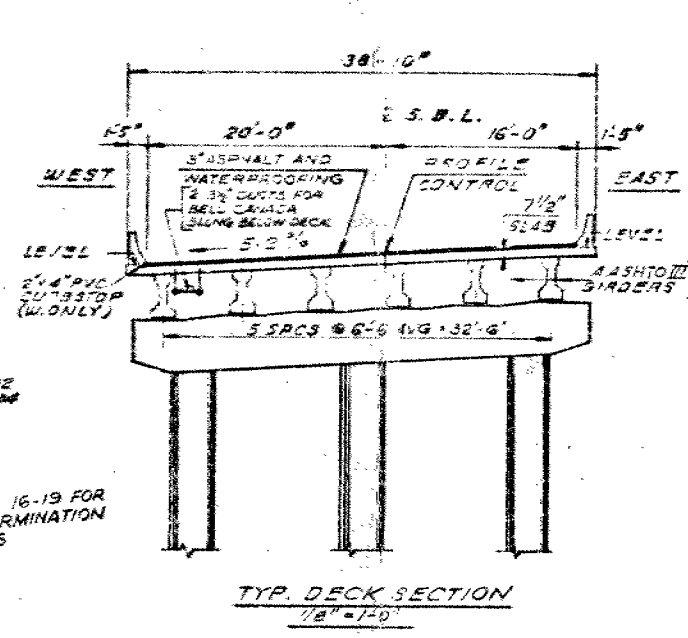
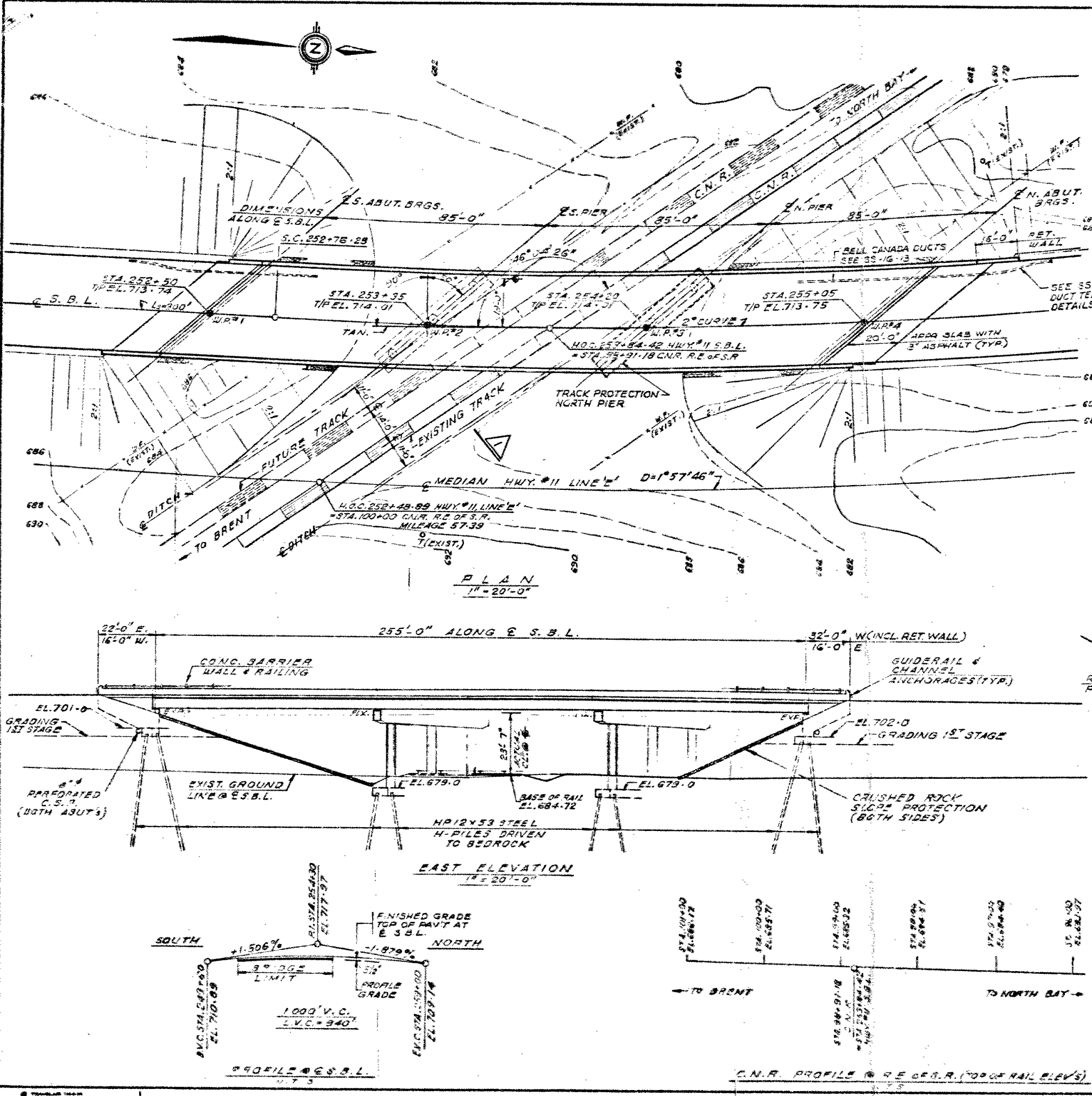


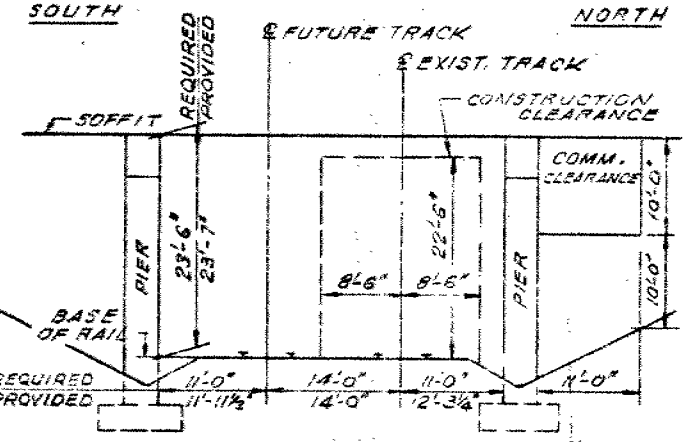
G.I.-30 SEPT. 1976

GEOCRES No. 31L-39DIST. 13 REGION W.P. No. 71-74-02CONT. No. 79-53W. O. No. STR. SITE No. 43-105BHWY. No. 11LOCATION C.N.R. OverheadNo of PAGES -OVERSIZE DRAWINGS TO BE INCLUDED WITH THIS REPORT.REMARKS:

MINISTRY OF TRANSPORTATION AND COMMUNICATIONS



NOTES:
• W.P. DENOTES WORKING POINT.
• T/P DENOTES TOP OF ASPHALT WEARING SURFACE.
• REFER TO GRADING DRAWINGS FOR CATCH BASINS OFF STRUCTURE.



HWY No 11 DIST. No 13	SHEET
CONT No WP No 71-74-02	
C.N.R. O'HEAD S.B.L. 2.8 MI. SOUTH OF HWY No 17 GENERAL PLAN	
DeLew Cather	

NOTES:
CLASS OF CONCRETE
PRESTRESSED GIRDERS 5000 PSI
DECK, BARRIER WALLS & PIERS 4000 PSI
REMAINDER 3000 PSI
CLEAR COVER TO REINFORCING STEEL
FOOTINGS, ABUTMENTS & RETAINING WALL 3"
PIERS & APPROACH SLABS 2"
DECK TOP 2" BOTTOM 1 1/2"
BARRIER WALLS AS SHOWN
PRESTRESSED GIRDERS
UNLESS NOTED OTHERWISE.
REINFORCING STEEL
C.S.A. 330 SERIES, GRADE 60 MINIMUM.
CONSTRUCTION NOTES
THE CONTRACTOR SHALL FINISH THE BEARING SEATS DEAD LEVEL TO THE SPECIFIED ELEVATIONS TO A TOLERANCE OF 1/8".
NO CONCRETE SHALL BE PLACED ABOVE ABUTMENT BEARING SEATS UNTIL THE CONCRETE IN THE DECK HAS BEEN PLACED.
BOULDERS OR STONE WITH A MAXIMUM GRAIN SIZE GREATER THAN 3" SHALL NOT BE PLACED IN APPROACH FILLS THROUGH WHICH PILES HAVE TO BE DRIVEN.
CONCRETE BARRIER WALL ON RETAINING WALL SHALL NOT BE CAST UNTIL THE RETAINING WALL BACKFILL HAS BEEN COMPLETED.

- LIST OF DRAWINGS
1. GENERAL PLAN
 2. BOREHOLE LOCATIONS & SOIL STRATA
 3. FOUNDATION LAYOUT
 4. FOOTING REINFORCEMENT
 5. SOUTH ABUTMENT
 6. NORTH ABUTMENT & NAV. RET. WALL
 7. PIERS
 8. PRESTRESSED GIRDERS & BEARINGS
 9. DECK PLAN
 10. DECK DETAILS
 11. APPROACH SLABS
 12. BARRIER WALLS
 13. STEEL RAILING (SINGLE TUBE)
 14. STANDARD DETAILS I
 15. STANDARD DETAILS II
 16. STANDARD DETAILS III
 17. TRACK PROTECTION
 18. AS CONSTRUCTED ELEV. & DIM.

CONCRETE QUANTITIES

CONCRETE QUANTITIES ARE LISTED BELOW FOR APPROPRIATE CONCRETE LUMP SUM ITEMS.

1. CONCRETE IN PIERS, ABUTMENTS, WINGWALLS & RETAINING WALL	2000 PSI	164 cu yd
	4000 PSI	113 cu yd
2. CONCRETE IN DECK & DIAPHRAGMS		231 cu yd
3. CONCRETE IN BARRIER WALLS		43 cu yd
4. CONCRETE IN APPROACH SLABS		48 cu yd

TO BE USED FOR CONSTRUCTION PURPOSES ONLY

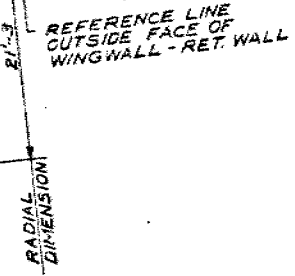
DATE FEB 23 1978

FOR REDUCED PLAN

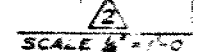
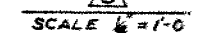
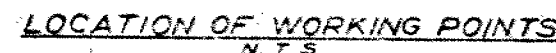
DATE FEB 23 1978

1 INCHES ON ORIGINAL PLAN

RECEIVED	
FEB 23 1978	
SOIL MECHANICS	
TRANSPORTATION & COMMUNICATIONS	
DESIGN	CHECK
LOADING	DATE
DRAWING	CHECK
DATE	DESCRIPTION



N.T.S



NOTES

1. SPACING OF PILES TO BE MEASURED AT UNDERSIDE OF FOOTINGS.
- 2 ALL PILES SHALL BE DRIVEN TO BEDROCK.

NOTES

1. SPACING OF PILES TO BE MEASURED AT UNDERSIDE OF FOOTINGS.
- 2 ALL PILES SHALL BE DRIVEN TO BEDROCK.



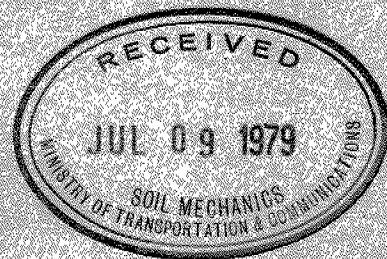
REVISIONS								
DATE BY		DESCRIPTION						
DESIGN	S.S.	CHECK	G.M.	LOADING	M.S.	N.W.	DATED	DEC
DRAWING		CHECK		SITE	N.W.			

FOUNDATION INVESTIGATION REPORT

CONTRACT NO 79-53



Ministry of
Transportation and
Communications



1

INDEX

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1	Index
2	Abbreviations & Symbols
3-81	Foundation Investigation Reports For
	W.P. 71-74-02 CNR Overhead SBL
	W.P. 71-74-03/04 Birch's Road Overpass
	W.P. 71-74-05/06 CPR & Lavase River Overhead
	W.P. 71-74-07 Lakeshore Drive Underpass

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

'N' VALUE: AN INDICATOR OF SUBSOIL QUALITY. IT IS OBTAINED FROM THE STANDARD PENETRATION TEST (CSA STD. A119.1). SPT 'N' VALUE IS THE NUMBER OF BLOWS REQUIRED TO CAUSE A STANDARD 2 INCH O.D. SPLIT-BARREL SAMPLER TO PENETRATE 12 INCHES INTO UNDISTURBED GROUND IN A BOREHOLE WHEN DRIVEN BY A HAMMER WEIGHING 140 POUNDS, FALLING FREELY A DISTANCE OF 30 INCHES. FOR PENETRATIONS OF LESS THAN 12 INCHES 'N' VALUES ARE INDICATED AS THE NUMBER OF BLOWS FOR THE PENETRATION ACHIEVED. 'N' VALUES CORRECTED FOR OVERBURDEN PRESSURE ARE DENOTED THUS N_c .

DYNAMIC CONE PENETRATION TEST (CSA STD. A119.3): CONTINUOUS PENETRATION OF A CONICAL STEEL POINT (2" O.D. 60 CONE ANGLE) DRIVEN BY 350 FT-LB IMPACTS ON 'A' SIZE DRILL RODS. THE RESISTANCE TO CONE PENETRATION IS MEASURED AS THE NUMBER OF BLOWS FOR EACH 12 INCH ADVANCE OF THE CONICAL POINT INTO THE UNDISTURBED GROUND.

SOIL QUALITY: SOILS ARE DESCRIBED BY THEIR COMPOSITION AND CONSISTENCY OR DENSITY.

CONSISTENCY: COHESIVE SOILS ARE DESCRIBED ON THE BASIS OF THEIR UNDRAINED SHEAR STRENGTH AS FOLLOWS:

S_u (PSF)	0 - 250	250 - 500	500 - 1000	1000 - 2000	2000 - 4000	> 4000
	VERY SOFT	SOFT	FIRM	STIFF	VERY STIFF	HARD

DENSENESS: COHESIONLESS SOILS ARE DESCRIBED ON THE BASIS OF SPT 'N' VALUES AS FOLLOWS:

'N' (BLOW/FT)	0 - 5	5 - 10	10 - 30	30 - 50	> 50
	VERY LOOSE	LOOSE	COMPACT	DENSE	VERY DENSE

ROCK QUALITY: 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 DRILLED IN THAT CORING RUN.

MODIFIED RECOVERY: SUM OF THOSE NATURALLY FRACTURED CORE PIECES, 4" 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	2"	2" - 12"	1' - 3'	3' - 10'	> 10'
JOINTING	VERY CLOSE	CLOSE	MOD. CLOSE	WIDE	VERY WIDE
BEDDING	VERY THIN	THIN	MEDIUM	THICK	VERY THICK

ABBREVIATIONS & SYMBOLS

LABORATORY TESTING

TRIAXIAL TESTS ARE DESCRIBED IN TERMS OF WHETHER THEY ARE CONSOLIDATED (C) OR NOT (U) ISOTROPICALLY (I) OR NOT (A) AND SHEARED DRAINED (D) OR UNDRAINED (U) WITH PORE PRESSURE MEASUREMENTS (BAR OVER SYMBOLS) EG. CUU = CONSOLIDATED ISOTROPIC UNDRAINED TRIAXIAL WITH PORE PRESSURE MEASUREMENT UNLESS OTHERWISE SPECIFIED IN REPORT ALL TESTS ARE IN COMPRESSION

FIELD SAMPLING

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

EARTH PRESSURE TERMS

μ COEFFICIENT OF FRICTION
 δ ANGLE OF WALL FRICTION
 k_o COEFFICIENT OF EARTH PRESSURE AT REST
 k_A COEFFICIENT OF ACTIVE EARTH PRESSURE
 k_P COEFFICIENT OF PASSIVE EARTH PRESSURE
 i ANGLE OF INCLINATION OF SURCHARGE
 w SLOPE ANGLE-BACKFACE OF WALL
 β ANGLE OF SLOPE
 N, N_q, N_c BEARING CAPACITY FACTORS
 D_f DEPTH OF FOOTING
 B, L FOOTING DIMENSIONS

INDEX PROPERTIES

γ UNIT WEIGHT OF SOIL (BULK DENSITY)
 γ_w UNIT WEIGHT OF WATER
 γ_d UNIT DRY WEIGHT OF SOIL (DRY DENSITY)
 γ' UNIT WEIGHT OF SUBMERGED SOIL
 G_s SPECIFIC GRAVITY OF SOLIDS
 e VOIDS RATIO
 e_o INITIAL VOIDS RATIO
 e_{max} e IN LOOSEST STATE
 e_{min} e IN DENSEST STATE
 D_r RELATIVE DENSITY = $\frac{e_{max} - e}{e_{max} - e_{min}}$
 n POROSITY
 w WATER CONTENT
 w_L LIQUID LIMIT
 w_p PLASTIC LIMIT
 w_s SHRINKAGE LIMIT
 I_p PLASTICITY INDEX = $w_L - w_p$
 I_L LIQUIDITY INDEX = $\frac{w - w_p}{w_L - w_p}$
 I_c CONSISTENCY INDEX = $\frac{w_L - w}{w_L - w_p}$
 A_c ACTIVITY = $\frac{I_p \text{ of soil}}{I_p \text{ of } \mu m \text{ Soil Fraction}}$
 Om ORGANIC MATTER CONTENT
 S_r DEGREE OF SATURATION
 S SENSITIVITY = $\frac{S_u(\text{undisturbed})}{S_u(\text{remoulded})}$

STRENGTH PARAMETERS

ϕ ANGLE OF SHEARING RESISTANCE
 τ_f PEAK SHEAR STRENGTH
 τ_R RESIDUAL SHEAR STRENGTH
 c COHESION INTERCEPT
 $\sigma_1, \sigma_2, \sigma_3$ NORMAL PRINCIPAL STRESSES
 u PORE WATER PRESSURE
 u_e EXCESS u
 r_u PORE PRESSURE RATIO
 q_u UNCONFINED COMPRESSIVE STRENGTH
 s_u UNDRAINED SHEAR STRENGTH
 ϵ LINEAR STRAIN
 γ SHEAR STRAIN
 ν POISSON'S RATIO
 E MODULUS OF ELASTICITY
 G MODULUS OF SHEAR DEFORMATION
 k_s MODULUS OF SUBGRADE REACTION
 m, n STABILITY COEFFICIENTS
 A, B PORE PRESSURE COEFFICIENTS

NOTE: EFFECTIVE STRESS PARAMETERS ARE DENOTED BY USE OF APOSTROPHE ABOVE THE SYMBOL, THUS:
 ϕ' = EFFECTIVE ANGLE OF SHEARING RESISTANCE;
 σ' = EFFECTIVE NORMAL STRESS

HYDRAULIC TERMS

h HYDRAULIC HEAD OR POTENTIAL
 q RATE OF DISCHARGE
 v VELOCITY OF FLOW
 i HYDRAULIC GRADIENT
 j SEEPAGE FORCE PER UNIT VOLUME
 η COEFFICIENT OF VISCOSITY
 k COEFFICIENT OF HYDRAULIC CONDUCTIVITY
 k_h k IN HORIZONTAL DIRECTION
 k_v k IN VERTICAL DIRECTION
 m_v COEFFICIENT OF VOLUME CHANGE
 c_v COEFFICIENT OF CONSOLIDATION
 C_c COMPRESSION INDEX
 C_r RECOMPRESSION INDEX
 d DRAINAGE PATH DISTANCE
 T_v TIME FACTOR
 U DEGREE OF CONSOLIDATION
 O_r OVERCONSOLIDATION RATIO (OCR)

FOUNDATION INVESTIGATION REPORT

For

CNR Overhead Southbound Lane
2.8 Miles South of Hwy. 17 and 11
W.P. 71-74-02, Site 43-105B
Hwy. 11, District 13, North Bay

INTRODUCTION

This report contains the results of a foundation investigation carried out at the site of the above mentioned project. The fieldwork was carried out during the period of November 23, 1976 to December 3, 1976. It consisted of a total of eight boreholes advanced by means of 3½" I.D. hollow stem flight augers to depths ranging from 43 to 53 feet below the ground surface. Bedrock was proven by obtaining BXL size rock core samples.

SITE DESCRIPTION AND GEOLOGY

The site is located about 220 feet northwest of the existing Hwy. 11 CNR Overhead approximately 2.8 miles south of the east junction of Hwy. 11 and 17 in the City of North Bay, District of Nipissing. Rolling terrain is prevalent throughout this area and the immediate vicinity of the site has been cleared of trees and is now overgrown with bushes. The existing Hwy. 11 CNR structure is a 37 foot single span concrete rigid frame structure. Gneiss bedrock outcrops are present on both sides of the Hwy. 11 embankment about 1000 feet south of the existing structure and also on the west side of the highway embankment about 200 feet north of the existing structure. A large swamp area about 200 feet north of the site extends from about 250 feet west of the existing highway westerly about 1000 feet.

Physiographically the site is located in the region known as the Canadian Shield. The Shield is characterized by the effects of intense glaciation which has left scattered rounded rock outcrops and rocky ridges separated by glacial deposits and muskeg.

SUBSURFACE CONDITIONS

General

Generally, uniform conditions were found to prevail over the site area. Subsoil consists of 40 to 53 feet of compact to dense sand with a trace of gravel. The sand is underlain by gneiss bedrock. Detailed descriptions of the overburden and bedrock encountered in each borehole are given on the Record of Borehole Sheets. The locations and elevations of the boreholes, together with the estimated stratigraphical sections as inferred from the borehole data and site geology, are shown on Contract Drawing No. 43-105B-2.

