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G.I.-30 SEPT. 1976

GEOCRES No. 31E-109
110
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DIST. 13 REGION

W.P. No. 528-89-00 (1,2,3)

CONT. No.

W. O. No.

STR. SITE No.

HWY. No. 11

LOCATION Eagle Lake Rd &
South Entrance to the Town of
No OF PAGES - Trout Lake

OVERSIZE DRAWINGS TO BE INCLUDED WITH THIS REPORT.

REMARKS:

FILE

Ministry
of
Transportation
Ontario

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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GEOCRES 31E-109

DATE JUL 2 0 1992

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

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 form 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.

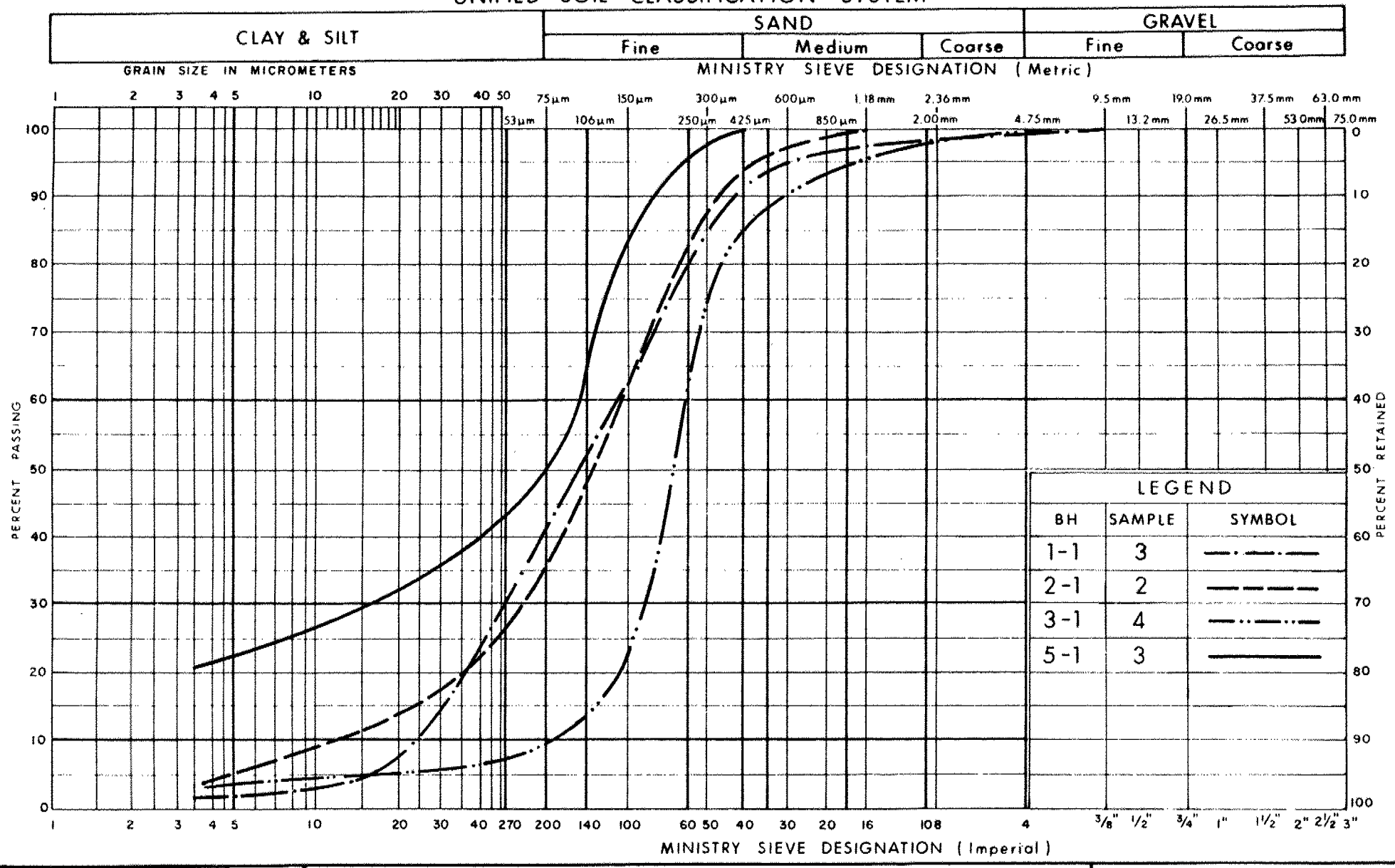
Recommendations given in this report are to be regarded as preliminary only, and as such are subject to revision when and if new information becomes available. It will be necessary to carry out additional field investigation when the final design details are available.

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



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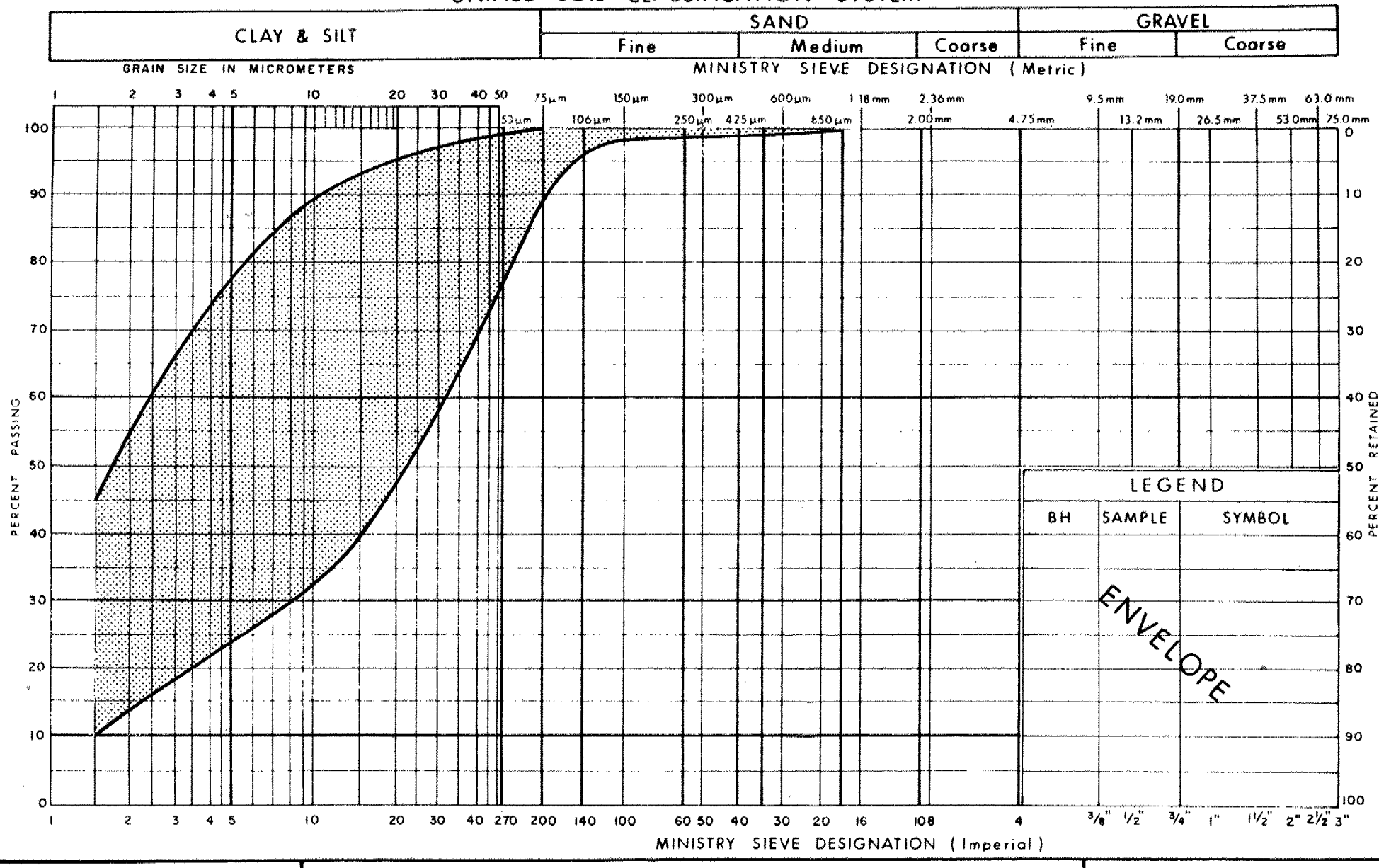
GRAIN SIZE DISTRIBUTION
SILTY SAND
TRACE CLAY

FIG No 1
W P 528-89-00 (1)

UNIFIED SOIL CLASSIFICATION SYSTEM



Ministry of Transportation
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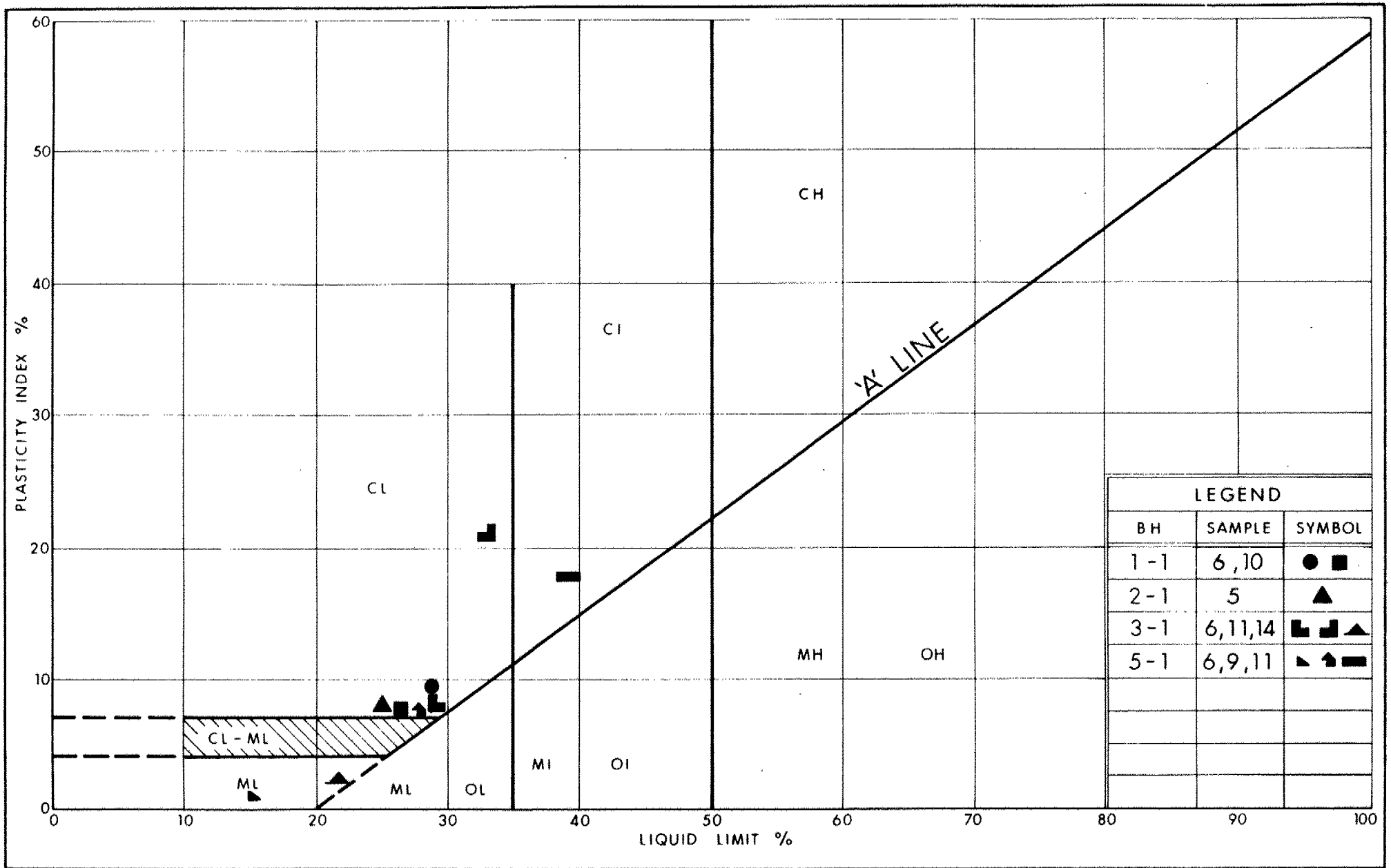
GRAIN SIZE DISTRIBUTION
CLAYEY SILT

