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## **FOUNDATION DESIGN SECTION**

**foundation  
investigation and  
design report**

ENGINEERING MATERIALS OFFICE  
FOUNDATION DESIGN SECTION

*CONT 93-215*

WP 641-89-02 DIST 20

HWY 17 STR SITE 41S-238

East Connection  
Kenora By-Pass to Hwy. 17

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F.A. Adams (2)  
K.G. Bassi  
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G. Norman (Cover Only)  
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# FOUNDATION INVESTIGATION REPORT

For

East Connection

Kenora By-Pass to Hwy. 17

W.P. 641-89-02, Site 41S-238

Highway 17, District 20, Kenora

## INTRODUCTION

This report contains the results of a foundation investigation carried out at the above mentioned site. The field work for this project was carried out between 1992 04 06 and 1992 04 14, and comprised of seven boreholes and Dynamic Cone Penetration Test adjacent to five of these boreholes. However, boreholes 1 to 3 were advanced during the previous investigation by Terraprobe Limited.

Boreholes were advanced to a maximum depth of 6.5 m (El: 340.5) below the existing ground level using a diamond drill and BW casing.

## SITE DESCRIPTION

The site under investigation is located at the east connection of Highway 17 and Kenora By-Pass (Hwy. 17A) which is approximately 20 km east of Kenora, near Longbow Lake.

The topography of the area is rolling, however, within the bridge location, it slopes southerly. The area in the vicinity of the site is rural in nature and consists of forest, bushes and swamps to the east. The proposed alignment of the bridge traverse through the rock outcrops at several locations.

## SUBSURFACE CONDITIONS

### General

The soil stratigraphy at this site varies from location to location and the underlying subsoil consists of shallow cover (0.4 m to 3.8 m) of compact to very

dense gravelly sand deposit or granular fill overlies granodiorite bedrock of the Superior Province. However, in some locations, stiff to very stiff silty clay underlies the topsoil or the gravelly sand deposit. For classification purposes, the soils encountered at this site can be divided into four different zones.

- a) Gravelly Sand, Some Silt (Fill)
- b) Gravelly Sand, Some Silt, Occasional Boulders
- c) Silty Clay, Occasional Silt Seams
- d) Granodiorite Bedrock

The subsurface conditions encountered during the course of the investigation, together with the field and laboratory test results are shown on the Record of Borehole Sheets contained in the Appendix of this report. A profile section and three stratigraphical sections are shown on Drawing No. 6418902-A. This drawing also shows the locations and elevations of the borings. Description of the strata encountered are given below.

#### Gravelly Sand, Some Silt (Fill)

This fill which was placed to raise the finished grade of the existing Highway 17 was encountered near the east end of the proposed bridge. The thickness of the fill varies from 0.6 m to 2.7 m and extends to elevations 345.5 to 343.5. This fill was observed to be in compact to dense (11 blows/0.3 m to 31 blows/0.3 m) state of denseness, however, fill under the existing Highway 17 was observed to be in very dense (133 blows/0.3 m ) state of denseness.

#### Gravelly Sand, Some Silt, Occasional Boulders

In majority of the area, this gravelly sand deposit was encountered immediately below the topsoil. The thickness of this deposit varies from 1.6 m to 1.8 m and extends to elevations 346.9 to 343.7. The results of the Grain Size Distribution Test carried out on representative soil samples are shown on Figure 1 in an envelope form. These results indicate that this deposit is predominantly composed of sand (47% to 71%) and gravel (19% to 32%). However, the upper part

of 0.6 m to 0.8 m of this deposit in boreholes 101 & 103 may be classified as silty sand. The Standard Penetration Test values vary over a wide range (19 blows/0.3 m to 56 blows/0.3 m) and indicate compact to very dense state of denseness.

#### Silty Clay, Occasional Silt Seams

This silty clay layer was encountered only in three boreholes (1, 103 & 104) located near the proposed west pier. The thickness of this layer varies from 1.1 m to 2.5 m. The natural moisture content was observed in the range of 27.5% to 33.6% with an average value of 29.3%. The Atterberg Limit Test results are shown on Figure 2 and these results indicate liquid limit in the range of 44 to 49 and plasticity index in the range of 24 to 28. The consistency may be classified as stiff to very stiff.

#### Granodiorite Bedrock

The rock cores were obtained using BXL core barrel and the description of the bedrock is included in the Appendix of this report.

The elevation of the bedrock within the bridge site varies from El: 351.2 to El: 343.5 with rock outcrops at several locations. The RQD values measured from BX cores indicate that the quality of the bedrock improves with the depth. The upper 0.6 m may be described as very poor to poor (RQD 0% to 45%) quality rock and below this depth, it may be described as fair to excellent (RQD Values 52% to 100%). The bedrock at this site may be classified as unweathered to slightly weathered granodiorite of the Superior Province.

#### Groundwater Conditions

The groundwater measurements were taken in open boreholes during the investigation and all the boreholes, with the exception of 1, 2, 3 & 108, were observed to be dry. However, the water level in boreholes 1, 2, 3 & 108 could not be established due to the presence of drill fluid (water) in the hole.

## DISCUSSION AND RECOMMENDATIONS

### General

It is proposed to construct an underpass at the intersection of Hwy. 17 and Kenora By-Pass (Hwy. 17A) east end to carry Highway 17A eastbound traffic over Highway 17 westbound lanes. In the vicinity of the intersection, the east and westbound lanes of Highway 17A will be constructed along separate horizontal and vertical alignments.

The bridge will be a three span (24.0 m end spans and 70.0 m centre span) concrete structure. The end spans will be constructed in the form of a cellular foundation by connecting the abutment and pier, and filled with concrete to counteract the loads imposed by the relatively longer centre span. The foundations for the bridge is proposed to be placed at elevation 343.0.

The finished grade of the underpass at the west end will be set at El: 351.05 and at the east end, it will be set at El: 350.66. In the vicinity of the bridge, the finished grade of the Highway 17 westbound lanes is expected to vary between El: 340.07 and El: 344.85.

### Structure Foundation

Considering the type of foundation and the depth (El: 343.0) at which it is proposed to be placed, it is recommended that the foundation be designed assuming a factored bearing capacity at U.L.S. of 10,000 kPa. Bearing capacity at S.L.S. Type II will not govern because the loads required to produce detrimental settlement of the structure will be much larger than the recommended values for factored bearing capacity at U.L.S.

Earth pressure should be computed as per Section 6.6.1.2.2 of the code and an unyielding foundation condition may be assumed for the computations. The Granular "A" or "B" backfill should be in accordance with the Special Provision No: 109F03. The following parameters are recommended for the granular backfill.

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

An unfactored coefficient of friction value of  $\tan 30^{\circ}$  may be assumed for the estimate of the sliding resistance. However, if adequate resistance against sliding cannot be mobilized, dowels may be used at the concrete and rock interface.

#### Approach Embankment

The maximum height of approach fill above the existing ground level at the east abutment is expected to be 4.0 m to 4.6 m, however, at the west abutment, it will be about 1.5 m. No major stability problems are anticipated for the approach embankments constructed with 2 horizontal to 1 vertical side slopes. The fill should consist of well compacted acceptable material. The topsoil as well as any spongy or soft areas observed within the width of the embankments should be removed before placing the fill.

#### Other Considerations

The total depth of excavation is expected to vary from about 2.8 m to a maximum of 8.6 m. However, the excavation in rock itself is expected to vary from about 0.5 m to a maximum of 8.2 m. No major stability problems are anticipated for the excavation in the overburden material with 2H:1V side slopes, however, the excavation in rock should be according to the current MTO practice.

MISCELLANEOUS

The field work for this investigation was carried out under the supervision of M. Vasavithasan, Foundation Engineer. The equipment used was owned and operated by Kenora Soil Drilling Ltd. This report was prepared by M. Vasavithasan, Foundation Engineer, reviewed by Mr. P. Payer, Senior Foundation Engineer, and approved by Mr. M. Devata, Chief Foundation Engineer.