The sand overburden and gneiss bedrock encountered are described in the paragraphs to follow.

Sand

Immediately below a thin veneer of topsoil and extending down to the bedrock surface is a deposit of sand. The sand stratum is estimated to vary in thickness from 40 to 53 feet. This granular deposit is comprised of 5 to 12 foot thick layers of fine sand and 12 to 25 foot thick layers of medium sand with a trace of gravel. Grain size distribution tests performed on representative samples from this stratum gave a coefficient of uniformity of 2 for the fine sand and 5 for the medium sand. These results indicate that the fine sand is uniform and that the medium sand is well graded. Grain size distribution envelopes, one for the fine sand and one for the medium sand, are shown on Figure 1 appended to this report.

In the upper ten foot portion of the sand stratum random layers or pockets about four inches in thickness of clayey silt to silty clay were encountered. Atterberg Limit Tests performed on two samples from these cohesive layers indicate that the material is an inorganic silty clay of low to intermediate plasticity. The results of the Atterberg Limits are shown on the Record of Borehole Sheets.

Based on Standard Penetration Test 'N' values which range randomly from 10 to 49 blows per foot, the relative density of the sand

stratum is estimated to be generally compact to dense with the exception of the silty clay to clayey silt layers where the consistency is estimated to be stiff.

Gneiss Bedrock

The overburden is underlain by bedrock which was proven in three of the boreholes by obtaining up to five feet of BXL size rock core at each location. Where cores were not taken it was assumed that the probable bedrock surface was where the augers or dynamic cone met refusal.

The bedrock may be described as a gneiss, pink-grey with medium to coarse texture and hard. The rock cores indicate that at some locations the bedrock is weathered in the upper one to five feet.

The bedrock surface in the vicinity of the site was encountered at elevations ranging from 633 to 643 which corresponds to depths ranging from 40 to 53 feet below existing ground surface.

Groundwater Observations

Groundwater level observations were carried out during the period of the investigation by measuring the water level in the open boreholes or by observing the wet line on the rods after completion of the dynamic cone penetration tests. The groundwater was found to vary from elevation 672 to 675 which corresponds to depths ranging from 8 to 15 feet below existing ground surface.

M Maclean

M. MacLean, P. Eng.
Project Engineer



M. Devata

M. Devata, P. Eng.
Supervising Engineer

APPENDIX

RECORD OF BOREHOLE NO 1

7

WP 71-74-02 LOCATION Co-ords. N. 16,817,523 E 1,024,782 ORIGINATED BY HS
 DIST 13 HWY 11 BORING DATE Nov. 23, 1976 COMPILED BY MM
 DATUM Geodetic BOREHOLE TYPE Hollow Stem Augers, BX Casing & Cone Test CHECKED BY

SOIL PROFILE			SAMPLES			GROUND WATER ELEV	DYNAMIC CONE PENETRATION RESISTANCE PLOT					LIQUID LIMIT W_L PLASTIC LIMIT W_P WATER CONTENT W			UNIT WEIGHT γ	REMARKS	
ELEV DEPTH	DESCRIPTION	STRAT. PLOT	NUMBER	TYPE	'N' VALUES		20 40 60 80 100					W_P W W_L					
							SHEAR STRENGTH										
							O UNCONFINED + FIELD VANE ● QUICK TRIAXIAL x LAB VANE					WATER CONTENT %					
685.7	Ground Surface															% GR SA SI CL	
0.0	Sand Trace of Gravel Compact to Dense		1	SS	92/2"	680										8 90 (2)	
			2	SS	8												
	Fine with pockets of clayey silt		3	SS	15												3 94 (3)
			4	SS	43												6 92 (2)
	Medium		5	SS	29	675.2											
			6	SS	38	670											
			7	SS	17												
	Fine		8	SS	28	660											0 96 (4)
			9	SS	13												
	Medium		10	SS	24	650											22 76 (2)
			11	SS	22	640											
632.7	End of Borehole																
53.0	Auger Refusal BX Casing Broken Probable Bedrock																

120/5"
and Bouncing

RECORD OF BOREHOLE NO 2

8

WP 71-74-02

LOCATION Co-ords N 16,817,396 E 1,024,841

ORIGINATED BY HS

DIST 13 HWY 11

BORING DATE Nov. 24, 25, 25, 1976

COMPILED BY CTJ

DATUM Geodetic

BOREHOLE TYPE Hollow Stem Auger, BX Casing & Cone Test

CHECKED BY

SOIL PROFILE			SAMPLES			GROUND WATER ELEV	DYNAMIC CONE PENETRATION RESISTANCE PLOT					LIQUID LIMIT — W _L PLASTIC LIMIT — W _P WATER CONTENT — W			UNIT WEIGHT Y	REMARKS
ELEV DEPTH	DESCRIPTION	STRAT. PLOT	NUMBER	TYPE	N' VALUES		20	40	60	80	100	W _P	W	W _L		
683.3	Ground Surface															
0.0	Sand Trace of gravel. Compact to Dense Fine with pockets of clayey silt		1	SS	10	680										1 97 (2)
			2	SS	23	674.9										2 97 (1)
			3	SS	35											
			4	SS	22											
	Medium		5	SS	25	670										13 85 (2)
			6	SS	38											
	Fine		7	SS	25											15 83 (2)
						660										0 99 (1)
	Medium		8	SS	29											9 88 (3)
			9	SS	16											
643.3						650										
40.0	Gneiss Bedrock		10	BX	100%	640										
638.3	Weathered															
45.0	End of Borehole															

OFFICE REPORT ON SOIL EXPLORATION

RECORD OF BOREHOLE NO 3

9

WP 71-74-02 LOCATION Co-ords N 16,817,464 E 1,024,832 ORIGINATED BY HS
 DIST 13 HWY 11 BORING DATE Nov. 29, 30, 1976; Dec. 1, 1976 COMPILED BY CTJ
 DATUM Geodetic BOREHOLE TYPE Hollow Stem Auger, BX Casing & Cone Test CHECKED BY

SOIL PROFILE			SAMPLES			GROUND WATER ELEV	DYNAMIC CONE PENETRATION RESISTANCE PLOT					LIQUID LIMIT w_L PLASTIC LIMIT w_p WATER CONTENT w w_p — w — w_L WATER CONTENT % 20 40 60	UNIT WEIGHT γ	REMARKS % GR SA SI CL
ELEV DEPTH	DESCRIPTION	STRAT. PLOT	NUMBER	TYPE	'N' VALUES		20	40	60	80	100			
682.4	Ground Surface					680								
0.0	Fine with pockets of clayey silt to silty clay Medium Sand Trace of Gravel Compact to Dense		1	SS	16									7 66 (27)
			2	SS	27									2 96 (2)
			3	SS	22									
			4	SS	43	674.9								14 83 (3)
			5	SS	32	670								
			6	SS	49									
640.4	Gneiss Bedrock Sound					640								
42.0 637.9			7	RC	100%									
			8	RC	100%									
44.5	End of Borehole													

OFFICE REPORT ON SOIL EXPLORATION

RECORD OF BOREHOLE NO 4

10

WP 71-74-02

LOCATION Co-ords. N 16,817,245 E 1,024,853

ORIGINATED BY HS

DIST 13 HWY 11

BORING DATE Nov. 29, 1976

COMPILED BY MM

DATUM Geodetic

BOREHOLE TYPE Hollow Stem Auger, & Cone Test

CHECKED BY

SOIL PROFILE			SAMPLES			GROUND WATER ELEV	DYNAMIC CONE PENETRATION RESISTANCE PLOT					LIQUID LIMIT — W _L PLASTIC LIMIT — W _P WATER CONTENT — W			UNIT WEIGHT Y	REMARKS
ELEV DEPTH	DESCRIPTION	STRAT. PLOT	NUMBER	TYPE	'N' VALUES		20	40	60	80	100	W _P	W	W _L		
686.5	Ground Surface															GR SA SI CL
0.0	Fine with pockets of clayey silt to silty clay Medium Sand Trace of Gravel Compact to Dense		1	SS	18	680 671.7 670 660 650 640										9 85 (6)
			2	SS	20											0 15 56 29
			3	SS	26											1 91 (3)
			4	SS	26											2 96 (2)
			5	SS	18											
			6	SS	22											
			7	SS	47											33 65 (2)
638.8																
47.7	Probable Bedrock															

RECORD OF BOREHOLE NO 5

11

WP 71-74-02 LOCATION Co-ords. N 16,817,452 E 1,024,793 ORIGINATED BY HS
 DIST 13 HWY 11 BORING DATE Dec. 1, 1976 COMPILED BY MM
 DATUM Geodetic BOREHOLE TYPE Dynamic Cone Test CHECKED BY

SOIL PROFILE			SAMPLES			GROUND WATER ELEV	DYNAMIC CONE PENETRATION RESISTANCE PLOT					LIQUID LIMIT — w_L PLASTIC LIMIT — w_p WATER CONTENT — w			UNIT WEIGHT γ	REMARKS
ELEV DEPTH	DESCRIPTION	STRAT. PLOT	NUMBER	TYPE	'N' VALUES		20	40	60	80	100	w_p	w	w_L		
680.4	Ground Surface					680										GR SA S! CL
0.0	Sand Compact to dense (Description Inferred)					672.9 ▼ 670										
						660										
						650										
						640										
635.4																
45.0	End of Cone Test Probable Bedrock															And Bouncing

RECORD OF BOREHOLE NO 6

12

WP 71-74-02 LOCATION Co-ords. N 16,817,367 E 1,024,803 ORIGINATED BY HS
 DIST 13 HWY 11 BORING DATE Dec. 2, 1976 COMPILED BY MM
 DATUM Geodetic BOREHOLE TYPE Hollow Stem Auger, BX Casing & Cone Test CHECKED BY _____

SOIL PROFILE			SAMPLES			GROUND WATER ELEV	DYNAMIC CONE PENETRATION RESISTANCE PLOT					LIQUID LIMIT w_L PLASTIC LIMIT w_p WATER CONTENT w			UNIT WEIGHT γ	REMARKS
ELEV DEPTH	DESCRIPTION	STRAT. PLOT	NUMBER	TYPE	'N' VALUES		20	40	60	80	100	w_p	w	w_L		
683.9	Ground Surface															
0.0																
	Fine with pockets of clayey silt		1	SS	12	680										0 98 (2)
			2	SS	21											0 95 (5)
			3	SS	20											
			4	SS	15											
	Medium		5	SS	15	670										0 99 (1)
			6	SS	11											
			7	SS	14	660										
	Sand Trace of Gravel Compact to Dense															
						650										
						640										
834.6																
49.3	Gneiss — Weathered		8	RC	70%											
832.4	Bedrock — Sound		9	RC	100%											
51.5	End of Borehole															
	NOTE: Groundwater level, Not established															

RECORD OF BOREHOLE NO 7

13

WP 71-74-02

LOCATION Co-ords. N 16,817,296 E 1,024,810

ORIGINATED BY HS

DIST 13 HWY 11

BORING DATE Dec. 3, 1976

COMPILED BY MM

DATUM Geodetic

BOREHOLE TYPE Dynamic Cone Penetration Test

CHECKED BY

SOIL PROFILE			SAMPLES			GROUND WATER ELEV	DYNAMIC CONE PENETRATION RESISTANCE PLOT				LIQUID LIMIT w_L PLASTIC LIMIT w_p WATER CONTENT w			UNIT WEIGHT γ	REMARKS
ELEV DEPTH	DESCRIPTION	STRAT. PLOT	NUMBER	TYPE	N' VALUES		20	40	60	80	100	SHEAR STRENGTH ○ UNCONFINED + FIELD VANE ● QUICK TRIAXIAL x LAB VANE			
685.9	Ground Surface														
0.0	Sand Compact to Dense (Description Inferred)														
633.9	End of Cone Test Probable Bedrock														
52.0	NOTE: Groundwater level Not Established														

120/9"
and Bouncing

20
15 5 % STRAIN AT FAILURE
10

RECORD OF BOREHOLE NO 8

14

WP 71-74-02

LOCATION Co-ords. N 16,817,314 E 1,024,849

ORIGINATED BY HS

DIST 13 HWY 11

BORING DATE Dec. 3, 1976

COMPILED BY MM

DATUM Geodetic

BOREHOLE TYPE Hollow Stem Auger and Cone Test

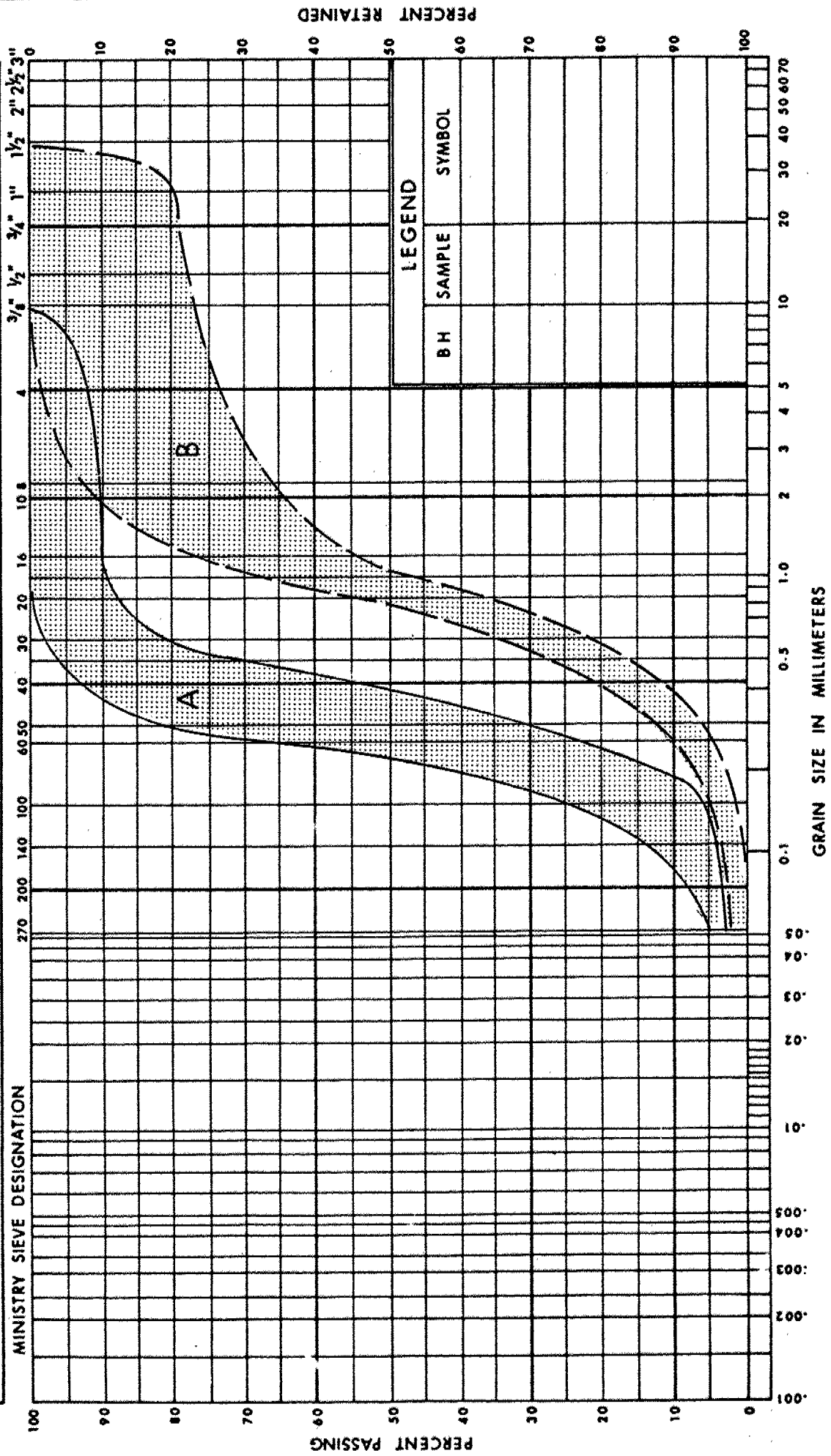
CHECKED BY

SOIL PROFILE			SAMPLES			GROUND WATER ELEV	DYNAMIC CONE PENETRATION RESISTANCE PLOT 20 40 60 80 100 SHEAR STRENGTH ○ UNCONFINED + FIELD VANE ● QUICK TRIAXIAL x LAB VANE	LIQUID LIMIT — w_L PLASTIC LIMIT — w_p WATER CONTENT — w w_p — w — w_L WATER CONTENT % 20 40 60	UNIT WEIGHT γ	REMARKS % GR SA SI CL
ELEV DEPTH	DESCRIPTION	STRAT. PLOT	NUMBER	TYPE	'N' VALUES					
683.2	Ground Surface									
0.0	Sand Trace of gravel, Compact to Dense Fine with pockets of clayey silt to silty clay Medium		1	SS	10	680				0 0 40 60
			2	SS	28					1 81 (18)
			3	SS	28					17 80 (3)
			4	SS	29					28 70 (2)
			5	SS	20	670				
			6	SS	19					
661.7			7	SS	18					
21.5	End of Borehole					660				
						650				
639.9										
43.3	End of Cone Probable Bedrock NOTE: Groundwater level Not established						120/3" and Bouncing			

 20
15 5 % STRAIN AT FAILURE
10

UNIFIED SOIL CLASSIFICATION SYSTEM

CLAY & SILT	SAND			GRAVEL		
	Fine	Medium	Coarse	Fine	Coarse	



BH	SAMPLE	SYMBOL

FIG No 1
 GRAIN SIZE DISTRIBUTION
 A - FINE
 B - MEDIUM
 SAND

FOUNDATION INVESTIGATION REPORT

For

Birch's Road Overpass

S.B.L. W.P. 71-74-03, Site 43-199A

N.B.L. W.P. 71-74-04, Site 43-199B

2.9 Miles South of Hwy. 17 and 11

Hwy. 11, District 13, North Bay

INTRODUCTION

This report contains the results of a foundation investigation for the above mentioned projects. Fieldwork was carried out during November 22 to November 27, 1976 and consisted of a total of 13 boreholes, four of which were accompanied by dynamic cone penetration tests. The borings were advanced to depths varying from 3 to 28 feet below ground surface by means of auger machines utilizing both hollow and solid stem continuous flight augers. Bedrock was proven in nine of the borings by obtaining BXL size rock core samples.

SITE DESCRIPTION AND GEOLOGY

The site is located approximately 2.9 miles south of the east junction of Hwy. 11 and Hwy. 17. Land in the vicinity of the site is generally undeveloped due to the presence of rock outcrops, swamps and tree covered areas. However, on both sides of Hwy. 11 at Birch's Road there is light industrial development.

Topographically, the site varies from flat to rolling. In the vicinity of the site the prominent features are the hilly gneiss bedrock outcrops and flat swampy terrain.

Physiographically the site is located in the region known as the Canadian Shield. The Shield is characterized by the effects of intense glaciation which has left scattered rounded rock outcrops and rocky ridges separated by glacial deposits and muskeg.

SUBSURFACE CONDITIONS

General

The overburden at the site is generally comprised of a thin veneer of topsoil overlying a 1 to 11 foot thick deposit of compact silty sand to sandy silt with a trace to some gravel and a trace of clay which in turn is overlying a 3 to 16 foot thick stratum of compact to very dense glacial till. In some locations on the northwest portion of the site the glacial till is overlain directly by a thin mantle of sandy topsoil or by a 1 foot thick layer of organic material. At the location of the existing Hwy. 11 embankment, the glacial till is overlain by a 9 to 12 foot thick granular type of fill. In all locations the glacial till is underlain by gneiss bedrock.

The boundaries between the various soil strata as determined by this investigation, are shown on the Record of Borehole Sheets. Inferred from this borehole data are the stratigraphical sections shown on Contract Drawing Nos. 43-199A-2A for the S.B.L. and 43-199B-2B for the N.B.L.

From the ground surface downwards the various soil strata and bedrock encountered are described in the following paragraphs.

Fill

At the location of the existing Hwy. 11 the roadway embankment fill was encountered immediately below a 3 to 4 inch thick asphalt pavement. The thickness of this stratum is estimated to range from 9 to 12 feet. The composition of the fill material is generally sand with gravel and some silt. The results of grain size distribution testing on representative samples of fill material are shown in an envelope form on Figure 1. At one location, the lower portion of the fill material contained a considerable amount of organics in a zone some three feet thick. Based on laboratory tests the organic content in this zone was found to be about nine percent by weight. The Standard Penetration Test 'N' values which generally vary randomly between eight and 75 blows per foot, indicates that the fill material is poorly to well compacted.

Silty Sand to Sandy Silt

Immediately below a thin mantle of topsoil is a granular stratum composed of silty sand to sandy silt, some gravel and a trace of clay. Figure 2 portrays the results of grain size distribution testing on this deposit. In certain locations this surficial deposit is overlain by highway fill material. The thickness of this surficial stratum fluctuates across the site from 1 to 11 feet. The colour of the stratum varies with alternate layers of reddish brown and grey of approximately 6 inches in thickness. Based on the Standard Penetration Test 'N' values which range from 7 to 29 blows per foot the relative density is estimated to be loose to compact.

Glacial Till

The glacial till stratum was encountered in all borehole locations across the site immediately below the silty sand to sandy silt stratum or the fill material or the organic material (swamp area). The upper boundary of this stratum was found to be approximately 1 to 13 feet below ground surface, whereas the lower boundary was found to be 3 to 28 feet below ground surface. The thickness of this stratum ranges from 3 to 16 feet. The glacial till is a heterogeneous mixture of silt, sand and gravel, trace of clay and occasional cobbles and boulders. The Standard Penetration Test gave 'N' values ranging from 19 to over 100 blows per foot. Based on these it is estimated that the relative density of the glacial till deposit is compact to very dense.