FIG No 2

W P 528-89-00(1)



LEGEND		
BH	SAMPLE	SYMBOL
1-1	6, 10	
2-1	5	
3-1	6, 11, 14	
5-1	6, 9, 11	

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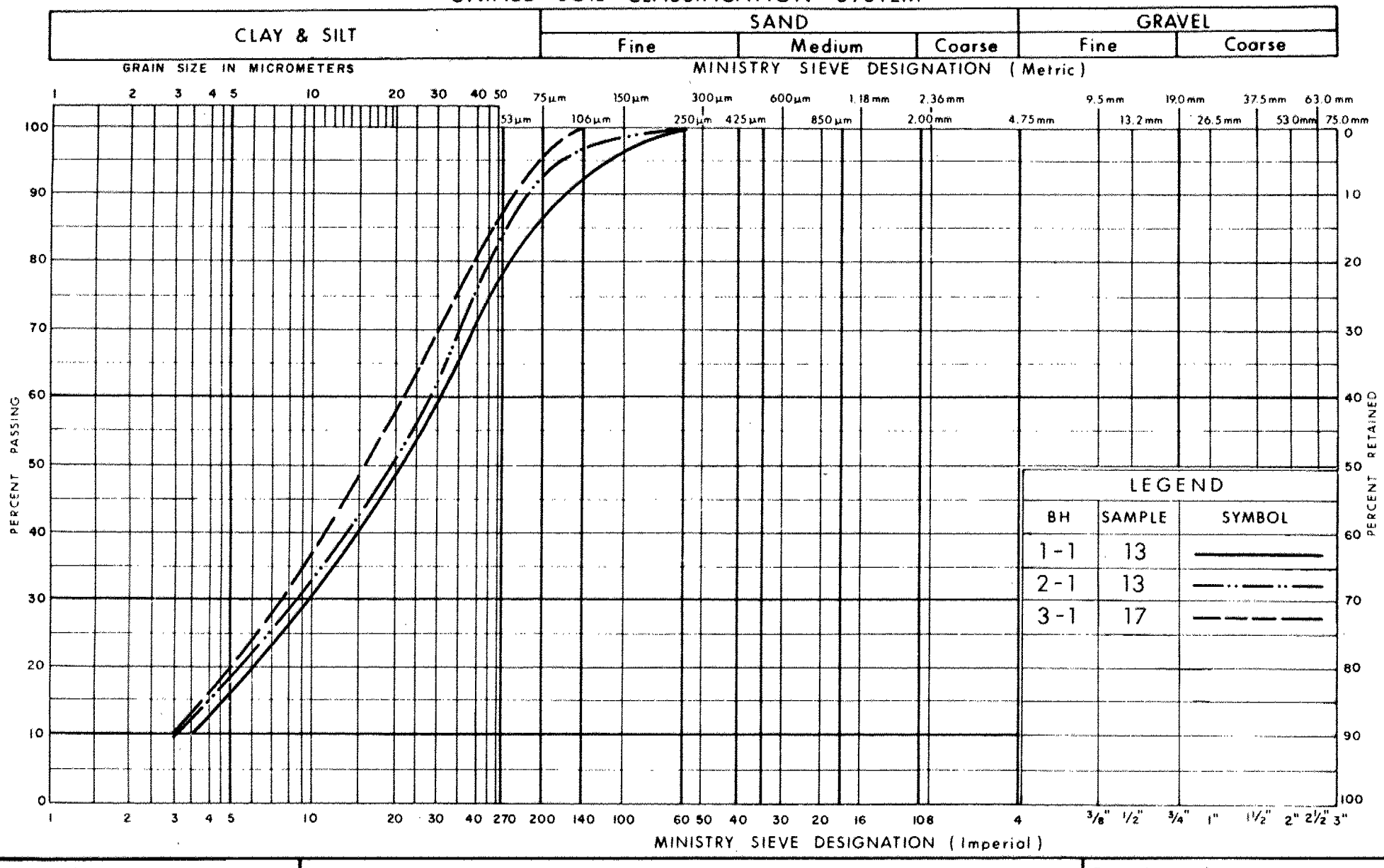
PLASTICITY CHART
CLAYEY SILT

FIG No 3
W P 528-89-00 (1)

UNIFIED SOIL CLASSIFICATION SYSTEM



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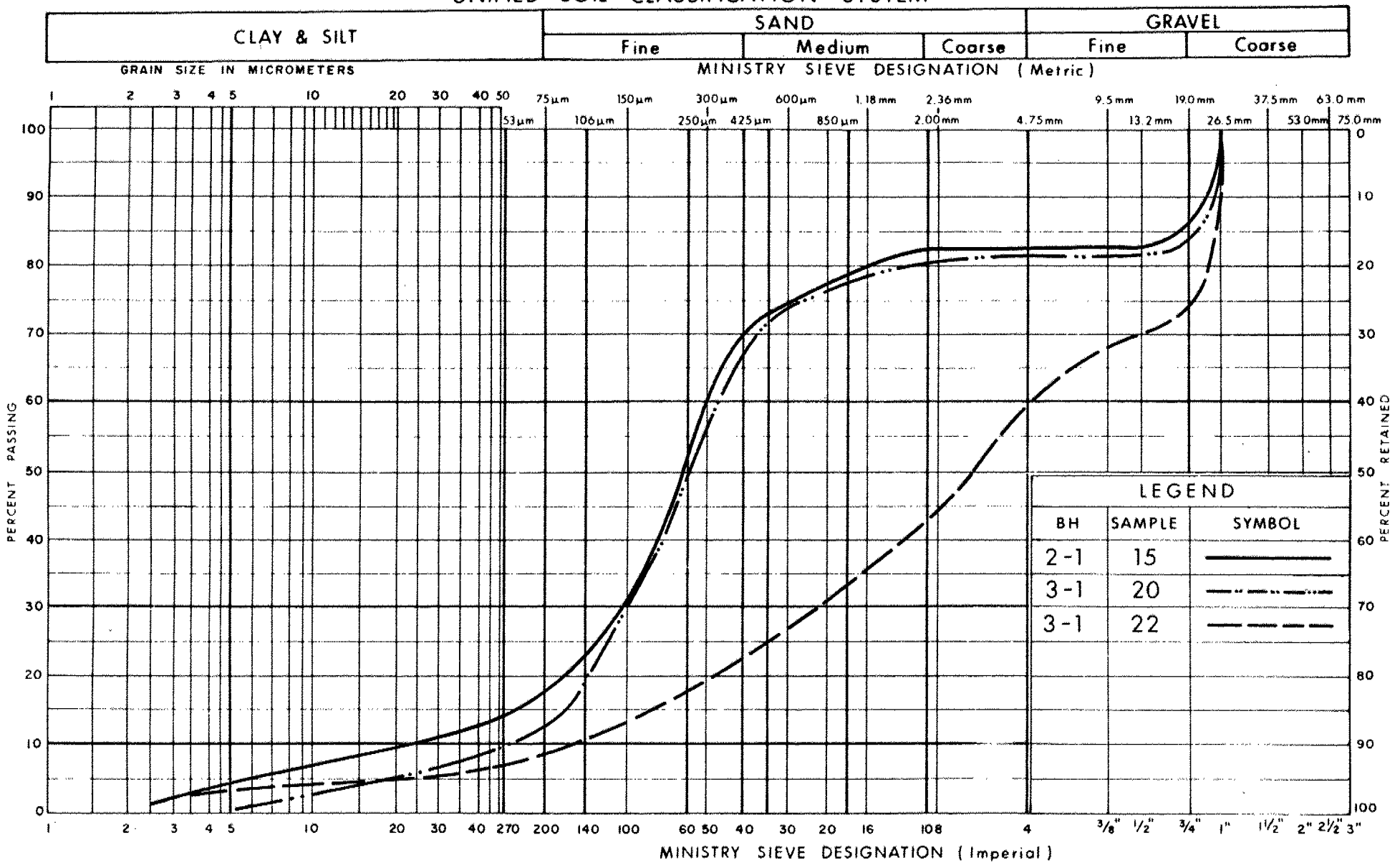
GRAIN SIZE DISTRIBUTION
SILT
TRACE SAND, TRACE CLAY

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

MECHANICAL PROPERTIES OF SOIL

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

PHYSICAL PROPERTIES OF SOIL

ρ_s	kg/m^3	DENSITY OF SOLID PARTICLES
γ_s	kN/m^3	UNIT WEIGHT OF SOLID PARTICLES
ρ_w	kg/m^3	DENSITY OF WATER
γ_w	kN/m^3	UNIT WEIGHT OF WATER
ρ	kg/m^3	DENSITY OF SOIL
γ	kN/m^3	UNIT WEIGHT OF SOIL
ρ_d	kg/m^3	DENSITY OF DRY SOIL
γ_d	kN/m^3	UNIT WEIGHT OF DRY SOIL
ρ_{sat}	kg/m^3	DENSITY OF SATURATED SOIL
γ_{sat}	kN/m^3	UNIT WEIGHT OF SATURATED SOIL
ρ'	kg/m^3	DENSITY OF SUBMERGED SOIL
γ'	kN/m^3	UNIT WEIGHT OF SUBMERGED SOIL

e	1,%	VOID RATIO
n	1,%	POROSITY
w	1,%	WATER CONTENT
S_r	%	DEGREE OF SATURATION
w_L	%	LIQUID LIMIT
w_p	%	PLASTIC LIMIT
w_S	%	SHRINKAGE LIMIT
I_p	%	PLASTICITY INDEX = $w_L - w_p$
I_L	1	LIQUIDITY INDEX = $\frac{w - w_p}{I_p}$
I_C	1	CONSISTENCY INDEX = $\frac{w_L - w}{I_p}$
e_{max}	1,%	VOID RATIO IN LOOSEST STATE
e_{min}	1,%	VOID RATIO IN DENSEST STATE
I_D	1	DENSITY INDEX = $\frac{e_{max} - e}{e_{max} - e_{min}}$
D	mm	GRAIN DIAMETER
D_n	mm	n PERCENT - DIAMETER
C_U	1	UNIFORMITY COEFFICIENT
h	m	HYDRAULIC HEAD OR POTENTIAL
q	m^3/s	RATE OF DISCHARGE
v	m/s	DISCHARGE VELOCITY
i	1	HYDRAULIC GRADIENT
k	m/s	HYDRAULIC CONDUCTIVITY
j	kN/m^3	SEEPAGE FORCE

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.

