.

Based on information provided by others, the existing bridge abutments are supported on end bearing piles, and the proposed work discussed herein is not to impact on these foundations.

5.2 Geotechnical Assessment

A tie-back retaining wall system is compatible with the geotechnical conditions at the site. The final design of the soldier pile and rock anchor locations will need to consider the location of the piles supporting the existing abutments.

The overhead signs may be founded on spread footings founded within the native silty clay or on bored piles.

The frost penetration depth to be used in all design work at this site is 1.8 m. The proposed retaining wall location will result in a reduction in frost protection to the underside of the existing abutments - as little as 0.85 m cover will be provided to the south abutment. Therefore, frost protection of the existing abutments will be required.

5.3 Geotechnical Recommendations for Earth Retaining Structures

5.3.1 Lateral Earth Pressures

Computation of earth pressures should be in accordance with Section 6-7 of the OHBDC 3rd Edition. For rigidly tied structures, where the wall is allowed to rotate less than 0.1 % of the wall height, the at-rest earth pressure should be used for design. Typically, for a tie-back retaining wall system, minimum excavation and backfilling is carried out behind the retaining wall, therefore lateral earth pressures acting on the walls should be based on soil parameters for the existing embankment fill. The following unfactored soil parameters may be used for design.

Soil Parameter	Existing Fill	
	1.5H : 1V Backslope	2H : 1V Backslope
Bulk Unit Weight, γ (kN/m ³)	20.5	20.5
Effective Friction Angle, ϕ	30°	30°
Rankine Coefficient of Active Earth Pressure (K_a)	0.59	0.54
Coefficient of Earth Pressure at Rest (K_o)	0.90	0.85

Slope paving should be placed to protect the steep (1.5H:1V) backslope. Backslopes with a vegetated cover should be made no steeper than 2:1. In addition, due to the steep backslope beneath the bridge structure, it is recommended that the upper 600 mm (minimum) of the backslope material consist of OPSS Granular A. This detail is shown in Drawing No. 11099-5, in Appendix 3.

5.3.2 Lateral Resistance of Vertical Piles

The lateral resistance of vertical piles should be determined in accordance with Section 6-9.8 of the Ontario Highway Bridge Design Code (OHBDC) 3rd Edition. The resistance provided by the soil may be determined in accordance with the methods described by B.B. Broms in the following papers, or by other appropriate methods:

Broms, B.B., 1964. "Lateral Resistance of Piles in Cohesive Soils". J. of Soil Mech. and Found. Div., ACSE, vol. 90, SM2: 27-63

Broms, B.B., 1964. "Design of Laterally Loaded Piles in Cohesionless Soils". J. of Soil Mech. and Found. Div., ACSE, vol. 90, SM3: 123-156



The following unfactored design parameters may be used for the design of laterally loaded piles:

Material	Unit Weight (kN/m ³)	Effective Friction Angle, ϕ	Rankine Passive Earth Pressure, K_p	Undrained Shear Strength, C_u (kPa)
Very Stiff Silty Clay	17.0	n/a	n/a	125
Stiff Silty Clay	17.0	n/a	n/a	75
Till	20.5	30°	3.0	n/a
Pavement Structure	22.0	35°	3.7	n/a

Where the upper material along the passive face consists of a drained pavement structure abutting the tie-back retaining wall, at least 800 mm thick, the passive pressure within the full frost penetration depth may be used, but should be reduced by a factor of 0.5, as depicted in Drawing No. 11099-6 in Appendix 3. Where the surficial soils along the passive face of the piles consist of native material or random fill, the passive pressure within the frost penetration depth of 1.8 m should be neglected when determining the lateral resistance.

5.3.3 Vertical Resistance of Piles

Tip elevations for end-bearing steel soldier piles are expected to range from 77 to 79 m.

No downdrag forces are expected at the proposed retaining wall locations since no additional fill placement is expected.

Due to limited clear height beneath the existing bridge deck, it is anticipated that pile driving will not be possible. Rather, it is anticipated that the piles will be installed using a vibratory hammer. Prior to installation of piles, it will be necessary to locate existing batter piles. It is anticipated that the clearance between existing piles and the new piles will be in the order of 375 mm. It is therefore recommended that the exposed portions of the existing piles be at least 600 mm in length so that the plumb direction may be determined using an electronic level such as a "Smart Level" or "Smart Tool" in order to project an approximate tip location prior to installing the new piles.

The following design parameters are recommended for steel piles installed using a vibratory hammer at this site:

Pile Type	Factored Resistance at ULS (kN)	Resistance at SLS (kN)
W250x49	380	270
W310x60	450	320
W360x64	490	350

Pile installation should be monitored by a qualified and experienced inspector. Attempts should be made in all cases to install the piles to a dense stratum.

5.3.4 Tieback (rock) Anchors

Grouted rock anchors should be used to tie back the wall. The following recommendations are provided for the design of grouted rock anchors:

- A rock to grout bond stress of 500 kPa (ULS) may be used for holes grouted with non-shrink grout having a minimum compressive strength of 30 Mpa.
- The minimum fixed anchor length (i.e. the length over which the rock to grout bond stress is developed) should be no less than 3 m.
- The minimum anchor spacing should be 900 mm centre to centre.
- To ensure against the possibility of a rock mass failure, the following design parameters may be used:
 - submerged unit weight = 15.2 kN/m^3
 - a 60° (apex angle) failure cone with the apex located at the midpoint of the bonded length
- The interaction between cones must be included in the overall stability analysis

All rock anchors should be proof loaded to 150 % of the design load. The minimum free anchor length normally required for stressing of the anchor is 1 to 2 m. This length may vary depending on the type of anchor and stressing equipment. The anchor designer/installer should be consulted to verify this requirement.



The free anchor length may be grouted, after the proof load test to provide corrosion protection to the anchor tendon.

5.3.5 Frost Protection

Proposed retaining structures will need to be protected against frost action. For the proposed concrete wall facing, this can be achieved by one of the following three methods:

1. Extending the base of the concrete facing to a depth of 1.8 m below grade.
2. Constructing a drained granular pad beneath the concrete panels. The granular pad should consist of free draining material which extends to 1.8 m below ground surface. If this option is selected, the details will be provided.
3. The use of extruded polystyrene insulation to provide the equivalent of 1.8 m of soil cover as protection. For design purposes at this site, 25 mm of insulation will provide frost protection equivalent to 500 mm of soil cover. Design details will need to be reviewed by the geotechnical consultant.

Existing foundations which will lose their soil protection will also need to be reviewed by the geotechnical consultant once the insulation details are developed.

