

DOCUMENT MICROFILMING IDENTIFICATION

GEOCRES No. 31L-48

DIST. 13 REGION

W.P. No. 72-74-05

CONT. No. 85-36

W. O. No.

STR. SITE No. 43-205

HWY. No. 11

LOCATION Mountain Rd. Underpass

No of PAGES -

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OVERSIZE DRAWINGS TO BE INCLUDED WITH THIS REPORT.

REMARKS:

# FOUNDATION INVESTIGATION REPORT

CONTRACT NO 85-36



Ontario

Ministry of  
Transportation and  
Communications

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NOTE: For purposes of the contract, these reports supersede all other foundation reports prepared by or for the Ministry in connection with the above-mentioned projects.

# 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 (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

### 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

### MECHANICAL PROPERTIES OF SOIL

$m_v$	$kPa^{-1}$	COEFFICIENT OF VOLUME CHANGE
$C_c$	1	COMPRESSION INDEX
$C_s$	1	SWELLING INDEX
$C_\alpha$	1	RATE OF SECONDARY CONSOLIDATION
$c_v$	$m^2/s$	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 = $\frac{c_u}{\tau_r}$

### PHYSICAL PROPERTIES OF SOIL

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

# FOUNDATION INVESTIGATION REPORT

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For

Mountain Road Overpass, NBL & SBL Structures

W.P. 72-74-05 & 14, Site 43-205 N & S

Hwy. 11, District 13, North Bay

## INTRODUCTION:

This report summarizes the factual information obtained from a foundation investigation program for the above-mentioned site. The initial fieldwork was carried out from 79 10 17 to 79 10 24 and consisted of 11 boreholes and 2 test pits, additional fieldwork was carried out from 81 06 08 to 81 06 11 and consisted of 11 boreholes.

All borings were advanced by means of hollow stem augers except for one borehole which was advanced by means of solid stem augers, diamond drilling techniques were also utilized in a number of boreholes. The boreholes ranged in depth from 1.7 to 9.4 m with bedrock proven in 9 of the borings by obtaining up to 2.1 m of BXL or AX size rock core.

## SITE DESCRIPTION AND GEOLOGY

The site is located on Mountain Road approximately 0.8 km east of existing Hwy.11 in the Township of North Himsforth, geographical District of Parry Sound.

The surrounding terrain is tree covered with a few rural developments. Topographically the area is hilly comprised of extensive bedrock outcrops with steep rock slopes. At the proposed site, Mountain Road is located in a partial earth cut through sandy overburden while bedrock outcrops were noted south of Mountain Road along the proposed Hwy. 11 centerline. Burford Creek crosses Mountain Road immediately east of the site and thereafter flows westerly parallel to Mountain Road. The creek is 4 to 6 m wide with an average depth of water of 0.1 m and has a cobble and boulder strewn bed. Physiographically the area is located in the Canadian Shield.

## SUBSURFACE CONDITIONS

### General

Subsurface conditions consist of up to 7.3 m of silty sand to gravelly sand with some silt overlying granite bedrock. In the area of the Mountain Road embankment, up to 1.6 m of fill material overlies the parent overburden.

Bedrock is exposed to the south of Mountain Road along the Hwy. 11 centerline. The upper 2 m of the surficial deposits in the western section of the site contain pockets and inclusions of organic silt up to 0.3 m thick.

The boundaries between the various subsoil and bedrock types are shown on the Record of Borehole Sheets. The locations and elevations of the boreholes and test pits together with two centerline profiles and 8 sections based on the borehole and test pit information are shown on Drawings No. 2 and 2A. In the paragraphs to follow the subsoil and bedrock types are described briefly.

### Fill Material

Fill material was encountered in all borings put down on Mountain Road and extends for a depth of up to 1.6 m. The fill material is composed of sand with some silt and a trace to some gravel with occasional cobbles. A grain size distribution envelope for the fill material is shown on Fig.1. Standard Penetration test 'N' values range from 13 to 24 blows per 0.3 m indicating the fill material has been subject to a moderate degree of compactive effort.

### Sandy Silt to Gravelly Sand

This granular deposit is the dominant deposit across the site extending from the parent ground surface down to a depth of up to 7.3 m to the bedrock surface. The results of grain size distribution testing on samples from this deposit is shown in envelope form on Fig.2. The grain size distribution established from representative samples from this deposit vary with depth as well as across the site in haphazard fashion.

Accordingly the composition of the deposit is described as ranging from a silty sand with a trace of gravel to a gravelly sand, some silt. The coefficient of uniformity for the grain size distribution curves range between 12 and 18 indicating a generally well graded deposit. This granular deposit was found to contain occasional cobbles across the site and on the west portion of the site the upper 2 m of the deposit contains inclusions and pockets of organic silt. Standard penetration test 'N' values generally range from 2 to 10 blows per 0.3 m in zones containing pockets of organic silt and elsewhere vary generally from 10 blows per 0.3 m to 73 blows per 0.15 m. Based on these results the relative density of the deposit is described as compact to very dense except in the pockets or inclusions of organic silt where the consistency is estimated to be soft.

### Bedrock

Granite bedrock is present across the site either exposed or beneath up to 7.3 m of overburden. In one borehole a diabase intrusion was found sandwiched between the granite gneiss. This small intrusion may be part of a larger diabase dike along the fault lying in the vicinity.

The bedrock was proven in 9 of the sampled boreholes by obtaining up to 2.1 m of BXL or AX size rock core. Elsewhere the bedrock surface was established by digging test pits or is estimated to be at the point of refusal to augering. The bedrock surface varies from elevation 215.3 to 205.1.

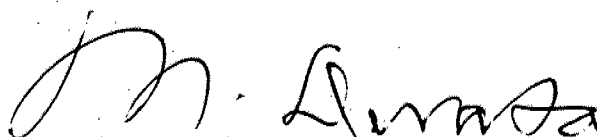
The bedrock was generally sound although considerable difficulty was encountered in rock coring because the presence of near vertical jointing resulted in excessing blocking of the core barrel. The recovery ratio and rock quality designation ratio was found to be 80 to 100% which indicates very good to excellent quality bedrock.

### Groundwater Elevation

Groundwater level observations were carried out by measuring in the open boreholes. In order to maintain traffic on Mountain Road it was not always possible to allow sufficient time for the groundwater to stabilize in the borehole. Hence, for some of the borings on Mountain Road the groundwater level was not established. Elsewhere the groundwater level varied from 0.15 to 0.6 m below ground surface which corresponds to elevation 210.9 to 213.3. These observations indicate that the groundwater level reflects topography.



H. Sturm, P. Eng.  
Project Foundations Engineer

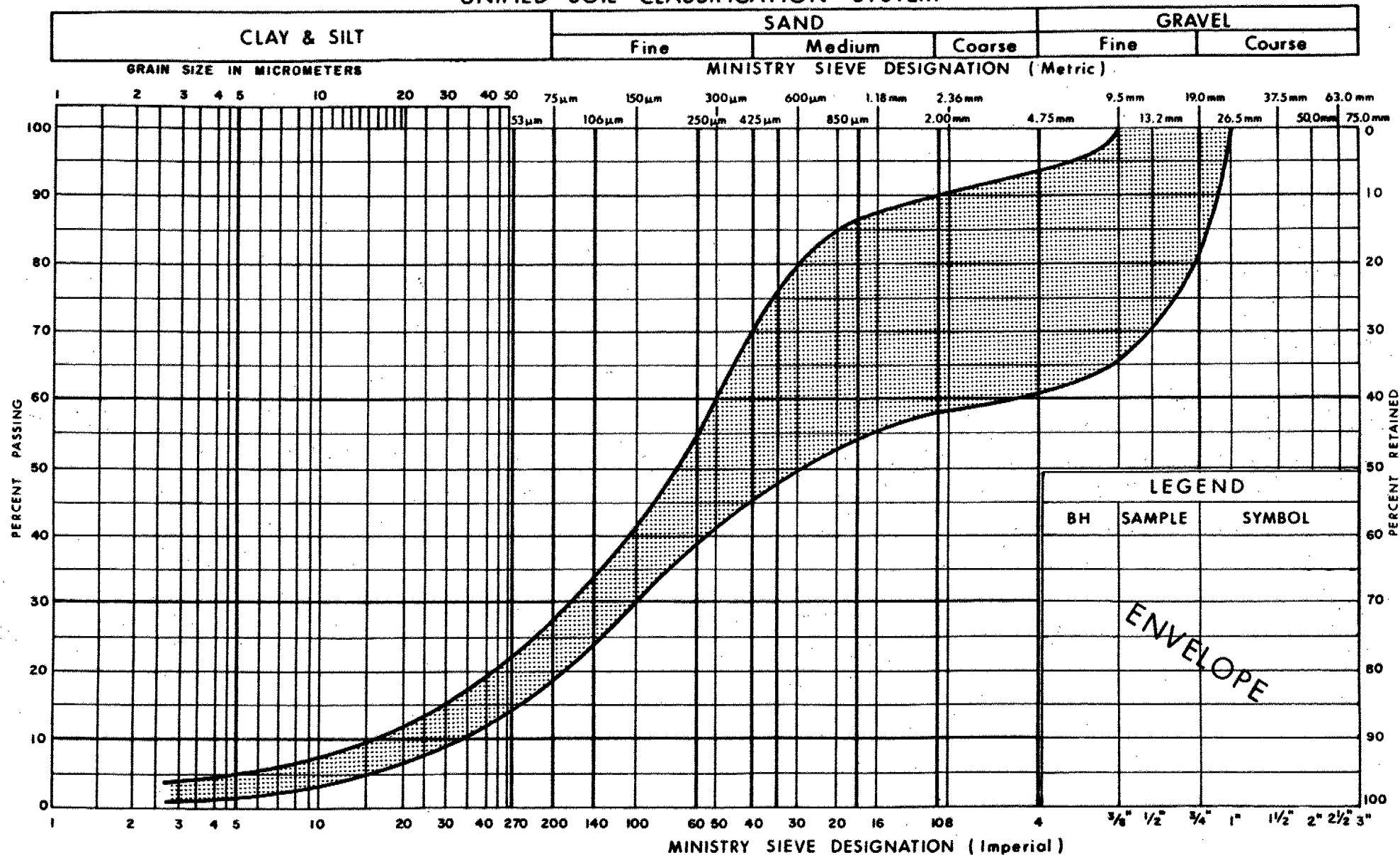


M. Devata, P. Eng.  
Senior Foundations Engineer (East)

## A P P E N D I X



## UNIFIED SOIL CLASSIFICATION SYSTEM



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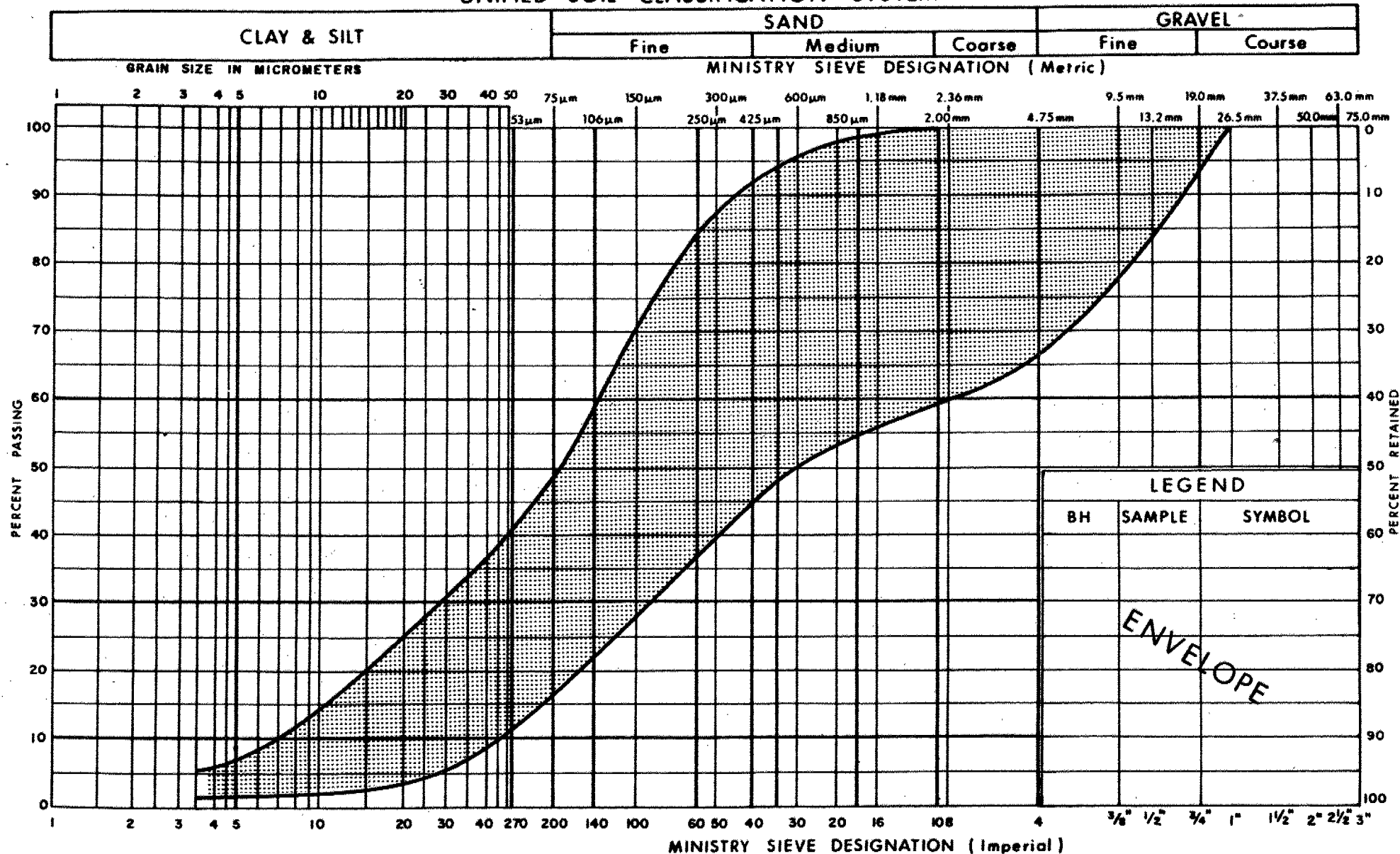
## GRAIN SIZE DISTRIBUTION FILL, SAND

TRACE TO SOME GRAVEL SOME SILT OCC COBBLES

FIG No 1

WP 72-74-05 & 14

## UNIFIED SOIL CLASSIFICATION SYSTEM



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**GRAIN SIZE DISTRIBUTION**  
**SILTY SAND, TRACE OF GRAVEL**  
**TO GRAVELLY SAND SOME SILT OCC COBBLES**

FIG No 2

W P 72-74-05 &amp; 14

∞

RECORD OF BOREHOLE No 1

METRIC 9

W P 72-74-05 & 14 LOCATION Co-ords. N 5 118 768.5; E 316 458.6 ORIGINATED BY MM  
DIST 13 HWY 11 BOREHOLE TYPE Hollow Stem Augers, Cone Test, AX Rock Core COMPILED BY MM  
DATUM Geodetic DATE 1979-10-18 CHECKED BY *CP*

SOIL PROFILE			SAMPLES			GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT	PLASTIC LIMIT	NATURAL MOISTURE CONTENT	LIQUID LIMIT	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>		
213.8	Ground Surface												GR SA SI CL
0.0	Fill Sand, some gravel, some silt, occasional cobbles		1	SS	13	*					7 77 (16)		
212.3													
1.5	Occasional cobbles		2	SS	73							212	
			3	SS	30								
	Sand, some gravel, some silt		4	SS	46								
	Compact to dense		5	SS	26							210	
			6	SS	44								
208.3	cobbles		7	RC	REC							75%	
5.5	Sound granite bedrock		8	RC	REC							50%	208
207.0		9	RC	REC	100%						17 61 (22)		
6.8	End of Borehole											RQD 0%	
												RQD 30%	
												RQD 100%	
	<u>*Note:</u>  Ground water level not established.												

RECORD OF BOREHOLE No 2

METRIC

W P 72-74-05 & 14 LOCATION Co-ords. N 5 118 770.6; E 316 443.8 ORIGINATED BY MM  
DIST 13 HWY 11 BOREHOLE TYPE Hollow Stem Augers, Cone Test COMPILED BY MM  
DATUM Geodetic DATE 1979-10-18 CHECKED BY *CP*

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	SHEAR STRENGTH					
213.1	Ground Surface													GR SA SI CL
0.0	Fill sand, some gravel, some silt occasional cobbles		1	SS	24		212							6 44 46 4
211.8	occasional cobbles		2	SS	19									
1.3	Silty sand trace		3	SS	10									
209.9	gravel compact		4	SS	41/75 mm									
3.2	End of Borehole Refusal to augering probable bedrock													

RECORD OF BOREHOLE No 3

METRIC 10

W P 72-74-05 & 14 LOCATION Co-ords. N 5 118 771.5; E 316 428.8 ORIGINATED BY MM  
DIST 13 HWY 11 BOREHOLE TYPE Hollow Stem Augers, Cone Test COMPILED BY MM  
DATUM Geodetic DATE 1979-10-23 CHECKED BY *CP*

SOIL PROFILE			SAMPLES			GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT		PLASTIC LIMIT	NATURAL MOISTURE CONTENT	LIQUID LIMIT	UNIT WEIGHT γ	REMARKS & GRAIN SIZE DISTRIBUTION (%) GR SA SI CL
ELEV DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE	'N' VALUES			20 40 60 80 100	20 40 60 80 100	W <sub>p</sub>	W	W <sub>L</sub>		
212.7	Ground Surface													
0.0	Fill sand, some gravel						212							
211.4	some silt, occasional cobbles		1	SS	20									
1.3	Gravelly sand													
210.8	compact		2	SS	43									35 43 18 4
1.9	End of Borehole													
	Refusal to augering probable bedrock													

RECORD OF BOREHOLE No 4

METRIC

W P 72-74-05 & 14 LOCATION Co-ords. N 5 118 775.2; E 316 414.0 ORIGINATED BY MM  
DIST 13 HWY 11 BOREHOLE TYPE Hollow Stem Augers, Cone Test, BXL Rock Core COMPILED BY MM  
DATUM Geodetic DATE 1979-10-23 CHECKED BY *CP*

SOIL PROFILE			SAMPLES			GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT		PLASTIC LIMIT	NATURAL MOISTURE CONTENT	LIQUID LIMIT	UNIT WEIGHT γ	REMARKS & GRAIN SIZE DISTRIBUTION (%) GR SA SI CL
ELEV DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE	'N' VALUES			20 40 60 80 100	20 40 60 80 100	W <sub>p</sub>	W	W <sub>L</sub>		
212.3	Ground Surface													
0.0	Fill sand, some gravel						212							
210.7	occasional cobbles		1	SS	19									
1.6	Gravelly Sand, some silt to		2	SS	53									41 44 12 3
	Silty sand, trace gravel		3	SS	23		210							
	Compact to dense		4	SS	12									
			5	SS	59		208							10 62 23 5
207.0														
5.3	Sound granite bedrock		6	BXL RC	REC 82%		206							RQD 82%
205.4														
6.9	End of Borehole													

+3, x5: Numbers refer to  
Sensitivity

20  
15 5 (%) STRAIN AT FAILURE  
10

EXPLORATION

OFFICE REPORT ON SOIL EXPLORATION



RECORD OF BOREHOLE No 5

METRIC 11

W P 72-74-05 & 14 LOCATION Co-ords. N 5 118 776.2; E 316 398.8 ORIGINATED BY MM  
DIST 13 HWY 11 BOREHOLE TYPE Hollow Stem Augers, Cone Test COMPILED BY MM  
DATUM Geodetic DATE 1979-10-23 CHECKED BY SP

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				
212.0	Ground Surface															
0.0	Fill sand, some gravel															
211.0	some silt															
1.0	with organic silt		1	SS	10											
			2	SS	38											
	Silty sand, trace		3	SS	42											
	gravel to		4	SS	25											
	Gravelly sand, some															
	silt															
207.2	Compact to dense		5	SS	100/	75 mm										
4.8	End of Borehole															
	Refusal to auger-															
	ing															
	Probable bedrock															
	*Note: Water level															
	not established															
	Note: Occasional															
	cobbles EL. 212.0															
	to EL. 210.5															

RECORD OF BOREHOLE No 6

METRIC

W P 72-74-05 & 14 LOCATION Co-ords. N 5 118 780.5; E 316 384.3 ORIGINATED BY MM  
DIST 13 HWY 11 BOREHOLE TYPE Hollow Stem Augers, Cone Test BXL Rock Core COMPILED BY MM  
DATUM Geodetic DATE 1979-10-23 CHECKED BY P

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				
211.8	Ground Surface															
0.0	Fill sand, trace															
210.8	gravel, some silt															
1.0	with gravel and		1	SS	23											
	pockets of organic		2	SS	32											
	silt		3	SS	5											
	Sand, trace gravel,		4	SS	17											
	some silt															
207.5	Compact to dense		5	SS	48											
4.3	Sound granite		6	BXL	REC											
206.3	bedrock			RC	100%											
5.5	End of Borehole															
	Note: Occasional															
	cobbles, Elev. 211.8															
	to Elev. 209.0															

+3, x5: Numbers refer to  
Sensitivity

20  
15 5 (%) STRAIN AT FAILURE  
10

## METRIC 12

SOIL PROFILE		SAMPLES			GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT	PLASTIC LIMIT	NATURAL MOISTURE CONTENT	LIQUID LIMIT	UNIT WEIGHT Y	REMARKS & GRAIN SIZE DISTRIBUTION (%) GR SA SI CL
ELEV DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE			'N' VALUES		Wp	W		
211.5	Ground Surface						SHEAR STRENGTH ○ UNCONFINED + FIELD VANE ● QUICK TRIAXIAL × LAB VANE	WATER CONTENT (%) 10 20 30				
0.0 210.9	<del>Fill sand, some gravel</del>	<del>X</del>			*							
0.6	With pockets of organic silt		1	SS	2			w = 65%			Om 9%	0 59 36 5
	Silty sand to gravelly sand, some silt		2	SS	26							0 63 35 2
	Compact		3	SS	24							
			4	SS	11							
			5	SS	11							
			6	SS	18							
206.0	End of Borehole Refusal to augering probable bedrock											
5.5	*Note: Water level not established.  Note: Occasional cobbles Elev. 211.5 to Elev. 209.0						50/0 mm					

## METRIC

[illegible]

20  
15  $\phi$  5 (%) STRAIN AT FAILURE  
10



RECORD OF BOREHOLE No 13

METRIC 13

W P 72-74-05 & 14 LOCATION Co-ords. N 5 118 766.3; E 316 383.4 ORIGINATED BY MM  
DIST 13 HWY 11 BOREHOLE TYPE Hollow Stem Augers and Cone Test COMPILED BY MM  
DATUM Geodetic DATE 1979-10-24 CHECKED BY CP

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				
212.9	Ground Surface															
0.0	with pockets of organic silt loose		1	SS	3	* 75 mm	212									
			2	SS	6											
	Silty sand to gravelly sand, some silt		3	SS	18		210									13 64 19 4
209.5	Compact		4	SS	50/											15 72 (13)
3.4	End of Borehole															
	Refusal to augering probable bedrock.															
	*Note: Water level not established.															
	Note: Occasional cobbles Elev. 211.5 to 210.0															

RECORD OF BOREHOLE No 14

METRIC

W P 72-74-05 & 14 LOCATION Co-ords. N 5 118 768.9; E 316 374.4 ORIGINATED BY MM  
DIST 13 HWY 11 BOREHOLE TYPE Hollow Stem Augers and Cone Test COMPILED BY MM  
DATUM Geodetic DATE 1979-10-22 CHECKED BY CP

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				
211.5	Ground Surface															
0.0	with organic mat'l. loose		1	SS	5	* 75 mm	210									
	Compact		2	SS	26											
	Occasional cobbles		3	SS	36											
	Gravelly sand, some silt to silty sand		4	SS	21		208									34 54 (12)
			5	SS	23											
			6	SS	19											
205.6			7	SS	50/		206									
5.9	End of Borehole															
	Refusal to augering probable bedrock.															



