

# FOUNDATION INVESTIGATION REPORT

CONTRACT NO 91-12



Ontario

Ministry of  
Transportation



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Note: For purposes of the contract, this report supersedes all other Foundation Reports prepared by, or for the Ministry in connection with the above mentioned project.

## 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 (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

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

### MECHANICAL PROPERTIES OF SOIL

$m_v$	$\text{kPa}^{-1}$	COEFFICIENT OF VOLUME CHANGE
$C_c$	1	COMPRESSION INDEX
$C_s$	1	SWELLING INDEX
$C_\alpha$	1	RATE OF SECONDARY CONSOLIDATION
$c_v$	$\text{m}^2/\text{s}$	COEFFICIENT OF CONSOLIDATION
H	m	DRAINAGE PATH
$T_v$	1	TIME FACTOR
U	%	DEGREE OF CONSOLIDATION
$\sigma'_{vo}$	kPa	EFFECTIVE OVERBURDEN PRESSURE
$\sigma'_p$	kPa	PRECONSOLIDATION PRESSURE
$\tau_f$	kPa	SHEAR STRENGTH
$c'$	kPa	EFFECTIVE COHESION INTERCEPT
$\phi'$	-°	EFFECTIVE ANGLE OF INTERNAL FRICTION
$c_u$	kPa	APPARENT COHESION INTERCEPT
$\phi_u$	-°	APPARENT ANGLE OF INTERNAL FRICTION
$\tau_r$	kPa	RESIDUAL SHEAR STRENGTH
$\tau_r$	kPa	REMOULDED SHEAR STRENGTH
$S_f$	1	SENSITIVITY = $\frac{c_u}{\tau_r}$

### STRESS AND STRAIN

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

### PHYSICAL PROPERTIES OF SOIL

$\rho_s$	$\text{kg}/\text{m}^3$	DENSITY OF SOLID PARTICLES	e	1, %	VOID RATIO	$e_{\min}$	1, %	VOID RATIO IN DENSEST STATE
$\gamma_s$	$\text{KN}/\text{m}^3$	UNIT WEIGHT OF SOLID PARTICLES	n	1, %	POROSITY	$I_D$	1	DENSITY INDEX = $\frac{e_{\max} - e}{e_{\max} - e_{\min}}$
$\rho_w$	$\text{kg}/\text{m}^3$	DENSITY OF WATER	w	1, %	WATER CONTENT	D	mm	GRAIN DIAMETER
$\gamma_w$	$\text{KN}/\text{m}^3$	UNIT WEIGHT OF WATER	$S_r$	%	DEGREE OF SATURATION	$D_n$	mm	n PERCENT - DIAMETER
$\rho$	$\text{kg}/\text{m}^3$	DENSITY OF SOIL	$w_L$	%	LIQUID LIMIT	$C_u$	1	UNIFORMITY COEFFICIENT
$\gamma$	$\text{KN}/\text{m}^3$	UNIT WEIGHT OF SOIL	$w_p$	%	PLASTIC LIMIT	h	m	HYDRAULIC HEAD OR POTENTIAL
$\rho_d$	$\text{kg}/\text{m}^3$	DENSITY OF DRY SOIL	$w_s$	%	SHRINKAGE LIMIT	q	$\text{m}^3/\text{s}$	RATE OF DISCHARGE
$\gamma_d$	$\text{KN}/\text{m}^3$	UNIT WEIGHT OF DRY SOIL	$I_p$	%	PLASTICITY INDEX = $w_L - w_p$	v	m/s	DISCHARGE VELOCITY
$\rho_{\text{sat}}$	$\text{kg}/\text{m}^3$	DENSITY OF SATURATED SOIL	$I_L$	1	LIQUIDITY INDEX = $\frac{w - w_p}{I_p}$	i	1	HYDRAULIC GRADIENT
$\gamma_{\text{sat}}$	$\text{KN}/\text{m}^3$	UNIT WEIGHT OF SATURATED SOIL	$I_C$	1	CONSISTENCY INDEX = $\frac{w_L - w}{I_p}$	k	m/s	HYDRAULIC CONDUCTIVITY
$\rho'$	$\text{kg}/\text{m}^3$	DENSITY OF SUBMERGED SOIL	$e_{\max}$	1, %	VOID RATIO IN LOOSEST STATE	j	$\text{KN}/\text{m}^2$	SEEPAGE FORCE
$\gamma'$	$\text{KN}/\text{m}^3$	UNIT WEIGHT OF SUBMERGED SOIL						

FOUNDATION INVESTIGATION REPORT  
For  
Regional Road #36 Proposed Crossing  
Hwy. #401, City of Cambridge  
W.P. 7-83-09, Site 33-151  
District #3, Stratford

## INTRODUCTION

This report contains the results of a site investigation carried out at the above mentioned site.

The field work for this project was carried out between 89 10 02 and 89 10 26, and comprised of ten sampled boreholes accompanied with Dynamic Cone Penetration Tests and coring of rock.

The boreholes were advanced to a maximum depth of 39.2 m below the existing ground level (El. 286.6) using continuous flight hollow stem auger and BX size diamond bit.

## SITE DESCRIPTION

The proposed site is located at the crossing of Hwy. 401 and Regional Road #36 in the City of Cambridge.

The topography of the site with the exception of the existing interchange (fills) is relatively flat and landscaped terrain. Physiographically the area is located in the region known as the "Guelph Drumlin Field" and consist of granular type materials.

## SUBSURFACE CONDITIONS

### General

The underlying subsoil at this site consists of granular (Granular 'A' or Granular 'B') fill underlain by natural soil predominantly composed of sand and silt, with virtually no gravel content. Despite the geological history of this area, glacial till was not encountered, except near terminal depth

in boreholes 8, 9 & 10. The natural soil is underlain by dolostone bedrock of the Guelph formation. For classification purposes, the soils encountered at this site can be divided into two different zones:

- a) Sand some silt and Gravel (Granular Fill)
- b) Layered Sand and Silt

The soils encountered during the course of the investigation, together with the field and laboratory test results are shown on the Record of Boreholes sheets contained in the Appendix of this report. Three stratigraphical profiles are shown on Drawing No. 78309-A.\* This drawing also shows the locations and elevations of the borings. Description of the strata encountered are given below.

#### Granular Fill

This fill which was placed to raise the finished grade of Hwy. 401 and the Regional Road #36 was encountered in all the boreholes, immediately below the existing ground level. The gradation tests carried out on representative samples are shown on Figure #1 in an envelope form. The gradation analyses indicate that this fill is predominantly composed of sand with varying proportions of silt and gravel sized particles. The natural moisture content of this fill varies from 3% to 16% with an average value of 9%. The Standard Penetration Test results indicate that this granular fill is in very loose to compact state of compaction (N-values 2 to 31 blows/30 cm). The thickness of this fill varies from 2.7 m to 8.5 m and extends to elevation 317.0±. In majority of the boreholes, a 0.3 m to 0.9 m thick organic silty layer was observed to separate the fill and the natural soil.

#### Layered Sand and Silt

The organic silty layer is underlain by this deposit. The gradation tests carried out on representative soil samples are shown on Figure #2 in an envelope form. The gradation analyses indicate that this deposit is

\* DWG NO 2 OF THE CONTRACT DWG'S

predominantly composed of sand and silt, with virtually no gravel content. The natural moisture content of this deposit varies over a wide range (3% to 32%) depending on the sand and silt contents. The Standard Penetration Test results indicate that this stratum is in compact to very dense state of compaction (N-values 11 blows/30 cm to 84 blows/30 cm). In boreholes 2, 6 & 8, occasional boulders and cobbles were encountered near terminal depth (El. 292.0± to 299.0±).

### Bedrock

Boreholes 8, 9 & 10 were taken into the bedrock and rock cores were obtained using BX-size diamond bits. The rock cores were examined by Mr. S.A. Senior, Geological Engineer and his description is included in the Appendix of this report.

The project area is underlain by dolostone bedrock of the Guelph Formation. The presence of boulders and cobbles immediately above the bedrock made the identification of weathered rock very difficult. However, in borehole 8, the thickness of weathered rock was observed to be about 1.83 m. The elevation of the unweathered rock is as follows:

<u>Borehole No.</u>	<u>Elevation</u>
8	289.8
9	289.1
10	290.7

The RQD values measured from BX size cores (0% to 7%) indicate that the bedrock up to the depth of drilling may be classified as very poor quality rock. However, in borehole 8, the rock quality was observed to improve (RQD = 68%) near terminal depth (El. 288.1).

### Ground Water Conditions

The ground water level was encountered in all the boreholes with the exception of borehole 7, and was observed between 12.5 m and 19.6 m (El.

306.0± to 307.0±) below the existing ground level. The ground water elevation at each borehole location is as follows:

<u>Borehole No.</u>	<u>Elevation Metre</u>
1	307.2
2	307.0
3	305.6
4	306.0
5	306.3
6	306.5
8	307.2
9	305.9
10	306.3

The groundwater elevations indicated above are based on the observations made during drilling operations and the stabilized water level could not be established in a short period of time. In our opinion, the water table may be expected to rise above the elevations indicated.

#### MISCELLANEOUS

The field work for this investigation was carried out under the supervision of Mr. M. Hopper. The equipment used was owned and operated by Marathon Drilling Company Limited. This report was prepared by Mr. M. Vasavithasan and reviewed by Mr. P. Payer, Senior Foundation Engineer.