5.4 Foundation Recommendations - Overhead Signs

The following design parameters may be used for footings as wide as 3 m:

Factored Bearing Resistance at ULS	300 kPa
Bearing Resistance at SLS	200 kPa

The bearing resistance at SLS is based on a maximum allowable settlement of 25 mm.

The effect of inclined loads on the bearing resistance should be accounted for as per Section 6-8.4.2 of the OHBDC, 3rd Edition.

All spread footings should be protected from frost action by a minimum soil cover of 1.8 m or equivalent insulation.

The foundations for the overhead signs may also be founded on bored piles. Laterally loaded bored piles may be designed using the methods and design parameters provided in Section 5.3.2 of this report.

5.5 General Construction Recommendations

Site Grading and Preparation

All organic soils, and other deleterious materials must be removed from beneath spread footings. Where deleterious materials are encountered, the material should be excavated, wasted and replaced with earth fill. The lateral extent of such excavation should include all deleterious material within an imaginary line drawn at an angle of 1 horizontal to 1 vertical, downward and away from the vertical edges of the culvert, to the competent native soil.

Stripping of deleterious materials should be inspected by geotechnical personnel to ensure that all unsuitable materials are removed prior to placement of concrete or Select Subgrade Material (SSM).

If required for grading purposes, earth fill should consist of Select Subgrade Material (SSM), placed in lifts no greater than 300 mm and compacted to at least 95 % Standard Proctor Maximum Dry Density (SPMDD).

Excavation and Backfill

Side slopes for open cut excavations should conform to Occupational Health and Safety Act (OHSA) regulations. Excavation side slopes should be inspected regularly for signs of instability and flattened as required. Alternatively excavation side slopes may be supported.

The existing granular fill is considered a Type 3 soil, in accordance with the OHSA, and excavations should therefore be carried out using side slopes no steeper than 1H:1V from the base of the excavation.

The very stiff silty clay would be considered a Type 2 soil, in accordance with the OHSA, and excavations should therefore be carried out using side slopes no steeper than 1H:1V from 1.2 m above the base of the excavation.

Where backfill material is required behind the retaining wall lagging, it is recommended that a clean material such as silica sand or pea gravel be used. This material should be tamped in place.



Dewatering

Excavations carried out above the water table are expected to receive minor groundwater inflow due to surface run-off and precipitation. Dewatering may be carried out using conventional sump and pump methods. Auger holes for bored piles will likely extend beneath the water table. Significant groundwater inflow may be expected if the auger hole penetrates the silty clay into the underlying glacial till or if sand seams within the silty clay are penetrated. Tremie techniques may be required for placement of concrete under these conditions.

Cement Type and Corrosion Protection

Two representative soil sample were submitted to Accutest Laboratories in Nepean, Ontario, for analysis of pH and water soluble sulphate and chloride, in order to determine cement type and reinforcing steel protection requirements.

The water soluble sulphate results were both 0.03 %. Results below 0.10 % are considered to represent a low degree of exposure to sulphate attack and therefore a normal Type 10 Portland cement should be suitable for use in concrete mixtures for this site.

The pH test results were 7.5 and 7.6. Test results between 5.5 and 9.0 are not considered to represent an environment overly conducive to corrosion of steel in contact with the site soils or groundwater. Water soluble chloride levels greater than 0.25 % are also an indication of an environment conducive to corrosion. The test results were between 0.149 % and 0.216 %, however, it should be noted that deicing carried out along this section of Highway 417 consists of a 100 % salt spread and therefore elevated chloride levels should be expected immediately adjacent to the future edge of roadway, possibly creating an environment favourable for corrosion of steel members such as piles and reinforcing steel.

6.0 CLOSURE

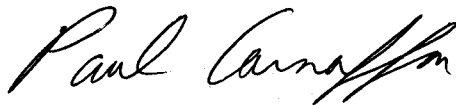
The recommendations made in this report are in accordance with our present understanding of the project. We request that we be permitted to review our recommendations when the drawings and specifications are complete.

A soil investigation is a limited sampling of a site. The conclusions given herein are based on information gathered at the specific borehole locations and can only be extrapolated to an undefined limited area around these locations. The extent of the limited area depends on the soil and groundwater conditions, as well as the history of the site reflecting natural, construction, and other activities. Should any conditions at the site be encountered which differ from those at the borehole locations, we request that we be notified immediately in order to assess the additional information and its effects on the above conclusions.

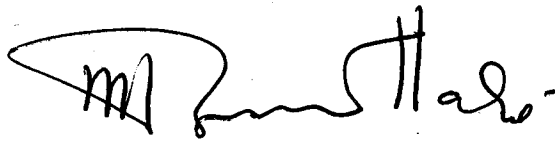
We trust the information presented herein meets your present requirements. Should you have any questions or require additional information, please do not hesitate to contact us.