# RECORD OF BOREHOLE No 101

METRIC <sup>14</sup>

W P 72-74-05 & 14 LOCATION Co-ords N 5 118 781.2; E 316 438.8 ORIGINATED BY ZM  
DIST 13 HWY 11 BOREHOLE TYPE Hollow Stem Auger COMPILED BY ZM  
DATUM Geodetic DATE 81 06 08 CHECKED BY [Signature]

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					
212.4	Ground Surface																
0.0	Sand, with gravel some silt  Compact to Dense	[Strat Plot]	1	SS	27	[Water Conditions]	212									28 47 14 11	
			2	SS	18		210										
			3	SS	34												
			4	SS	24												
208.7	Sound Granite Bedrock	[Strat Plot]	5	BXL RC	REC 100%	[Water Conditions]	208										
3.7																	
207.2	End of Borehole																
5.2																	



# RECORD OF BOREHOLE No 102

METRIC <sup>15</sup>

W P 72-74-05 & 14 LOCATION Co-ords N 5 118 781.7; E 316 425.6 ORIGINATED BY ZM  
 DIST 13 HWY 11 BOREHOLE TYPE Hollow Stem Augers COMPILED BY ZM  
 DATUM Geodetic DATE 81 06 09 CHECKED BY CP

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				
212.2	Ground Surface															GR SA SI CL
0.0	Gravelly Sand some silt to silty sand some gravel		1	SS	36	*	212									44 44 9 3
			2	SS	50											
	Compact to Very Dense		3	SS	26		210									17 55 24 4
			4	SS	60											
207.9							208									
4.3	End of Borehole Refusal to augering probable bedrock  *Water level not established															



# RECORD OF BOREHOLE No 103

METRIC 16

W P 72-74-05 & 14 LOCATION Co-ords N 5 118 787.9; E 316 391.4 ORIGINATED BY ZM  
DIST 13 HWY 11 BOREHOLE TYPE Hollow Stem Augers COMPILED BY ZM  
DATUM Geodetic DATE 81 06 09 CHECKED BY CP

SOIL PROFILE			SAMPLES			GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT					PLASTIC LIMIT NATURAL MOISTURE CONTENT LIQUID LIMIT			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>		
211.6	Ground Surface																
0.0	Sand, some gravel trace silt																
210.2	Dense		1	SS	42												
1.4	Sound Granite Bedrock		2	BXL RC	REC 100%												
208.1			3	BXL	REC												
3.5	End of Borehole		4	RC	100%												

# RECORD OF BOREHOLE No 104

17

W P. 72-74-05 & 14 LOCATION Co-ords N 5 118 787.5; E 316 383.2 ORIGINATED BY ZH  
 DIST 13 HWY 11 BOREHOLE TYPE Solid Stem Augers COMPILED BY ZH  
 DATUM Geodetic DATE 81 06 09 CHECKED BY [Signature]

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					
211.5	Ground Surface																
0.0	Probable Sand																
208.6																	
2.9	End of Borehole																
	Refusal to augering probable bedrock																

# RECORD OF BOREHOLE No 105

METRIC 18

W P 72-74-05 & 14 LOCATION Co-ords N 5 118 758.3; E 316 390.0 ORIGINATED BY ZM  
DIST 13 HWY 11 BOREHOLE TYPE Hollow Stem Augers COMPILED BY ZM  
DATUM Geodetic DATE 81 06 09 CHECKED BY *CP*

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					
213.7	Ground Surface																GR SA SI CL
0.0	Sand some gravel trace silt		1	SS	14	*											0 91 9 0
			2	SS	49		212										
	Pocket of Organic Silt		3	SS	4	150 mm											
	Gravelly Sand some silt		4	SS	73	150 mm											
							210										
	Compact to Very Dense		5	SS	26		208										
			6	SS	24												
206.4																	
7.3	Sound Granite Bedrock Diabase Intrusion		7	BXL RC	REC 80%		206										
			8	BXL RC	REC 100%												
204.3																	
9.4	End of Borehole  *Water level not established  NOTE: Occasional cobbles Elev. 213.0 to Elev. 206.5																

OFFICE REPORT ON SOIL EXPLORATION

# RECORD OF BOREHOLE No 106

METRIC 19

W P 72-74-05 & 14 LOCATION Co-ords N 5 118 754.7; E 316 403.0 ORIGINATED BY ZM  
DIST 13 HWY 11 BOREHOLE TYPE Hollow Stem Augers COMPILED BY ZM  
DATUM Geodetic DATE 81 06 10 CHECKED BY CP

SOIL PROFILE		SAMPLES			GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT					PLASTIC LIMIT NATURAL MOISTURE CONTENT LIQUID LIMIT			UNIT WEIGHT γ	REMARKS & GRAIN SIZE DISTRIBUTION (%) GR SA SI CL
ELEV DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE			'N' VALUES	20	40	60	80	100	W <sub>p</sub>	W		
214.9 0.0	Ground Surface															
	Sand, some gravel trace silt  Compact to Very Dense		1	SS	13	↓	214									19 66 11 4
			2	SS	47											
			3	SS	20		212									
			4	SS	41											
			5	SS	44		210									
			6	SS	35											
			7	SS	42											
			8	SS	49											
208.0 6.9	End of Borehole															0 66 33 1
	Refusal to augering probable bedrock  NOTE: Occasional cobbles Elev. 211.5 to Elev. 209.0															

+3, x5: Numbers refer to  
Sensitivity

20  
15-5 (%) STRAIN AT FAILURE



**METRIC** 20

[illegible]

+3, x5: Numbers refer to Sensitivity

# RECORD OF BOREHOLE No 108

METRIC 21

W P 72-74-05 & 14 LOCATION Co-ords N 5 118 748.4; E 316 445.1 ORIGINATED BY ZM  
 DIST 13 HWY 11 BOREHOLE TYPE Hollow Stem Augers COMPILED BY ZM  
 DATUM Geodetic DATE 81 06 10 CHECKED BY dp

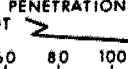

SOIL PROFILE			SAMPLES			GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT		PLASTIC LIMIT W <sub>p</sub>	NATURAL MOISTURE CONTENT W	LIQUID LIMIT W <sub>L</sub>	UNIT WEIGHT Y	REMARKS & GRAIN SIZE DISTRIBUTION (%) GR SA SI CL
ELEV DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE	'N' VALUES			20	40					
216.6	Ground Surface													
0.0	Sand some gravel trace silt Compact					*	216							
214.6	End of Borehole		1	SS	10									
2.0	Refusal to auger probable bedrock  *Water level not established  NOTE: Occasional cobbles Elev. 216.5 to 215.0													



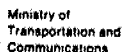
# RECORD OF BOREHOLE No 109

METRIC 22

W P 72-74-05 & 14 LOCATION Co-ords N 5 118 794.1; E 316 440.3 ORIGINATED BY ZM  
DIST 13 HWY 11 BOREHOLE TYPE Hollow Stem Augers COMPILED BY ZM  
DATUM Geodetic DATE 81 06 11 CHECKED BY CP

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									
○ UNCONFINED + FIELD VANE ● QUICK TRIAXIAL x LAB VANE								WATER CONTENT (%)									
212.0	Ground Surface																
0.0	Sand, some gravel trace silt					*											
	Compact to Very Dense		1	SS	26		210										
			2	SS	30												
			3	SS	72												
207.9	End of Borehole						208										
4.1	Refusal to augering probable bedrock																
	*Water level not established																
	NOTE: Occasional cobbles Elev. 211.5 to Elev. 209.5																





## METRIC 23

W P 72-74-05 & 14 LOCATION Co-ords N 5 118 799.4; E 316 405.7 ORIGINATED BY ZM  
DIST 13 HWY 11 BOREHOLE TYPE Hollow Stem Augers COMPILED BY ZM  
DATUM Geodetic DATE 81 06 11 CHECKED BY JP

[illegible]

+3, x5: Numbers refer to Sensitivity



15  $\phi$  5 (%) STRAIN AT FAILURE



# RECORD OF BOREHOLE No 111

METRIC 24

W P 72-74-05 & 14 LOCATION Co-ords N 5 118 803.3; E 316 379.6 ORIGINATED BY ZM  
DIST 13 HWY 11 BOREHOLE TYPE Hollow Stem Augers COMPILED BY ZM  
DATUM Geodetic DATE 81 06 11 CHECKED BY CP

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					
210.9	Ground Surface																
0.0	Sand some gravel some silt  Very Loose to Compact		1	SS	3	*	210									0 65 29 6	
			2	SS	16		208										
			3	SS	17												
			4	SS	6												
			5	SS	30	180 mm	206										
205.1																	
5.8	End of Borehole  Refusal to augering probable bedrock  *Water level not established  NOTE: Occasional cobbles Elev. 210.5 to Elev. 207.0																

FOUNDATION INVESTIGATION REPORT  
For  
North and Southbound Lanes  
Astorville Rd. Interchange Overpass  
4.8 km South of Hwy. #94  
W.P. 72-74-06/07, Site 44-213  
Hwy. 11N, District 13, North Bay

25

INTRODUCTION:

This report contains the results of a foundation investigation carried out at this location during the period of 79-08-07 to 22. The fieldwork was carried out with a continuous flight auger machine mounted on a muskeg vehicle. The borings were advanced by employing 82 mm I.D. hollow stem augers and conventional washboring and diamond drilling techniques.

SITE DESCRIPTION

The site is located some 350 m east of the existing junction of Astorville Rd. and Hwy. 11 along Astorville Rd. At this location, Astorville Rd. runs approximately parallel to Wistiwasing River and some 15 m north. The river is a 15 m wide slow flowing and meandering waterway. The flood plain on the southern side of the river is about 30 m in width. This flood plain is covered by forest, underlain with dense brush and at certain areas with marshy areas. Immediately south of the flood plain, the land rises steeply in an irregular fashion. Rock outcrops are frequent on the slopes. On the northern side of Wistiwasing River the ground gradually rises to the north. The existing Astorville Rd. is a two lane paved roadway.

SUBSURFACE CONDITIONS

General

The predominant soil types encountered at this site are silty clay to clay, sand and gravel (with bouldery zones) and Gneiss bedrock. Generally the very soft to firm silty clay to clay deposit was encountered at the surface except in the southwest corner of the investigated site where silty sand is the surficial deposit overlying the silty clay. On the south side of the Wistiwasing River a 0.6 to 3.6 m silt layer was encountered sandwiched between the silty clay to clay and the underlying sand and gravel deposit. In addition, silty sand and organic silt zones were observed in borehole 1A. Overlying the gneiss bedrock is a 2.4 to 11.4 m deposit of sand and gravel some silt and is found across the site except for the southeast corner (BH 8). Boulders and cobbles were frequently encountered in the lower portions of the sand and gravel deposit. Gneiss bedrock underlies the above described subsoils and varies in elevation from 206.0 to 218.9.

The boundaries between the various soil types, insitu and laboratory test results, and stabilized ground water levels, are shown on the attached Record of Borehole Sheets. The locations and elevations of the borings, along with estimated stratigraphical sections based on borehole data, are shown on Drawing #2.

The various soil types encountered are briefly described in the following paragraphs.

#### Silty Clay to Clay (Stratified)

This deposit was encountered across the site and varies in thickness from 1.7 to 5 m. The material in the stratum consists of layers or zones of silty clay (of low to medium plasticity) and clay in somewhat random fashion. Irregular lenses and seams (up to 10 mm) of inorganic silt were also observed throughout the deposit. A plot of liquid limit versus plasticity index is shown on Fig. 1 of the appendix.

Physical properties of the material as determined from field and laboratory tests are summarized as follows:

	Range	Average
Natural Moisture Content (%)	18-73	46
Liquid Limit (%)	25-66	47
Plastic Limit (%)	11-22	17
Bulk Density (kN/m <sup>3</sup> )	16.3-19.7	19.0
Undrained Shear Strength (kPa)		
Unconfined	9-3	19
Field Vane	11-38	24
Sensitivity	2-10	-

Grain-size distribution curves are presented in an envelope form on Fig.2. The consistency of the overall deposit may be described as very soft to firm based on undrained shear strengths ranging from 9 to 38 kPa.

#### Silt Trace of Sand, Silty Clay Seams

Beneath the stratified silty clay and clay deposit a 0.6 to 3.6 m silt layer was encountered at the south side of the river (BH's 1A, 7 and 8). The material in the stratum consists of mainly inorganic silt trace of sand and occasional seams of silty clay. The natural moisture content was found to be between 9 to

30%. Based on the obtained 'N' values (1 to 19 blows/0.3 m) the denseness may be described as very loose to compact.

#### Sand and Gravel, Some Silt and Trace of Clay and Bouldery Zones

Immediately below the above described strata (silty clay and silt) a granular type deposit consisting of sand and gravel some silt and trace of clay was encountered. This stratum ranges in thickness from 2.4 to 11.4 m. Extensive zones of cobbles and boulders were encountered within this stratum and the zones vary in thickness from 1.5 to 8.5 m. Diamond Drilling techniques were required to advance the borings through the bouldery zones. Grain size distribution curves are plotted in an envelope form on Fig.3 of the appendix. The natural moisture content is in the order of 10%. The obtained standard penetration tests 'N' values ranging from 1 to over 100 blows/0.3 m indicate a denseness ranging from very loose to very dense.

#### Bedrock

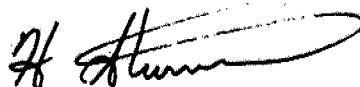
The bedrock at this location as described by Mr. B. K. Glassford, Geologist consists of pink-grey coloured, hard to medium and coarse textured Gneiss. For bedrock surface elevations references should be made to the Record of Borehole Sheets or Drawing No. 2.

#### Groundwater Conditions

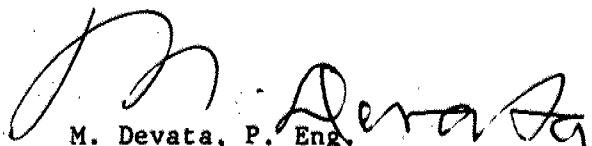
The following groundwater levels were observed during the field investigation:

<u>B.H. No.</u>	<u>Elevation</u>
1A	222.5
3A	221.8
4	222.6
5	223.2
6	223.3
7	222.4
8	222.5
10	222.2
12	223.2
13	222.0

The water level in Wistiwasing River was found to be at elevation 221.9 in March 1978 at the time of the original survey. Seasonal fluctuation of river water level is expected.

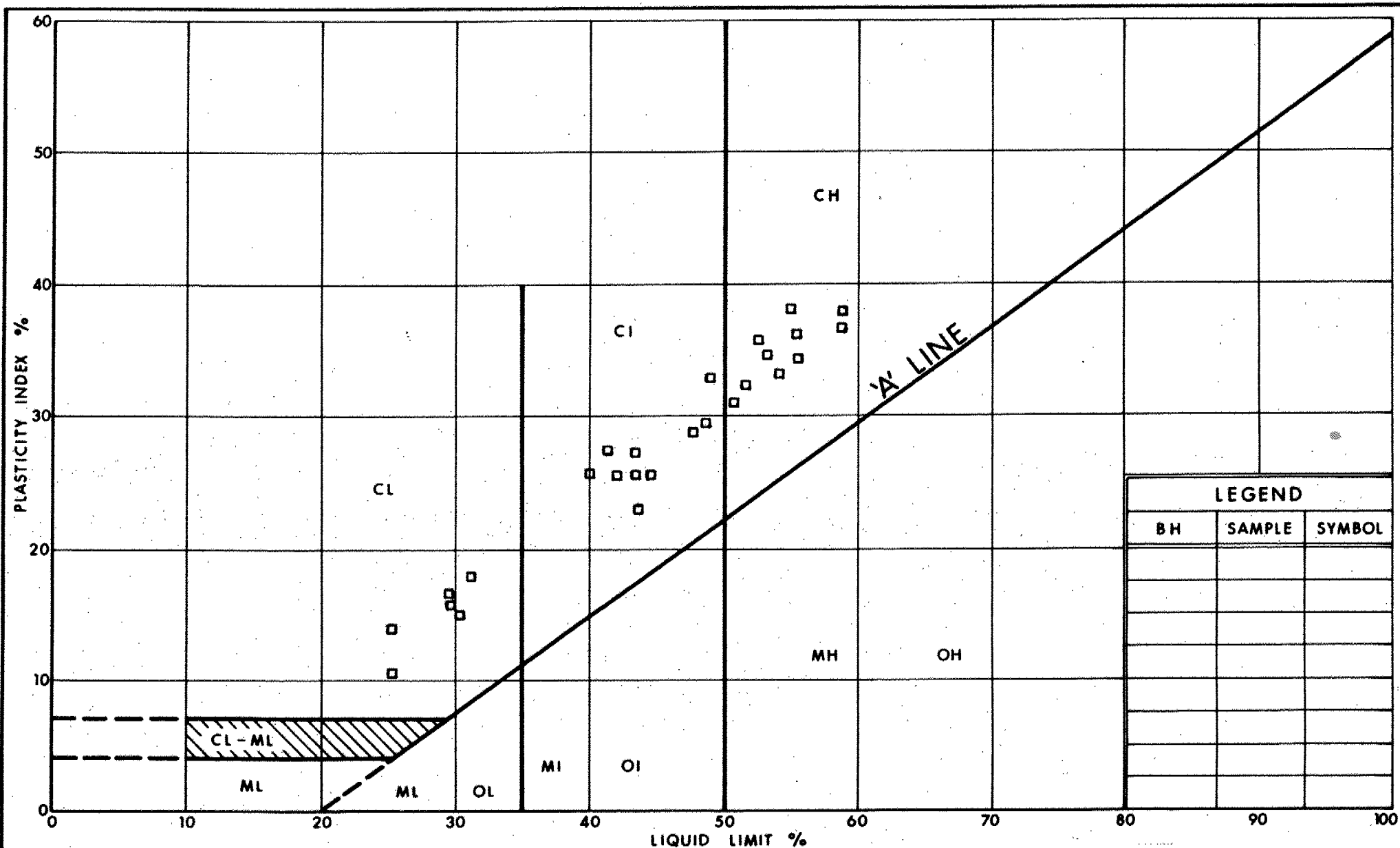


H. Sturm, P. Eng.  
Project Foundations Engineer



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

A P P E N D I X



**Ontario**

**Ministry of  
Transportation and  
Communications**

## PLASTICITY CHART

### SILTY CLAY TO CLAY (STRATIFIED)

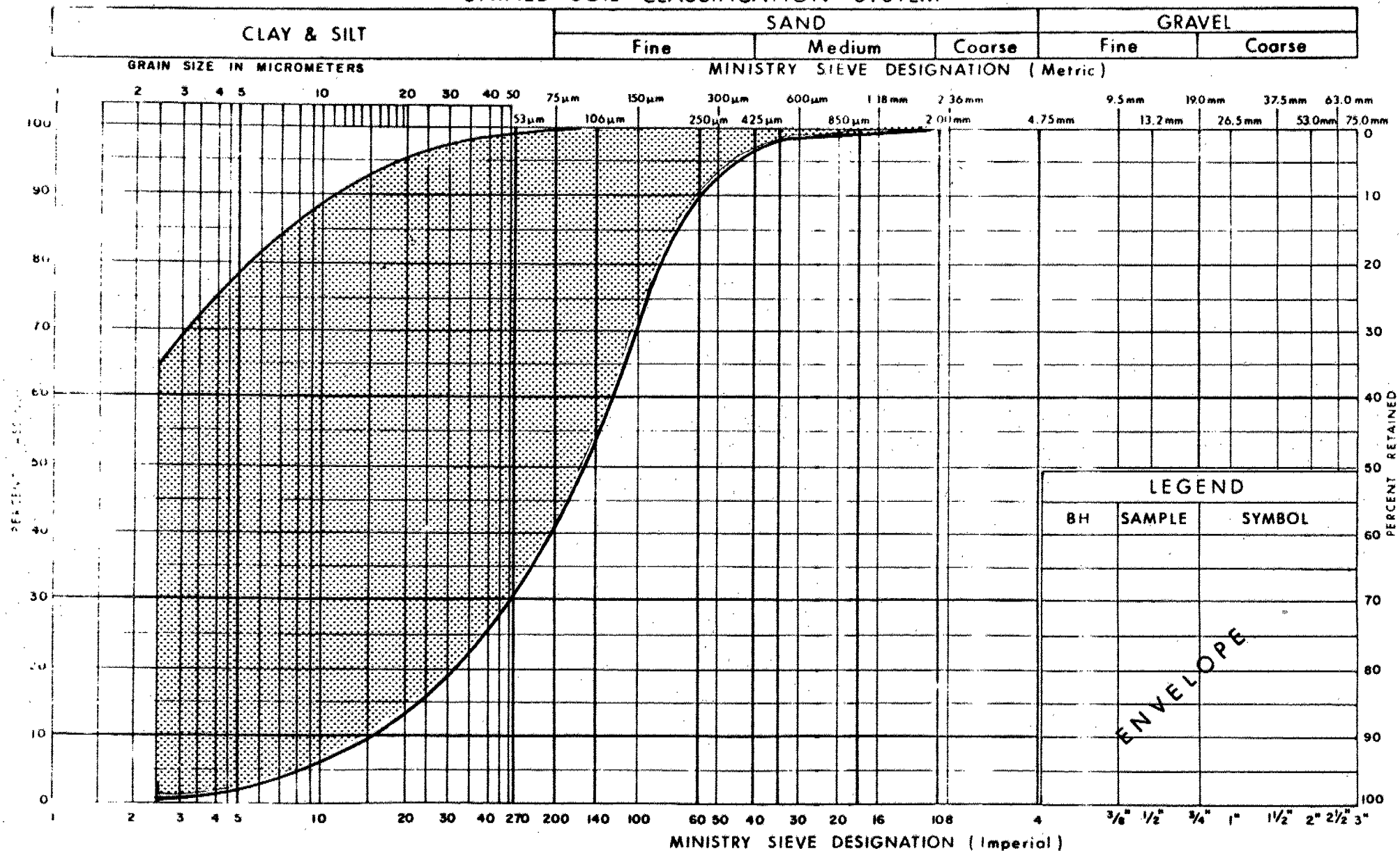
FIG No 1

W P 72-74-06107

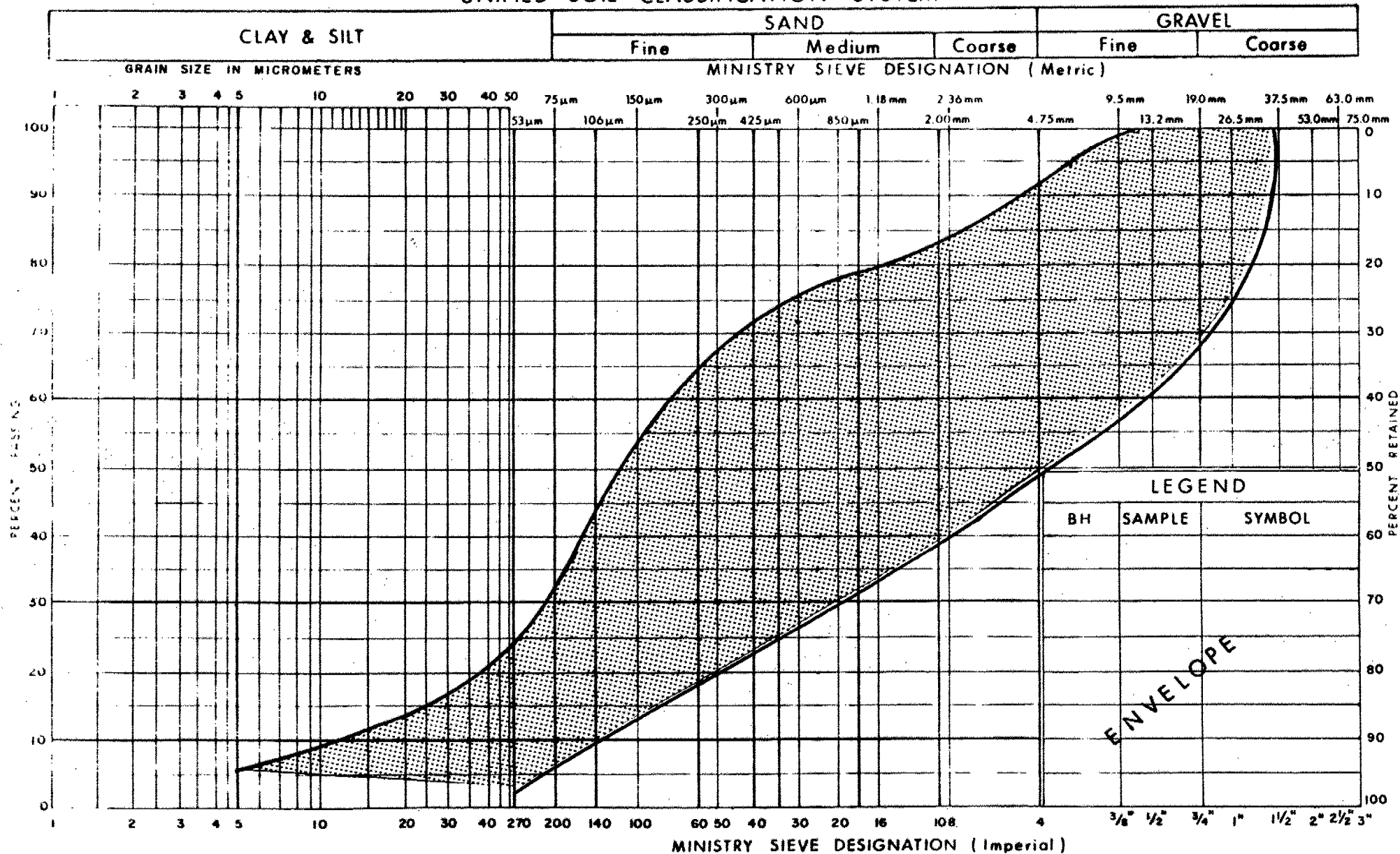
5



## UNIFIED SOIL CLASSIFICATION SYSTEM



## UNIFIED SOIL CLASSIFICATION SYSTEM



## METRIC 33

SOIL PROFILE			SAMPLES			GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT	PLASTIC LIMIT	NATURAL MOISTURE CONTENT	LIQUID LIMIT	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>		
223.4	Ground Level												GR 3A 51 CL

