

G.I.-30 SEPT. 1976

GEOCRES No. 31E-109  
110DIST. 13 REGION 111W.P. No. 528-89-00 (1,2,3)

CONT. No. \_\_\_\_\_

W. O. No. \_\_\_\_\_

STR. SITE No. \_\_\_\_\_

HWY. No. 11LOCATION Eagle Lake Rd &South Entrance to the Town of  
No of PAGES - Trout Lake=====  
OVERSIZE DRAWINGS TO BE INCLUDED WITH THIS REPORT. \_\_\_\_\_REMARKS: \_\_\_\_\_  
\_\_\_\_\_  
\_\_\_\_\_  
\_\_\_\_\_



Ministry  
of  
Transportation

FILE

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## FOUNDATION DESIGN SECTION

**foundation  
investigation and  
design report**

ENGINEERING MATERIALS OFFICE  
FOUNDATION DESIGN SECTION

WP 528-89-00(1) DIST 13

HWY 11 STR SITE -

Route Study - Alternative TC7  
Beaver Creek/CNR Tracks

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## MEMORANDUM

To: P. Furst  
Head, Structural Section  
Northern Region

Date: 92/07/10

Frm: Foundation Design Section  
RM 315, Central Building

Re: Route Study - Alternative TC7  
Hwy. 11 - Beaver Creek/CNR Tracks  
WP 528-89-00(1)  
District 13, North Bay

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A preliminary foundation investigation was carried out to provide information for the planning of the proposed structure and approach fills at the above site.

The field work for this investigation was carried out between 92/03/31 and 92/04/10, and comprised of four sampled boreholes and five dynamic cone penetration tests. Boreholes were extended down to refusal depths with bedrock confirmed in one location. One borehole and cone test were conducted 165 m east of the proposed Hwy 11 centerline at a second possible alignment location. Ground surface elevations throughout the site ranged from 312.3 m to 313 m with the exception of the 1.5 m - 2.5 m elevated CNR tracks crossing the site. The locations of the boreholes and cone tests are shown on the attached marked up plan.

It is proposed to construct structures to carry the realigned Hwy 11 over Beaver Creek and the CNR tracks. At this time the structure and exact approach details are not known, except that approach fill heights will be about 12 m high.

The subsurface soil conditions consisted of the following distinct layers. Surficially about 1.0 m to 2.2 m thick organic layer was encountered, which was underlain by about 0.9 m to 2.4 m thick very loose to loose silty sand (Fig. 1). Below the silty sand layer a 10.5 m to 14.9 m thick cohesive stratum, composed of clayey silt was encountered. Based on field vane shear strengths obtained within this stratum, it is considered to possess a firm to stiff consistency (Fig. 2,3). This stratum was underlain by about 7.6 m to 9.1 m thick layer of silt with a very loose to compact state of denseness (Fig. 4). Underlying the above layer at a depth of 23.0 - 26.2 m is a heterogeneous mixture of silt, sand and gravel (random boulders) (Fig. 5). As all boreholes except one (BH 3-1) were terminated in this deposit its thickness was not determined. It was found to be in a compact to very dense state of denseness. Bedrock was encountered and cored in one borehole (BH 3-1) with a 3.05 m sample retrieved at a depth of 36.1. It was described as a quartzite of the

Grenville Province, strong, slightly weathered to unweathered. In the remaining boreholes, refusal to further advance the augering was encountered at depths of 24.5 m and 26.2 m below grade, the refusal depth increasing generally from south to north.

Observations of the groundwater level was carried out by measuring the water levels in open boreholes during the course of the investigation. Due to the swampy nature of the site the water table was found to be at the surface down to 0.76 m below ground surface. However upon approaching the refusal depths an artesian condition was found to exist with a pressure head of 1.5 m. One borehole (BH 1-1) had an initial pressure head of 4.3 m which when checked the next morning went down to 1.5 m. Water levels are expected to increase during spring thaw and summer seasons.

The Record of Borehole log sheets, plasticity chart, grain size distribution charts and plan are attached.

Considering the subsoil conditions at this site, any structure will have to be supported on piles driven down to bedrock or any other competent end bearing stratum which may be encountered approximately 24.5 m to 36.1 m below the existing ground surface.

For the purpose of the O.H.B.D.C., a factored axial bearing capacity at ULS of 1600 KN and an SLS Type II bearing capacity of 1150 KN shall be used for 310 X 110 steel H piles. It should be noted that due to the presence of boulders termination depths of piles may be variable. Termination depths generally range from 24.5 m - 29.6 m, with the exception of one borehole (BH 3-1) where bedrock was encountered at 36.1 m. In view of the above, pile installations should be controlled by the Hiley formula.

With the construction of the approach embankments and the resulting settlements due to the consolidation of the foundation soils, the piles at the abutments may be subjected to some downdrag forces. For preliminary design purposes 1350 KN and 1000 KN shall be used for factored ULS and SLS capacities for a 310 X 110 steel H pile at the abutment.

Use of standard pile tips to facilitate driving of piles without damage, use of batter piles to resist lateral forces and provision of 2.0 m earth cover for pile caps for frost protection, etc. should be adhered to.

Similarly, lateral earth pressures on structures should be computed using appropriate earth pressure coefficients for flexible abutments and at rest earth pressure for rigid abutments.

Construction of 12 m high approach embankment with forward and side slopes of 2H:1V will require a midheight berm width of 38 m. It is expected to undergo settlement in the order of 0.8 m which would occur over a long period of time. In view of this the fill should be placed well in advance to reduce the post construction settlements.

Alternatively, consideration may be given to utilizing lightweight fills. For forward and side slopes of 2H:1V a midheight berm width of 22 m would be required which would have an approximate settlement of 0.7 m.

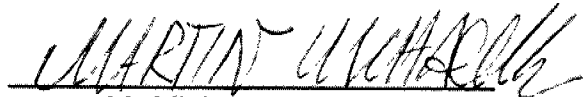
Dewatering problems during the construction of pile caps for the abutments could be avoided by locating the pile caps up within the fill. However, the pile caps for the pier will have to be constructed 2.0 m below the grade level requiring a dewatering scheme utilizing sump pumps or sheet piles.

Based on the results of one borehole (BH 5-1) relocating the alignment further east of the proposed alignment is not recommended as there are no improvements to the subsoil conditions at this location.

In the construction of the embankment fills, all softened and/or organic material should be excavated for their full depth within the plan limits prior to fill placement.

Recommendations given in this report are to be regarded as preliminary only, and as such are subject to revision when and if new information becomes available. It will be necessary to carry out additional field investigation when the final design details are available.

If there are any questions, please do not hesitate to contact this office.



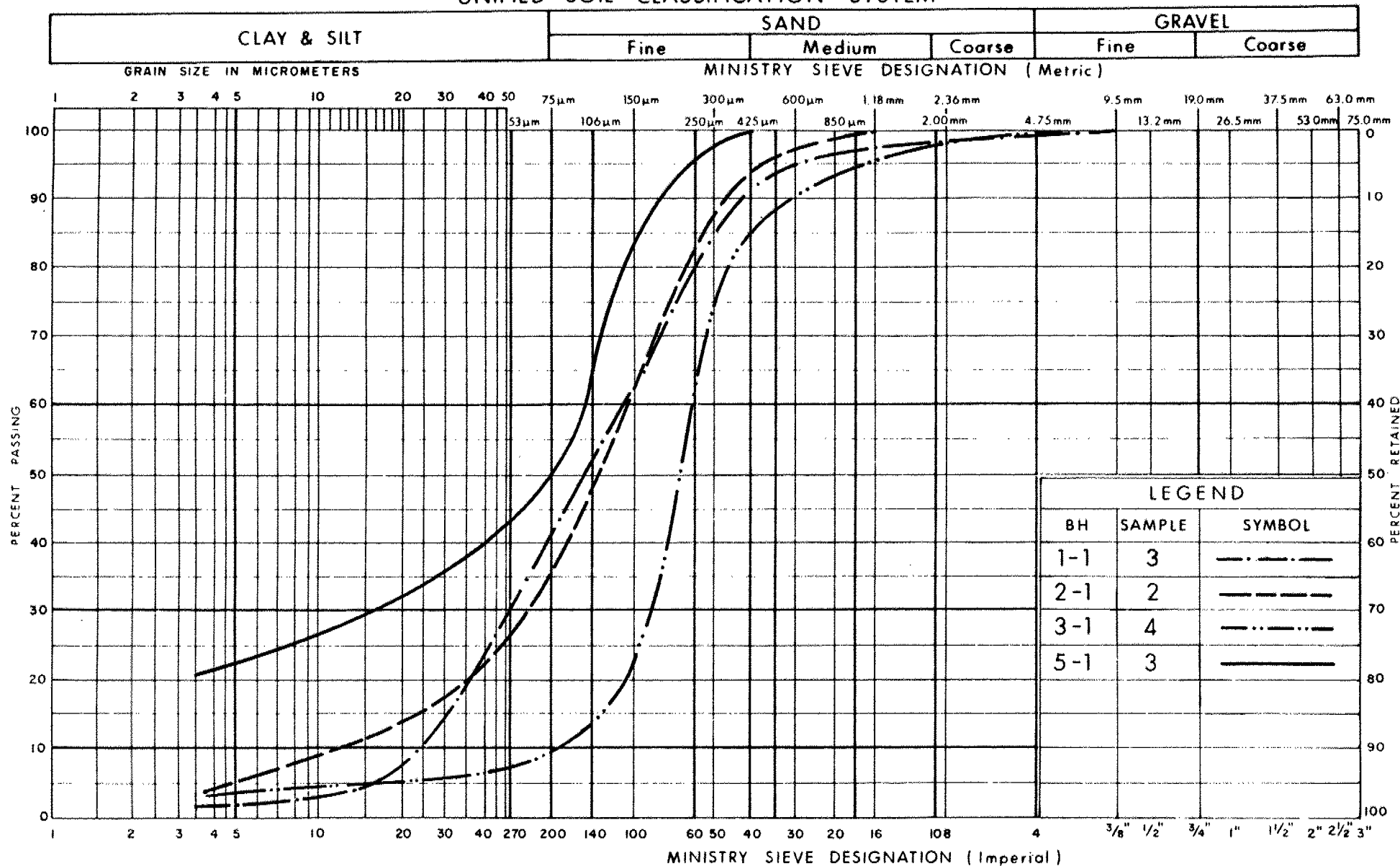
M. Michalek

Jr. Foundation Engineer

For: Dr. B. Iyer, P. Eng  
Sr. Foundation Engineer

## APPENDIX

## UNIFIED SOIL CLASSIFICATION SYSTEM



GRAIN SIZE DISTRIBUTION  
SILTY SAND  
TRACE CLAY

FIG No 1

W P 528-89-00 (1)

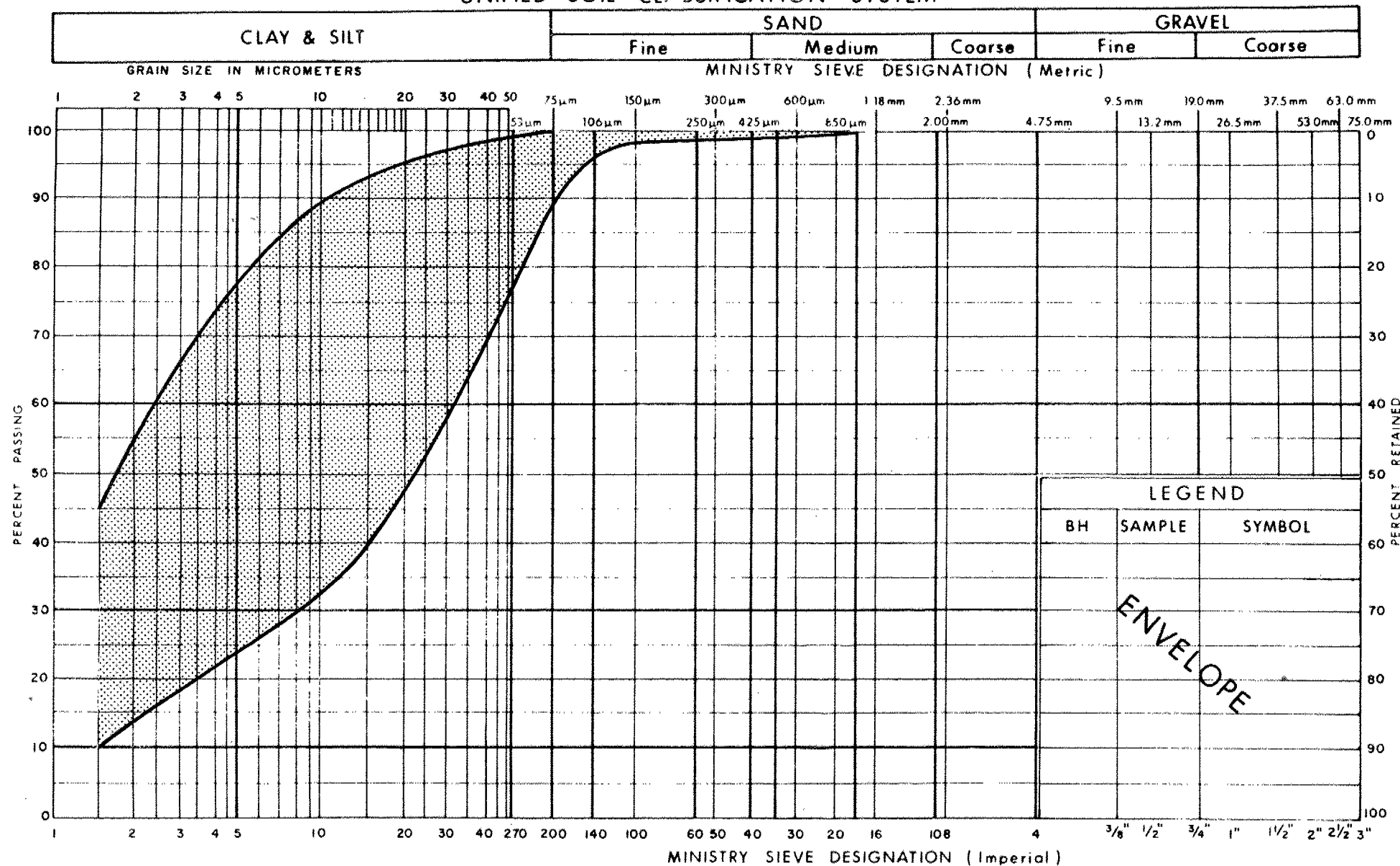


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## UNIFIED SOIL CLASSIFICATION SYSTEM