Yours very truly,

JACQUES, WHITFORD LIMITED

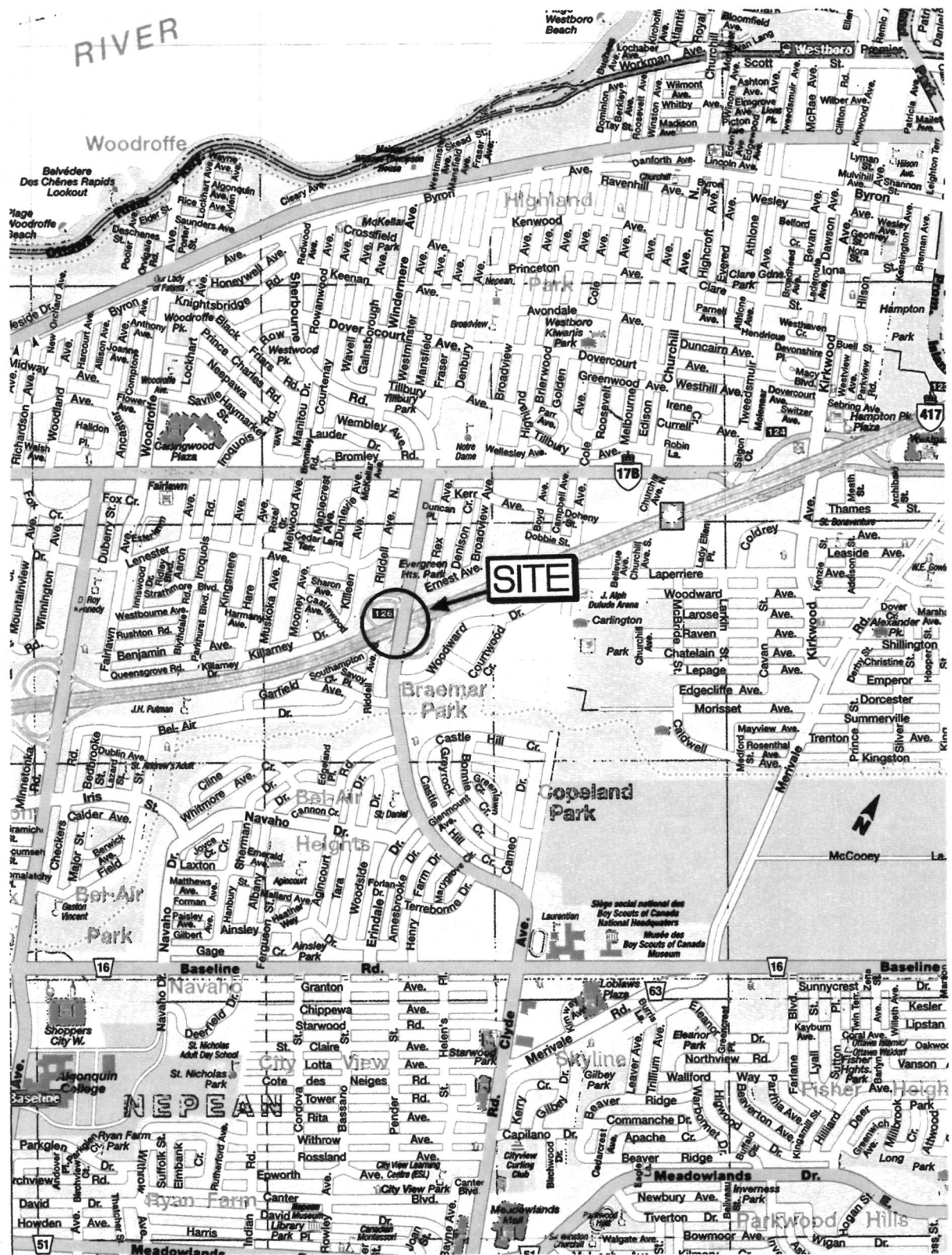


Paul Carnaffan, M.Eng., P.Eng.



J.G.A. Raymond Haché, M.Sc., P.Eng.

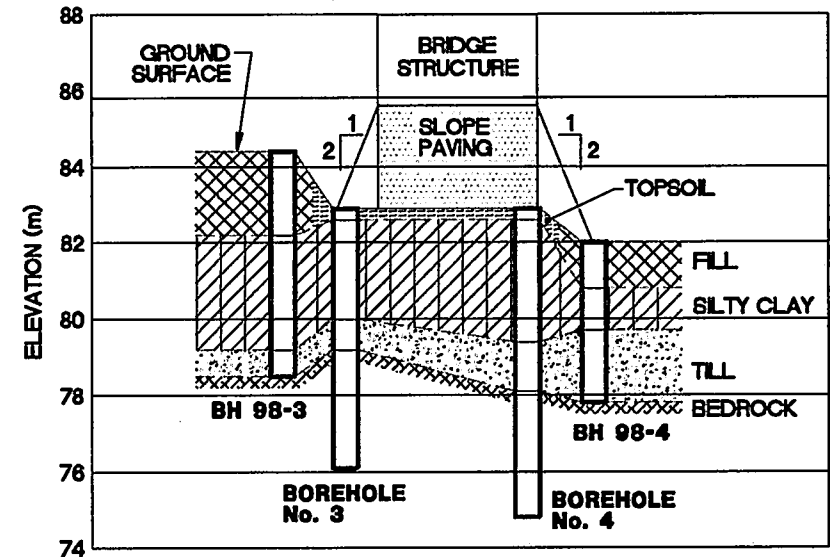
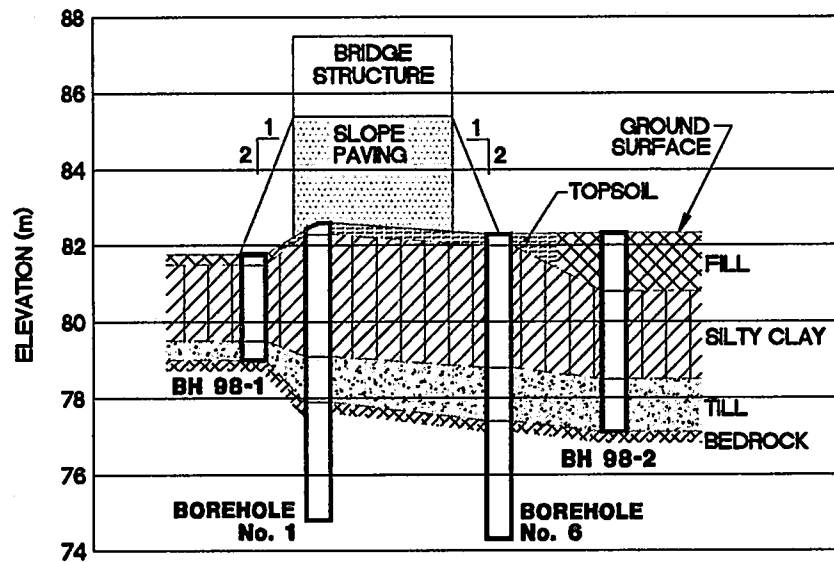
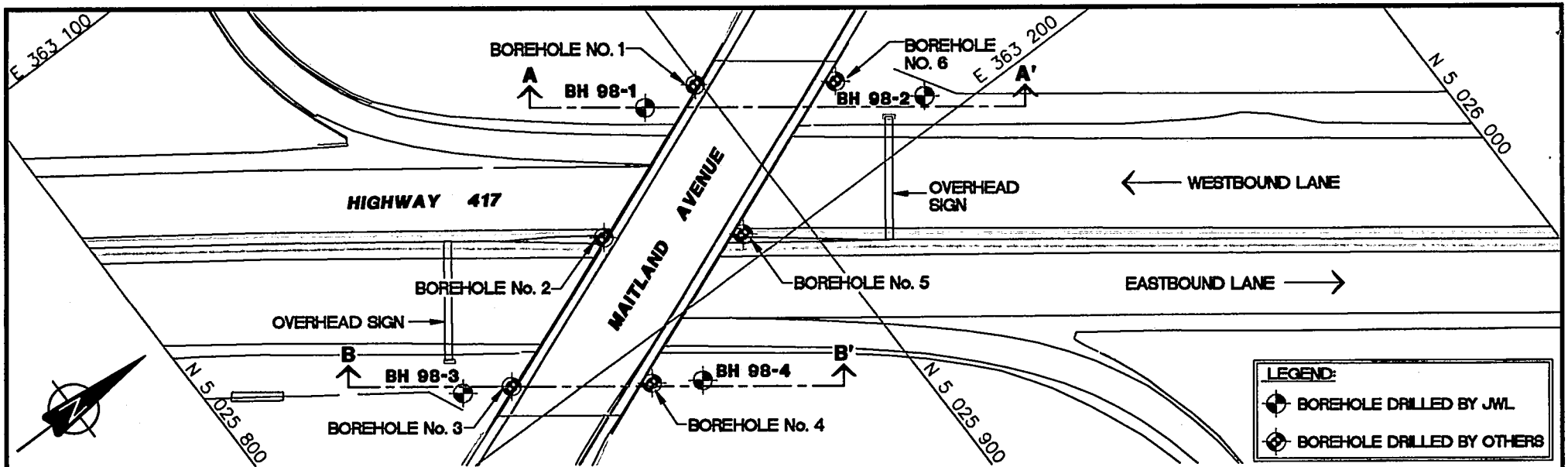