*M. Vasavithasan*

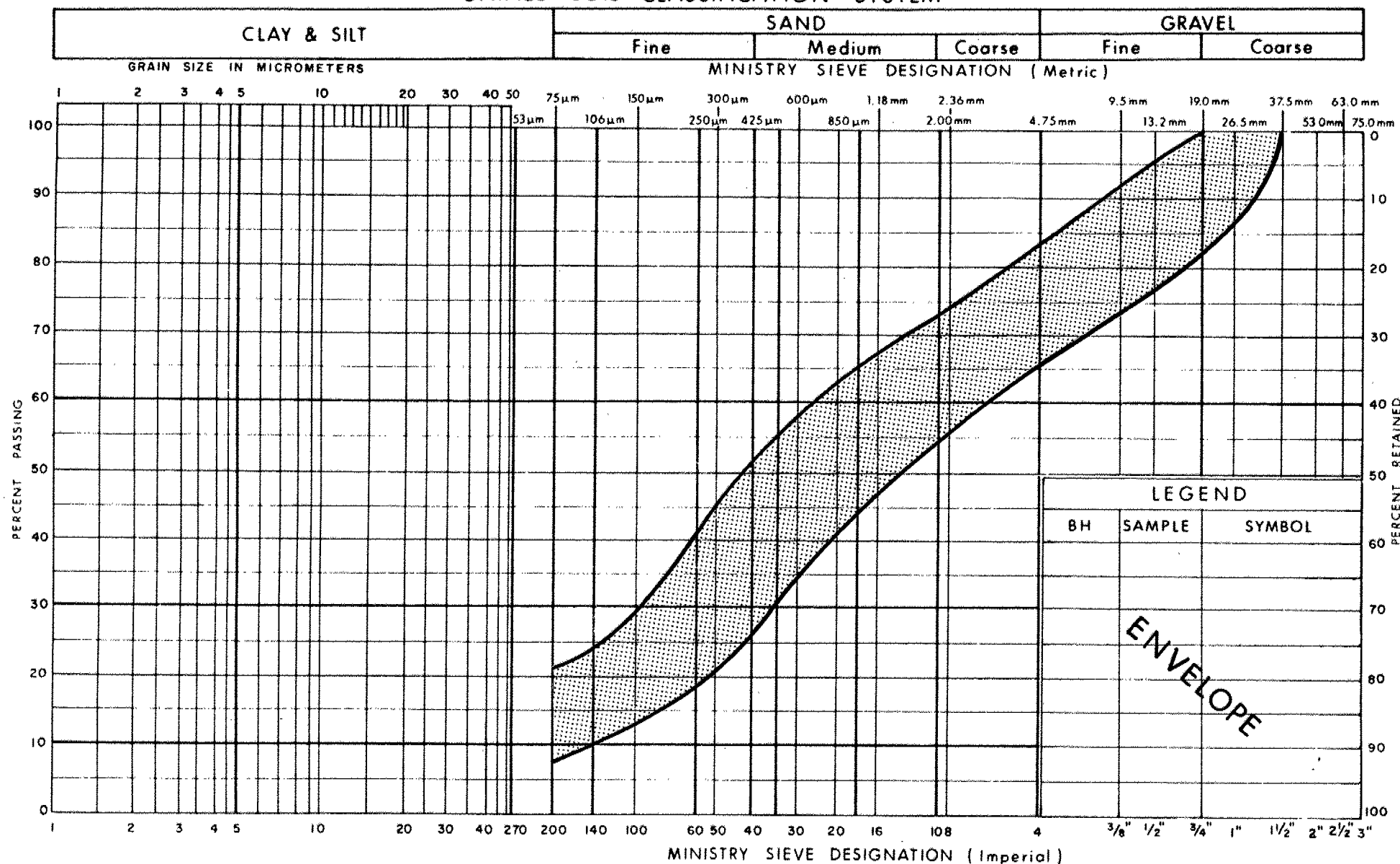
M. Vasavithasan, P. Eng.  
Foundation Engineer

*M. Devata*

M. Devata, P. Eng.  
Chief Foundation Engineer

## APPENDIX

## UNIFIED SOIL CLASSIFICATION SYSTEM

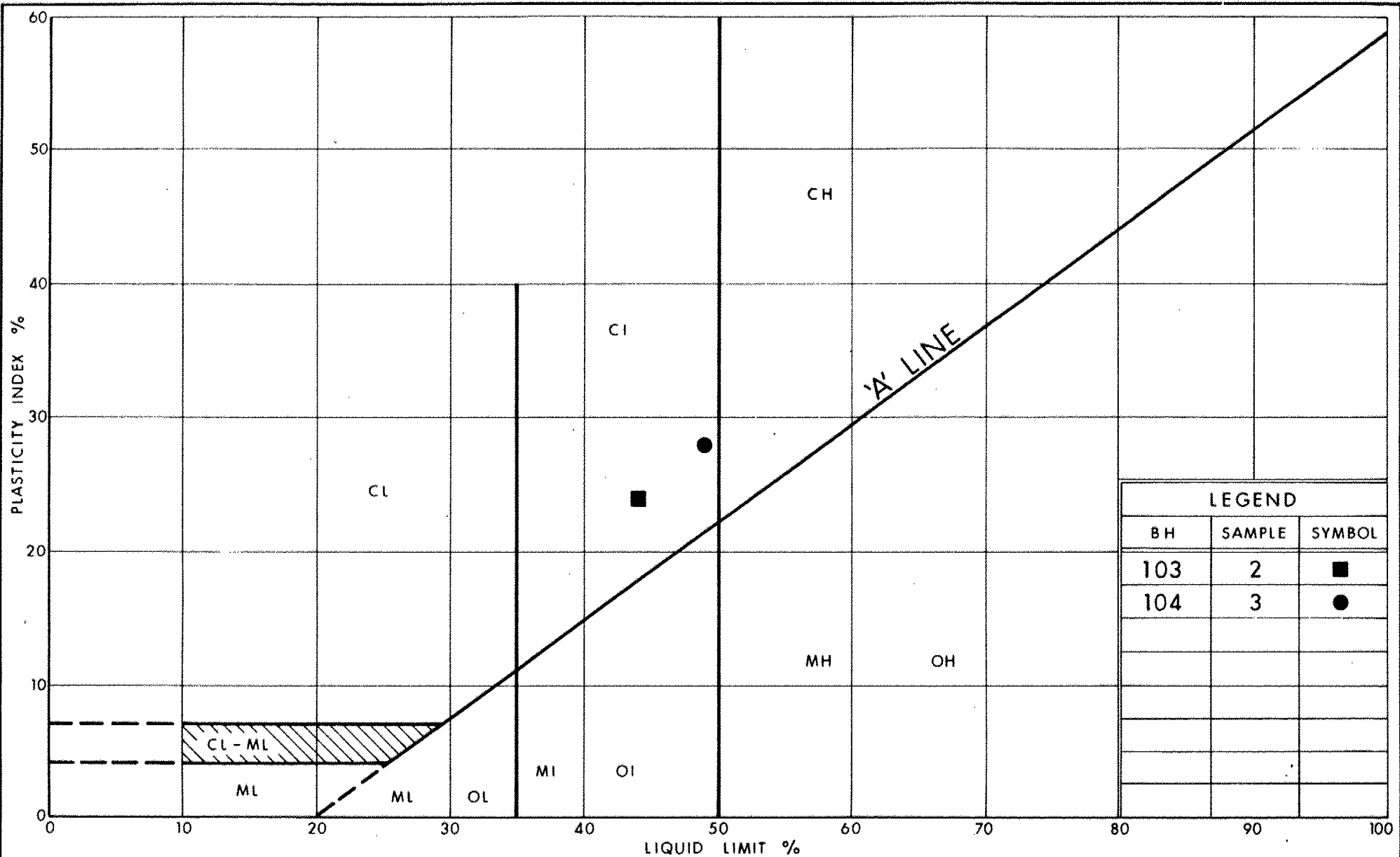


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GRAIN SIZE DISTRIBUTION  
GRAVELLY SAND, SOME SILT

FIG No 1

W P 641-89-02



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# PLASTICITY CHART SILTY CLAY, OCCASIONAL SILT SEAMS

FIG No 2

W P 641-89-02

## 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

### 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
$C_a$	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
$S_f$	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 OF 1

METRIC

W.P. 641 - 89 - 02 LOCATION STA. 30 + 860.7; O/S 6.8m LT. CL. HWY. 17A EBL ORIGINATED BY R.P.  
 DIST 20 HWY 17 & 17A BOREHOLE TYPE CONE TEST & NW CASING COMPILED BY M.V.  
 DATUM GEODETIC DATE 90 05 22 CHECKED BY P.P.

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							
347.3	Ground Surface											
0.0	Topsoil Soft		1	SS	3	*	347					
			2	SS	13		346					
	SILTY CLAY, Occasional Silt Seams Stiff		3	SS	11		345					0 1 37 62
344.6	Boulders		4	SS	8	/25cm						
2.7	GRANODIORITE BEDROCK		5	RC	REC							RQD = 100%
343.9	Unweathered			BQ	100%		344					
3.4	End of Borehole * Note: Water Level Not Established  Formerly BH #1 of Terroprobe Report											

# RECORD OF BOREHOLE No 2

1 OF 1

METRIC

W.P. 641 - 89 - 02 LOCATION STA. 30 + 889.8; O/S 0.6m LT. CL. HWY. 17A EBL ORIGINATED BY R.P.  
 DIST 20 HWY 17 & 17A BOREHOLE TYPE BQ ROCK CORING COMPILED BY M.V.  
 DATUM GEODETIC DATE 90 05 22 CHECKED BY P.P.