Gneiss Bedrock

The overburden is underlain by bedrock which was proven in 9 of the boreholes by obtaining up to 10 feet of BXL size rock core samples at each location. The bedrock surface was found to range from elevation 657 to elevation 686 corresponding to depths ranging from 3 to 28 feet below ground surface.

In certain locations where the bedrock was found to be close to the surface and fluctuating across the site, test pits were excavated to bedrock to confirm the elevation of the bedrock as determined by the coring operations.

The bedrock may be generally described as a gneiss, pink-grey, medium to coarse textured and hard. In the vicinity of the structure abutments for the southbound lane some of the rock cores showed open joints and fractures dipping at 30° - 45° in the upper surface of the bedrock as described in the Record of Borehole Sheets. These openings, although generally not weathered, will allow water to flow through them. In some locations the upper portion of the bedrock is weathered to a depth of up to two feet.

The rock quality designation (RQD) classification gives an indication of the quality of the bedrock with respect to the number of fractures and amount of softening or alteration of the rock mass. The RQD is the total length of rock core pieces of 4 or more inches in length expressed as a percentage of the total length of core drilled. The RQD for the rock cores varies from 80 to 100% indicating a generally very good to excellent quality of rock.

Groundwater Observations

The groundwater elevation was observed in boreholes 2, 5, 6 and 8 by measuring in the open borehole during the field investigation. The groundwater level was encountered at elevations ranging from 679 to 685 corresponding to depths ranging from 1 to 15 feet below ground surface. The results of the readings are shown on the Record of Borehole Sheets, as well as on Contract Drawing No. 43-199A-2A and 43-199B-2B.

M. MacLean

M. MacLean, P. Eng.
Project Engineer

M. Devata

M. Devata, P. Eng.
Supervising Engineer



APPENDIX

RECORD OF BOREHOLE NO 1

21

WP 71-74-03/04

LOCATION Co-ords N 16, 816, 204 E 1,025,101

ORIGINATED BY M M

DIST 13 HWY 11 NBL

BORING DATE November 26, 1976

COMPILED BY M M

DATUM Geodetic

BOREHOLE TYPE Solid Stem Auger BX Casing

CHECKED BY

SOIL PROFILE			SAMPLES			GROUND WATER ELEV	DYNAMIC CONE PENETRATION RESISTANCE PLOT					LIQUID LIMIT w_L PLASTIC LIMIT w_p WATER CONTENT w			UNIT WEIGHT Y	REMARKS
ELEV DEPTH	DESCRIPTION	STRAT. PLOT	NUMBER	TYPE	'N' VALUES		20	40	60	80	100	w_p	w	w_L		
691.7	Ground Surface															GR SA SI CL
0.0	Asphalt					690										
	Fill Sand, with gravel and some silt, light brown		1	SS	22											29 56 (15)
678.7	Black Organics Loose		2	SS	6	680										Org. 8.8%
13.0	Het. mixture of silt, sand and gravel, trace of clay occ. cobbles and boulders (Glacial Till) Dense to very Dense		3	SS	34											
			4	SS	94	670										35 44 (21)
665.2			5	SS	727											
26.5			6	RC	90%											RQD 80%
659.2	Gneiss bedrock Sound		7	RC	100%	660										
32.5	End of Borehole															
	Note Ground Water Level not obtained															

RECORD OF BOREHOLE NO 2

22

WP 71 74 03/04 LOCATION Co-ords N 16, 816, 191 E 1,025,051 ORIGINATED BY M M
 DIST 13 HWY 11 NBL BORING DATE November 24 and 25, 1976 COMPILED BY M M
 DATUM Geodetic BOREHOLE TYPE Soild Stem Auger BX Casing and Cone CHECKED BY

SOIL PROFILE			SAMPLES			GROUND WATER ELEV	DYNAMIC CONE PENETRATION RESISTANCE PLOT					LIQUID LIMIT W_L PLASTIC LIMIT W_P WATER CONTENT W			UNIT WEIGHT γ	REMARKS
ELEV DEPTH	DESCRIPTION	STRAT. PLOT	NUMBER	TYPE	N' VALUES		20	40	60	80	100	W_P	W	W_L		
693.1	Ground Surface															
0.0	Asphalt															
	Fill		1	SS	75	690										4 84 (12)
	Sand Trace to some		2	SS	32											12 75 (13)
	Gravel and some Silt		3	SS	57											
684.1	Lt. Brown															
9.0	Silty Sand to Sandy		4	SS	7											3 34 61 2
681.1	Silt Trace of Gravel															
12.0	& Clay Loose		5	SS	75	680										
	Het. Mixture of Silt		6	SS	64	678.6										8 60 (32)
	Sand & Gravel, trace															
	of Clay occ. cobbles															
673.1	& boulders (Glacial															
	fill) Very Dense															
20.0	Weathered		7	RC	20%	670										
	Gneiss															
	Bedrock		8	RC	100%											RQD 90%
664.0	Sound															
29.1	End of Borehole															

RECORD OF BOREHOLE NO 3

23

WP 71-74-03/04 LOCATION Co-ords N 16, 816, 279 E 1,025,077 ORIGINATED BY M M
 DIST 13 HWY 11 NBL BORING DATE November 25 and 26, 1976 COMPILED BY M M
 DATUM Geodetic BOREHOLE TYPE Hollow Stem Auger, BX Casing and Cone CHECKED BY _____

SOIL PROFILE			SAMPLES			GROUND WATER ELEV	DYNAMIC CONE PENETRATION RESISTANCE PLOT					LIQUID LIMIT w_L PLASTIC LIMIT w_p WATER CONTENT w			UNIT WEIGHT γ	REMARKS
ELEV DEPTH	DESCRIPTION	STRAT. PLOT	NUMBER	TYPE	'N' VALUES		20	40	60	80	100	w_p	w	w_L		
694.2	Ground Surface															
0.0	Asphalt															
	Fill															
	Sand, With Gravel and Trace of Silt		1	SS	8	690										25 68 (7)
685.2	Light Brown															
9.0	Het. mixture of silt sand and gravel Trace of clay. Occ. cobbles & boulders: (glacial fill) Very dense		2	SS	54											8 43 48 1
			3	RC	50%											
678.5			4	RC	50%	680										
15.7	Gneiss Bedrock		5	RC	100%											RQD 90%
673.4	Sound															
20.8	End of Borehole															
	Note Ground Water Level Not Obtained															

RECORD OF BOREHOLE NO 4

24

WP 71-74-03/04 LOCATION Co-ords N 16, 816, 264 E 1,025,031 ORIGINATED BY M M
 DIST 13 HWY 11 BORING DATE November 27, 1976 COMPILED BY M M
 DATUM Geodetic BOREHOLE TYPE Hollow Stem Augers, BX Casing CHECKED BY _____

SOIL PROFILE			SAMPLES			GROUND WATER ELEV	DYNAMIC CONE PENETRATION RESISTANCE PLOT					LIQUID LIMIT W_L PLASTIC LIMIT W_P WATER CONTENT W W_P — W — W_L WATER CONTENT % 20 40 60	UNIT WEIGHT γ	REMARKS % GR SA SI CL
ELEV DEPTH	DESCRIPTION	STRAT. PLOT	NUMBER	TYPE	'N' VALUES		20	40	60	80	100			
695.1	Ground Surface													
0.0	Asphalt													
	Fill Sand, Trace Gravel and some Silt Light Brown					690								
683.1			1	SS	32									8 81 (11)
682.9	Glacial Till													
13.8	Weathered		2	RC	80%	680								RQD 85%
676.8	Gneiss Bedrock Sound													
18.3	End of Borehole													
	Note: Ground Water Level not Obtained													

RECORD OF BOREHOLE NO 5

25

WP 71-74-03/04 LOCATION Co-ords N 16, 816, 161 E 1, 024, 976 ORIGINATED BY M M
 DIST 13 HWY 11 SBL BORING DATE November 23 & 24, 1976 COMPILED BY M M
 DATUM Geodetic BOREHOLE TYPE Solid Stem Augers and BX Casing CHECKED BY _____

SOIL PROFILE			SAMPLES			GROUND WATER ELEV	DYNAMIC CONE PENETRATION RESISTANCE PLOT					LIQUID LIMIT W_L PLASTIC LIMIT W_P WATER CONTENT W			UNIT WEIGHT γ	REMARKS
ELEV DEPTH	DESCRIPTION	STRAT. PLOT	NUMBER	TYPE	'N' VALUES		20	40	60	80	100	W_p	W	W_L		
684.5	Ground Surface															
0.0	Topsoil															
	Silty Sand to Sandy Silt, Trace to some Gravel, Trace of Clay. Alternate Layers of Reddish Brown and Grey - Compact		1	SS	24	680.5						o				15 60 (25)
673.5			2	SS	28							o				5 58 (37)
11.0	Het. Mixture of Silt, Sand & Gravel, trace of Clay Occ. Cobbles and Boulders		3	SS	100/6'											
	(Glacial Till) Very Dense		4	SS	72	670						o				4 60 31 5
			5	SS	82							o				8 55 27 10
657.0			6	SS	100/2	660										
27.5	Gneiss Bedrock (open joints at elev 654.5, 653.0, 650.2 and 649.7)		7	RC	90%											
648.5			8	RC	100%	650										RQD 80%
36.0	End of Borehole															

RECORD OF BOREHOLE NO 6

26

WP 71 74 03/04 LOCATION Co-ords N 16,816,149 E 1,024,937 ORIGINATED BY M M
 DIST 13 HWY 11 SBL BORING DATE November 22 and 23, 1976 COMPILED BY M M
 DATUM Geodetic BOREHOLE TYPE Solid Stem Augers, BX Casing, and Cone CHECKED BY

SOIL PROFILE			SAMPLES			GROUND WATER ELEV	DYNAMIC CONE PENETRATION RESISTANCE PLOT					LIQUID LIMIT w_L PLASTIC LIMIT w_p WATER CONTENT w			UNIT WEIGHT γ	REMARKS
ELEV DEPTH	DESCRIPTION	STRAT. PLOT	NUMBER	TYPE	'N' VALUES		20	40	60	80	100	w_p	w	w_L		
684.9	Ground Surface															
0.0	Topsoil															
680.9	Silty Sand to Sandy Clay Compact		1	SS	20	680										0 29 68 3
4.0	Het. Mixture of Silt, Sand & Gravel, Trace of Clay, Occ. Cobbles		2	SS	17	681.8										19 57 (24)
676.8	& Boulders Compact		3	SS	19											RQD 100%
8.1	Gneiss Bedrock Sound		4	RC	100%											
671.4																
13.5	End of Borehole					670										
Note: 45° Open Joint Every 6" From Depth 8.1' to 10.1' Below Ground Surface																

RECORD OF BOREHOLE NO 7

27

WP 71-74-03/04

LOCATION Co-ords N 16, 816, 231 E 1, 024, 955

ORIGINATED BY M M

DIST 13 HWY 11 SBL

BORING DATE November 22 and 23, 1976

COMPILED BY M M

DATUM Geodetic

BOREHOLE TYPE Hollow Stem Auger, BX Casing & Cone

CHECKED BY

ELEV DEPTH	SOIL PROFILE DESCRIPTION	STRAT. PLT	SAMPLES			GROUND WATER ELEV	DYNAMIC CONE PENETRATION RESISTANCE PLOT					LIQUID LIMIT w_L PLASTIC LIMIT w_p WATER CONTENT w			UNIT WEIGHT γ	REMARKS
			NUMBER	TYPE	N' VALUES		20	40	60	80	100	w_p	w	w_L		
688.7	Ground Surface															
0.0	Topsoil		1	SS	29											19 61 (20)
	Silty Sand to Sandy Silt. Trace to some Gravel. Trace of Clay. Compact. Alternate Layers of Reddish Brown and Grey		2	SS	25											7 57 26 10
679.7			3	SS	21											
9.0	Het. Mixture of Silt, Sand, & Gravel. Trace of Clay. Occ. Cobbles and Boulders		4	SS	80/3"	680										
	(Glacial Till)		5	RC	10%											32 60 (8)
	Very Dense		6	SS	94/9"											
667.7			7	SS	100/1"	670										
21.0	(Vertical Joints)		8	RC	100%											RQD 0
			9	RC	100%											RQD 100%
	Gneiss Bedrock		10	RC	100%	660										
658.0	Sound															
30.7	End of Borehole															
	Note Ground Water Level Not Obtained															

OFFICE REPORT ON SOIL EXPLORATION

RECORD OF BOREHOLE NO 8

28

WP 71-74-03/04 LOCATION Co-ords N 16, 816, 220 E 1, 024, 917 ORIGINATED BY M M
 DIST 13 HWY 11 SBL BORING DATE November 24, 1976 COMPILED BY M M
 DATUM Geodetic BOREHOLE TYPE Hollow Stem Augers, and BX Casing CHECKED BY

SOIL PROFILE			SAMPLES			GROUND WATER ELEV	DYNAMIC CONE PENETRATION RESISTANCE PLOT					LIQUID LIMIT W_L PLASTIC LIMIT W_P WATER CONTENT W			UNIT WEIGHT γ	REMARKS
ELEV DEPTH	DESCRIPTION	STRAT. PLOT	NUMBER	TYPE	'N' VALUES		20 40 60 80 100					W_P W W_L				
							SHEAR STRENGTH ○ UNCONFINED + FIELD VANE ● QUICK TRIAXIAL x LAB VANE					WATER CONTENT %				
685.9	Ground Surface					ELEV										
684.9	Organic Mat'l Black					684.9										
1.0	Set. sil. of silt.															
681.4	Sand & Gravel, Cobble & Boulders (Glacial)															
4.5	Gneiss Bedrock (Open Joint at Elev. 678.1)		1	RC	100%	680									RQD 95%	
676.9																
9.0	End of Borehole															
						670										

RECORD OF BOREHOLE NO 9

29

WP 71-74-03/04 LOCATION Co-ords N 16, 816, 155 E 1, 024, 955 ORIGINATED BY M M
 DIST 13 HWY 11 SBL BORING DATE November 24, 1976 COMPILED BY M M
 DATUM Geodetic BOREHOLE TYPE Solid Stem Augers to Refusal CHECKED BY

SOIL PROFILE			SAMPLES			GROUND WATER ELEV	DYNAMIC CONE PENETRATION RESISTANCE PLOT					LIQUID LIMIT W_L PLASTIC LIMIT W_P WATER CONTENT W			UNIT WEIGHT γ	REMARKS
ELEV DEPTH	DESCRIPTION	STRAT. PLOT	NUMBER	TYPE	'N' VALUES		20	40	60	80	100	W_P	W	W_L		
684.7	Ground Surface															
0.0	Silty Sand to Silt															
681.2	Silt Some Gravel & Trace of Clay															
3.5	Het. Mixture of Silt Sand & Gravel Trace of Clay. Occ. Cobbles and Boulders					680										
669.7						670										
15.0	Auger Refusal Probable Bedrock															
	Note Ground Water Level Not Obtained															

RECORD OF BOREHOLE NO 10

30

WP 71-74-03/04 LOCATION Co-ords N 16, 816, 152 E 1, 024, 947 ORIGINATED BY M M
 DIST 13 HWY 11 SBL BORING DATE November 26, 1976 COMPILED BY M M
 DATUM Geodetic BOREHOLE TYPE Soild Stem Augers to Refusal CHECKED BY _____

SOIL PROFILE			SAMPLES			GROUND WATER ELEV	DYNAMIC CONE PENETRATION RESISTANCE PLOT					LIQUID LIMIT W_L PLASTIC LIMIT W_P WATER CONTENT W			UNIT WEIGHT γ	REMARKS
ELEV DEPTH	DESCRIPTION	STRAT. PLOT	NUMBER	TYPE	'N' VALUES		20	40	60	80	100	W_P	W	W_L		
684.8	Ground Surface															GR SA SI CL
679.8	Silty Sand to Sandy Silt Some Gravel & Trace of Clay					680										
5.0	Het. Mix. Silt, Sand & Gravel, Trace of Clay															
675.8	Occ. Cobbles and Boulders															
9.0	Auger Refusal Probable Bedrock					670										
	Note Ground Water Level not Obtained															

WP 71-74-03/04 LOCATION Co-ords N 16, 816, 225 E 1, 024, 936 ORIGINATED BY MM
DIST 13 HWY 11 SBL BORING DATE November 25, 1976 COMPILED BY MM
DATUM Geodetic BOREHOLE TYPE Solid Stem Augers to Refusal CHECKED BY _____

[illegible]

20
15 ϕ 5 % STRAIN AT FAILURE
10

RECORD OF BOREHOLE NO 12

32

WP 71-74-03/04 LOCATION Co ords N 16, 816, 224 E 1, 024, 933 ORIGINATED BY M M
 DIST 13 HWY 11 SBL BORING DATE November 25, 1976 COMPILED BY M M
 DATUM Geodetic BOREHOLE TYPE Solid Stem Augers and BX Casing CHECKED BY

SOIL PROFILE			SAMPLES			GROUND WATER ELEV	DYNAMIC CONE PENETRATION RESISTANCE PLOT					LIQUID LIMIT W_L PLASTIC LIMIT W_P WATER CONTENT W			UNIT WEIGHT γ	REMARKS % GR SA SI CL
ELEV DEPTH	DESCRIPTION	STRAT. PLOT	NUMBER	TYPE	'N' VALUES		20	40	60	80	100	W_P	W	W_L		
688.2	Ground Surface															
0.0	Het. Mix. of Topsoil Sand & Gravel, Trace of Clay Occ. Cobbles & Boulders (Glacial Till)															
682.0			1	RC	100%											
6.2	Gneiss Bedrock (Open fractures at Elev. 675.3, 674.6 & 674.4 with weathered faces)		2	RC	80%	680										
			3	RC	100%											RQD 90%
671.9																
16.3	End of Borehole Note Ground Water Level Not Obtained					670										

OFFICE REPORT ON SOIL EXPLORATION

RECORD OF BOREHOLE NO 13

33

WP 71-74-03/04

LOCATION Co-ords N 16, 816, 228 E 1, 024, 944

ORIGINATED BY M M

DIST 13 HWY 11

BORING DATE November 25, 1976

COMPILED BY M M

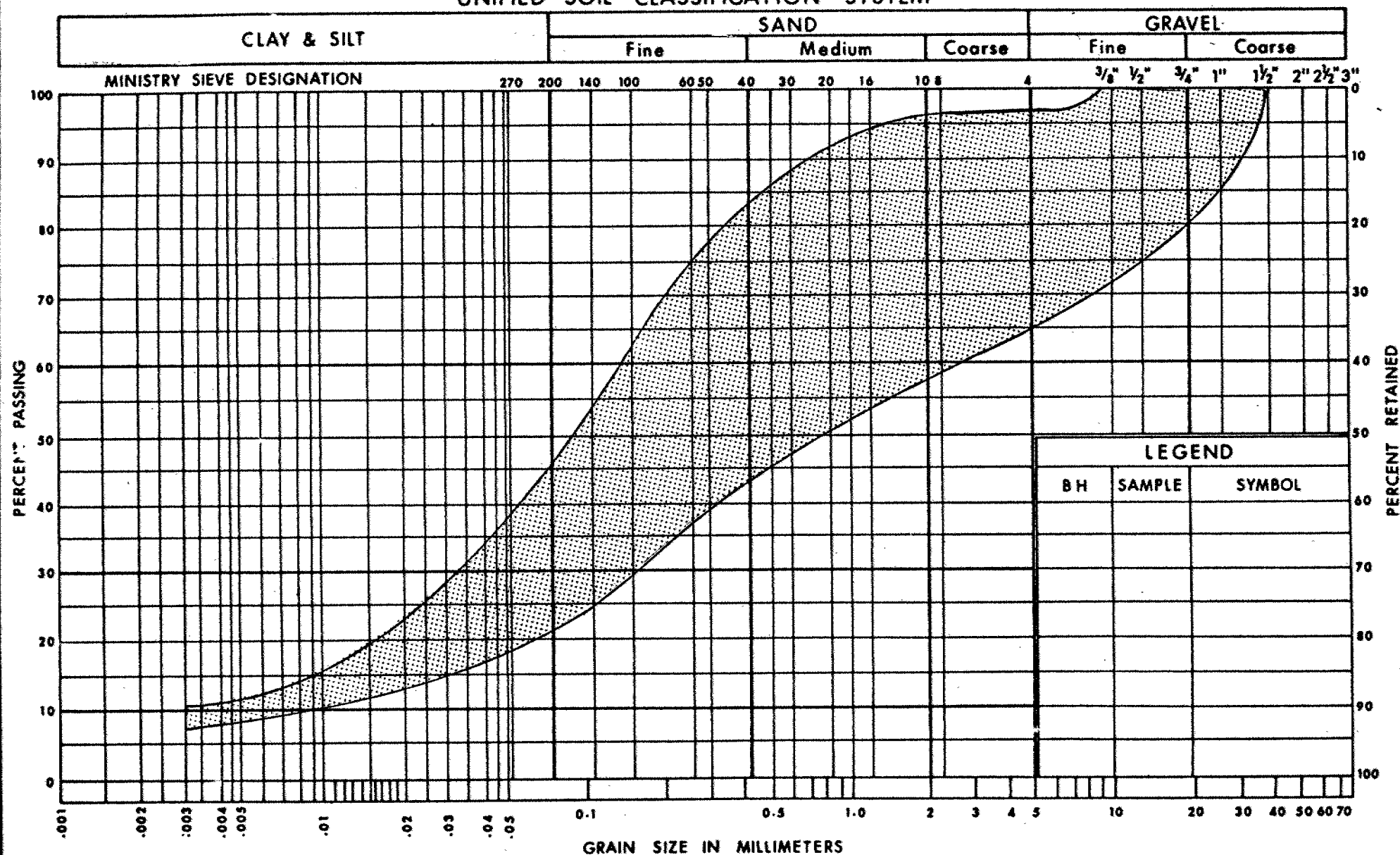
DATUM Geodetic

BOREHOLE TYPE Solid Stem Augers to Refusal

CHECKED BY

SOIL PROFILE			SAMPLES			GROUND WATER ELEV	DYNAMIC CONE PENETRATION RESISTANCE PLOT					LIQUID LIMIT W_L PLASTIC LIMIT W_P WATER CONTENT W			UNIT WEIGHT Y	REMARKS	
ELEV DEPTH	DESCRIPTION	STRAT. PLOT	NUMBER	TYPE	'N' VALUES		20	40	60	80	100	SHEAR STRENGTH ○ UNCONFINED + FIELD VANE ● QUICK TRIAXIAL x LAB VANE					WATER CONTENT %
688.5	Ground Surface																
0.0	het. Mixture of Silt Sand, & Gravel, Trace of Clay Occ. Cobbles and Boulders																
683.2	Auger Refusal Probable Bedrock																
5.3	Note Ground Water Level Not Obtained					680											

UNIFIED SOIL CLASSIFICATION SYSTEM



**Ministry of
Transportation and
Communications**

Ontario

GRAIN SIZE DISTRIBUTION GLACIAL TILL

HET MIX OF SILT SAND & GRAVEL TRACE OF CLAY

FIG No 3

W P 71-74-03/04

FOUNDATION INVESTIGATION REPORT

For

C.P.R. and Lavase River Overhead
S.B.L. W.P. 71-74-05, Site 43-200A
N.B.L. W.P. 71-74-06, Site 43-200B
3.3 Miles South of Hwy. 17 and 11
Hwy. 11, District 13, North Bay

INTRODUCTION

This report contains the results of a foundation investigation carried out for the above projects. The investigation was carried out by the Geotechnical Consultants Peto MacCallum Ltd. who were retained by the Ministry for the purpose. Fieldwork was carried out from December 8, 1976 to January 21, 1977 and consisted of a total of 34 sampled borings, 13 accompanied by dynamic cone penetration tests, as well as four additional separate dynamic cone penetration tests. These borings were carried out by means of drill rigs equipped with solid and hollow stem continuous flight augers and diamond drilling capabilities. Reference should be made to the individual borehole sheets for the method of advancement employed in each borehole. In addition, 45 hand auger probes were carried out within the river bed and swampy area. The location of these probings, as well as the results of the probe, are given on Figure 5 and attached field notes Sheet 1 and Sheet 2.