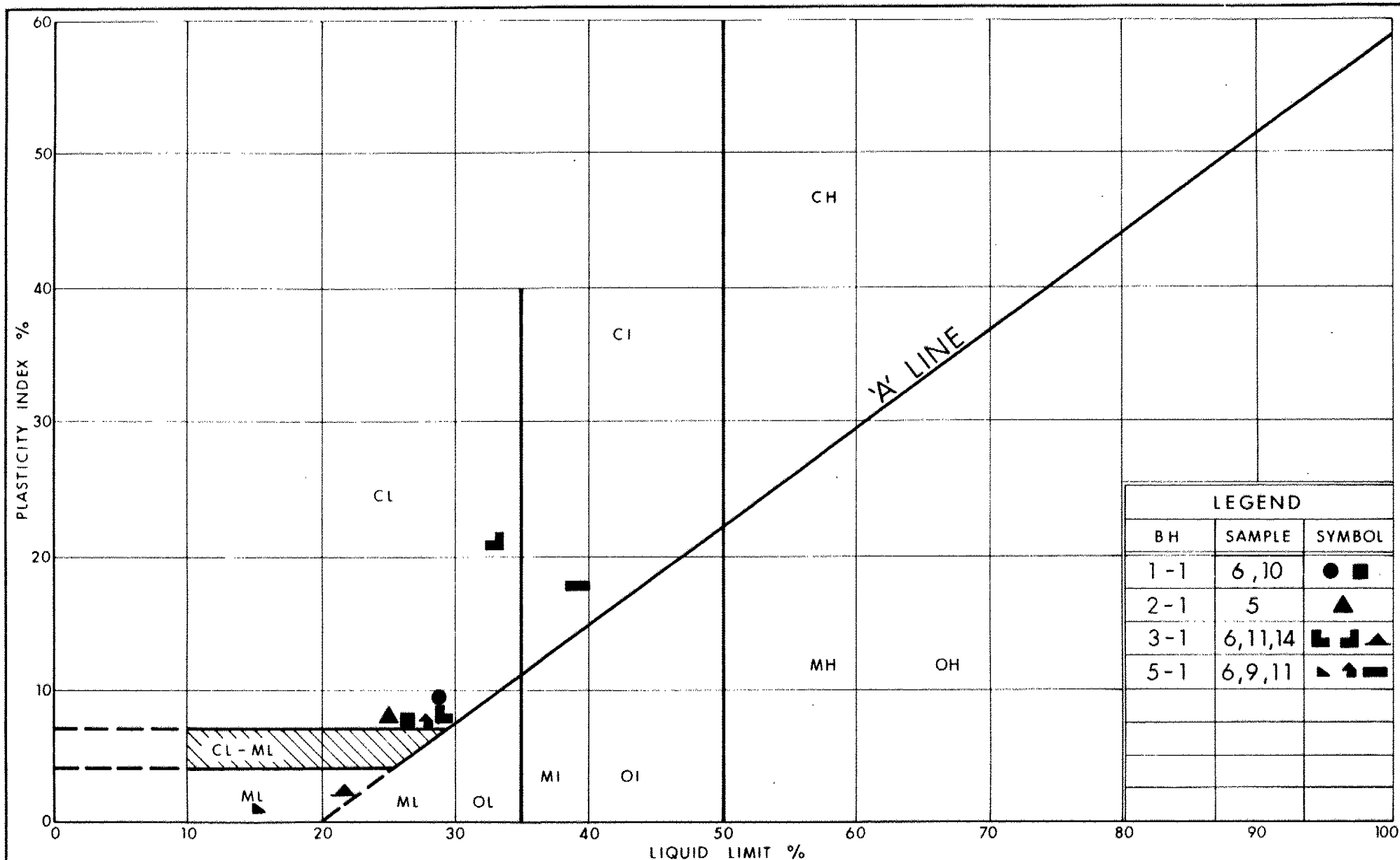


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## GRAIN SIZE DISTRIBUTION CLAYEY SILT

FIG No 2

W P 528-89-00 (1)



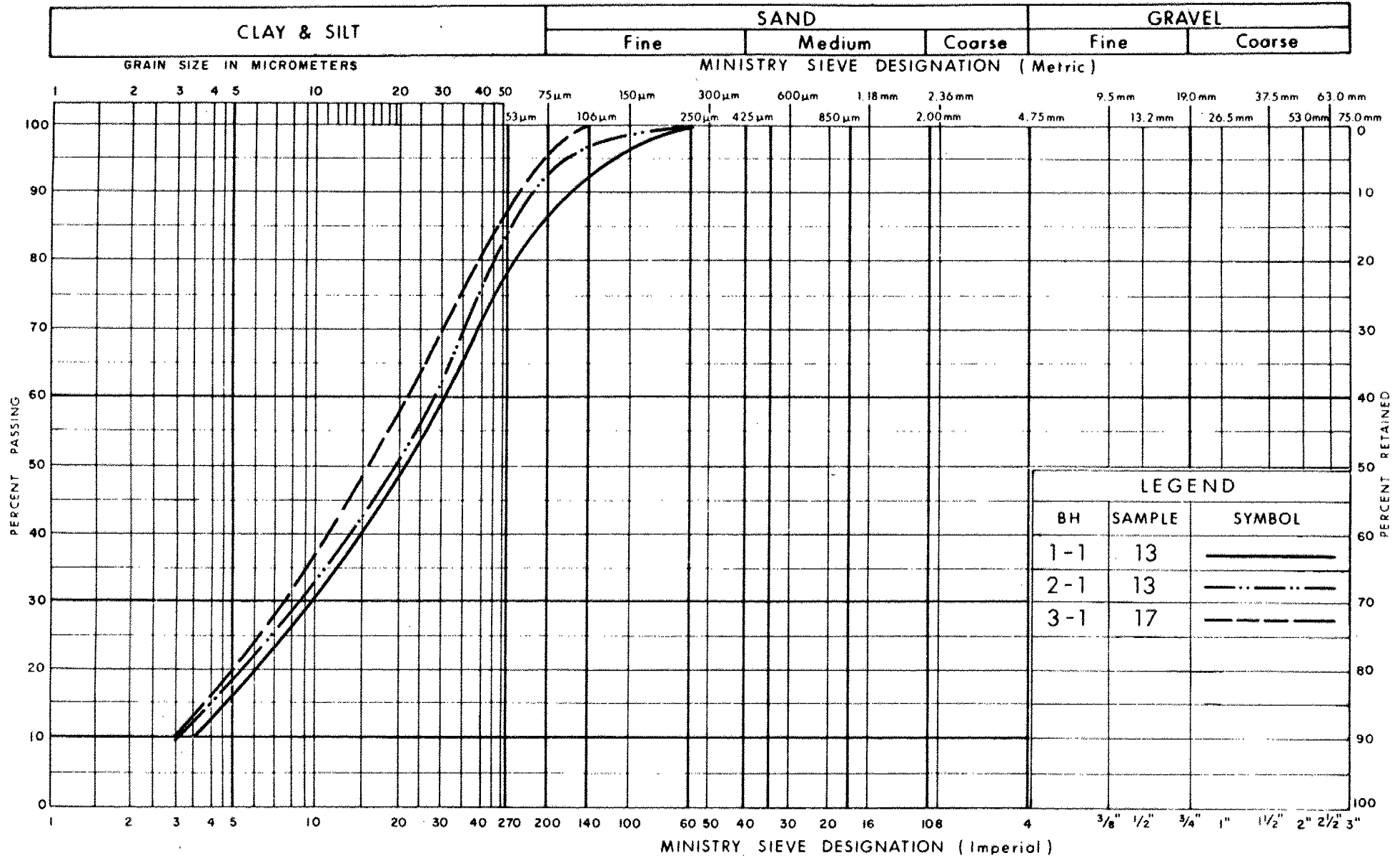
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## PLASTICITY CHART CLAYEY SILT

FIG No 3

W P 528-89-00 (1)

## UNIFIED SOIL CLASSIFICATION SYSTEM



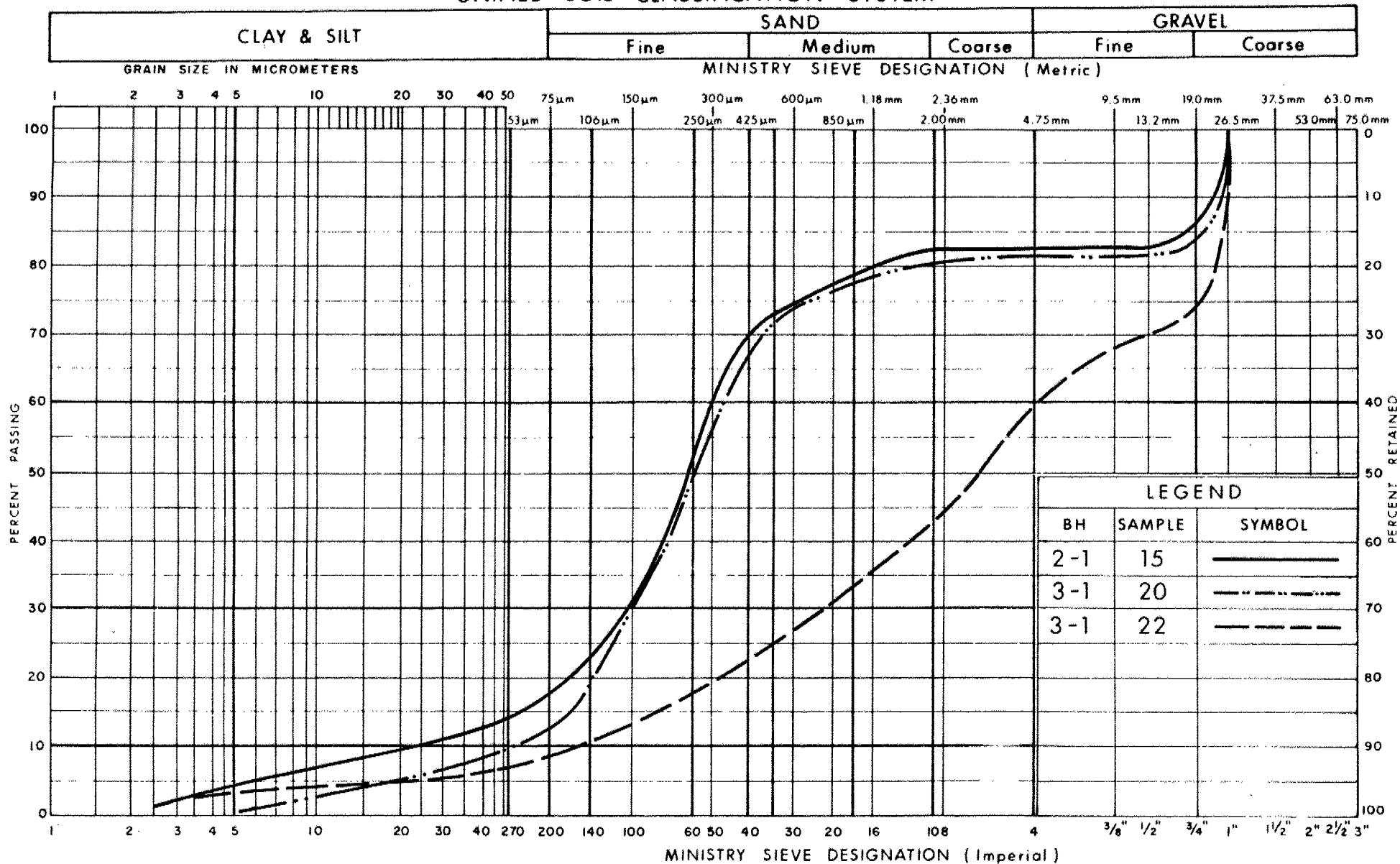
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**GRAIN SIZE DISTRIBUTION**  
**SILT**  
TRACE SAND, TRACE CLAY

FIG No 4

W P 528-89-00(1)

## UNIFIED SOIL CLASSIFICATION SYSTEM



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**GRAIN SIZE DISTRIBUTION**  
**HETEROGENEOUS MIXTURE OF SILT, SAND & GRAVEL**  
 (GLACIAL TILL)

FIG No 5

W P 528-89-00(1)

## EXPLANATION OF TERMS USED IN REPORT

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

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

SOILS ARE DESCRIBED BY THEIR COMPOSITION AND CONSISTENCY OR DENSENESS.