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>		
346.9	Rock Outcrop		1	RC BQ	REC 100%	*											RQD = 100%
0.0	GRANODIORITE BEDROCK Unweathered		2	RC BQ	REC 100%												RQD = 100%
			3	RC BQ	REC 100%												RQD = 100%
			4	RC BQ	REC 100%												RQD = 100%
			5	RC BQ	REC 100%												RQD = 100%
343.9																	
3.0	End of Borehole * Note: Water Level Not Established Formerly BM #2 of Terraprobe Report																

# RECORD OF BOREHOLE No 3

1 OF 1

METRIC

W.P. 641 - 89 - 02 LOCATION STA. 30 + 909.3; O/S 3.6m LT. CL. HWY. 17A EBL ORIGINATED BY R.P.  
 DIST 20 HWY 17 & 17A BOREHOLE TYPE NW CASING COMPILED BY M.V.  
 DATUM GEODETIC DATE 90 05 21 CHECKED BY P.P.

SOIL PROFILE		SAMPLES			GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT					PLASTIC LIMIT w <sub>p</sub>	NATURAL MOISTURE CONTENT w	LIQUID LIMIT w <sub>L</sub>	UNIT WEIGHT 7 kN/m <sup>3</sup>	REMARKS & GRAIN SIZE DISTRIBUTION (%) GR SA SI CL
ELEV DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE			20	40	60	80	100					
346.1	Ground Surface															
0.0	Topsoil		1	SS	11											
345.5	GRAVELLY SAND, Some Silt, Compact (Fill)		2	RC BQ	REC 92%											RQD = 75%
0.6			3	RC	REC											RQD = 0%
	GRANODIORITE BEDROCK		4	RC BQ	REC 100%	100%										RQD = 93%
	Unweathered		5	RC BQ	REC 100%											RQD = 100%
342.9			6	RC BQ	REC 100%											RQD = 100%
3.2	End of Borehole															
	Note: Water Level Not Established Formerly BH # 3 of Terroprobe Report															

# RECORD OF BOREHOLE No 101

1 OF 1

METRIC

W.P. 641 - 89 - 02 LOCATION STA. 30 + 794.2; O/S 7.8m RT. CL. HWY. 17A EBL ORIGINATED BY M.V.  
 DIST 20 HWY 17 & 17A BOREHOLE TYPE CONE TEST & BW CASING COMPILED BY M.V.  
 DATUM GEODETTIC DATE 92 04 07 & 08 CHECKED BY P.P.

SOIL PROFILE			SAMPLES			GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT		PLASTIC LIMIT NATURAL MOISTURE CONTENT LIQUID LIMIT			UNIT WEIGHT	REMARKS & GRAIN SIZE DISTRIBUTION (%)
ELEV DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE	'N' VALUES			20	40	60	80	100		
349.8	Ground Surface													
0.0	Topsoil					DRY *								
	Roots		1	SS	52									
	SILTY SAND, Some Gravel, Boulders, Compact to Very Dense		2	SS	28									
			3	SS	60	/10cm								
346.8														
2.9			4	RC BX	REC 83%									RQD = 0%
	GRANODIORITE BEDROCK Unweathered		5	RC BX	REC 95%									RQD = 45%
343.6														
6.2	End of Borehole													
	Note: Borehole Was Dry on 92 04 14													

# RECORD OF BOREHOLE No 102

1 OF 1

METRIC

W.P. 641 - 89 - 02 LOCATION STA. 30 + 801.4; O/S 7.8m LT. CL. HWY. 17A EBL ORIGINATED BY M.V.  
 DIST 20 HWY 17 & 17A BOREHOLE TYPE BW CASING COMPILED BY M.V.  
 DATUM GEODETIC DATE 92 04 08 CHECKED BY P.P.

SOIL PROFILE			SAMPLES			GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT					PLASTIC LIMIT w <sub>p</sub>	NATURAL MOISTURE CONTENT w	LIQUID LIMIT w <sub>L</sub>	UNIT WEIGHT γ 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					
351.6	Ground Surface																
0.0 351.2	Topsail					DRY *											
0.4	GRANODIORITE BEDROCK Unweathered		1	RC BX	REC 67%		351										RQD = 13%
			2	RC BX	REC 93%		350										RQD = 60%
			3	RC BX	REC 88%		349										RQD = 88%
			4	RC BX	REC 99%												RQD = 90%
348.2																	
3.4	End of Borehole * Note: Borehole Was Dry on 92 04 14																

# RECORD OF BOREHOLE No 103

1 OF 1

METRIC

W.P. 641 - 89 - 02 LOCATION STA. 30 + 818.2; O/S 7.8m RT. CL. HWY. 17A EBL ORIGINATED BY M.V.  
DIST 20 HWY 17 & 17A BOREHOLE TYPE CONE TEST & BW CASING COMPILED BY M.V.  
DATUM GEODETIC DATE 92 04 09 & 10 CHECKED BY P.P.

SOIL PROFILE			SAMPLES			GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT	PLASTIC LIMIT W <sub>P</sub>	NATURAL MOISTURE CONTENT W	LIQUID LIMIT W <sub>L</sub>	UNIT WEIGHT γ	REMARKS & GRAIN SIZE DISTRIBUTION (%)
ELEV DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE	'N' VALUES								
347.5	Ground Surface												
0.0	Topsoil					DRY							
346.4	SILTY SAND, Some Gravel, Compact		1	SS	9								
1.1	SILTY CLAY, Trace of Sand, Occasional Silt Seams, Stiff to Very Stiff		2	SS	17								
345.4													
2.1	GRAVELLY SAND, Some Silt, Very Dense		3	SS	56								
			4	SS	56								
343.7													
343.3	GRANODIORITE BEDROCK		5	RC	REC	75%							RQD = 0%
4.2	End of Borehole												
	Note: Borehole Was Dry on 92 04 14												

# RECORD OF BOREHOLE No 104

1 OF 1

METRIC

W.P. 641 - 89 - 02 LOCATION STA. 30 + 825.5; O/S 7.8m LT. CL. HWY. 17A EBL ORIGINATED BY M.V.  
 DIST. 20 HWY 17 & 17A BOREHOLE TYPE CONE TEST & BW CASING COMPILED BY M.V.  
 DATUM GEODETIC DATE 92 04 10 CHECKED BY P.P.

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							
349.1	Ground Surface											
0.0	Topsoil					DRY *						
	GRAVELLY SAND, Some Silt, Occasional Boulders, Compact		1	SS	19							
			2	SS	28							
346.9												
2.2	SILTY CLAY, Occasional Silt & Sand Seams, Stiff		3	SS	12							
345.8			4	SS	100	/10cm						
3.3	GRANODIORITE BEDROCK Unweathered		5	RC BX	REC 88%							
342.6												
6.5	End of Borehole * Note: Borehole Was Dry on 92 04 14											

# RECORD OF BOREHOLE No 105

1 OF 1

METRIC

W.P. 641 - 89 - 02 LOCATION STA. 30 + 887.5; O/S 7.8m RT. CL. HWY. 17A EBL ORIGINATED BY M.V.  
 DIST 20 HWY 17 & 17A BOREHOLE TYPE BW CASING COMPILED BY M.V.  
 DATUM GEODETIC DATE 92 04 13 CHECKED BY P.P.

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>		
346.6	Asphalt Surface																
0.0	Asphalt					DRY *											
	GRAVELLY SAND, Some Silt, Very Dense ( Fill )		1	SS	133												
344.7	Boulders																
1.9			2	RC BX	REC 92%											RQD = 72%	
	GRANODIORITE BEDROCK Unweathered		3	RC BX	REC 93%											RQD = 93%	
			4	RC BX	REC 97%											RQD = 80%	
			5	RC BX	REC 90%											RQD = 52%	
341.6																	
5.0	End of Borehole																
	Note: Borehole Was Dry on 92 04 14																

RECORD OF BOREHOLE No 106

1 OF 1

METRIC

W.P. 641 - 89 - 02 LOCATION STA. 30 + 896.1; O/S 8.2m LT. CL. HWY. 17A EBL ORIGINATED BY M.V.  
DIST. 20 HWY 17 & 17A BOREHOLE TYPE CONE TEST & BW CASING COMPILED BY M.V.  
DATUM GEODETIC DATE 92 04 11 CHECKED BY P.P.

SOIL PROFILE			SAMPLES			GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT			PLASTIC LIMIT W <sub>p</sub>	NATURAL MOISTURE CONTENT W	LIQUID LIMIT W <sub>L</sub>	UNIT WEIGHT 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	20 40 60 80 100					
348.8	Ground Surface														
0.0	Topsoil					DRY *									
	GRAVELLY SAND, Some Silt, Occasional Boulders, Dense to Very Dense		1	SS	48		348								
346.7			2	SS	52		347								19 67 (14)
2.1			3	RC BX	REC 80%		346								RQD = 69%
	GRANODIORITE BEDROCK Unweathered		4	RC BX	REC 100%		345								RQD = 79%
343.7							344								
5.1	End of Borehole														
	Note: Borehole Was Dry on 92 04 14														

# RECORD OF BOREHOLE No 108

1 OF 1

METRIC

W.P. 641 - 89 - 02 LOCATION STA. 30 + 920.2; O/S 6.2m LT. CL. HWY. 17A EBL ORIGINATED BY M.V.  
 DIST 20 HWY 17 & 17A BOREHOLE TYPE CONE TEST & BW CASING COMPILED BY M.V.  
 DATUM GEODETIC DATE 92 04 13 & 14 CHECKED BY P.P.