ELEV / DEPTH	DESCRIPTION	STRAT PLOT	SAMPLES: NUMBER	TYPE	'N' VALUES	GROUND WATER CONDITIONS
312.5	Ground Surface					
0.0 / 311.5	Organics		1	SS	0	/46cm
1.0	Silty Sand, Trace Clay Very Loose to Loose		2	SS	7	
			3	SS	7	
309.1			4	SS	2	
3.4	Clayey Silt Pockets of Silt and Silty Clay Firm		5	SS	0	/46cm
			6	SS	0	/46cm
			7	TW	PM	
			8	SS	0	/46cm
			9	SS	0	/46cm
			10	SS	0	/46cm
298.6			11	SS	2	
13.9	Silt, Trace Sand Trace Clay Very Loose to Loose		12	SS	7	
			13	SS	4	
			14	SS	3	
289.5						
23.0 / 288.0	Heterogeneous Mixture of Silt, Sand and Gravel (Glacial Till) Very Dense		15	SS	18	/10cm
24.5 / 286.8	Quartzite Bedrock or Boulder Strong		16	RC	REC 98%	
25.7	End of Borehole * Artesian condition encountered 92/05/06 - 4.3 m 92/05/07 - 1.5 m					

ELEVATION SCALE: 312, 310, 308, 306, 304, 302, 300, 298, 296, 294, 292, 290, 288

DYNAMIC CONE PENETRATION RESISTANCE PLOT 20 40 60 80 100

SHEAR STRENGTH kPa
o UNCONFINED + FIELD VANE
● QUICK TRIAXIAL × LAB VANE
20 40 60 80 100

PLASTIC LIMIT w_P NATURAL MOISTURE CONTENT w LIQUID LIMIT w_L
WATER CONTENT (%) 20 40 60

120/10cm

UNIT WEIGHT γ kN/m^3: 16.5

REMARKS & GRAIN SIZE DISTRIBUTION (%)	GR	SA	SI	CL
	1	55	42	2
	0	1	90	9
	0	0	78	22
	1	10	80	9
RQD 98%				

$+^3$, $\times^5$: Numbers refer to Sensitivity

20
15 5 (%) STRAIN AT FAILURE
10

RECORD OF BOREHOLE No 2-1 1 OF 1 METRIC

W.P. 528-89-00(1) LOCATION Coords: N 5 090 406, E 315 606 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.

ELEV / DEPTH	DESCRIPTION	NUMBER	TYPE	'N' VALUES	GROUND WATER CONDITIONS	REMARKS & GRAIN SIZE DISTRIBUTION (%) GR SA SI CL
312.3	Ground Surface					
0.0 / 311.1	Organics	1	SS	0	/46cm	
1.2 / 310.2	Silty Sand, Trace Clay Very Loose to Loose	2	SS	7		0 64 31 5
2.1	Clayey Silt Pockets of Silt and Silty Clay Firm	3	SS	5		
		4	SS	5		0 4 73 23
		5	SS	0	/46cm	
		6	SS	0	/46cm	
		7	TW	PM		
		8	SS	0	/46cm	
		9	SS	0	/46cm	
		10	SS	2		
		11	SS	1		
295.3		12	SS	1		
17.0	Silt Trace Sand, Trace Clay Very Loose to Compact	13	SS	2		0 8 85 7
		14	SS	12		
287.7		15	SS	27		
24.6 / 286.1	Heterogeneous Mixture of Silt, Sand and Gravel (Glacial Till) Very Dense	16	SS	120 / 15cm		17 67 15 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

DYNAMIC CONE PENETRATION RESISTANCE PLOT 20 40 60 80 100

SHEAR STRENGTH kPa
o UNCONFINED + FIELD VANE
• QUICK TRIAXIAL × LAB VANE
20 40 60 80 100

ELEVATION SCALE 312 310 308 306 304 302 300 298 296 294 292 290 288

PLASTIC LIMIT w_P NATURAL MOISTURE CONTENT w LIQUID LIMIT w_L

WATER CONTENT (%) 20 40 60

UNIT WEIGHT γ kN/m^3

+8 +8 +7 +6 +8 +5 +5 +5 +2 125 120/10cm

$+^3$, $\times^5$: Numbers refer to Sensitivity

$\frac{20}{15 \diamond 5}$ (%) STRAIN AT FAILURE
$\frac{}{10}$

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.

ELEV / DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE	'N' VALUES	GROUND WATER CONDITIONS	ELEVATION SCALE
312.4	Ground Surface						312
0.0			1	SS	4		
	Organics Wood Particles		2	SS	2		
310.2			3	SS	0	/46cm	310
2.2	Silty Sand, Trace Clay Very Loose		4	SS	3		
309.0			5	SS	2		
3.4			6	SS	5		308
			7	SS	0	/46cm	
			8	SS	0	/46cm	306
			9	TW	PM		
	Clayey Silt Pockets of Silt and Silty Clay Firm to Stiff		10	SS	0	/46cm	304
			11	SS	1		302
			12	SS	3		300
			13	SS	1		298
			14	SS	3		
296.2							296
16.2			15	SS	0	/46cm	
			16	SS	5		294
			17	SS	5		292
	Silt Trace Sand, Trace Clay Very Loose		18	SS	0	/46cm	
			19	SS	4		290
286.2							288
26.2			20	SS	41		286
	Heterogeneous Mixture of Silt, Sand and Gravel (Glacial Till) Compact to Very Dense Numerous Boulders						284
			21	RC	REC	67%	
281.9							282
30.5	Continued						

DYNAMIC CONE PENETRATION RESISTANCE PLOT 20 40 60 80 100

SHEAR STRENGTH kPa
o UNCONFINED + FIELD VANE
• QUICK TRIAXIAL × LAB VANE
20 40 60 80 100

PLASTIC LIMIT w_P NATURAL MOISTURE CONTENT w LIQUID LIMIT w_L
WATER CONTENT (%)
20 40 60

UNIT WEIGHT γ kN/m^3	REMARKS & GRAIN SIZE DISTRIBUTION (%) GR SA SI CL
	1 90 6 3
	0 4 71 25
18.5	
	0 0 65 35
	0 4 88 8
	20 68 11 1
	RQD 25%

Continued

$+^3$, $\times^5$: Numbers refer to Sensitivity

20
15 ◇ 5 (%) STRAIN AT FAILURE
10

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.I.

ELEV / DEPTH	DESCRIPTION	STRAT PLOT	SAMPLES: NUMBER	SAMPLES: TYPE	SAMPLES: 'N' VALUES	GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT (20 40 60 80 100) / SHEAR STRENGTH kPa (o UNCONFINED, • QUICK TRIAXIAL, + FIELD VANE, × LAB VANE; 20 40 60 80 100)	PLASTIC LIMIT w_P / NATURAL MOISTURE CONTENT w / LIQUID LIMIT w_L — WATER CONTENT (%) 20 40 60	UNIT WEIGHT γ kN/m³	REMARKS & GRAIN SIZE DISTRIBUTION (%) GR SA SI CL
281.9	Continued										
30.5	Heterogeneous Mixture of Silt, Sand and Gravel (Glacial Till) Compact to Dense Numerous Boulders		22	SS	26		280		o		40 52 5 3
276.3							278	120/23cm			
38.1	Quartzite Bedrock Strong Weathered to Slightly Weathered		23	RC	REC 88.3%		276				RQD 80%
273.2			24	RC	REC 100%		274				RQD 95%
39.2	End of Borehole • Artesian condition encountered 92/05/08 – 1.6 m 92/05/09 – 1.7 m										

+3, ×5 : Numbers refer to Sensitivity

20 / 15 ◇ 5 / 10 (%) STRAIN AT FAILURE

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.

ELEV / DEPTH	DESCRIPTION	STRAT PLOT	SAMPLES: NUMBER	SAMPLES: TYPE	SAMPLES: 'N' VALUES	GROUND WATER CONDITIONS
312.5	Ground Surface					
0.0	Probable Organics					
310.1						
2.4	Probable Silty Sand, Trace Clay					
308.5						
4.0	Probable Clayey Silt Pockets of Silt and Clayey Silt					
297.0						
15.5	Probable Silt, Trace Sand Trace Clay					
287.9						
24.6	Probable Heterogeneous Mixture of Silt, Sand and Gravel (Glacial Till)					
282.9						
29.6	End of Cone Test					

ELEVATION SCALE: 312, 310, 308, 306, 304, 302, 300, 298, 296, 294, 292, 290, 288, 286, 284

DYNAMIC CONE PENETRATION RESISTANCE PLOT: 20 40 60 80 100

SHEAR STRENGTH kPa
o UNCONFINED + FIELD VANE
● QUICK TRIAXIAL × LAB VANE
20 40 60 80 100

PLASTIC LIMIT w_P | NATURAL MOISTURE CONTENT w | LIQUID LIMIT w_L

WATER CONTENT (%) 20 40 60

UNIT WEIGHT γ kN/m³

REMARKS & GRAIN SIZE DISTRIBUTION (%) GR SA SI CL

120/23cm

$+^3$, $\times^5$: Numbers refer to Sensitivity

$\frac{20}{15 \diamond 5}$ (%) STRAIN AT FAILURE
10

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.I.