0.0

222

220

218

216

214

212

210.6

12.8 End of Cone Test

+3, x5: Numbers refer to Sensitivity

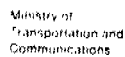


RECORD OF BOREHOLE No 1A

METRIC 34

W P 72-74-06 & 07 LOCATION Co-ords. N 5 117 168.0; E 315 893.1 ORIGINATED BY PRK  
DIST 13 HWY 11 Line 'G' BOREHOLE TYPE Hollow Stem Auger, BX Casing, Bi-Cone COMPILED BY PRK  
DATUM Geodetic DATE 1979 08 13 & 14 CHECKED BY

SOIL PROFILE			SAMPLES			GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT					UNIT WEIGHT Y	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		
223.4	Ground Level													
0.0	Silty Sand		1	SS	9									0 73 25 2
221.4	Trace of Clay		2	SS	8									
2.0	Loose		3	SS	1									
220.5	Organic Silt		4	SS	1/									
220.5	Very Soft		5	TW	PM									
2.9	Silty Clay to Clay		6	SS	PM									
218.8	(Stratified)		7	TW	PM									
218.8	Very Soft to Soft		8	SS	1/									
4.6	Silt		9	SS	5									
	Occasional Seams of		10	SS	9									
	Silty Clay, Trace of		11	SS	7									
	Sand													
	Very Loose to Loose													
215.2	Sand & Gravel		12	SS	16									0 5 93 2
8.2	Some Silt		13	SS	21									
	Trace of Clay		14	RC										
	Compact		15	BXL										
	Boulders		16	BXL										
			17	RC										
			18	BXL										
			20	RC										
			21	BXL										
206.0														
17.4	Gneiss - Bedrock													
204.6	Sound													
18.8	End of Borehole													

[illegible]

20  
15  $\phi$  5 (%) STRAIN AT FAILURE  
10



RECORD OF BOREHOLE No 3

METRIC 36

W P 72-74-06 & 07 LOCATION Co-ords. N 5 117 203.8; E 315 901.2 ORIGINATED BY PRK  
DIST 13 HWY 11 Line 'G' BOREHOLE TYPE Cone Test COMPILED BY HS  
DATUM Geodetic DATE 1979 08 17 CHECKED BY \_\_\_\_\_

SOIL PROFILE			SAMPLES			GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT 20 40 60 80 100 SHEAR STRENGTH ○ 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								
222.7 0.0	Ground Level												
212.4 10.3	End of Cone Test							100/0.25 m					



RECORD OF BOREHOLE No 3A

METRIC 37

W P 72-74-06 & 07 LOCATION Co-ords. N 5 117 201.7; E 315 903.5 ORIGINATED BY HS  
DIST 13 HWY 11 Line 'G' BOREHOLE TYPE Hollow Stem Auger, BX Casing COMPILED BY HS  
DATUM Geodetic DATE 1979 08 17 CHECKED BY \_\_\_\_\_

SOIL PROFILE			SAMPLES			GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT					UNIT WEIGHT $\gamma$ kN/m <sup>3</sup>	REMARKS & GRAIN SIZE DISTRIBUTION (%)
ELEV DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE	'N' VALUES			20	40	60	80	100		
222.7	Ground Level													
0.0	Silty Clay to Clay (Stratified) Occasional Seams of Silt Soft to Firm		1	SS	5		222							
			2	SS	5									
			3	SS	-		220							
219.0			4	TW	PM									
3.7			5	SS	6									
	Sand & Gravel Some Silt Trace of Clay Loose to Compact		6	SS	23		218							
			7	SS	28									
			8	SS	11		216							
			9	SS	29									
			10	SS	20									
			11	SS	138		214							
	Boulders		12	RC										
212.1			12A	BXL										
10.6	Gneiss - Bedrock		12B	RC	100%		212							
211.5				BXL	REC									
11.2	End of Borehole													

+3, x5: Numbers refer to  
Sensitivity

20  
15  
10  
5 (%) STRAIN AT FAILURE

RECORD OF BOREHOLE No 4

METRIC 38

W P 72-74-06 & 07 LOCATION Co-ords. N 5 117 195.8; E 315 913.2 ORIGINATED BY PRK  
DIST 13 HWY 11 Line 'G' BOREHOLE TYPE Hollow Stem Auger & Cone Test COMPILED BY HS  
DATUM Geodetic DATE 1979 08 17 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					
223.4	Ground Level													
0.0	Silty Clay to Clay (Stratified) With Occasional Seams of Silt Very Soft to Firm		1	SS	5								19.7	0 0 36 64 0 6 54 40
			2	TW	PH									
			3	SS	-									
			4	SS	-									
218.8			5	TW	PM									
4.6	End of Borehole													
212.1														
11.3	End of Cone Test													





## RECORD OF BOREHOLE No 5

METRIC

39

W P 72-74-06 & 07 LOCATION Co-ords. N 5 117 235.0; E 315 9 14.2 ORIGINATED BY PRK  
DIST 13 HWY 11 Line 'G' BOREHOLE TYPE Hollow Stem Auger, BX Casing & Cone Test COMPILED BY PRK  
DATUM Geodetic DATE 1979 08 08 to 09 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>	WATER CONTENT (%) W	UNIT WEIGHT γ kN/m <sup>3</sup>	REMARKS & GRAIN SIZE DISTRIBUTION (%) GR SA SI CL
ELEV DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE	'N' VALUES			20	40	60	80	100						
224.3	Ground Level						224											
0.0	Silty Clay to Clay (Stratified) With Seams of Silt Very Soft to Firm		1	SS	9		224											
			2	SS	5		222											
221.3			3	TW	PM		222											
3.0	Sand with Gravel Some Silt Compact to Very Dense		4	SS	3/	0.15 m	220											
			5	SS	11		220											
			6	SS	70	0.10 m	220											
			7	SS	27/	0.10 m	220											
			8	SS	108/	0.22 m	218											
			9	SS	100/	0.10 m	218											
			10	SS	100/	0.15 m	216											
			11	SS	100/	0.80 m	216											
			12	RC			214											
			13	BXL			214											
			14	BXL			214											
			15	SS	112/	0.15 m	212											
			16	RC			212											
			17	BXL			212											
			18	SS	120/	0.08 m	212											
			19	RC	100%		210											
210.0							210											
14.3	Gneiss - Bedrock (Shattered)																	
208.9																		
15.4	End of Borehole																	

+3, x5: Numbers refer to  
Sensitivity20  
15 5 (%) STRAIN AT FAILURE  
10



RECORD OF BOREHOLE No 6

METRIC 40

W P 72-74-06 & 07 LOCATION Co-ords. N 5 117 223.7; E 315 925.7 ORIGINATED BY PRK  
DIST 13 HWY 11 Line 'G' BOREHOLE TYPE Hollow Stem Auger, BX Casing & Cone Test COMPILED BY PRK  
DATUM Geodetic DATE 1979 08 07 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							WATER CONTENT (%)				
								20 40 60 80 100							20 40 60				
								○ UNCONFINED ● QUICK TRIAXIAL	+ FIELD VANE x LAB VANE										
224.4	Ground Level																		
0.0	Silty Clay to Clay (Stratified)  Very Soft to Firm		1	SS	10		224												
			2	SS	9		222												
			3	SS	1														
			4	SS	0														
220.7	Sand & Gravel Some Silt Trace of Clay and Occasional Boulders  Loose to Very Dense		5	TW	PM		220												
3.7			6	SS	8														
			7	SS	76														
			8	SS	150/	0.28 m	218								47 53 16 2				
			9	RC BX											25 66 9				
			10	SS	170/	0.28 m									26 62 12				
216.3																			
8.1	End of Borehole																		



RECORD OF BOREHOLE No 7

METRIC 41

W P 72-74-06 & 07 LOCATION Co-ords. N 5 117 137.2; E 315 917.1 ORIGINATED BY PRK  
DIST 13 HWY 11 Line 'G' BOREHOLE TYPE Hollow Stem Auger, BX Casing & Cone Test COMPILED BY HS  
DATUM Geodetic DATE 1979 08 15 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				
223.3	Ground Level															
0.0	Silty Clay to Clay Very Soft to Firm (Stratified)		1	SS	15		222									0 68 32
			2	SS	9											
			3	SS	0											
			4	TW	PM		220									
219.5			5	TW	PM											0 8 87 5
3.8	Silt Occasional Clayey Silt Seams, Trace of Sand Loose to Compact		6	SS	6		218									
217.5			7	SS	19											
5.8	Sand & Gravel Some Silt and Boulders  Compact to Very Dense		8	SS	51/	0.18 m Bounding	216									31 53 16
			9	RC BX												44 46 10
			10	SS	28											
213.9							214									
9.4	Gneiss - Bedrock		11	RC BXL	100% REC											
212.4																
10.9	End of Borehole															

+3, x5: Numbers refer to  
Sensitivity

20  
15  
10  
5 (%) STRAIN AT FAILURE



RECORD OF BOREHOLE No 8

METRIC 42

W P 72-74-06 & 07 LOCATION Co-ords. N 5 117 126.5; E 315 927.7 ORIGINATED BY PRK  
DIST 13 HWY 11 Line 'G' BOREHOLE TYPE Hollow Stem Auger & Cone Test COMPILED BY HS  
DATUM Geodetic DATE 1979 08 13 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 kN/m <sup>3</sup>	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					
223.3	Ground Level													
0.0	Clayey Silt to Clay (Stratified) Very Soft to Soft		1	SS	10		222						16.3	0 3 40 57
			2	SS	1									
			3	TW	PM									
219.5			4	SS	3		220							
3.8	Silt, Very Loose		5	SS	0									
218.9														
4.4	Gneiss - Bedrock Sound		6	RC BXL	100% REC		218	100/0.18 m Refusal						
217.7														
5.6	End of Borehole													

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

20  
15  
10  
5  
0  
5 (%) STRAIN AT FAILURE



RECORD OF BOREHOLE No 9

METRIC 43

W P 72-74-06 & 07 LOCATION Co-ords. N 5 117 172.2; E 315 932.7 ORIGINATED BY PRK  
DIST 13 HWY 11 Line 'G' BOREHOLE TYPE Cone Test COMPILED BY HS  
DATUM Geodetic DATE 1979 08 17 CHECKED BY \_\_\_\_\_

SOIL PROFILE			SAMPLES			GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT 20 40 60 80 100 SHEAR STRENGTH ○ 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 (%)	UNIT WEIGHT γ	REMARKS & GRAIN SIZE DISTRIBUTION (%) GR SA SI CL	
ELEV DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE	'N' VALUES							
222.8 0.0	Ground Level											
213.3 9.5	End of Cone Test											



RECORD OF BOREHOLE No 10

METRIC 44

W P 72-74-06 & 07 LOCATION Co-ords. N 5 117 161.1; E 315 944.0 ORIGINATED BY PRK  
DIST 13 HWY 11 Line 'G' BOREHOLE TYPE Hollow Stem Auger, BX Casing & Cone Test COMPILED BY HS  
DATUM Geodetic DATE 1979 08 16 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 kN/m <sup>3</sup>	REMARKS & GRAIN SIZE DISTRIBUTION (%) GR SA SI CL
ELEV DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE	'N' VALUES			20	40	60	80	100					
222.9	Ground Level																
0.0	Silty Clay to Clay (Stratified) Trace of Sand Very Soft to Soft		1	SS	5		222									16.5	
			2	SS	0												0 9 91
			3	TW	PM												
219.1			4	SS	0		220										
3.8	Sand & Gravel Some Silt Trace of Clay		5	TW	PM												
			6	SS	20												13 27 59 1
			7	SS	11												37 48 15
	Compact		8	SS	12												37 47 16
			8A	SS	13												
	Occasional Boulders		9	SS	24												
			10	SS	30												34 53 13
			11	SS	33/	0.15 m											5 90 5
							212										
							210										
	Bouldery Zone		12	RC													
			13	RC													
207.7			14	BX			208										
15.2	Gneiss - Bedrock		15	RC	95%												
206.7				BX	REC												
16.2	End of Borehole																

+3, x5: Numbers refer to  
Sensitivity

20  
15 5 (%) STRAIN AT FAILURE  
10

## RECORD OF BOREHOLE No 11

METRIC 45

W P 72-74-06 & 07 LOCATION Co-ords. N 5 117 207.2; E 315 948.3 ORIGINATED BY PRK

DIST 13 HWY 11 Line 'G' BOREHOLE TYPE Cone Test COMPILED BY HS

DATUM Geodetic DATE 1979 08 09 CHECKED BY \_\_\_\_\_

SOIL PROFILE			SAMPLES			GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT	PLASTIC LIMIT $W_p$	NATURAL MOISTURE CONTENT $W$	LQUID LIMIT $W_L$	UNIT WEIGHT $\gamma$	REMARKS & GRAIN SIZE DISTRIBUTION (%) GR SA SI CL
ELEV DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE	'N' VALUES			SHEAR STRENGTH ○ UNCONFINED + FIELD VANE ● QUICK TRIAXIAL x LAB VANE		WATER CONTENT (%)			
224.6 0.0	Ground Level						224						
217.8 6.8	End of Cone Test						218	100/0.10 m					

+3, x5: Numbers refer to Sensitivity

20

15  $\phi$  5 (%) STRAIN AT FAILURE

10

OFFICE REPORT ON SOIL EXPLORATION

RECORD OF BOREHOLE No 12

METRIC 46

W P 72-74-06 & 07 LOCATION Co-ords. N 5 117 195.1; E 315 960.7 ORIGINATED BY PRK  
DIST 13 HWY 11 Line 'G' BOREHOLE TYPE Hollow Stem Auger, BX Casing & Cone Test COMPILED BY HS  
DATUM Geodetic DATE 1979 08 09 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 (%)
ELEV DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE	'N' VALUES			20 40 60 80 100		W <sub>p</sub> W W <sub>L</sub>			
224.4	Ground Level												
0.0	Silty Clay to Clay (Stratified) Trace of Sand Soft to Firm		1	SS	11		224						
			2	SS	7		222	9.6				17.0	0 1 37 62
			3	TW	PM								
			4	SS	2								
220.4							220						
4.0	Sand & Gravel Traces of Silt and Clay Boulders Very Dense		5	SS	84								
			6	RC									
			7	BXL				100/0.12 m					
218.0						0.15 m							59 37 4
6.4	End of Borehole												



RECORD OF BOREHOLE No 13

METRIC 47

W P 72-74-06 & 07 LOCATION Co-ords. N 5 117 183.6; E 315 926.0 ORIGINATED BY HS  
DIST 13 HWY 11 BOREHOLE TYPE Hollow Stem Auger, BX Casing & Cone Test COMPILED BY HS  
DATUM Geodetic DATE 1979 08 21 to 22 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				
222.8	Ground Level															
0.0	Silty Clay to Clay (Stratified) Some Sand Very Soft to Firm		1	SS	10		222									
			2	SS	6											
			3	TW	PH		220									
			4	TW	PH											
			5	SS	0											
217.9			6	TW	PM		218									
4.9	Sandy Silt to Silty Sand Trace of Gravel and Clay Loose		7	SS	8											
			8	SS	4											
215.4			9	SS	9		216									
7.4	Sand with Gravel Some Silt Trace of Clay Very Loose to Dense		10	SS	31											
			11	SS	18		214									
			12	SS	2		212									
			12A	SS	1		210									
			13	BXL												
			13A	BXL												
			14	SS	181		208									
			15	BXL												
206.5																
206.0	Gneiss-Assumed Bedrock		16	RC												
16.8	End of Borehole															

SAMPLE DISPOSITION NOTICE		
TYPE	DISCARD AFTER	RECOMM. BY
JARS	79 12 31	MD
TUBES		
ROCK CORES	Are around 17 cont	MD

ENGINEERING MATERIALS OFFICE  
PAVEMENT & FOUNDATION DESIGN SECTION

WP 72-74-05 DIST 13  
HWY 11 STR SITE 43-205  
Mountain Road Overpass

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FOUNDATION INVESTIGATION REPORT  
For  
Mountain Road Overpass  
Highway 11, District 13, North Bay  
W.P. 72-74-05 Site 43-205

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INTRODUCTION

This report contains the results of a foundation investigation for the above structure. The fieldwork was carried out on October 17 to October 24, 1979 and consisted of 11 sampled boreholes and two test pits. All borings were advanced by means of hollow stem augers or diamond drilling techniques to depths of up to 6.9 metres below ground surface. Bedrock was proven in 5 of the borings by obtaining up to 1.6 metres of BXL or AX size rock core.

SITE DESCRIPTION AND GEOLOGY

The site is located on Mountain Road approximately 0.8 kilometres east of existing Hwy. 11 in the Township of North Himsworth, geographical District of Parry Sound.

The surrounding terrain is tree covered with a few rural developments. Topographically the area is hilly comprised of extensive bedrock outcrops with steep rock slopes. At the proposed site, Mountain Road is located in a partial earth cut through sandy overburden while bedrock outcrops were noted south of Mountain Road along the proposed Hwy. 11 centerline. Burford Creek crosses Mountain Road immediately east of the site and thereafter flows westerly parallel to Mountain Road. The creek is 4 to 6 metres wide with an average depth of water of 0.1 metres and has a cobble and boulder strewn bed. Physiographically the area is located in the Canadian Shield.

## SUBSURFACE CONDITIONS

### General

Subsurface conditions consist of up to 5.9 metres of silty sand to gravelly sand with some silt overlying granite bedrock. In the area of the Mountain Road embankment, up to 1.6 metres of fill material overlies the parent overburden.

Bedrock is exposed to the south of Mountain Road along the Hwy. 11 centerline. The upper 2 metres of the surficial deposits west of the Hwy. 11 centerline contain pockets and inclusions of organic silt up to 0.3 metres thick.

The boundaries between the various subsoil and bedrock types are shown on the Record of Borehole sheets. The locations and elevations of the boreholes and test pits together with two longitudinal sections based on the borehole and test pit information are shown on Drawing 727405-A. In the paragraphs to follow the subsoil and bedrock types are described briefly.

### Fill Material

Fill material was encountered in all borings put down on Mountain Road and extends for a depth of up to 1.6 metres. The fill material is composed of sand with some silt and a trace to some gravel with occasional cobbles. A grain size distribution envelope for the fill material is shown on Figure 1. Standard Penetration test 'N' values range from 13 to 24 blows per 0.3 metres indicating the fill material has been subject to a moderate degree of compactive effort.

### Sandy Silt to Gravelly Sand

This granular deposit is the dominant deposit across the site extending from the parent ground surface down to a depth of up to 5.9 metres to the bedrock surface. The results of grain size distribution testing on samples from this deposit is shown in envelope form on Figure 2. The grain size distribution established from representative samples from this deposit vary with depth as well as across the site in haphazard fashion.

Accordingly the composition of the deposit is described as ranging from a silty sand with a trace of gravel to a gravelly sand, with some silt. The coefficient of uniformity for the grain size distribution curves range between 12 and 18 indicating a generally well graded deposit. This granular deposit was found to contain occasional cobbles across the site and on the west portion of the site the upper 2 metres of the deposit contains inclusions and pockets of organic silt. Standard penetration test 'N' values generally range from 2 to 10 blows per 0.3 metre in zones containing pockets of organic silt and elsewhere vary generally from 10 to 48 blows per 0.3 metre. Based on these results the relative density of the deposit is described as compact to dense except in those surficial zones with organic silt which is estimated to have a very loose to compact relative density.

### Bedrock

Granite bedrock is present across the site either exposed or beneath up to 5.9 metres of overburden. The bedrock was proven in five of the sampled boreholes by obtaining up to 1.3 metres of BX or AX size rock core. Elsewhere the bedrock surface was established by digging test pits or is estimated to be at the point of refusal to augering. The bedrock surface varies from elevation 215.3 to 205.6.

The bedrock was generally sound although considerable difficulty was encountered in rock coring because the presence of near vertical jointing resulted in excessing blocking of the core barrel. The recovery ratio and rock quality designation ratio was found to be 80 to 100 percent which indicates very good to excellent quality bedrock.