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

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

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

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

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

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

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

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

**JOINTING AND BEDDING:**

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

## ABBREVIATIONS AND SYMBOLS

### FIELD SAMPLING

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

### STRESS AND STRAIN

$u_w$	kPa	PORE WATER PRESSURE
$r_u$	1	PORE PRESSURE RATIO
$\sigma$	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 <sup>-1</sup>	COEFFICIENT OF VOLUME CHANGE
$C_c$	1	COMPRESSION INDEX
$C_s$	1	SWELLING INDEX
$C_\alpha$	1	RATE OF SECONDARY CONSOLIDATION
$c_v$	m <sup>2</sup> /s	COEFFICIENT OF CONSOLIDATION
H	m	DRAINAGE PATH
$T_v$	1	TIME FACTOR
U	%	DEGREE OF CONSOLIDATION
$\sigma'_{v0}$	kPa	EFFECTIVE OVERBURDEN PRESSURE
$\sigma'_p$	kPa	PRECONSOLIDATION PRESSURE
$\tau_f$	kPa	SHEAR STRENGTH
$c'$	kPa	EFFECTIVE COHESION INTERCEPT
$\phi'$	-°	EFFECTIVE ANGLE OF INTERNAL FRICTION
$c_u$	kPa	APPARENT COHESION INTERCEPT
$\phi_u$	-°	APPARENT ANGLE OF INTERNAL FRICTION
$\tau_R$	kPa	RESIDUAL SHEAR STRENGTH
$\tau_r$	kPa	REMOULDED SHEAR STRENGTH
$S_f$	1	SENSITIVITY = $\frac{c_u}{\tau_r}$


### PHYSICAL PROPERTIES OF SOIL

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

# RECORD OF BOREHOLE No 1-1

1 OF 1

METRIC

W.P. 528-89-00(1) LOCATION  Coords: N 5 090 300, E 315 616 ORIGINATED BY M.M.  
DIST 13 HWY 11 BOREHOLE TYPE Hollow Stem Auger, Cone, Rock Core, BW Casing COMPILED BY M.M.  
DATUM Geodetic DATE 92/05/03 CHECKED BY B.I.

SOIL PROFILE			SAMPLES			GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT		PLASTIC LIMIT NATURAL MOISTURE CONTENT		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	20 40 60 80 100	W <sub>p</sub>	W		
312.5	Ground Surface												
0.0	Organics		1	SS	0	/46cm	312						
311.5													
1.0	Silty Sand, Trace Clay Very Loose to Loose		2	SS	7		310						1 55 42 2
			3	SS	7								
309.1			4	SS	2								
3.4	Clayey Silt Pockets of Silt and Silty Clay Firm		5	SS	0	/46cm	308						0 1 90 9
			6	SS	0	/46cm							
			7	TW	PM		306					16.5	
			8	SS	0	/46cm	304						
			9	SS	0	/46cm	302						0 0 78 22
			10	SS	0	/46cm							
			11	SS	2		300						
298.6													
13.9	Silt, Trace Sand Trace Clay Very Loose to Loose		12	SS	7		298						
							296						
			13	SS	4		294						1 10 80 9
			14	SS	3		292						
289.5							290						
23.0	Heterogeneous Mixture of Silt, Sand and Gravel (Glacial Till) Very Dense		15	SS	19	/10cm	288						
288.0													
24.5	Quartzite Bedrock or Boulder Strong		16	RC	REC 98%								RQD 98%
286.8													
25.7	End of Borehole * Artesian condition encountered 92/05/06 - 4.3 m 92/05/07 - 1.5 m												

# RECORD OF BOREHOLE No 2-1

1 OF 1

METRIC

W.P. 528-89-00(1) LOCATION Coords: N 5 090 406, E 315 808 ORIGINATED BY M.M.  
DIST 13 HWY 11 BOREHOLE TYPE Hollow Stem Augers, BW Casing COMPILED BY M.M.  
DATUM Geodetic DATE 92/04/02 CHECKED BY B.I.

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 80 100					
312.3	Ground Surface													
0.0	Organics		1	SS	0	/46cm	312							
311.1														
1.2	Silty Sand, Trace Clay		2	SS	7									0 64 31 5
310.2	Very Loose to Loose													
2.1	Clayey Silt Pockets of Silt and Silty Clay Firm		3	SS	5		310							
			4	SS	5									
			5	SS	0	/46cm	308							0 4 73 23
			6	SS	0	/46cm								
			7	TW	PM		306							
			8	SS	0	/46cm	304							
			9	SS	0	/46cm	302							
			10	SS	2		300							
			11	SS	1		298							
			12	SS	1		296							
295.3							294							0 8 85 7
17.0	Silt Trace Sand, Trace Clay Very Loose to Compact		13	SS	2		292							
			14	SS	12		290							
287.7			15	SS	27		288							17 67 15 1
24.6	Heterogeneous Mixture of Silt, Sand and Gravel (Glacial Till) Very Dense		16	SS	120	/15cm								
286.1														
26.2	End of Borehole Probable Bedrock or Boulder • Artesian condition encountered 92/04/01 - 1.2 m 92/04/02 - 1.5 m													

# RECORD OF BOREHOLE No 3-1

1 OF 2

METRIC

W.P. 528-89-00(1) LOCATION Coords: N 5 090 445, E 315 658 ORIGINATED BY M.M.  
DIST 13 HWY 11 BOREHOLE TYPE Hollow Stem Augers, BW Casing, Rock Core COMPILED BY M.M.  
DATUM Geodetic DATE 92/03/31 CHECKED BY B.I.

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 7 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					
312.4	Ground Surface																
0.0			1	SS	4		312										
	Organics Wood Particles		2	SS	2												
310.2			3	SS	0	/46cm											
2.2			4	SS	3		310										1 90 6 3
309.0	Silty Sand, Trace Clay Very Loose		5	SS	2												
3.4			6	SS	5		308										0 4 71 25
			7	SS	0	/46cm											
			8	SS	0	/46cm	306										
			9	TW	PM		304									18.5	
			10	SS	0	/46cm	302										
	Clayey Silt Pockets of Silt and Silty Clay Firm to Stiff		11	SS	1		300										0 0 65 35
			12	SS	3		298										
			13	SS	1		296										
296.2			14	SS	3		294										
16.2			15	SS	0	/46cm	292										0 4 88 8
			16	SS	5		290										
			17	SS	5		288										
	Silt Trace Sand, Trace Clay Very Loose		18	SS	0	/46cm	286										
			19	SS	4		284										
286.2			20	SS	41		282										20 68 11 1
26.2	Heterogeneous Mixture of Silt, Sand and Gravel (Glacial Till) Compact to Very Dense Numerous Boulders		21	RC	REC												RQD 25%
281.9																	
30.5																	

Continued

+3, x5, Numbers refer to  
Sensitivity

20  
15-5 (%) STRAIN AT FAILURE  
10

Continued



# RECORD OF BOREHOLE No 3-1

2 OF 2

METRIC

W.P. 528-89-00(1) LOCATION Coords: N 5 090 445, E 315 658 ORIGINATED BY M.M.  
DIST 13 HWY 11 BOREHOLE TYPE Hollow Stem Augers, BW Casing, Rock Core COMPILED BY M.M.  
DATUM Geodetic DATE 92/03/31 CHECKED BY B.L.

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					
281.9	Continued															
30.5			22	SS	26											40 52 5 3
276.3																
36.1	Quartzite Bedrock Strong Weathered to Slightly Weathered		23	RC	REC 88.3%											RQD 80%
273.2			24	RC	REC 100%											RQD 95%
39.2	End of Borehole • Artesian condition encountered 92/05/08 - 1.6 m 92/05/09 - 1.7 m															

# RECORD OF BOREHOLE No 4-1

1 OF 1

METRIC

W.P. 528-89-00(1) LOCATION Coords: N 5 090 491, E 313 644 ORIGINATED BY M.M.  
 DIST 13 HWY 11 BOREHOLE TYPE Cone Test COMPILED BY M.M.  
 DATUM Geodetic DATE 92/04/07 CHECKED BY B.I.

SOIL PROFILE			SAMPLES			GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT		PLASTIC NATURAL LIQUID LIMIT MOISTURE CONTENT			UNIT WEIGHT $\gamma$ 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 80 100	W <sub>p</sub> W W <sub>L</sub>	WATER CONTENT (%) 20 40 60			
312.5	Ground Surface													
0.0	Probable Organics						312							
310.1							310							
2.4	Probable Silty Sand, Trace Clay						308							
308.5							306							
4.0	Probable Clayey Silt Pockets of Silt and Clayey Silt						304							
							302							
							300							
							298							
297.0							296							
15.5	Probable Silt, Trace Sand Trace Clay						294							
							292							
							290							
							288							
287.9							286							
24.6	Probable Heterogeneous Mixture of Silt, Sand and Gravel (Glacial Till)						284							
282.9														
29.6	End of Cone Test													

# RECORD OF BOREHOLE No 5-1

1 OF 1

METRIC

W.P. 528-89-00(1) LOCATION Coords: N 090 460, E 315 815 ORIGINATED BY M.M.  
 DIST 13 HWY 11 BOREHOLE TYPE Hollow Stem Auger, Cone Test COMPILED BY M.M.  
 DATUM Geodetic DATE 92/04/10 CHECKED BY B.J.

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 7 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 80 100					
313.0	Ground Surface													
311.8	Organics		1	SS	4		312							
1.2	Silty Sand, Trace Clay Very Loose to Compact		2	SS	9									
			3	SS	13									
			4	SS	15									
310.1			5	SS	5									
2.9	Clayey Silt Pockets of Silt and Silty Clay Firm		6	SS	0	/46cm	308							0 48 33 19
			7	SS	0	/46cm								0 8 83 9
			8	SS	0	/46cm	306							
			9	SS	0	/46cm	304							
			10	TW	PM									
			11	SS	0	/46cm	302							0 0 55 45
300.4			12	SS	3		300							
12.6	End of Borehole													
	Probable Clayey Silt													
296.1														
16.9	Probable Silt Trace Sand, Trace Clay													
287.1														
25.9	End of Cone Test													



*FILE*



Ministry  
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## **FOUNDATION DESIGN SECTION**

**foundation  
investigation and  
design report**

ENGINEERING MATERIALS OFFICE  
FOUNDATION DESIGN SECTION

WP 528-89-00(2) DIST 13  
HWY 13 STR SITE -  
Route Study - Alternative SS1  
South River Crossing

DISTRIBUTION

P. Furst (2)  
J. McDougall  
G. Todd  
S. Wilson (2)  
K.G. Bassi  
S.J. Dunham  
E.A. Joseph  
D.J. Armatage (Cover Only)  
F. Bacchus (Cover Only)  
File

## MEMORANDUM

To: P. Furst  
Head, Structural Section  
Northern Region

Date: 92/05/15

Frm: Foundation Design Section  
RM 315, Central Building

Re: Route Study - Alternative SS1  
Hwy 11 - South River Crossing  
WP 528-89-00(2)  
District 13, North Bay

---

A preliminary foundation investigation was carried out to provide information for the planning of the proposed structure and approach fills at the above site.

The field work for this investigation was carried out between 92/04/11 to 92/04/21, and comprised of two sampled boreholes together with two dynamic cone penetrations tests adjacent to these holes. Boreholes were extended down to depths of 27.0 m and 36.6 m, with bedrock confirmed in one location and end bearing material encountered in the other. Both boreholes were located west of the South River, no borehole was carried out to the east of the river due to access problems. Ground surface elevations throughout the site ranged from 328.5 m to 331 m to the west of the South River, with a natural embankment to the east ranging in elevation from 328.5 m to 364 m. The locations of the boreholes and cone tests are shown on the attached marked up plan.