SOIL PROFILE			SAMPLES			GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT		PLASTIC LIMIT w <sub>p</sub>	NATURAL MOISTURE CONTENT w	LIQUID LIMIT w <sub>L</sub>	UNIT WEIGHT γ kN/m <sup>3</sup>	REMARKS & GRAIN SIZE DISTRIBUTION (%) GR SA SI CL
ELEV DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE	'N' VALUES			20	40					
346.2	Ground Surface													
0.0	GRAVELLY SAND, Some Silt, Occasional Boulders, Dense ( Fill )		1	SS	31	* /23cm	346							
			2	SS	31		345							
							344							
343.5	Boulders		3	SS	116		343							
2.7			4	RC BX	REC 88%		342							
			5	RC BX	REC 95%		341							
			6	RC BX	REC 95%									
340.5	GRANODIORITE BEDROCK Unweathered		7	RC BX	REC 93%									
5.7	End of Borehole * Note: Water Level Not Established													

# ROCK CORE DESCRIPTION

## WP 641-89-02

Page 1 of 2

CORE RECOVERY					CORE DESCRIPTION	
BH#	RC#	DEPTH (m)	% CR*	% RQD*	DEPTH (m)	DESCRIPTION
101	1	3.05-3.51	83	0	3.05-6.17	GRANODIORITE (chlorite-bearing and gneissic), greyish orange pink to medium dark grey; coarse to medium grained; strong; unweathered to slightly weathered (moderately weathered, 3.48-3.51 m); fractures moderately close to extremely close spaced, flat to near vertical, undulating to planar, smooth to rough.
	2	3.51-6.17	95	45		
102	1	0.38-1.14	67	13	0.38-3.43	GRANODIORITE (chlorite-bearing and gneissic), medium dark grey to greyish orange pink; coarse to medium grained; strong; unweathered to slightly weathered; fractures moderately close to very close spaced, flat to near vertical, undulating to planar, smooth to rough.
	2	1.14-1.91	93	60		
	3	1.91-2.67	88	88		
	4	2.67-3.43	99	90		
104	1	3.40-6.45	88	75	3.40-6.45	GRANODIORITE (chlorite-bearing and gneissic), medium dark grey to greyish orange pink; coarse to fine grained; strong; unweathered to slightly weathered; fractures moderately close to close spaced, flat to near vertical, undulating to planar, smooth to rough.
105	1	1.91-2.67	92	72	1.91-4.95	GRANODIORITE (chlorite-bearing and gneissic), medium dark grey; coarse to fine grained; strong; unweathered to slightly weathered; fractures moderately close to very close spaced, flat to dipping, planar to undulating, smooth to rough.
	2	2.67-3.43	93	93		
	3	3.43-4.19	97	80		
	4	4.19-4.95	90	52		

\*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

# ROCK CORE DESCRIPTION

## WP 641-89-02

Page 2 of 2

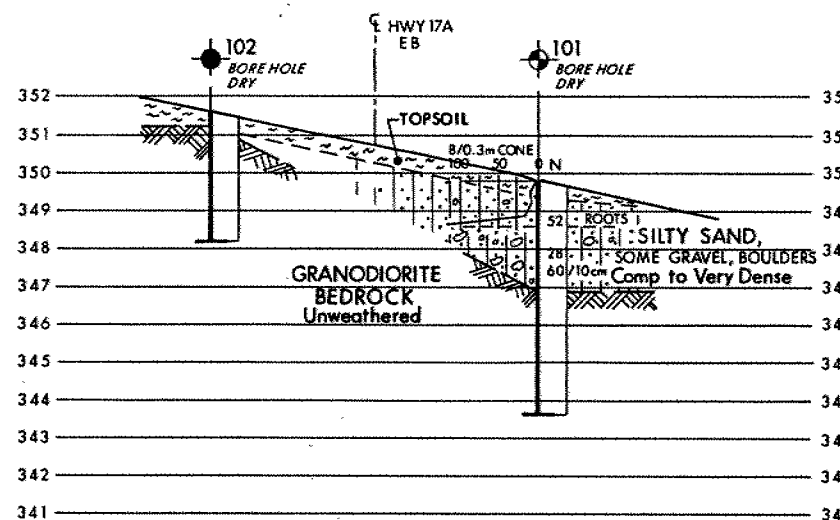
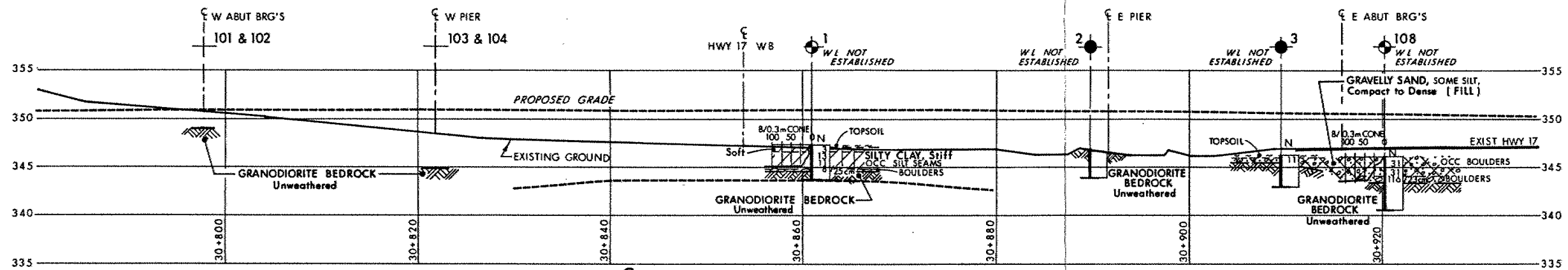
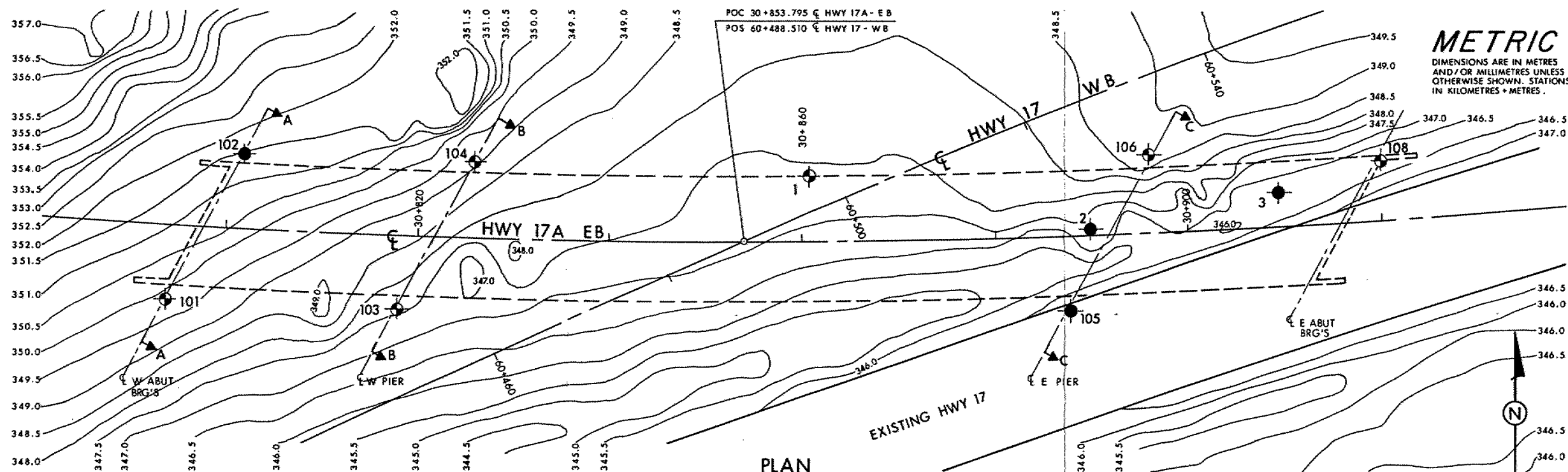
CORE RECOVERY					CORE DESCRIPTION	
BH#	RC#	DEPTH (m)	% CR*	% RQD*	DEPTH (m)	DESCRIPTION
106	1	2.08-2.84	80	69	2.08-5.13	GRANODIORITE (chlorite-bearing and gneissic), medium dark grey; coarse to medium grained; strong; unweathered to slightly weathered; fractures moderately close to very close spaced, flat to near vertical, undulating to planar, smooth to rough.
	2	2.84-5.13	100	79		
108	1	2.67-3.43	88	65	2.67-5.72	GRANODIORITE (chlorite-bearing and gneissic), medium dark grey to greyish orange pink; coarse to fine grained; strong; unweathered to slightly weathered; fractures moderately close to very close spaced, flat to near vertical, planar to undulating, smooth to rough.
	2	3.43-4.19	95	47		
	3	4.19-4.95	95	77		
	4	4.95-5.72	93	93		