SITE DESCRIPTION AND GEOLOGY

The site is located approximately 3.3 miles south of the junction of Hwy. 17 and 11.

The site is currently vegetated with grass and bush cover. In the area between the railway tracks and Lavase River where the terrain is relatively flat, local swamp areas are present. The south slope of the river valley is pronounced and is dotted with boulders and rock outcrops.

At the time of the investigation the site was covered with snow. In spite of severe cold weather Lavase River did not freeze over fully due to warm industrial waste water discharge from nearby industries.

At this location Lavase River flows in a generally westerly direction to Lake Nipissing. In the vicinity of the site the river is variable in width being generally 50 feet wide. The water level at the time of the investigation was at elevation 660.8 with a corresponding depth of water of up to six feet deep. The river flood plain varies in width from 240 to 280 feet wide and being generally 10 feet below average ground surface. At this location the river itself is located on the south portion of the river valley and the C.P.R. tracks are located immediately north of the valley. Physiographically, the site is at the northern boundary of the Georgian Bay - Ottawa Valley area. Subsurface features comprise rounded bedrock knobs having a thin drift cover. The Wisconsin glaciers deposited a sandy and stony till. During their retreat kames and eskers were deposited. Within the flood plain of existing rivers recent alluvium comprising fine sands and silts are deposited.

The region is part of the Precambrian Canadian Shield with bedrock comprised mainly of metasedimentary and metavolcanic origin. Bedrock depths are relatively shallow at the investigated site.

SUBSOIL CONDITIONS

General

Subsurface conditions across this site are variable. Within the river flood plain surficial deposits consist of alluvial deposits up to six feet of clayey silt interlayered with fine sand and minor organics. Elsewhere, beneath a nominal depth of topsoil or beneath the alluvial deposits is the predominant stratum up to 39 feet thick extending generally to the bedrock surface and composed of generally silty fine sand to gravelly coarse sand with bouldery layers. The bedrock surface was found to be irregular. In some places north of the C.P.R. tracks bedrock

outcrops; however, in the area of the Lavase River flood plain, bedrock was encountered at apparently random depths varying from 8 to 39 feet below ground surface.

Because of the variances of subsurface and bedrock conditions reference should be made to the individual borehole sheets for the boundaries between the various soil types and bedrock. Five stratigraphical sections inferred from the borehole data are shown on Contract Drawing Nos. 43-200A-2A and 2B for the S.B.L. and Contract Drawing Nos. 43-200B-2A and 2B for the N.B.L. Following is a brief description of the major soil and bedrock types encountered.

Topsoil

On the high ground surficially sandy topsoil was encountered varying from nominal thickness to about six inches.

Alluvial Deposits

Within the channel of the Lavase River and in the swampy area surficially clayey silt interlayered with fine sand and minor organics was noted. Generally this deposit is soft. A shear strength value of 870 psf recorded in Borehole 11 by a field vane test is probably due to the sand content and is not considered representative. These deposits are recognized along the centre line of the south abutment of the northbound lanes.

Similarly, organic sandy silt was located in Borehole 22 and Probe 22A near the southern approach to the southbound lanes.

Extensive probing was carried out within the river using hand auger equipment. From the fieldwork it is inferred that the depth of this stratum varies from two feet to a maximum of eight feet. The maximum depths are generally along the centre line of the present river course. An average value of four feet is considered realistic. Field notes on swamp probing are appended with the borehole logs.

Gravelly Sand and Fine Sand

The overburden is comprised of gravelly sand and fine sand. The compositions of these granular deposits are variable. Representative grading curves are appended. (Figure Nos. 1 to 3)

No distinctive layering is recognized. Often bouldery layers are present within this deposit which could not be penetrated by power auger equipment. Relative density can be rated as loose to compact; with depth the density appears to increase.

A thin veneer of silty sand till two to four feet thick was encountered over bedrock at some locations (Boreholes 3 and 8). A typical grading curve is given on Figure 4.

Bedrock

Bedrock surface is very uneven across the site. There are several rock outcrops on the high ground along the northerly approaches and on the valley rim to the east and west of the proposed right-of-way.

Generally, bedrock occurs at relatively shallow depth. It is very close to the surface at Boreholes 4 and 5 near the centre line of the north abutment of the southbound lane. It dips to depths ranging from 36 to 39 feet at the centre pier of the same lane. On the average, depths to bedrock vary from 15 to 25 feet across the site. Bedrock was proven in Boreholes 2, 8, 9, 10, 11, 12, 17 and 22 by core drilling. At other locations bedrock was assumed where augers met refusal to further penetration and driller's judgement precluded boulders.

The bedrock underlying the site is a fine to medium grained metasediment derived largely from siliceous sandstone and siltstone. The predominant lithology is a biotite gneiss which is generally migmatitic, i.e., it contains veins and lenses of granitic material.

Rock Quality Designator based on BX core varies from fair to excellent, indicating a generally good quality rock.

Groundwater Conditions

Groundwater level observations have been carried out during the period of the investigation in several boreholes. The observations are recorded on the borehole log sheets. Some water levels are inferred because the boreholes caved.

The recorded observations indicate that the groundwater level in the overburden varies from approximate elevation 661 near the river to about 679 in Borehole 6 at the northern approach to the southbound lane. Water level in the Lavase River at the time of the investigation was recorded at elevation 660.8.

M Maclean

M. MacLean, P. Eng.
Project Engineer



M. Devata

M. Devata, P. Eng.
Supervising Engineer

APPENDIX

MINISTRY OF TRANSPORTATION AND COMMUNICATIONS-ONTARIO

HIGHWAY ENGINEERING DIVISION - ENGINEERING MATERIALS OFFICE - SOIL MECHANICS SECTION

RECORD OF BOREHOLE No 1,1A

43

WP 71-74-05 & 06

LOCATION

Co-ords. 16,814,727 N; 1,026,275 E.
Co-ords. 16,814,729 N; 1,026,272 E.

ORIGINATED BY JBS

DIST 13 HWY 11

BORING DATE December 8, 1976

COMPILED BY GDP

DATUM Geodetic

BOREHOLE TYPE Solid Stem Auger

CHECKED BY MB

SOIL PROFILE			SAMPLES			GROUND WATER ELEV	DYNAMIC CONE PENETRATION RESISTANCE PLOT					LIQUID LIMIT W_L PLASTIC LIMIT W_P WATER CONTENT W			UNIT WEIGHT γ	REMARKS
ELEV DEPTH	DESCRIPTION	STRAT. PLOT	NUMBER	TYPE	'N' VALUES		20	40	60	80	100	W_P	W	W_L		
679.6	Ground Level															
679.3	Topsoil															
0.3	Gravelly sand, odd cobbles. Becoming fine sand trace silt. Trace gravel. Light brown fine sand layers. Very dense. Brown		1	SS	50	675										Very hard augering
			2	SS	65											
672.6	End of Borehole. Refusal to augering, probable boulder. Note: Borehole dry on completion.															
7.0																
	Borehole No. 1A Co-ords. 16,814,729 N; 1,026,272 E.															
679.6	Ground Level															
	Topsoil															
0.3	Soil conditions similar to borehole 1 no samples taken to 9.6					675										Very hard augering
	Gravelly sand, odd cobble sizes.		1	SS	38	670										
	Dense. Brown					665										
663.6	End of Borehole. Refusal to augering, probable bedrock. Note: Borehole dry on completion.															
16.0																

20
15 ϕ 5 % STRAIN AT FAILURE
10

RECORD OF BOREHOLE No 2, 2A

WP 71-74-05 & 06
DIST 13 HWY 11
DATUM Geodetic

LOCATION Co-ords. 16,814,684 N; 1,026,247 E.
Co-ords. 16,814,688 N; 1,026,243 E.
BORING DATE December 9, 1976 & January 21, 1977
BOREHOLE TYPE Hollow Stem Auger, BXL Rock Core & Cone Test

ORIGINATED BY WJ
COMPILED BY MB
CHECKED BY MB

SOIL PROFILE			SAMPLES			GROUND WATER ELEV	DYNAMIC CONE PENETRATION RESISTANCE PLOT					LIQUID LIMIT w_L PLASTIC LIMIT w_p WATER CONTENT w			UNIT WEIGHT γ	REMARKS
ELEV DEPTH	DESCRIPTION	STRAT. PLOT	NUMBER	TYPE	'N' VALUES		20	40	60	80	100	w_p	w	w_L		
670.5	Ground Level					670										
0.2	Topsoil															
	Sand, fine		1	SS	13											
	Compact.															
	Some gravel below 6.5 feet.		2	SS	19	665										
659.5	Compact. Brown		3	SS	13	660										
11.0	Bedrock. Biotite Gneiss. Sound rock.															
	RQD = 96%		4	RC BXL	100% REC											
	RQD = 86%		5	RC BXL	100% REC	655										
	RQD = 83%		6	RC BXL	100% REC											
	RQD = 91%		7	RC BXL	100% REC	650										
643.9						645										
26.6	End of Borehole Note: On completion hole caved at 664.5															
	Borehole No. 2A Co-ords. 16,814,688 N; 1,026,243 E.															
670.5	Ground Level					670										
0.2	Topsoil															
	Hole augered without sampling to check refusal.															
	Soil conditions as in borehole 2.															
658.5	Compact. Brown					660										
12.0	End of Borehole. Refusal to augering, probable bedrock. Note: On completion hole caved at 660.8. Water level not established.															

BX casing reamed from 11.0 to 11.5. Sampling with BXL core barrel from 11.0.

MINISTRY OF TRANSPORTATION AND COMMUNICATIONS-ONTARIO

HIGHWAY ENGINEERING DIVISION - ENGINEERING MATERIALS OFFICE - SOIL MECHANICS SECTION

RECORD OF BOREHOLE NO 3 3A

45

WP 71-74-05 & 06 LOCATION Co-ords. 16,814,822 N; 1,026,107 E. ORIGINATED BY JBS
 DIST 13 HWY 11 BORING DATE December 10, 1976 COMPILED BY MB
 DATUM Geodetic BOREHOLE TYPE Solid Stem Auger CHECKED BY MB

SOIL PROFILE			SAMPLES			GROUND WATER ELEV	DYNAMIC CONE PENETRATION RESISTANCE PLOT					LIQUID LIMIT w_L PLASTIC LIMIT w_p WATER CONTENT w			UNIT WEIGHT γ	REMARKS
ELEV DEPTH	DESCRIPTION	STRAT. PLOT	NUMBER	TYPE	N' VALUES		20	40	60	80	100	w_p	w	w_L		
682.7	Ground Level															
0.2	Topsoil															
	Gravelly sand, some silt.		1	SS	46	680										
	Occasional cobble sizes.		2	SS	36											
	Compact to dense.					675										
670.7	Brown		3	SS	23											
12.0	Silty sand till.					670										
667.7	Very dense. Brown		4	SS	50											14 49 33 4
15.0	End of Borehole. Refusal to augering, probable bedrock. Note: On completion hole caved at 673.2															
	Borehole No. 3A Co-ords. 16,814,832 N; 1,026,107 E.															
682.7	Ground Level															
0.0	Borehole augered without sampling to check refusal.					680										
	Soil conditions as in borehole 3.															
	Gravelly sand, compact to dense.					675										
	Brown					670										
668.7																
14.0	End of Borehole. Refusal to augering, probable bedrock. Note: Water level not established.															

MINISTRY OF TRANSPORTATION AND COMMUNICATIONS-ONTARIO

HIGHWAY ENGINEERING DIVISION - ENGINEERING MATERIALS OFFICE - SOIL MECHANICS SECTION

RECORD OF BOREHOLE NO 4,5,6

46

WP 71-74-05 & 06

LOCATION

Co-ords. 16,814,653 N; 1,026,139 E.
Co-ords. 16,814,614 N; 1,026,103 E.
Co-ords. 16,814,761 N; 1,025,990 E.

ORIGINATED BY JBS

DIST 13 HWY 11

BORING DATE

December 12, 1976

COMPILED BY MB

DATUM Geodetic

BOREHOLE TYPE

Solid Stem Auger

CHECKED BY MB

SOIL PROFILE			SAMPLES			GROUND WATER ELEV	DYNAMIC CONE PENETRATION RESISTANCE PLOT					LIQUID LIMIT — w_L PLASTIC LIMIT — w_p WATER CONTENT — w w_p — w — w_L WATER CONTENT % 10 20 30	UNIT WEIGHT γ	REMARKS
ELEV DEPTH	DESCRIPTION	STRAT. PLOT	NUMBER	TYPE	N' VALUES		20	40	60	80	100			
677.4	Ground Level													
676.9	Topsoil													
0.5	End of Borehole. Refusal to augering, probable bedrock. Rock outcrops nearby. Note: Borehole dry on completion.					675								
	Borehole No. 5 Co-ords. 16,814,614 N; 1,026,103 E.													
679.6	Ground Level													
	Topsoil													
0.5	Gravelly sand.													
677.6	Cobbles													
2.0	End of Borehole. Refusal to augering, probable bedrock. Rock outcrops nearby. Note: Borehole dry on completion.					675								
	Borehole No. 6 Co-ords. 16,814,761 N; 1,025,990 E.													
690.2	Ground Level													
	Minimal topsoil. Gravelly sand. Layers of fine sand or silt. Rust Brown		1	SS	15									
686.2	Compact.													
4.0	Silty clay, Near plastic limit.		2	SS	23	685								
683.2	Firm to stiff. Brown													
7.0	Sandy silt, trace of clay													
680.2	Dense. Brown					680								
10.0	Sand, fine.		3	SS	38									
678.7	Dense Brown													
11.5	End of Borehole. Refusal to augering, probable bedrock. Note: Three attempts failed to penetrate surificial cobble layer.													

MINISTRY OF TRANSPORTATION AND COMMUNICATIONS-ONTARIO

HIGHWAY ENGINEERING DIVISION - ENGINEERING MATERIALS OFFICE - SOIL MECHANICS SECTION

47

RECORD OF BOREHOLE NO 7

WP 71-74-05 & 06 LOCATION Co-ords. 16,814,595 N; 1,026,317 E. ORIGINATED BY JBS
 DIST 13 HWY 11 BORING DATE December 15, 1976 COMPILED BY MB
 DATUM Geodetic BOREHOLE TYPE Solid Stem Auger and Cone Test CHECKED BY MB

SOIL PROFILE			SAMPLES			GROUND WATER ELEV	DYNAMIC CONE PENETRATION RESISTANCE PLOT					LIQUID LIMIT W_L PLASTIC LIMIT W_P WATER CONTENT W			UNIT WEIGHT γ	REMARKS
ELEV DEPTH	DESCRIPTION	STRAT. PLOT	NUMBER	TYPE	'N' VALUES		20	40	60	80	100	W_P	W	W_L		
666.8	Ground Level															
0.0	Nominal topsoil.					665										
	Gravelly sand, coarse, with some silt layers.		1	SS	11	660										
	Compact															
	Brown changing to grey		2	SS	17	655										
	Becoming gravelly fine sand with some silt. Cobbles below 21.0		3	SS	10	650										
	Compact		4	SS	19	645										
641.8						640										
25.0	End of Borehole. Refusal to augering, probable boulder.															
638.8																
28.0	End of Cone Test.															

20
15 5 % STRAIN AT FAILURE
10

HIGHWAY ENGINEERING DIVISION - ENGINEERING MATERIALS OFFICE - SOIL MECHANICS SECTION

48

RECORD OF BOREHOLE NO 8

WP 71-74-05 & 06 LOCATION Co-ords. 16,814,622 N; 1,026,374 E. ORIGINATED BY JBS
 DIST 13 HWY 11 BORING DATE December 15, 1976 & January 17 & 19, 1977 COMPILED BY MB
 DATUM Geodetic BOREHOLE TYPE Hollow Stem Auger, BXL Rock Core & Cone Test CHECKED BY MB

SOIL PROFILE			SAMPLES			GROUND WATER ELEV	DYNAMIC CONE PENETRATION RESISTANCE PLOT					LIQUID LIMIT W_L PLASTIC LIMIT W_P WATER CONTENT W			UNIT WEIGHT γ	REMARKS
ELEV DEPTH	DESCRIPTION	STRAT. PLOT	NUMBER	TYPE	'N' VALUES		20	40	60	80	100	W_p	W	W_L		
662.5	Ground Level															
0.4	Topsoil															
	Gravelly sand, coarse		1	SS	15	660										
	Cobbles below 7.6					655										
	Very bouldery below 9.0		2	SS	65	650										
	Compact to very dense.															
	Refusal on augers at 15.0 - boulder.															
647.5			3	RC												
15.0			4	BXL	44% REC											
	Boulders		5	RC	49% REC	645										
643.5			6	BXL												
19.0	Gravelly sand		7	SS	123	640										
	Very dense															
635.5			8	RC		635										
27.0	Brown Grey		9	BXL												
	Silty sand, fine, some gravel.		10	RC		630										
630.5			11	BXL												
32.0	Silty sand till.															
628.5	Very dense. Grey															
34.0	Bedrock. Biotite Gneiss. Fractured		8	RC	100% REC.	625										
	RQD = 35%		9	BXL												
	RQD = 37%		10	RC	100% REC.	620										
	RQD = 17%		11	BXL												
	RQD = 56%					615										
612.8																
49.7	End of Borehole															

20
 15 ϕ 5 % STRAIN AT FAILURE
 10

MINISTRY OF TRANSPORTATION AND COMMUNICATIONS-ONTARIO

HIGHWAY ENGINEERING DIVISION - ENGINEERING MATERIALS OFFICE - SOIL MECHANICS SECTION

RECORD OF BOREHOLE NO 8A

49

WP 71-74-05 & 06 LOCATION Co-ords. 16,814,628 N; 1,026,378 E. ORIGINATED BY JBS
 DIST 13 HWY 11 BORING DATE December 15, 1976 COMPILED BY MB
 DATUM Geodetic BOREHOLE TYPE Solid Stem Auger CHECKED BY MB

SOIL PROFILE			SAMPLES			GROUND WATER ELEV	DYNAMIC CONE PENETRATION RESISTANCE PLOT					LIQUID LIMIT w_L PLASTIC LIMIT w_p WATER CONTENT w		UNIT WEIGHT γ	REMARKS
ELEV DEPTH	DESCRIPTION	STRAT. PLOT	NUMBER	TYPE	'N' VALUES		20	40	60	80	100	w_p — w — w_L			
662.5	Ground Level														
0.0	Hole augered without sampling to check refusal. Soil conditions as in borehole 8. Gravelly sand, coarse, some gravel.					660									
						655									
651.0															
11.5	End of Borehole. Refusal to augering, probable boulder. Note: Water level not established.					650									

20
15 ϕ 5 % STRAIN AT FAILURE
10

MINISTRY OF TRANSPORTATION AND COMMUNICATIONS-ONTARIO

HIGHWAY ENGINEERING DIVISION - ENGINEERING MATERIALS OFFICE - SOIL MECHANICS SECTION

RECORD OF BOREHOLE No 9

50

WP 71-74-05 & 06

LOCATION Co-Ords. 16,814,564 N; 1,026,228 E.