KEY PLAN

1: 25 000





MCCORMICK RANKIN CORPORATION
 GWP 203-86-02
 HIGHWAY 417/MATLAND AVENUE BRIDGE REHABILITATION
 BOREHOLE LOCATION AND CROSS-SECTION PLANS

OTTAWA,

ONTARIO

Scale: 1:1000 HORIZ.
 1:200 VERT.

Date: 98/11/04

Drawing No.: 11099-2

Dwn. by: GBB

Appd.: PC



Jacques Whitford

SYMBOLS AND TERMS USED ON BOREHOLE AND TEST PIT RECORDS

SOIL DESCRIPTION

Terminology describing common soil genesis:

<i>Topsoil</i>	-	mixture of soil and humus capable of supporting good vegetative growth
<i>Peat</i>	-	fibrous aggregate of visible and invisible fragments of decayed organic matter
<i>Till</i>	-	unstratified glacial deposit which may range from clay to boulders
<i>Fill</i>	-	any materials below the surface identified as placed by humans (excluding buried services)

Terminology describing soil structure:

<i>Desiccated</i>	-	having visible signs of weathering by oxidization of clay minerals, shrinkage cracks, etc.
<i>Fissured</i>	-	having cracks, and hence a blocky structure
<i>Varved</i>	-	composed of regular alternating layers of silt and clay
<i>Stratified</i>	-	composed of alternating successions of different soil types, e.g. silt and sand
<i>Layer</i>	-	> 75 mm
<i>Seam</i>	-	2 mm to 75 mm
<i>Parting</i>	-	< 2 mm
<i>Well Graded</i>	-	having wide range in grain sizes and substantial amounts of all intermediate particle sizes
<i>Uniformly Graded</i>	-	predominantly of one grain size

Terminology describing soils on the basis of grain size and plasticity is based on the Unified Soil Classification System (USCS) (ASTM D-2488). The classification excludes particles larger than 76 mm (3 inches). This system provides a group symbol (e.g. SM) and group name (e.g. silty sand) for identification.

Terminology describing materials outside the USCS, (e.g. particles larger than 76 mm, visible organic matter, construction debris) is based upon the proportion of these materials present:

<i>Trace, or occasional</i>	Less than 10%
<i>Some</i>	10-20%

The standard terminology to describe cohesionless soils includes the compactness (formerly "relative density"), as determined by laboratory test or by the Standard Penetration Test 'N' - value.

Relative Density	'N' Value	Compactness %
<i>Very Loose</i>	< 4	< 15
<i>Loose</i>	4-10	15-35
<i>Compact</i>	10-30	35-65
<i>Dense</i>	30-50	65-85
<i>Very Dense</i>	> 50	> 85

The standard terminology to describe cohesive soils includes the consistency, which is based on undrained shear strength as measured by insitu vane tests, penetrometer tests, unconfined compression tests, or occasionally by standard penetration tests.

Consistency	Undrained Shear Strength		'N' Value
	kips/sq. ft.	kPa	
<i>Very Soft</i>	<0.25	<12.5	<2
<i>Soft</i>	0.25-0.5	12.5-25	2-4
<i>Firm</i>	0.5-1.0	25-50	4-8
<i>Stiff</i>	1.0-2.0	50-100	8-15
<i>Very Stiff</i>	2.0-4.0	100-200	15-30
<i>Hard</i>	>4.0	>200	>30

ROCK DESCRIPTION

Rock Quality Designation (RQD)

The classification is based on a modified core recovery percentage in which all pieces of sound core over 100 mm long are counted as recovery. The smaller pieces are considered to be due to close shearing, jointing, faulting, or weathering in the rock mass and are not counted. RQD was originally intended to be done on NW core; however, it can be used on different core sizes if the bulk of the fractures caused by drilling stresses are easily distinguishable from *in situ* fractures.

RQD

ROCK QUALITY

90-100	Excellent, intact, very sound
75-90	Good, massive, moderately jointed or sound
50-75	Fair, blocky and seamy, fractured
25-50	Poor, shattered and very seamy or blocky, severely fractured
0-25	Very poor, crushed, very severely fractured

Terminology describing rock mass:

Spacing (mm)	Bedding, Laminations, Bands	Discontinuities
2000-6000	<i>Very Thick</i>	<i>Very Wide</i>
600-2000	<i>Thick</i>	<i>Wide</i>
200-600	<i>Medium</i>	<i>Moderate</i>
60-200	<i>Thin</i>	<i>Close</i>
20-60	<i>Very Thin</i>	<i>Very Close</i>
<20	<i>Laminated</i>	<i>Extremely Close</i>
<6	<i>Thinly Laminated</i>	

Strength Classification	Uniaxial Compressive Strength (MPa)
<i>Very Low</i>	1-25
<i>Low</i>	25-50
<i>Medium</i>	50-100
<i>High</i>	100-200
<i>Very High</i>	>200

Terminology describing weathering:

Slight

Weathering limited to the surface of major discontinuities. Typically iron stained.