The soil stratum consisted surficially of a 0.3 m - 0.6 m thick organic layer. Underlying the organics was a stratum consisting of very loose to dense sand (Fig. 1). This extended down to 16.7 m and 24.4 m in BH 2-2 and BH 1-2 respectively. Generally this layer is loose becoming compact to dense with depth. Underlying the above is a deposit of heterogeneous mixture of silt, sand and gravel (Fig. 2). BH 1-2 contained a heavy concentration of boulders randomly encountered down to the refusal depth of 36.6 m. Standard penetration tests in BH 2-2 within this layer indicated a dense to very dense state of denseness. In this borehole bedrock was encountered and cored at a depth of 23.9 m with a 3.1 m sample retrieved. It was described as a quartzite of the Grenville Province, strong, slightly weathered to unweathered.

Observations of the groundwater level was carried out by measuring the water levels in open boreholes during the course of the investigation. Due to the swampy nature of the site the water table was found to be 0.3 m above the ground surface to 0.48 m below. Water levels are expected to increase during spring thaw and the summer seasons.

Record of Borehole log sheets, grain size distribution charts and plans are included.

Considering the subsoil conditions at this site, any structure will have to be supported on piles driven down to bedrock or any other competent end bearing stratum which may be encountered approximately 23.9 m to 24.4 m below the existing ground surface.

For the purpose of the O.H.B.D.C., a factored axial bearing capacity at ULS of 1600 kN and a SLS Type II bearing capacity of 1150 kN shall be used for 310 X 110 steel H piles. It should, however, be noted that due to the presence of boulders and varying bedrock depths termination depths of piles may be variable. In view of the above, pile installation should be controlled by the Hiley formula.

Use of standard pile tips to facilitate driving of piles without damage, use of batter piles to resist lateral forces and provision of 2.0 m earth cover for pile caps for frost protection etc. should be adhered to.

Similarly, lateral earth pressures on structures should be computed using appropriate earth pressure coefficients for flexible abutments and at rest earth pressures for rigid abutments.

Construction of 8 m high approach embankment will require forward and side slopes of 2H : 1V. It is expected to undergo settlement in the order of 100 mm to 120 mm. Elastic settlements will occur immediately following the placement of the fill.

Dewatering problems during the construction of pile caps for the abutments could be avoided by locating the pile caps up within the fill. However, the pile caps for the pier will have to be constructed 2.0 m below the grade level requiring a dewatering scheme utilizing oversized excavations and sump pumps.

In the construction of the embankment fills, all softened and/or organic material should be excavated for their full depth within the plan limits prior to fill placement.

Recommendations given in this report are to be regarded as preliminary only, and as such are subject to revision when and if new information becomes available. It will be necessary to carry out additional field investigation when the final design details are available.

If there are any questions, please do not hesitate to contact this office.



M. Michalek

Jr. Foundation Engineer

For:

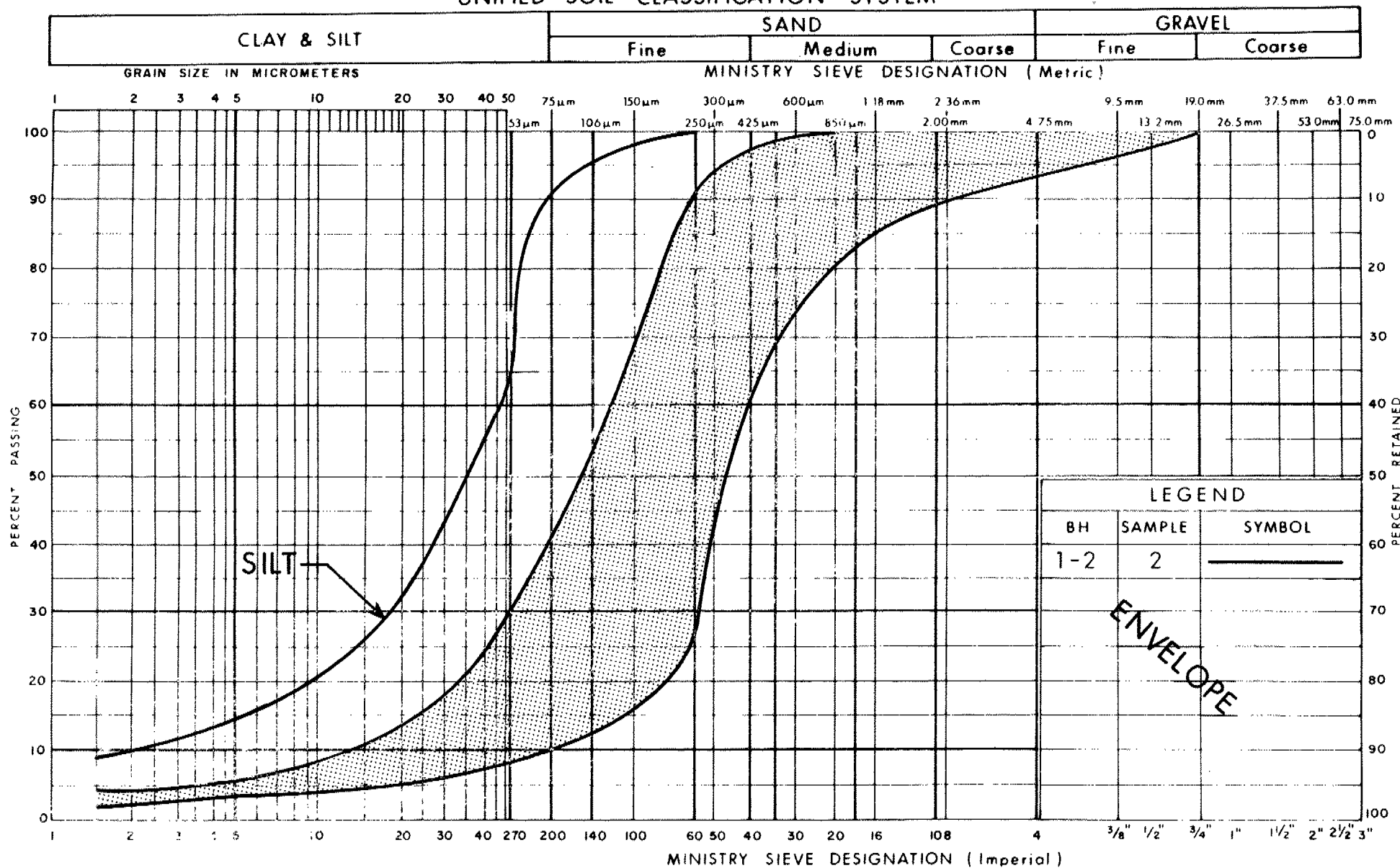
Dr. B. Iyer, P. Eng

Sr. Foundation Engineer



## APPENDIX

## UNIFIED SOIL CLASSIFICATION SYSTEM



Ontario

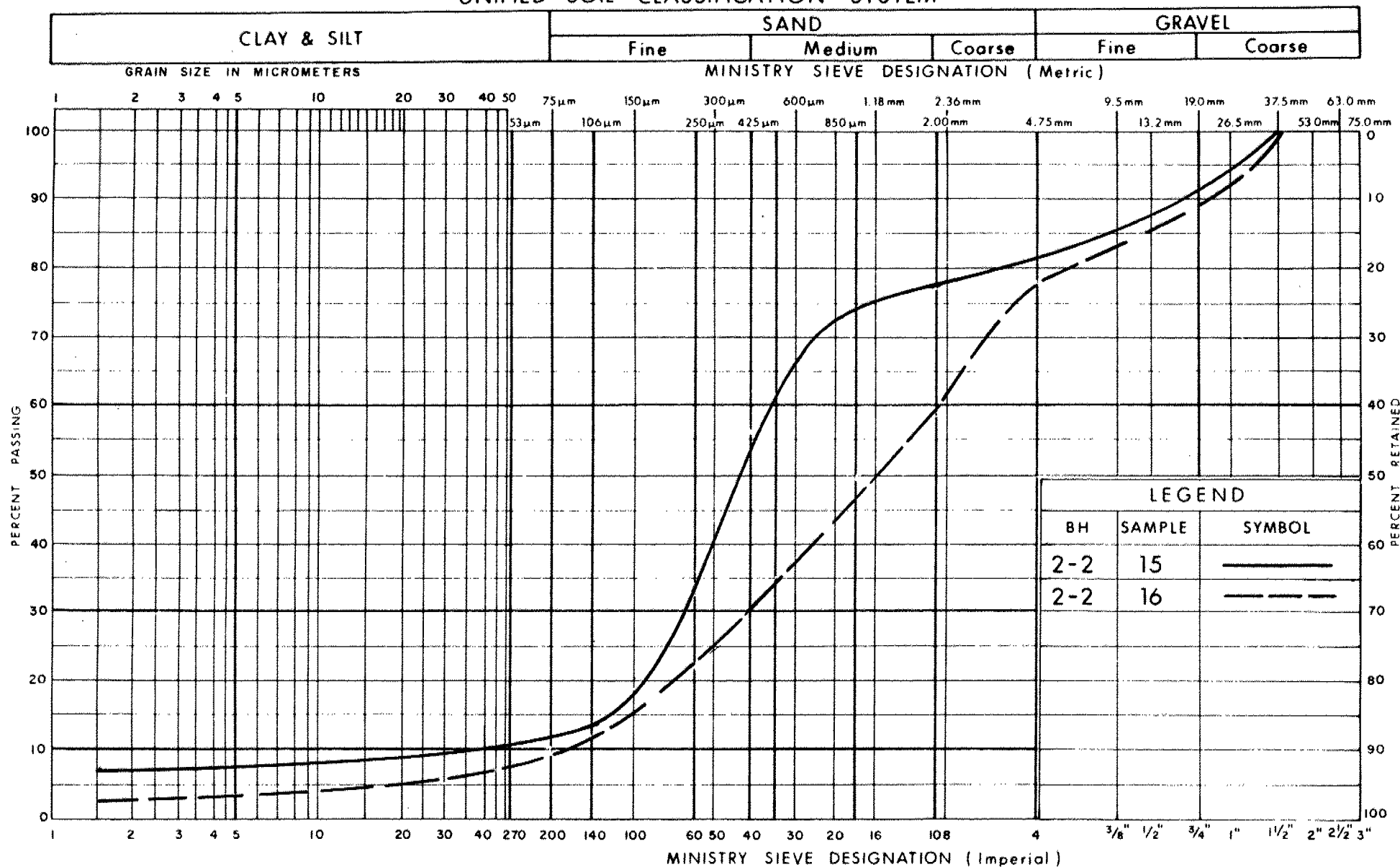
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GRAIN SIZE DISTRIBUTION  
SAND  
TRACE / WITH SILT, TRACE CLAY

FIG No 1

W P 528-89-00 (2)

## UNIFIED SOIL CLASSIFICATION SYSTEM



Ministry of  
Transportation

**GRAIN SIZE DISTRIBUTION**  
**HETEROGENEOUS MIXTURE OF SILT, SAND & GRAVEL**  
 (GLACIAL TILL)

FIG No 2

W P 528-89-00(2)

## EXPLANATION OF TERMS USED IN REPORT

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

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

SOILS ARE DESCRIBED BY THEIR COMPOSITION AND CONSISTENCY OR DENSENESS.

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

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

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

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

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

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

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

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

**JOINTING AND BEDDING:**

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

## ABBREVIATIONS AND SYMBOLS

### FIELD SAMPLING

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

### MECHANICAL PROPERTIES OF SOIL

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

### STRESS AND STRAIN

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

### PHYSICAL PROPERTIES OF SOIL

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

# RECORD OF BOREHOLE No 1-2

1 OF 2

METRIC

W.P. 528-89-00(2) LOCATION Coords: N 5 079 860, E 313 565 ORIGINATED BY M.M.  
 DIST 13 HWY 11 BOREHOLE TYPE Hollow Stem Auger, Cone, Rock Core, Wash Boring COMPILED BY M.M.  
 DATUM Geodetic DATE 92/04/14 CHECKED BY B.I.