#### Groundwater Elevation

Groundwater level observations were carried out by measuring in the open boreholes. In order to maintain traffic on Mountain Road it was not always possible to allow sufficient time for the groundwater to stabilize in the borehole. Hence, for some of the borings on Mountain Road the groundwater level was not established. Elsewhere the groundwater level varied from 0.15 to 0.6 metres below ground surface which corresponds to elevation 210.9 to 213.3. These observations indicate that the groundwater level reflects topography.

## DISCUSSION AND RECOMMENDATIONS

### General

It is proposed to upgrade Hwy. 11 to a four lane facility south of North Bay. A structure is required to carry the new Hwy. 11 over Mountain Road and current proposals call for either a 10.5 m x 4.65 m opening concrete rigid frame open footing type tunnel or alternatively a multi-plate super span arch (11.5 m x 5.5 m) on concrete strip footings with a total structure length of 94 metres. The required fill height in this area is in the order of 15 metres high.

Our recommendations for the design and construction of the structure and related approaches are given in the paragraphs to follow.

### Structure

The proposed profile grade and the frost protection requirements are such that the footing founding elevation would be between 215.0 and 212.0 metres. At this founding level, a portion of the south footing some 20 metres long would be located in sound bedrock. The remainder of the south footing as well as the entire north footing would be about at the original ground surface.

A structure founded in such a manner would be required to accommodate substantial differential settlements within the footing as well as between footings. If the structure cannot be articulated in such a manner to accommodate the anticipated movements, then it will be necessary to either carry the foundation down to bedrock or support the footing on piles driven to bedrock.

The crossing could be more economically accomplished from a foundation point of view by one or two multi-plate super span arch culvert(s) or a closed type concrete rigid frame

	5-L.S. II	Foot 6-L.S	
12 BP 53	100T (900 kN)	130T (1150 kN)	Pile to be driven to Bedrock
12 BP 74	130T (1150 kN)	180T (1600 kN)	given A.R. on 81 03 24

M.A.

box culvert(s).

To ensure a uniform subgrade reaction for a concrete box culvert it will be necessary to provide a minimum 0.5 metre granular pad beneath the box culvert. This granular pad should extend a minimum distance of 1 metre beyond the plan limits of the box culvert. If the box culvert is constructed in such a manner a coefficient of subgrade reaction of  $0.8 \text{ kg/cm}^3$  can be used for design purposes. For design of the box culvert walls a coefficient of earth pressure at rest  $K_0$  of 0.5 should be used to estimate the earth pressures acting on the wall.

For a multi-plate super span arch culvert the bedding should be carefully shaped to accommodate the base arch shape. Particular care should be taken to achieve maximum dry density under the haunches. The arch culvert should be provided with a minimum of 1 metre of granular pad for bedding purposes extending a distance of 1 metre past the span-length limits.

An arch culvert constructed in such a manner could be designed for a corner bearing pressure of 300 kPa. The fill material should be brought up in equal lifts simultaneous on both sides of the arch culvert. Earth fill should be placed on the top of the arch when the fill material has come up to  $1/5$  the height of the arch.

The presence of pockets of organic silt within the upper 2 metres of the silty sand to gravelly sand deposit on the western area of the site would be detrimental to the performance of a structure or fills of the magnitude contemplated. Therefore, it is recommended that these pockets of organic silt be entirely removed beneath the plan limits of the embankment and structure to a distance of 20 metres beyond the structure limits within the embankment area.



The excavation should be brought up by means of free draining granular material to allow underwater compaction. In some areas it may be necessary to bring the original ground surface up to the bedding level, this should be done using a granular type fill compacted in accordance with current M.T.C. practices.

### Approach Fills

The fill height in this area is up to 15 metres high. Because of the presence of shallow silty sand to gravelly sand over bedrock no problems are anticipated with respect to deep seated rotational failure. However, earth fills with 2:1 side slopes will be subject to instability within the fill material itself unless berms are provided. For fills in excess of 10 metres high earth fills should be provided with a mid height 3 metre wide berm. If rock fills are contemplated embankment heights in excess of 10 metres high should be provided with 1.25:1 slopes and a 3 metre wide berm.

As mentioned previously the presence of organic pockets within the upper silty sand to gravelly sand deposit will be detrimental to the performance of the magnitude fills contemplated. For this reason all the organic material within the plan limits of the embankment should be removed for fill heights in excess of 5 metres high.

*M MacLean*

M. MacLean, P. Eng.  
Project Foundations Engineer



*M. Devata*

M. Devata, P. Eng.  
Senior Foundations Engineer

November, 1979.

## APPENDIX



Ministry of  
Transportation and  
Communications

HIGHWAY ENGINEERING DIVISION-ENGINEERING MATERIALS OFFICE-SOIL MECHANICS SECTION

RECORD OF BOREHOLE No 1

METRIC

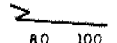

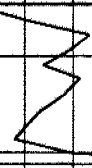
W P 72-74-05 14 LOCATION Co-ords. N 5 118 768.5; E 316 458.6 ORIGINATED BY MM  
DIST 13 HWY 11 BOREHOLE TYPE Hollow Stem Augers, Cone Test, AX Rock Core COMPILED BY MM  
DATUM Geodetic DATE 1979-10-18 CHECKED BY CP

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 Y	REMARKS & GRAIN SIZE DISTRIBUTION (%)
ELEV DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE	'N' VALUES			20 40 60 80 100					
213.8	Ground Surface												GR SA SI CL
0.0	Fill Sand, some gravel, some silt, occasional cobbles		1	SS	13	*			7 77 (16)				
212.3			2	SS	73					212			
1.5	Occasional cobbles		3	SS	30					210			
	Sand, some gravel, some silt		4	SS	46								
	Compact to dense		5	SS	26								
			6	SS	44								
208.3	cobbles		7	RC	REC					75%	208		
5.5	Sound granite bedrock		8	RC	REC					50%			
207.0			9	RC	REC					100%			
6.8	End of Borehole												
	*Note:  Ground water level not established.												

RECORD OF BOREHOLE No 2

METRIC

W P 72-74-05 14 LOCATION Co-ords. N 5 118 770.6; E 316 443.8 ORIGINATED BY MM  
DIST 13 HWY 11 BOREHOLE TYPE Hollow Stem Augers, Cone Test COMPILED BY MM  
DATUM Geodetic DATE 1979-10-18 CHECKED BY CP

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									SHEAR STRENGTH ○ UNCONFINED    + FIELD VANE ● QUICK TRIAXIAL    x LAB VANE
213.1	Ground Surface												GR SA SI CL	
0.0	Fill sand, some gravel, some silt													
211.8	occasional cobbles		1	SS	24									
1.3	occasional cobbles		2	SS	19									
	Silty sand trace		3	SS	10									
209.9	gravel compact		4	SS	41	75 mm	210						6 44 46 4	
3.2	End of Borehole							100/175 mm						
	Refusal to augering probable bedrock													

+3, x5: Numbers refer to  
Sensitivity

20  
15 5 (%) STRAIN AT FAILURE  
10

OFFICE REPORT ON SOIL EXPLORATION

SOIL EXPLORATION



## HIGHWAY ENGINEERING DIVISION-ENGINEERING MATERIALS OFFICE-SOIL MECHANICS SECTION

RECORD OF BOREHOLE No 3										METRIC				
W F 72-74-05 <u>E 14</u>		LOCATION Co-ords. N 5 118 771.5; E 316 428.8				ORIGINATED BY MM								
DIST 13 HWY 11		BOREHOLE TYPE Hollow Stem Augers, Cone Test				COMPILED BY MM								
DATUM Geodetic		DATE 1979-10-23				CHECKED BY <u>CP</u>								
SOIL PROFILE		SAMPLES			GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT		PLASTIC NATURAL LIQUID LIMIT			UNIT WEIGHT	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>	WATER CONTENT (%)				10 20 30
212.7	Ground Surface													
0.0	Fill sand, some gravel													
211.4	some silt, occasional cobbles		1	SS	20									
1.3	Gravelly sand		2	SS	43									
210.8	compact													
1.9	End of Borehole													
	Refusal to augering probable bedrock													

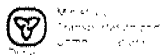
RECORD OF BOREHOLE No 4										METRIC				
W F 72-74-05 <u>E 14</u>		LOCATION Co-ords. N 5 118 775.2; E 316 414.0				ORIGINATED BY MM								
DIST 13 HWY 11		BOREHOLE TYPE Hollow Stem Augers, Cone Test, BXL Rock Core				COMPILED BY MM								
DATUM Geodetic		DATE 1979-10-23				CHECKED BY <u>CP</u>								
SOIL PROFILE		SAMPLES			GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT		PLASTIC NATURAL LIQUID LIMIT			UNIT WEIGHT	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>	WATER CONTENT (%)				10 20 30
212.3	Ground Surface													
0.0	Fill sand, some gravel													
210.7	some silt occasional cobbles		1	SS	19									
1.6	Gravelly Sand, some silt to		2	SS	53									
	Silty sand, trace gravel		3	SS	23									
	Compact to dense		4	SS	12									
			5	SS	59									
207.0														
5.3	Sound granite bedrock		6	BXL RC	82%									
205.4														
6.9	End of Borehole													

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

20  
15-5 (%) STRAIN AT FAILURE  
10

EXP-1410-1

OFFICE REPORT ON SOIL EXPLORATION



## HIGHWAY ENGINEERING DIVISION-ENGINEERING MATERIALS OFFICE-SOIL MECHANICS SECTION

RECORD OF BOREHOLE No 5										METRIC		
W P 72-74-05 S 14		LOCATION Co-ords. N 5 118 776.2; E 316 398.8				ORIGINATED BY MM						
DIST 13 HWY 11		BOREHOLE TYPE Hollow Stem Augers, Cone Test				COMPILED BY MM						
DATUM Geodetic		DATE 1979-10-23				CHECKED BY <i>JP</i>						
SOIL PROFILE			SAMPLES			GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT 20 40 60 80 100 SHEAR STRENGTH ○ 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							
212.0	Ground Surface											
0.0	Fill sand, some gravel											
211.0	some silt											
1.0	with organic silt		1	SS	10							
			2	SS	38							
	Silty sand, trace gravel to		3	SS	42							
			4	SS	25							
	Gravelly sand, some silt											
207.2	Compact to dense		5	SS	100/75 mm							
4.8	End of Borehole											
	Refusal to augering											
	Probable bedrock											
	*Note: Water level not established											
	Note: Occasional cobbles EL. 212.0 to EL. 210.5											

OFFICE REPORT ON SOIL EXPLORATION

RECORD OF BOREHOLE No 6										METRIC		
W P 72-74-05 S 14		LOCATION Co-ords. N 5 118 780.5; E 316 384.3				ORIGINATED BY MM						
DIST 13 HWY 11		BOREHOLE TYPE Hollow Stem Augers, Cone Test BXL Rock Core				COMPILED BY MM						
DATUM Geodetic		DATE 1979-10-23				CHECKED BY <i>JP</i>						
SOIL PROFILE			SAMPLES			GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT 20 40 60 80 100 SHEAR STRENGTH ○ 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							
211.8	Ground Surface											
0.0	Fill sand, trace gravel, some silt											
210.8												
1.0	with gravel and pockets of organic silt		1	SS	23							
			2	SS	32							
			3	SS	5							
	Sand, trace gravel, some silt		4	SS	17							
207.5	Compact to dense		5	SS	48							
4.3	Sound granite bedrock		6	BXL RC	REC 100%							
206.3												
5.5	End of Borehole											
	Note: Occasional cobbles, Elev. 211.8 to Elev. 209.0											

SOIL EXPLORATION

+3, x5: Numbers refer to Sensitivity  
20  
15  
10  
5 (% ) STRAIN AT FAILURE



## HIGHWAY ENGINEERING DIVISION-ENGINEERING MATERIALS OFFICE-SOIL MECHANICS SECTION

## RECORD OF BOREHOLE No 7

METRIC

W F 72-74-05 E 14 LOCATION Co-ords. N 5 118 782.2; E 316 369.5 ORIGINATED BY MM  
 DIST 13 HWY 11 BOREHOLE TYPE Hollow Stem Augers, Cone Test COMPILED BY MM  
 DATUM Geodetic DATE 1979-10-22 CHECKED BY CP

SOIL PROFILE		SAMPLES			GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT		PLASTIC LIMIT	NATURAL MOISTURE CONTENT	LIQUID LIMIT	UNIT WEIGHT	REMARKS & GRAIN SIZE DISTRIBUTION (%)
ELEV. DEPTH	DESCRIPTION	STRAT. PLOT	NUMBER	TYPE			20	40	60	80	100		
211.5	Ground Surface												
0.0	Fill sand, some gravel				*								
210.9													
0.6	With pockets of organic silt		1	SS	2							Om 9%	0 59 36 5
			2	SS	26								
	Silty sand to gravelly sand, some silt		3	SS	24								0 63 35 2
			4	SS	11								
	Compact		5	SS	11								
206.0			6	SS	18								
5.5	End of Borehole Refusal to augering probable bedrock												
	*Note: Water level not established.												
	Note: Occasional cobbles Elev. 211.5 to Elev. 209.0												

OFFICE REPORT ON SOIL EXPLORATION

## RECORD OF BOREHOLE No 8

METRIC

W F 72-74-05 E 14 LOCATION Co-ords. N 5 118 758.7; E 316 449.0 ORIGINATED BY MM  
 DIST 13 HWY 11 BOREHOLE TYPE Hollow Stem Augers, Cone Test BXL Rock Core COMPILED BY MM  
 DATUM Geodetic DATE 1979-10-17 CHECKED BY CP

SOIL PROFILE		SAMPLES			GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT		PLASTIC LIMIT	NATURAL MOISTURE CONTENT	LIQUID LIMIT	UNIT WEIGHT	REMARKS & GRAIN SIZE DISTRIBUTION (%)
ELEV. DEPTH	DESCRIPTION	STRAT. PLOT	NUMBER	TYPE			20	40	60	80	100		
213.5	Ground Surface												
0.0	Silty sand, trace gravel Occasional cobbles		1	SS	29								6 59 31 4
211.3	Compact		2	SS	40								
2.2	Sound granite bedrock		3	BXL RC	REC	100%							RQD 87%
			4	BXL RC	REC	100%							RQD 100%
209.7			5	BXL RC	REC	100%							RQD 100%
3.8	End of Borehole												

L EXPLORATION

+3, x5: Numbers refer to Sensitivity  
 20  
 15  $\phi$  5 (%) STRAIN AT FAILURE  
 10



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HIGHWAY ENGINEERING DIVISION-ENGINEERING MATERIALS OFFICE-SOIL MECHANICS SECTION

RECORD OF BOREHOLE No 13

METRIC

W P 72-74-05 14 LOCATION Co-ords. N 5 118 766.3; E 316 383.4 ORIGINATED BY MM  
DIST 13 HWY 11 BOREHOLE TYPE Hollow Stem Augers and Cone Test COMPILED BY MM  
DATUM Geodetic DATE 1979-10-24 CHECKED BY JP

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					
212.9	Ground Surface																
0.0	with pockets of organic silt loose		1	SS	3		212										
			2	SS	6												
	Silty sand to gravelly sand, some silt		3	SS	18												13 64 19 4
209.5	Compact		4	SS	50/	75 mm	210										15 72 (13)
3.4	End of Borehole																
	Refusal to augering probable bedrock.																
	*Note: Water level not established.																
	Note: Occasional cobbles Elev. 211.5 to 210.0																

RECORD OF BOREHOLE No 14

METRIC

W P 72-74-05 14 LOCATION Co-ords. N 5 118 768.9; E 316 374.4 ORIGINATED BY MM  
DIST 13 HWY 11 BOREHOLE TYPE Hollow Stem Augers and Cone Test COMPILED BY MM  
DATUM Geodetic DATE 1979-10-22 CHECKED BY JP

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					
211.5	Ground Surface																
0.0	with organic mat'l. loose		1	SS	5		210										
	Compact		2	SS	26												
	Occasional cobbles		3	SS	36												
	Gravelly sand, some silt to silty sand		4	SS	21												34 54 (12)
			5	SS	23		208										
			6	SS	19												
205.6			7	SS	50/	75 mm	206										
	End of Borehole																
	Refusal to augering probable bedrock.																

+3, x5 : Numbers refer to  
Sensitivity

20  
15  
10  
5 (%) STRAIN AT FAILURE

ON SOIL EXPLORATION

REPORT ON SOIL EXPLORATION



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HIGHWAY ENGINEERING DIVISION-ENGINEERING MATERIALS OFFICE-SOIL MECHANICS SECTION

RECORD OF BOREHOLE No 15

METRIC

W P 72-74-05 E 14 LOCATION Co-ords. N 5 118 768.8; E 316 363.3 ORIGINATED BY MM  
DIST 13 HWY 11 BOREHOLE TYPE Hollow Stem Augers, Cone Test, EXL Rock Core COMPILED BY MM  
DATUM Geodetic DATE 1979-10-18 CHECKED BY CP

SOIL PROFILE			SAMPLES			GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT 20 40 60 80 100 SHEAR STRENGTH ○ 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 (%)	UNIT WEIGHT γ	REMARKS & GRAIN SIZE DISTRIBUTION (%) GR SA SI CL
ELEV DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE	'N' VALUES						
211.5	Ground Surface										
0.0	With organic material Loose		1	SS	3						
	Compact to dense		2	SS	27						
	Gravelly sand		3	SS	38						
207.9	some silt		4	SS	41						
3.6	Sound granite bedrock		5	EXL RC	REC 100%						RQD 100%
206.5											
5.0	End of Borehole										

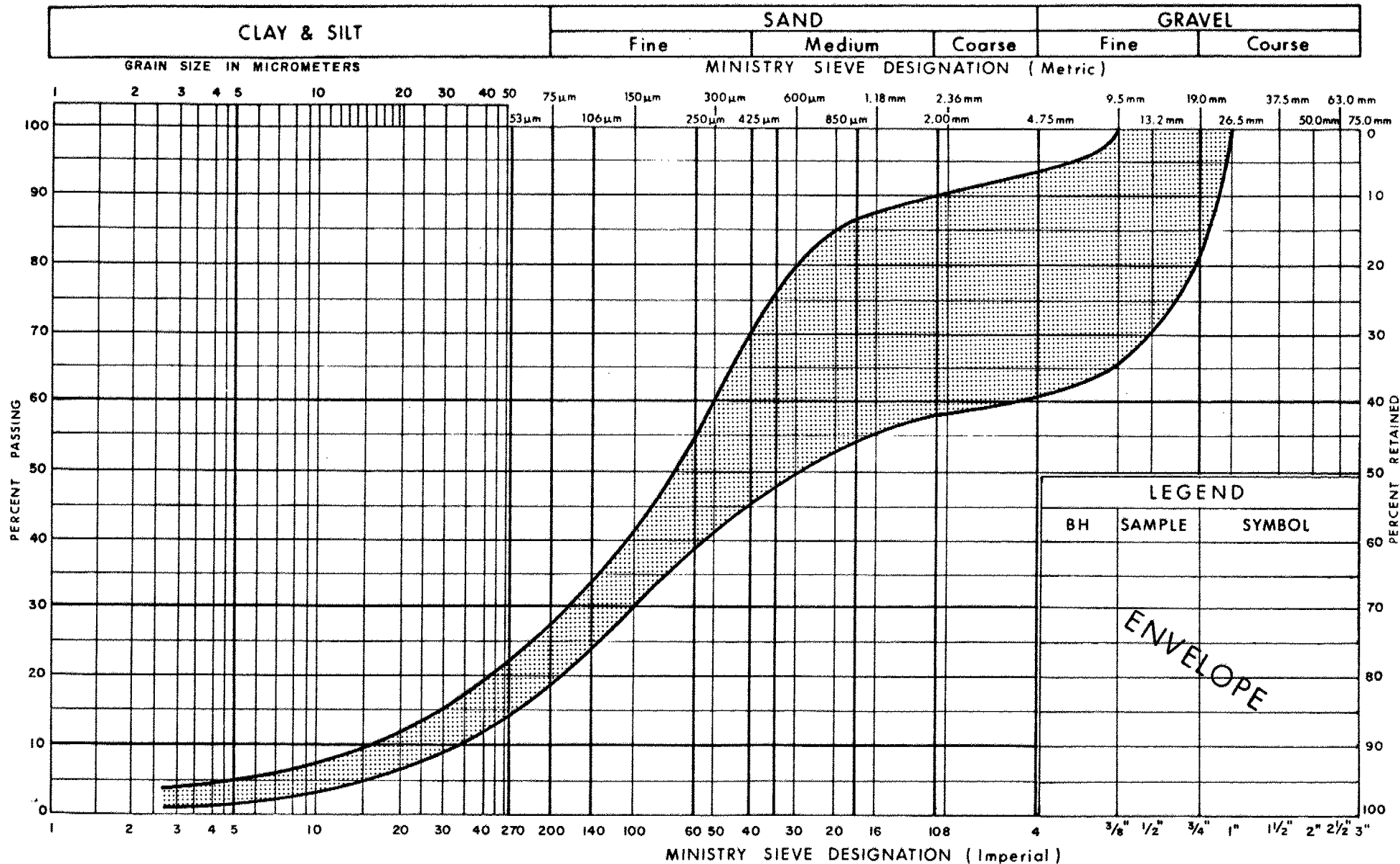
+3, x5: Numbers refer to  
Sensitivity

20  
15 5 (%) STRAIN AT FAILURE  
10

OFFICE REPORT ON SOIL EXPLORATION



## UNIFIED SOIL CLASSIFICATION SYSTEM



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## GRAIN SIZE DISTRIBUTION

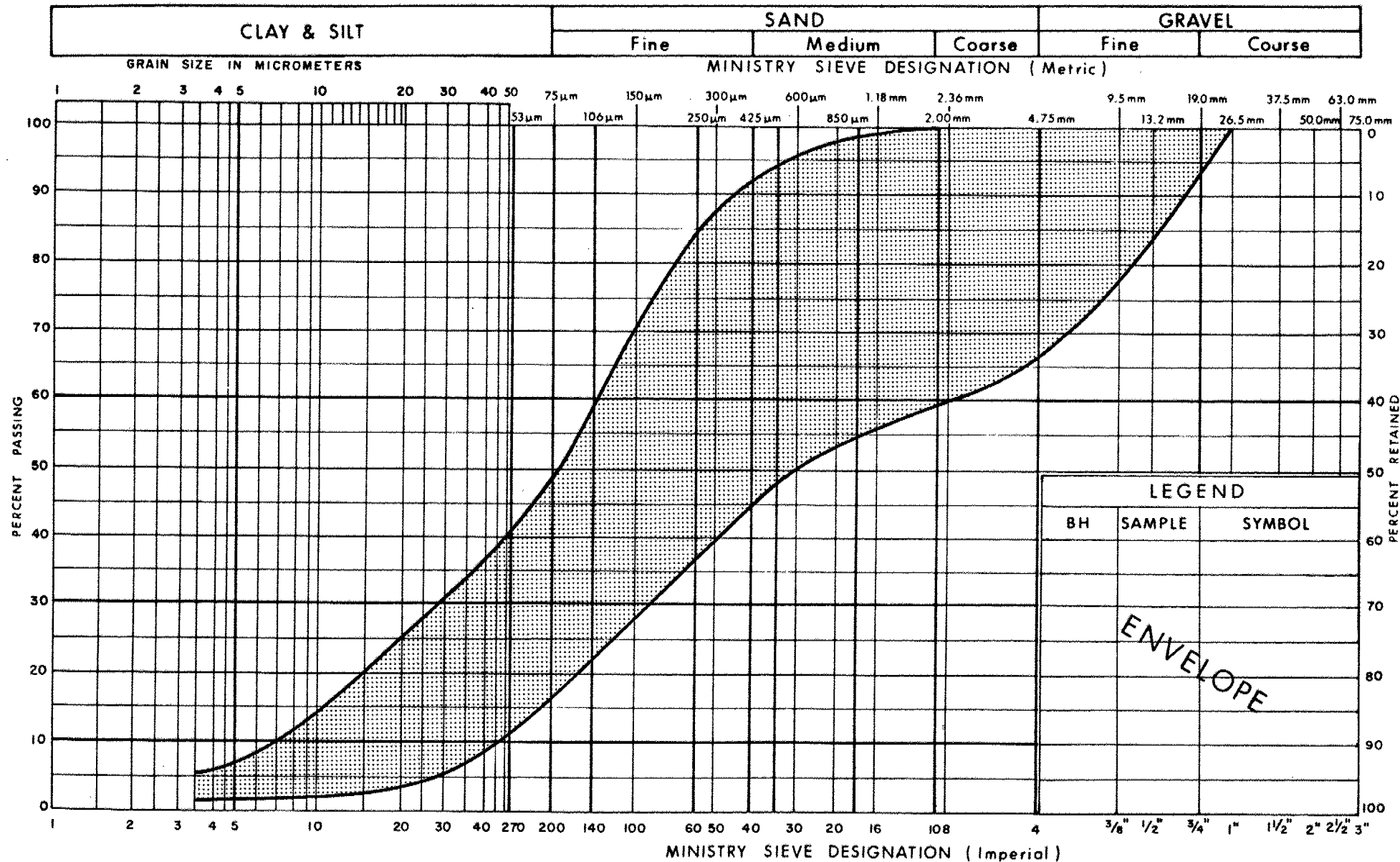
### FILL, SAND

TRACE TO SOME GRAVEL SOME SILT OCC COBBLES

FIG No 1

W P 72-74-05 14

## UNIFIED SOIL CLASSIFICATION SYSTEM



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**GRAIN SIZE DISTRIBUTION**  
**SILTY SAND, TRACE OF GRAVEL**  
**TO GRAVELLY SAND SOME SILT OCC COBBLES**