ELEV / DEPTH	DESCRIPTION	STRAT PLOT	SAMPLES NUMBER	SAMPLES TYPE	SAMPLES 'N' VALUES	GROUND WATER CONDITIONS	ELEVATION SCALE
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		
310.1			4	SS	15		310
2.9	Clayey Silt Pockets of Silt and Silty Clay Firm		5	SS	5		
			6	SS	0	/46cm	308
			7	SS	0	/46cm	
			8	SS	0	/46cm	306
			9	SS	0	/46cm	
	Stiff		10	TW	PM		304
			11	SS	0	/46cm	302
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						

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

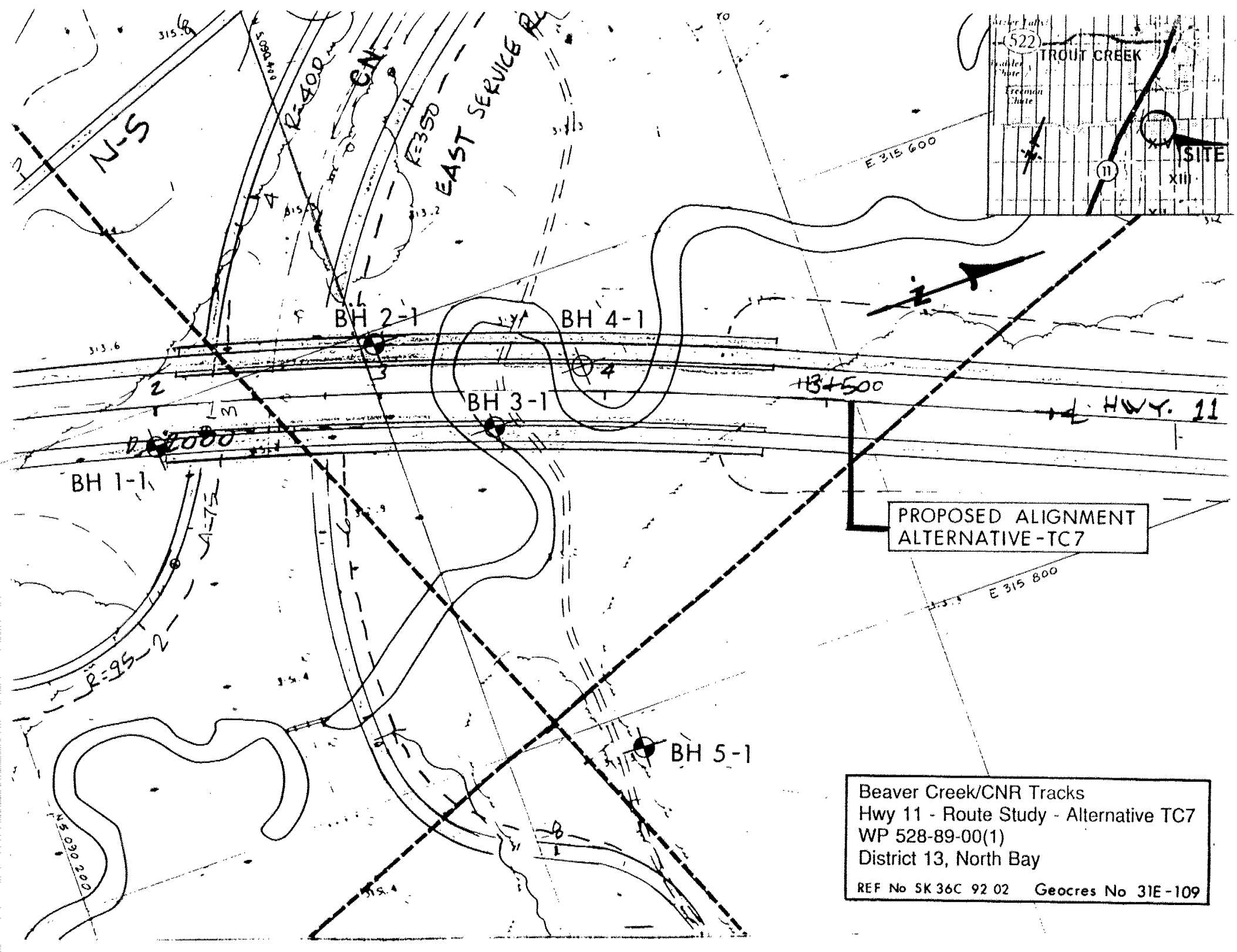
PLASTIC LIMIT w_P | NATURAL MOISTURE CONTENT w | LIQUID LIMIT w_L
WATER CONTENT (%)
20 40 60

UNIT WEIGHT γ kN/m^3

REMARKS & GRAIN SIZE DISTRIBUTION (%)	GR	SA	SI	CL
	0	48	33	19
	0	8	83	9
	0	0	55	45

$+^3$, $\times^5$; Numbers refer to Sensitivity

20
15 ◇ 5 (%) STRAIN AT FAILURE
10


522
TROUT CREEK
SITE
N-S
R=400
CN
R=350
EAST SERVICE RD
E 315 600
BH 2-1
BH 4-1
BH 3-1
BH 1-1
BH 5-1
13+500
HWY. 11
PROPOSED ALIGNMENT
ALTERNATIVE - TC7
E 315 800
R=95.2
A=75
N 5 030 200
Beaver Creek/CNR Tracks
Hwy 11 - Route Study - Alternative TC7
WP 528-89-00(1)
District 13, North Bay
REF No SK 36C 92 02 Geocres No 31E-109

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

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File

GEOCRES 31E-110

DATE JUL 20 1992

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.

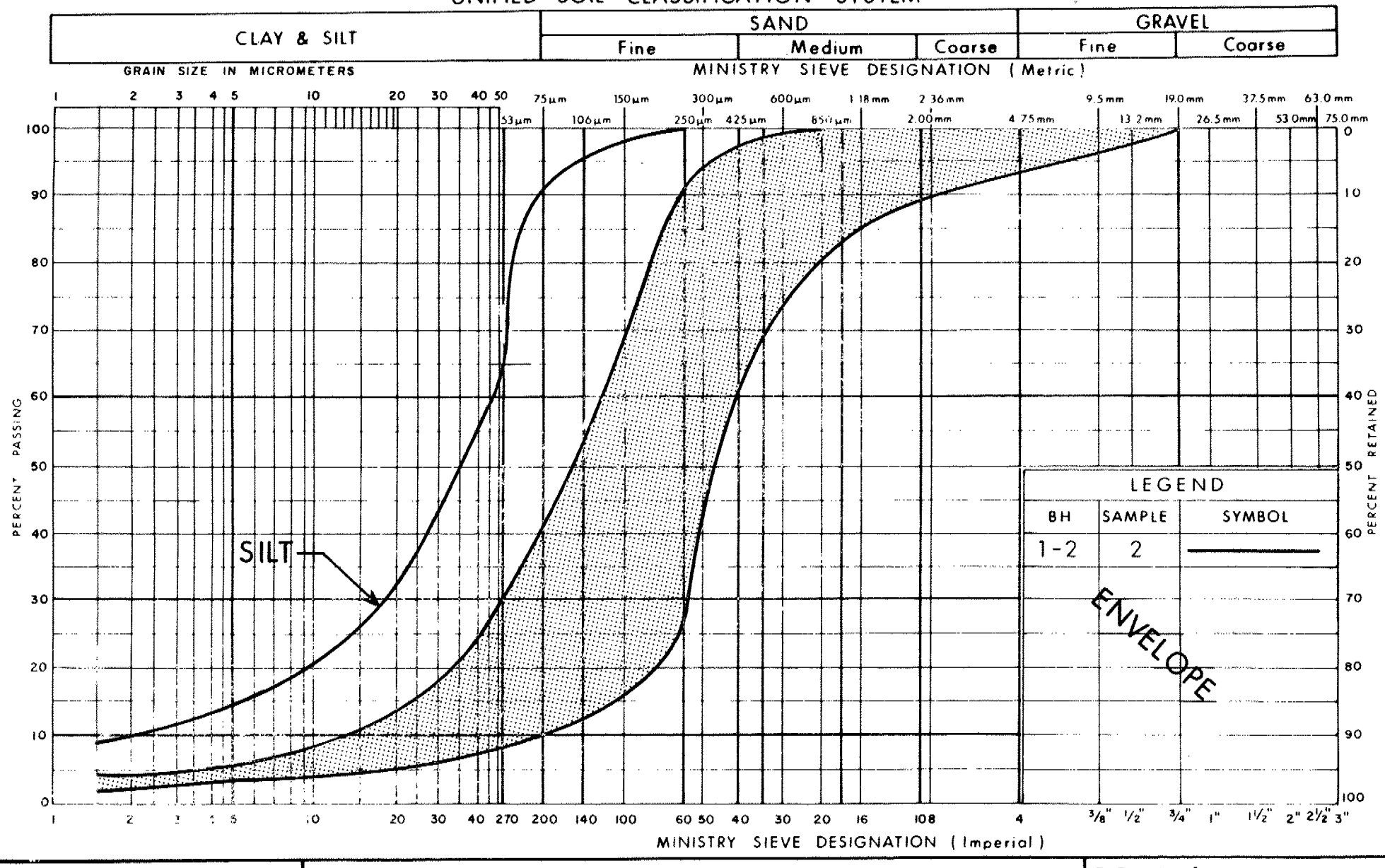
Recommendations given in this report are to be regarded as preliminary only, and as such are subject to revision when and if new information becomes available. It will be necessary to carry out additional field investigation when the final design details are available.

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



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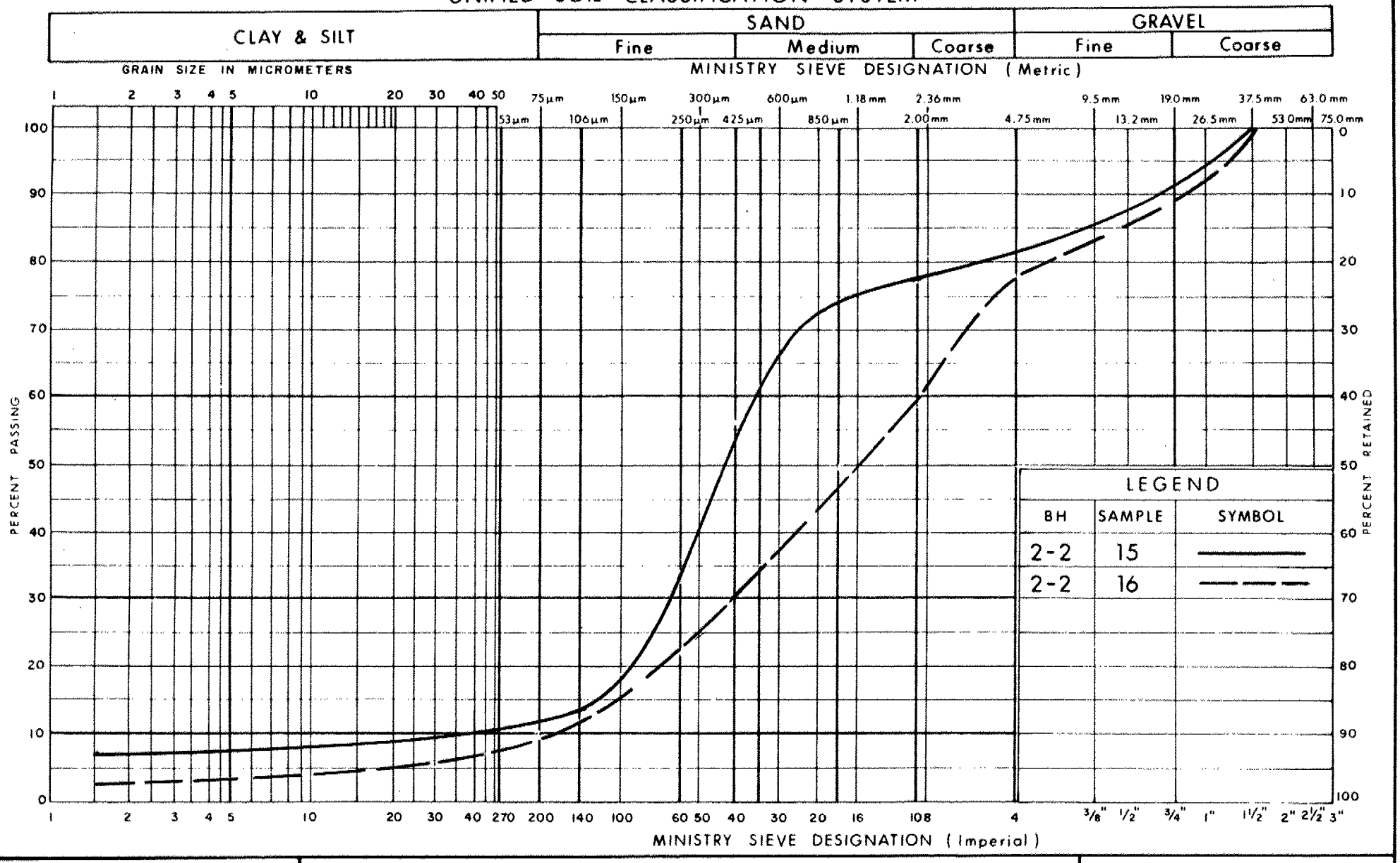
GRAIN SIZE DISTRIBUTION
SAND
TRACE / WITH SILT, TRACE CLAY