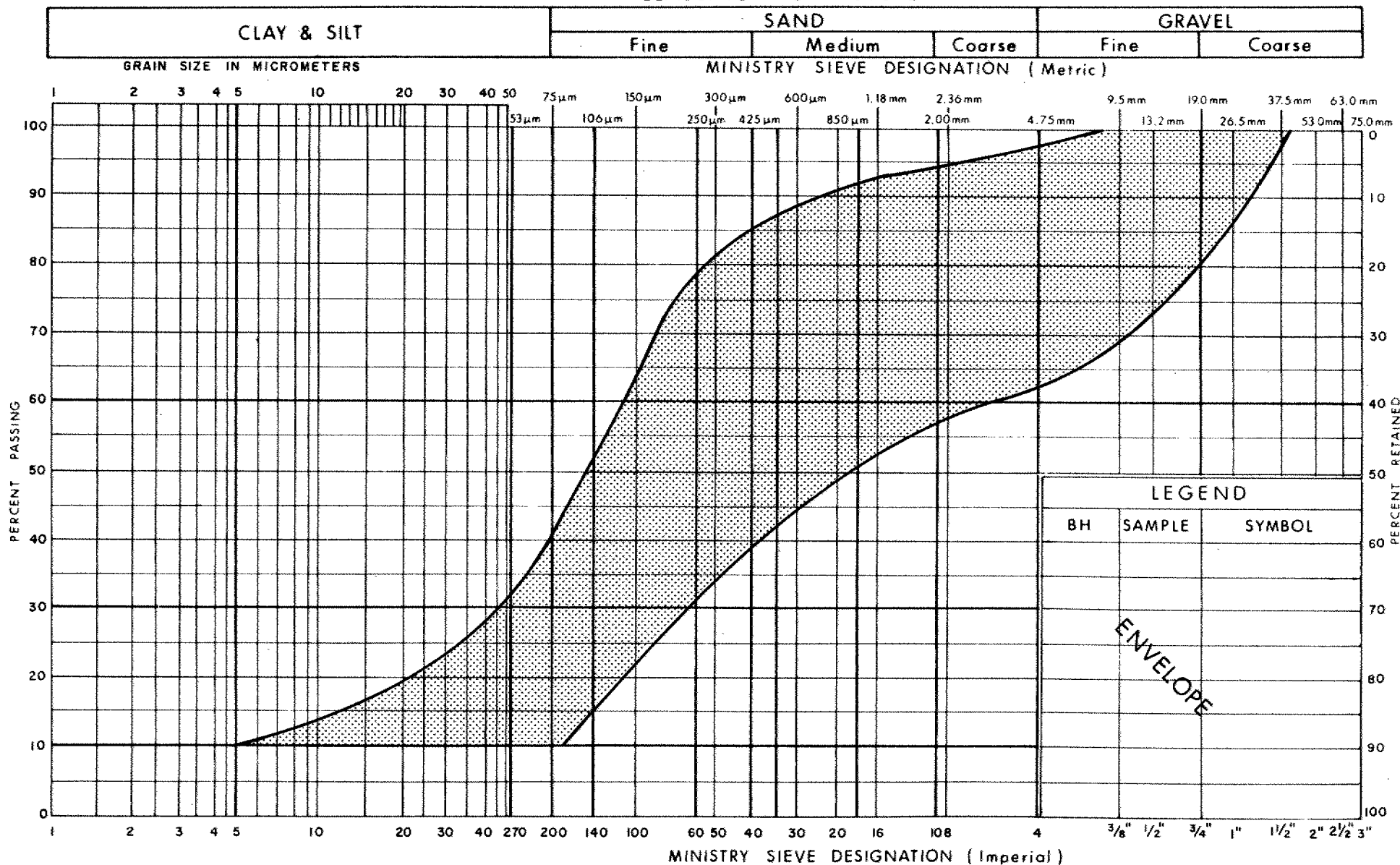


*M. Vasavithasan*  
 M. Vasavithasan, P. Eng.  
 Foundation Engineer

*P. Payer*  
 M. Devata, P. Eng.  
 Chief Foundation Engineer

## APPENDIX

## UNIFIED SOIL CLASSIFICATION SYSTEM



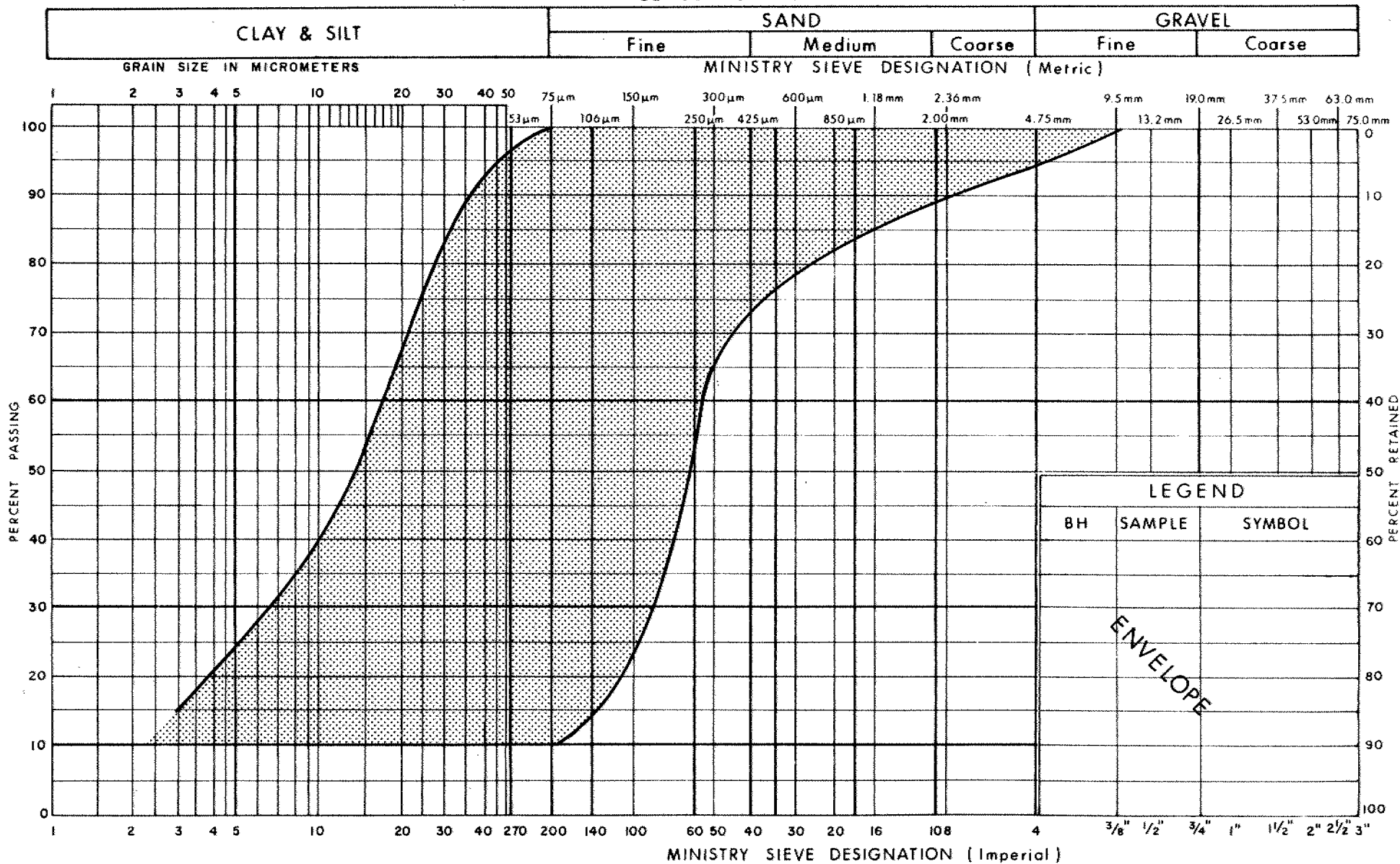
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## GRAIN SIZE DISTRIBUTION SAND & GRAVEL SOME SILT (FILL)

FIG No 1

W P 7-83-09

## UNIFIED SOIL CLASSIFICATION SYSTEM



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GRAIN SIZE DISTRIBUTION  
SANDY SILT TO SILTY SAND

FIG No 2

W P 7-83-09

# **ROCK CORE DESCRIPTION** **WP 7-83-09**

Page 1 of 1.

CORE RECOVERY					CORE DESCRIPTION	
BH#	RC#	DEPTH (m)	% CR*	% RQD*	DEPTH (m)	DESCRIPTION
8	39	35.48-35.53	100	0	35.48-39.22	<b>DOLOSTONE</b> , very light grey; medium to fine grained, vuggy; medium strong rock; slightly weathered to unweathered; close to extremely close spaced fractures.
	41	35.53-35.79	95	0		
	42	35.70-36.27	50	0		
	43	36.27-36.53	100	0		
	44	36.53-36.70	86	0		
	45	36.70-37.74	95	0		
	46	37.74-39.22	100	68		
9	32	34.90-35.20	-	-	34.90-36.58	<b>OVERBURDEN</b> , boulders, cobbles
	33	35.20-36.25	-	-	36.58-37.16	<b>DOLOSTONE</b> , very light grey; medium to fine grained, vuggy; medium strong rock; moderately to slightly weathered; very close spaced fractures.
	34	36.25-37.16	42	0		
10	19	27.61-29.13	40	-	27.61-29.26	<b>OVERBURDEN</b> , boulders, cobbles
	20	29.13-30.66	93	7	29.26-30.66	<b>DOLOSTONE</b> , light grey; medium grained, vuggy; medium strong rock; slightly weathered to unweathered; very close spaced fractures.

\*CR = CORE RECOVERY

\*RQD = ROCK QUALITY DESIGNATION

(NOTE: Depths are approximated in zones of poor core recovery)

Logged by: SAS, Soils and Aggregates Section.

# RECORD OF BOREHOLE No 1

METRIC

W P 7-83-09 LOCATION Co-ords: N4 808 433.9, E 239 242.2 ORIGINATED BY MH  
 DIST 3 HWY 401 BOREHOLE TYPE Continuous Flight Auger (H.S.) COMPILED BY PM  
 DATUM Geodetic DATE 89 10 02 CHECKED BY

SOIL PROFILE			SAMPLES			GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT		PLASTIC LIMIT W <sub>p</sub>	NATURAL MOISTURE CONTENT W	LIQUID LIMIT W <sub>L</sub>	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							SHEAR STRENGTH kPa		WATER CONTENT (%)	
								○ UNCONFINED	+ FIELD VANE						● QUICK TRIAXIAL	x LAB VANE	10 20 30	
319.7	Ground Level																	
0.0	Silty Sand to Sandy Silt Very Loose to Compact (Fill)	X	1	SS	24									8 56 (36)				
			2	SS	13													
			3	SS	5													
			4	SS	4													
317.1			5	SS	8													
			6	SS	2													
2.6	Sandy Silt to Silty Sand Compact to Very Dense	.	7	SS	12									0 29 (71)				
			8	SS	18													
			9	SS	28													
			10	SS	28										0 66 (34)			
			11	SS	22													
			12	SS	26													
			13	SS	21										0 89 (11)			
			14	SS	24													
			15	SS	22													
			16	SS	22										0 31 (69)			
			17	SS	45													
			18	SS	53													
			19	SS	18										0 61 (39)			
			20	SS	29													
			21	SS	17													
301.1	End of Borehole		22	SS	32								0 16 (84)					
18.6																		

OFFICE REPORT ON SOIL EXPLORATION

# RECORD OF BOREHOLE No 2

METRIC

W P 7-83-09 LOCATION Co-ords: N4 808 427.5, E 239 234.8 ORIGINATED BY MH  
DIST 3 HWY 401 BOREHOLE TYPE Continuous Flight Auger (H.S.): BW Casing COMPILED BY PM  
DATUM Geodetic DATE 89 10 02 to 89 10 03 CHECKED BY

SOIL PROFILE			SAMPLES			GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT		PLASTIC LIMIT W <sub>p</sub>	NATURAL MOISTURE CONTENT W	LIQUID LIMIT W <sub>L</sub>	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	SHEAR STRENGTH kPa					
319.6	Ground Level		1	SS	3									
0.0	Silty Sand to Sandy Silt, Trace of Gravel, Very Loose to Compact		2	SS	7									8 65 24 3
			3	SS	15									1 48 (51)
			4	SS	6									
			5	SS	3									
			6	SS	2									
316.4	(Fill)		7	SS	8									
3.2			8	SS	15									
			9	SS	20									
			10	SS	26									
			11	SS	31									
			12	SS	31									
			13	SS	30									
			14	SS	23									
	Sandy Silt to Silty Sand, Compact to Dense		15	SS	24									
			16	SS	30									
			17	SS	58									0 8 (92)
			18	SS	27									
			19	SS	39									
			20	SS	16									
			21	SS	50									
	Occasional Boulders		22	RC										
			23	SS	58									
295.1			24	SS	62									0 91 (9)
24.5	End of Borehole													

OFFICE REPORT ON SOIL EXPLORATION



RECORD OF BOREHOLE No 3

METRIC

W P 7-83-09 LOCATION Co-ords: N4 808 426.4, E 239 209.1 ORIGINATED BY MH  
DIST 3 HWY 401 BOREHOLE TYPE Continuous Flight Auger (H.S.) COMPILED BY PM  
DATUM Genderic DATE 89 10 03 to 89 10 04 CHECKED BY