ORIGINATED BY JBS

DIST 13 HWY 11

BORING DATE December 15, 1976 & January 6 & 7, 1977

COMPILED BY MB

DATUM Geodetic

BOREHOLE TYPE Hollow Stem Auger, BX Rock Core & Cone Test

CHECKED BY MB

SOIL PROFILE			SAMPLES			GROUND WATER ELEV	DYNAMIC CONE PENETRATION RESISTANCE PLOT					LIQUID LIMIT w_L PLASTIC LIMIT w_p WATER CONTENT w			UNIT WEIGHT γ	REMARKS
ELEV DEPTH	DESCRIPTION	STRAT. PLT	NUMBER	TYPE	N' VALUES		20	40	60	80	100	w_p	w	w_L		
661.6	Ground Level															
0.5	Topsoil															
	Sand, fine															
	Loose	Brown	1	SS	5	660										
653.6						655										
8.0	Gravelly sand, coarse, with occasional layers of medium sand.		2	SS	25	650										
	Compact		3	SS	18	645										
			4	SS	10	640										
636.6		Brown														
25.0	Very dense.	Grey	5	SS	100/6"	635										
	Boulders															
						630										
625.6																
36.0	Bedrock. Biotite Gneiss. Sound rock.					625										
	RQD = 54%		6	RC BXL	100% REC.	620										
	RQD = 41%		7	RC BXL	100% REC.	615										
	RQD = 90%		8	RC BXL	100% REC.											
611.1																
50.5	End of Borehole					610										

BX casing reamed to 36.5. Diamond drilling in BXL core started from 36.0.

20
15 ϕ 5 % STRAIN AT FAILURE
10

MINISTRY OF TRANSPORTATION AND COMMUNICATIONS-ONTARIO

HIGHWAY ENGINEERING DIVISION - ENGINEERING MATERIALS OFFICE - SOIL MECHANICS SECTION

RECORD OF BOREHOLE NO 10

51

WP 71-74-05 & 06

LOCATION Co-ords. 16,814,546 N; 1,026,179 E.

ORIGINATED BY JBS

DIST 13 HWY 11

BORING DATE December 16, 1976 & January 20, 1977

COMPILED BY MB

DATUM Geodetic

BOREHOLE TYPE Hollow Stem Auger, BXL Rock Core & Cone Test

CHECKED BY MB

SOIL PROFILE			SAMPLES			GROUND WATER ELEV	DYNAMIC CONE PENETRATION RESISTANCE PLOT					LIQUID LIMIT w_L PLASTIC LIMIT w_p WATER CONTENT w			UNIT WEIGHT γ	REMARKS
ELEV DEPTH	DESCRIPTION	STRAT. PLOT	NUMBER	TYPE	'N' VALUES		20	40	60	80	100	w_p	w	w_L		
661.3	Ground Level															
0.0	Nominal topsoil.					660										
	Gravelly sand, coarse, with occasional silt layers and odd cobbles.		1	SS	20	655										
	Compact.	Brown	2	SS	8	650										
			3	SS	20	645										
	More gravel below 23.0		4	SS	11	640										
637.3				RC												
24.0	Boulders		5	BXL	100%											
	Refusal on augers. BX casing reamed to 24.5. Sand washing up.		6	RC BXL	35% REC	635										
	AX casing reamed to 28.3.		7	RC AXT	37% REC	630										
	After sample 3, sand washing up.					625										
622.3																
39.0	Bedrock. Biotite Gneiss. Fractured.		8	RC BXL	100% REC	620										
	RQD = 76%															
617.3																
44.0	End of Borehole					615										

13 85 2 0

BX casing driven to 37.0 and diamond drilling in BXL casing started at 39.0.

20
15 ϕ 5 % STRAIN AT FAILURE
10

HIGHWAY ENGINEERING DIVISION - ENGINEERING MATERIALS OFFICE - SOIL MECHANICS SECTION

RECORD OF BOREHOLE NO 11

52

WP 71-74-05 & 06 LOCATION Co-ords. 16,814,564 N; 1,026,451 E. ORIGINATED BY WJ
 DIST 13 HWY 11 BORING DATE December 16, 1976 & January 11, 1977 COMPILED BY MB
 DATUM Geodetic BOREHOLE TYPE Hollow Stem Auger, BXL Rock Core & Cone Test CHECKED BY MB

SOIL PROFILE			SAMPLES			GROUND WATER ELEV	DYNAMIC CONE PENETRATION RESISTANCE PLOT					LIQUID LIMIT w_L PLASTIC LIMIT w_p WATER CONTENT w WATER CONTENT % w_p w w_L 10 20 30	UNIT WEIGHT γ	REMARKS
ELEV DEPTH	DESCRIPTION	STRAT. PLOT	NUMBER	TYPE	'N' VALUES		20	40	60	80	100			
661.8	Ground Level													
0.0	Clayey silt with silty clay and fine sand layers.		1	TW	PM									
654.95	Some organics and hair roots. Very soft. Dark Grey		2	SS	1									
6.85	Sand, fine. Some silt.													
	Cobbles below ± 10.0		3	SS	8									
	Loose to compact													
	Grey													
	Very bouldery from 15.0 to 20.0		4	SS	29									
	Sandy from 20.0 to 23.0													
	Bouldery again below 23.0													
	Very dense.													
636.2	Grey													
25.6	Bedrock. Biotite Gneiss. RQD = 38% weathered sound		5	RC	BXL100% REC.									
	RQD = 80%		6	RC	BXL100% REC.									
	RQD = 96%		7	RC	BXL100% REC.									
	RQD = 94%		8	RC	BXL100% REC.									
621.3														
40.5	End of Borehole													

673.8

+870

BX casing reamed to 25.8.
 Diamond drilling in BXL core barrel from 25.5.

HIGHWAY ENGINEERING DIVISION - ENGINEERING MATERIALS OFFICE - SOIL MECHANICS SECTION

53

RECORD OF BOREHOLE NO 11A

WP 71-74-05 & 06 LOCATION Co-ords. 16,814,560 N; 1,026,447 E. ORIGINATED BY JBS
 DIST 13 HWY 11 BORING DATE December 17, 1976 COMPILED BY MB
 DATUM Geodetic BOREHOLE TYPE Solid Stem Auger CHECKED BY MB

SOIL PROFILE			SAMPLES			GROUND WATER ELEV	DYNAMIC CONE PENETRATION RESISTANCE PLOT					LIQUID LIMIT W_L PLASTIC LIMIT W_P WATER CONTENT W			UNIT WEIGHT γ	REMARKS
ELEV DEPTH	DESCRIPTION	STRAT. PLOT	NUMBER	TYPE	'N' VALUES		20 40 60 80 100					W_P W W_L				
							SHEAR STRENGTH					WATER CONTENT %				
						○ UNCONFINED + FIELD VANE ● QUICK TRIAXIAL x LAB VANE										
661.8	Ground Level															
0.0	Hole augered without sampling to check refusal.					660										
	Clayey silt with silty clay and fine sand layers.															
654.95						655										
6.85	Sand, fine															
	Bouldery					650										
						645										
640.3						640										
21.5	End of Borehole. Refusal to augering, probable boulder. Note: Water level not established.															

HIGHWAY ENGINEERING DIVISION - ENGINEERING MATERIALS OFFICE - SOIL MECHANICS SECTION

RECORD OF BOREHOLE NO 12

54

WP 71-74-05 & 06

LOCATION Co-ords. 16,814,521 N; 1,026,417 E.

ORIGINATED BY WJ

DIST 13 HWY 11

BORING DATE December 17, 1976, January 8 & 10, 1977

COMPILED BY MB

DATUM Geodetic

BOREHOLE TYPE Hollow Stem Auger, BXL Rock Core & Cone Test

CHECKED BY MB

SOIL PROFILE			SAMPLES			GROUND WATER ELEV	DYNAMIC CONE PENETRATION RESISTANCE PLOT					LIQUID LIMIT w_L PLASTIC LIMIT w_p WATER CONTENT w			UNIT WEIGHT γ	REMARKS
ELEV DEPTH	DESCRIPTION	STRAT. PLOT	NUMBER	TYPE	'N' VALUES		20	40	60	80	100	w_p	w	w_L		
661.9	Ground Level															
0.0	Clayey silt, some hair roots.		1	AS		660										
655.9	Very soft to firm. Brown		2	SS	5	655										
6.0	Sand, fine															
	Trace of gravel.		3	SS	23	650										
	Compact to dense.		4	SS	16	645										
640.4	Grey		5	SS	40	640										
21.5	Bedrock. Biotite Gneiss.		6	RC BXL	100% REC.											
	RQD = 56%															
			7	RC BXL	100% REC.	635										
	RQD = 63%															
	weathered sound															
			8	RC BXL	100% REC.	630										
	RQD = 48%															
625.4			9	RC BXL	100% REC.	625										
	RQD = 92%															
36.5	End of Borehole. Note: On completion hole caved at 656.9															

BX casing reamed to 21.7. Diamond drilling in BXL core barrel started from 21.5.

MINISTRY OF TRANSPORTATION AND COMMUNICATIONS-ONTARIO

HIGHWAY ENGINEERING DIVISION - ENGINEERING MATERIALS OFFICE - SOIL MECHANICS SECTION

RECORD OF BOREHOLE NO 13, 14

55

WP 71-74-05 & 06

LOCATION

Co-ords. 16,814,477 N; 1,026,383 E.

ORIGINATED BY JBS

DIST 13 HWY 11

BORING DATE

December 17, 1976

COMPILED BY MB

DATUM Geodetic

BOREHOLE TYPE

Cone Test

CHECKED BY MB

SOIL PROFILE			SAMPLES			GROUND WATER ELEV	DYNAMIC CONE PENETRATION RESISTANCE PLOT					LIQUID LIMIT w_L PLASTIC LIMIT w_p WATER CONTENT w w_p — w — w_L WATER CONTENT %	UNIT WEIGHT γ	REMARKS
ELEV DEPTH	DESCRIPTION	STRAT. PLOT	NUMBER	TYPE	'N' VALUES		20	40	60	80	100			
661.5	Ground Level													
0.0														
660														
655														
650														
645														
640														
636.5														
25.0	End of Cone Test													
635														
	Borehole No. 14													
	Co-ords. 16,814,570 N; 1,026,385 E.													
661.9	Ground Level													
0.0														
660														
655														
650														
647.9														
14.0	End of Cone Test													

20
15 ϕ 5 % STRAIN AT FAILURE
10

OFFICE REPORT ON SOIL EXPLORATION

MINISTRY OF TRANSPORTATION AND COMMUNICATIONS-ONTARIO

HIGHWAY ENGINEERING DIVISION - ENGINEERING MATERIALS OFFICE - SOIL MECHANICS SECTION

RECORD OF BOREHOLE No 15, 16

56

WP 71-74-05 & 06

LOCATION

Co-ords. 16,814,510 N; 1,026,510 E.

ORIGINATED BY JBS

DIST 13 HWY 11

BORING DATE

December 18, 1976

COMPILED BY MB

DATUM Geodetic

BOREHOLE TYPE

Solid Stem Auger & Cone Test

CHECKED BY MB

SOIL PROFILE			SAMPLES			GROUND WATER ELEV	DYNAMIC CONE PENETRATION RESISTANCE PLOT					LIQUID LIMIT w_L PLASTIC LIMIT w_p WATER CONTENT w			UNIT WEIGHT γ	REMARKS
ELEV DEPTH	DESCRIPTION	STRAT. PLOT	NUMBER	TYPE	'N' VALUES		20	40	60	80	100	w_p	w	w_L		
662.2	Ground Level															
0.0	Clayey silt with sand layers.		1	TW	PM	660										
658.2	Firm. Dark Grey		2	SS	9	655										12 82 6 0
4.0	Gravelly sand, coarse, saturated. Some layers of fine sand.		3	SS	6	650										
	Loose Grey					645										
	Occasional cobble and boulder below 17.0					640										
641.2	End of Borehole. Refusal to augering, probable bedrock. Note: Water level not established.															
21.0	Borehole No. 16 Co-ords. 16,814,575 N; 1,026,542 E.															
662.2	Ground Level															
0.0						665										
						660										
						655										
						650										
644.2																
18.0	End of Cone Test.															

20
15 ϕ 5 % STRAIN AT FAILURE
10

OFFICE REPORT ON SOIL EXPLORATION

MINISTRY OF TRANSPORTATION AND COMMUNICATIONS-ONTARIO

HIGHWAY ENGINEERING DIVISION - ENGINEERING MATERIALS OFFICE - SOIL MECHANICS SECTION

RECORD OF BOREHOLE No 17, 17A

57

WP 71-74-05 & 06 LOCATION Co-ords. 16,814,507 N; 1,026,284 E. ORIGINATED BY WJ
DIST 13 HWY 11 BORING DATE December 18, 1976 & January 8, 1977 COMPILED BY MB
DATUM Geodetic BOREHOLE TYPE Hollow Stem Auger, BXL Rock Core & Cone Test CHECKED BY MB

SOIL PROFILE			SAMPLES			GROUND WATER ELEV	DYNAMIC CONE PENETRATION RESISTANCE PLOT					LIQUID LIMIT W_L PLASTIC LIMIT W_P WATER CONTENT W			UNIT WEIGHT γ	REMARKS
ELEV DEPTH	DESCRIPTION	STRAT. PLOT	NUMBER	TYPE	'N' VALUES		20	40	60	80	100	W_P	W	W_L		
663.1	Ground Level															GR SA SI CL
0.0	Sand, fine															
	Loose.		1	SS	6											
655.1	Brown															
8.0	Bedrock. Biotite Gneiss. Sound rock.		2	RC BXL	100% REC.											BX casing reamed to 8.5 Diamond drilling in BXL core barrel started from 8.0
	RQD = 92%		3	RC BXL	100% REC.											
	RQD = 100%		4	RC BXL	100% REC.											
	RQD = 63%															
639.6	End of Borehole															
23.5	Borehole No. 17A Co-ords. 16,814,512 N; 1,026,282 E.															
663.1	Ground Level															
0.0	Borehole augered without sampling to check refusal.															
	Soil conditions similar to borehole 17.															
	Sand, fine															
	Loose.															
	Brown															
652.6	End of Borehole.															
10.5	Refusal to augering, probable bedrock. Note: Water level not established.															

58

WP	71-74-05 & 06	LOCATION	Co-Ords. 16,814,545 N; 1,026,315 E.	ORIGINATED BY	JBS
DIST	13 HWY 11	BORING DATE	December 20, 1976	COMPILED BY	MB
DATUM	Geodetic	BOREHOLE TYPE	Solid Stem Auger	CHECKED BY	MB

[illegible]

20
15 ϕ 5 % STRAIN AT FAILURE
10

MINISTRY OF TRANSPORTATION AND COMMUNICATIONS-ONTARIO

HIGHWAY ENGINEERING DIVISION - ENGINEERING MATERIALS OFFICE - SOIL MECHANICS SECTION

RECORD OF BOREHOLE No 19

59

WP 71-74-05 & 06 LOCATION Co-Ords. 16,814,499 N; 1,026,354 E. ORIGINATED BY JBS
 DIST 13 HWY 11 BORING DATE December 20, 1976 COMPILED BY MB
 DATUM Geodetic BOREHOLE TYPE Cone Test CHECKED BY MB

SOIL PROFILE			SAMPLES			GROUND WATER ELEV	DYNAMIC CONE PENETRATION RESISTANCE PLOT					LIQUID LIMIT w_L PLASTIC LIMIT w_p WATER CONTENT w			UNIT WEIGHT γ	REMARKS
ELEV DEPTH	DESCRIPTION	STRAT. PLOT	NUMBER	TYPE	'N' VALUES		20	40	60	80	100	SHEAR STRENGTH ○ UNCONFINED + FIELD VANE ● QUICK TRIAXIAL x LAB VANE				
661.9 0.0	Ground Level															
						660										
						655										
						650										
						645										
						640										
635.9 26.0	End of Cone Test.					635										

MINISTRY OF TRANSPORTATION AND COMMUNICATIONS-ONTARIO

HIGHWAY ENGINEERING DIVISION - ENGINEERING MATERIALS OFFICE - SOIL MECHANICS SECTION

RECORD OF BOREHOLE No 20

60

WP 71-74-05 & 06

LOCATION Co-ords. 16,814,699 N; 1,026,568 E.

ORIGINATED BY JBS

DIST 13 HWY 11

BORING DATE December 21, 1976

COMPILED BY MB

DATUM Geodetic

BOREHOLE TYPE Solid Stem Auger

CHECKED BY MB

SOIL PROFILE			SAMPLES			GROUND WATER ELEV	DYNAMIC CONE PENETRATION RESISTANCE PLOT					LIQUID LIMIT w_L PLASTIC LIMIT w_p WATER CONTENT w			UNIT WEIGHT γ	REMARKS
ELEV DEPTH	DESCRIPTION	STRAT. PLOT	NUMBER	TYPE	'N' VALUES		20	40	60	80	100	w_p	w	w_L		
663.5	Ground Level															
0.0	Topsoil															
662.0																
1.5	Sand, fine															
660.5	trace silt.		1	SS	13	660										
3.0	Gravelly sand, coarse,		2	SS	6											
						655										
			3	SS	8											
						650										
						645										
						640										
						635										
632.5																
31.0	End of Borehole. Refusal to augering, probable bedrock.															

After sample 3, hole augered without sampling to check refusal.

Loose. Brown

12 86 2 0

MINISTRY OF TRANSPORTATION AND COMMUNICATIONS-ONTARIO

HIGHWAY ENGINEERING DIVISION - ENGINEERING MATERIALS OFFICE - SOIL MECHANICS SECTION

RECORD OF BOREHOLE NO 21, 21A

61

WP 71-74-05 & 06 LOCATION Co-ords. 16,814,643 N; 1,026,462 E. ORIGINATED BY JBS
 DIST 13 HWY 11 BORING DATE December 21, 1976 COMPILED BY MB
 DATUM Geodetic BOREHOLE TYPE Solid Stem Auger CHECKED BY MB

SOIL PROFILE			SAMPLES			GROUND WATER ELEV	DYNAMIC CONE PENETRATION RESISTANCE PLOT					LIQUID LIMIT W_L PLASTIC LIMIT W_P WATER CONTENT W			UNIT WEIGHT γ	REMARKS % GR SA SI CL
ELEV DEPTH	DESCRIPTION	STRAT. PLOT	NUMBER	TYPE	'N' VALUES		20 40 60 80 100					W_P W W_L				
							SHEAR STRENGTH									
							O UNCONFINED + FIELD VANE ● QUICK TRIAXIAL X LAB VANE					WATER CONTENT %				
665.4	Ground Level															
0.0	Borehole augered without sampling to check refusal. Sand, fine.					665										
661.4	Brown															
4.0	Gravelly sand, coarse, some cobbles and boulders		1	AS		660									13 75 12 0	
	Brown					655										
652.4																
13.0	End of Borehole. Refusal to augering, probable boulder. Note: Water level not established.															
	Borehole No. 21A Co-ords. 16,814,647 N; 1,026,457 E.															
665.4	Ground Level					665										
0.0	Borehole augered without sampling to check refusal. Sand, fine.					665										
661.4	Sand, fine.															
4.0	Gravelly sand with cobbles and boulders					660										
	Brown					655										
650.4																
15.0	End of Borehole. Refusal to augering, probable boulder. Note: Water level not established.					650										

OFFICE REPORT ON SOIL EXPLORATION

HIGHWAY ENGINEERING DIVISION - ENGINEERING MATERIALS OFFICE - SOIL MECHANICS SECTION

RECORD OF BOREHOLE NO 22

62

WP 71-74-05 & 06 LOCATION Co-ords. 16,814,445 N; 1,026,270 E. ORIGINATED BY WJ
 DIST 13 HWY 11 BORING DATE December 22, 1976. COMPILED BY MB
 DATUM Geodetic BOREHOLE TYPE Hollow Stem Auger, BXL Rock Core & Cone Test CHECKED BY MB

SOIL PROFILE			SAMPLES			GROUND WATER ELEV	DYNAMIC CONE PENETRATION RESISTANCE PLOT					LIQUID LIMIT w_L PLASTIC LIMIT w_p WATER CONTENT w w_p — w — w_L WATER CONTENT % 10 20 30	UNIT WEIGHT γ	REMARKS
ELEV DEPTH	DESCRIPTION	STRAT. PLOT	NUMBER	TYPE	'N' VALUES		20	40	60	80	100			
661.4	Ground Level													
0.4	Clayey silt.					660								
	Very soft. Brown		1	SS	1									
657.4														
4.0	Organic silt with medium to coarse sand.		2	SS	1	655							50.4	
653.4	Very loose. Dark Brown													
8.0	Sand, fine		3	SS	4	650								0 94 6 0
	Loose to compact.													
	Brown		4	SS	3	645								0 93 7 0
642.5			5	SS	11	640								
21.5	Boulders													
637.9														
23.5	Bedrock. Biotite Gneiss. Sound rock. RQD = 57% (on first run)		6	RC BXL	100% REC.	635								BXL core barrel. First run from 23.5 to 26.85 Full recovery. Second run from 26.85 to 28.0
633.4			7	RC BXL	58% REC.									0.6 of core lost in hole due to damaged core barrel.
28.0	End of Borehole.													