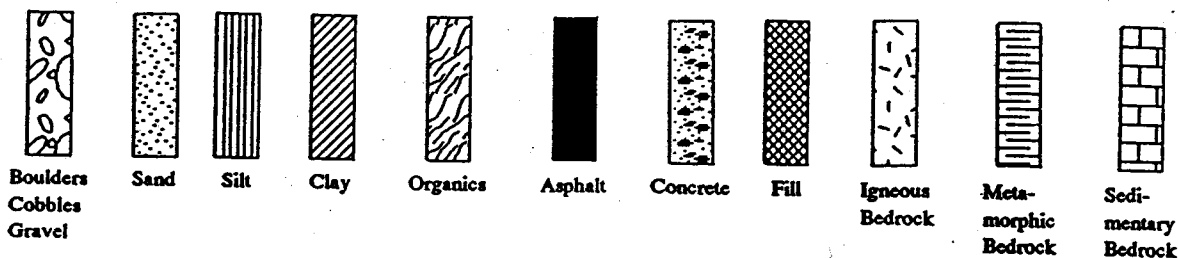


Moderate
High

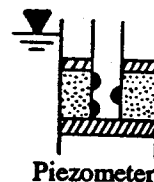
- Weathering extends throughout rock mass. Rock is not friable.
- Weathering extends throughout rock mass. Rock is friable.

STRATA PLOT

Strata plots symbolize the soil or bedrock description. They are combinations of the following basic symbols:



WATER LEVEL MEASUREMENT



SAMPLE TYPE

SS Split spoon sample (obtained by performing the Standard Penetration Test)

ST Shelby tube or thin wall tube

PS Piston sample

BS Bulk sample

WS Wash sample

HQ, NQ, BQ, etc. Rock core samples obtained with the use of standard size diamond drilling bits.

N - VALUE

Numbers in this column are the results of the Standard Penetration Test: the number of blows of a 140 pound (64 kg) hammer falling 30 inches (760 mm), required to drive a 2 inch (50.8 mm) O.D. split spoon sampler one foot (305 mm) into the soil. For split spoon samples where insufficient penetration was achieved and 'N' values cannot be presented, the number of blows are reported over sampler penetration in millimetres (e.g. 50/75).

OTHER TESTS

S Sieve analysis

G_s Specific gravity of soil particles

k Permeability (cm/sec)

↓ Single packer permeability test; test interval from depth shown to bottom of borehole

↑ Double packer permeability test; test interval as indicated

○ Falling head permeability test using casing

▽ Falling head permeability test using well point or piezometer

H Hydrometer analysis

γ Unit weight

C Consolidation

CD Consolidated drained triaxial

CU Consolidated undrained triaxial with pore pressure measurements

UU Unconsolidated undrained triaxial

DS Direct shear

Q_u Unconfined compression

I_p Point Load Index (I_p on Borehole Record equals I_p(50); the index corrected to a reference diameter of 50 mm)



Environnement Canada

RECORD OF BOREHOLE No 98-1

1 OF 1

METRIC

W.P. 203-86-02 LOCATION Hwy 417 WBL at Maitland Avenue ORIGINATED BY LP
 DIST 429 HWY 417 BOREHOLE TYPE Hollow Stem Augers COMPILED BY PC
 DATUM Geodetic DATE 98.08.27 & 98.08.28 CHECKED BY PC

SOIL PROFILE			SAMPLES			GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT					UNIT WEIGHT γ kN/m ³	REMARKS & GRAIN SIZE DISTRIBUTION (%) GR SA SI CL			
ELEV DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE	"N" VALUES			SHEAR STRENGTH kPa									
								20 40 60 80 100									
								20 40 60 80 100									
82.3 0.0	Brown, silty sand, trace organics: FILL		1	SS	5		82										
81.6 0.8	Brown, silty clay, some gravel, trace organics: FILL		2	SS	8		81										
80.8 1.5	Very stiff, brown, SILTY CLAY, occasional sand seams		3	SS	7		80										
			4	SS	4												
79.3 3.0	Stiff	5	SS	3	79												
78.5 3.8	Loose to compact, grey, silty sand with gravel, trace clay: TILL	6	SS	7	78												
		7	SS	16													
77.1 5.2	End of Borehole																
	Auger Refusal on Inferred Bedrock																
	- standpipe installed																
	- standard penetration tests carried out using 45 lb hammer and 30 inch freefall																
	max. field vane capacity was 150 kPa which was exceeded by soil resistance.																

RECORD OF BOREHOLE No 98-2

1 OF 1

METRIC

W.P. 203-86-02 LOCATION Hwy 417 WBL at Maitland Avenue ORIGINATED BY LP
 DIST 429 HWY 417 BOREHOLE TYPE Hollow Stem Augers COMPILED BY PC
 DATUM Geodetic DATE 98.08.27 & 98.08.28 CHECKED BY PC

SOIL PROFILE			SAMPLES			GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT					PLASTIC LIMIT W _P	NATURAL MOISTURE CONTENT W	LIQUID LIMIT W _L	UNIT WEIGHT γ kN/m ³	REMARKS & GRAIN SIZE DISTRIBUTION (%) GR SA SI CL	
ELEV DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE	"N" VALUES			SHEAR STRENGTH kPa										WATER CONTENT (%)
								○ UNCONFINED	× FIELD VANE	● QUICK TRIAXIAL	× LAB VANE							
81.8							20	40	60	80	100							
0.0	Dark brown, silty sand: FILL		1	SS	3													
81.5																		
0.3	Very stiff, brown, SILTY CLAY		2	SS	9													
			3	SS	7													
79.5																		
2.3	Compact, brown, silty sand, some gravel, trace clay: TILL		4	SS		*REF												
79.0																		
2.8	End of Borehole																	
	Auger Refusal on Inferred Bedrock																	
	- max. field vane capacity was 150 kPa which was exceeded by soil resistance.																	
	*REF = split spoon refusal																	

x³, x³: Numbers refer to
Sensitivity

20
15
10
(%) STRAIN AT FAILURE

RECORD OF BOREHOLE No 98-3

1 OF 1

METRIC

W.P. 203-86-02 LOCATION Hwy 417 EBL at Maitland Avenue ORIGINATED BY LP
 DIST 429 HWY 417 BOREHOLE TYPE Hollow Stem Augers COMPILED BY PC
 DATUM Geodetic DATE 98.08.26 & 98.08.27 CHECKED BY PC





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					
84.4 0.0	Brown, sand, some silt, trace organics, clayey pockets: FILL		1	SS	6		84										
			2	SS	3												
			3	SS	6												
82.1 2.3	Very stiff, brown, SILTY CLAY, occasional sand seams		4	SS	8		82										
			5	SS	6												
80.6 3.8	stiff		6	SS	3												
			7	SS	5												
79.2 5.3	Loose, brown, clayey sand, some silt, trace gravel: TILL		8	SS	7		79										
78.5 5.9	End of Borehole																
	Auger Refusal on Inferred Bedrock																
	- max. field vane capacity was 150 kPa which was exceeded by soil resistance.																