\*CR = CORE RECOVERY

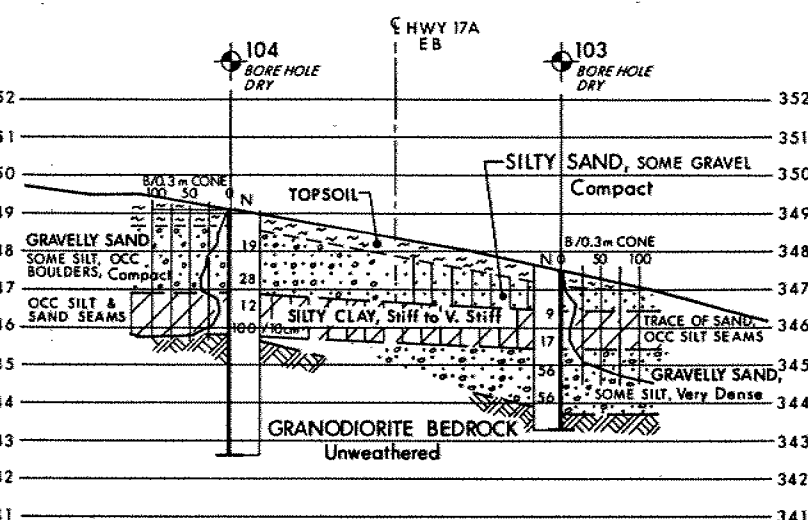
\*RQD = ROCK QUALITY DESIGNATION

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

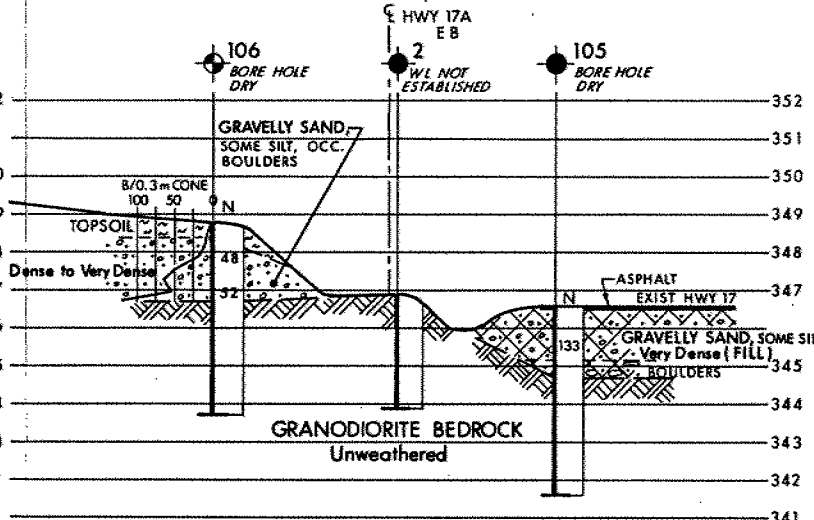
Logged by: DAW, Soils and Aggregates Section



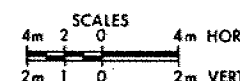
SECTION A-A



SECTION B-B



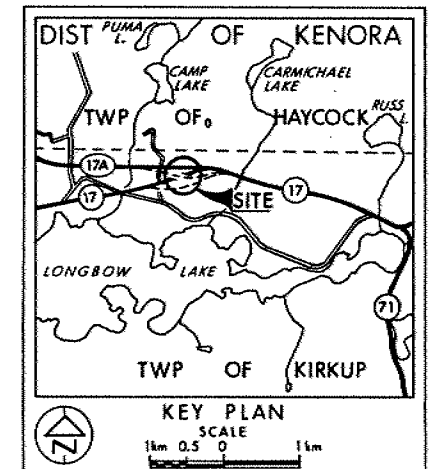
SECTION C-C



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

CONT No  
WP No 641-89-02  
EAST CONNECTION  
KENORA BY-PASS TO HWY 17  
BORE HOLE LOCATIONS & SOIL STRATA

SHEET



LEGEND

- Bore Hole
- ⊕ Dynamic Cone Penetration Test (Cone)
- ⊕ Bore Hole & Cone
- N Blows/0.3m (Std Pen Test, 475 J/blow)
- CONE Blows/0.3m (60° Cone, 475 J/blow)
- W L at time of investigation 1990 05 & 1992 04.

No	ELEVATION	STATION	OFFSET HWY 17A EB
1	347.3	30+860.7	6.8m LT
2	346.9	30+889.8	0.6m LT
3	346.1	30+909.3	3.6m LT
101	349.8	30+794.2	7.8m RT
102	351.6	30+801.4	7.8m LT
103	347.5	30+818.2	7.8m RT
104	349.1	30+825.5	7.8m LT
105	346.6	30+887.5	7.8m RT
106	348.8	30+896.1	8.2m LT
108	346.2	30+920.2	6.2m LT

NOTE

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

NOTE: The complete foundation investigation and design report for this project and other related documents may be examined at the Engineering Materials Office, Downsview. Information contained in this report and related documents is specifically excluded in accordance with the conditions of Section 102-2 of Form 100.

REV	DATE	BY	DESCRIPTION
1			
2			
3			
4			
5			
6			
7			
8			
9			
10			

Geocres No 52E-35

HWY No 17  
SUBM'D M.V. CHECKED DATE 1992 06 04 SITE 415-238  
DRAWN R.S. CHECKED APPROVED DWG 6418902-A

# FOUNDATION INVESTIGATION REPORT

*93-215*  
**CONTRACT NO. ~~92-220~~**



Ministry of  
Transportation

## INDEX

<u>Page No:</u>	<u>DESCRIPTION</u>
1	Index
2	Abbreviations & Symbols
3 - 21	Foundation Investigation Report for  East Connection Kenora By-Pass to Hwy. 17 W.P. 641-89-02, Site 41S-238 Hwy. 17, District 20 Kenora

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

## EXPLANATION OF TERMS USED IN REPORT

2

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

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

SOILS ARE DESCRIBED BY THEIR COMPOSITION AND CONSISTENCY OR DENSENESS.

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

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

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

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

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

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

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

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

**JOINTING AND BEDDING:**

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

## ABBREVIATIONS AND SYMBOLS

### FIELD SAMPLING

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

### STRESS AND STRAIN

$u_w$	kPa	PORE WATER PRESSURE
$r_u$	1	PORE PRESSURE RATIO
$\sigma$	Pa	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
$S_t$	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						

## FOUNDATION INVESTIGATION REPORT

For

East Connection

Kenora By-Pass to Hwy. 17

W.P. 641-89-02, Site 41S-238

Highway 17, District 20, Kenora

### INTRODUCTION

This report contains the results of a foundation investigation carried out at the above mentioned site. The field work for this project was carried out between 1992 04 06 and 1992 04 14, and comprised of seven boreholes and Dynamic Cone Penetration Test adjacent to five of these boreholes. However, boreholes 1 to 3 were advanced during the previous investigation by Terraprobe Limited.

Boreholes were advanced to a maximum depth of 6.5 m (El: 340.5) below the existing ground level using a diamond drill and BW casing.

### SITE DESCRIPTION

The site under investigation is located at the east connection of Highway 17 and Kenora By-Pass (Hwy. 17A) which is approximately 20 km east of Kenora, near Longbow Lake.

The topography of the area is rolling, however, within the bridge location, it slopes southerly. The area in the vicinity of the site is rural in nature and consists of forest, bushes and swamps to the east. The proposed alignment of the bridge traverse through the rock outcrops at several locations.

### SUBSURFACE CONDITIONS

#### General

The soil stratigraphy at this site varies from location to location and the underlying subsoil consists of shallow cover (0.4 m to 3.8 m) of compact to very

dense gravelly sand deposit or granular fill overlies granodiorite bedrock of the Superior Province. However, in some locations, stiff to very stiff silty clay underlies the topsoil or the gravelly sand deposit. For classification purposes, the soils encountered at this site can be divided into four different zones.

- a) Gravelly Sand, Some Silt (Fill)
- b) Gravelly Sand, Some Silt, Occasional Boulders
- c) Silty Clay, Occasional Silt Seams
- d) Granodiorite Bedrock

The subsurface conditions encountered during the course of the investigation, together with the field and laboratory test results are shown on the Record of Borehole Sheets contained in the Appendix of this report. A profile section and three stratigraphical sections are shown on Drawing No. 6418902-A.\* This drawing also shows the locations and elevations of the borings. Description of the strata encountered are given below.