SOIL PROFILE		SAMPLES			GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT 20 40 60 80 100 SHEAR STRENGTH kPa ○ UNCONFINED + FIELD VANE ● QUICK TRIAXIAL × LAB VANE 20 40 60 80 100	PLASTIC LIMIT w <sub>p</sub> NATURAL MOISTURE CONTENT w LIQUID LIMIT w <sub>L</sub>	WATER CONTENT (%) 20 40 60	UNIT WEIGHT 7 KN/m <sup>3</sup>	REMARKS & GRAIN SIZE DISTRIBUTION (%) GR SA SI CL	
ELEV DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE								'N' VALUES
329.8	Ground Surface - Swamp											
329.2	Organics		1	SS	0	/46cm						
0.6	Silt		2	SS	5						0 5 90 5	
			3	SS	11							
			4	SS	9							
			5	SS	4							0 66 33 1
			6	SS	4							
			7	SS	0	/46cm						
			8	SS	1							0 80 19 1
			9	SS	0	/46cm						
			10	SS	0	/46cm						
			11	SS	3							
			12	SS	17							0 94 5 1
			13	SS	33							
		305.4										
24.4												
	Boulder											
	Heterogeneous Mixture of Silt, Sand, Gravel and Boulders											
	Boulder											
	(Glacial Till)											
	Boulder											
299.3												
30.5												

Continued

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

20  
15-5 (%) STRAIN AT FAILURE  
10

Continued

# RECORD OF BOREHOLE No 1-2 2 OF 2 METRIC

W.P. 528-89-00(2) LOCATION Coords: N 5 079 860, E 313 565 ORIGINATED BY M.M.  
 DIST 13 HWY 11 BOREHOLE TYPE Hollow Stem Auger, Cone, Rock Core, Wash Boring COMPILED BY M.M.  
 DATUM Geodetic DATE 92/04/14 CHECKED BY B.I.

SOIL PROFILE			SAMPLES			GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT					PLASTIC LIMIT NATURAL MOISTURE CONTENT LIQUID LIMIT			UNIT WEIGHT 7 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	W <sub>p</sub>	W	W <sub>L</sub>		
299.3	Continued  Heterogeneous Mixture of Silt, Sand, Gravel and Boulders (Glacial Till)  ----- Boulder																
30.5																	
293.2																	
36.6	End of Borehole																

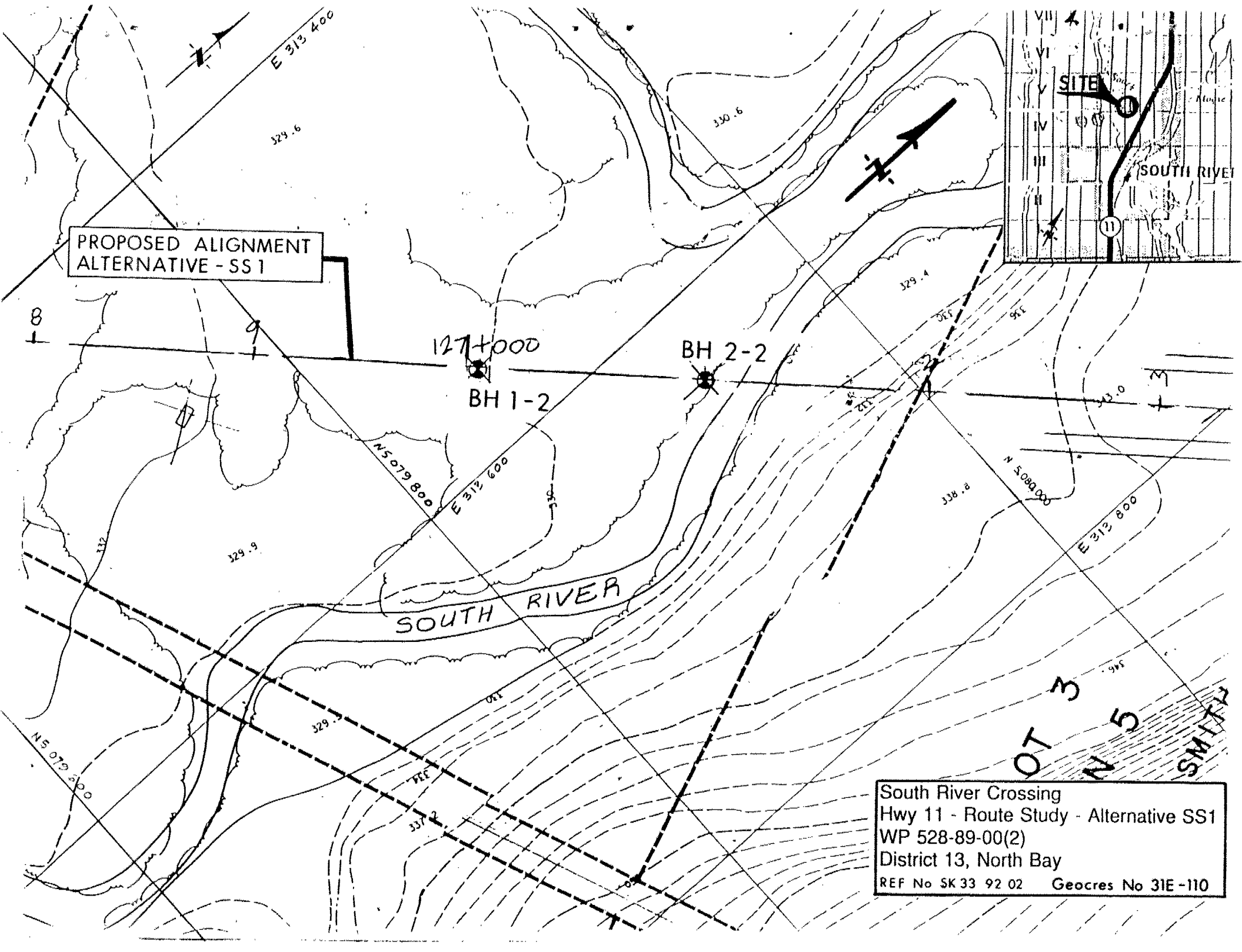
# RECORD OF BOREHOLE No 2-2

1 OF 1

METRIC

W.P. 528-89-00(2) LOCATION Coords: N 5 079 933, E 313 636 ORIGINATED BY M.M.  
DIST 13 HWY 11 BOREHOLE TYPE Hollow Stem Auger, Cone, Rock Core, Wash Boring COMPILED BY M.M.  
DATUM Geodetic DATE 92/04/11 CHECKED BY B.I.

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	20 40 60 80 100					
330.1	Ground Surface													
0.0	Organics		1	SS	2									
			2	SS	0	/46cm								
			3	SS	1									0 60 39 1
			4	SS	0	/46cm								
			5	SS	1									
			6	SS	3									
			7	SS	12									3 90 4 3
	Sand Trace Clay Trace/With Silt Very Loose to Compact		8	SS	0	/46cm								
			9	SS	2									
			10	SS	6									
			11	SS	14									
			12	SS	8									0 89 8 3
			13	SS	13									
			14	SS	24									
313.4														
16.7			15	SS	33									19 72 7 2
	Heterogeneous Mixture of Silt, Sand and Gravel (Glacial Till) Very Dense													
			16	SS	153	/23cm								23 68 8 1
306.2														
23.9			17	RC	REC 98%									RQD 82%
	Quartzite Bedrock Strong, Slightly Weathered to Unweathered													
			18	RC	REC 92%									RQD 73%
303.1														
27.0	End of Borehole													



PROPOSED ALIGNMENT  
ALTERNATIVE - SS1

127+000  
BH 1-2

BH 2-2

SOUTH RIVER

SITE

SOUTH RIVER

South River Crossing  
Hwy 11 - Route Study - Alternative SS1  
WP 528-89-00(2)  
District 13, North Bay  
REF No SK 33 92 02    Geocres No 31E-110





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*FILE*

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## **FOUNDATION DESIGN SECTION**

**foundation  
investigation and  
design report**

ENGINEERING MATERIALS OFFICE  
FOUNDATION DESIGN SECTION

WP 528-89-00(3) DIST 13

HWY 11 STR SITE -

Route Study - Alternative SS1  
Creek Crossing - South of River Rd./  
West of Eagle Lake Rd.

DISTRIBUTION

P. Furst (2)  
J. McDougall  
G. Todd  
S. Wilson (2)  
K.G. Bassi  
S.J. Dunham  
E.A. Joseph  
D.J. Armatage (Cover Only)  
F. Bacchus (Cover Only)  
File

## MEMORANDUM

To: P. Furst  
Head, Structural Section  
Northern Region

Date: 92/07/10

Frm: Foundation Design Section  
RM 315, Central Building

Re: Route Study - Alternative SS1  
Hwy. 11 - Creek Crossing - south of River Rd./west of Eagle Lake Rd.  
WP 528-89-00(3)  
District 13, North Bay

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A preliminary foundation investigation was carried out to provide information for the planning of the proposed structure and approach fills at the above site.

The field work for this investigation was carried out between 92/04/22 to 92/04/24, and comprised of one borehole and two dynamic cone tests. Due to flooding conditions of the creek at the time of the investigation the borehole and cone tests were placed as close as possible to the proposed alignment. The location of the boreholes and cone tests are shown on the attached marked up plan.

It is proposed to construct a structure to carry the realigned Hwy 11 over the unnamed creek. At this time the structure type, location and exact approach details are not known. Fills of up to 5 - 6 m are expected. Ground surface elevations throughout the site ranged from 330 m to 333 m from east to west.

The soil stratum in the one borehole consisted of a 0.6 m thick surficial organic layer. Underlying this deposit was a loose to compact 18.7 m thick silt (Fig. 1). In turn this deposit is underlain by a dense to very dense layer of heterogeneous mixture of silt, sand and gravel (glacial till) which contained boulders at a depth of 30.5 m from the surface (Fig 2).

Observations of the groundwater level was carried out by measuring the water levels in open borehole during the course of the investigation. The water table was found to be 0.3 m below the ground surface at the borehole, however due to the swampy nature of the area the water level could be as high as 0.5 m above the ground surface. Water levels are expected to increase during spring thaw and the summer seasons.

Record of Borehole log sheets, grain size distribution charts and plans are included.

The proposed structure at this site may consist of a bridge or a concrete culvert. General recommendations are given below for foundation design for both types.

Considering the subsoil conditions at this site, any bridge structure will have to be supported on piles driven down to a competent end bearing stratum which was encountered approximately at a depth of 30.5 m below the existing ground surface.

For the purpose of the O.H.B.D.C., a factored axial bearing capacity at ULS of 1600 kN and a SLS Type II bearing capacity of 1150 kN shall be used for 310 X 110 steel H piles. It should, however, be noted that due to the presence of boulders termination depths of piles may be variable. In view of the above, pile installation should be controlled by the Hiley formula.

Use of standard pile tips to facilitate driving of piles without damage, use of batter piles to resist lateral forces and provision of 2.0 m earth cover for pile caps for frost protection etc. should be adhered to.

Similarly, lateral earth pressures on structures should be computed using appropriate earth pressure coefficients for flexible abutments and at rest earth pressures for rigid abutments.

For a culvert placed within the native granular subsoil, SLS type II and ULS factored bearing capacities of 100 kPa and 250 kPa are recommended assuming a 3 m wide footing resting on a 0.6 m thick compacted Granular 'A' pad. The culvert will undergo settlements of the order of 100 mm. It is therefore recommended that the culvert design shall include adequate camber and articulated joints to offset settlements. Further details would be provided by this office if this option is used.

Construction of 6 m high approach embankment will require forward and side slopes of 2H : 1V. It is expected to undergo a total settlement in the order of 70 mm to 100 mm. Elastic settlements will occur immediately following the placement of the fill.

In the construction of the embankment fills, all softened and/or organic material should be excavated for their full depth within the plan limits prior to fill placement.

Dewatering problems during the construction of pile caps for the abutments could be avoided by locating the pile caps up within the fill. However, construction of the culvert will involve excavation below existing creek groundwater level, requiring a dewatering scheme utilizing sump pumps. Temporary rerouting of the creek might be necessary during construction if a culvert is to be utilized at this site.

Recommendations given in this report are to be regarded as preliminary only, and as such are subject to revision when and if new information becomes available. It will probably be necessary to carry out additional field investigation when the final design details are available. If there are any questions, please do not hesitate to contact this office.