RECORD OF BOREHOLE No 98-4

1 OF 1

METRIC

W.P. 203-86-02 LOCATION Hwy 417 EBL at Maitland Avenue ORIGINATED BY LP
 DIST 429 HWY 417 BOREHOLE TYPE Hollow Stem Augers COMPILED BY PC
 DATUM Geodetic DATE 98.08.26 & 98.08.27 CHECKED BY PC

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 kPa									WATER CONTENT (%)
								○ UNCONFINED	× FIELD VANE	● QUICK TRIAXIAL	× LAB VANE						
82.0							82	20	40	60	80	100	10	20	30	kN/m ³	GR SA SI CL
0.0	Brown, silty sand: FILL		1	SS	16												
80.8			2	SS	5		81										
1.2	Very stiff to stiff, brown, SILTY CLAY		3	SS	4		80								60.1		
79.7																	
2.3	Loose, brown-grey, silty sand with gravel, trace clay: TILL		4	SS	8		79										
79.0																	
3.1	Grey, silty clay, som gravel: TILL		5	SS	4		78										
77.8			6	SS		*REF											
4.2	End of Borehole																
	Auger Refusal on Inferred Bedrock																
	- standpipe installed																
	- standard penetartion tests carried out using 45 lb hammer and 30 inch freefall																
	*REF=split spoon refusal																

RECORD OF BOREHOLE No 1

1 OF 1

METRIC

W.P. 930-58 LOCATION Bridge No. 3 at Maitland Avenue ORIGINATED BY MTO
DIST 9 HWY 417 BOREHOLE TYPE COMPILED BY MTO
DATUM Geodetic DATE 58.05.09 & 58.05.12 CHECKED BY








SOIL PROFILE			SAMPLES			GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT					UNIT WEIGHT γ kN/m ³	REMARKS & GRAIN SIZE DISTRIBUTION (%) GR SA SI CL
ELEV DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE	"N" VALUES			SHEAR STRENGTH kPa						
								20 40 60 80 100						
								20 40 60 80 100						
82.6														
0.0	TOP SOIL													
82.3														
0.3	HARD, FISSURED, SILTY, BROWNISH GREY CLAY		1	SS	23									
80.8														
1.9	VERY STIFF, FISSURED, SILTY, BROWNISH GREY CLAY		2	SS	14									
			3	SS	10									
			4	SS	13									
79.1														
3.5	DENSE SANDY TILL		5	SS	150 / 225 mm									
77.9			6	SS	65	75 mm								
4.7	LIMESTONE (drilled)		7	RC										
77.3														REC = 71%
5.3	LIMESTONE (drilled) bedding thickness 2.5"		8	RC										REC = 89%
76.6														
6.0	LIMESTONE (drilled) bedding thickness 3"		9	RC										REC = 96%
75.4														
7.2	LIMESTONE (drilled) bedding thickness 2"		10	RC										REC = 87%
74.8														
7.8	BOTTOM OF HOLE													
	Record of Borehole reproduced from Dwg No. D 4158-3													

RECORD OF BOREHOLE No 2

1 OF 1

METRIC

W.P. 930-58 LOCATION Bridge No. 3 at Maitland Avenue ORIGINATED BY MTD
 DIST 9 HWY 417 BOREHOLE TYPE _____ COMPILED BY MTD
 DATUM Geodetic DATE 58.05.15 & 58.05.15 CHECKED BY _____

SOIL PROFILE			SAMPLES			GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT					UNIT WEIGHT γ kN/m ³	REMARKS & GRAIN SIZE DISTRIBUTION (%) GR SA SI CL							
ELEV DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE	"N" VALUES			SHEAR STRENGTH kPa													
							<div>20 40 60 80 100</div> <div>○ UNCONFINED × FIELD VANE</div> <div>● QUICK TRIAXIAL × LAB VANE</div>					<div>PLASTIC LIMIT NATURAL MOISTURE CONTENT LIQUID LIMIT</div> <div>W_P W W_L</div> <div>WATER CONTENT (%)</div> <div>10 20 30</div>									
83.0																					
0.0	TOP SOIL																				
82.7																					
0.3	HARD, FISSURED, SILTY, BROWNISH GREY CLAY		1	SS			82														
81.6																					
1.4	VERY STIFF, FISSURED, SILTY, BROWNISH GREY CLAY		2	SS			81														
80.8																					
2.2	STIFF, FISSURED, SILTY, BROWNISH GREY CLAY		3	SS			80														
80.1																					
2.9	LOOSE TILL		4	SS	5		79														
79.3																					
3.7	LIMESTONE (drilled) bedding thickness 2.5"		5	RC			78							REC = 93%							
77.8																					
5.2	LIMESTONE (drilled) bedding thickness 3"		6	RC			77							REC = 100%							
76.3																					
6.7	BOTTOM OF HOLE																				

RECORD OF BOREHOLE No 3

1 OF 1

METRIC

W.P. 930-58 LOCATION Bridge No. 3 at Maitland Avenue ORIGINATED BY MTO
 DIST 9 HWY 417 BOREHOLE TYPE _____ COMPILED BY MTO
 DATUM Geodetic DATE 58.05.13 & 58.05.13 CHECKED BY _____

SOIL PROFILE			SAMPLES			GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT					UNIT WEIGHT γ kN/m ³	REMARKS & GRAIN SIZE DISTRIBUTION (%)					
ELEV DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE	"N" VALUES			SHEAR STRENGTH kPa											
82.9 0.0	TOP SOIL							20	40	60	80	100							
82.6 0.3	HARD, FISSURED, SILTY, BROWNISH GREY CLAY		1	SS			82												
81.6 1.4	VERY STIFF, FISSURED, SILTY, BROWNISH GREY CLAY		2	SS			81												
80.8 2.2	STIFF, FISSURED, SILTY, BROWNISH GREY CLAY		3	SS															
80.0 2.9	LOOSE TILL		4	SS			80												
79.3 3.7	LIMESTONE (drilled) bedding thickness 2"		5	RC			79												REC = 83%
78.1 4.8	LIMESTONE (drilled) bedding thickness 2" to 3"		6	RC			78												REC = 100%
76.9 6.0	LIMESTONE (drilled) bedding thickness 3"		7	RC			77												REC = 86%
76.1 6.8	BOTTOM OF HOLE																		

RECORD OF BOREHOLE No 4

1 OF 1

METRIC

W.P. 930-58 LOCATION Bridge No. 3 at Maitland Avenue ORIGINATED BY MTO
 DIST 9 HWY 417 BOREHOLE TYPE COMPILED BY MTO
 DATUM Geodetic DATE 58.05.12 & 58.05.12 CHECKED BY