OFFICE REPORT ON SOIL EXPLORATION

MINISTRY OF TRANSPORTATION AND COMMUNICATIONS-ONTARIO

HIGHWAY ENGINEERING DIVISION - ENGINEERING MATERIALS OFFICE - SOIL MECHANICS SECTION

63

RECORD OF BOREHOLE No 22A,B,C,D

WP 71-74-05 & 06 LOCATION Co-ords. 16,814,440 N; 1,026,259 E. & 16,814,435 N; 1,026,250 E. ORIGINATED BY WJ
DIST 13 HWY 11 BORING DATE January 17, 1977 Co-ords. 16,814,442 N; 1,026,280 E. & 16,814,434 N; 1,026,273 E. COMPILED BY MB
DATUM Geodetic BOREHOLE TYPE Solid Stem Auger CHECKED BY MB

SOIL PROFILE			SAMPLES			GROUND WATER ELEV	DYNAMIC CONE PENETRATION RESISTANCE PLOT					LIQUID LIMIT w_L PLASTIC LIMIT w_p WATER CONTENT w			UNIT WEIGHT γ	REMARKS
ELEV DEPTH	DESCRIPTION	STRAT. PLOT	NUMBER	TYPE	N' VALUES		20	40	60	80	100	w_p	w	w_L		
661.6	Ground Level															
0.0	Sandy silt, trace of clay & gravel.		1	AS		660										Borehole augered without sampling to check organic.
659.6	Brown															
2.0	Organic silt with some sand.		2	AS												
656.6	Dark Brown															
5.0	Sand, fine,		3	AS		655										
654.6	Light Grey															
7.0	End of Borehole Note: Water level not established.															
	Borehole No. 22B Co-ords. 16,814,435 N; 1,026,250 E.															
662.0	Ground Level															
0.0	Sand, fine, slight silt content.		1	AS		660										Borehole augered without sampling to check organic.
	Brown															
657.0	Light Grey		2	AS												
5.0	End of Borehole Note: Water level not established.															
	Borehole No. 22C Co-ords. 16,814,442 N; 1,026,280 E.															
661.4	Ground Level															
0.0	Sand, fine.		1	AS		660										Borehole augered without sampling to check organic.
	Brown															
656.4																
5.0	End of Borehole Note: Water level not established.															
	Borehole No. 22D Co-ords. 16,814,434 N; 1,026,273 E.															
662.0	Ground Level															
0.0	Sand, fine.					660										Borehole augered without sampling to check organic.
	Brown															
657.0																
5.0	End of Borehole Note: Water level not established.															

MINISTRY OF TRANSPORTATION AND COMMUNICATIONS-ONTARIO

HIGHWAY ENGINEERING DIVISION - ENGINEERING MATERIALS OFFICE - SOIL MECHANICS SECTION

RECORD OF BOREHOLE NO 23

64

WP 71-74-05 & 06 LOCATION Co-ords. 16,814,428 N; 1,026,343 E. ORIGINATED BY WJ
DIST 13 HWY 11 BORING DATE December 23, 1976 & January 14, 1977 COMPILED BY MB
DATUM Geodetic BOREHOLE TYPE Solid Stem Auger & Cone Test CHECKED BY MB

SOIL PROFILE			SAMPLES			GROUND WATER ELEV	DYNAMIC CONE PENETRATION RESISTANCE PLOT					LIQUID LIMIT w_L PLASTIC LIMIT w_p WATER CONTENT w w_p w w_L WATER CONTENT % 10 20 30	UNIT WEIGHT γ	REMARKS
ELEV DEPTH	DESCRIPTION	STRAT. PLOT	NUMBER	TYPE	'N' VALUES		20	40	60	80	100			
663.0	Ground Level													
0.3	Sand, fine with some gravel. Loose. Brown													
661.0														
2.0	Gravelly sand, medium to coarse. Loose Brown		1	SS	7	660								
654.0						655								
9.0	Sand, fine, some gravel. Very loose. Grey		2	SS	2	650								
645.5			3	SS	2									
17.5	End of Borehole. Refusal to augering, probable bedrock. Note: On completion hole caved at 660.0.					645								

MINISTRY OF TRANSPORTATION AND COMMUNICATIONS-ONTARIO

HIGHWAY ENGINEERING DIVISION - ENGINEERING MATERIALS OFFICE - SOIL MECHANICS SECTION

RECORD OF BOREHOLE No 24

65

WP 71-74-05 & 06

LOCATION Co-Ords. 16,814,385 N; 1,026,397 E.

ORIGINATED BY WJ

DIST 13 HWY 11

BORING DATE December 23, 1976

COMPILED BY MB

DATUM Geodetic

BOREHOLE TYPE Solid Stem Auger & Cone Test

CHECKED BY MB

SOIL PROFILE			SAMPLES			GROUND WATER ELEV	DYNAMIC CONE PENETRATION RESISTANCE PLOT 20 40 60 80 100 SHEAR STRENGTH ○ UNCONFINED + FIELD VANE ● QUICK TRIAXIAL x LAB VANE	LIQUID LIMIT — w_L PLASTIC LIMIT — w_p WATER CONTENT — w w_p — w — w_L WATER CONTENT % 10 20 30	UNIT WEIGHT γ	REMARKS % GR SA SI CL
ELEV DEPTH	DESCRIPTION	STRAT. PLOT	NUMBER	TYPE	'N' VALUES					
665.5	Ground Level									
0.3	Sand, fine					665				
	Loose.		1	SS	9	660				0 84 16 0
	Brown Grey		2	SS	6	655				
651.5										
14.0	Gravelly sand, coarse, some cobbles and boulders.		3	SS	35	650				
	Dense									
	Grey									
645.5										
20.0	End of Borehole. Refusal to augering, probable bedrock.					645				

20
15 5 % STRAIN AT FAILURE
10

OFFICE REPORT ON SOIL EXPLORATION

HIGHWAY ENGINEERING DIVISION - ENGINEERING MATERIALS OFFICE - SOIL MECHANICS SECTION

RECORD OF BOREHOLE NO 25

66

WP 71-74-05 & 06 LOCATION Co-Ords. 16,814,376 N; 1,026,516 E. ORIGINATED BY WJ
 DIST 13 HWY 11 BORING DATE January 4 and 14, 1977 COMPILED BY MB
 DATUM Geodetic BOREHOLE TYPE Solid Stem Auger & Cone Test CHECKED BY MB

SOIL PROFILE			SAMPLES			GROUND WATER ELEV	DYNAMIC CONE PENETRATION RESISTANCE PLOT					LIQUID LIMIT w_L PLASTIC LIMIT w_p WATER CONTENT w			UNIT WEIGHT γ	REMARKS
ELEV DEPTH	DESCRIPTION	STRAT. PLOT	NUMBER	TYPE	N' VALUES		20	40	60	80	100	WATER CONTENT % 10 20 30				
671.2	Ground Level															
0.25	Silty sand, fine, odd gravel, Yellow Brown Pale Brown Compact		1	SS	16	670										
661.7						665										
9.5	Gravelly sand, fine to coarse Very loose. Brown Grey		2	SS	5	660										
			3	SS	3	655										
650.2			4	SS	17	650										
21.0	Sand, fine, some gravel, odd cobble, Compact to dense. Boulders from 27.0 Grey		5	SS	30	645										
641.7																
29.5	End of Borehole. Refusal to augering, probable bedrock. Note: On completion wet cave in at 662.2 water level inferred.															

MINISTRY OF TRANSPORTATION AND COMMUNICATIONS-ONTARIO

HIGHWAY ENGINEERING DIVISION - ENGINEERING MATERIALS OFFICE - SOIL MECHANICS SECTION

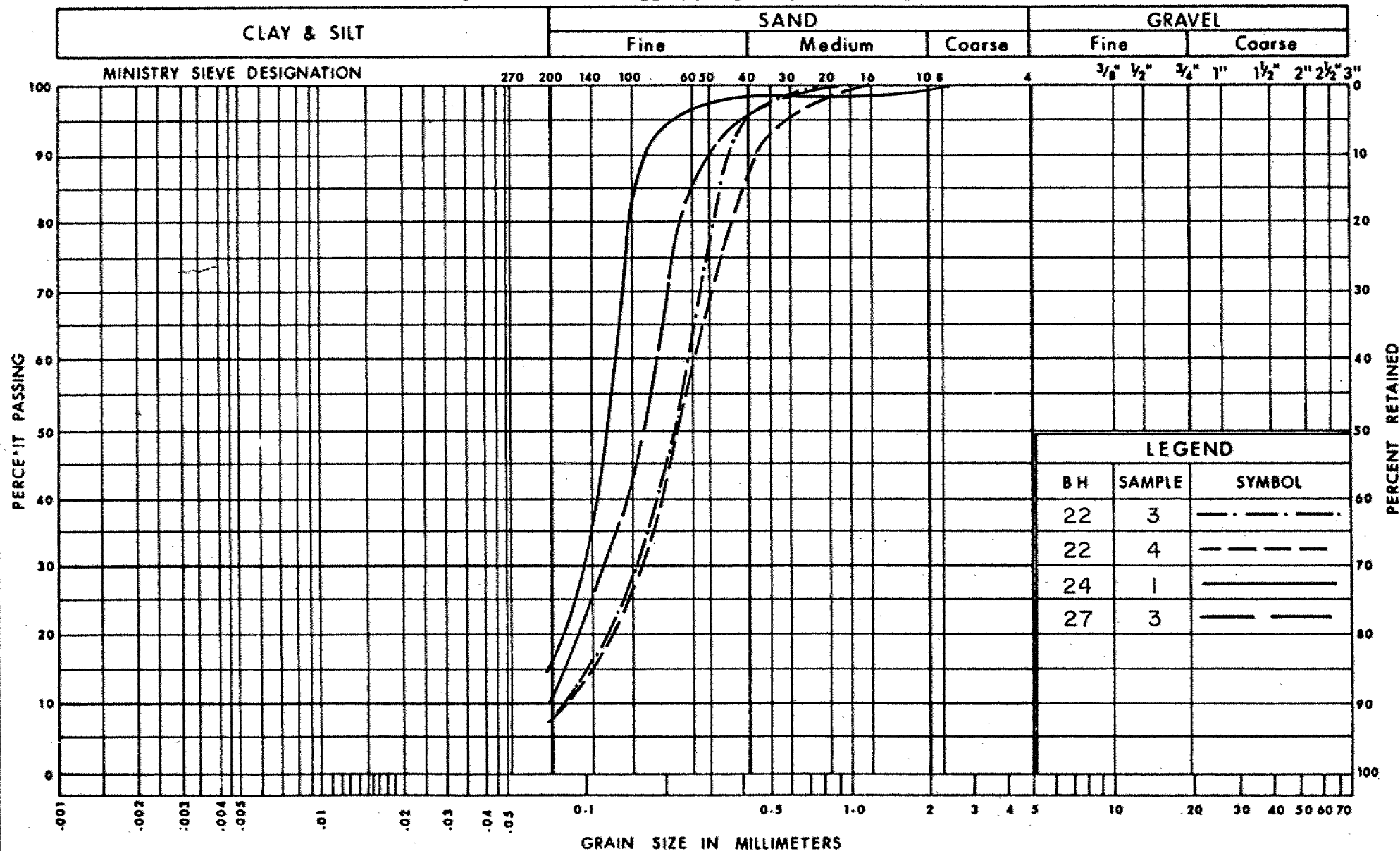
RECORD OF BOREHOLE NO 26, 27

67

WP 71-74-05 & 06 LOCATION Co-ords. 16,814,478 N; 1,026,302 E. ORIGINATED BY WJ
DIST 13 HWY 11 BORING DATE January 21, 1977 COMPILED BY MB
DATUM Geodetic BOREHOLE TYPE Hand Auger* CHECKED BY MB

SOIL PROFILE			SAMPLES			GROUND WATER ELEV	DYNAMIC CONE PENETRATION RESISTANCE PLOT					LIQUID LIMIT W_L PLASTIC LIMIT W_P WATER CONTENT W			UNIT WEIGHT Y	REMARKS % GR SA SI CL
ELEV DEPTH	DESCRIPTION	STRAT. PLOT	NUMBER	TYPE	N' VALUES		20	40	60	80	100	W_P	W	W_L		
660.8	Water Level					660										
0.0	Water					660										
656.55	River Bottom					655										
4.25	Gravelly sand, coarse		1	SS	15	655										30 66 4 0
	Loose to compact.		2	SS	9											
652.6	Grey Brown		3	SS	100/5"											
8.2	End of Borehole. Refusal to augering, probable bedrock.					650										
	Borehole No. 27 Co-ords. 16,814,464N; 1,026,266 E.															
660.8	Water Level					660										
0.0	Water					660										
	River Bottom					655										
2.75	Sand					655										
3.25	Organic silt with some sand seams.		1	SS	5	655										
654.3	Loose. Dark Brown															
6.5	Gravelly sand, fine to coarse.		2	SS	15	650										10 87 3 0
	Some sand seams.		3	SS	25	650										
	Compact. Grey Brown															
645.8						645										
15.0	Sand, fine		4	SS	30	645										0 89 11 0
	Odd gravel.					640										
			5	SS	45	640										
636.0	Dense. Grey		6	SS	100/3"											
24.8	End of Borehole. Refusal to augering, probable bedrock.					630										
	*Note: 41 lb. Hammer used. N-values shown on logs are corrected values corresponding to standard weight hammer and standard drop.															

UNIFIED SOIL CLASSIFICATION SYSTEM



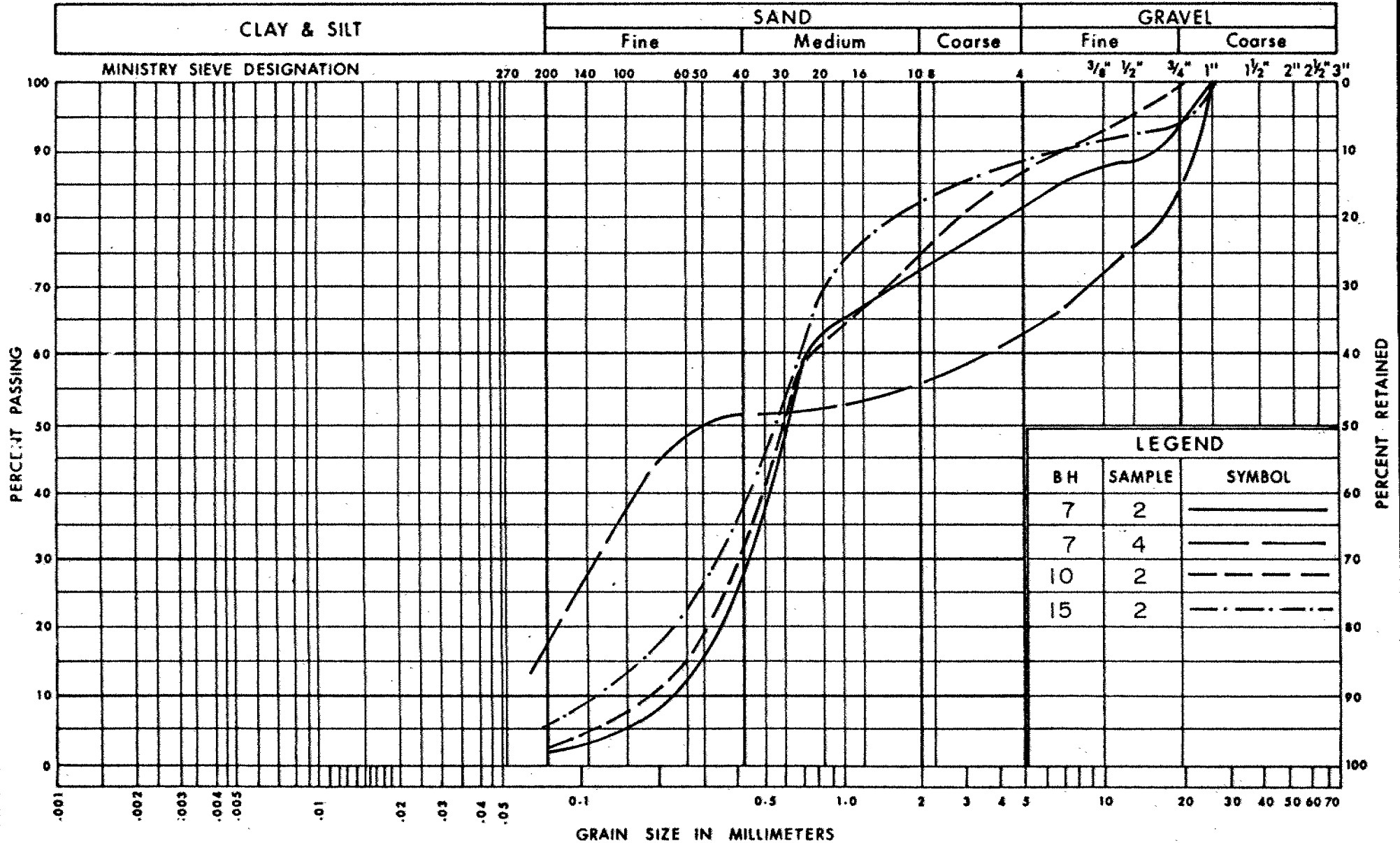
Ministry of
Transportation and
Communications

GRAIN SIZE DISTRIBUTION
SAND
FINE

FIG No 1

WP 71-74-05 & 06

UNIFIED SOIL CLASSIFICATION SYSTEM



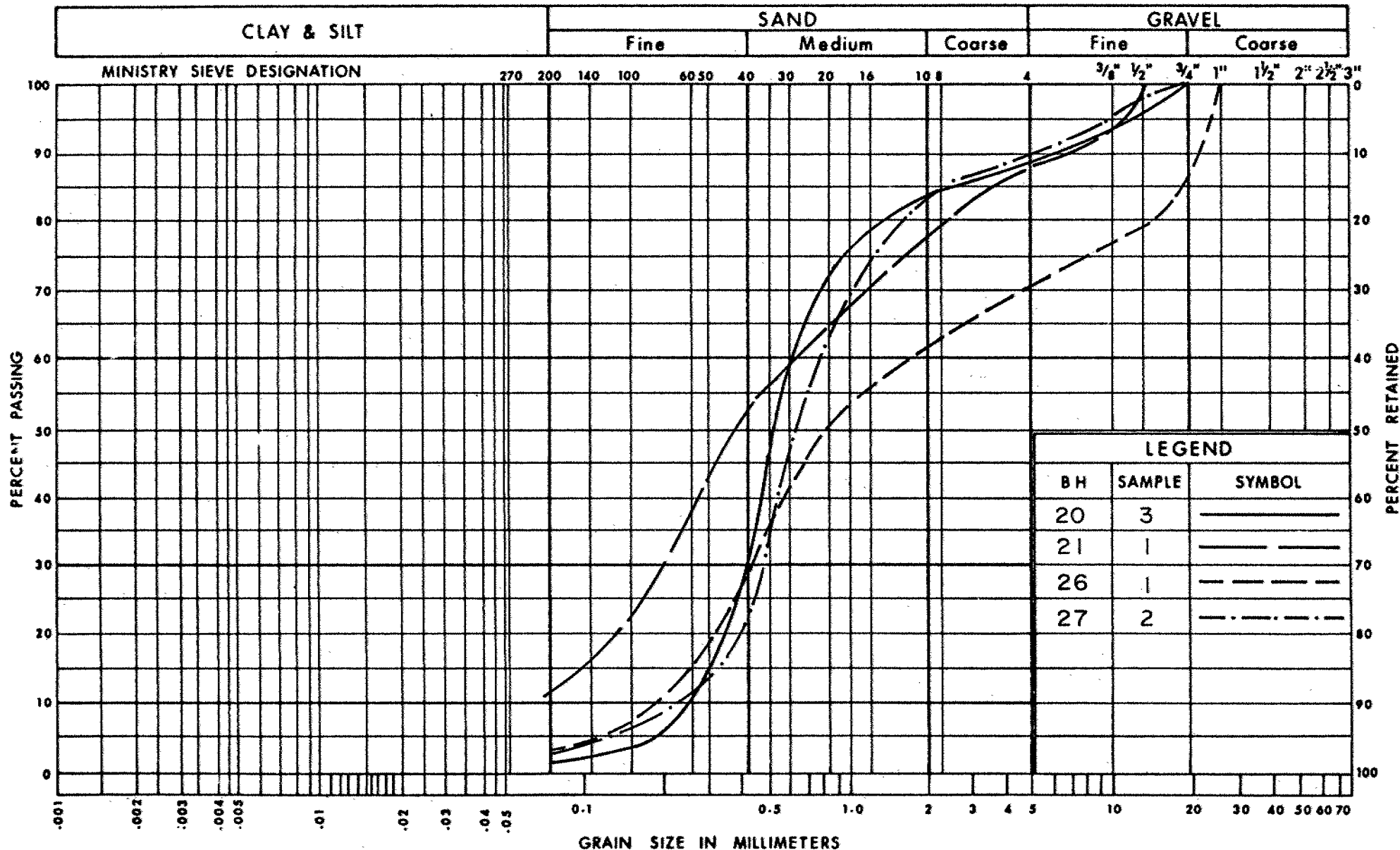
Ministry of
Transportation and
Communications