FIG No 2

W P 72-74-05 &amp; 14

## 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/0.3 m)	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
$S_t$	1	SENSITIVITY = $\frac{c_u}{\tau_r}$

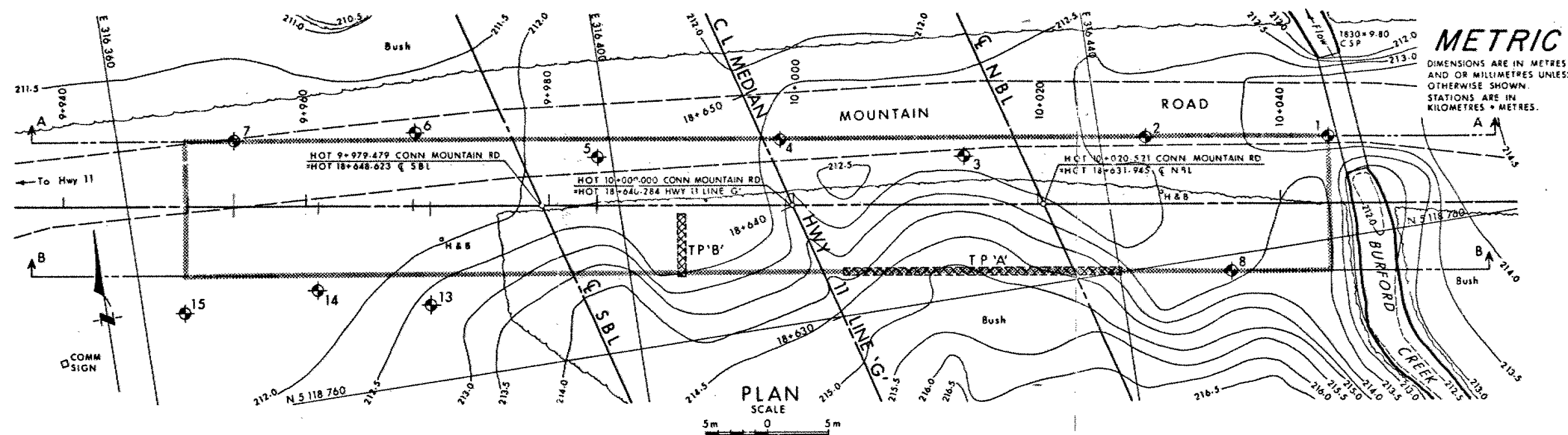
### STRESS AND STRAIN

$u_w$	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						

		Sta		
BH	5	9+384	LT	4
	6	9+969	LT	6
	7	9+954	LT	5.5
	13	9+970	RT	8.0
	14	9+961	RT	7.0
	15	9+950	RT	8.6



CONT No  
WP No 72-74-05

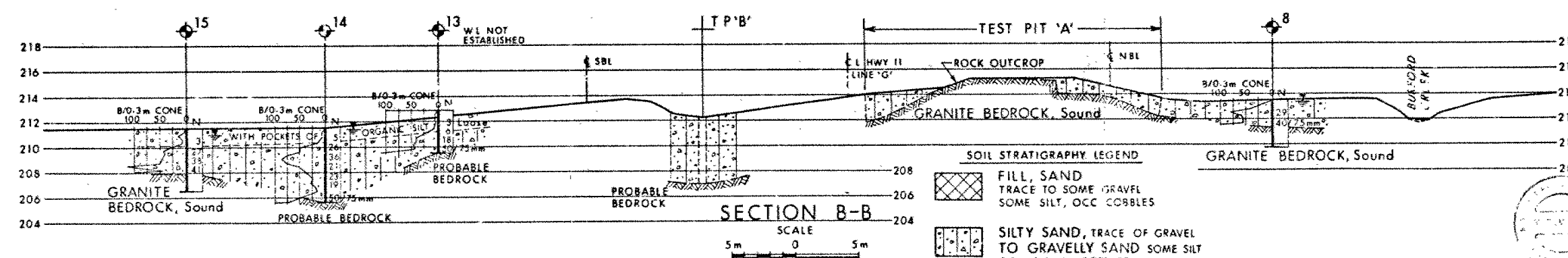
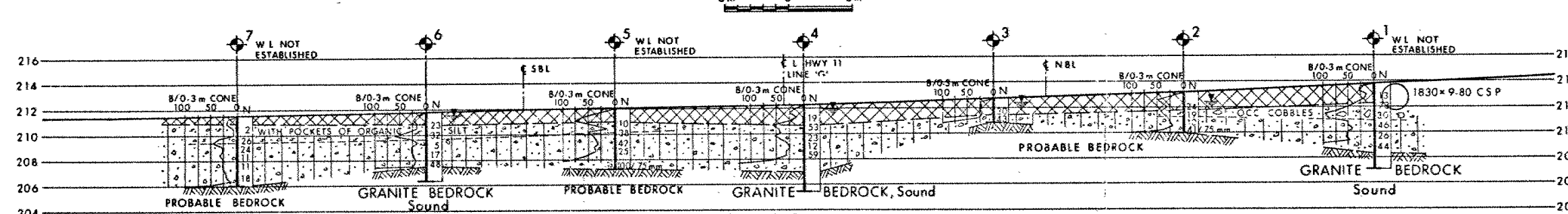
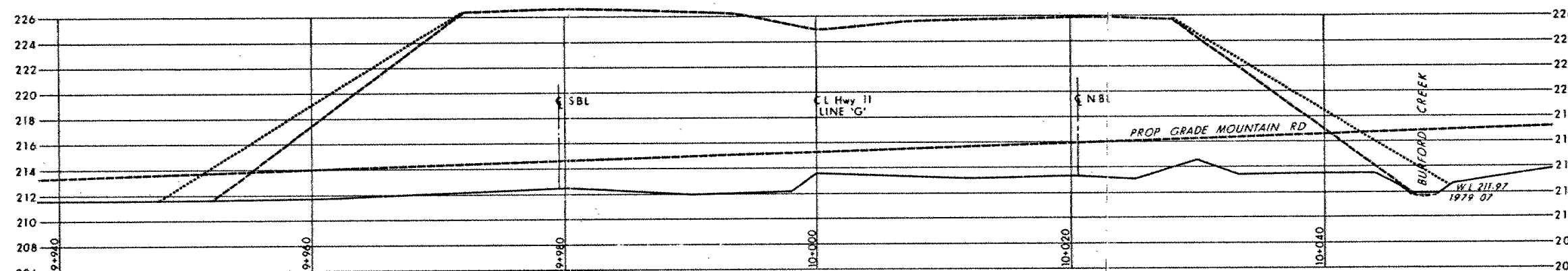
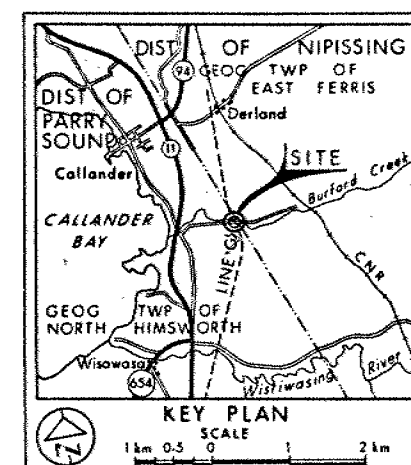
MOUNTAIN ROAD OVERPASS  
(3.1 km South of Hwy 94)  
BORE HOLE LOCATIONS & SOIL STRATA



SHEET

**METRIC**

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



**LEGEND**

- Bore Hole
- ⊕ Dynamic Cone Penetration Test (Cone)
- ⊕ Bore Hole & Cone
- N Blows/0.3m (Std Pen Test, 475 J/blow)
- CONE Blows/0.3m (60° Cone, 475 J/blow)
- W.L. at time of investigation 1979 10
- W.L. Not Established in BH# 1, 5, 7 and 13
- TP Test Pit

No	ELEVATION	CO-ORDINATES NORTH	EAST
1	213.8	5118 768.5	316 458.6
2	213.1	5118 770.6	316 443.8
3	212.7	5118 771.5	316 428.8
4	212.3	5118 775.2	316 414.0
5	212.0	5118 776.2	316 398.8
6	211.8	5118 780.5	316 384.3
7	211.5	5118 782.2	316 369.5
8	213.5	5118 758.7	316 449.0
13	212.9	5118 766.3	316 383.4
14	211.5	5118 768.9	316 374.4
15	211.5	5118 768.8	316 363.3

**NOTE**

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

REVISIONS	DATE	BY	DESCRIPTION

Geocres No 311-48  
Hwy No 11 LINE 'G' DIST 13  
SURV'D M.M. CHECKED DATE 1979 11 28 SITE 43-205  
DRAWN CHECKED DATE 1979 11 28 DWG 727405-A

# RECORD OF BOREHOLE No 101

METRIC

W P 72-74-05 & 14 LOCATION Co-ords N 5 118 781.2; E 316 438.8 ORIGINATED BY ZM  
 DIST 13 HWY 11 BOREHOLE TYPE Hollow Stem Auger COMPILED BY ZM  
 DATUM Geodetic DATE 81 06 08 CHECKED BY [Signature]

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									
212.4	Ground Surface						20	40	60	80	100						
0.0	Sand, with gravel some silt		1	SS	27												
			2	SS	18												
	Compact to Dense		3	SS	34												
			4	SS	24												
208.7																	
3.7	Sound Granite Bedrock		5	BXL RC	REC 100%											28 47 14 11	
207.2																	
5.2	End of Borehole																



# RECORD OF BOREHOLE No 102

METRIC

W P 72-74-05 & 14 LOCATION Co-ords N 5 118 781.7; E 316 425.6 ORIGINATED BY ZM  
DIST 13 HWY 11 BOREHOLE TYPE Hollow Stem Augers COMPILED BY ZM  
DATUM Geodetic DATE 81 06 09 CHECKED BY CP

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							WATER CONTENT (%)
								○ UNCONFINED	+ FIELD VANE ● QUICK TRIAXIAL    x LAB VANE						
212.2	Ground Surface														
0.0	Gravelly Sand some silt to silty sand some gravel	0.0 0.5 1.0 1.5 2.0 2.5 3.0 3.5 4.0 4.5 5.0 5.5 6.0 6.5 7.0 7.5 8.0 8.5 9.0 9.5 10.0	1	SS	36	*	212							44 44 9 3	
			2	SS	50		210								
	Compact to Very Dense		3	SS	26										
			4	SS	60										
207.9	End of Borehole						208								
4.3	Refusal to augering probable bedrock														
	*Water level not established														



## METRIC

W P 72-74-05 & 14 LOCATION Co-ords N 5 118 787.9; E 316 391.4 ORIGINATED BY ZM  
DIST 13 HWY 11 BOREHOLE TYPE Hollow Stem Augers COMPILED BY ZM  
DATUM Geodetic DATE 81 06 09 CHECKED BY JP.

[illegible]

+3, x5: Numbers refer to Sensitivity





Ministry of  
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Communications  
Ontario

## RECORD OF BOREHOLE No 104

W P 72-74-05 & 14 LOCATION Co-ords N 5 118 787.5; E 316 383.2 ORIGINATED BY ZM  
DIST 13 HWY 11 BOREHOLE TYPE Solid Stem Augers COMPILED BY ZM  
DATUM Geodetic DATE 81 06 09 CHECKED BY [Signature]

SOIL PROFILE			SAMPLES			GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT					PLASTIC LIMIT NATURAL MOISTURE CONTENT LIQUID LIMIT			UNIT WEIGHT $\gamma$	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>		
211.5	Ground Surface																
0.0	Probable Sand																
208.6																	
2.9	End of Borehole																
	Refusal to augering probable bedrock																

+3, x5 : Numbers refer to  
Sensitivity

20  
15-5 (%) STRAIN AT FAILURE  
10

# RECORD OF BOREHOLE No 105

METRIC

W P 72-74-05 & 14 LOCATION Co-ords N 5 118 758.3; E 316 390.0 ORIGINATED BY ZM  
 DIST 13 HWY 11 BOREHOLE TYPE Hollow Stem Augers COMPILED BY ZM  
 DATUM Geodetic DATE 81 06 09 CHECKED BY [Signature]

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					
213.7	Ground Surface																GR SA SI CL
0.0	Sand some gravel trace silt		1	SS	14	*											0 91 9 0
			2	SS	49		212										
	Pocket of Organic Silt		3	SS	4	150 mm											
	Gravelly Sand some silt		4	SS	73	150 mm											
							210										
	Compact to Very Dense		5	SS	26												
			6	SS	24		208										
206.4																	
7.3	Sound Granite Bedrock Diabase Intrusion		7	BXL RC	REC 80%		206										
204.3			8	BXL RC	REC 100%												
9.4	End of Borehole  *Water level not established  NOTE: Occasional cobbles Elev. 213.0 to Elev. 206.5																

+3, x5: Numbers refer to  
Sensitivity

20  
15 5 (%) STRAIN AT FAILURE  
10



# RECORD OF BOREHOLE No 106

METRIC

W P 72-74-05 & 14 LOCATION Co-ords N 5 118 754.7: E 316 403.0 ORIGINATED BY ZM  
DIST 13 HWY 11 BOREHOLE TYPE Hollow Stem Augers COMPILED BY ZM  
DATUM Geodetic DATE 81 06 10 CHECKED BY [Signature]

SOIL PROFILE			SAMPLES			GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT					PLASTIC NATURAL LIQUID LIMIT MOISTURE LIMIT CONTENT			UNIT WEIGHT Y	REMARKS & GRAIN SIZE DISTRIBUTION (%)
ELEV DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE	'N' VALUES			20 40 60 80 100	Wp	W	Wl	WATER CONTENT (%)					
214.9	Ground Surface															GR SA SI CL	
0.0	Sand, some gravel trace silt  Compact to Very Dense	[Strat Plot Scale]	1	SS	13	[Ground Water Conditions]	214									19 66 11 4	
			2	SS	47												
			3	SS	20												
			4	SS	41												
			5	SS	44												
			6	SS	35												
			7	SS	42												
			8	SS	49												
208.0	End of Borehole															0 66 33 1	
6.9	Refusal to augering probable bedrock  NOTE: Occasional cobbles Elev. 211.5 to Elev. 209.0																

OFFICE REPORT ON SOIL EXPLORATION



## METRIC

W P 72-74-05 & 14 LOCATION Co-ords N 5 118 753.2; E 316 434.1 ORIGINATED BY ZM  
DIST 13 HWY 11 BOREHOLE TYPE Hollow Stem Augers COMPILED BY ZM  
DATUM Geodetic DATE 81 06 10 CHECKED BY OP

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



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# RECORD OF BOREHOLE No 108

METRIC

W P 72-74-05 & 14 LOCATION Co-ords N 5 118 748.4; E 316 445.1 ORIGINATED BY ZM  
DIST 13 HWY 11 BOREHOLE TYPE Hollow Stem Augers COMPILED BY ZM  
DATUM Geodetic DATE 81 06 10 CHECKED BY *GP*

SOIL PROFILE			SAMPLES			GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT 20 40 60 80 100 SHEAR STRENGTH ○ 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								
216.6	Ground Surface					*	216						
0.0	Sand some gravel trace silt												
214.6	Compact		1	SS	10								
2.0	End of Borehole  Refusal to auger probable bedrock  *Water level not established  <u>NOTE:</u> Occasional cobbles Elev. 216.5 to 215.0												

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

20  
15  
10

5 (%) STRAIN AT FAILURE



# RECORD OF BOREHOLE No 109

METRIC

W P 72-74-05 & 14 LOCATION Co-ords N 5 118 794.1; E 316 440.3 ORIGINATED BY ZM  
DIST 13 HWY 11 BOREHOLE TYPE Hollow Stem Augers COMPILED BY ZM  
DATUM Geodetic DATE 81 06 11 CHECKED BY CP

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	NUMBER	TYPE			'N' VALUES	20	40	60	80					
212.0	Ground Surface															
0.0	Sand, some gravel trace silt		1	SS	26	*										
	Compact to Very Dense		2	SS	30											
			3	SS	72											
207.9																
4.1	End of Borehole															
	Refusal to augering probable bedrock															
	*Water level not established															
	NOTE: Occasional cobbles Elev. 211.5 to Elev. 209.5															

+3, x5 : Numbers refer to Sensitivity

20  
15 5 (%) STRAIN AT FAILURE  
10



# RECORD OF BOREHOLE No 110

METRIC

W P 72-74-05 & 14 LOCATION Co-ords N 5 118 799.4; E 316 405.7 ORIGINATED BY ZM  
DIST 13 HWY 11 BOREHOLE TYPE Hollow Stem Augers COMPILED BY ZM  
DATUM Geodetic DATE 81 06 11 CHECKED BY OP

SOIL PROFILE			SAMPLES			GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT 20 40 60 80 100 SHEAR STRENGTH ○ 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 (%)	UNIT WEIGHT γ	REMARKS & GRAIN SIZE DISTRIBUTION (%) GR SA SI CL
ELEV DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE	'N' VALUES						
211.5 0.0	Ground Surface										
	Sand some gravel some silt		1	SS	32		210				
	Compact to Dense		2	SS	16						
			3	SS	14						
			4	SS	41						
207.2			5	SS	30	30 mm	208				20 52 24 4
4.3	End of Borehole										
	Refusal to augering probable bedrock										
	NOTE: Occasional cobbles Elev. 211.5 to Elev. 209.0										

# RECORD OF BOREHOLE No 111

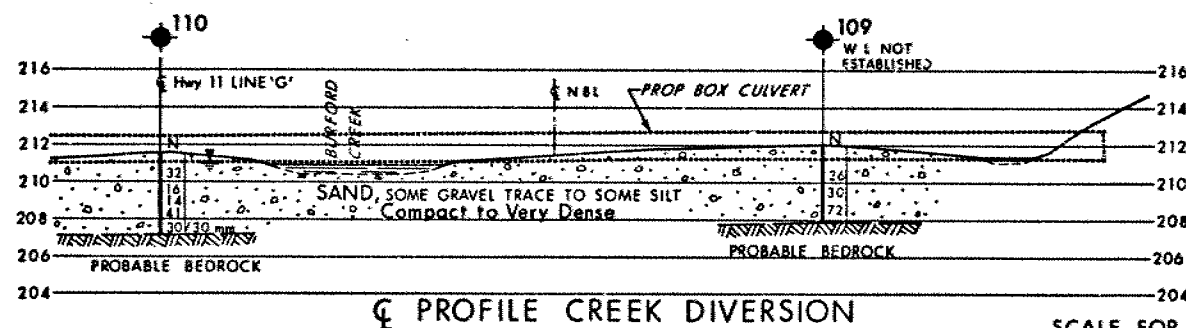
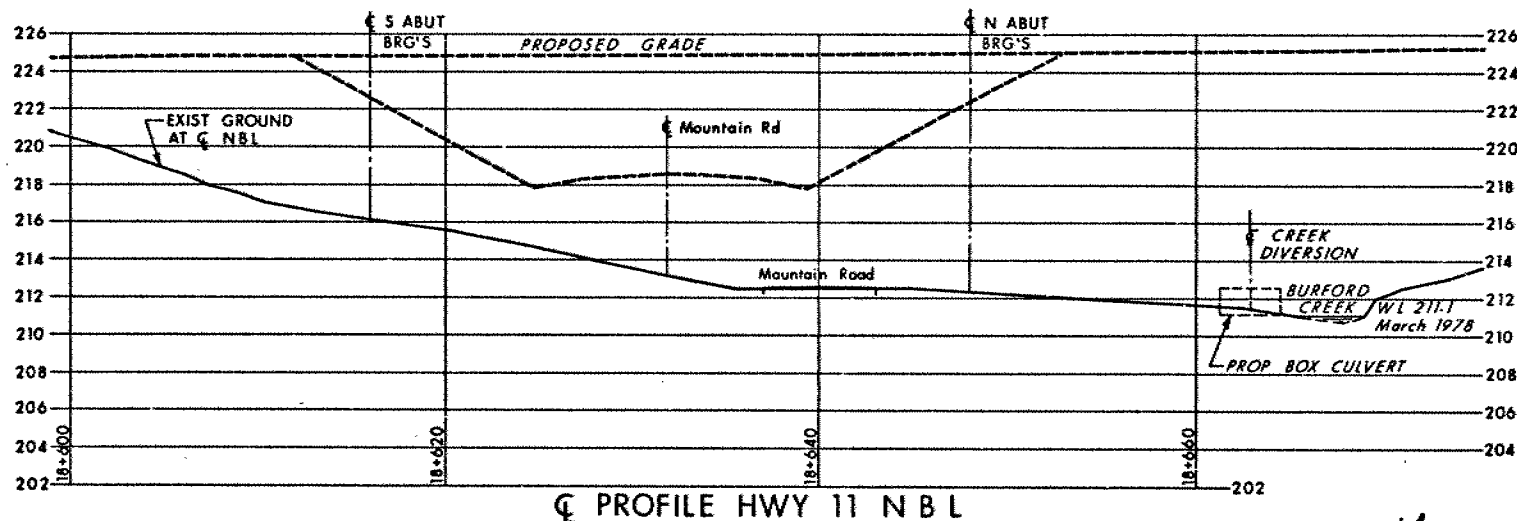
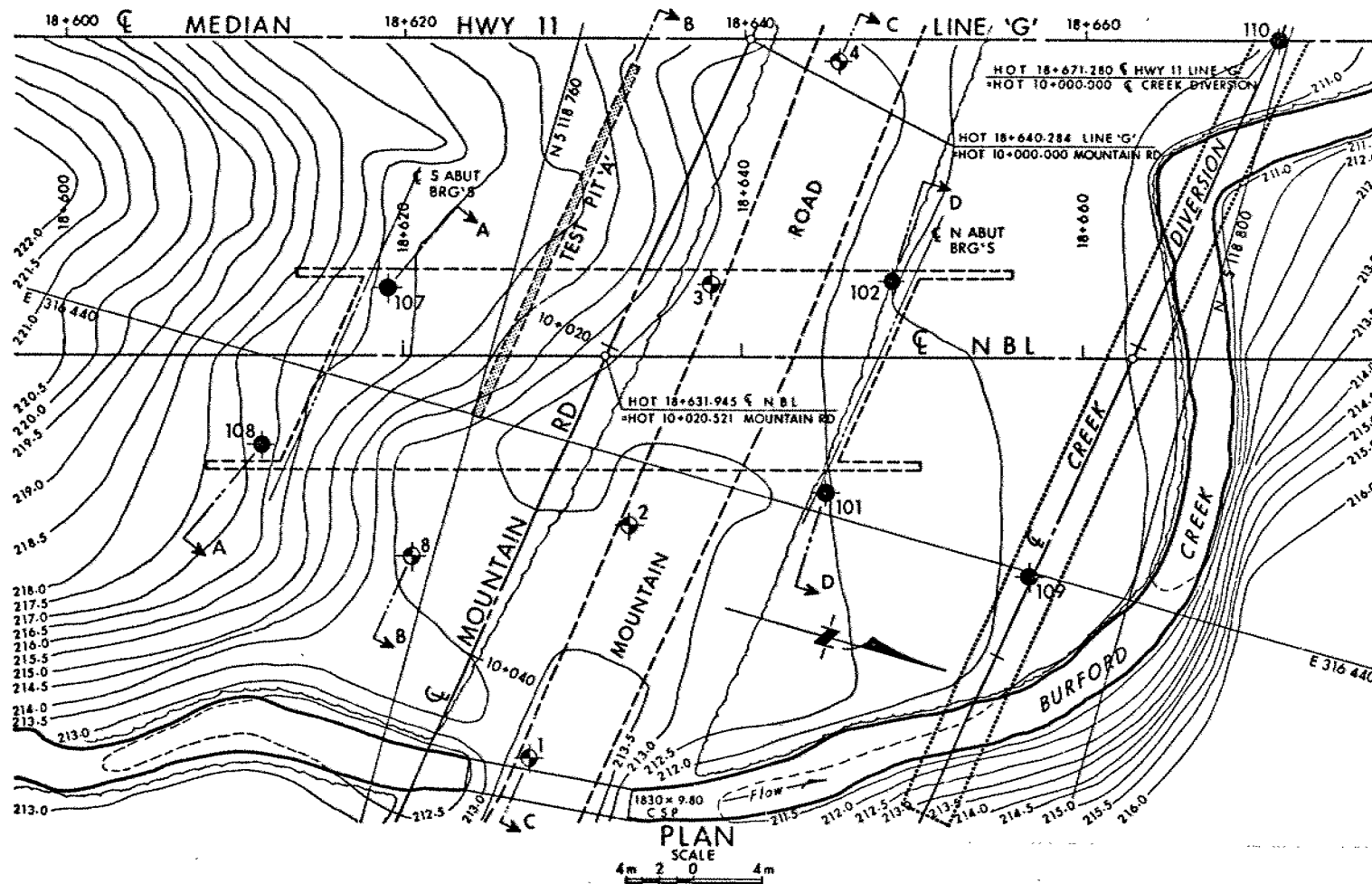
METRIC