SOIL PROFILE			SAMPLES			GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT		PLASTIC NATURAL LIQUID LIMIT MOISTURE LIMIT CONTENT			UNIT WEIGHT $\gamma$	REMARKS & GRAIN SIZE DISTRIBUTION (%) GR SA SI CL
ELEV DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE	'N' VALUES			20 40 60 80 100	100	W <sub>p</sub>	W	W <sub>L</sub>		
319.3	Ground Level													
0.0	Topsoil		1	SS	7									
	Sand, Some		2	SS	5									17 63 15 5
	Silt, Trace of		3	SS	10									
	Gravel, Loose to		4	SS	12									
	Compact		5	SS	19									
316.6	(Fill)		6	SS	17									
2.7	Organic Silt, Loose		7	SS	6									
	Silty Sand to Sandy Silt, Compact to Dense		8	SS	8									3 47 (50)
			9	SS	31									
			10	SS	29									
			11	SS	22									0 23 (77)
			12	SS	29									
			14	SS	34									
			15	SS	31									
			16	SS	35									
			17	SS	29									
			18	SS	30									
			19	SS	26									
			20	SS	36									
			21	SS	45									
			22	SS	84									0 8 (92)
			23	SS	29									
			24	SS	17									3 3 (94)
302.2			25	SS	24									
17.1	End of Borehole													

OFFICE REPORT ON SOIL EXPLORATION

# RECORD OF BOREHOLE No 4

METRIC

W P 7-83-09 LOCATION Co-ords: N4 808 426.0, E 239 218.8 ORIGINATED BY MH  
DIST 3 HWY 401 BOREHOLE TYPE Continuous Flight Auger (H.S.) COMPILED BY PM  
DATUM Geodetic DATE 89 10 04 CHECKED BY

SOIL PROFILE		SAMPLES			GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT		NATURAL MOISTURE CONTENT			UNIT WEIGHT Y	REMARKS & GRAIN SIZE DISTRIBUTION (%)
ELEV DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE			'N' VALUES	20 40 60 80 100	W <sub>p</sub> W W <sub>L</sub>	PLASTIC LIMIT	LIQUID LIMIT		
320.0	Ground Level												
0.0	Sand, Some Silt and Gravel, Loose to Compact		1	SS	6								
			2	SS	16								
			3	SS	11								
			4	SS	11								
	(Fill)		5	SS	26								
317.2			6	SS	67								
2.7	Organic Silt, Some		7	SS	5								
316.3	Sand, V. Loose to Loose		8	SS	2								
3.6			9	SS	3								
			10	SS	29								
			11	SS	29								
			12	SS	24								
			13	SS	30								
	Silty Sand to Sandy Silt, Compact to Dense		14	SS	21								
			15	SS	32								
			16	SS	40								
			17	SS	51								
			18	SS	23								
			19	SS	17								
			20	SS	27								
	Occasional Cobbles												
298.4			RC	REC									
21.6	End of Borehole												

OFFICE REPORT ON SOIL EXPLORATION

# RECORD OF BOREHOLE No 5

METRIC

W P 7-83-09 LOCATION Co-ords: N4 808 388.2, E 239 244.8 ORIGINATED BY MH  
 DIST 3 HWY 401 BOREHOLE TYPE Continuous Flight Auger (H.S.) COMPILED BY PM  
 DATUM Geodetic DATE 89 10 05 CHECKED BY

OFFICE REPORT ON SOIL EXPLORATION

SOIL PROFILE		SAMPLES			GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT		NATURAL MOISTURE CONTENT			UNIT WEIGHT γ	REMARKS & GRAIN SIZE DISTRIBUTION (%)
ELEV. DEPTH	DESCRIPTION	STRAT. PLOT	NUMBER	TYPE			'N' VALUES	20 40 60 80 100	W <sub>p</sub>	W	W <sub>L</sub>		
320.0	Ground Level												
319.6	Topsoil		1	SS	4								
0.5	Sand, Some Silt and Gravel, Very Loose to Compact (Fill)		2	SS	9								
			3	SS	7								
			4	SS	14								
			5	SS	21								
317.3			6	SS	13								
2.7	Clayey Silt, Very Soft		7	SS	1								
	Sand, Some Silt and Gravel Compact to Dense		8	SS	13								
315.6			9	SS	55								
4.4	Silty Sand to Sandy Silt, Compact to Dense		10	SS	19								
			11	SS	21								
			12	SS	33								
			13	SS	36								
			14	SS	27								
			15	SS	25								
			16	SS	23								
			17	SS	29								
			18	SS	32								
			19	SS	36								
			20	SS	49								
			21	SS	41								
			22	SS	42								
			23	SS	11								
			24	SS	41								
298.4				25	SS	55							
21.6	End of Borehole												

# RECORD OF BOREHOLE No 6

METRIC

W P 7-83-09 LOCATION Co-ords: N4 808 407.4, E 239 242.9 ORIGINATED BY MH  
 DIST 3 HWY 401 BOREHOLE TYPE Continuous Flight Auger (H.S.) COMPILED BY PM  
 DATUM Geodetic DATE 89 10 05 to 89 10 06 CHECKED BY

SOIL PROFILE		SAMPLES			GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT		PLASTIC LIMIT W <sub>p</sub>	NATURAL MOISTURE CONTENT W	LIQUID LIMIT W <sub>L</sub>	UNIT WEIGHT γ	REMARKS & GRAIN SIZE DISTRIBUTION (%)
ELEV DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE			'N' VALUES	20 40 60 80 100					
320.0	Ground Level												
0.0	Sand, Some Silt and Gravel, Very Loose to Compact (Fill)		1	SS	16								
			2	SS	12								
			3	SS	7								
			4	SS	4								
317.3			5	SS	20								
			6	SS	31								
2.7	Silty Sand, Trace of Organic, Compact		7	SS	11								
316.4			8	SS	10								
3.6			9	SS	27								
			10	SS	34								
			11	SS	63								
			12	SS	33								
			13	SS	14								
			14	SS	27								
			15	SS	24								
			16	SS	25								
			17	SS	39								
			18	SS	43								
			19	SS	20								
			20	SS	18								
			21	SS	14								
			22	SS	71								
			23	SS	50								
			24	RC									
			25	RC									
291.7	Occasional Boulders		26	SS	68								
28.3	End of Borehole												

OFFICE REPORT ON SOIL EXPLORATION

# RECORD OF BOREHOLE No 7

METRIC

W P 7-83-09 LOCATION Co-ords: N4 808 454.4, E 239 216.1 ORIGINATED BY MH  
 DIST 3 HWY 401 BOREHOLE TYPE Continuous Flight Auger (H.S.) COMPILED BY PM  
 DATUM Geodetic DATE 89 10 10 CHECKED BY

SOIL PROFILE			SAMPLES			GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT				PLASTIC LIMIT W <sub>p</sub>	NATURAL MOISTURE CONTENT W	LIQUID LIMIT W <sub>L</sub>	UNIT WEIGHT γ	REMARKS & GRAIN SIZE DISTRIBUTION (%)
ELEV DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE	'N' VALUES			20	40	60	80	100				
325.6	Shoulder Level		1	SS	75											
0.0	Asphalt		2	SS	23											
			3	SS	16											
			4	SS	15											
			5	SS	28											
			6	SS	27											
			7	SS	27											
			8	SS	20											
			9	SS	21											
			10	SS	12											
			11	SS	5											
			12	SS	14											
			13	SS	30											
			14	SS	37											
			15	SS	43											
			16	SS	32											
			17	SS	21											
			18	SS	38											
			19	SS	26											
316.9																
8.7	End of Borehole															

OFFICE REPORT ON SOIL EXPLORATION

# RECORD OF BOREHOLE No 8

METRIC

W P 7-83-09 LOCATION Co-ords: N4 808 448.6, E 239 227.6 ORIGINATED BY MH  
DIST 3 HWY 401 BOREHOLE TYPE Continuous Flight Auger (H.S.), BX Casing COMPILED BY PM  
DATUM Geodetic DATE 89 10 11 CHECKED BY

OFFICE REPORT ON SOIL EXPLORATION

SOIL PROFILE		STRAT	SAMPLES		GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT		PLASTIC LIMIT W <sub>p</sub>	NATURAL MOISTURE CONTENT W	LIQUID LIMIT W <sub>L</sub>	UNIT WEIGHT γ	REMARKS & GRAIN SIZE DISTRIBUTION (%)	
ELEV DEPTH	DESCRIPTION		NUMBER	TYPE			N' VALUES	20 40 60 80 100						WATER CONTENT (%)
325.8	Ground Level												GR SA SI CL	
0.0	Sand Some Silt and Gravel, Loose to Compact (Fill)		1	SS	10								31 59 (10)	
			2	SS	16									
			3	SS	16									
			4	SS	5									
			5	SS	20									
			6	SS	18									
			7	SS	15									
			8	SS	12									
			9	SS	11									
			10	SS	19									
320.9	Sand, Some Organic Silt & Gravel, Compact		11	SS	14								11 49 (40)	
4.9			12	SS	16								2 84 (14)	
	Silty Sand,  to Sandy  Silt, Compact  to Dense		13	SS	19									
			14	SS	35									
			15	SS	31									
			16	SS	15									
			17	SS									5 55 34 (6)	
			18	SS	12									
			19	SS	18									
			20	SS	22								0 68 (32)	
			21	SS	30									
			22	SS	29								0 28 (72)	
			23	SS	31									
			24	SS	27									
			25	SS	37									
			26	SS	38									
			27	SS	43									
			28	SS	59								0 11 (89)	
			29	SS	27									
			30	SS	16								0 1 (99)	
		Occasional Boulders		RC	REC									
				31	BX	90%								
			32	SS	54									
295.6														
30.2														

Continued

+3, x<sup>5</sup>: Numbers refer to Sensitivity

20  
15 ± 5 (%) STRAIN AT FAILURE

Continued

# RECORD OF BOREHOLE No 8

METRIC

W P 7-83-09 LOCATION Co-ords: N4 808 448.6, E 239 227.6 ORIGINATED BY MH  
 DIST 3 HWY 401 BOREHOLE TYPE Continuous Flight Auger (H.S.), BX Casing COMPILED BY PM  
 DATUM Geodetic DATE 89 10 11 to 89 10 12 CHECKED BY

SOIL PROFILE			SAMPLES			GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT		PLASTIC LIMIT W <sub>p</sub>	NATURAL MOISTURE CONTENT W	LIQUID LIMIT W <sub>L</sub>	UNIT WEIGHT γ	REMARKS & GRAIN SIZE DISTRIBUTION (%) GR SA SI CL
ELEV DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE	'N' VALUES			20	40					
295.6	Continued													
30.2	Silty Sand to Sandy Silt, Dense to Very Dense		33	SS	103	28cm								
	Occasional Boulders		34	RC BXL	40%									
			35	SS	71									
291.7														
34.1			36	RC BXL	25									
	Weathered Unweathered		*											
	Dolostone Bedrock		45	RC BXL	99%									
			46	RC BX	97%									
286.6														
39.2	End of Borehole													
	* Note Sample													
	No.	Type	Rec.	RQD										
	37	RC	40%	0										
	38	RC	80%	0										
	39	RC	100%	0										
	41	RC	95%	0										
	42	RC	50%	0										
	43	RC	100%	0										
	44	RC	86%	0										

OFFICE REPORT ON SOIL EXPLORATION

RECORD OF BOREHOLE No 9

METRIC

W P 7-83-09 LOCATION Co-ords: N4 808 366.4, E 239 245.6 ORIGINATED BY MH  
DIST 3 HWY 401 BOREHOLE TYPE Continuous Flight Auger (H.S.), Casing NX COMPILED BY PM  
DATUM Geodetic DATE 89 10 17 to 89 10 23 CHECKED BY