GRAIN SIZE DISTRIBUTION
GRAVELLY SAND

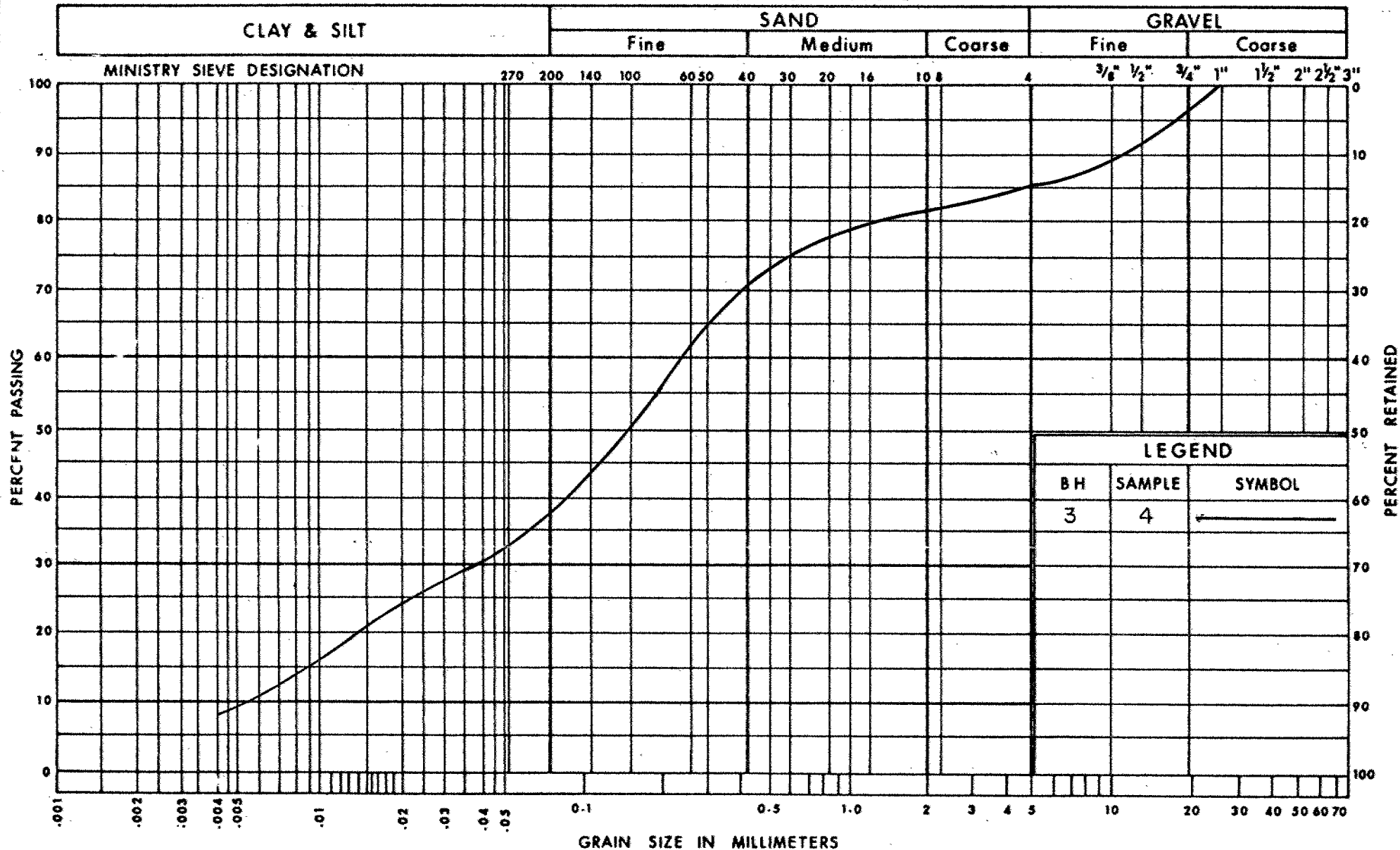
FIG No 2

W P 71-74-05 & 06

UNIFIED SOIL CLASSIFICATION SYSTEM



UNIFIED SOIL CLASSIFICATION SYSTEM



Ministry of
Transportation and
Communications

GRAIN SIZE DISTRIBUTION
SILTY SAND TILL

FIG No 4

W P 71-74-05 & 06

FOUNDATION INVESTIGATION REPORT

For

Lakeshore Drive Underpass
W.P. 71-74-07, Site 43-201
Hwy. 11, District 13, North Bay

INTRODUCTION

This report contains the results of a foundation investigation done at the site of the above mentioned project. The investigation was carried out during the period of October 26, 1977 to October 28, 1977. The fieldwork consisted of six sampled boreholes advanced by means of 3½" I.D. hollow stem augers and six auger probing holes advanced by means of solid stem flight augers. The fieldwork also included five hand dug test pits and two hand dug trenches. The boreholes were advanced to depths ranging from 8.5 feet to 25 feet below the ground surface. In addition, bedrock was proven by recovering BX size rock core samples.

DESCRIPTION OF SITE AND GEOLOGY

The site is located some 750 feet northeast of the junction of Hwy. 11 and Dupont Road in the southern portion of the City of North Bay. A large part of the site is situated in a basin which is surrounded by undulating high ground. The low lying area in the basin is not well drained. At the time of investigation it was inundated with 6 to 8 inches of water. Bedrock is exposed at the ground surface in several locations at this site. A large rock knob is located on the west side of Dupont Road in the southern portion of the site. The land in this area is covered with pine trees and spruces with occasional poplars. Most of the trees in the vicinity of the site are not mature.

Geologically the area is located in the Canadian Shield with bedrock of Precambrian age. The overburden at this site consists of granular glacio-fluvial deposits.

SUBSURFACE CONDITIONS

General

Subsoil at this site consists of a fine to medium sand with gravel. In the northern portion of the site the granular stratum also contains numerous cobbles and boulders below a depth of 16 feet below the ground surface. The bedrock surface is irregular and due to this the thickness of the overburden is quite variable. In places in the centre portion of the site bedrock is exposed or exists at a shallow depth. In the southern portion of the site the thickness of the overburden was found to be in the order of 16 feet, whereas in the northern portion of the site the thickness of the overburden was found to be in excess of 25 feet.

The locations and elevations of the borings, test pits and trenches are shown in Contract Drawing No. 43-201-2, together with the estimated stratigraphy. A description of the subsoil is as follows.

Sand With Gravel

This is the predominant deposit at the site. The material in this stratum is composed of fine to medium sand with gravel. Typical grain size distribution curves of the material are summarized in Figure 1 in an envelope form. In the northern portion of the site the granular stratum also contains numerous cobbles and boulders below a depth of 16 feet below the ground surface.

The thickness of this sand stratum is variable, largely due to the irregularity of the bedrock surface. In the centre portion of the site bedrock is exposed at the ground surface or is under a thin mantle of sand. In the southern portion of the site the thickness of the granular stratum ranges from about 15 feet to 17 feet. In the northern portion of the site the thickness of the granular stratum was found to be greater than 25 feet.

The full extent of the granular stratum in the northern portion of the site was not explored because of the presence of numerous cobbles and boulders below a depth of 16 feet.

The 'N' values recorded in this granular stratum range from 8 blows/foot to 37 blows/foot, generally increasing with depth. It is estimated from these 'N' values that the granular stratum has a relative density of loose to compact, generally increasing with depth.

Bedrock

Bedrock at this site is a granite, generally hard and sound. In the southern portion of the site bedrock surface varies between elevation 673 and elevation 676. In the centre portion of the site bedrock is exposed at the ground surface in certain locations or exists at a shallow depth. The bedrock surface in the centre portion of the site is relatively level being at about elevation 681.7 to elevation 682, except at one location where bedrock surface is sloping down westerly to about elevation 677 at a slope angle of about 6(H):1(V). Bedrock was not proven in the northern portion of the site because of the presence of numerous cobbles and boulders.

Groundwater Conditions

Groundwater observations were carried out at the time of the field investigation. The observations indicate that the groundwater inundates the ground surface by a depth of 6 to 8 inches in low lying areas or is encountered at a depth of up to 10 feet below ground surface in higher areas. These depths correspond to an elevation of approximately 681.5.

M. MacLean

M. MacLean, P. Eng.
Project Engineer



M. Devata

M. Devata, P. Eng.
Supervising Engineer

APPENDIX



RECORD OF BOREHOLE No 1

76

W P 71-74-07 LOCATION N 16 813 554; E 1 027 253 ORIGINATED BY BL
DIST 13 HWY 11 BOREHOLE TYPE Hollow Stem Auger COMPILED BY BL
DATUM Geodetic DATE Oct. 26, 1977 CHECKED BY

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	REMARKS & GRAIN SIZE DISTRIBUTION (%) GR SA SI CL
ELEV DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE	'N' VALUES			20	40	60	80	100					
691.2	Ground Surface																
0.0	Sand: fine changing with depth to medium with gravel		1	SS	8		690										0 97 (3)
	Loose to compact		2	SS	29												
			3	SS	17												
	Auger refusal on probable bedrock		4	SS	33		680										15 88 (2)
676.2			5	SS	37												
15.0	End of Hole																

RECORD OF BOREHOLE No 2

W P 71-74-07 LOCATION N 16 813 528; E 1 027 283 ORIGINATED BY BL
DIST 13 HWY 11 BOREHOLE TYPE Hollow Stem Auger COMPILED BY BL
DATUM Geodetic DATE Oct. 26, 1977 CHECKED BY

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	REMARKS & GRAIN SIZE DISTRIBUTION (%) GR SA SI CL
ELEV DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE	'N' VALUES			20	40	60	80	100					
690.7	Ground Surface																
0.0	Sand: Fine changing with depth to medium with gravel		1	SS	18		690										11 87 (2)
	Compact		2	SS	13		680										0 99 (1)
	Auger refusal at 674.7																
674.7																	
16.0	Granite: sound		3	RC	Rec	95%											
671.7						RQD	85%										
19.0	End of Hole																

RECORD OF BOREHOLE No. 3

77

W P 71-74-07 LOCATION N 16 813 647; E 1 027 312 ORIGINATED BY BL
DIST 13 HWY 11 BOREHOLE TYPE Hollow Stem Auger COMPILED BY BL
DATUM Geodetic DATE Oct. 27, 1977 CHECKED BY _____

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	REMARKS & GRAIN SIZE DISTRIBUTION (%) GR SA SI CL			
ELEV DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE	'N' VALUES												
								SHEAR STRENGTH ○ UNCONFINED + FIELD VANE ● QUICK TRIAXIAL × LAB VANE									
681.2	Ground Surface						20	40	60	80	100						
0.0	Sand; fine to medium																
677.7	Some gravel																
3.5	Granite Bedrock:		1	RC	Rec	100%											
672.7	Sound				RQD	100%											
8.5	End of Hole																
AH 3A Solid Stem Auger																	
681.5	Ground Surface						N 16 813 657 E 1 027 311										
0.0	Sand																
675.3	Auger refusal on probable bedrock																
6.2	End of Hole																
AH 3B Solid Stem Auger																	
681.5	Ground Surface						N 16 813 648 E 1 027 321										
0.0	Sand																
677.3	Auger refusal on probable bedrock																
4.2	End of Hole																
AH 3C Solid Stem Auger																	
681.5	Ground Surface						N 16 813 645 E 1 027 303										
0.0	Sand																
676.0	Auger refusal on probable bedrock																
5.5	End of Hole																

+3, x5: Numbers refer to Sensitivity

20

15 

10

RECORD OF BOREHOLE No 5

78

W P 71-74-07 LOCATION N 16 813 740; E 1 027 372 ORIGINATED BY BL
DIST 13 HWY 11 BOREHOLE TYPE Hollow Stem Auger COMPILED BY BL
DATUM Geodetic DATE Oct. 27, 1977 CHECKED BY _____

[illegible]

+3, x5 : Numbers refer to Sensitivity

20
15 ϕ 5 (%) STRAIN AT FAILURE
10




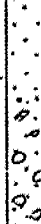
OFFICE REPORT ON SOIL EXPLORATION



RECORD OF BOREHOLE No 6

79

W P 71-74-07 LOCATION N 16 813 712; E 1 027 400 ORIGINATED BY BL
DIST 13 HWY 11 BOREHOLE TYPE Hollow Stem Auger COMPILED BY BL
DATUM Geodetic DATE Oct. 28, 1977 CHECKED BY _____

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	REMARKS & GRAIN SIZE DISTRIBUTION (%) GR SA SI CL
ELEV DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE	'N' VALUES			20	40	60	80	100					
680.9	Water Surface																
0.0	Sand: Medium, with gravel.		1	SS	17		680										
	Compact		2	SS	25		670										
665.9																	
15.0	Bouldery																
662.9																	
18.0	End of Hole																
AH 10																	
	Solid Stem Auger																
690.4	Ground Surface																
0.0	Sand: Fine changing with depth to medium with gravel Occasional Cobbles.						690										
	Auger refusal on probable bedrock						680										
673.2																	
17.2	End of Hole																

+3, x5: Numbers refer to
Sensitivity

20
15 \div 5 (%) STRAIN AT FAILURE
10



RECORD OF BOREHOLE No 11

80

W P 71-74-07 LOCATION N 16 813 726; E 1 027 387 ORIGINATED BY BL
DIST 13 HWY 11 BOREHOLE TYPE Hollow stem, BX Casing COMPILED BY BL
DATUM Geodetic DATE Oct. 27, 1977 CHECKED BY

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 Y	REMARKS & GRAIN SIZE DISTRIBUTION (%)
ELEV DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE	'N' VALUES			20	40	60	80	100					
680.9	Water Surface																GR SA SI CL
0.0	Sand Medium, with gravel loose to compact		1	SS	11		680										
			2	SS	10		670										
662.4			3	RC			660										
18.5	Boulders with sand and gravel		4	RC													
655.9			5	RC													
25.0	End of Hole		6	RC													
	AH 11A Solid Stem Auger					Oct. 28, 1977											
							N 16 813 720 E 1 027 382										
680.9	Water Surface																
	Sand: medium, with gravel						680										
	Loose to Compact						670										
664.9							660										
16.0	Boulders with sand and gravel																
658.4																	
22.5	End of Hole																

*3, *5: Numbers refer to
Sensitivity

20
15 \div 5 (%) STRAIN AT FAILURE
10

FOUNDATION INVESTIGATION & DESIGN REPORT

W.P. 71-74-02

DIST. 13

HWY. 11

STR. SITE 43-105B

CNR Overhead Southbound
2.8 Miles South of Hwy. 17 & 11

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SAMPLE DISPOSITION NOTICE		
TYPE	DISCARD AFTER	RECOMM. BY
JARS	March 11/77	MD
TUBES	"	"
ROCK CORES	Save until [unclear] [unclear]	"

FOUNDATION INVESTIGATION REPORT

For

CNR Overhead Southbound
2.8 Miles South of Hwy. 17 & 11
Hwy. 11, District 13, North Bay
W.P. 71-74-02, Site 43-105B

INTRODUCTION

This report contains the results of a foundation investigation carried out at the site of the above mentioned project. The fieldwork was carried out during the period of November 23, 1976 to December 3, 1976. It consisted of a total of 8 boreholes advanced by means of 3¼" I.D. hollow stem flight augers to depths ranging from 43 to 53 feet below the ground surface. Bedrock was proven by obtaining BXL size rock core samples.

SITE DESCRIPTION AND GEOLOGY

The site is located about 220 feet northwest of the existing Hwy. 11 CNR Overhead approximately 2.8 miles south of the east junction of Hwy. 11 and 17 in the City of North Bay, District of Nipissing. Flat terrain is prevalent throughout this area and the immediate vicinity of the site has been cleared of trees and is now overgrown with bushes. The existing Hwy. 11 CNR structure is a 37 foot single span concrete rigid frame structure. Gneiss bedrock outcrops are present on both sides of the Hwy. 11 embankment about 1000 feet south of the existing structure and also on the west side of the highway embankment about 200 feet north of the existing structure. A large swamp area about 200 feet north of the site extends from about 250 feet west of the existing highway westerly about 1000 feet.

Physiographically the site is located in the region known as the Canadian Shield. The Shield is characterized by the effects of intense glaciation which has left scattered rounded rock outcrops and rocky ridges separated by glacial deposits and muskeg.

SUBSURFACE CONDITIONS

General

Generally, uniform conditions were found to prevail over the site area. Subsoil consists of 40 to 53 feet of compact to dense sand with a trace of gravel. The sand is underlain by gneiss bedrock. Detailed descriptions of the overburden and bedrock encountered in each borehole are given on the Record of Borehole

Sheets. The locations and elevations of the boreholes, together with the estimated stratigraphical sections as inferred from the borehole data and site geology, are shown on Drawing No. 717402-A.

The sand overburden and gneiss bedrock encountered are described in the paragraphs to follow.

Sand

Immediately below a thin veneer of topsoil and extending down to the bedrock surface is a deposit of sand. The sand stratum is estimated to vary in thickness from 40 to 53 feet. This granular deposit is comprised of 5 to 12 foot thick layers of fine sand and 12 to 25 foot thick layers of medium sand with a trace of gravel. Grain size distribution tests performed on representative samples from this stratum gave a coefficient of uniformity of 2 for the fine sand and 5 for the medium sand. These results indicate that the fine sand is uniform and that the medium sand is well graded. Grain size distribution envelopes, one for the fine sand and one for the medium sand, are shown on Figure 1 appended to this report.

In the upper ten foot portion of the sand stratum random layers or pockets, about 4 inches in thickness, of clayey silt to silty clay were encountered. Atterberg Limit Tests performed on two samples from these cohesive layers indicate that the material is an inorganic silty clay of low to intermediate plasticity. The results of the Atterberg Limits are shown on the Record of Borehole Sheets.

Based on Standard Penetration Test 'N' values which range randomly from 10 to 49 blows per foot, the relative density of the sand stratum is estimated to be generally compact to dense with the exception of the silty clay to clayey silt layers where the consistency is estimated to be stiff.

Gneiss Bedrock

The overburden is underlain by bedrock which was proven in 3 of the boreholes by obtaining up to 5 feet of BXL size rock core at each location. Where cores were not taken it was assumed that the probable bedrock surface was where the augers or dynamic cone met refusal.

The bedrock may be described as a gneiss, pink-grey, with medium to coarse texture and hard. The rock cores indicate that at some locations the bedrock is weathered in the upper 1 to 5 feet.

The bedrock surface in the vicinity of the site was encountered at elevations ranging from 633 to 643 which corresponds to depths ranging from 40 to 53 feet below existing ground surface.

Groundwater Observations

Groundwater level observations were carried out during the period of the investigation by measuring the water level in the open boreholes or by observing the wet line on the rods after completion of the dynamic cone penetration tests. The groundwater was found to vary from elevation 672 to 675 which corresponds to depths ranging from 8 to 15 feet below existing ground surface.

DISCUSSION AND RECOMMENDATIONS

General

It is proposed to reconstruct Hwy. 11 as a controlled access highway in the City of North Bay from Lakeshore Drive to Highway 17. About 2.8 miles south of the east junction of Hwy. 11 and 17 the C.N.R. track crosses the proposed alignment of Hwy. 11. The existing C.N.R. overhead will be used to facilitate the crossing of the northbound lanes; whereas a three span overhead has been proposed to carry the southbound lanes over the track.

The profile grade of Hwy. 11 in the vicinity of the C.N.R. overhead is approximately at elevation 713. The associated approach fills will have a maximum fill height of about 30 feet.

The following recommendations pertain to the design and construction of the structure foundations and approach fills.

Structure Foundations

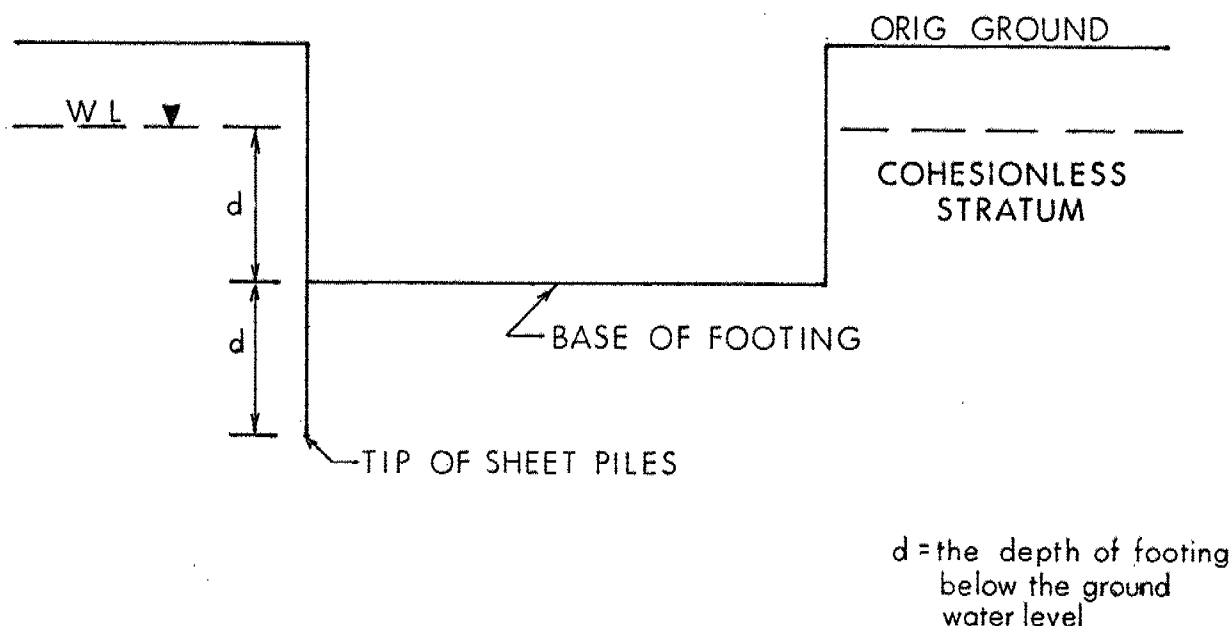
Piers - refer B.H. 2,5,5 and 8: The piers can be founded on spread footings or on end-bearing piles driven to bedrock.

If the spread footing scheme is adopted, the footings may be located in the competent sand stratum at or below elevation 677. The base of the footing, however, should have a minimum of 5 feet of soil cover for frost protection purposes. An allowable bearing value of up to 2.5 tsf. can be used in the design of the footings. At this bearing value the anticipated settlement of the pier footing should not exceed one inch.

If the allowable bearing pressure is not desirable for the pier footings from a structural design point of view, the pier can be supported on end-bearing piles founded on the bedrock surface. The allowable pile loads would depend on the pile section chosen. For example, a 12 BP 74 steel 'H' pile may be designed for an allowable load of up to 95 tons per pile. The pile caps should be protected with a minimum cover of 5 feet above the base of the pile cap for frost protection purposes.