FIG No 1

W P 528-89-00 (2)

UNIFIED SOIL CLASSIFICATION SYSTEM



Ministry of Transportation
Ontario

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 (R Q D), FOR MODIFIED RECOVERY, IS:

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

JOINTING AND BEDDING:

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

ABBREVIATIONS AND SYMBOLS

FIELD SAMPLING

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

STRESS AND STRAIN

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

MECHANICAL PROPERTIES OF SOIL

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

PHYSICAL PROPERTIES OF SOIL

ρ_s	kg/m^3	DENSITY OF SOLID PARTICLES
γ_s	kN/m^3	UNIT WEIGHT OF SOLID PARTICLES
ρ_w	kg/m^3	DENSITY OF WATER
γ_w	kN/m^3	UNIT WEIGHT OF WATER
ρ	kg/m^3	DENSITY OF SOIL
γ	kN/m^3	UNIT WEIGHT OF SOIL
ρ_d	kg/m^3	DENSITY OF DRY SOIL
γ_d	kN/m^3	UNIT WEIGHT OF DRY SOIL
ρ_{sat}	kg/m^3	DENSITY OF SATURATED SOIL
γ_{sat}	kN/m^3	UNIT WEIGHT OF SATURATED SOIL
ρ'	kg/m^3	DENSITY OF SUBMERGED SOIL
γ'	kN/m^3	UNIT WEIGHT OF SUBMERGED SOIL

e	1, %	VOID RATIO
n	1, %	POROSITY
w	1, %	WATER CONTENT
S_r	%	DEGREE OF SATURATION
w_L	%	LIQUID LIMIT
w_p	%	PLASTIC LIMIT
w_S	%	SHRINKAGE LIMIT
I_p	%	PLASTICITY INDEX = $w_L - w_p$
I_L	1	LIQUIDITY INDEX = $\frac{w - w_p}{I_p}$
I_C	1	CONSISTENCY INDEX = $\frac{w_L - w}{I_p}$
e_{max}	1, %	VOID RATIO IN LOOSEST STATE
e_{min}	1, %	VOID RATIO IN DENSEST STATE
I_D	1	DENSITY INDEX = $\frac{e_{max} - e}{e_{max} - e_{min}}$
D	mm	GRAIN DIAMETER
D_n	mm	n PERCENT - DIAMETER
C_U	1	UNIFORMITY COEFFICIENT
h	m	HYDRAULIC HEAD OR POTENTIAL
q	m^3/s	RATE OF DISCHARGE
v	m/s	DISCHARGE VELOCITY
i	1	HYDRAULIC GRADIENT
k	m/s	HYDRAULIC CONDUCTIVITY
j	kN/m^3	SEEPAGE FORCE

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.

ELEV / DEPTH	DESCRIPTION	NUMBER	TYPE	'N' VALUES	GROUND WATER CONDITIONS
329.8	Ground Surface - Swamp				
329.2	Organics	1	SS	0	/46cm
0.6	Silt	2	SS	5	
		3	SS	11	
		4	SS	9	
		5	SS	4	
		6	SS	4	
		7	SS	0	/46cm
		8	SS	1	
	Sand Trace Clay Trace/With Silt Very Loose to Compact	9	SS	0	/46cm
		10	SS	0	/46cm
		11	SS	3	
		12	SS	17	
	Dense	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				

DYNAMIC CONE PENETRATION RESISTANCE PLOT 20 40 60 80 100

SHEAR STRENGTH kPa
o UNCONFINED + FIELD VANE
• QUICK TRIAXIAL × LAB VANE
20 40 60 80 100

ELEVATION SCALE: 328, 326, 324, 322, 320, 318, 316, 314, 312, 310, 308, 306, 304, 302, 300

PLASTIC LIMIT w_P NATURAL MOISTURE CONTENT w LIQUID LIMIT w_L
WATER CONTENT (%) 20 40 60

UNIT WEIGHT γ kN/m³

123
120/25cm

REMARKS & GRAIN SIZE DISTRIBUTION (%)	GR	SA	SI	CL
	0	5	90	5
	0	66	33	1
	0	80	19	1
	0	94	5	1

+3, ×5 : 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 20 40 60 80 100 / SHEAR STRENGTH kPa ○ UNCONFINED + FIELD VANE ● QUICK TRIAXIAL × LAB VANE 20 40 60 80 100	PLASTIC LIMIT w_P NATURAL MOISTURE CONTENT w LIQUID LIMIT w_L WATER CONTENT (%) 20 40 60	UNIT WEIGHT γ kN/m³	REMARKS & GRAIN SIZE DISTRIBUTION (%) GR SA SI CL
ELEV / DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE	'N' VALUES						
299.3	Continued										
30.5	Heterogeneous Mixture of Silt, Sand, Gravel and Boulders (Glacial Till)						298				
							296				
293.2	Boulder						294				
36.6	End of Borehole										

+³, ×⁵: Numbers refer to Sensitivity

20
15 ◇ 5 (%) STRAIN AT FAILURE
10

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.

ELEV / DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE	'N' VALUES	GROUND WATER CONDITIONS	REMARKS & GRAIN SIZE DISTRIBUTION (%) GR SA SI CL
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		
313.4			14	SS	24		
16.7	Heterogeneous Mixture of Silt, Sand and Gravel (Glacial Till) Very Dense		15	SS	33		19 72 7 2
			16	SS	153	/23cm	23 68 8 1
306.2							
23.9	Quartzite Bedrock Strong, Slightly Weathered to Unweathered		17	RC	REC 98%		RQD 82%
			18	RC	REC 92%		RQD 73%
303.1							
27.0	End of Borehole						

ELEVATION SCALE: 328, 326, 324, 322, 320, 318, 316, 314, 312, 310, 308, 306, 304

DYNAMIC CONE PENETRATION RESISTANCE PLOT 20 40 60 80 100

SHEAR STRENGTH kPa
o UNCONFINED + FIELD VANE
● QUICK TRIAXIAL × LAB VANE
20 40 60 80 100

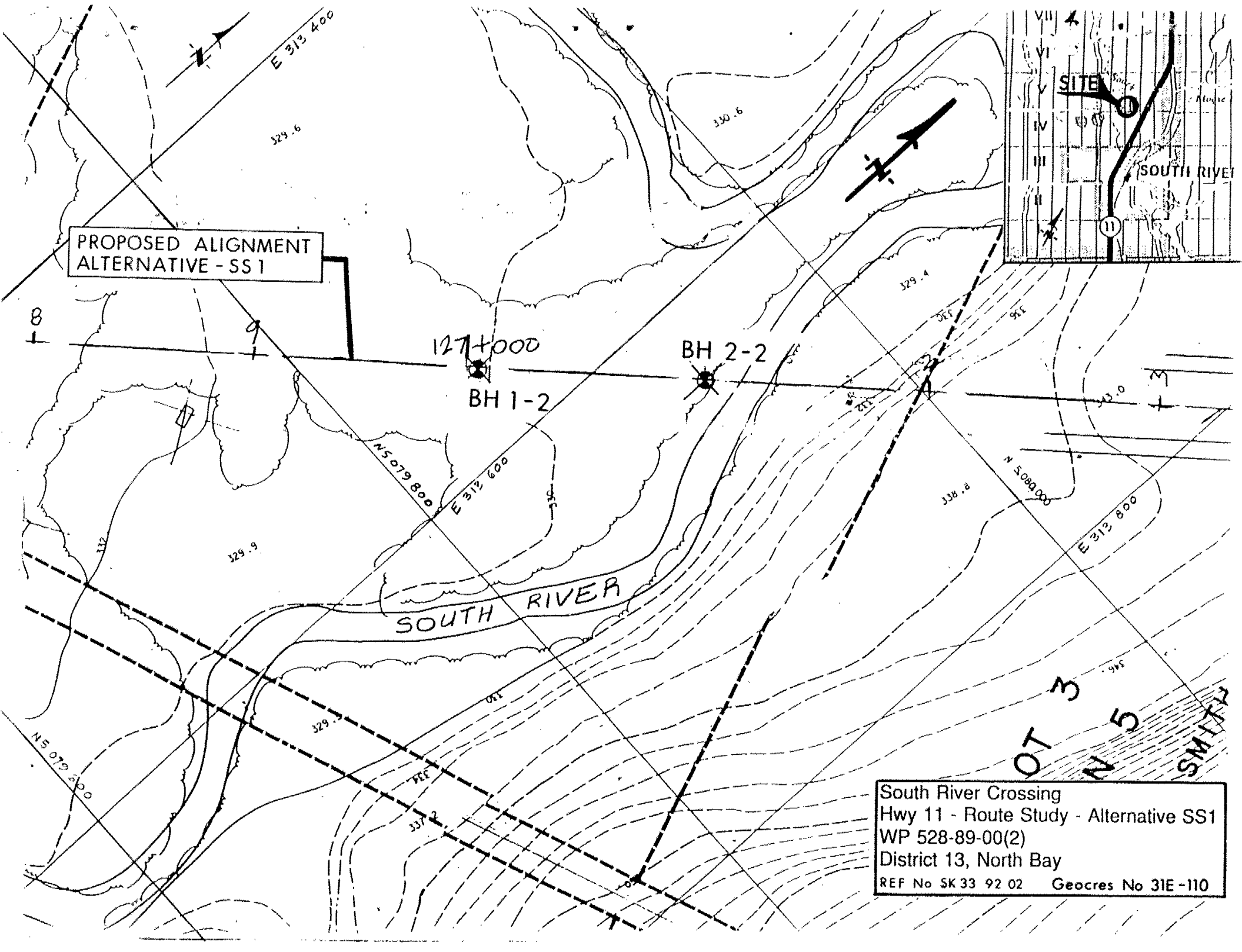
PLASTIC LIMIT w_P NATURAL MOISTURE CONTENT w LIQUID LIMIT w_L
WATER CONTENT (%) 20 40 60

UNIT WEIGHT γ kN/m^3

120/23cm

$+^3$, $\times^5$: Numbers refer to Sensitivity

$\frac{20}{15 \diamond 5}$ (%) STRAIN AT FAILURE
10


PROPOSED ALIGNMENT
ALTERNATIVE - SS 1
127+000
BH 1-2
BH 2-2
SOUTH RIVER
SITE
SOUTH RIVER
E 313 400
N 5 079 800
E 313 600
N 5 080 000
E 313 800
329.6
330.6
329.4
329.9
336.8
329.7
337.2
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

FILE

Ministry
of
Transportation
Ontario

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
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K.G. Bassi
S.J. Dunham
E.A. Joseph
D.J. Armatage (Cover Only)
F. Bacchus (Cover Only)
File

GEOCRES 31E-111

DATE JUL 20 1992

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

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.