OFFICE REPORT ON SOIL EXPLORATION

SOIL PROFILE			SAMPLES			GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT					PLASTIC LIMIT W <sub>p</sub>	NATURAL MOISTURE CONTENT W	LIQUID LIMIT W <sub>L</sub>	UNIT WEIGHT γ	REMARKS & GRAIN SIZE DISTRIBUTION (%)
ELEV DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE	*N* VALUES			20	40	60	80	100					
325.7	Ground Level																
0.0			1	SS	7												
			2	SS	13												
			3	SS	10												
			4	SS	12												
			5	SS	17												
			6	SS	15												
			7	SS	12												
			8	SS	8												
			9	SS	10												
			10	SS	10												
			11	SS	6												
			12	SS	26												
			13	SS	29												
			14	SS	28												
			15	SS	34												
			16	SS	26												
317.2	Organic Silt		17	SS	10												
8.5			18	SS	54												
			19	SS	80												
			20	SS	47												
			21	SS	25												
			22	SS	25												
			23	SS	20												
			24	SS	24												
			25	SS	40												
			26	SS	97												
			27	SS	23												
			28	SS	24												
			29	SS	109												
295.5																	
30.2																	

Continued

+3, x5: Numbers refer to  
Sensitivity

20  
15 x 5 (%) STRAIN AT FAILURE

Continued

# RECORD OF BOREHOLE No 9

METRIC

W P 7-83-09 LOCATION Co-ords: N4 808 366.4, E 239 245.6 ORIGINATED BY MH  
 DIST 3 HWY 401 BOREHOLE TYPE Continuous Flight Auger (H.S.), Casing NX COMPILED BY PM  
 DATUM Geodetic DATE 89 10 17 to 89 10 23 CHECKED BY

SOIL PROFILE			SAMPLES			GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT					PLASTIC LIMIT NATURAL MOISTURE CONTENT LIQUID LIMIT			UNIT WEIGHT $\gamma$	REMARKS & GRAIN SIZE DISTRIBUTION (%) GR SA SI CL	
ELEV DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE	'N' VALUES			20	40	60	80	100	W <sub>p</sub>	W	W <sub>L</sub>			
295.5	Continued    Occasional Boulders		30	SS	32													
30.2																		
					31	SS	64											
					32	RC	50%											
289.1			33	RC	12%													
288.5	Dolostone Bedrock		34	RC BX	REC 43%											RQD = 0		
37.2	End of Borehole																	

OFFICE REPORT ON SOIL EXPLORATION

# RECORD OF BOREHOLE No 10

METRIC

W P 7-83-09 LOCATION Co-ords: N4 808 407.8, E 239 219.4 ORIGINATED BY MH  
 DIST 3 HWY 401 BOREHOLE TYPE Continuous Flight Auger (H.S.), BX Casing COMPILED BY PM  
 DATUM Geodetic DATE 89 10 24 to 89 10 25 CHECKED BY \_\_\_\_\_

SOIL PROFILE		SAMPLES			GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT		PLASTIC LIMIT W <sub>p</sub>	NATURAL MOISTURE CONTENT W	LIQUID LIMIT W <sub>L</sub>	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					
320.0	Ground Level												
0.0													
	Silty Sand to Sandy Silt, Compact to Dense		1	SS	15								
			2	SS	45								
			3	SS	15								
			4	SS	26								
			5	SS	4								
			6	SS	12								
			7	SS	19								
			8	SS	32								
			9	SS	21								
			10	SS	14								
			11	SS	26								
			12	SS	34								
			13	SS	17								
			14	SS	21								
		15	SS	45									
		16	SS	14									
		17	SS	28									
		18	SS	86/									
	Occasional Boulders		19	BX	42%								
290.7			20	BX	96%								
29.3	Dolostone Bedrock												
289.3													
30.7	End of Borehole												

104/30cm  
 28cm Bouncing  
 RQD = 7%

OFFICE REPORT ON SOIL EXPLORATION



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## FOUNDATION DESIGN SECTION

**foundation  
investigation and  
design report**

R

*CONT 91-12*  
ENGINEERING MATERIALS OFFICE  
FOUNDATION DESIGN SECTION

WP 7-83-09 DIST 3

HWY 401 STR SITE 33-151

Regional Road #36 Proposed Crossing  
Hwy. #401, City of Cambridge

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FOUNDATION INVESTIGATION REPORT  
For  
Regional Road #36 Proposed Crossing  
Hwy. #401, City of Cambridge  
W.P. 7-83-09, Site 33-151  
District #3, Stratford

INTRODUCTION

This report contains the results of a site investigation carried out at the above mentioned site to provide information for the design and construction of the bridge, retaining wall and approaches.

The field work for this project was carried out between 89 10 02 and 89 10 26, and comprised of ten sampled boreholes accompanied with Dynamic Cone Penetration Tests and coring of rock.

The boreholes were advanced to a maximum depth of 39.2 m below the existing ground level (El. 286.6) using continuous flight hollow stem auger and BX size diamond bit.

SITE DESCRIPTION

The proposed site is located at the crossing of Hwy. 401 and Regional Road #36 in the City of Cambridge.

The topography of the site with the exception of the existing interchange (fills) is relatively flat and landscaped terrain. Physiographically the area is located in the region known as the "Guelph Drumlin Field" and consist of granular type materials.

SUBSURFACE CONDITIONS

General

The underlying subsoil at this site consists of granular (Granular 'A' or Granular 'B') fill underlain by natural soil predominantly composed of sand and silt, with virtually no gravel content. Despite the geological history of this area, glacial till was not encountered, except near terminal depth

in boreholes 8, 9 & 10. The natural soil is underlain by dolostone bedrock of the Guelph formation. For classification purposes, the soils encountered at this site can be divided into two different zones:

- a) Sand some silt and Gravel (Granular Fill)
- b) Layered Sand and Silt

The soils encountered during the course of the investigation, together with the field and laboratory test results are shown on the Record of Boreholes sheets contained in the Appendix of this report. Three stratigraphical profiles are shown on Drawing No. 78309-A. This drawing also shows the locations and elevations of the borings. Description of the strata encountered are given below.

#### Granular Fill

This fill which was placed to raise the finished grade of Hwy. 401 and the Regional Road #36 was encountered in all the boreholes, immediately below the existing ground level. The gradation tests carried out on representative samples are shown on Figure #1 in an envelope form. The gradation analyses indicate that this fill is predominantly composed of sand with varying proportions of silt and gravel sized particles. The natural moisture content of this fill varies from 3% to 16% with an average value of 9%. The Standard Penetration Test results indicate that this granular fill is in very loose to compact state of compaction (N-values 2 to 31 blows/30 cm). The thickness of this fill varies from 2.7 m to 8.5 m and extends to elevation 317.0±. In majority of the boreholes, a 0.3 m to 0.9 m thick organic silty layer was observed to separate the fill and the natural soil.

#### Layered Sand and Silt

The organic silty layer is underlain by this deposit. The gradation tests carried out on representative soil samples are shown on Figure #2 in an envelope form. The gradation analyses indicate that this deposit is

predominantly composed of sand and silt, with virtually no gravel content. The natural moisture content of this deposit varies over a wide range (3% to 32%) depending on the sand and silt contents. The Standard Penetration Test results indicate that this stratum is in compact to very dense state of compaction (N-values 11 blows/30 cm to 84 blows/30 cm). In boreholes 2, 6 & 8, occasional boulders and cobbles were encountered near terminal depth (El. 292.0± to 299.0±).

### Bedrock

Boreholes 8, 9 & 10 were taken into the bedrock and rock cores were obtained using BX-size diamond bits. The rock cores were examined by Mr. S.A. Senior, Geological Engineer and his description is included in the Appendix of this report.

The project area is underlain by dolostone bedrock of the Guelph Formation. The presence of boulders and cobbles immediately above the bedrock made the identification of weathered rock very difficult. However, in borehole 8, the thickness of weathered rock was observed to be about 1.83 m. The elevation of the unweathered rock is as follows:

<u>Borehole No.</u>	<u>Elevation</u>
8	289.8
9	289.1
10	290.7

The RQD values measured from BX size cores (0% to 7%) indicate that the bedrock up to the depth of drilling may be classified as very poor quality rock. However, in borehole 8, the rock quality was observed to improve (RQD = 68%) near terminal depth (El. 288.1).

### Ground Water Conditions

The ground water level was encountered in all the boreholes with the exception of borehole 7, and was observed between 12.5 m and 19.6 m (El.

306.0± to 307.0±) below the existing ground level. The ground water elevation at each borehole location is as follows:

<u>Borehole No.</u>	<u>Elevation Metre</u>
1	307.2
2	307.0
3	305.6
4	306.0
5	306.3
6	306.5
8	307.2
9	305.9
10	306.3

The groundwater elevations indicated above are based on the observations made during drilling operations and the stabilized water level could not be established in a short period of time. In our opinion, the water table may be expected to rise above the elevations indicated.

## DISCUSSION AND RECOMMENDATIONS

### General

It is proposed to widen the existing bridge along the Regional Road #36 at the Hwy. 401 crossing to provide exit from Hwy. 401 as well as entry facility to Hwy. 401. These facilities will require construction of a retaining wall in front of the north abutment, and piers and abutments for the bridge widening.

The piers and abutments of the existing bridge are supported on approximately 7.6 m long HP 310 x 79 driven piles founded at about elevation 309.0±.

### Structure Foundation

Considering the type of soils encountered at this site, shallow foundation may not be feasible. In addition, if displacement type driven piles such as closed end pipe are used, the vibrations created by the pile driving may cause some disturbance to the existing foundation. However, low displacement piles such as steel H-piles may be used to support the piers and abutments. If steel H-piles are selected, it should be driven at least 3 times the flange width away from the existing piles. The following bearing capacity values are recommended for the steel H-piles.

	<u>Pile Tip Elevation</u>	
	<u>309 m</u>	<u>305 m</u>
Factored Capacity at U.L.S.	230 kns.	510 kns.
Capacity at S.L.S. Type II	200 kns.	300 kns.

Alternatively, the proposed structures may (piers and abutments) be supported on caissons founded at about elevation 309.0±. The following bearing capacity values are recommended for the design of the caissons.

<u>Centre Pier</u>	<u>Pile Diameter in Metre</u>	
	0.76	1.00
Factored Capacity at U.L.S.	1160 kN	2000 kN
Capacity at S.L.S. Type II	700 kN	1200 kN

<u>North and South Piers and Abutments</u>	<u>Pile Diameter in Metre</u>	
	0.76	1.00
Factored Capacity at U.L.S.	1520 kN	2640 kN
Capacity at S.L.S. Type II	900 kN	1550 kN

If caisson size in between 0.76 m and 1.0 m is selected, the bearing capacity values may be interpolated from the above recommendations.

If caissons are constructed below ground water level, loosening of the founding soil could be anticipated. The soil is highly susceptible to conditions of unbalanced hydrostatic head and seepage forces and is likely to 'boil' and become unstable under such conditions. The Contractor shall maintain the stability of the soil in the sides and bases of the holes for the caissons at all times from commencement of their construction to the placing of concrete.

Some differential settlement is expected to take place between the new and the existing structures. In view of this, it is advisable to provide either a 'slip' or 'isolation' joint between the existing and the new structures.

If caissons are selected to support the piers and abutments, the construction of pile-cap may be eliminated by taking the caissons to the underside of the bridge deck.

#### Retaining Wall

Considering the removal and backfilling of large volume of fill material and construction difficulties, tangent piles (drilled-in-place concrete piles) with anchors may be used instead of concrete retaining wall. We

understand that there are machineries available in the construction industry to construct large diameter drilled-in-place concrete piles under limited head-room facility. With this in view, the option of tangent pile wall with soil anchors is recommended.

The presence of granular fill and the silty sandy soil encountered at this site will require liner for the construction of tangent pile wall. Considering the limited space the liner will have to be lowered in short lengths.

The soil anchors may be constructed using hollow-stem auger or cased hole and grout injected under pressure while the hollow-stem auger or casing is withdrawn.

If the cement grout is injected under pressure, a maximum bond stress value of 75 kPa is recommended for the design of the soil anchors.