MARTIN MICHALEK

M. Michalek

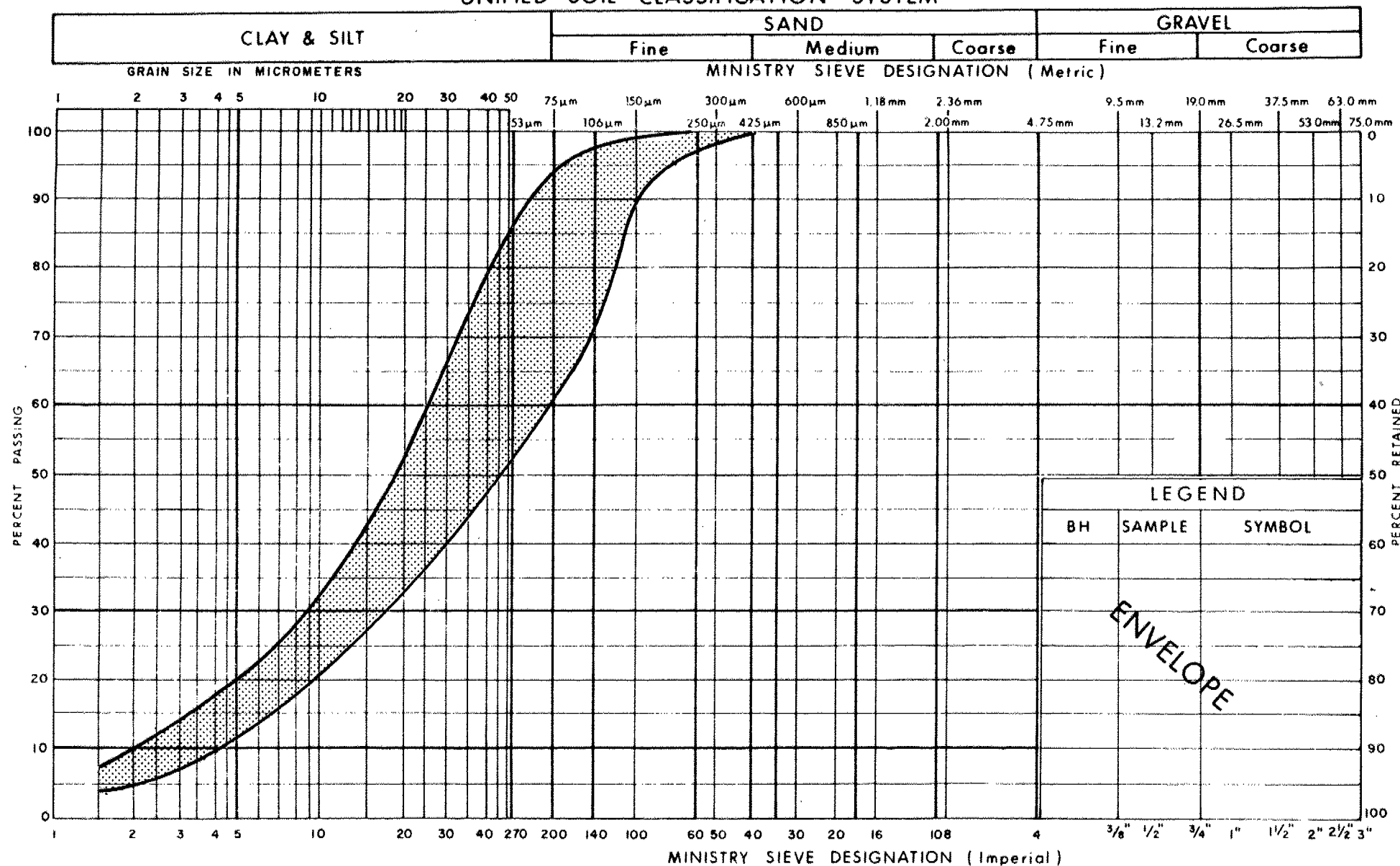
Jr. Foundation Engineer

For: Dr. B. Iyer, P. Eng.

Sr. Foundation Engineer

## APPENDIX

## UNIFIED SOIL CLASSIFICATION SYSTEM



Ontario

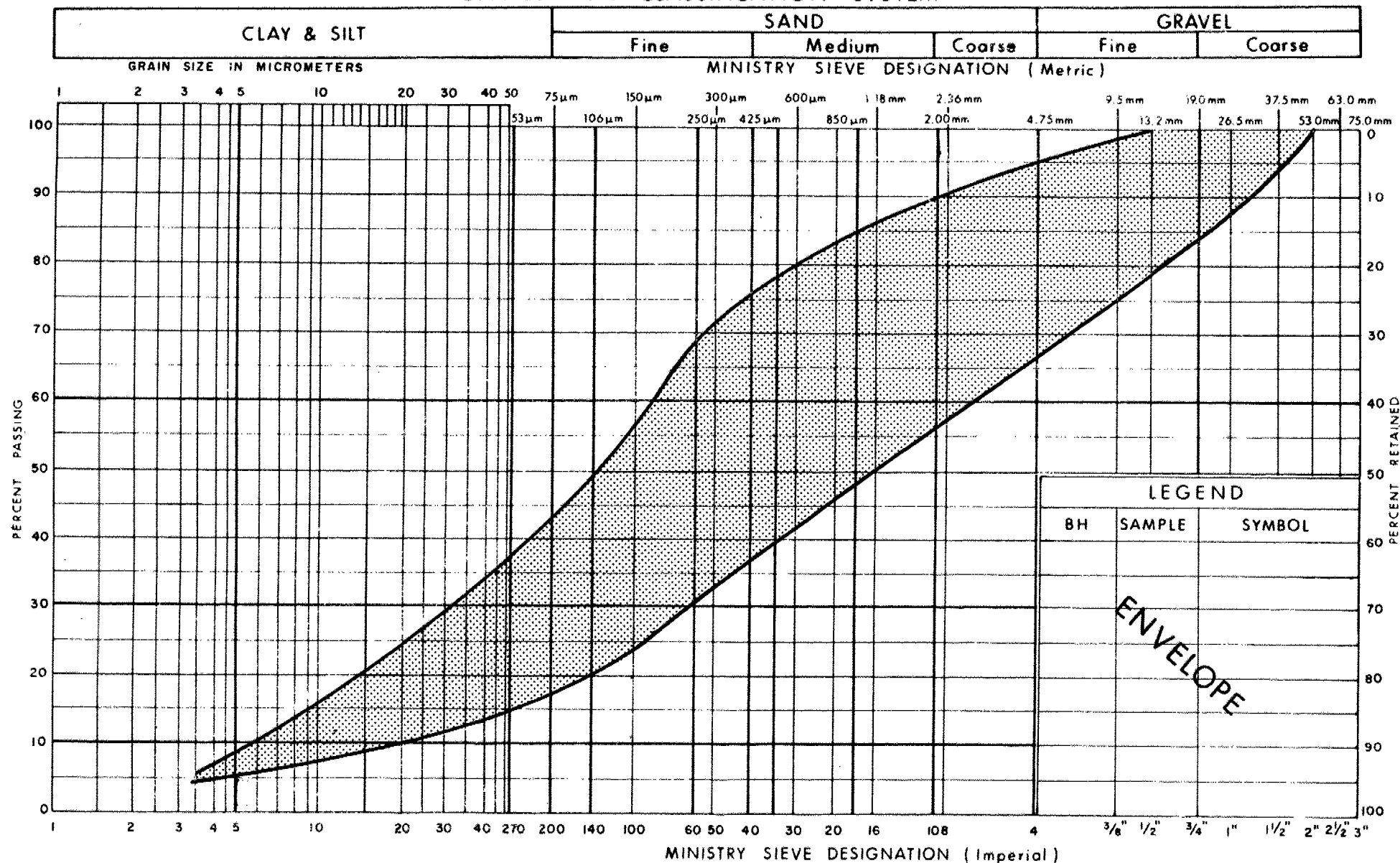
Ministry of  
Transportation

**GRAIN SIZE DISTRIBUTION**  
**SILT**  
 TRACE / SOME SAND, TRACE CLAY

FIG No 1

W P 528 - 89 - 00 (3)

## UNIFIED SOIL CLASSIFICATION SYSTEM



Ontario

Ministry of  
Transportation

**GRAIN SIZE DISTRIBUTION**  
**HETEROGENEOUS MIXTURE OF SILT, SAND & GRAVEL**  
 (GLACIAL TILL)

FIG No 2

W P 528-89-00(3)



## EXPLANATION OF TERMS USED IN REPORT

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

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

SOILS ARE DESCRIBED BY THEIR COMPOSITION AND CONSISTENCY OR DENSENESS.

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

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

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

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

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

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

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

R Q D (%)	0 - 25	25 - 50	50 - 75	75 - 90	90 - 100
	VERY POOR	POOR	FAIR	GOOD	EXCELLENT

**JOINTING AND BEDDING:**

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

## ABBREVIATIONS AND SYMBOLS

### FIELD SAMPLING

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

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

# RECORD OF BOREHOLE No 1-3

1 OF 1

METRIC

W.P. 528-89-00(3) LOCATION Coords: N 5 079 051, E 312 751 ORIGINATED BY M.M.  
DIST 13 HWY 11 BOREHOLE TYPE Cone Test COMPILED BY M.M.  
DATUM Geodetic DATE 92/04/24 CHECKED BY B.I.

SOIL PROFILE		SAMPLES			GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT 20 40 60 80 100 SHEAR STRENGTH kPa ○ UNCONFINED + FIELD VANE ● QUICK TRIAXIAL * LAB VANE	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								
332.1	Ground Surface											
0.0	Probable Organics											
	Probable Silt, Trace/Some Sand Trace Clay											
317.1												
15.0												
	Probable Heterogeneous Mixture of Silt, Sand and Gravel (Glacial Till)											
310.5												
21.6	End of Borehole							120/25cm				

# RECORD OF BOREHOLE No 2-3

1 OF 2

METRIC

W.P. 528-89-00(3) LOCATION Coords: N 5 078 999, E 312 883 ORIGINATED BY M.M.  
DIST 13 HWY 11 BOREHOLE TYPE Hollow Stem Augers, Cone test, Washboring COMPILED BY M.M.  
DATUM Geodetic DATE 92/04/22 CHECKED BY B.I.

SOIL PROFILE			SAMPLES			GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT 20 40 60 80 100	SHEAR STRENGTH kPa ○ UNCONFINED + FIELD VANE ● QUICK TRIAXIAL * LAB VANE 20 40 60 80 100	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										
332.7	Ground Surface														
0.0	Organics		1	SS	2										
			2	SS	10										
			3	SS	7										
			4	SS	8										
			5	SS	8										
			6	SS	7										
			7	SS	7										
			8	SS	9										
			9	SS	9										
			10	SS	18										
			11	SS	17										
			12	SS	15										
			13	SS	11										
			14	SS	10										
314.0															
18.7															
			15	SS	32										
			16	SS	113										
			17	SS	44										
			18	SS	120										
302.2															
30.5															

Continued

+3, x<sup>3</sup>: Numbers refer to Sensitivity  
20 15-25 (%) STRAIN AT FAILURE  
10

Continued

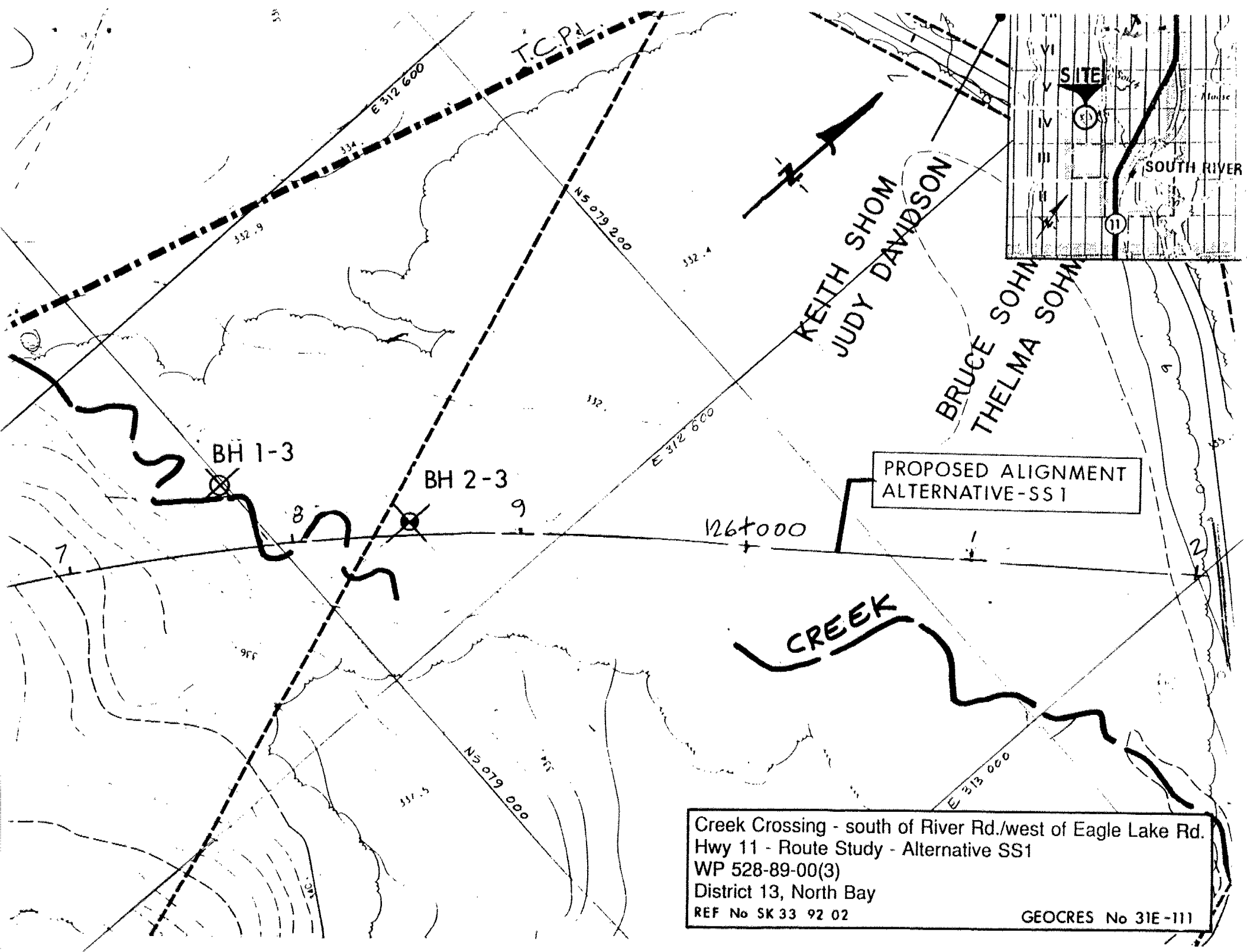
# RECORD OF BOREHOLE No 2-3

2 OF 2

METRIC

W.P. 528-89-00(3) LOCATION Coords: N 5 078 999, E 312 683 ORIGINATED BY M.M.  
 DIST 13 HWY 11 BOREHOLE TYPE Hollow Stem Augers, Cone test, Washboring COMPILED BY M.M.  
 DATUM Geodetic DATE 92/04/22 CHECKED BY B.J.