W P 72-74-05 & 14 LOCATION Co-ords N 5 118 803.3; E 316 379.6 ORIGINATED BY ZM  
 DIST 13 HWY 11 BOREHOLE TYPE Hollow Stem Augers COMPILED BY ZM  
 DATUM Geodetic DATE 81 06 11 CHECKED BY CP

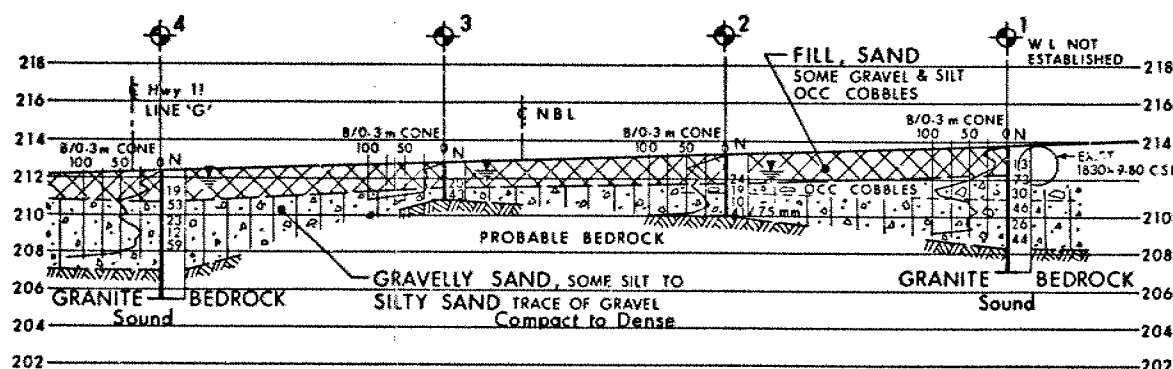
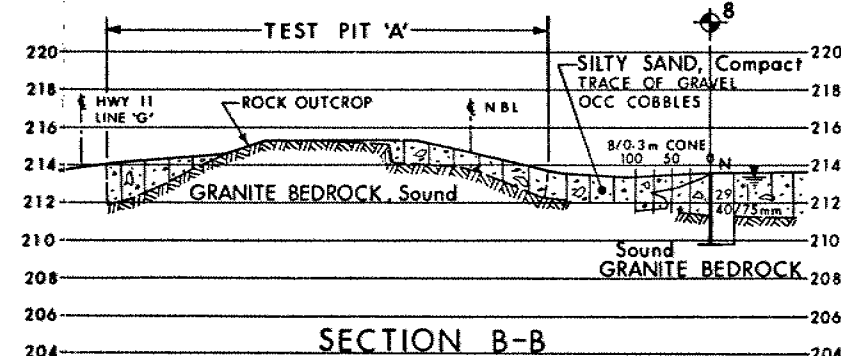
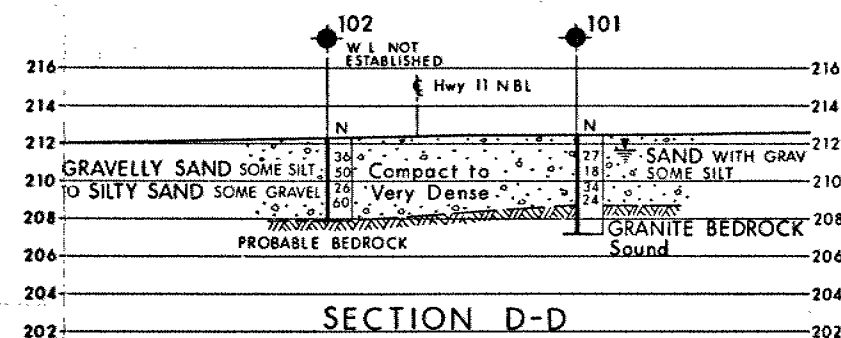
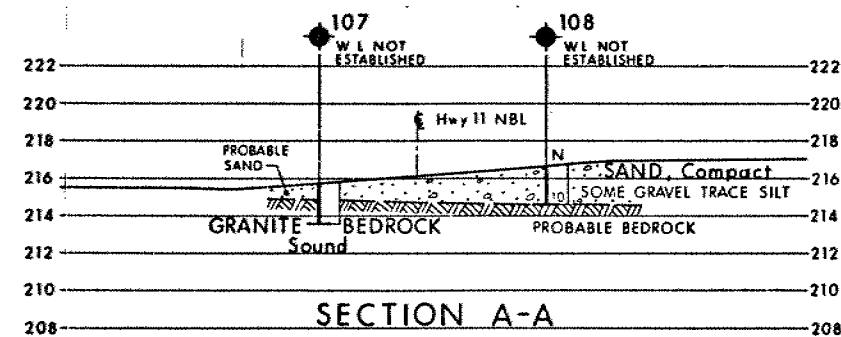
SOIL PROFILE		SAMPLES			GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT		PLASTIC LIMIT W <sub>p</sub>	NATURAL MOISTURE CONTENT W	LIQUID LIMIT W <sub>L</sub>	UNIT WEIGHT γ	REMARKS & GRAIN SIZE DISTRIBUTION (%) GR SA SI CL
ELEV DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE			'N' VALUES	20					
210.9	Ground Surface												
0.0	Sand some gravel some silt  Very Loose to Compact		1	SS	3	*							0 65 29 6
			2	SS	16								
			3	SS	17								
			4	SS	6								
			5	SS	30/180 mm								
205.1	End of Borehole												
5.8	Refusal to augering probable bedrock  *Water level not established  NOTE: Occasional cobbles Elev. 210.5 to Elev. 207.0												

OFFICE REPORT ON SOIL EXPLORATION





SCALE FOR PROFILES & SECTIONS  
4m 2m 0m 4m



# **METRIC**

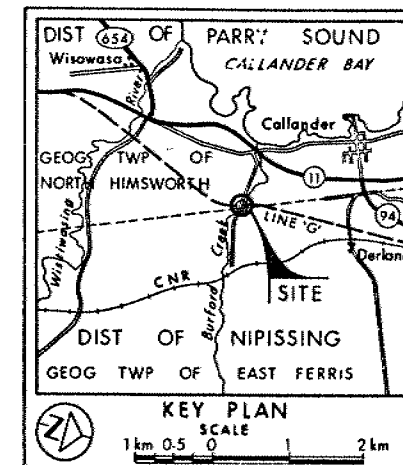
DIMENSIONS ARE IN METRES  
AND/OR MILLIMETRES UNLESS  
OTHERWISE SHOWN.  
STATIONS ARE IN  
KILOMETRES + METRES.

CONT No  
WP No 72-74-05

MOUNTAIN ROAD OVERPASS  
(NORTH BOUND LANE)  
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)
- W.L. at time of investigation  
1979 10 and 1981 06
- W.L. Not Established in Boreholes  
1, 102, 107, 108 and 109

No	ELEVATION	CO-ORDINATES NORTH	EAST
1	213.8	5 118 768.5	316 458.6
2	213.1	5 118 770.6	316 443.8
3	212.7	5 118 771.5	316 428.8
4	212.3	5 118 775.2	316 414.0
8	213.5	5 118 758.7	316 449.0
101	212.4	5 118 781.2	316 438.8
102	212.2	5 118 781.7	316 425.6
107	215.7	5 118 753.2	316 434.1
108	216.6	5 118 748.4	316 445.1
109	212.0	5 118 794.1	316 440.3
110	211.5	5 118 799.4	316 405.7

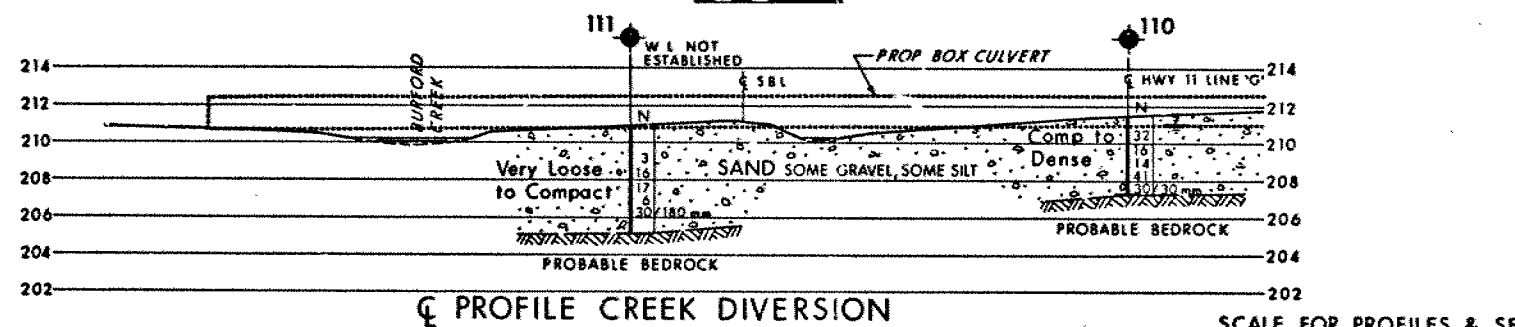
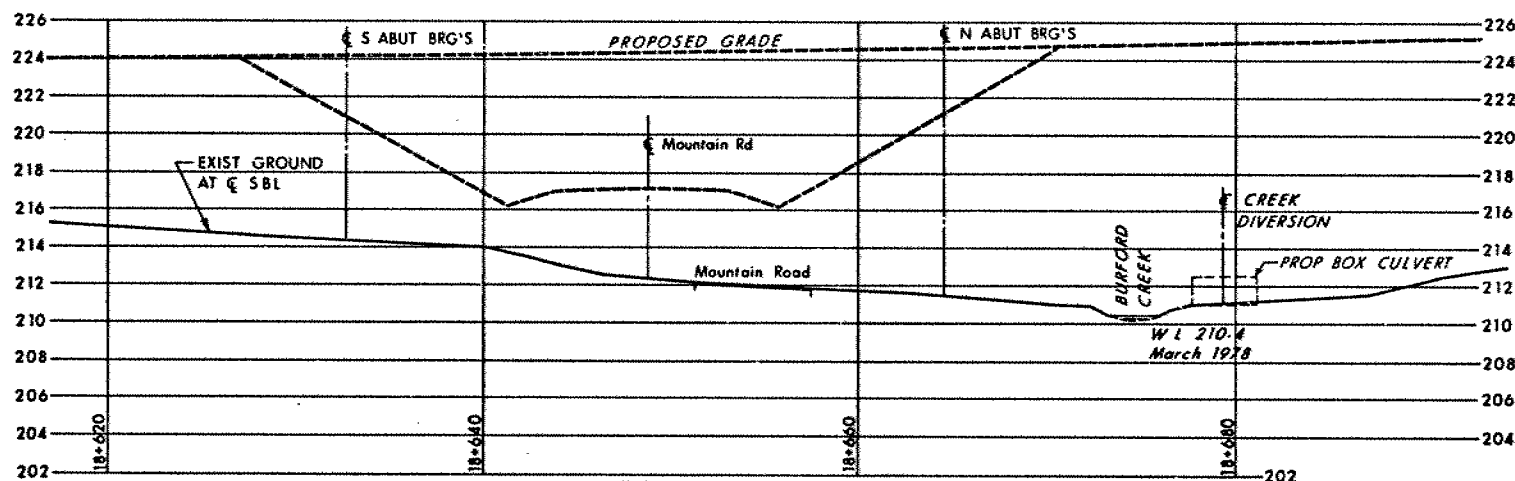
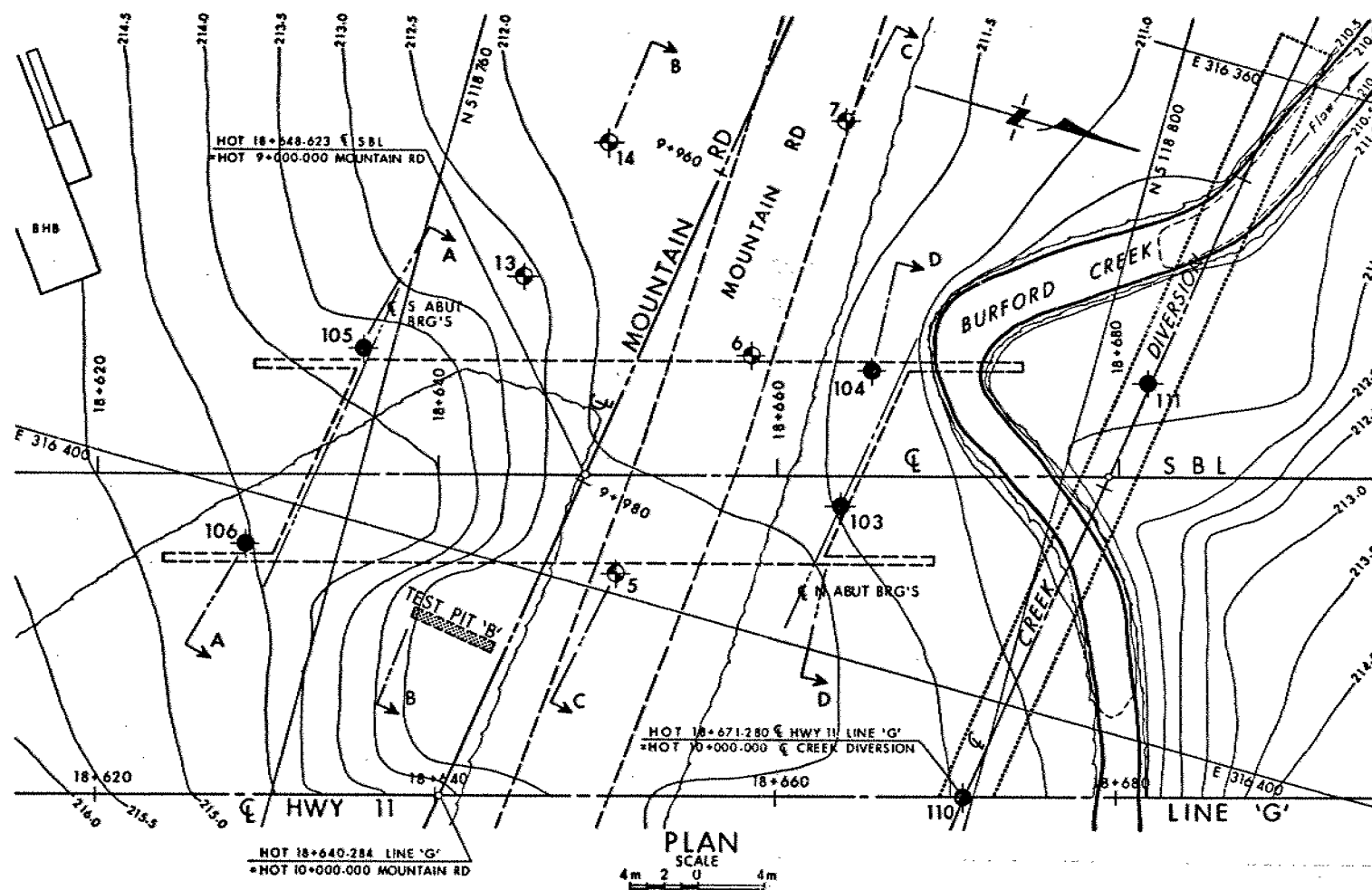
## **NOTE**

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

REVISIONS	DATE	BY	DESCRIPTION

Geocres No 31L-48

HWY No 11 LINE 'G' NBL	DIST 13
SUBMD MM CHECKED	DATE 1984 06 14
DRAWN GJ CHECKED	APPROVED
	SITE 43-205 N
	DWG 2

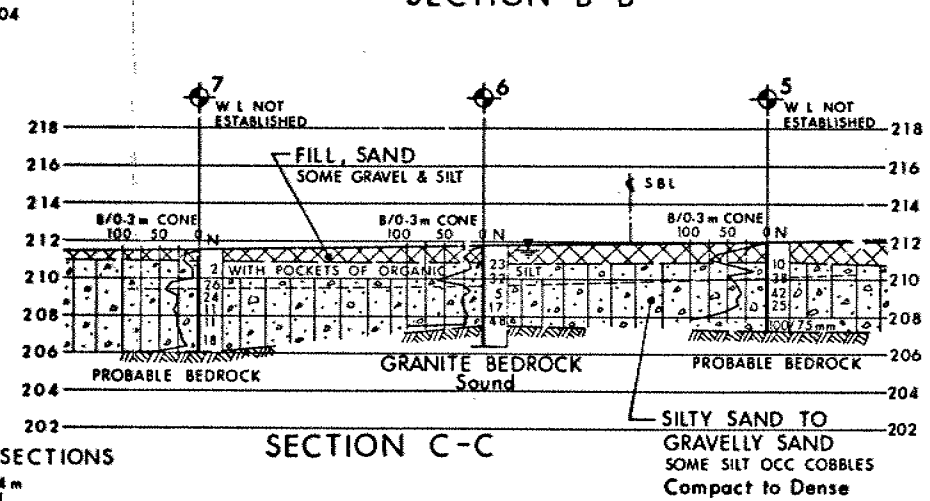
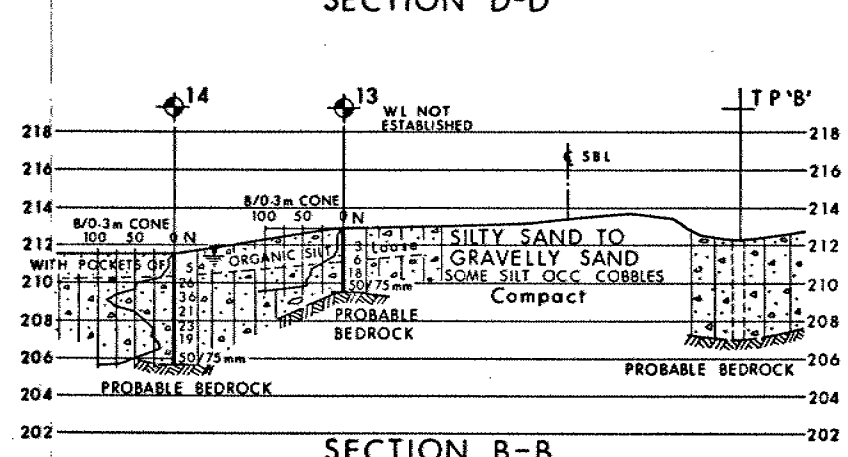
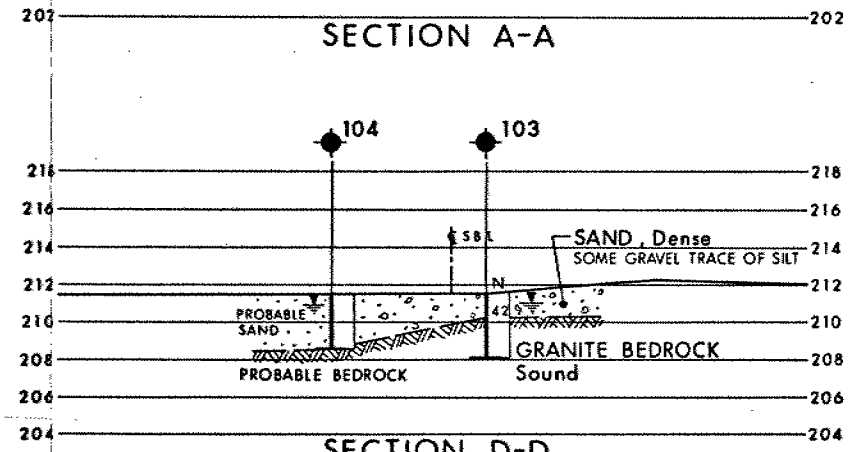
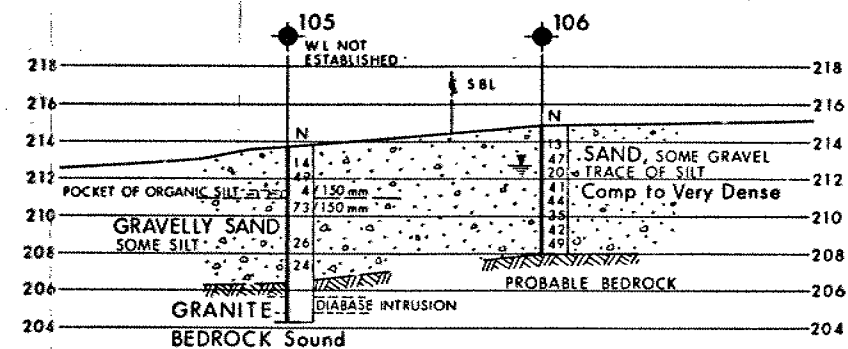