For aesthetic purposes, the wall may be covered with concrete pannels.

Alternatively, the retaining wall may be constructed using the following construction sequence.

- 1) Close Regional Road #36 for traffic during construction.
- 2) Remove embankment fill on both side of the north abutment simultaneously to elevation 317±, and on the south side of the south abutment to about elevation 324±.
- 3) After excavation, wire brush clean the exposed piling of all dirt and loose scale, inspect for damage and apply sufficient coat of coal tar paint to avoid transfer of any down-drag load during compaction of backfill.
- 4) Construct caissons using drilled-in-place concreting.

5) Construct pile cap and retaining wall.

6) Compact the backfill on both side of the abutment simultaneously.

Earth pressure should be computed as per 6.1.2.2 of the code. In the case of retaining wall and abutments, an unyielding foundation condition may be assumed for the earth pressure computations. The Granular 'A' or 'B' backfill should be in accordance with the Special Provision No. 109F03. The following parameters are recommended for the granular backfill.

	<u>Granular 'A'</u>	<u>Granular 'B'</u>
Angle of Internal Friction	$\phi = 35^\circ$	$\phi = 30^\circ$
Unit Weight ( $\text{kN/m}^3$ )	$\gamma = 22.8$	$\gamma = 21.2$

#### Approach Embankment

A maximum fill height of about 7 m may be expected at this crossing. The subsoil conditions at this site is not expected to create any stability problems for the approach embankments constructed with 2 horizontal to 1 vertical slopes. The fill material should consist of well compacted acceptable material. The topsoil as well as any spongy or soft areas observed within the base width of the embankment, should be removed before placing the fill.

#### Other Considerations

The pile caps should have a minimum of 1.2 m earth cover for frost protection. Ground water problems are not anticipated within the proposed founding level of the caisson.

#### MISCELLANEOUS

The field work for this investigation was carried out under the supervision of Mr. M. Hopper. The equipment used was owned and operated by Marathon

Drilling Company Limited. This report was prepared by Mr. M. Vasavithasan and reviewed by Mr. P. Payer, Senior Foundation Engineer.



M. Vasavithasan, P.Eng.  
Foundation Engineer

M. Devata, P.Eng.  
Chief Foundation Engineer

## APPENDIX

## 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:

R Q D (%)	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

### MECHANICAL PROPERTIES OF SOIL

$m_v$	$\text{kPa}^{-1}$	COEFFICIENT OF VOLUME CHANGE
$C_c$	1	COMPRESSION INDEX
$C_s$	1	SWELLING INDEX
$C_a$	1	RATE OF SECONDARY CONSOLIDATION
$C_v$	$\text{m}^2/\text{s}$	COEFFICIENT OF CONSOLIDATION
H	m	DRAINAGE PATH
$T_v$	1	TIME FACTOR
U	%	DEGREE OF CONSOLIDATION
$\sigma'_{vo}$	kPa	EFFECTIVE OVERBURDEN PRESSURE
$\sigma'_p$	kPa	PRECONSOLIDATION PRESSURE
$\tau_f$	kPa	SHEAR STRENGTH
$c'$	kPa	EFFECTIVE COHESION INTERCEPT
$\phi'$	-°	EFFECTIVE ANGLE OF INTERNAL FRICTION
$c_u$	kPa	APPARENT COHESION INTERCEPT
$\phi_u$	-°	APPARENT ANGLE OF INTERNAL FRICTION
$\tau_R$	kPa	RESIDUAL SHEAR STRENGTH
$\tau_r$	kPa	REMOULDED SHEAR STRENGTH
$S_t$	1	SENSITIVITY = $\frac{c_u}{\tau_r}$

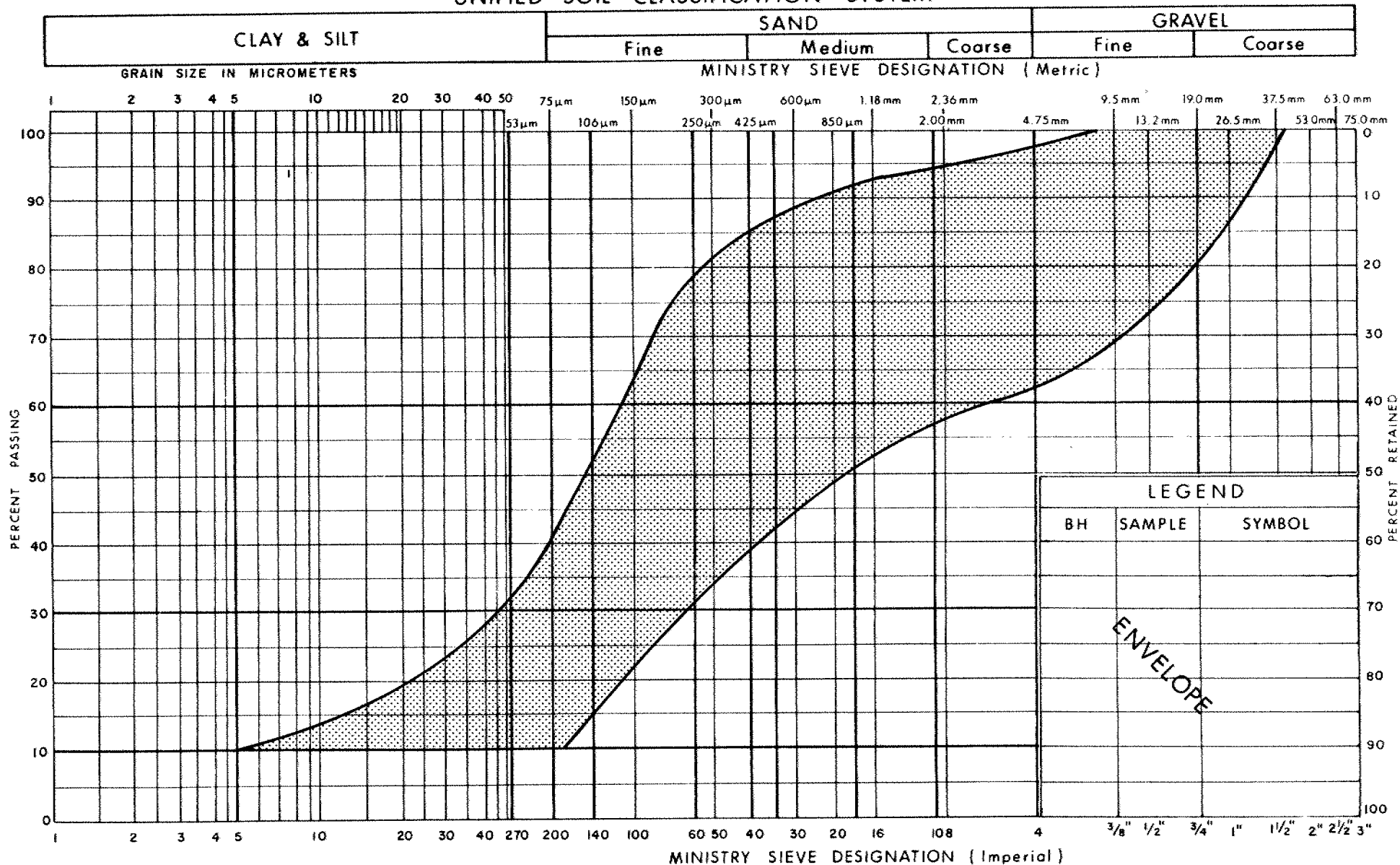
### STRESS AND STRAIN

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

### PHYSICAL PROPERTIES OF SOIL

$\rho_s$	$\text{kg}/\text{m}^3$	DENSITY OF SOLID PARTICLES	e	1, %	VOID RATIO	$e_{\min}$	1, %	VOID RATIO IN DENSEST STATE
$\gamma_s$	$\text{kN}/\text{m}^3$	UNIT WEIGHT OF SOLID PARTICLES	n	1, %	POROSITY	$I_D$	1	DENSITY INDEX = $\frac{e_{\max} - e}{e_{\max} - e_{\min}}$
$\rho_w$	$\text{kg}/\text{m}^3$	DENSITY OF WATER	w	1, %	WATER CONTENT	D	mm	GRAIN DIAMETER
$\gamma_w$	$\text{kN}/\text{m}^3$	UNIT WEIGHT OF WATER	$S_r$	%	DEGREE OF SATURATION	$D_n$	mm	n PERCENT - DIAMETER
$\rho$	$\text{kg}/\text{m}^3$	DENSITY OF SOIL	$w_L$	%	LIQUID LIMIT	$C_u$	1	UNIFORMITY COEFFICIENT
$\gamma$	$\text{kN}/\text{m}^3$	UNIT WEIGHT OF SOIL	$w_p$	%	PLASTIC LIMIT	h	m	HYDRAULIC HEAD OR POTENTIAL
$\rho_d$	$\text{kg}/\text{m}^3$	DENSITY OF DRY SOIL	$w_s$	%	SHRINKAGE LIMIT	q	$\text{m}^3/\text{s}$	RATE OF DISCHARGE
$\gamma_d$	$\text{kN}/\text{m}^3$	UNIT WEIGHT OF DRY SOIL	$I_p$	%	PLASTICITY INDEX = $w_L - w_p$	v	m/s	DISCHARGE VELOCITY
$\rho_{\text{sat}}$	$\text{kg}/\text{m}^3$	DENSITY OF SATURATED SOIL	$I_L$	1	LIQUIDITY INDEX = $\frac{w - w_p}{I_p}$	i	1	HYDRAULIC GRADIENT
$\gamma_{\text{sat}}$	$\text{kN}/\text{m}^3$	UNIT WEIGHT OF SATURATED SOIL	$I_C$	1	CONSISTENCY INDEX = $\frac{w_L - w}{I_p}$	k	m/s	HYDRAULIC CONDUCTIVITY
$\rho'$	$\text{kg}/\text{m}^3$	DENSITY OF SUBMERGED SOIL	$e_{\max}$	1, %	VOID RATIO IN LOOSEST STATE	j	$\text{kN}/\text{m}^2$	SEEPAGE FORCE
$\gamma'$	$\text{kN}/\text{m}^3$	UNIT WEIGHT OF SUBMERGED SOIL						