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>	WATER CONTENT (%)
302.2	Continued  Heterogeneous Mixture of Silt, Sand and Gravel (Glacial Till) Dense to Very Dense (Numerous Boulders)		19	SS	120													
30.5																		
			20	SS	120													
295.7			21	SS	120													
37.0	End of Borehole																	



Creek Crossing - south of River Rd./west of Eagle Lake Rd.  
Hwy 11 - Route Study - Alternative SS1  
WP 528-89-00(3)  
District 13, North Bay  
REF No SK 33 92 02  
GEOCRES No 31E-111

## MEMORANDUM

To: P. Furst  
Head, Structural Section  
Northern Region

Frm: Foundation Design Section  
RM 315, Central Building

Re: Beaver Creek/CNR Tracks  
Hwy 11 - Route Study - Alternative TC7  
WP 528-89-00(1)  
District 13, North Bay

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Date: 92/05/15

A preliminary foundation investigation was carried out to provide information for the planning of the proposed structure and approach fills at the above site.

The field work for this investigation was carried out between 92/03/31 and 92/04/10, and comprised of four sampled boreholes and five dynamic cone penetration tests. Boreholes were extended down to refusal depths with bedrock confirmed in one location. One borehole and cone test were conducted 165 m east of the proposed Hwy 11 centerline at a second possible alignment location. Ground surface elevations throughout the site ranged from 312.3 m to 313 m with the exception of the 1.5 m - 2.5 m elevated CNR tracks crossing the site. The locations of the boreholes and cone tests are shown on the attached marked up plan.

It is proposed to construct structures to carry the realigned Hwy 11 over Beaver Creek and the CNR tracks. At this time the structure and exact approach details are not known, except that approach fill heights will be about 12 m high.

The subsurface soil conditions consisted of the following distinct layers. Surficially about 1.0 m to 2.2 m thick organic layer was encountered, which was underlain by about 0.9 m to 2.4 m thick very loose to loose silty sand. Below the silty sand layers a 10.5 m to 14.9 m thick cohesive stratum, composed of clayey silt to silty clay was encountered. Based on field vane shear strengths obtained within this stratum, it is considered to possess a firm to stiff consistency. This stratum was underlain by about 9.2 m to 19.9 m thick layer of very loose to dense silty sand. Bedrock was encountered and cored in one borehole (BH 3-1) with a 3.05 m sample retrieved at a depth of 36.1. It was described as a quartzite of the Grenville Province, strong, slightly weathered to unweathered. In the remaining boreholes, refusal to further advance the augering was encountered at depths of 24.5 m and 26.2 m below grade, the refusal depth increasing generally from south to north.

Observations of the groundwater level was carried out by measuring the water levels in open boreholes during the course of the investigation. Due to the swampy nature of the site the water table was found to be at the surface down to 0.76 m below ground surface. However upon approaching the refusal depths an artesian condition was found to exist with a pressure head of 1.5 m. One borehole (BH 1-1) had an initial pressure head of 4.3 m which when checked the next morning went down to 1.5 m. Water levels are expected to increase during spring thaw and summer seasons.

The Record of Borehole log sheets are forthcoming pending laboratory test results.

Considering the subsoil conditions at this site, any structure will have to be supported on piles driven down to bedrock or any other competent end bearing stratum which may be encountered approximately 24.5 m to 36.1 m below the existing ground surface.

For the purpose of the O.H.B.D.C., a factored axial bearing capacity at ULS of 1600 kN and an SLS Type II bearing capacity of 1150 kN shall be used for 310 X 110 steel H piles. It should be noted that due to the presence of boulders termination depths of piles may be variable. Termination depths generally range from 24.2 m - 29.6 m, with the exception of one borehole (BH 3-1) where bedrock was encountered at 36.1 m. In view of the above, pile installations should be controlled by the Hiley formula.

With the construction of the approach embankments and the resulting settlements due to the consolidation of the foundation soils, the piles at the abutments may be subjected to some downdrag forces. For preliminary design purposes 1350 kN and 1000 kN shall be used for factored ULS and SLS capacities for a 310 X 110 steel H pile at the abutment.

Use of standard pile tips to facilitate driving of piles without damage, use of batter piles to resist lateral forces and provision of 2.0 m earth cover for pile caps for frost protection, etc. should be adhered to.

Similarly, lateral earth pressures on structures should be computed using appropriate earth pressure coefficients for flexible abutments and at rest earth pressure for rigid abutments.

Construction of 12 m high approach embankment with forward and side slopes of 2H:1V will require a midheight berm width of 38 m. It is expected to undergo settlement in the order of 0.8 m which would occur over a long period of time. In view of this the fill should be placed well in advance to reduce the post construction settlements.

Alternatively, consideration may be given to utilizing lightweight fills. For forward and side slopes of 2H:1V a midheight berm width of 22 m would be required which would have an approximate settlement of 0.7 m.

Dewatering problems during the construction of pile caps for the abutments could be avoided by locating the pile caps up within the fill. However, the pile caps for the pier will

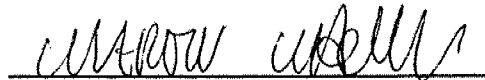
have to be constructed 2.0 m below the grade level requiring a dewatering scheme utilizing sump pumps or sheet piles.

Based on the results of one borehole (BH 5-1) relocating the alignment further east of the proposed alignment is not recommended as there are no improvements to the subsoil conditions at this location.

In the construction of the embankment fills, all softened and/or organic material should be excavated for their full depth within the plan limits prior to fill placement.

Recommendations given in this report are to be regarded as preliminary only, and as such are subject to revision when and if new information becomes available. It will be necessary to carry out additional field investigation when the final design details are available.

If there are any questions, please do not hesitate to contact this office.



M. Michalek

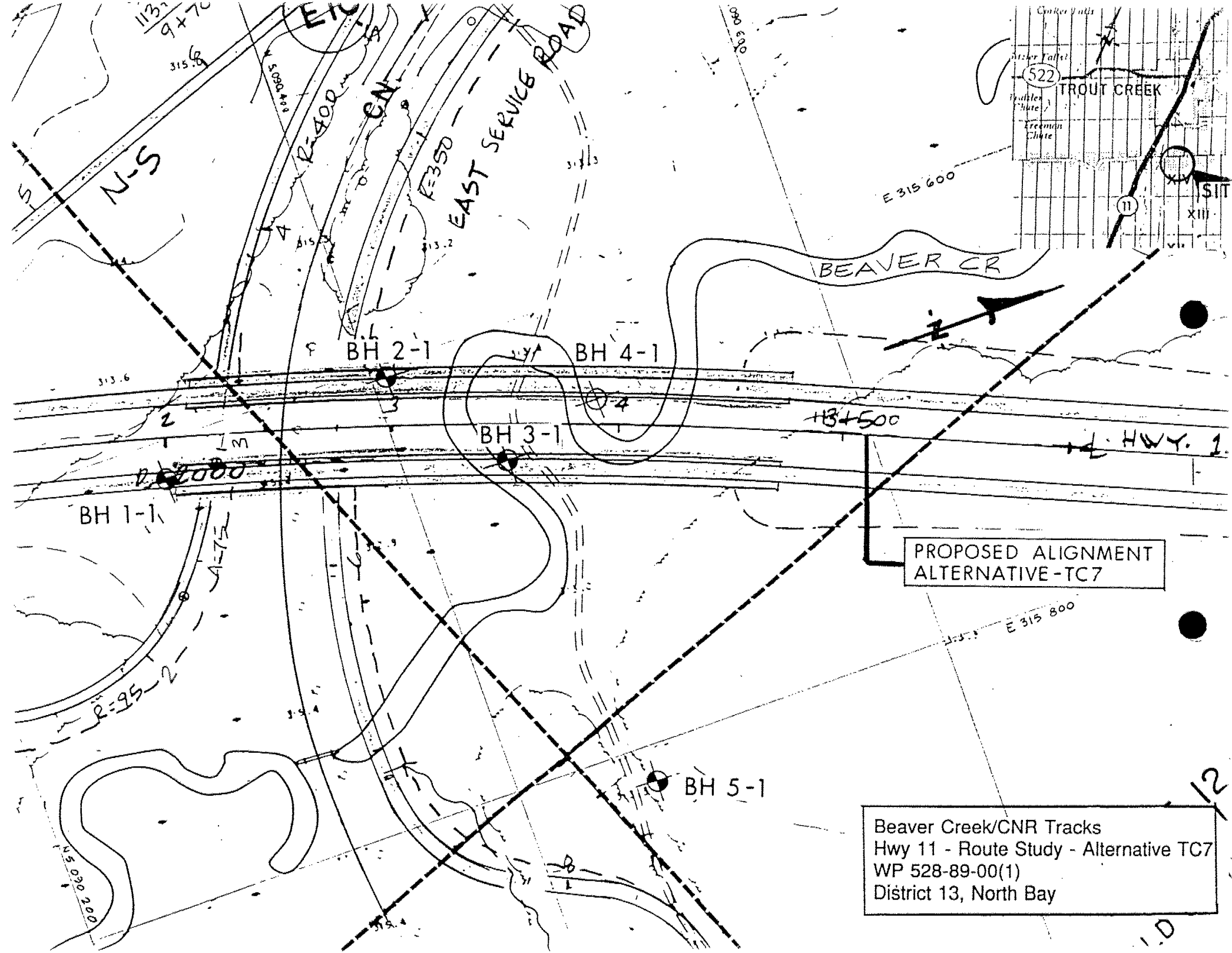
Jr. Foundation Engineer

For:

Dr. B. Iyer, P. Eng

Sr. Foundation Engineer





Beaver Creek/CNR Tracks  
Hwy 11 - Route Study - Alternative TC7  
WP 528-89-00(1)  
District 13, North Bay

## MEMORANDUM

To: P. Furst  
Head, Structural Section  
Northern Region

Date: 92/05/15

Frm: Foundation Design Section  
RM 315, Central Building

Re: South River Crossing  
Hwy 11 - Route Study - Alternative SS1  
WP 528-89-00(2)  
District 13, North Bay

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A preliminary foundation investigation was carried out to provide information for the planning of the proposed structure and approach fills at the above site.

The field work for this investigation was carried out between 92/04/11 to 92/04/21, and comprised of two sampled boreholes together with two dynamic cone penetrations tests adjacent to these holes. Boreholes were extended down to depths of 27.0 m and 36.6 m, with bedrock confirmed in one location and end bearing material encountered in the other. Both boreholes were located west of the South River, no borehole was carried out to the east of the river due to access problems. Ground surface elevations throughout the site ranged from 328.5 m to 331 m to the west of the South River, with a natural embankment to the east ranging in elevation from 328.5 m to 364 m. The locations of the boreholes and cone tests are shown on the attached marked up plan.

The soil stratum consisted surficially of a 0.3 m - 0.6 m thick organic layer. Underlying the organics was a stratum consisting of very loose to dense silty sand to sandy silt with pockets of trace/some clay. This extended down to 16.4 m and 23.8 m in BH 2-2 and BH 1-2 respectively. Generally this layer is loose becoming compact to dense with depth. Underlying the above is a deposit of sands and gravels with boulders. BH 1-2 contained a heavy concentration of boulders randomly encountered down to the refusal depth of 36.6 m. Standard penetration tests in BH 2-2 within this layer indicated a dense to very dense state of denseness. In this borehole bedrock was encountered and cored at a depth of 23.9 m with a 3.1 m sample retrieved. It was described as a quartzite of the Grenville Province, strong, slightly weathered to unweathered.

Observations of the groundwater level was carried out by measuring the water levels in open boreholes during the course of the investigation. Due to the swampy nature of the site the water table was found to be 0.3 m above the ground surface to 0.48 m below. Water levels are expected to increase during spring thaw and the summer seasons.