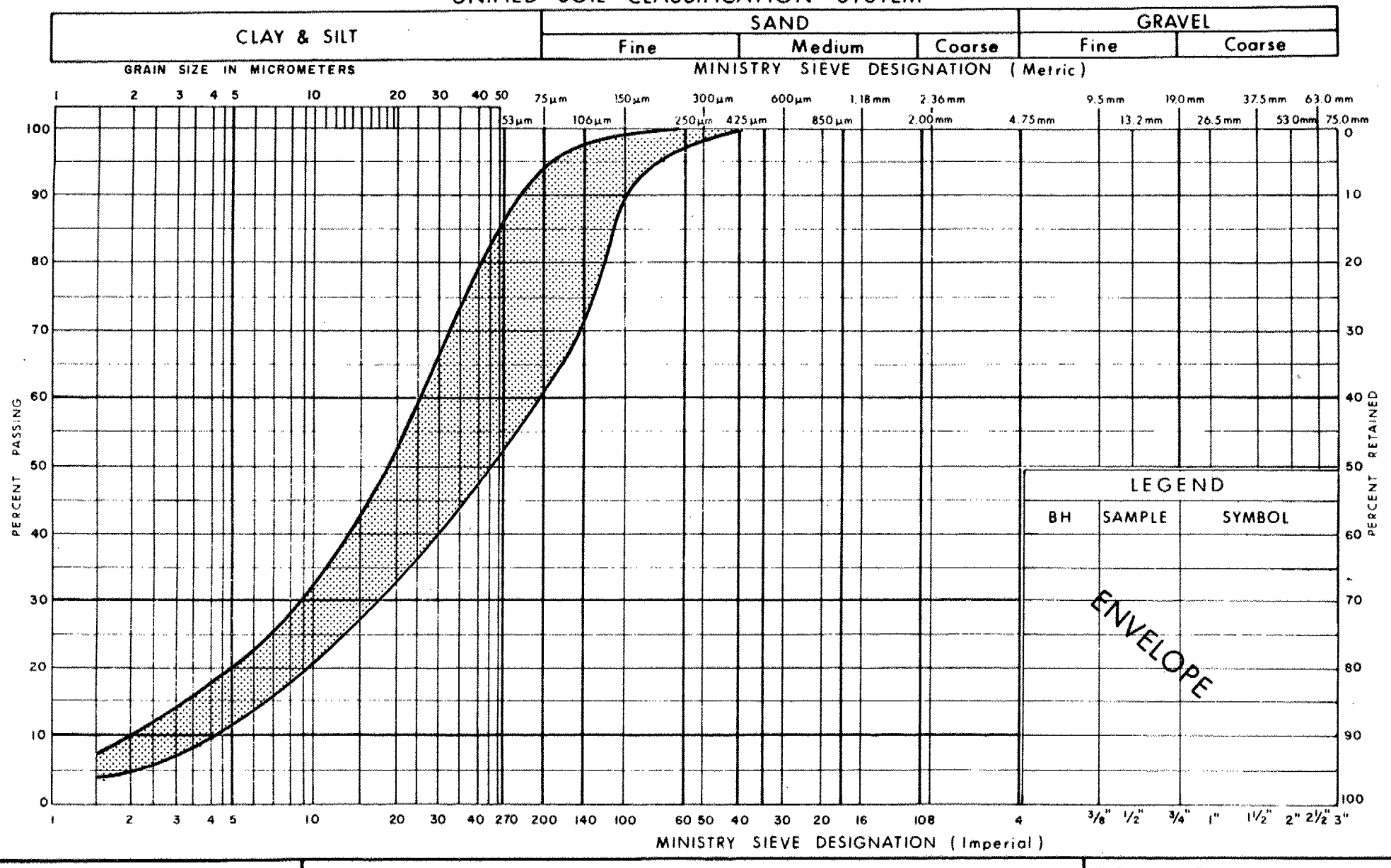
MARTIN MICHALEK

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

APPENDIX

78 12 M

UNIFIED SOIL CLASSIFICATION SYSTEM



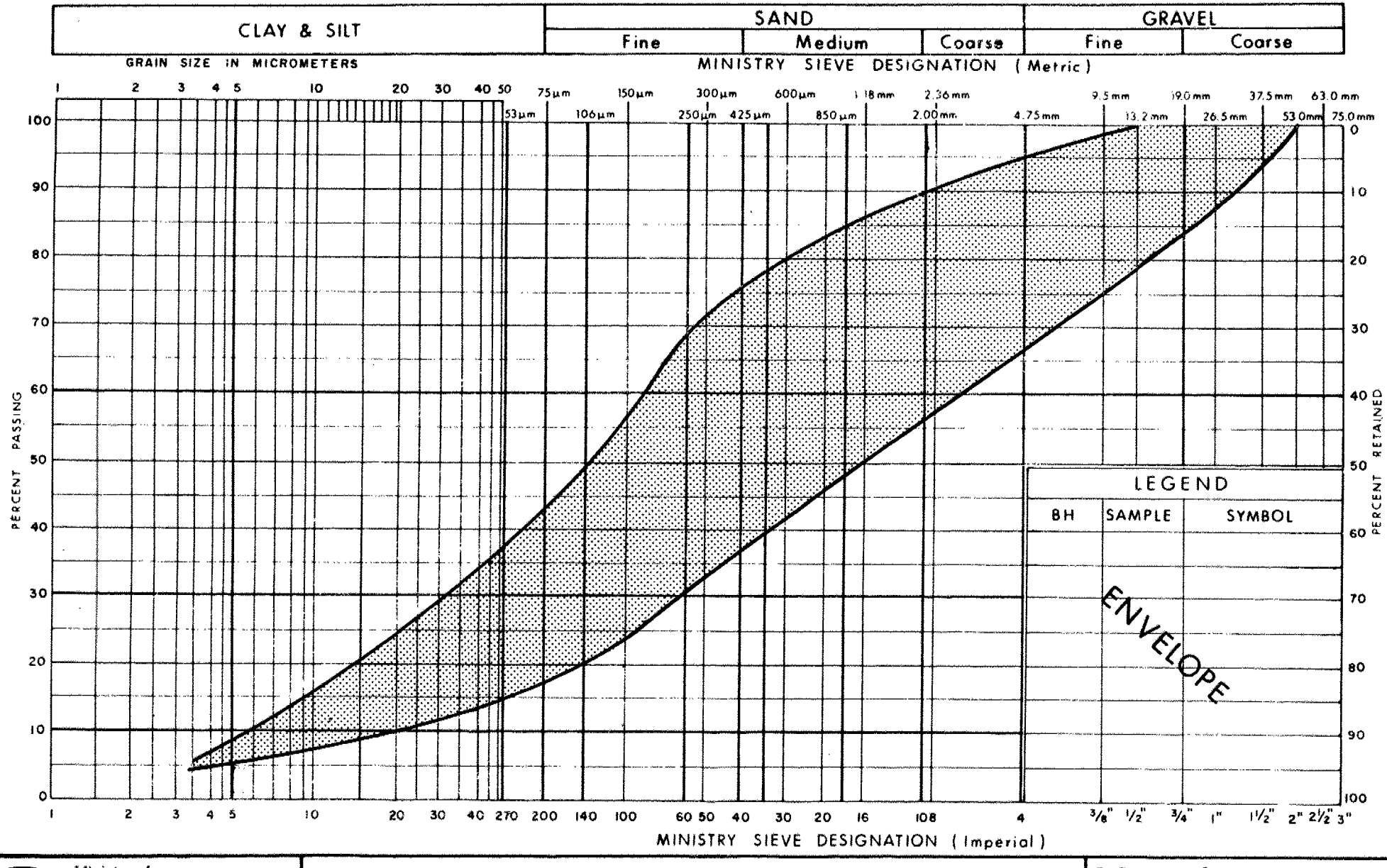
Ministry of Transportation
Ontario

GRAIN SIZE DISTRIBUTION
SILT
TRACE / SOME SAND, TRACE CLAY

FIG No 1

W P 528-89-00(3)

UNIFIED SOIL CLASSIFICATION SYSTEM



Ministry of Transportation
Ontario

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

MECHANICAL PROPERTIES OF SOIL

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

PHYSICAL PROPERTIES OF SOIL

ρ_s	kg/m^3	DENSITY OF SOLID PARTICLES
γ_s	kN/m^3	UNIT WEIGHT OF SOLID PARTICLES
ρ_w	kg/m^3	DENSITY OF WATER
γ_w	kN/m^3	UNIT WEIGHT OF WATER
ρ	kg/m^3	DENSITY OF SOIL
γ	kN/m^3	UNIT WEIGHT OF SOIL
ρ_d	kg/m^3	DENSITY OF DRY SOIL
γ_d	kN/m^3	UNIT WEIGHT OF DRY SOIL
ρ_{sat}	kg/m^3	DENSITY OF SATURATED SOIL
γ_{sat}	kN/m^3	UNIT WEIGHT OF SATURATED SOIL
ρ'	kg/m^3	DENSITY OF SUBMERGED SOIL
γ'	kN/m^3	UNIT WEIGHT OF SUBMERGED SOIL

e	1,%	VOID RATIO
n	1,%	POROSITY
w	1,%	WATER CONTENT
S_r	%	DEGREE OF SATURATION
w_L	%	LIQUID LIMIT
w_p	%	PLASTIC LIMIT
w_S	%	SHRINKAGE LIMIT
I_p	%	PLASTICITY INDEX = $w_L - w_p$
I_L	1	LIQUIDITY INDEX = $\frac{w - w_p}{I_p}$
I_C	1	CONSISTENCY INDEX = $\frac{w_L - w}{I_p}$
e_{max}	1,%	VOID RATIO IN LOOSEST STATE

e_{min}	1,%	VOID RATIO IN DENSEST STATE
I_D	1	DENSITY INDEX = $\frac{e_{max} - e}{e_{max} - e_{min}}$
D	mm	GRAIN DIAMETER
D_n	mm	n PERCENT - DIAMETER
C_U	1	UNIFORMITY COEFFICIENT
h	m	HYDRAULIC HEAD OR POTENTIAL
q	m^3/s	RATE OF DISCHARGE
v	m/s	DISCHARGE VELOCITY
i	1	HYDRAULIC GRADIENT
k	m/s	HYDRAULIC CONDUCTIVITY
j	kN/m^3	SEEPAGE FORCE