#### Gravelly Sand, Some Silt (Fill)

This fill which was placed to raise the finished grade of the existing Highway 17 was encountered near the east end of the proposed bridge. The thickness of the fill varies from 0.6 m to 2.7 m and extends to elevations 345.5 to 343.5. This fill was observed to be in compact to dense (11 blows/0.3 m to 31 blows/0.3 m) state of denseness, however, fill under the existing Highway 17 was observed to be in very dense (133 blows/0.3 m ) state of denseness.

#### Gravelly Sand, Some Silt, Occasional Boulders

In majority of the area, this gravelly sand deposit was encountered immediately below the topsoil. The thickness of this deposit varies from 1.6 m to 1.8 m and extends to elevations 346.9 to 343.7. The results of the Grain Size Distribution Test carried out on representative soil samples are shown on Figure 1 in an envelope form. These results indicate that this deposit is predominantly composed of sand (47% to 71%) and gravel (19% to 32%). However, the upper part

\* SHEET NO 157 OF THE CONTRACT DWG'S

of 0.6 m to 0.8 m of this deposit in boreholes 101 & 103 may be classified as silty sand. The Standard Penetration Test values vary over a wide range (19 blows/0.3 m to 56 blows/0.3 m) and indicate compact to very dense state of denseness.

#### Silty Clay, Occasional Silt Seams

This silty clay layer was encountered only in three boreholes (1, 103 & 104) located near the proposed west pier. The thickness of this layer varies from 1.1 m to 2.5 m. The natural moisture content was observed in the range of 27.5% to 33.6% with an average value of 29.3%. The Atterberg Limit Test results are shown on Figure 2 and these results indicate liquid limit in the range of 44 to 49 and plasticity index in the range of 24 to 28. The consistency may be classified as stiff to very stiff.

#### Granodiorite Bedrock

The rock cores were obtained using BXL core barrel and the description of the bedrock is included in the Appendix of this report.

The elevation of the bedrock within the bridge site varies from El: 351.2 to El: 343.5 with rock outcrops at several locations. The RQD values measured from BX cores indicate that the quality of the bedrock improves with the depth. The upper 0.6 m may be described as very poor to poor (RQD 0% to 45%) quality rock and below this depth, it may be described as fair to excellent (RQD Values 52% to 100%). The bedrock at this site may be classified as unweathered to slightly weathered granodiorite of the Superior Province.

#### Groundwater Conditions

The groundwater measurements were taken in open boreholes during the investigation and all the boreholes, with the exception of 1, 2, 3 & 108, were observed to be dry. However, the water level in boreholes 1, 2, 3 & 108 could not be established due to the presence of drill fluid (water) in the hole.

MISCELLANEOUS

The field work for this investigation was carried out under the supervision of M. Vasavithasan, Foundation Engineer. The equipment used was owned and operated by Kenora Soil Drilling Ltd. This report was prepared by M. Vasavithasan, Foundation Engineer, reviewed by Mr. P. Payer, Senior Foundation Engineer, and approved by Mr. M. Devata, Chief Foundation Engineer.

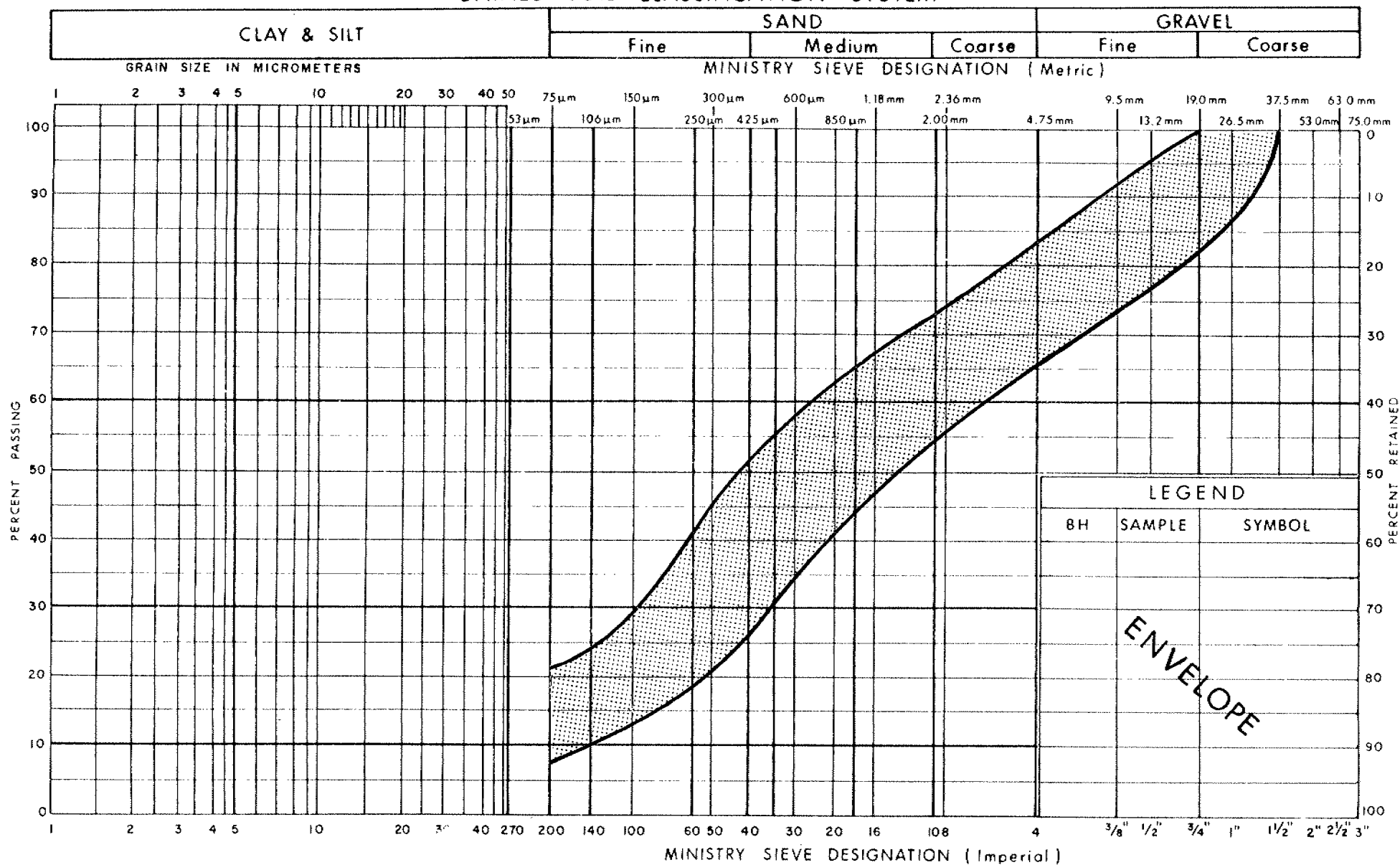


P. Payer, P. Eng.  
Senior Foundation Engineer

M.S. Devata, P. Eng.  
Chief Foundation Engineer

## APPENDIX

## UNIFIED SOIL CLASSIFICATION SYSTEM



Ontario

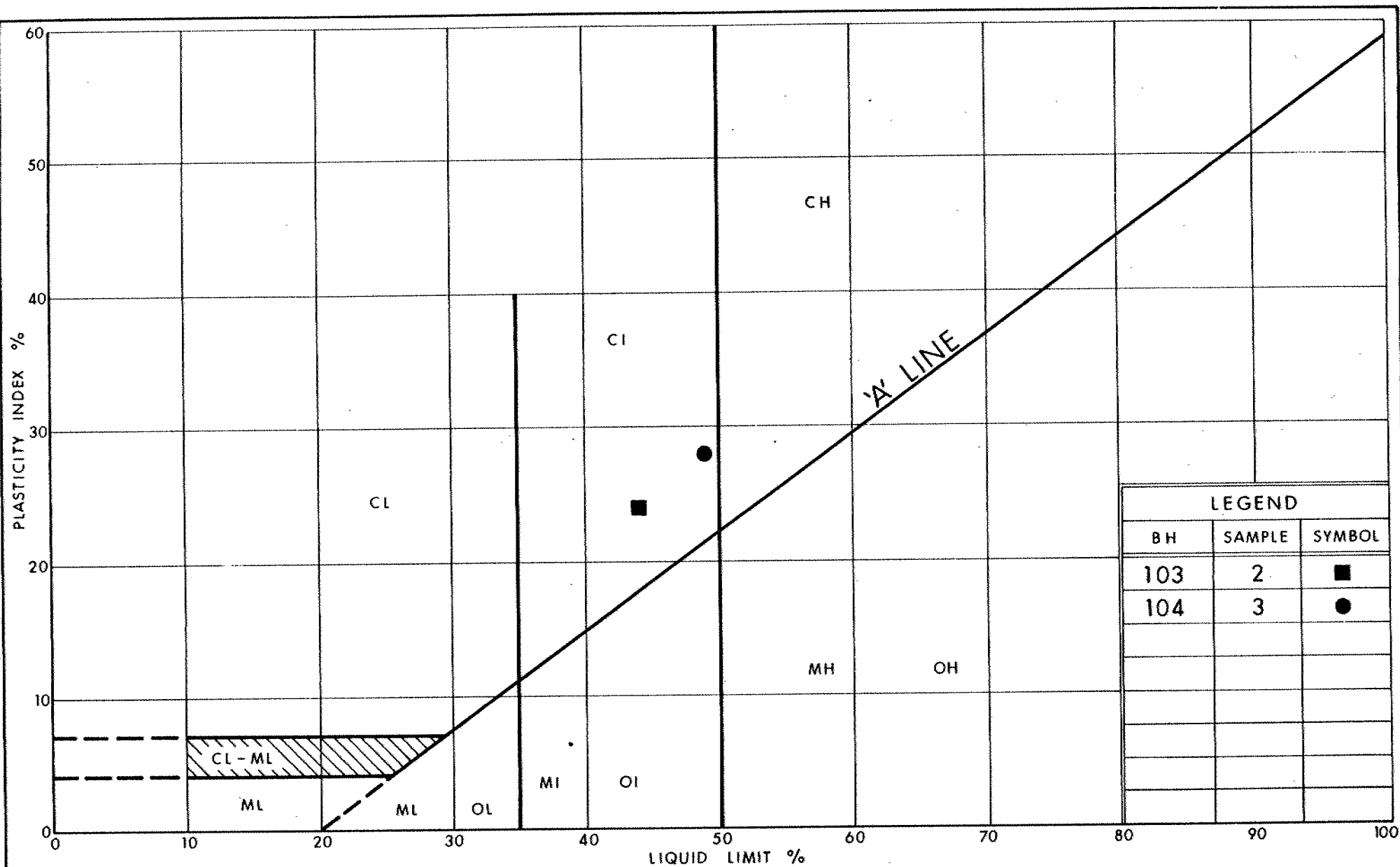
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GRAIN SIZE DISTRIBUTION