Record of Borehole log sheets are forthcoming pending laboratory test results.

Considering the subsoil conditions at this site, any structure will have to be supported on piles driven down to bedrock or any other competent end bearing stratum which may be encountered approximately 23.9 m to 24.4 m below the existing ground surface.

For the purpose of the O.H.B.D.C., a factored axial bearing capacity at ULS of 1600 kN and a SLS Type II bearing capacity of 1150 kN shall be used for 310 X 110 steel H piles. It should, however, be noted that due to the presence of boulders and varying bedrock depths termination depths of piles may be variable. In view of the above, pile installation should be controlled by the Hiley formula.

Use of standard pile tips to facilitate driving of piles without damage, use of batter piles to resist lateral forces and provision of 2.0 m earth cover for pile caps for frost protection etc. should be adhered to.

Similarly, lateral earth pressures on structures should be computed using appropriate earth pressure coefficients for flexible abutments and at rest earth pressures for rigid abutments.

Construction of 8 m high approach embankment will require forward and side slopes of 2H : 1V. It is expected to undergo settlement in the order of 100 mm to 120 mm. Elastic settlements will occur immediately following the placement of the fill.

Dewatering problems during the construction of pile caps for the abutments could be avoided by locating the pile caps up within the fill. However, the pile caps for the pier will have to be constructed 2.0 m below the grade level requiring a dewatering scheme utilizing oversized excavations and sump pumps.

In the construction of the embankment fills, all softened and/or organic material should be excavated for their full depth within the plan limits prior to fill placement.

Recommendations given in this report are to be regarded as preliminary only, and as such are subject to revision when and if new information becomes available. It will be necessary to carry out additional field investigation when the final design details are available.

If there are any questions, please do not hesitate to contact this office.



M. Michalek

Jr. Foundation Engineer

For:

Dr. B. Iyer, P. Eng

Sr. Foundation Engineer

PROPOSED ALIGNMENT  
ALTERNATIVE - SS 1

127+000

BH 1-2

BH 2-2

SOUTH RIVER

South River Crossing  
Hwy 11 - Route Study - Alternative SS1  
WP 528-89-00(2)  
District 13, North Bay

SITE

SOUTH RIVER

## MEMORANDUM

To: P. Furst  
Head, Structural Section  
Northern Region

Date: 92/05/15

Frm: Foundation Design Section  
RM 315, Central Building

Re: Creek Crossing - south of River Rd./west of Eagle Lake Rd.  
Hwy 11 - Route Study - Alternative SS1  
WP 528-89-00(3)  
District 13, North Bay

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A preliminary foundation investigation was carried out to provide information for the planning of the proposed structure and approach fills at the above site.

The field work for this investigation was carried out between 92/04/22 to 92/04/24, and comprised of one borehole and two dynamic cone tests. Due to flooding conditions of the creek at the time of the investigation the borehole and cone tests were placed as close as possible to the proposed alignment. The location of the boreholes and cone tests are shown on the attached marked up plan.

It is proposed to construct a structure to carry the realigned Hwy 11 over the unnamed creek. At this time the structure type, location and exact approach details are not known. Fills of up to 5 - 6 m are expected. Ground surface elevations throughout the site ranged from 330 m to 332 m from east to west.

The soil stratum in the one borehole consisted of a 0.6 m thick surficial organic layer which is underlain by a 1.5 m thick deposit of very loose to loose silty sand to sandy silt. Underlying this deposit was a loose to compact 14.9 m thick silt, trace/some clay, trace sand. In turn this deposit is underlain by a dense to very dense 20 m thick layer of sand and gravel (Glacial Till) which contained boulders at a depth of 30.5 m from the surface.

Observations of the groundwater level was carried out by measuring the water levels in open borehole during the course of the investigation. The water table was found to be 0.3 m below the ground surface at the borehole, however due to the swampy nature of the area the water level could be as high as 0.5 m above the ground surface. Water levels are expected to increase during spring thaw and the summer seasons.

Record of Borehole log sheets are forthcoming pending laboratory test results.

The proposed structure at this site may consist of a bridge or a concrete culvert. General recommendations are given below for foundation design for both types.

Considering the subsoil conditions at this site, any bridge structure will have to be supported on piles driven down to a competent end bearing stratum which was encountered approximately at a depth of 30.5 m below the existing ground surface.

For the purpose of the O.H.B.D.C., a factored axial bearing capacity at ULS of 1600 kN and a SLS Type II bearing capacity of 1150 kN shall be used for 310 X 110 steel H piles. It should, however, be noted that due to the presence of boulders termination depths of piles may be variable. In view of the above, pile installation should be controlled by the Hiley formula.

Use of standard pile tips to facilitate driving of piles without damage, use of batter piles to resist lateral forces and provision of 2.0 m earth cover for pile caps for frost protection etc. should be adhered to.

Similarly, lateral earth pressures on structures should be computed using appropriate earth pressure coefficients for flexible abutments and at rest earth pressures for rigid abutments.

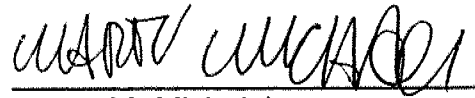
For a culvert placed within the native granular subsoil, SLS type II and ULS factored bearing capacities of 100 kPa and 250 kPa are recommended assuming a 3 m wide footing resting on a 0.6 m thick compacted Granular 'A' pad. The culvert will undergo settlements of the order of 100 mm. It is therefore recommended that the culvert design shall include adequate camber and articulated joints to offset settlements. Further details would be provided by this office if this option is used.

Construction of 6 m high approach embankment will require forward and side slopes of 2H : 1V. It is expected to undergo a total settlement in the order of 70 mm to 100 mm. Elastic settlements will occur immediately following the placement of the fill.

In the construction of the embankment fills, all softened and/or organic material should be excavated for their full depth within the plan limits prior to fill placement.

Dewatering problems during the construction of pile caps for the abutments could be avoided by locating the pile caps up within the fill. However, construction of the culvert will involve excavation below existing creek groundwater level, requiring a dewatering scheme utilizing sump pumps. Temporary rerouting of the creek might be necessary during construction if a culvert is to be utilized at this site.

Recommendations given in this report are to be regarded as preliminary only, and as such are subject to revision when and if new information becomes available. It will probably be necessary to carry out additional field investigation when the final design details are available. If there are any questions, please do not hesitate to contact this office.



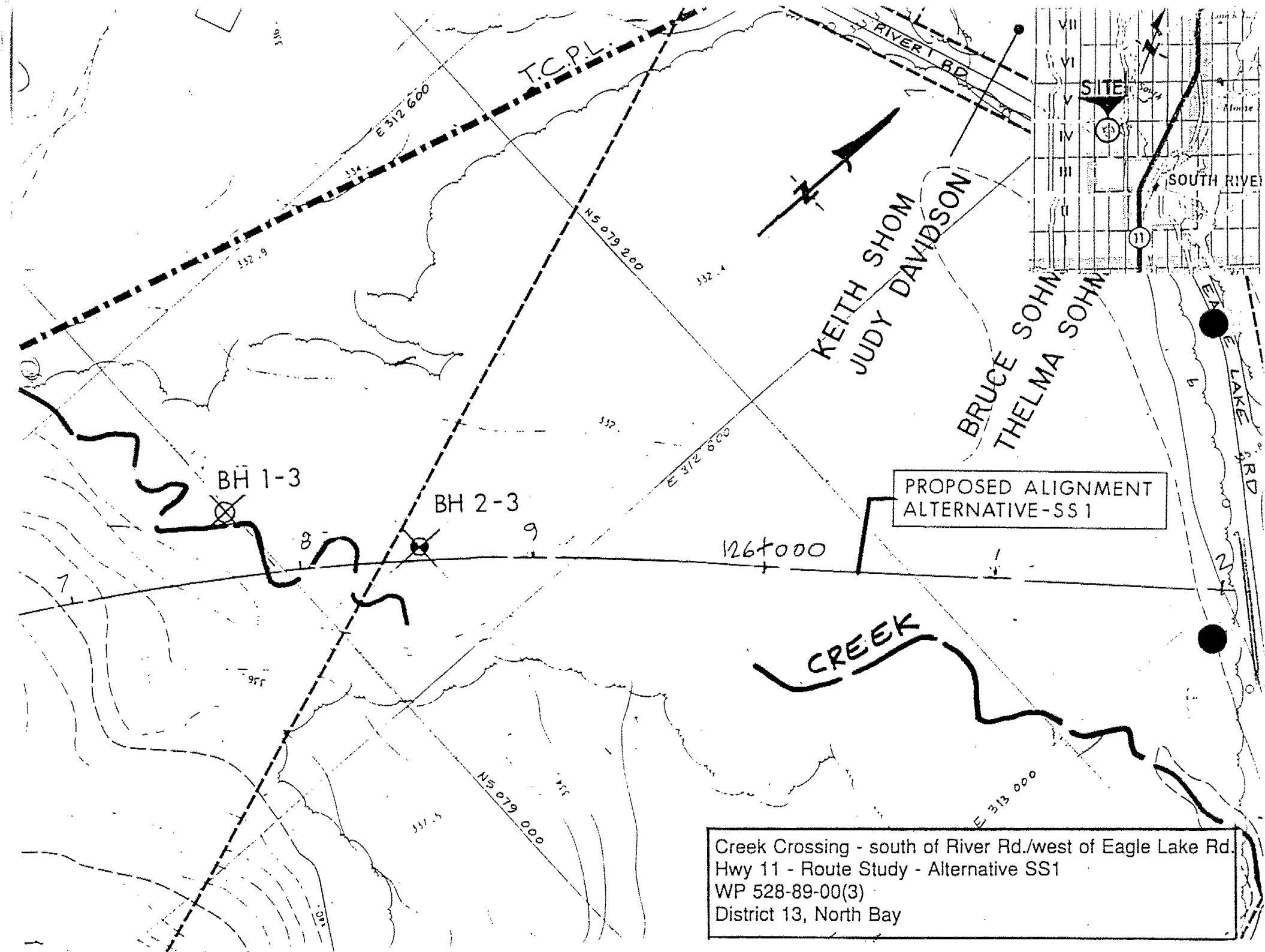
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M. Michalek

Jr. Foundation Engineer

For: Dr. B. Iyer, P. Eng.

Sr. Foundation Engineer





# memorandum

235-3696



To: M.S. Devata  
Chief Foundation Engineer  
Foundation Design Section  
Central Building, Room 315

Date: 92 04 30

Attn: M. Michalek

From: Soils and Aggregates Section  
Engineering Materials Office  
Central Building, Room 311

File No: 3162-2-4-113

Re: **Borehole Core Description**  
**Highway 11/CNR, Trout Creek (1-1, 3-1)**  
**Highway 11/Eagle Lake Road, South River (2-2)**  
**W.P. 528-89-00**

As requested by you, core from three (3) boreholes was logged. A description is appended. Bedrock is **QUARTZITE** of the Grenville Province. Depth to bedrock and depth to unweathered to slightly weathered bedrock in each borehole are tabulated below:

Borehole Number	Depth to bedrock in metres below ground surface	Depth to unweathered to slightly weathered bedrock in metres below ground surface
1-1	24.5	24.5
2-2	23.9	23.9
3-1	36.1	36.1

If you have any questions, please contact me.

*D.A. Williams*

David A. Williams,  
Petrographer.

DAW/jlp  
Attachment

# ROCK CORE DESCRIPTION

## WP 528-89-00

Page 1 of 1

CORE RECOVERY					CORE DESCRIPTION	
BH#	RC#	DEPTH (m)	% CR*	% RQD*	DEPTH (m)	DESCRIPTION
1-1	16	24.48-25.70	98	98	24.48-25.70	QUARTZITE (feldspathic, garnetiferous, and chloritic), greyish orange pink to greyish black; fine to coarse grained; strong; unweathered to slightly weathered; fractures wide spaced, dipping, planar to undulating, smooth to rough.
2-2	18	23.93-25.45	98	82	23.93-26.97	QUARTZITE (feldspathic, garnetiferous, and chloritic), greyish orange pink to greyish black; fine to coarse grained; strong; unweathered to slightly weathered; fractures moderately close to extremely close spaced, flat to near vertical, planar to undulating, smooth to rough.
	19	25.45-26.97	92	73		
3-1	21	29.41-30.02	67	25	29.41-30.02	QUARTZITE (feldspathic, garnetiferous, and chloritic), greyish orange pink to greyish black; fine to coarse grained; strong; unweathered to slightly weathered; fractures moderately close to very close spaced, flat to near vertical, planar to undulating, smooth to rough.
	23	36.12-37.64	88	80	36.12-39.17	
	24	37.64-39.17	100	94		

\*CR = CORE RECOVERY

\*RQD = ROCK QUALITY DESIGNATION

(NOTE: Depths are approximated where core recovery is less than 100%)

Logged by: DAW, Soils and Aggregates Section