SCALE FOR PROFILES & SECTIONS



# METRIC

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

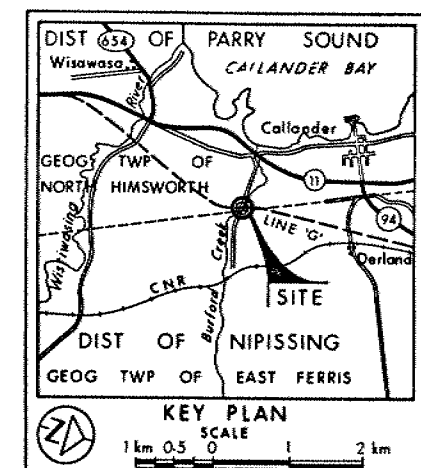


CONT No  
WP No 72-74-14

MOUNTAIN ROAD OVERPASS  
(SOUTH BOUND LANE)  
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 1979 10 and 1981 06
- WL Not Established in Boreholes 5, 7, 13, 105 and 111

No	ELEVATION	CO-ORDINATES	
		NORTH	EAST
5	212.0	5 118 776.2	316 398.8
6	211.8	5 118 780.5	316 384.3
7	211.5	5 118 782.2	316 369.5
13	212.9	5 118 766.3	316 383.4
14	211.5	5 118 768.9	316 374.4
103	211.6	5 118 787.9	316 391.4
104	211.5	5 118 787.5	316 383.2
105	213.7	5 118 758.3	316 390.0
106	214.9	5 118 754.7	316 403.0
110	211.5	5 118 799.4	316 405.7
111	210.9	5 118 803.3	316 379.6


## NOTE

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

REVISIONS	DATE	BY	DESCRIPTION

Geocres No 31L-48  
HWY No 11 LINE 'G' SBL DIST 13  
SUBMITTAL CHECKED DATE 1984 06 14 SITE 43-205 S  
DRAWN BY CHECKED BY APPROVED DWG 2



DIST. No 13		SHEET
CONT No		
WP No 72-74-14		
MOUNTAIN ROAD OVERPASS, S.B.L.		FOOTINGS
 McNEELY ENGINEERING & STRUCTURES LTD. KINGSTON OTTAWA		

# METRIC

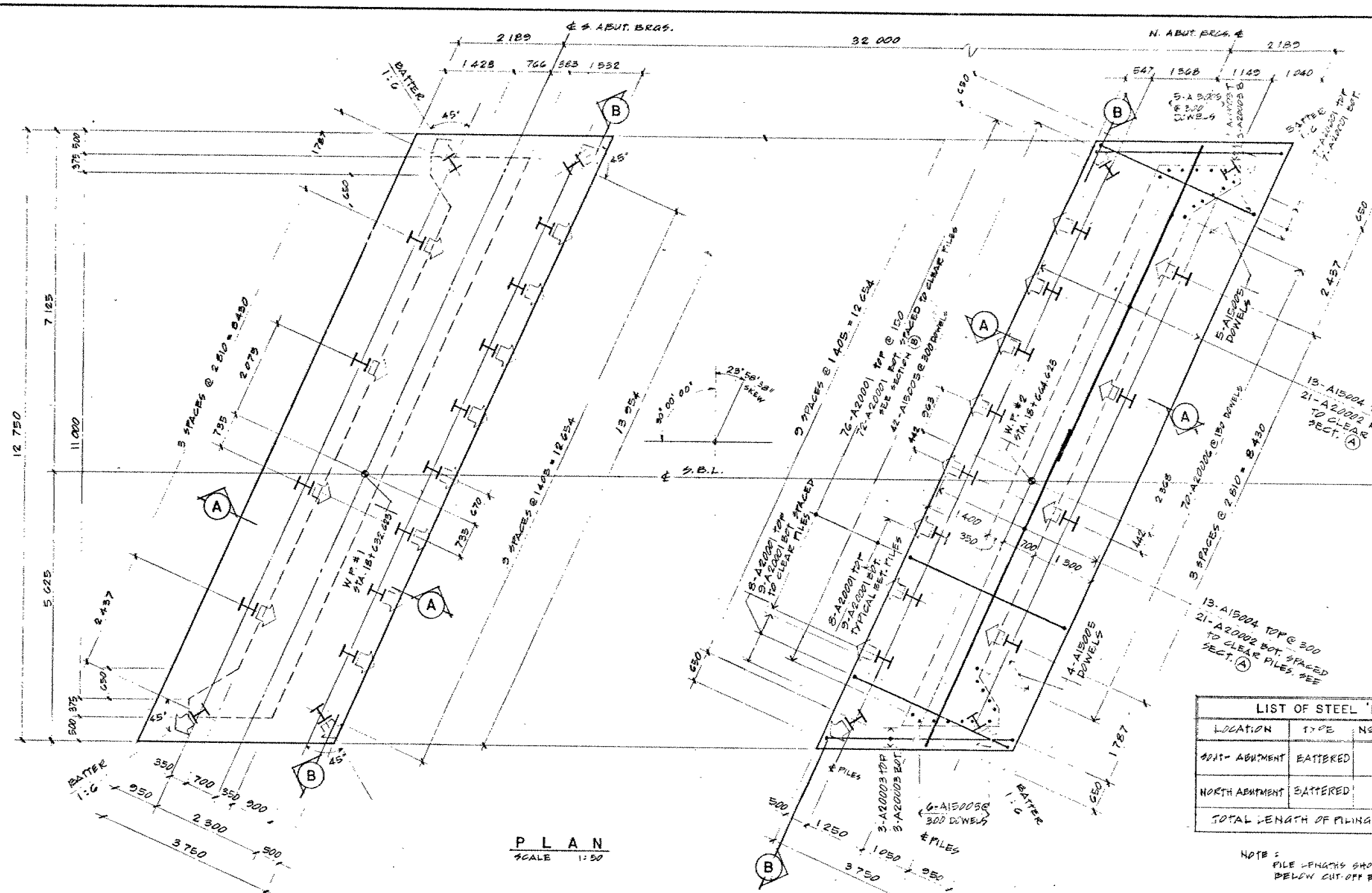
DIMENSIONS ARE IN MILLIMETRES UNLESS OTHERWISE SHOWN. ELEVATIONS, COORDINATES, CURVE AND ALIGNMENT DATA ARE IN METRES. STATIONS ARE IN KILOMETRES + METRES.

## REINFORCING STEEL NOTATIONS:

- N.F. — NEAR FACE
- F.F. — FAR FACE
- EW — EAST WINGWALL
- WW — WEST WINGWALL

## PILE DESIGN DATA:

LOAD AT SERVICEABILITY LIMIT STATES TYPE II — 900 kN  
 FACTORED LOAD AT ULTIMATE LIMIT STATES — 1200 kN




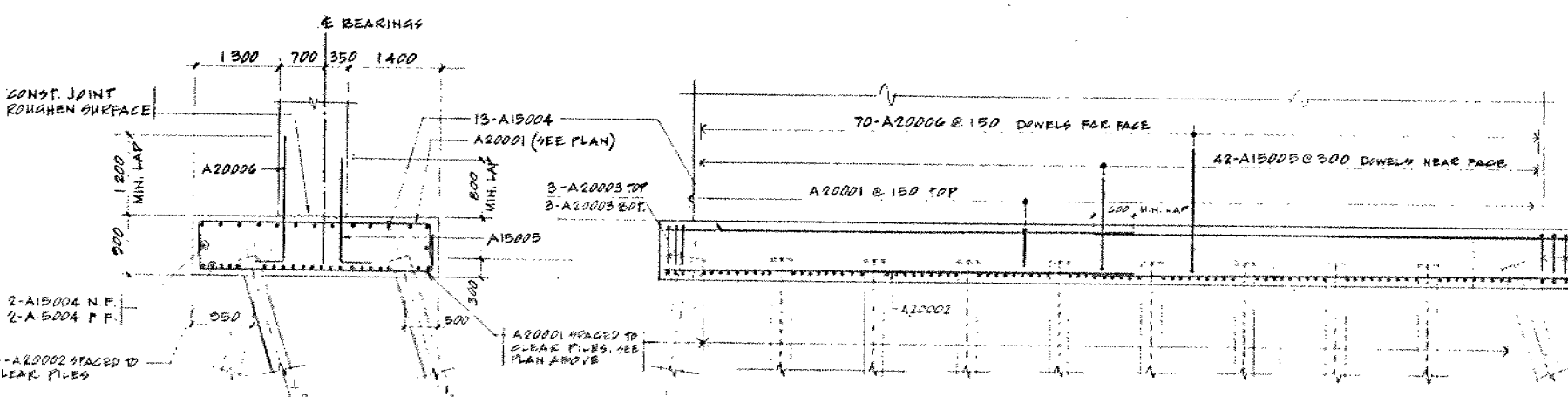
PLAN  
SCALE 1:50

LIST OF STEEL 'H' PILES (HP310x79)				
LOCATION	TYPE	NO. REQ'D.	LENGTH	REMARKS
SOUTH ABUTMENT	BATTERED	16	139 200	
NORTH ABUTMENT	BATTERED	16	178 200	
TOTAL LENGTH OF PILING-IN PLACE = 387 400 (32 PILES)				

NOTE: PILE LENGTHS SHOWN ARE THE THEORETICAL LENGTHS BELOW CUT-OFF ELEVATIONS.

## NOTES

- 1) BATTERED PILES SHOWN THIS  1:3 TYPICAL UNLESS OTHERWISE INDICATED.
- 2) SEE ABUTMENT DRAWING FOR GEOMETRY OF WALLS ABOVE FOOTINGS.



SECTION A  
SCALE 1:50

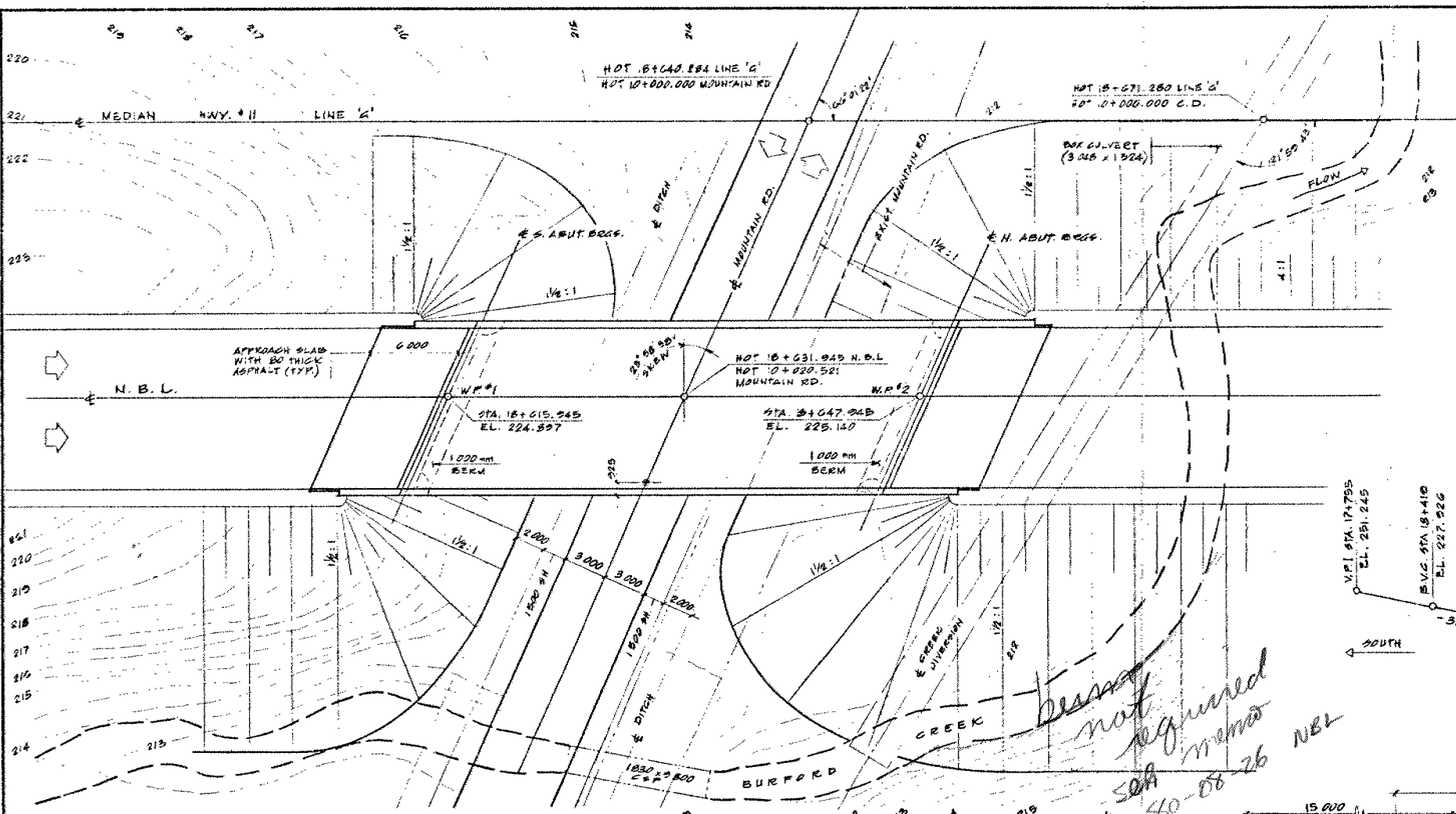
SECTION B  
SCALE 1:50



DRAWING NOT TO BE SCALED  
 100 mm ON ORIGINAL DRAWING

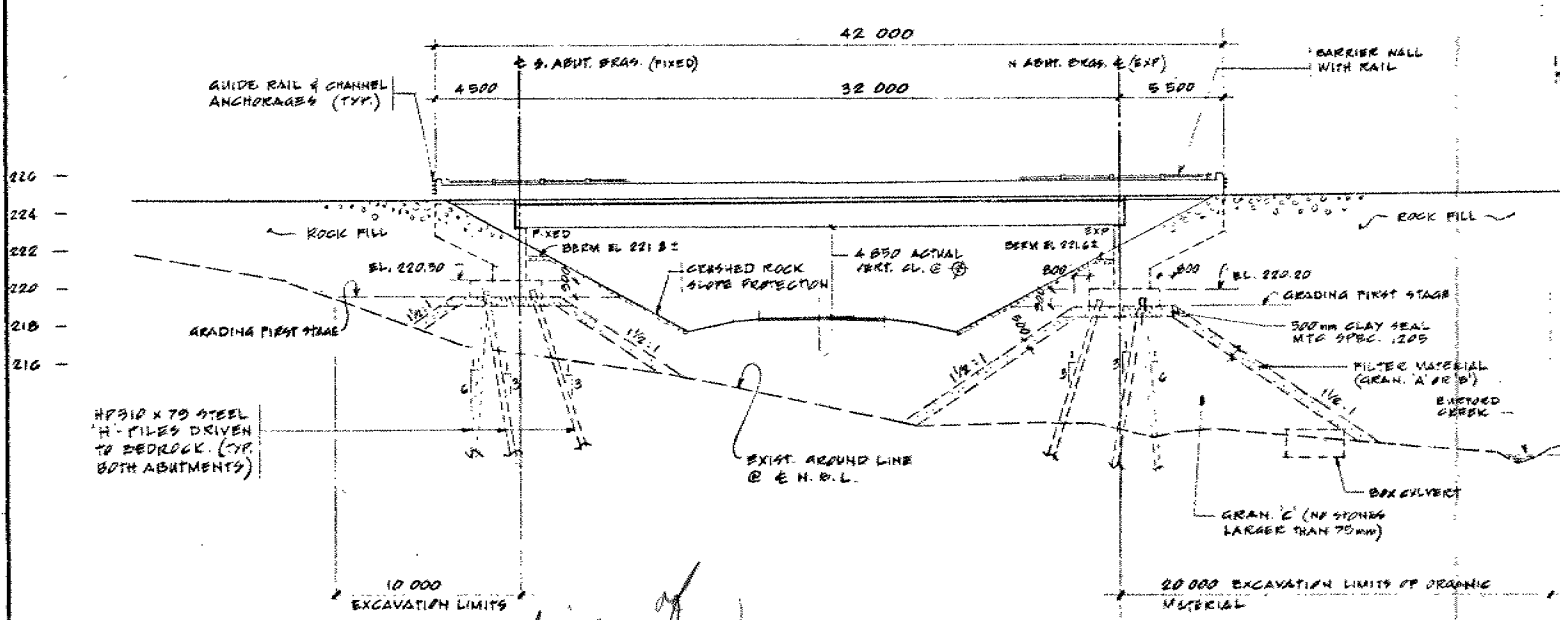
REVISIONS	DATE	BY	DESCRIPTION

MINISTRY OF TRANSPORTATION AND COMMUNICATIONS ONTARIO

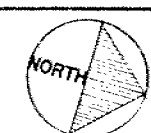


BENCHMARK ELEV. 218.882  
BOLT IN BEDROCK  
G.I. 60 M LT. STA. 15+589.20

PLAN  
SCALE 1:200



EAST ELEVATION  
SCALE 1:200



METRIC

DIMENSIONS ARE IN MILLIMETRES  
UNLESS OTHERWISE SHOWN.  
ELEVATIONS, COORDINATES, CURVE  
AND ALIGNMENT DATA ARE IN METRES.  
STATIONS ARE IN KILOMETRES + METRES.

DIST No 13  
CONT No  
WP No 72-74-05

MOUNTAIN ROAD  
OVERPASS, N.B.L.  
GENERAL ARRANGEMENT

McNEELY ENGINEERING  
& STRUCTURES LTD.  
KINGSTON OTTAWA

SHEET

GENERAL NOTES:  
REINFORCING STEEL SHALL BE GRADE 400  
UNLESS OTHERWISE SPECIFIED.  
BAR MARKED WITH SUFFIX 'C' SHALL BE COATED BARS.

CLASS OF CONCRETE

DECK AND BARRIER WALLS	30	MPa
REMAINDER	20	MPa

CLEAR COVER TO REINFORCING STEEL

FOOTINGS AND ABUTMENTS	75	mm
DECK: TOP + 50 mm BOTTOM	40	mm
BARRIER WALLS	50	mm
APPROACH SLABS	50	mm

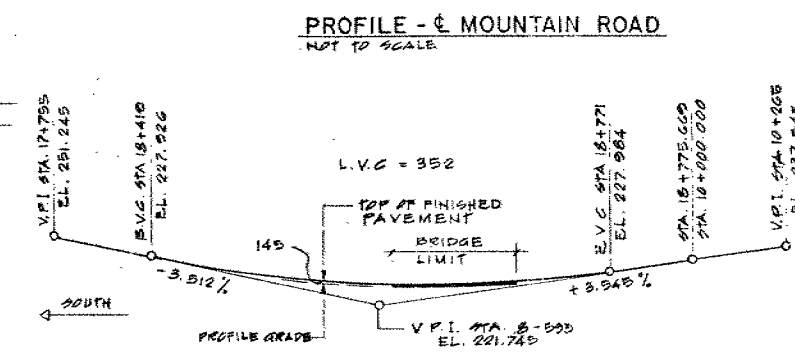
UNLESS OTHERWISE NOTED

CONSTRUCTION NOTES:  
THE CONTRACTOR SHALL FINISH THE BEARING SEATS  
DEAD LEVEL TO THE SPECIFIED ELEVATIONS TO A  
TOLERANCE OF  $\pm 3$  mm. NO CONCRETE SHALL BE  
PLACED ABOVE THE ABUTMENT BEARING SEATS  
UNTIL THE CONCRETE IN THE DECK HAS BEEN PLACED.

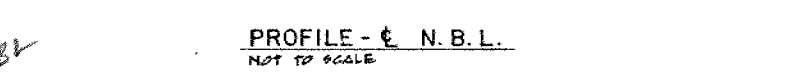
CONCRETE QUANTITIES  
CONCRETE QUANTITIES ARE LISTED FOR APPROXIMATE  
CONCRETE LUMP SUM TENDER ITEMS:

FOOTINGS	0.45	m <sup>3</sup>
ABUTMENTS AND WINGWALLS	123	m <sup>3</sup>
DECK	65	m <sup>3</sup>
BARRIER WALLS	10	m <sup>3</sup>
APPROACH SLABS	33	m <sup>3</sup>