## UNIFIED SOIL CLASSIFICATION SYSTEM



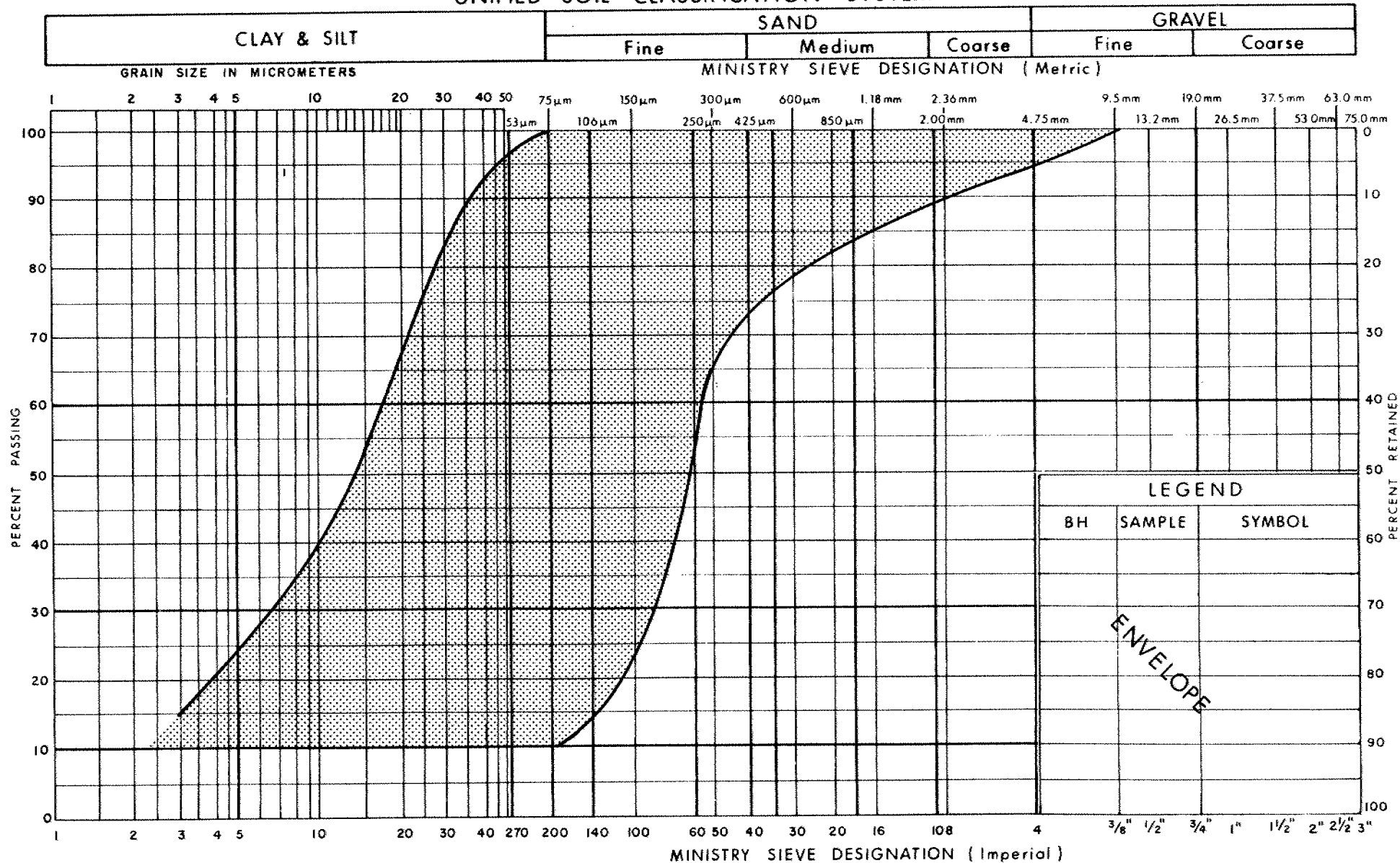
Ministry of  
Transportation

GRAIN SIZE DISTRIBUTION  
SAND & GRAVEL SOME SILT (FILL)

FIG No 1

W P 7-83-09

## UNIFIED SOIL CLASSIFICATION SYSTEM



Ministry of  
Transportation

GRAIN SIZE DISTRIBUTION  
SANDY SILT TO SILTY SAND

FIG No 2

W P 7-83-09

# ROCK CORE DESCRIPTION

## WP 7-83-09

Page 1 of 1.

CORE RECOVERY					CORE DESCRIPTION	
BH#	RC#	DEPTH (m)	% CR*	% RQD*	DEPTH (m)	DESCRIPTION
8	39	35.48-35.53	100	0	35.48-39.22	<b>DOLOSTONE</b> , very light grey; medium to fine grained, vuggy; medium strong rock; slightly weathered to unweathered; close to extremely close spaced fractures.
	41	35.53-35.79	95	0		
	42	35.70-36.27	50	0		
	43	36.27-36.53	100	0		
	44	36.53-36.70	86	0		
	45	36.70-37.74	95	0		
	46	37.74-39.22	100	68		
9	32	34.90-35.20	-	-	34.90-36.58	<b>OVERBURDEN</b> , boulders, cobbles
	33	35.20-36.25	-	-	36.58-37.16	<b>DOLOSTONE</b> , very light grey; medium to fine grained, vuggy; medium strong rock; moderately to slightly weathered; very close spaced fractures.
	34	36.25-37.16	42	0		
10	19	27.61-29.13	40	-	27.61-29.26	<b>OVERBURDEN</b> , boulders, cobbles
	20	29.13-30.66	93	7	29.26-30.66	<b>DOLOSTONE</b> , light grey; medium grained, vuggy; medium strong rock; slightly weathered to unweathered; very close spaced fractures.

\*CR = CORE RECOVERY

\*RQD = ROCK QUALITY DESIGNATION

(NOTE: Depths are approximated in zones of poor core recovery)

Logged by: SAS, Soils and Aggregates Section.



# RECORD OF BOREHOLE No 1

METRIC

W P 7-83-09 LOCATION Co-ords: N4 808 433.9, E 239 242.2 ORIGINATED BY MH  
DIST 3 HWY 401 BOREHOLE TYPE Continuous Flight Auger (H.S.) COMPILED BY PM  
DATUM Geodetic DATE 89 10 02 CHECKED BY \_\_\_\_\_

SOIL PROFILE			SAMPLES			GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT					UNIT WEIGHT $\gamma$	REMARKS & GRAIN SIZE DISTRIBUTION (%)
ELEV DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE	'N' VALUES			20 40 60 80 100						
319.7	Ground Level													
0.0	Silty Sand to Sandy Silt Very Loose to Compact (Fill)		1	SS	24									8 56 (36)
			2	SS	13									
			3	SS	5									
			4	SS	4									
			5	SS	8									
			6	SS	2									
317.1	Sandy Silt to Silty Sand Compact to Very Dense		7	SS	12									
2.6			8	SS	18									
			9	SS	28									0 29 (71)
			10	SS	28									
			11	SS	22									
			12	SS	26									0 66 (34)
			13	SS	21									
			14	SS	24									
			15	SS	22									
			16	SS	22									0 89 (11)
			17	SS	45									
			18	SS	53									0 31 (69)
			19	SS	18									
			20	SS	29									0 61 (39)
			21	SS	17									
301.1	End of Borehole		22	SS	32									0 16 (84)
18.6														

OFFICE REPORT ON SOIL EXPLORATION



# RECORD OF BOREHOLE No 2

METRIC

W P 7-83-09 LOCATION Co-ords: N4 808 427.5, E 239 234.8 ORIGINATED BY MH  
DIST 3 HWY 401 BOREHOLE TYPE Continuous Flight Auger (H.S.): BW Casing COMPILED BY PM  
DATUM Geodetic DATE 89 10 02 to 89 10 03 CHECKED BY

SOIL PROFILE			SAMPLES			GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT 20 40 60 80 100 SHEAR STRENGTH kPa ○ UNCONFINED + FIELD VANE ● QUICK TRIAXIAL x LAB VANE	PLASTIC LIMIT W <sub>p</sub> NATURAL MOISTURE CONTENT W LIQUID LIMIT W <sub>L</sub> WATER CONTENT (%) 10 20 30	UNIT WEIGHT γ	REMARKS & GRAIN SIZE DISTRIBUTION (%) GR SA SI CL
ELEV DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE	'N' VALUES						
319.6	Ground Level										
0.0	Silty Sand to Sandy Silt, Trace of Gravel, Very Loose to Compact		1	SS	3						8 65 24 3
			2	SS	7						
			3	SS	15						1 48 (51)
			4	SS	6						
			5	SS	3						
			6	SS	2						
316.4	(Fill)		7	SS	8						
3.2			8	SS	15						
			9	SS	20						
			10	SS	26						
			11	SS	31						
			12	SS	31						
			13	SS	30						
			14	SS	23						
	Sandy Silt to Silty Sand, Compact to Dense		15	SS	24						
			16	SS	30						
			17	SS	58						0 8 (92)
			18	SS	27						
			19	SS	39						
			20	SS	16						
			21	SS	50						
	Occasional Boulders		22	RC							
			23	SS	58						
295.1			24	SS	62						0 91 (9)
24.5	End of Borehole										

OFFICE REPORT ON SOIL EXPLORATION



# RECORD OF BOREHOLE No 3

METRIC

W P 7-83-09 LOCATION Co-ords: N4 808 426.4, E 239 209.1 ORIGINATED BY MH  
DIST 3 HWY 401 BOREHOLE TYPE Continuous Flight Auger (H.S.) COMPILED BY PM  
DATUM Geodetic DATE 89 10 03 to 89 10 04 CHECKED BY \_\_\_\_\_

SOIL PROFILE			SAMPLES			GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT					PLASTIC LIMIT W <sub>p</sub>	NATURAL MOISTURE CONTENT W	LIQUID LIMIT W <sub>L</sub>	UNIT WEIGHT γ	REMARKS & GRAIN SIZE DISTRIBUTION (%)
ELEV DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE	'N' VALUES			20	40	60	80	100					
319.3	Ground Level		1	SS	7												
0.0	Topsoil		2	SS	5												
	Sand, Some		3	SS	10												
	Silt, Trace of		4	SS	12												
	Gravel, Loose to		5	SS	19												
316.6	(Fill)		6	SS	17												
2.7	Organic Silt, Loose		7	SS	6												
			8	SS	8												
			9	SS	31												
			10	SS	29												
			11	SS	22												
			12	SS	29												
			14	SS	34												
			15	SS	31												
	Silty Sand		16	SS	35												
	to Sandy		17	SS	29												
	Silt, Compact		18	SS	30												
	to Dense		19	SS	26												
			20	SS	36												
			21	SS	45												
			22	SS	84												
			23	SS	29												
			24	SS	17												
302.2			25	SS	24												
17.1	End of Borehole																

OFFICE REPORT ON SOIL EXPLORATION

## METRIC

W P 7-83-09 LOCATION Co-ords: N4 808 426.0, E 239 218.8 ORIGINATED BY MH  
DIST 3 HWY 401 BOREHOLE TYPE Continuous Flight Auger (H.S.) COMPILED BY PM  
DATUM Geodetic DATE 89 10 04 CHECKED BY \_\_\_\_\_

OFFICE REPORT ON SOIL EXPLORATION



# RECORD OF BOREHOLE No 5

METRIC

W P 7-83-09 LOCATION Co-ords: N4 808 388.2, E 239 244.8 ORIGINATED BY MH  
DIST 3 HWY 401 BOREHOLE TYPE Continuous Flight Auger (H.S.) COMPILED BY PM  
DATUM Geodetic DATE 89 10 05 CHECKED BY \_\_\_\_\_

SOIL PROFILE			SAMPLES			GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT 20 40 60 80 100 SHEAR STRENGTH kPa ○ UNCONFINED + FIELD VANE ● QUICK TRIAXIAL x LAB VANE	PLASTIC LIMIT W <sub>p</sub> NATURAL MOISTURE CONTENT W LIQUID LIMIT W <sub>L</sub> WATER CONTENT (%) 10 20 30	UNIT WEIGHT γ	REMARKS & GRAIN SIZE DISTRIBUTION (%) GR SA SI CL
ELEV DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE	'N' VALUES						
320.0	Ground Level										
318.5	Topsoil		1	SS	4						
0.5	Sand, Some Silt and Gravel, Very Loose to Compact (Fill)		2	SS	9						
			3	SS	7						
			4	SS	14						
			5	SS	21						
317.3			6	SS	13						
2.7	Clayey Silt, Very Soft		7	SS	1						
	Sand, Some Silt and Gravel Compact to Dense		8	SS	13						
315.6			9	SS	55						
4.4			10	SS	19						
			11	SS	21						
			12	SS	33						
			13	SS	36						
			14	SS	27						
			15	SS	25						
			16	SS	23						
			17	SS	20						
			18	SS	32						
			19	SS	36						
			20	SS	49						
			21	SS	41						
			22	SS	42						
			23	SS	11						
			24	SS	41						
298.4			25	SS	55						
21.6	End of Borehole										