GRAVELLY SAND, SOME SILT

FIG No 1

W P 641-89-02



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Transportation

Ontario

# PLASTICITY CHART SILTY CLAY, OCCASIONAL SILT SEAMS

FIG No 2

W P 641-89-02

6

# **ROCK CORE DESCRIPTION** **WP 641-89-02**

Page 1 of 2

CORE RECOVERY					CORE DESCRIPTION	
BH#	RC#	DEPTH (m)	% CR*	% RQD*	DEPTH (m)	DESCRIPTION
101	1	3.05-3.51	83	0	3.05-6.17	<b>GRANODIORITE</b> (chlorite-bearing and gneissic), greyish orange pink to medium dark grey; coarse to medium grained; strong; unweathered to slightly weathered (moderately weathered, 3.48-3.51 m); fractures moderately close to extremely close spaced, flat to near vertical, undulating to planar, smooth to rough.
	2	3.51-6.17	95	45		
102	1	0.38-1.14	67	13	0.38-3.43	<b>GRANODIORITE</b> (chlorite-bearing and gneissic), medium dark grey to greyish orange pink; coarse to medium grained; strong; unweathered to slightly weathered; fractures moderately close to very close spaced, flat to near vertical, undulating to planar, smooth to rough.
	2	1.14-1.91	93	60		
	3	1.91-2.67	88	88		
	4	2.67-3.43	99	90		
104	1	3.40-6.45	88	75	3.40-6.45	<b>GRANODIORITE</b> (chlorite-bearing and gneissic), medium dark grey to greyish orange pink; coarse to fine grained; strong; unweathered to slightly weathered; fractures moderately close to close spaced, flat to near vertical, undulating to planar, smooth to rough.
105	1	1.91-2.67	92	72	1.91-4.95	<b>GRANODIORITE</b> (chlorite-bearing and gneissic), medium dark grey; coarse to fine grained; strong; unweathered to slightly weathered; fractures moderately close to very close spaced, flat to dipping, planar to undulating, smooth to rough.
	2	2.67-3.43	93	93		
	3	3.43-4.19	97	80		
	4	4.19-4.95	90	52		

\*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

# **ROCK CORE DESCRIPTION** **WP 641-89-02**

Page 2 of 2

CORE RECOVERY					CORE DESCRIPTION	
BH#	RC#	DEPTH (m)	% CR*	% RQD*	DEPTH (m)	DESCRIPTION
106	1	2.08-2.84	80	69	2.08-5.13	GRANODIORITE (chlorite-bearing and gneissic), medium dark grey; coarse to medium grained; strong; unweathered to slightly weathered; fractures moderately close to very close spaced, flat to near vertical, undulating to planar, smooth to rough.
	2	2.84-5.13	100	79		
108	1	2.67-3.43	88	65	2.67-5.72	GRANODIORITE (chlorite-bearing and gneissic), medium dark grey to greyish orange pink; coarse to fine grained; strong; unweathered to slightly weathered; fractures moderately close to very close spaced, flat to near vertical, planar to undulating, smooth to rough.
	2	3.43-4.19	95	47		
	3	4.19-4.95	95	77		
	4	4.95-5.72	93	93		

\*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

# RECORD OF BOREHOLE No 1

1 OF 1

METRIC

W.P. 641 - 89 - 02 LOCATION STA. 30 + 860.7; O/S 6.8m LT. CL. HWY. 17A EBL ORIGINATED BY R.P.  
 DIST 20 HWY 17 & 17A BOREHOLE TYPE CONE TEST & NW CASING COMPILED BY M.V.  
 DATUM GEODETIC DATE 90 05 22 CHECKED BY P.P.


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>	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								
347.3	Ground Surface												
0.0	Topsoil Soft		1	SS	3	*	347						
	SILTY CLAY, Occasional Silt Seams Stiff		2	SS	13		346						
			3	SS	11		345						
344.6		Boulders	4	SS	8	/25cm	345						
2.7	GRANODIORITE BEDROCK		5	RC	REC								
343.9	Unweathered			BQ	100%		344						RQD = 100%
3.4	End of Borehole												
	* Note: Water Level Not Established  Formerly BH #1 of Terraprobe Report												

RECORD OF BOREHOLE No 2

1 OF 1

METRIC

W.P. 641 - 89 - 02 LOCATION STA. 30 + 889.8; O/S 0.6m LT. CL. HWY. 17A EBL ORIGINATED BY R P  
DIST 20 HWY 17 & 17A BOREHOLE TYPE BO ROCK CORING COMPILED BY M V  
DATUM GEODETIC DATE 90.05.22 CHECKED BY P P

SOIL PROFILE			SAMPLES			GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT					PLASTIC LIMIT W <sub>p</sub>	NATURAL MOISTURE CONTENT W	LIQUID LIMIT W <sub>L</sub>	UNIT WEIGHT γ	REMARKS & GRAIN SIZE DISTRIBUTION (%)
ELEV DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE	'N' VALUES			20	40	60	80	100					
346.9	Rock Outcrop																
0.0	GRANODIORITE BEDROCK Unweathered		1	RC BQ	REC 100%	*	346										RQD = 100%
			2	RC BQ	REC 100%												RQD = 100%
			3	RC BQ	REC 100%												RQD = 100%
			4	RC BQ	REC 100%												RQD = 100%
			5	RC BQ	REC 100%												RQD = 100%
343.9							344										
3.0	End of Borehole																
	* Note: Water Level Not Established Formerly BH #2 of Terraprobe Report																

# RECORD OF BOREHOLE No 3

1 OF 1

METRIC

W.P. 641 - 89 - 02 LOCATION STA. 30 + 909.3; O/S 3.6m LT. CL. HWY. 17A EBL ORIGINATED BY R P  
 DIST 20 HWY 17 & 17A BOREHOLE TYPE NW CASING COMPILED BY M V  
 DATUM GEODETIC DATE 90 05 21 CHECKED BY P P

SOIL PROFILE			SAMPLES			GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT					PLASTIC LIMIT W <sub>P</sub>	NATURAL MOISTURE CONTENT W	LIQUID LIMIT W <sub>L</sub>	UNIT WEIGHT γ	REMARKS & GRAIN SIZE DISTRIBUTION (%)
ELEV DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE	'N' VALUES			20	40	60	80	100					
346.1	Ground Surface																
0.0	Topsoil		1	SS	11	*											
345.5	GRAVELLY SAND, Some Silt, Compact ( Fill )		2	RC BQ	REC 92%												
0.6			3	RC	REC	100%	345										RQD = 75%
			4	RC BQ	REC 100%												RQD = 0%
	GRANODIORITE BEDROCK Unweathered		5	RC BQ	REC 100%		344										RQD = 93%
			6	RC BQ	REC 100%												RQD = 100%
342.9							343										RQD = 100%
3.2	End of Borehole																
	Note: Water Level Not Established Formerly BH # 3 of Terroprobe Report																

# RECORD OF BOREHOLE No 101

1 OF 1

METRIC

W.P. 641 - 89 - 02 LOCATION STA. 30 + 794.2; O/S 7.8m RT. CL. HWY. 17A EBL ORIGINATED BY M.V.  
DIST 20 HWY 17 & 17A BOREHOLE TYPE CONE TEST & BW CASING COMPILED BY M.V.  
DATUM GEODETIC DATE 92 04 07 & 08 CHECKED BY P.P.