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	PLASTIC LIMIT w_P / NATURAL MOISTURE CONTENT w / LIQUID LIMIT w_L	UNIT WEIGHT γ kN/m³	REMARKS & GRAIN SIZE DISTRIBUTION (%)
ELEV / DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE	'N' VALUES			SHEAR STRENGTH kPa ○ UNCONFINED ● QUICK TRIAXIAL + FIELD VANE × LAB VANE	WATER CONTENT (%)		GR SA SI CL
332.1	Ground Surface							20 40 60 80 100			
0.0	Probable Organics						330				
	Probable Silt, Trace/Some Sand Trace Clay						328				
							326				
							324				
							322				
							320				
							318				
317.1											
15.0	Probable Heterogeneous Mixture of Silt, Sand and Gravel (Glacial Till)						316				
							314				
							312				
310.5											
21.6	End of Borehole							120/25cm			

+³, ×³ : Numbers refer to Sensitivity

20
15 ◇ 5 (%) STRAIN AT FAILURE
10

RECORD OF BOREHOLE No 2-3 1 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.I.

ELEV / DEPTH	DESCRIPTION	STRAT PLOT	SAMPLES NUMBER	SAMPLES TYPE	SAMPLES 'N' VALUES	GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT 20 40 60 80 100 / SHEAR STRENGTH kPa ○ UNCONFINED ● QUICK TRIAXIAL + FIELD VANE × LAB VANE 20 40 60 80 100	PLASTIC LIMIT w_P / NATURAL MOISTURE CONTENT w / LIQUID LIMIT w_L WATER CONTENT (%) 20 40 60	UNIT WEIGHT γ kN/m^3	REMARKS & GRAIN SIZE DISTRIBUTION (%) GR SA SI CL
332.7	Ground Surface										
0.0	Organics		1	SS	2	▼					
			2	SS	10						
			3	SS	7						
			4	SS	8						
			5	SS	8						0 3 94 3
	Silt Trace Clay Trace/Some Sand Loose to Compact		6	SS	7						
			7	SS	7						
			8	SS	9						
			9	SS	9						
			10	SS	18						
			11	SS	17						
			12	SS	15						
			13	SS	11						
314.0			14	SS	10						0 22 72 6
18.7			15	SS	32						
	Heterogeneous Mixture of Silt,Sand and Gravel (Glacial Till) Dense to Very Dense		16	SS	113						
			17	SS	44						6 56 33 5
			18	SS	120						
302.2											
30.5	Continued										Continued

+^{3}, ×^{5}: Numbers refer to Sensitivity

20 / 15 ◇ 5 (%) STRAIN AT FAILURE / 10

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.

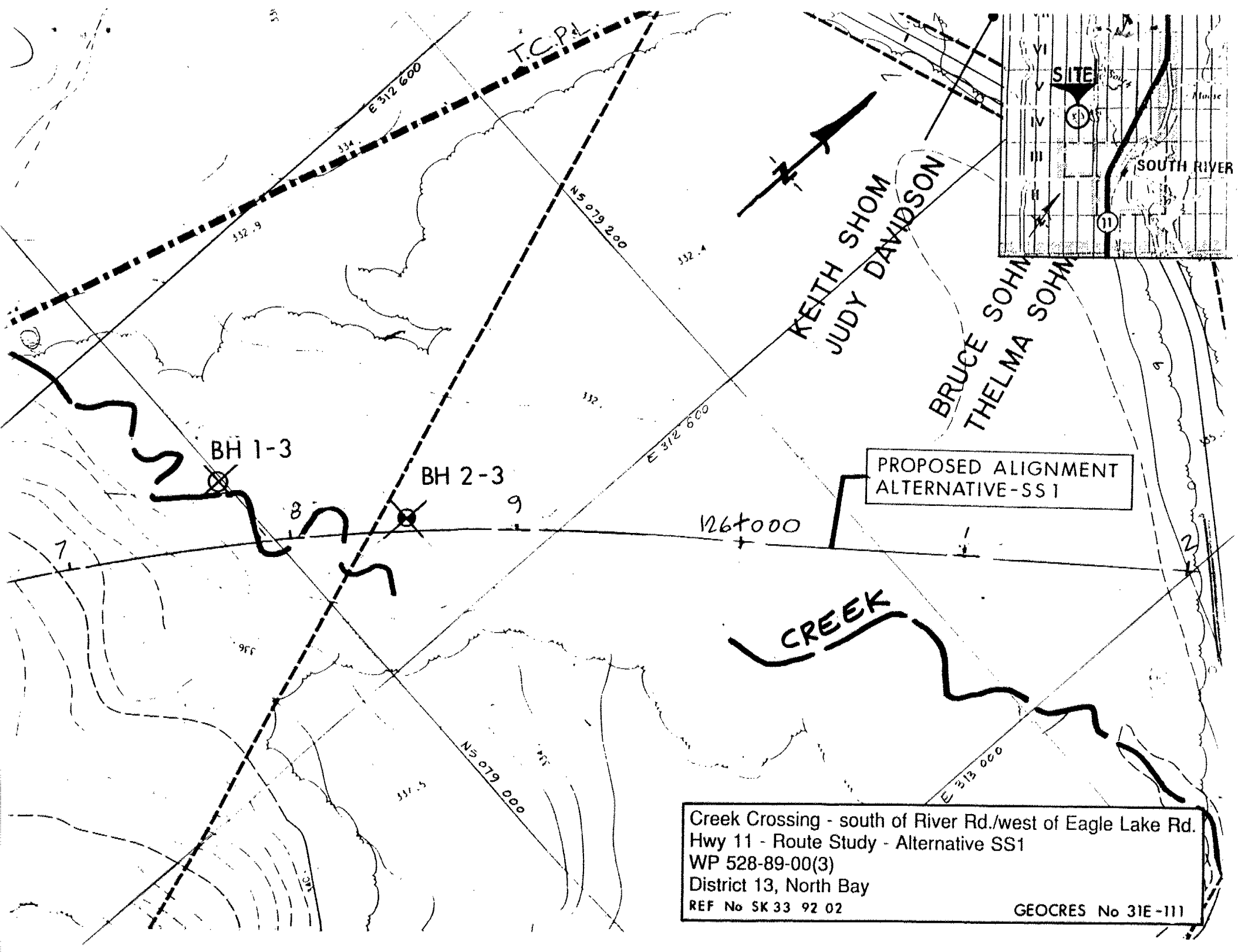
DIST 13 HWY 11 BOREHOLE TYPE Hollow Stem Augers,Cone test,Washboring COMPILED BY M.M.

DATUM Geodetic DATE 92/04/22 CHECKED BY B.I.

SOIL PROFILE			SAMPLES			GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT 20 40 60 80 100 / SHEAR STRENGTH kPa o UNCONFINED + FIELD VANE • QUICK TRIAXIAL × LAB VANE 20 40 60 80 100	PLASTIC LIMIT w_P NATURAL MOISTURE CONTENT w LIQUID LIMIT w_L WATER CONTENT (%) 20 40 60	UNIT WEIGHT γ kN/m^3	REMARKS & GRAIN SIZE DISTRIBUTION (%)
ELEV / DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE	'N' VALUES						GR SA SI CL
302.2	Continued										
30.5	Heterogeneous Mixture of Silt, Sand and Gravel (Glacial Till) Dense to Very Dense (Numerous Boulders)		19	SS	120		298				
			20	SS	120		296				38 41 17 4
295.7			21	SS	120		294				
37.0	End of Borehole										

+^{3}, x^5 ; Numbers refer to Sensitivity

$\frac{20}{15 \diamond 5}$ (%) STRAIN AT FAILURE
10


T.C.P.L.
E 312 600
N5 079 200
332.9
334
332.4
KEITH SHOM
JUDY DAVIDSON
BRUCE SOHM
THELMA SOHM
SITE
SOUTH RIVER
BH 1-3
BH 2-3
8
9
7
2
126+000
PROPOSED ALIGNMENT
ALTERNATIVE-SS1
CREEK
E 312 600
N5 079 000
E 313 000
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

Date: 92/05/15

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

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 form 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 posses 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 retrived 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.

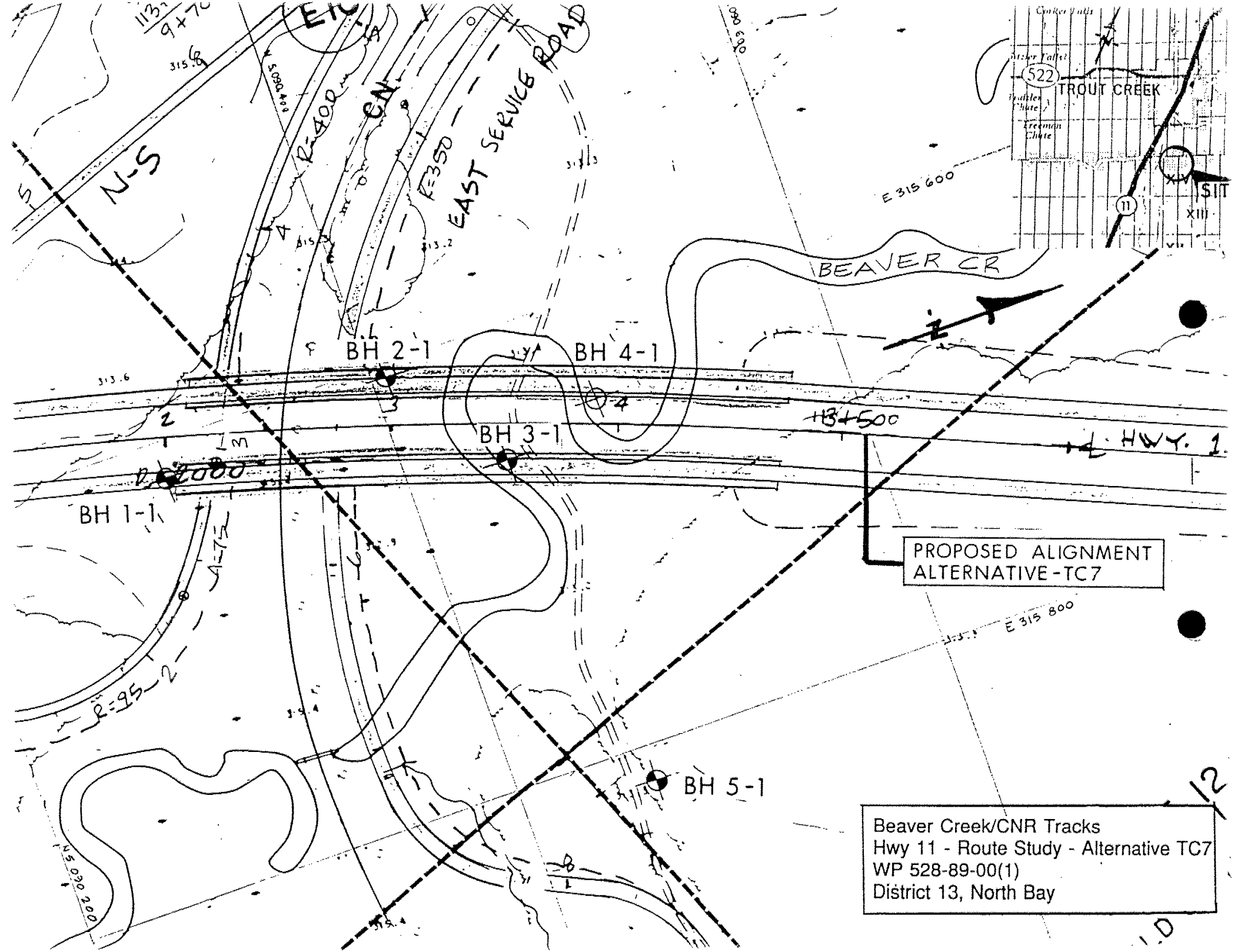
Based on the results of one borehole (BH 5-1) relocating the alignment further east of the proposed alignment is not recommended as there are no improvements to the subsoil conditions at this location.