OFFICE REPORT ON SOIL EXPLORATION

## METRIC

W P 7-83-09 LOCATION Co-ords: N4 808 407.4, E 239 242.9 ORIGINATED BY MH  
DIST 3 HWY 401 BOREHOLE TYPE Continuous Flight Auger (H.S.) COMPILED BY PM  
DATUM Geodetic DATE 89 10 05 to 89 10 06 CHECKED BY \_\_\_\_\_

[illegible]

# RECORD OF BOREHOLE No 7

METRIC

W P 7-83-09 LOCATION Co-ords: N4 808 454.4, E 239 216.1 ORIGINATED BY MH  
 DIST 3 HWY 401 BOREHOLE TYPE Continuous Flight Auger (H.S.) COMPILED BY PM  
 DATUM Geodetic DATE 89 10 10 CHECKED BY

SOIL PROFILE			SAMPLES			GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT 20 40 60 80 100 SHEAR STRENGTH kPa ○ UNCONFINED + FIELD VANE ● QUICK TRIAXIAL x LAB VANE	PLASTIC LIMIT W <sub>p</sub>	NATURAL MOISTURE CONTENT W	LIQUID LIMIT W <sub>L</sub>	UNIT WEIGHT γ	REMARKS & GRAIN SIZE DISTRIBUTION (%) GR SA SI CL
ELEV DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE	'N' VALUES								
325.6	Shoulder Level												
0.0	Asphalt		1	SS	75								
	Sand With Silt,  Some Gravel,  Compact to  Dense  (Fill)		2	SS	23								
			3	SS	16								
			4	SS	15								
			5	SS	28								
			6	SS	27								
			7	SS	27								
			8	SS	20								
			9	SS	21								
			10	SS	12								
			11	SS	5								
			12	SS	14								
			13	SS	30								
			14	SS	37								
			15	SS	43								
			16	SS	32								
			17	SS	21								
			18	SS	38								
316.9				19	SS	26							
8.7	End of Borehole												

OFFICE REPORT ON SOIL EXPLORATION

## RECORD OF BOREHOLE No 8

METRIC

W P 7-83-09

LOCATION Co-ords: N4 808 448.6, E 239 227.6

ORIGINATED BY MH

DIST 3 HWY 401

BOREHOLE TYPE Continuous Flight Auger (H.S.), BX Casing

COMPILED BY PM

DATUM Geodetic

DATE 89 10 11

CHECKED BY \_\_\_\_\_

[illegible]

OFFICE REPORT ON SOIL EXPLORATION

Continued

+3, x5: Numbers refer to

20  
15-20.5 (%) STRAIN AT FAILURE

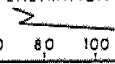
Continued



# RECORD OF BOREHOLE No 8

METRIC

W P 7-83-09 LOCATION Co-ords: N4 808 448.6, E 239 227.6 ORIGINATED BY MH  
DIST 3 HWY 401 BOREHOLE TYPE Continuous Flight Auger (H.S.), BX Casing COMPILED BY PM  
DATUM Geodetic DATE 89 10 11 to 89 10 12 CHECKED BY \_\_\_\_\_

SOIL PROFILE			SAMPLES			GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT 				PLASTIC LIMIT W <sub>p</sub>	NATURAL MOISTURE CONTENT W	LIQUID LIMIT W <sub>L</sub>	UNIT WEIGHT γ	REMARKS & GRAIN SIZE DISTRIBUTION (%) GR SA SI CL
ELEV DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE	'N' VALUES			SHEAR STRENGTH kPa ○ UNCONFINED + FIELD VANE ● QUICK TRIAXIAL x LAB VANE								
295.6	Continued															
30.2	Silty Sand to Sandy Silt, Dense to Very Dense		33	SS	103/28cm											
	Occasional Boulders		34	RC	40%											
			35	SS	71											
291.7																
34.1	Weathered Unweathered		36	BXL	25											
			*													
	Dolostone Bedrock		45	RC	REC											
			45	BXL	86%											
			46	RC	REC											
			46	BX	97%											
286.6																
39.2	End of Borehole															
* Note Sample																
No.	Type	Rec.	RQD													
37	RC	40%	0													
38	RC	80%	0													
39	RC	100%	0													
41	RC	95%	0													
42	RC	50%	0													
43	RC	100%	0													
44	RC	86%	0													

OFFICE REPORT ON SOIL EXPLORATION



# RECORD OF BOREHOLE No 9

METRIC

W P 7-83-09 LOCATION Co-ords: N4 808 366.4, E 239 245.6 ORIGINATED BY MH  
DIST 3 HWY 401 BOREHOLE TYPE Continuous Flight Auger (H.S.), Casing NX COMPILED BY PM  
DATUM Geodetic DATE 89 10 17 to 89 10 23 CHECKED BY

SOIL PROFILE			SAMPLES			GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT					PLASTIC LIMIT W <sub>p</sub>	NATURAL MOISTURE CONTENT W	LIQUID LIMIT W <sub>L</sub>	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					
325.7	Ground Level																
0.0			1	SS	7												
			2	SS	13												33 53 (14)
			3	SS	10												
			4	SS	12												
			5	SS	17												
			6	SS	15												28 44 (28)
			7	SS	12												
			8	SS	8												
			9	SS	10												19 48 (33)
			10	SS	10												
			11	SS	6												
			12	SS	26												
			13	SS	29												
			14	SS	28												
			15	SS	24												37 49 (14)
			16	SS	26												
317.2	Organic Silt		17	SS	10												
8.5			18	SS	54												
			19	SS	80												
			20	SS	47												
			21	SS	25												
			22	SS	25												
			23	SS	20												
			24	SS	24												
			25	SS	40												
			26	SS	97												
			27	SS	23												
			28	SS	24												
			29	SS	109												
295.5																	
30.2																	

OFFICE REPORT ON SOIL EXPLORATION

Continued

\*3, x5: Numbers refer to  
penetration

20  
15 & 5 (%) STRAIN AT FAILURE

Continued



# RECORD OF BOREHOLE No 9

METRIC

W P 7-83-09 LOCATION Co-ords: N4 808 366.4, E 239 245.6 ORIGINATED BY MH  
DIST 3 HWY 401 BOREHOLE TYPE Continuous Flight Auger (H.S.), Casing NX COMPILED BY PM  
DATUM Geodetic DATE 89 10 17 to 89 10 23 CHECKED BY

SOIL PROFILE			SAMPLES			GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT					PLASTIC LIMIT W <sub>p</sub>	NATURAL MOISTURE CONTENT W	LIQUID LIMIT W <sub>L</sub>	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					
295.5	Continued		30	SS	32												
30.2																	
	Occasional Boulders		31	SS	64												
			32	RC	50%												
			33	RC	12%												
289.1																	
288.5	Dolostone Bedrock		34	RC BX	REC 43%											RQD = 0	
37.3	End of Borehole																

OFFICE REPORT ON SOIL EXPLORATION



# RECORD OF BOREHOLE No 10

METRIC

W P 7-83-09 LOCATION Co-ords: N4 808 407.8, E 239 219.4 ORIGINATED BY MH  
DIST 3 HWY 401 BOREHOLE TYPE Continuous Flight Auger (H.S.), BX Casing COMPILED BY PM  
DATUM Geodetic DATE 89 10 24 to 89 10 25 CHECKED BY

SOIL PROFILE			SAMPLES			GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT 20 40 60 80 100 SHEAR STRENGTH kPa ○ UNCONFINED + FIELD VANE ● QUICK TRIAXIAL x LAB VANE	PLASTIC LIMIT W <sub>p</sub> NATURAL MOISTURE CONTENT W LIQUID LIMIT W <sub>L</sub> WATER CONTENT (%) 10 20 30	UNIT WEIGHT γ	REMARKS & GRAIN SIZE DISTRIBUTION (%) GR SA SI CL
ELEV DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE	'N' VALUES						
320.0 0.0	Ground Level										
	Silty Sand to Sandy Silt, Compact to Dense		1	SS	15						
			2	SS	45						
			3	SS	15						
			4	SS	26						
			5	SS	4						
			6	SS	12						
			7	SS	19						
			8	SS	32						
			9	SS	21						
			10	SS	14						
			11	SS	26						
			12	SS	34						
			13	SS	17						
			14	SS	21						
			15	SS	45						
			16	SS	14						
			17	SS	28						
		18	SS	86/							
	Occasional Boulders		19	BX	REC 42%						
290.7 29.3	Dolostone Bedrock		20	BX	REC 96%						
289.3 30.7	End of Borehole										

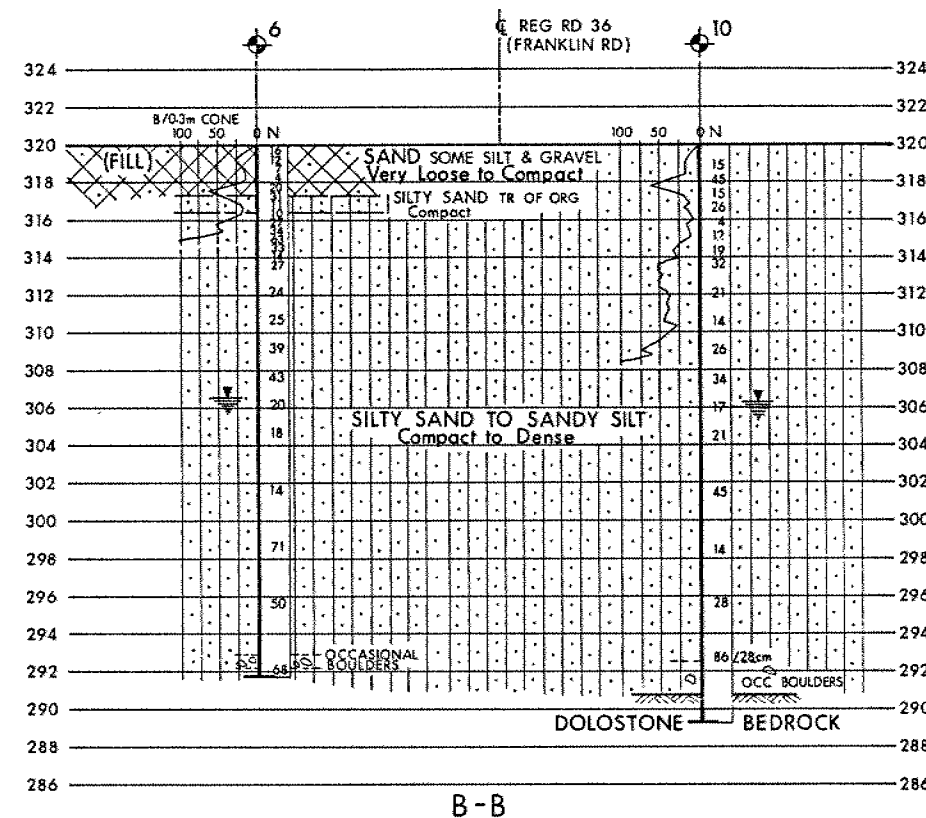
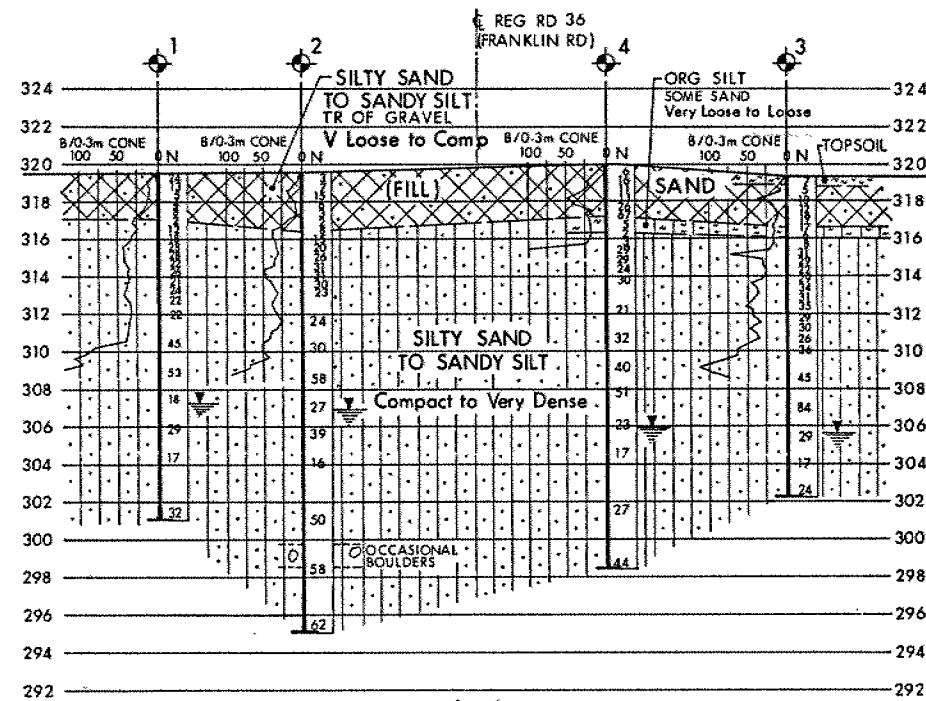
318  
316  
314  
312  
310  
308  
306  
304  
302  
300  
298  
296  
294  
292