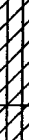





SOIL PROFILE			SAMPLES			GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT				UNIT WEIGHT γ kN/m ³	REMARKS & GRAIN SIZE DISTRIBUTION (%) GR SA SI CL			
ELEV DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE	"N" VALUES			SHEAR STRENGTH kPa						WATER CONTENT (%)		
82.9							20 40 60 80 100									
0.0	TOP SOIL															
82.6																
0.3	HARD, FISSURED, SILTY, BROWNISH GREY CLAY		1	SS												
81.5																
1.4	VERY STIFF, FISSURED, SILTY, BROWNISH GREY CLAY		2	SS												
80.7																
2.2	STIFF, FISSURED, SILTY, BROWNISH GREY CLAY		3	SS												
			4	SS												
79.4																
3.5	LOOSE TILL		5	SS	7											
78.3																
4.6	DENSE TILL															
78.1																
4.8	LIMESTONE (drilled) bedding thickness 2" some vertical seams		6	RC									REC = 81%			
76.6																
6.3	LIMESTONE (drilled) bedding thickness 2"		7	RC									REC = 60%			
76.0																
6.9	LIMESTONE (drilled) bedding thickness 2"		8	RC									REC = 80%			
74.8																
8.1	BOTTOM OF HOLE															

RECORD OF BOREHOLE No 5

1 OF 1

METRIC

W.P. 930-58 LOCATION Bridge No. 3 at Maitland Avenue ORIGINATED BY MTO
 DIST 9 HWY 417 BOREHOLE TYPE COMPILED BY MTO
 DATUM Geodetic DATE 58.05.14 & 58.05.14 CHECKED BY

SOIL PROFILE			SAMPLES			GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT					UNIT WEIGHT γ kN/m ³	REMARKS & GRAIN SIZE DISTRIBUTION (%) GR SA SI CL
ELEV DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE	"N" VALUES			SHEAR STRENGTH kPa						
82.7 0.0 82.4	TOP SOIL													
0.3	HARD, FISSURED, SILTY, BROWNISH GREY CLAY		1	SS		 450mm 75mm	82							
81.3														
1.4	VERY STIFF, FISSURED, SILTY, BROWNISH GREY CLAY		2	SS			81							
			3	SS			80							
79.8														
2.9	STIFF, FISSURED, SILTY, BROWNISH GREY CLAY		4	SS			79							
79.0														
3.7	SOFT, VERY SILTY, GREY CLAY		5	SS	1									
78.4														
4.3	DENSE TILL		6	SS	23									
78.0			7	SS	63									
4.7	LIMESTONE (drilled)		8	RC		78							REC = 60%	
77.5														
5.2	LIMESTONE (drilled) bedding thickness 3"		9	RC		77							REC = 33%	
76.6														
6.1	LIMESTONE (drilled) bedding thickness 3" one 80 degree joint in core break		10	RC		76							REC = 87%	
75.0														
7.7	LIMESTONE (drilled) bedding thickness 3"		11	RC		75							REC = 100%	
74.5														
8.2	BOTTOM OF HOLE													

\times^3, \times^3 : Numbers refer to Sensitivity 20 15 10 5 (%) STRAIN AT FAILURE

RECORD OF BOREHOLE No 6

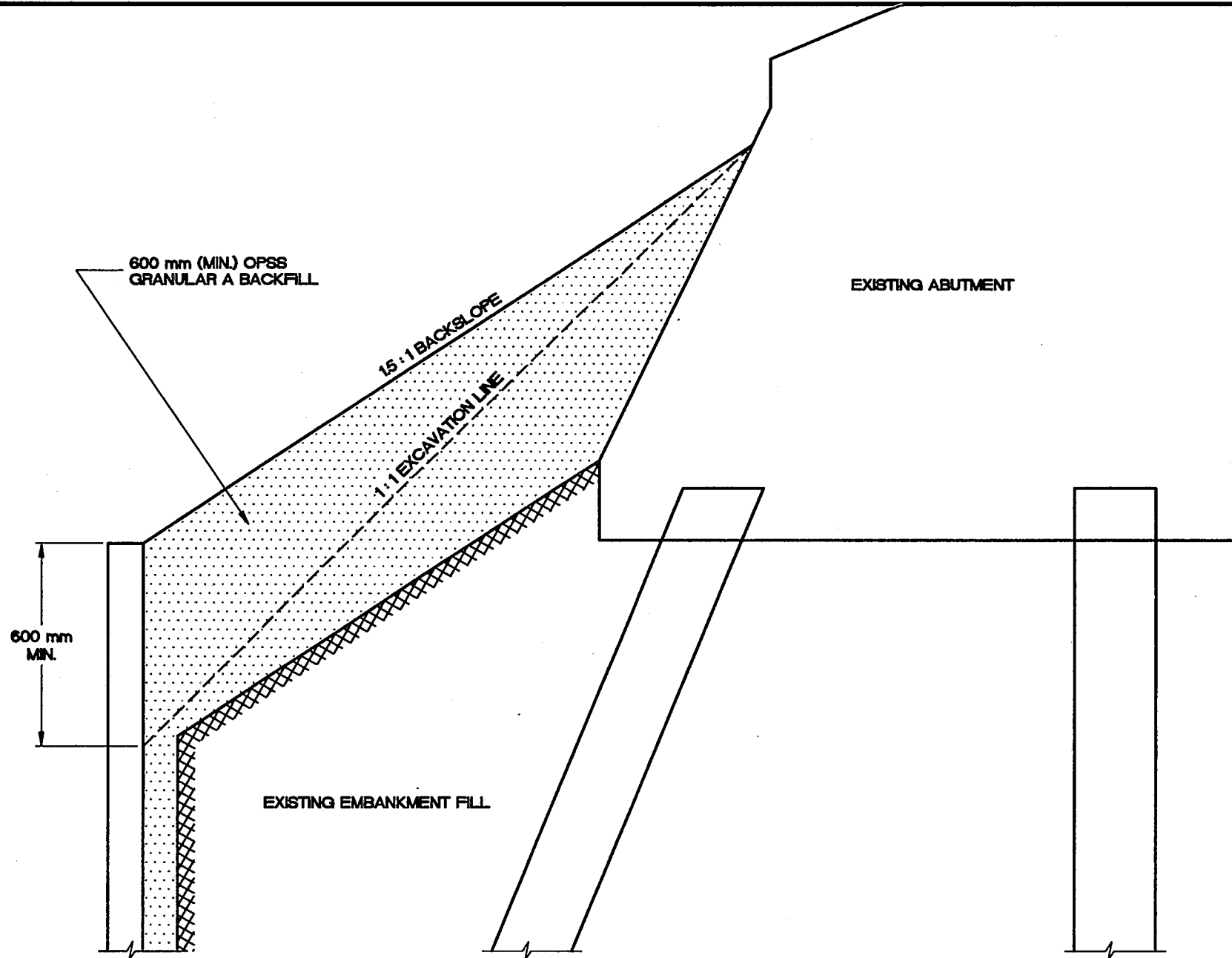
1 OF 1

METRIC

W.P. 930-58 LOCATION Bridge No. 3 at Maitland Avenue ORIGINATED BY MTO
 DIST 9 HWY 417 BOREHOLE TYPE COMPILED BY MTO
 DATUM Geodetic DATE 58.05.13 & 58.05.14 CHECKED BY