SOIL PROFILE		SAMPLES			GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT	PLASTIC LIMIT W <sub>p</sub>	NATURAL MOISTURE CONTENT W	LIQUID LIMIT W <sub>L</sub>	UNIT WEIGHT γ	REMARKS & GRAIN SIZE DISTRIBUTION (%)
ELEV DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE								
349.8	Ground Surface											
0.0	Topsoil											
	Roots											
	SILTY SAND, Some Gravel, Boulders, Compact to Very Dense		1	SS	52							
			2	SS	28							
			3	SS	60							
346.9												
2.9			4	RC BX	REC 83%							RQD = 0%
	GRANODIORITE BEDROCK Unweathered		5	RC BX	REC 95%							RQD = 45%
343.6												
6.2	End of Borehole											
	Note: Borehole Was Dry on 92 04 14											

# RECORD OF BOREHOLE No 102

1 OF 1

METRIC

W.P. 641 - 89 - 02 LOCATION STA. 30 + 801.4; O/S 7.8m LT. CL. HWY. 17A EBL ORIGINATED BY M.V.  
 DIST 20 HWY 17 & 17A BOREHOLE TYPE BW CASING COMPILED BY M.V.  
 DATUM GEODETIC DATE 92 04 08 CHECKED BY P.P.

SOIL PROFILE			SAMPLES			GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT		PLASTIC LIMIT W <sub>p</sub>	NATURAL MOISTURE CONTENT W	LIQUID LIMIT W <sub>L</sub>	UNIT WEIGHT γ 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
351.6	Ground Surface														
0.0 351.2	Topsoil					DRY *									
0.4	GRANODIORITE BEDROCK Unweathered		1	RC BX	REC 67%									RQD = 13%	
			2	RC BX	REC 93%										RQD = 60%
			3	RC BX	REC 88%										RQD = 88%
			4	RC BX	REC 99%										RQD = 90%
348.2															
3.4	End of Borehole * Note: Borehole Was Dry on 92 04 14														

RECORD OF BOREHOLE No 103

1 OF 1

METRIC

W.P. 641 - 89 - 02 LOCATION STA. 30 + 818.2; O/S 7.8m RT. CL. HWY. 17A EBL ORIGINATED BY M.V.  
DIST 20 HWY 17 & 17A BOREHOLE TYPE CONE TEST & BW CASING COMPILED BY M.V.  
DATUM GEODETIC DATE 92 04 09 & 10 CHECKED BY P.P.

SOIL PROFILE			SAMPLES			GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT 20 40 60 80 100	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								
347.5	Ground Surface												
0.0	Topsoil					DRY *							
346.4	SILTY SAND, Some Gravel, Compact		1	SS	9								
1.1	SILTY CLAY, Trace of Sand, Occasional Silt Seams, Stiff to Very Stiff		2	SS	17								
345.4													
2.1	GRAVELLY SAND, Some Silt, Very Dense		3	SS	56								
			4	SS	56								
343.7													
343.3	GRANODIORITE BEDROCK		5	RC	REC	75%							
4.2	End of Borehole												
	Note: Borehole Was Dry on 92 04 14												

RECORD OF BOREHOLE No 104

1 OF 1

METRIC

W.P. 641 - 89 - 02 LOCATION STA. 30 + 825.5; O/S 7.8m LT. CL. HWY. 17A EBL ORIGINATED BY M.V.  
DIST 20 HWY 17 & 17A BOREHOLE TYPE CONE TEST & BW CASING COMPILED BY M.V.  
DATUM GEODETIC DATE 92 04 10 CHECKED BY P.P.

SOIL PROFILE			SAMPLES			GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT 20 40 60 80 100	PLASTIC LIMIT W <sub>p</sub>	NATURAL MOISTURE CONTENT W	LIQUID LIMIT W <sub>L</sub>	UNIT WEIGHT γ	REMARKS & GRAIN SIZE DISTRIBUTION (%) C SA SI CL
ELEV. DEPTH	DESCRIPTION	STRAT. PLOT	NUMBER	TYPE	'N' VALUES								
349.1	Ground Surface												
0.0	Topsoil					DRY *							
	GRAVELLY SAND, Some Silt, Occasional Boulders, Compact		1	SS	19		348						
			2	SS	28		347						21 71 (8)
346.9													
2.2	SILTY CLAY, Occasional Silt & Sand Seams, Stiff		3	SS	12		346						
345.8			4	SS	100	/10cm							
3.3													
	GRANODIORITE BEDROCK Unweathered		5	RC BX	REC 88%		345						RQD = 75%
							344						
							343						
342.6													
6.5	End of Borehole * Note: Borehole Was Dry on 92 04 14												

RECORD OF BOREHOLE No 105

1 OF 1

METRIC

W.P. 641 - 89 - 02 LOCATION STA. 30 + 887.5; O/S 7.8m RT. CL. HWY. 17A EBL ORIGINATED BY M.V.  
DIST 20 HWY 17 & 17A BOREHOLE TYPE BW CASING COMPILED BY M.V.  
DATUM GEODETIC DATE 92 04 13 CHECKED BY P.P.

SOIL PROFILE			SAMPLES			GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT					PLASTIC LIMIT w <sub>p</sub>	NATURAL MOISTURE CONTENT w	LIQUID LIMIT w <sub>L</sub>	UNIT WEIGHT γ	REMARKS & GRAIN SIZE DISTRIBUTION (%)
ELEV DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE	'N' VALUES			20	40	60	80	100					
346.6	Asphalt Surface																
0.0	Asphalt																
	GRAVELLY SAND, Some Silt, Very Dense ( Fill )		1	SS	133												
344.7	Boulders																
1.9			2	RC BX	REC 92%												RQD = 72%
	GRANODIORITE BEDROCK Unweathered		3	RC BX	REC 93%												RQD = 93%
			4	RC BX	REC 97%												RQD = 80%
			5	RC BX	REC 90%												RQD = 52%
341.6																	
5.0	End of Borehole																
	* Note: Borehole Was Dry on 92 04 14																

RECORD OF BOREHOLE No 106

1 OF 1

METRIC

W.P. 641 - 89 - 02 LOCATION STA. 30 + 896.1; O/S 8.2m LT. CL. HWY. 17A EBL ORIGINATED BY M.V.  
DIST 20 HWY 17 & 17A BOREHOLE TYPE CONE TEST & BW CASING COMPILED BY M.V.  
DATUM GEODETIC DATE 92 04 11 CHECKED BY P.P.

SOIL PROFILE			SAMPLES			GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT		PLASTIC LIMIT W <sub>p</sub>	NATURAL MOISTURE CONTENT W	LIQUID LIMIT W <sub>L</sub>	UNIT WEIGHT γ	REMARKS & GRAIN SIZE DISTRIBUTION (%)
ELEV DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE	'N' VALUES			20	40					
348.8	Ground Surface													
0.0	Topsoil					DRY +								
	GRAVELLY SAND. Some Silt, Occasional Boulders, Dense to Very Dense		1	SS	48									
346.7			2	SS	52									19 67 (14)
2.1			3	RC BX	REC 80%									RQD = 9%
	GRANODIORITE BEDROCK Unweathered		4	RC BX	REC 100%									RQD = 79%
343.7														
5.1	End of Borehole													
	* Note: Borehole Was Dry on 92 04 14													

RECORD OF BOREHOLE No 108

1 OF 1

METRIC

W.P. 641 - 89 - 02 LOCATION STA. 30 + 920.2; O/S 6.2m LT. CL. HWY. 17A EBL ORIGINATED BY M V  
DIST 20 HWY 17 & 17A BOREHOLE TYPE CONE TEST & BW CASING COMPILED BY M V  
DATUM GEODETIC DATE 92 04 13 & 14 CHECKED BY P P

SOIL PROFILE			SAMPLES			GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT	PLASTIC LIMIT W <sub>P</sub>	NATURAL MOISTURE CONTENT W	LIQUID LIMIT W <sub>L</sub>	UNIT WEIGHT γ	REMARKS & GRAIN SIZE DISTRIBUTION (%)
ELEV DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE	'N' VALUES								
346.2	Ground Surface												
0.0	GRAVELLY SAND, Some Silt, Occasional Boulders, Dense ( Fill )		1	SS	31								
			2	SS	31								
343.5	Boulders		3	SS	116	/23cm							
2.7	GRANODIORITE BEDROCK Unweathered		4	RC BX	REC 88%								RQD = 65%
			5	RC BX	REC 95%								RQD = 47%
			6	RC BX	REC 95%								RQD = 77%
340.5			7	RC BX	REC 93%								RQD = 93%
5.7	End of Borehole * Note: Water Level Not Established												