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


BH 1-1
BH 2-1
BH 3-1
BH 4-1
BH 5-1
PROPOSED ALIGNMENT
ALTERNATIVE - TC7
EAST SERVICE ROAD
BEAVER CR
HWY. 11
TROUT CREEK
522
R=400
R=350
R=95
N-S
E 315 600
E 315 800
13+500
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

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.

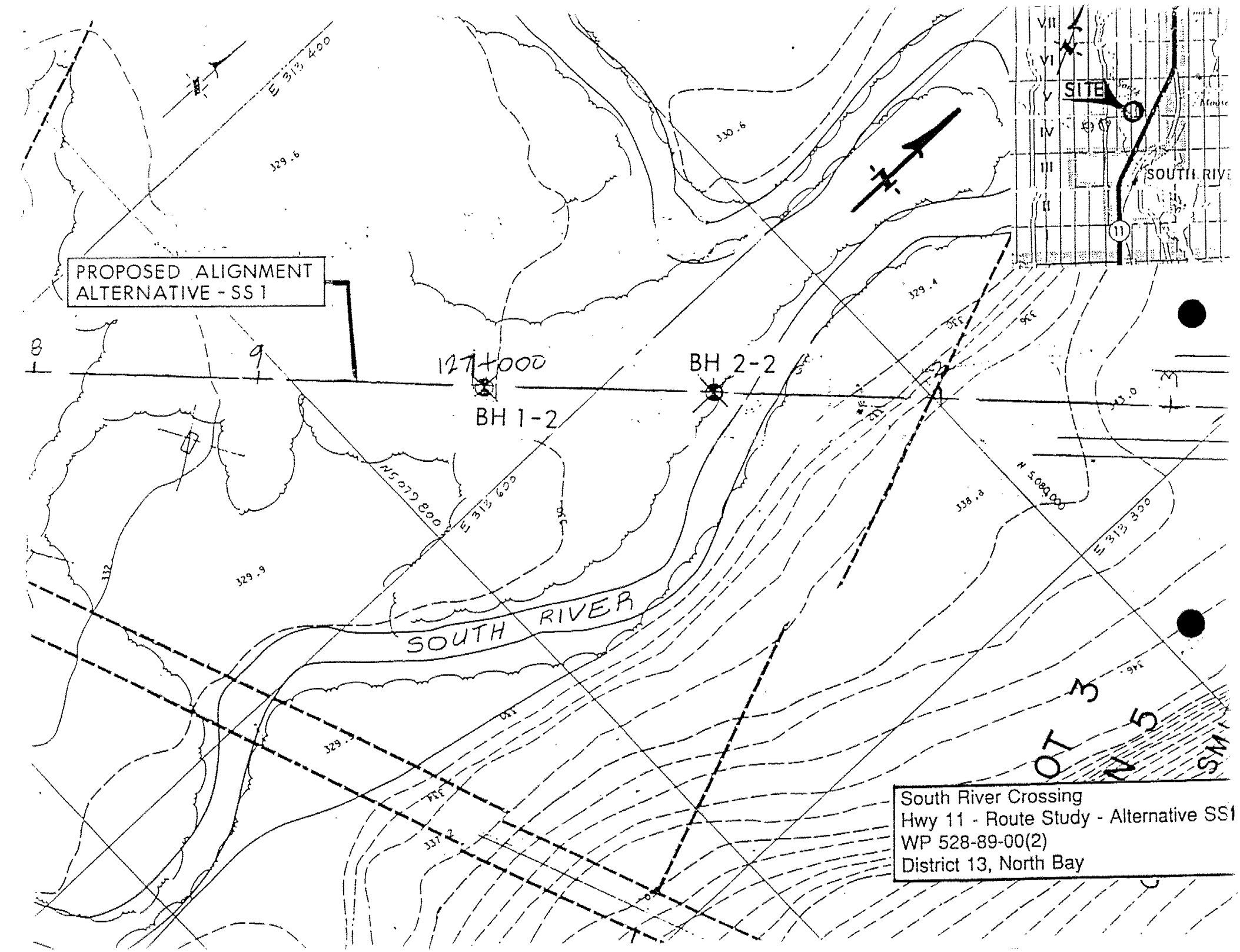
Dewatering problems during the construction of pile caps for the abutments could be avoided by locating the pile caps up within the fill. However, the pile caps for the pier will have to be constructed 2.0 m below the grade level requiring a dewatering scheme utilizing oversized excavations and sump 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 2-2
BH 1-2
SOUTH RIVER
SITE
SOUTH RIVE
E 313 400
N 5 079 800
E 313 600
N 5 080 000
E 313 300
329.6
330.6
329.4
329.9
338.8
337.2
342.0
8
9
South River Crossing
Hwy 11 - Route Study - Alternative SS1
WP 528-89-00(2)
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: 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

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 articluated joints to offset settlements. Further details would be provided by this office if this option is used.

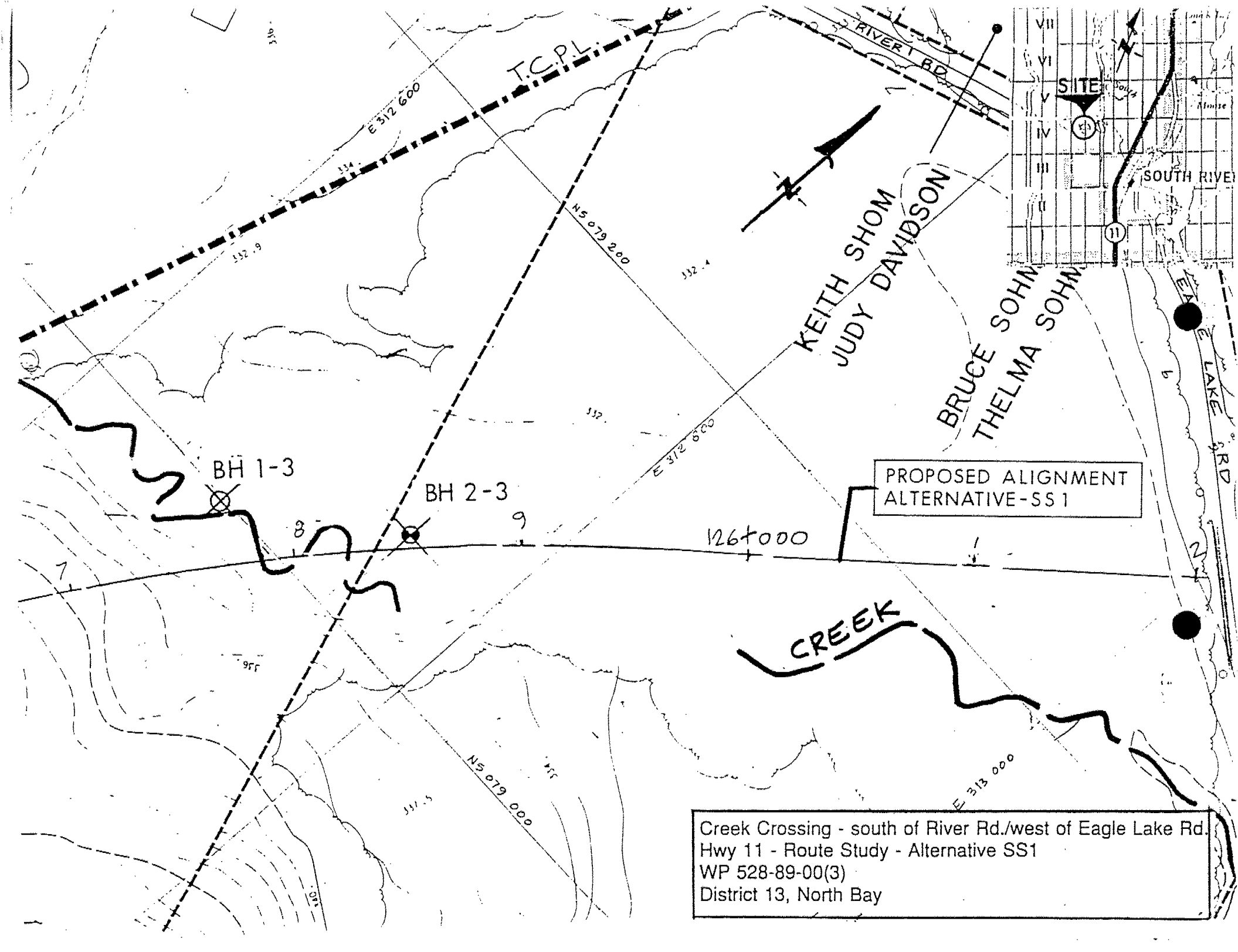
Construction of 6 m high approach embankment will require forward and side slopes of 2H : 1V. It is expected to undergo a total settlement in the order of 70 mm to 100 mm. Elastic settlements will occur immediately following the placement of the fill.

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.

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


T.C.P.L.
RIVER RD.
E 312 600
N 5 079 200
KEITH SHOM
JUDY DAVIDSON
BRUCE SOHN
THELMA SOHN
SITE
SOUTH RIVER
EAGLE LAKE RD.
BH 1-3
BH 2-3
E 312 800
PROPOSED ALIGNMENT
ALTERNATIVE-SS1
126+000
CREEK
N 5 079 000
E 313 000
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

memorandum

235-3696 Ontario

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

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