SOIL PROFILE			SAMPLES			GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT					UNIT WEIGHT γ kN/m ³	REMARKS & GRAIN SIZE DISTRIBUTION (%)
ELEV DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE	"N" VALUES			SHEAR STRENGTH kPa						
								20 40 60 80 100						
82.3														
0.0	TOP SOIL													
82.0														
0.3	HARD, FISSURED, SILTY, BROWNISH GREY CLAY		1	SS			82							
81.0														
1.4	VERY STIFF, FISSURED, SILTY, BROWNISH GREY CLAY		2	SS			81							
80.2														
2.2	STIFF, FISSURED, SILTY, BROWNISH GREY CLAY		3	SS			80							
			4	SS			79							
78.8														
3.5	LOOSE TILL													
78.2			5	SS	7									
4.1	DENSE TILL		6	SS	33	150mm	78							
			7	SS	44	75mm								
77.4														
5.0	LIMESTONE (drilled) bedding thickness 2"		8	RC			77							
76.3													REC = 93%	
6.0	LIMESTONE (drilled) bedding thickness 3"		9	RC			76							
													REC = 94%	
74.9							75							
7.4	LIMESTONE (drilled) bedding thickness 3"		10	RC										
74.3													REC = 95%	
8.0	BOTTOM OF HOLE													

$\times^3 \times^3$: Numbers refer to Sensitivity 20 15 10 (%) STRAIN AT FAILURE



GWP 203-86-02
HWY 417 / MAITLAND AVE. BRIDGE REHABILITATION
RETAINING WALL BACKFILL

Scale:

N.T.S.

Drawing No.:

11099-5

Date:

98/11/04

Dwn. by:

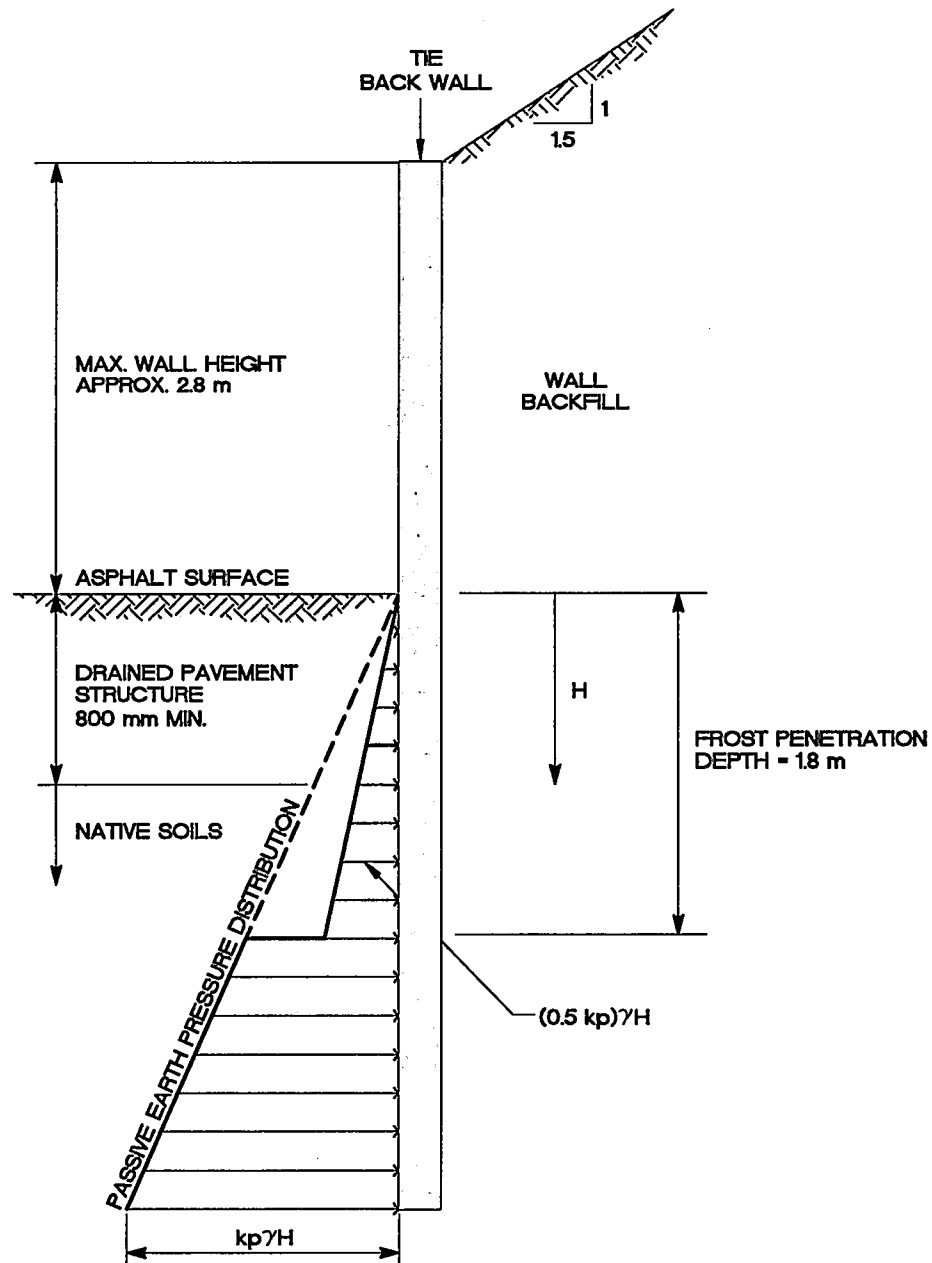
GBB

Appd.:

PC



**Jacques
Whitford**



GWP 203-86-02

HWY 417 / MAITLAND AVE. BRIDGE REHABILITATION
PASSIVE EARTH PRESSURE DISTRIBUTION

Scale:

N.T.S.

Drawing No.:

11099-6

Date:

98/11/06

Dwn. by:

GBB

Appd.:

PC



Jacques
Whitford