104/30cm

28cm Bouncing

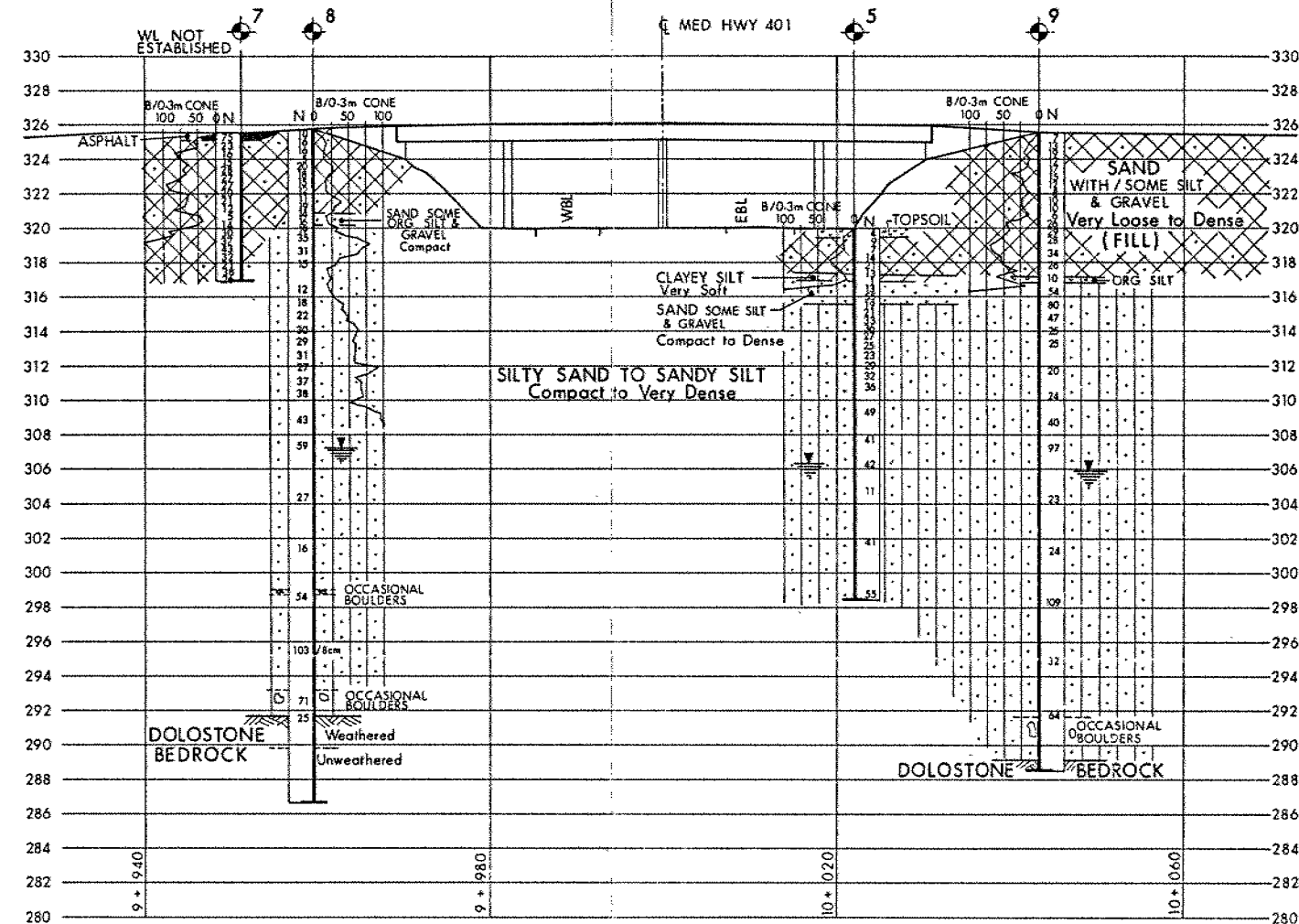
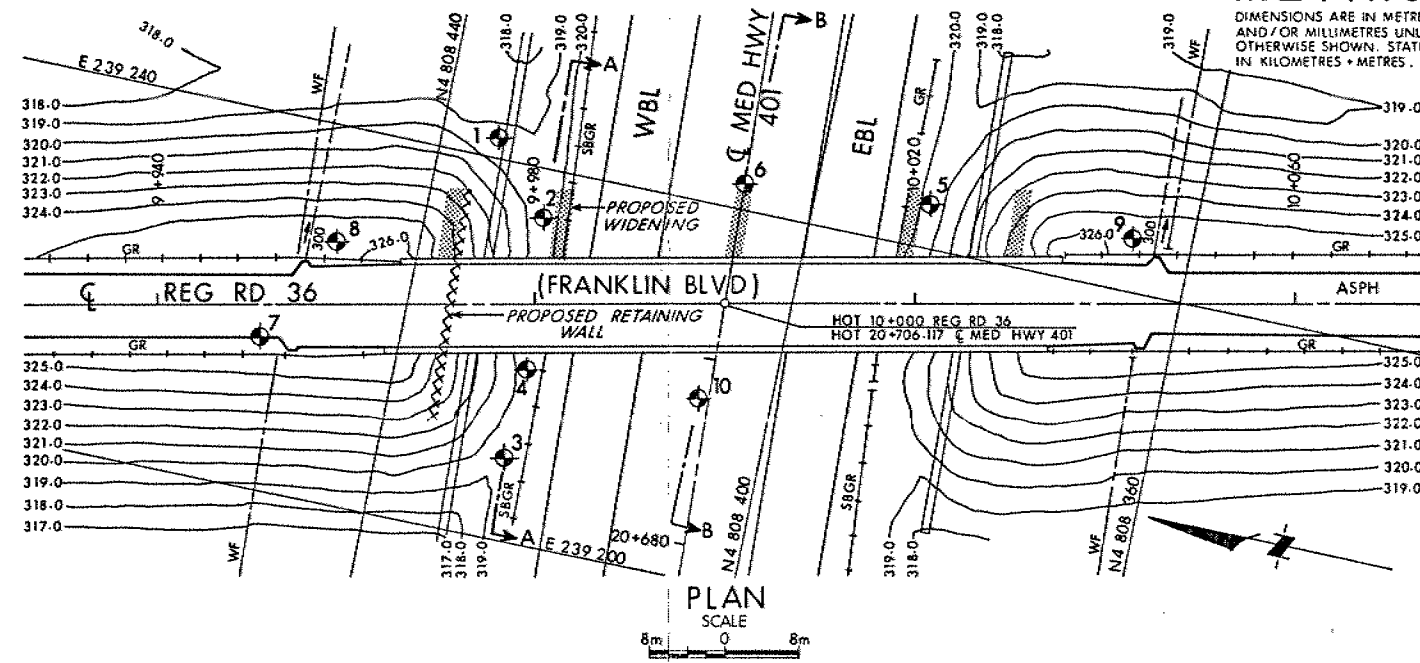
RQD = 7%

OFFICE REPORT ON SOIL EXPLORATION



# SECTIONS

SCALE  
4m 0 4m



# PROFILE REG RD 36

SCALE  
8m 4 0 8m Hor  
4m 2 0 4m Vert

# METRIC

DIMENSIONS ARE IN METRES  
AND/OR MILLIMETRES UNLESS  
OTHERWISE SHOWN. STATIONS  
IN KILOMETRES + METRES.

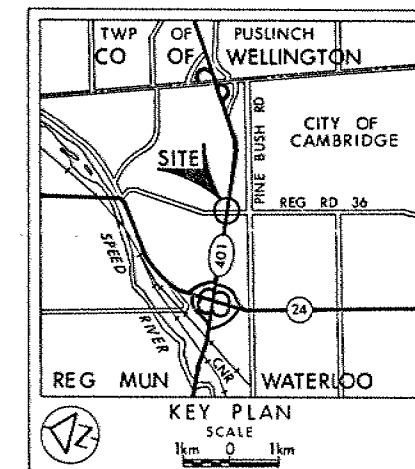
CONT No  
WP No 7-83-09

REG RD 36 (FRANKLIN BLVD)

BORE HOLE LOCATIONS & SOIL STRATA



SHEET



# 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)
- WL at time of investigation 89 10

No	ELEVATION	CO-ORDINATES	
		NORTH	EAST
1	319.7	4 808 433.9	239 242.2
2	319.6	4 808 427.5	239 234.8
3	319.3	4 808 426.4	239 209.1
4	320.0	4 808 426.0	239 218.8
5	320.0	4 808 388.2	239 244.8
6	320.0	4 808 407.4	239 242.9
7	325.6	4 808 454.4	239 216.1
8	325.8	4 808 448.6	239 227.6
9	325.7	4 808 366.4	239 245.6
10	320.0	4 808 407.8	239 219.4

# NOTE

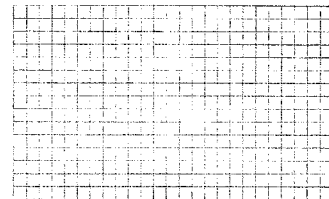
The boundaries between soil strata have been established only at Bore Hole locations. Between Bore Holes the boundaries are assumed from geological evidence.

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.

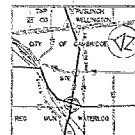
REV	DATE	BY	DESCRIPTION
1			
2			
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Geocres No 40P8-104

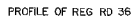
HWY No 401	DIST 3
SUBMD MV CHECKED	DATE 90 01 17
DRAWN DT CHECKED	APPROVED
	SITE 33-151
	DWG 78309-A



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



### KEY PLAN



DATE	REVISIONS AND ADDITIONS		
MINISTRY OF TRANSPORTATION ENGINEERING AND ROAD DESIGN OFFICE DURHAM AND HALLOWILL STATIONS			
BRIDGE SITE PLAN			
PROPOSED CROSSING			
AT			
REG RD 38			
AND			
KING'S HIGHWAY 401			
JOB # DON 2-5-81	DISTRICT 4-BURLINGTON		CITY OF CAMBRIDGE NEW BRIDGE DIVISION
SCALE AS SHOWN 7-63-78	PROFILE E164-421		REGION NORTHWESTERN PLAN E164-401
SURVEY 81-03	PLAN 81-03		
SITE 20-101	PLAN E-164-401-1		