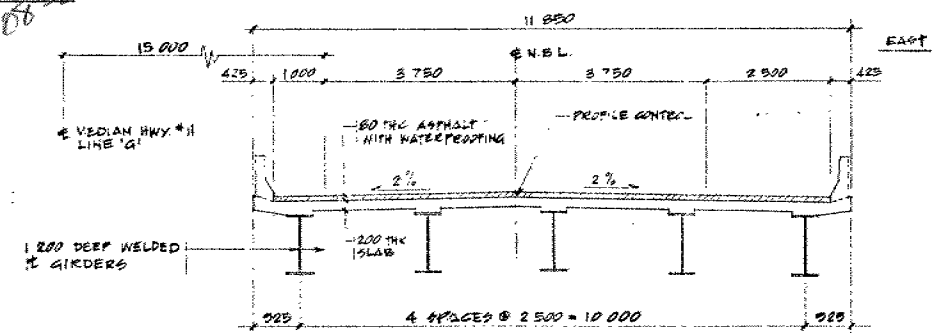
STRUCTURAL STEEL QUANTITY --- 53 TONNES



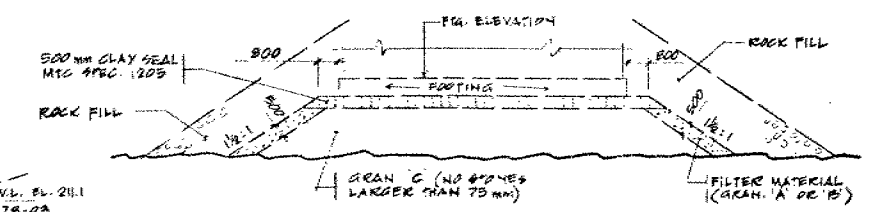
PROFILE - MOUNTAIN ROAD  
NOT TO SCALE



PROFILE - N.B.L.  
NOT TO SCALE



DECK SECTION  
SCALE 1:75



LATERAL GRANULAR CORE REQUIREMENTS  
(TYPICAL FOR BOTH ABUTMENTS)  
NOT TO SCALE

NOTE:  
FOR THE EXTENT OF REMOVAL OF THE SOFT  
ORGANIC MATERIAL BELOW THE BASE WIDTH  
OF ROAD EMBANKMENTS, AND APPROACH  
FILL BENCHING REQUIREMENTS, SEE  
GRADING DRAWINGS

excavation not required under NBL

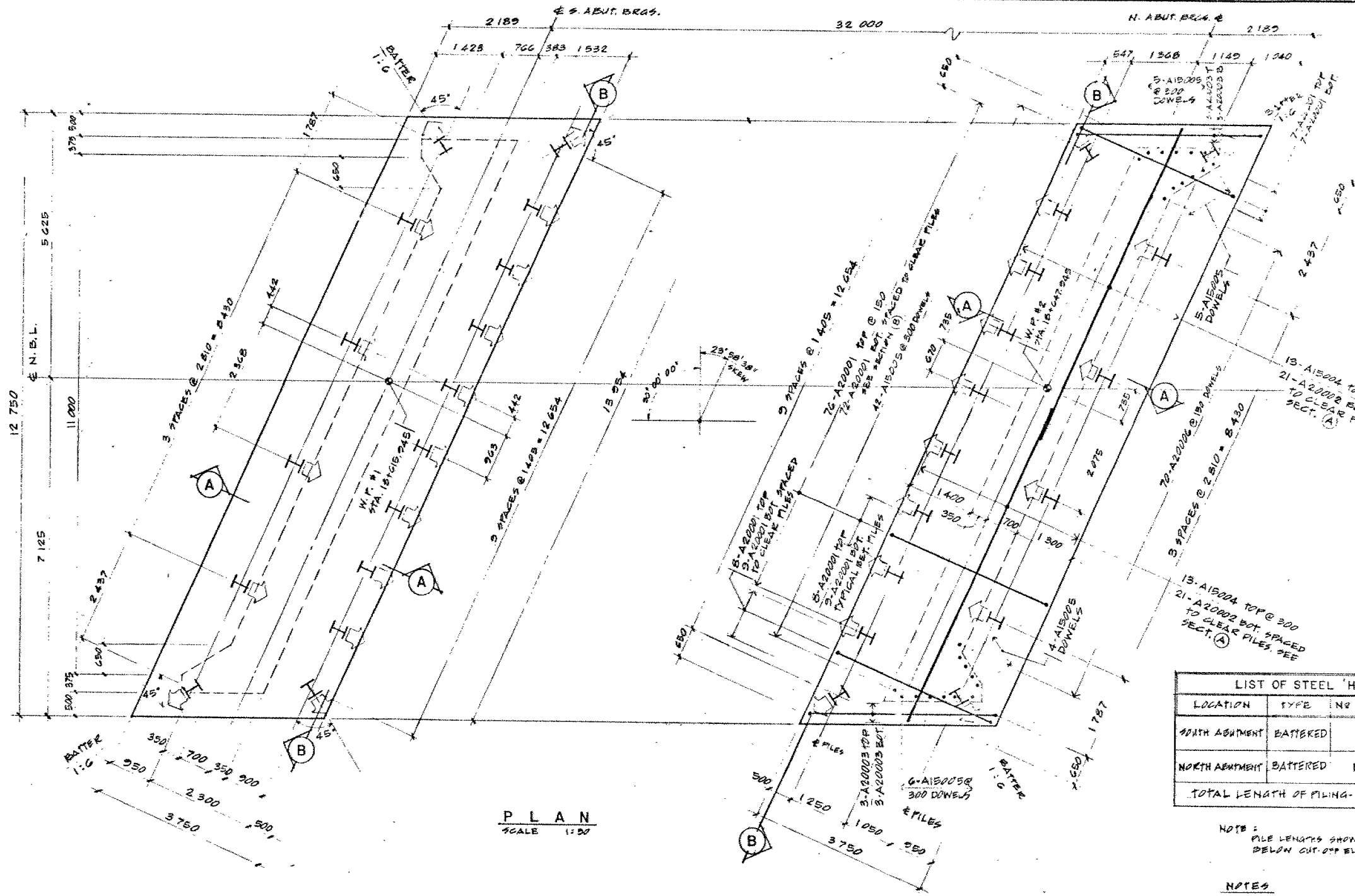


DRAWING NOT TO BE SCALED  
100 mm ON ORIGINAL DRAWING

REVISIONS

NO.	DATE	BY	DESCRIPTION
1			
2			
3			
4			
5			
6			
7			
8			
9			
10			





METRIC

DIMENSIONS ARE IN MILLIMETRES  
UNLESS OTHERWISE SHOWN.  
ELEVATIONS, COORDINATES, CURVE  
AND ALIGNMENT DATA ARE IN METRES.  
STATIONS ARE IN KILOMETRES + METRES.

DIST. No 13  
CONT No  
WP No 72-74-05

MOUNTAIN ROAD  
OVERPASS, N.B.L.  
FOOTINGS

MCCNEELY ENGINEERING  
& STRUCTURES LTD.  
KINGSTON OTTAWA

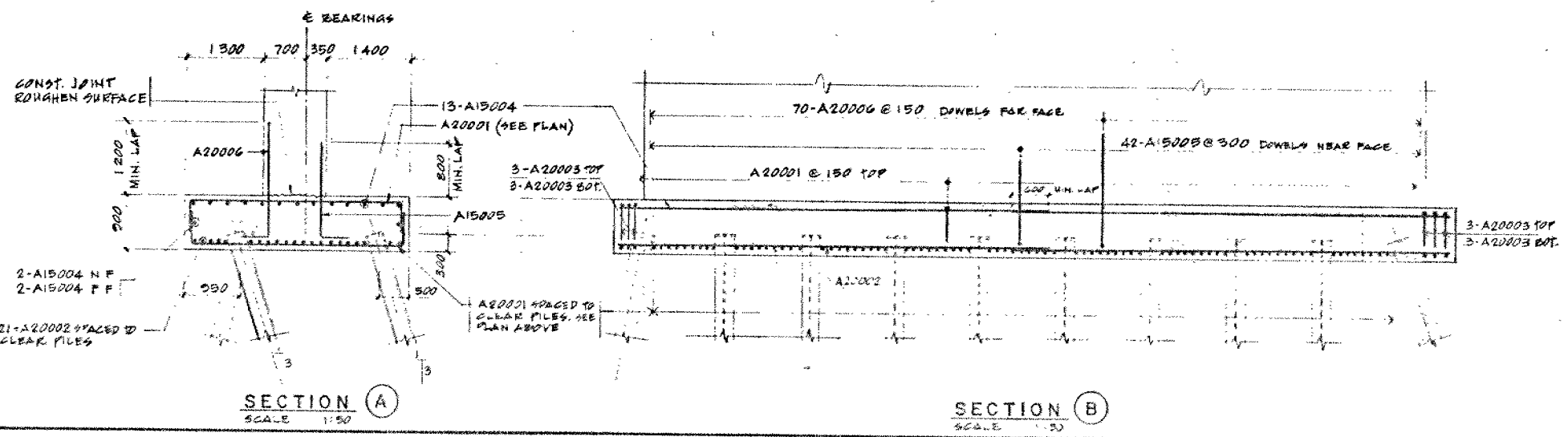
REINFORCING STEEL NOTATIONS:  
N.F. — NEAR FACE  
F.F. — FAR FACE  
E.W. — EAST WINGWALL  
W.W. — WEST WINGWALL

PILE DESIGN DATA:  
LOAD AT SERVICEABILITY LIMIT STATES TYPE II — 900 kN  
FACTORED LOAD AT ULTIMATE LIMIT STATES — 1200 kN

LIST OF STEEL 'H' PILES (HP310 x 79)				
LOCATION	TYPE	NO REQD.	LENGTH	REMARKS
SOUTH ABUTMENT	BATTERED	16	120 860	
NORTH ABUTMENT	BATTERED	16	169 380	
TOTAL LENGTH OF PILING-IN PLACE = 290 440 (32 PILES)				

NOTE:  
PILE LENGTHS SHOWN ARE THE THEORETICAL LENGTHS  
BELOW CUT-OFF ELEVATIONS

- NOTES
- 1) BATTERED PILES SHOWN THIS WAY 1:3 TYPICAL UNLESS OTHERWISE INDICATED
  - 2) SEE ABUTMENT DRAWING FOR GEOMETRY OF WALLS ABOVE FOOTINGS.



DRAWING NOT TO BE SCALED  
100 mm ON ORIGINAL DRAWING

REVISIONS	DATE	BY	DESCRIPTION

# memorandum



Ontario

248-3286

*Superata*

To: **D.R. Barnes, Manager  
Construction Office  
Northern Region  
North Bay, Ontario**

Date: **86 05 13**

File No.: **3162-2-4-114**

From: **Soils and Aggregates Section  
Engineering Materials Office  
Downsview, Ontario**

Re: **Rock Cut Excavation  
North Bay Bypass  
Contract 85-36**

At the request of your office, three rock cuts on the North Bay Bypass were visited, on 86 04 22, in the company of N. Bissonnette, Project Supervisor, and yourself.

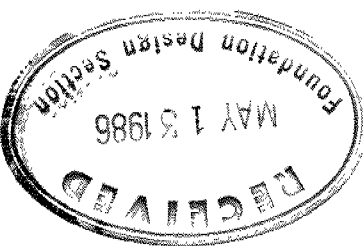
1. Rock Cut South of Wasi River (approx. Sta. 16+620)

This rock cut has been excavated in hard, massive granite gneiss which is intersected by widely spaced joints (natural planes of weakness). In my opinion, the irregular nature of the presplit face, most of the overbreak, and probably all the toes have resulted from poor drilling control. Considerable deflection of blasthole traces from the vertical is evident. Figures 1 and 2 show examples of non-vertical blastholes. Non-parallelism of blastholes results in a non-uniform concentration of explosive in the rock mass. In general, blastholes along the presplit line are approximately 900 mm apart, greater than M.T.C. maximum requirement of 750 mm. There is also evidence that some parts of the rock mass behind the presplit line have been disturbed and loosened by blasting e.g. fresh, irregular blast-induced cracks in previously intact rock, as well as large open cracks indicating substantial disturbance of the rock mass are in evidence.

2. Rock Cut North of Mountain Road (approx. Sta. 10+135)

This rock cut has been excavated in hard, massive granite gneiss very similar to the rock of the Wasi River Rock Cut described above. In general, blastholes in this rock cut were drilled vertically and along the presplit line. Some deflections from the vertical are in evidence. Spacing between blastholes along the presplit line is about 700 mm. The contractor appears to have produced a better product at this location than at the Wasi River. The contractor evidently contends that rock at this location is softer than rock south of the Wasi River.

Rock samples were taken from both of these rock cuts. Thin sections were cut and studied in the laboratory. The rock from the two cuts described above is coarsegrained granite gneiss consisting predominantly of quartz and feldspar with about 5 percent biotite mica. The two rock types are virtually identical. It is my conclusion that the rock at the two sites has very similar mineralogical and engineering properties.



3. Median Rock North of Highway 94

Rock was excavated from the median at this location for use as rockfill. The contractor claimed that rock was easier to excavate at this site than from the other two rock cuts described in 1 and 2 above. This rock was sampled on site. A thin section was cut and studied, and the rock was found to be finegrained and rich in biotite mica (about 20 percent). It is my conclusion that rock excavation at this site was easier due to the higher biotite content and more laminated nature of this gneiss.

If you have any questions, please contact me.



E.R. Magni,  
Geologist.

pc: J.I. McDougall  
J. Curtis  
M. Devata ✓

ERM/jlo  
86 05 13  
3162-2-4-114  
Attachment





FIGURE 1

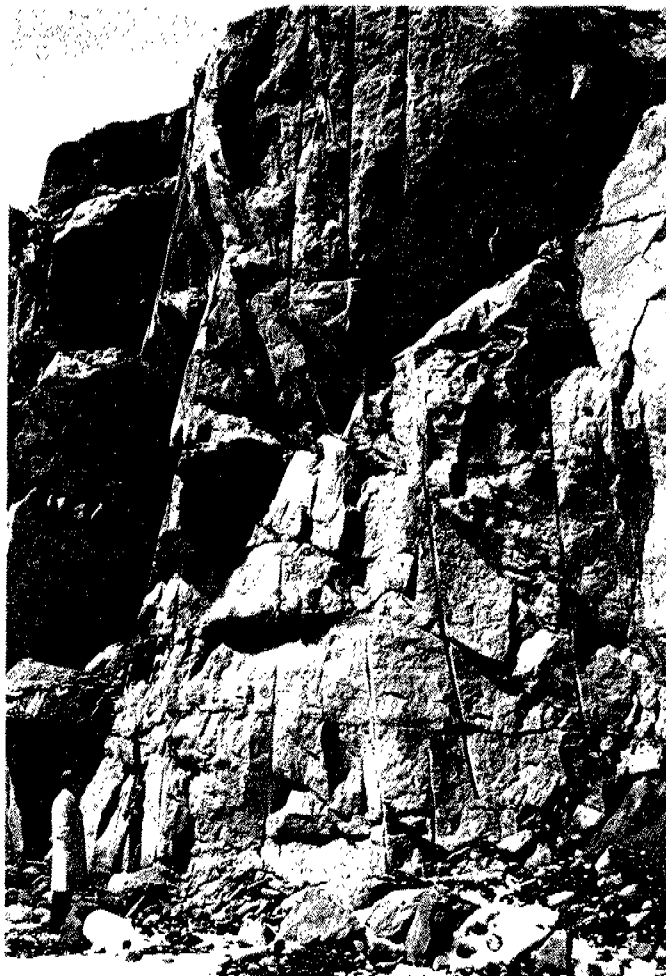


FIGURE 2

*Examples of poor drilling; note diverging and converging blasthole traces.*

# memorandum



To: Mr. D. F. Barnes  
Manager  
Construction Office  
Northern Region

Date: 86 02 04

Attention: D. Zimmerman

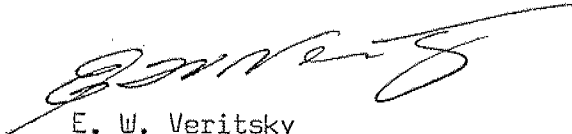
FROM: Geotechnical Section  
Northern Region

CONTRACT 85-36, HWY 11 NEW  
FROM 1.8 km S ASTORVILLE RD. N'LY 4.3 km  
DISTRICT # 13, NORTH BAY

Because of the erratic nature of the rock in the area this Section was advised that there is apparently an insufficient quantity to complete the fill on the northbound lanes, north side adjacent to the Astorville Road. A cost savings could be realized by using earth in lieu of rock borrow from the median.

The impact of an earth fill was examined including protection of slopes from erosion, washouts in the median and need for additional culverts. Since a structure was involved, the Foundations Section was contacted for their comments. Unfortunately, in the Foundation Design Report it was recommended that the soft soil be removed to its full horizontal and vertical extent within the approaches. The material was excavated to accommodate a rock fill and additional excavation is necessary for an earth fill leading to additional cost.

On considering these factors, it was recommended that a modification be made to extend the earth fill southerly. The remainder especially over the area which was excavated shall be rock fill. This shall include the on and off ramps. Sufficient rock borrow is required to complete the fills in this manner.

  
E. W. Veritsky  
Pavement Design &  
Evaluation Officer

EWV/ap  
cc: B. D. MacKinnon  
K. L. Williams  
G. A. Wrong  
G. Szekreny  
File (2)



SEND  
TO

Mr Gene Veritsky  
Geotechnical Section  
Northern Region - North Bay

FROM

B. E. RUCK

DEPT.

FOUNDATIONS

DATE

84 05 22

SUBJECT

MOUNTAIN RD O'PASS WP 72-74-05

Further to our telephone conversation of May 22, we provide the following comments:

- 1) Berms of 3m width are required for side slopes (at mid-height) in areas of fill of 10 m or higher.
- 2) Berms not required for forward slopes or between structures (ie median)
- 3) All should be benched for S Abut NBL's.

REPLY

*B. E. Ruck*

REPLY FROM

REPLY DATE

Mr. A.E. McKim  
Head, Operating Section  
Structural Office  
West Building


1980-11-07

From: Pavement & Foundation Design Section  
Room 313, Central Building

Re: Mountain Road Overpass  
W.P. 72-74-05/14, Site 43-205  
Highway 11, District 13, North Bay

A review of the preliminary structural drawings for these bridges leads to the following foundation related comments. The excavation of organic material shown back of the abutments should extend for at least 5 metres in front of the abutments. Due to the change in design from a single rigid frame to twin structures with perched abutments no soils information is available in the new abutment locations. It will therefore be necessary to undertake a supplementary field investigation to estimate pile lengths for the abutments. It is anticipated this work will be carried out prior to the final structural design.

PJS:ea

  
P.J. Stuart  
Foundations Engineer

# memorandum



To: Mr. A.E. McKim  
Head, Operating Section  
Structural Office

Date: 1980-08-26

Attention: Mr. A. Radkowski

From: Pavement & Foundation Design Section  
Room 313, Central Building  
Downsview

Re: Mountain Road Overpass  
W.P. 72-74-14, Site #43-205S S.B.L.  
Hwy. 11, Dist. 13, North Bay

In response to your request of 1980 08 15 we have reviewed the Preliminary Bridge Plan Drawing 43-205S - P1 and have the following comments to make.

The original foundation investigation was based on the assumption that in order to facilitate this crossing either an open rigid frame concrete tunnel or a multiplate super span arch would be constructed at this location. The preliminary plan shows a substantial change in the structure concept; i.e. a 35 metre single span structure founded on steel 'H' piles driven to bedrock. In view of the revised scheme additional subsurface information is required in the area of the abutments to enable estimates of the required pile lengths. It is our understanding that there may be revisions to the abutment locations as shown on the preliminary plan. Accordingly the additional boreholes will be carried out after the abutment locations have been finalized.

According to the structural plan the approach fills are to be constructed of rock fill with the abutments being founded on steel 'H' piles driven through the approach fill to bedrock. In order to facilitate the driving of piles it will be necessary to provide a granular core in the area of the abutments. The necessary design and construction requirements for a granular core are shown on Figure 1.

In the Foundation Investigation and Design report we recommended that for fills in excess of 10 metres high a 3 metre berm would be required for stability of the fill material within the fill itself. The structural plans show a 3 metre wide berm on the north abutment and a nominal berm for the south abutment. In the final geometry shown on the plans, Mountain Road serves as a berm for the forward approach slopes reducing the effective fill height to 8 metres. Accordingly the berms shown in the forward slopes are not required. For the side slopes the length of fills with more than 10 metres of fill is limited, in the plan extend to about 20 metres in length, and in view of this, side slope berms are not considered necessary on the west side of the structure approaches.



In our Foundation report we recommended removal of the surficial organic pockets which are located on the western portion of the site. Additional subexcavation requirements and limits will be supplied upon completion of the additional boreholes to be carried out. In view of the steep existing topography in the north approach area it is recommended that the approach fills be keyed into the existing slopes by means of benching. The Standard DD 414, Benching of Earth Slopes could be used as a guide for benching requirements.

We have no further comments at this time.

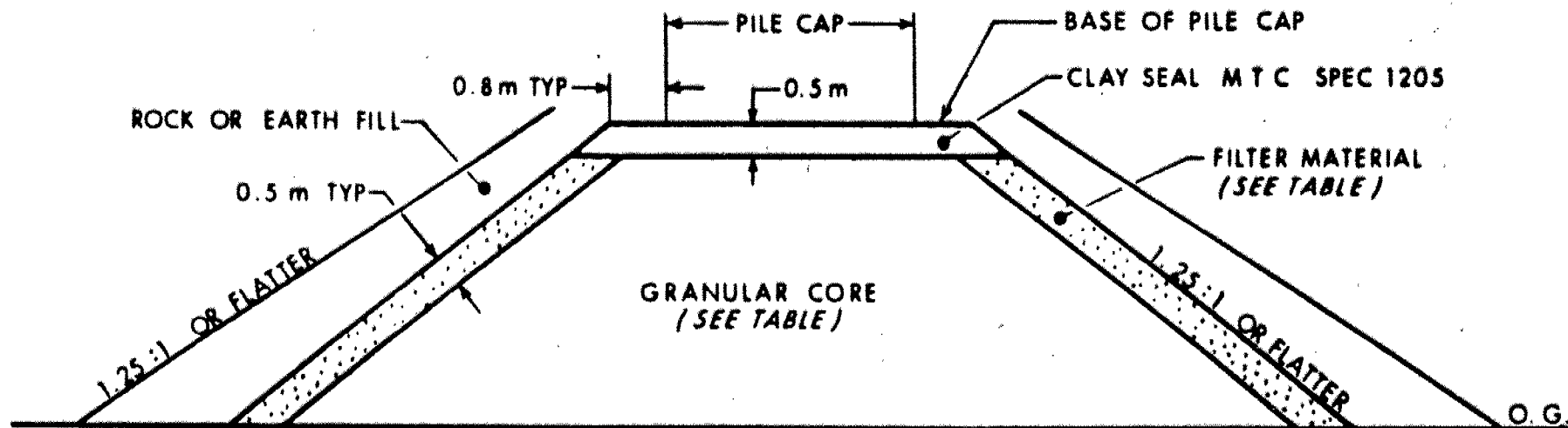
*M. MacLean*

M. MacLean  
Project Foundations Engineer  
For:  
M. Devata  
Senior Foundations Engineer

MM:ea

cc: S. McCombie

FILTER MATERIAL REQUIREMENTS	GRANULAR CORE COMPOSITION
NOT REQUIRED	GRAN 'A'
NOT REQUIRED	GRAN 'B'
GRAN 'A' or 'B'	GRAN 'C' MINUS STONES LARGER THAN 75 mm
DEPENDENT ON GRADATION OF CORE	OTHER GRANULAR MATERIAL



## REQUIREMENTS FOR GRANULAR CORE

N T S

FIG 1



## Memorandum

To: Mr. J. C. McAllister,  
Head,  
Structural Office,  
Northern Region.

Attention:

From: Pav't. & Foundation Design Section,  
Engineering Materials Office,  
Room 315, Central Building,  
Downsview, Ontario.

Date: 79 11 08

Our File Ref.

In Reply to

Subject:

Re: Mountain Road Overpass,  
Hwy. 11, District 13, North Bay,  
W.P. 72-74-05, Site 43-205.

Further to your request, we have recently completed the fieldwork portion of our foundation investigation for the above project. Due to the urgency of this project, we are hereby providing you with recommendations for the design and construction in order to meet your immediate needs. A complete Foundation Investigation Report will be forthcoming upon completion of drafting and laboratory testing by the later part of November, 1979.

Attached are two stratigraphical sections based on the recent foundation investigation. The sections are located along the proposed footing locations, o/s 5.5 m right and left of the Mountain Road Centreline and show standard penetration test 'N' values in the overburden and the boundaries between the overburden and bedrock surface. Generally speaking, subsurface conditions consist of overburden deposits up to 5.9 metres thick composed of loose to compact silty sand and compact to dense sand, some gravel overlying granite bedrock. Bedrock outcrops were noted south of Mountain Road. In the area of concern, the bedrock surface varies widely from elevation 205.6 to 215.4. Some pockets of soft organic silt up to 0.3 metres thick occur in the upper 2.1 metres on the west side of the area of concern. The groundwater level is about 0.5 metres below the ground surface.

It is proposed to facilitate this crossing with a 10 m x 4.6 m open concrete rigid frame tunnel or alternatively a multiplate super span arch on concrete strip footings with a total length of approximately 94 metres.

The proposed profile grade and the frost protection requirements are such that the footing founding elevation would be between 215.0 and 212.0 metres. At this founding level, portions of the footing would be founded within the granite bedrock, and major portions within the overburden. A structure founded in such a manner would be required to accommodate substantial differential settlements within the footing as well as between footings.

If the structure cannot be articulated in such a manner to accommodate the anticipated movements, then it will be necessary to either carry the foundation down to bedrock or support the



footing on piles driven to bedrock. The crossing could be more economically accomplished from the foundation point of view by a multiplate super span arch culvert or a closed type concrete rigid frame box culvert. In either case, it will be necessary to provide the structure with a 0.5 metre granular pad.

If you have any queries, please do not hesitate to call this office.

*M MacLean*

MM/MD/cy

M. MacLean,  
Project Foundations Engineer.  
For: M. Devata,  
Senior Foundations Engineer.

c.c. A. Radkowski  
S. McCombie  
W. Peck  
Files ✓