Due to the pervious nature of the subsoil a temporary dewatering scheme will be required during construction of the footings or pile caps if the footing excavations are at or below the prevailing groundwater level. Such a dewatering scheme can be achieved by constructing a cofferdam of interlocking steel sheet

piling. The sheeting should be driven to a depth below the base of the excavation equal to the prevailing unbalanced hydrostatic head to prevent boiling of the excavation (see sketch below).



Abutment footings - refer B.H. 1, 3, 7 and 4: The abutments may be supported on spread footings founded on a compacted granular 'A' pad within the approach fills. The granular 'A' pad should be constructed with side slopes of 1:1 and should extend to a horizontal distance of at least 8 feet from the footing edges as shown in Figure No. 2 appended to this report. The approach fills within a distance of 50 feet behind the pad should be brought up to the top of footing level before excavating for the abutment footings. An allowable bearing value of 2.5 tsf. may be used in footing design. If this scheme is followed, the maximum differential settlements between the pier founded on spread footings, or on piles, should be less than one inch.

Alternatively the abutment footings may be supported on end bearing piles founded on the bedrock surface. The allowable loads would depend on the particular pile section chosen (eg. a 12 BP 74 steel 'H' piles may be designed for 95 tons per pile). No boulder or rock fill should be used in areas which piles are to be driven.

It may be advisable to consider a single span structure with closed type abutments if economies warrant. Closed type abutments may be founded as discussed under Piers.

Other Considerations

For estimating the earth pressure on the abutments a coefficient of active earth pressure of $K_a = 0.33$ may be used if some movement at the top of the wall is permitted, whereas if no movement at the top of the wall is anticipated, a coefficient of earth pressure at rest $K_o = 0.5$ may be used for design purposes.

To estimate the horizontal resistance to sliding between rough concrete and the granular subsoil or the granular 'A' pad, a coefficient of friction of 0.6 may be used.

Furthermore, to prevent the build up of hydrostatic pressures behind the abutment wall, free draining granular material should be used for backfill behind the wall as per current M.T.C. Standards.

Approach Fills

No stability problems are anticipated with fill heights up to 30 feet if constructed of properly compacted fill with side slopes of 2:1.

MISCELLANEOUS

The fieldwork for this investigation was carried out under the supervision of Mr. H. Shah, Project Engineer. The equipment used was owned and operated by Master Soils Investigation Ltd.

This report was written by Mr. M. MacLean, Project Engineer and reviewed by Mr. M. Devata, Supervising Engineer.

M. MacLean

M. MacLean, P. Eng.
Project Engineer

M. Devata

M. Devata, P. Eng.
Supervising Engineer



APPENDIX

FOUNDATION REQUEST

In a memorandum dated October 28, 1976, Mr. J.C. McAllister of the Regional Planning and Design Office, Structural Section, requested the Soil Mechanics Section to carry out a foundation investigation at the site of the proposed Hwy. 11 SB, C.N.R. Overhead.

Existing Structure

The existing structure of Hwy. 11 over the C.N.R. tracks is a 37 foot single span concrete rigid frame bridge, with a deck width of 44 feet. At this location the skew angle of Hwy. 11 to the C.N.R. track is about 144° . The existing structure is founded on steel end bearing piles and shows no signs of deterioration.

Proposed Geometrics

The site of the proposed crossing is approximately 2.8 miles south of the east junction of Hwy. 11 and Hwy. 17. The proposed alignment of the northbound lanes at this location is approximately the same as that of existing Hwy. 17; the proposed alignment of the southbound lanes parallels that of the northbound lanes and is offset to the west about 160 feet. At the proposed structure location the southbound lanes are aligned on a $2^{\circ}00'$ horizontal curve. The skew angle of the C.N.R. tracks to the proposed tangents on southbound Hwy. 11 alignment is about 146° .

FIELD AND LABORATORY INVESTIGATION PROCEDURES

A field investigation was carried out from November 23 to December 3, 1976. A total of 6 sampled boreholes, each accompanied by a dynamic cone penetration test, together with 2 separate dynamic cone penetration tests, were put down during the course of the investigation. The boreholes were advanced using two track mounted auger machines equipped with hollow stem flight augers.

The locations and elevations of the boreholes were surveyed by personnel from the North Bay Regional Surveys and Plans Section.

Soil samples were recovered by means of a 2 inch O.D. split spoon sampler driven in accordance with the specifications of the Standard Penetration Test. Samples were visually examined and identified in the field and again in the laboratory.

Bedrock samples were obtained by BX rock coring. The rock cores were examined by Ms. Z. Koniuszky.

RECORD OF BOREHOLE NO 1

WP 71-74-02

LOCATION Co-ords. N. 16,817,523 E 1,024,782

ORIGINATED BY HS

DIST 13 HWY 11

BORING DATE Nov. 23, 1976

COMPILED BY MM

DATUM Geodetic

BOREHOLE TYPE Hollow Stem Augers, BX Casing & Cone Test

CHECKED BY

SOIL PROFILE			SAMPLES			GROUND WATER ELEV	DYNAMIC CONE PENETRATION RESISTANCE PLOT					LIQUID LIMIT W_L PLASTIC LIMIT W_P WATER CONTENT W			UNIT WEIGHT γ	REMARKS
ELEV DEPTH	DESCRIPTION	STRAT. PLOT	NUMBER	TYPE	N' VALUES		20	40	60	80	100	W_P	W	W_L		
685.7	Ground Surface															GR SA SI CL
0.0	Sand Trace of Gravel Compact to Dense		1	SS	92/2"	680						o				8 90 (2)
			2	SS	8							o				
	Fine with pockets of clayey silt		3	SS	15							o				3 94 (3)
			4	SS	43							o				6 92 (2)
	Medium		5	SS	29	675.2										
			6	SS	38	670										
			7	SS	17											
	Fine		8	SS	28	660						o				0 96 (4)
			9	SS	13											
	Medium		10	SS	24	650						o				22 76 (2)
			11	SS	22	640										
632.7	End of Borehole															
53.0	Auger Refusal BX Casing Broken Probable Bedrock															120/5" and Bouncing

RECORD OF BOREHOLE NO 2

WP 71-74-02 LOCATION Co-ords N 16,817,396 E 1,024,841 ORIGINATED BY HS
DIST 13 HWY 11 BORING DATE Nov. 24,25,25, 1976 COMPILED BY CTJ
DATUM Geodetic BOREHOLE TYPE Hollow Stem Auger, BX Casing & Cone Test CHECKED BY

SOIL PROFILE			SAMPLES			GROUND WATER ELEV	DYNAMIC CONE PENETRATION RESISTANCE PLOT					LIQUID LIMIT W_L PLASTIC LIMIT W_p WATER CONTENT W W_p — W — W_L WATER CONTENT % 20 40 60	UNIT WEIGHT γ	REMARKS % GR SA S! CL
ELEV DEPTH	DESCRIPTION	STRAT. PLOT	NUMBER	TYPE	N' VALUES		20	40	60	80	100			
683.3	Ground Surface													
0.0	Sand Trace of gravel. Compact to Dense Fine with pockets of clayey silt		1	SS	10	680								1 97 (2)
			2	SS	23	674.9								2 97 (1)
			3	SS	35									
			4	SS	22									
	Medium		5	SS	25	670								13 85 (2)
			6	SS	38									
	Fine		7	SS	25	660								15 83 (2)
			8	SS	29									0 99 (1)
	Medium		9	SS	16	650								9 88 (3)
643.3														
40.0	Gneiss Bedrock		10	BX	100%	640								
638.3	Weathered													
45.0	End of Borehole													

ENGINEERING SERVICES BRANCH-GEOTECHNICAL OFFICE-SOIL MECHANICS SECTION

RECORD OF BOREHOLE NO 3

WP 71-74-02 LOCATION Co-ords N 16,817,464 E 1,024,832 ORIGINATED BY HS
 DIST 13 HWY 11 BORING DATE Nov. 29, 30, 1976; Dec. 1, 1976 COMPILED BY CTJ
 DATUM Geodetic BOREHOLE TYPE Hollow Stem Auger, BX Casing & Cone Test CHECKED BY

SOIL PROFILE			SAMPLES			GROUND WATER ELEV	DYNAMIC CONE PENETRATION RESISTANCE PLOT				LIQUID LIMIT w_L PLASTIC LIMIT w_p WATER CONTENT w			UNIT WEIGHT γ	REMARKS
ELEV DEPTH	DESCRIPTION	STRAT. PLOT	NUMBER	TYPE	'N' VALUES		20	40	60	80	100	w_p	w	w_L	
682.4	Ground Surface														
0.0	Fine with pockets of clayey silt to silty clay Medium		1	SS	16	680									7 66 (27)
			2	SS	27										2 96 (2)
			3	SS	22										
			4	SS	43	674.9									14 83 (3)
			5	SS	32	670									
			6	SS	49										
	Sand Trace of Gravel Compact to Dense					660									
						650									
						640									
640.4	Gneiss Bedrock		7	RC	100%	640									
42.0	Sound		8	RC	100%										
637.9															
44.5	End of Borehole														

HIGHWAY ENGINEERING DIVISION - ENGINEERING MATERIALS OFFICE - SOIL MECHANICS SECTION

RECORD OF BOREHOLE NO 4

WP 71-74-02 LOCATION Co-ords. N 16,817,245 E 1,024,853 ORIGINATED BY HS
 DIST 13 HWY 11 BORING DATE Nov. 29, 1976 COMPILED BY MM
 DATUM Geodetic BOREHOLE TYPE Hollow Stem Auger, & Cone Test CHECKED BY

SOIL PROFILE			SAMPLES			GROUND WATER ELEV	DYNAMIC CONE PENETRATION RESISTANCE PLOT 20 40 60 80 100 SHEAR STRENGTH ○ UNCONFINED + FIELD VANE ● QUICK TRIAXIAL x LAB VANE	LIQUID LIMIT W_L PLASTIC LIMIT W_P WATER CONTENT W W_P W W_L WATER CONTENT % 20 40 60	UNIT WEIGHT γ	REMARKS % GR SA SI CL
ELEV DEPTH	DESCRIPTION	STRAT. PLOT	NUMBER	TYPE	'N' VALUES					
686.5	Ground Surface									
0.0	Fine with pockets of clayey silt to silty clay		1	SS	18					9 85 (6)
			2	SS	20					0 15 56 29
			3	SS	26					1 91 (3)
			4	SS	26					
			5	SS	18					2 96 (2)
	Medium		6	SS	22					
			7	SS	47					33 65 (2)
	Sand Trace of Gravel Compact to Dense									
638.8										
47.7	Probable Bedrock									

RECORD OF BOREHOLE NO 5

WP 71-74-02 LOCATION Co-ords. N 16,817,452 E 1,024,793 ORIGINATED BY HS
 DIST 13 HWY 11 BORING DATE Dec. 1, 1976 COMPILED BY MM
 DATUM Geodetic BOREHOLE TYPE Dynamic Cone Test CHECKED BY

SOIL PROFILE			SAMPLES			GROUND WATER ELEV	DYNAMIC CONE PENETRATION RESISTANCE PLOT					LIQUID LIMIT W_L PLASTIC LIMIT W_P WATER CONTENT W W_P W W_L WATER CONTENT %	UNIT WEIGHT γ	REMARKS
ELEV DEPTH	DESCRIPTION	STRAT. PLOT	NUMBER	TYPE	'N' VALUES		20	40	60	80	100			
680.4	Ground Surface													GR SA SI CL
0.0	Sand Compact to dense (Description Inferred)					680 672.9 670 660 650 640								
635.4	End of Cone Test Probable Bedrock													And Bouncing

20
15 ϕ 5 % STRAIN AT FAILURE
10

HIGHWAY ENGINEERING DIVISION - ENGINEERING MATERIALS OFFICE - SOIL MECHANICS SECTION

RECORD OF BOREHOLE NO 6

WP 71-74-02

LOCATION Co-ords. N 16,817,367 E 1,024,803

ORIGINATED BY HS

DIST 13 HWY 11

BORING DATE Dec. 2, 1976

COMPILED BY MM

DATUM Geodetic

BOREHOLE TYPE Hollow Stem Auger, BX Casing & Cone Test

CHECKED BY

SOIL PROFILE			SAMPLES			GROUND WATER ELEV	DYNAMIC CONE PENETRATION RESISTANCE PLOT					LIQUID LIMIT — w_L PLASTIC LIMIT — w_p WATER CONTENT — w			UNIT WEIGHT γ	REMARKS
ELEV DEPTH	DESCRIPTION	STRAT. PLOT	NUMBER	TYPE	'N' VALUES		20	40	60	80	100	w_p	w	w_L		
683.9	Ground Surface															
0.0	Fine with pockets of clayey silt		1	SS	12	680										0 98 (2)
			2	SS	21											0 95 (5)
			3	SS	20											
			4	SS	15											
			5	SS	15	670										0 99 (1)
			6	SS	11											
			7	SS	14											
	Medium															
	Sand Trace of Gravel Compact to Dense					660										
						650										
						640										
834.6																
49.3	Gneiss — Weathered		8	RC	70%											
832.4	Bedrock — Sound		9	RC	100%											
51.5	End of Borehole															
	NOTE: Groundwater level, Not established															

20
15 ϕ 5 % STRAIN AT FAILURE
10

OFFICE REPORT ON SOIL EXPLORATION

RECORD OF BOREHOLE NO 7

WP 71-74-02

LOCATION Co-ords. N 16,817,296 E 1,024,810

ORIGINATED BY HS

DIST 13 HWY 11

BORING DATE Dec. 3, 1976

COMPILED BY MM

DATUM Geodetic

BOREHOLE TYPE Dynamic Cone Penetration Test

CHECKED BY

SOIL PROFILE			SAMPLES			GROUND WATER ELEV	DYNAMIC CONE PENETRATION RESISTANCE PLOT					LIQUID LIMIT — w_L PLASTIC LIMIT — w_p WATER CONTENT — w			UNIT WEIGHT γ	REMARKS		
ELEV DEPTH	DESCRIPTION	STRAT. PLOT	NUMBER	TYPE	'N' VALUES		20	40	60	80	100	SHEAR STRENGTH ○ UNCONFINED + FIELD VANE ● QUICK TRIAXIAL x LAB VANE					WATER CONTENT % w_p — w — w_L	
685.9	Ground Surface																	
0.0	Sand Compact to Dense (Description Inferred)																	
633.9																		
52.0	End of Cone Test Probable Bedrock NOTE: Groundwater level Not Established																	

20
15 — 5 % STRAIN AT FAILURE
10

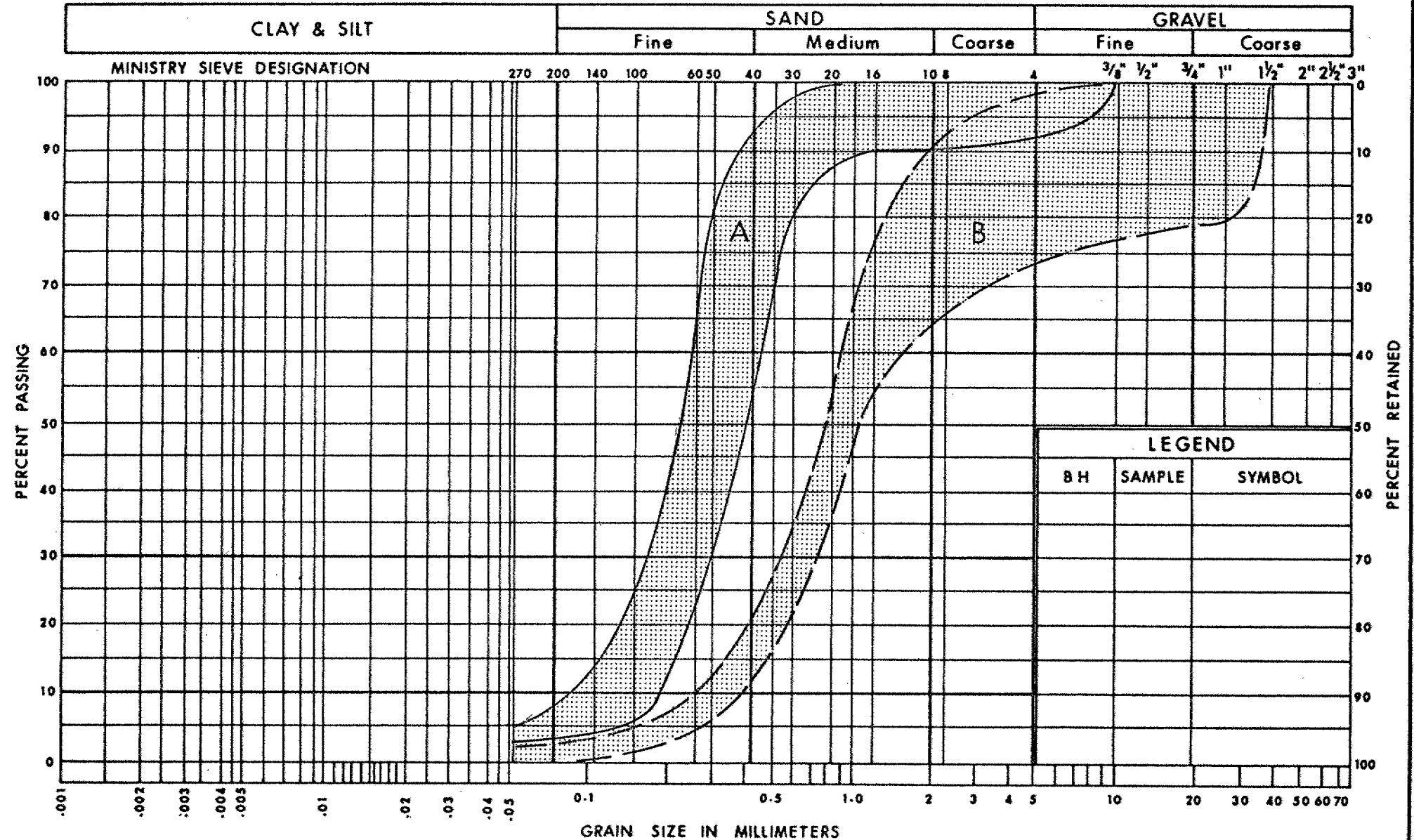
HIGHWAY ENGINEERING DIVISION - ENGINEERING MATERIALS OFFICE - SOIL MECHANICS SECTION

RECORD OF BOREHOLE NO 8

WP 71-74-02 LOCATION Co-ords. N 16,817,314 E 1,024,849 ORIGINATED BY HS
 DIST 13 HWY 11 BORING DATE Dec. 3, 1976 COMPILED BY MM
 DATUM Geodetic BOREHOLE TYPE Hollow Stem Auger and Cone Test CHECKED BY

SOIL PROFILE			SAMPLES			GROUND WATER ELEV	DYNAMIC CONE PENETRATION RESISTANCE PLOT					LIQUID LIMIT W_L PLASTIC LIMIT W_P WATER CONTENT W			UNIT WEIGHT γ	REMARKS
ELEV DEPTH	DESCRIPTION	STRAT. PLOT	NUMBER	TYPE	N' VALUES		20	40	60	80	100	W_P	W	W_L		
683.2	Ground Surface															GR SA SI CL
0.0	Sand Trace of gravel Compact to Dense Fine with pockets of clayey silt to silty clay Medium		1	SS	10	680										0 0 40 60
			2	SS	28											1 81 (18)
			3	SS	28											17 80 (3)
			4	SS	29	670										28 70 (2)
			5	SS	20											
			6	SS	19											
661.7			7	SS	18											
21.5	End of Borehole					660										
						650										
639.9																
43.3	End of Cone Probable Bedrock NOTE: Groundwater level Not established															120/3" and Bouncing

UNIFIED SOIL CLASSIFICATION SYSTEM



**Ministry of
Transportation and
Communications**

Ontario

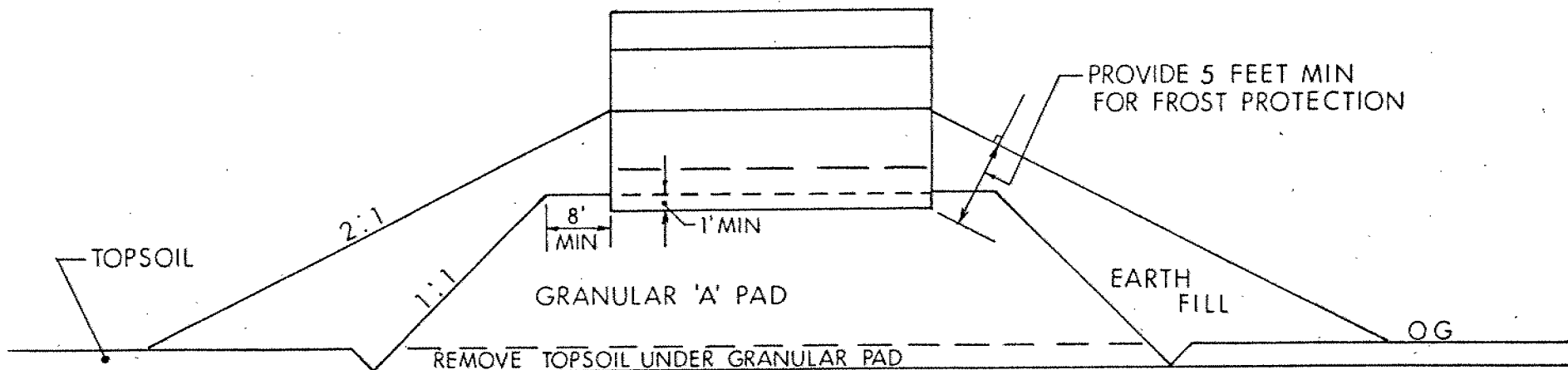
ENGINEERING SERVICES BRANCH

GRAIN SIZE DISTRIBUTION
SAND A-FINE
B-MEDIUM

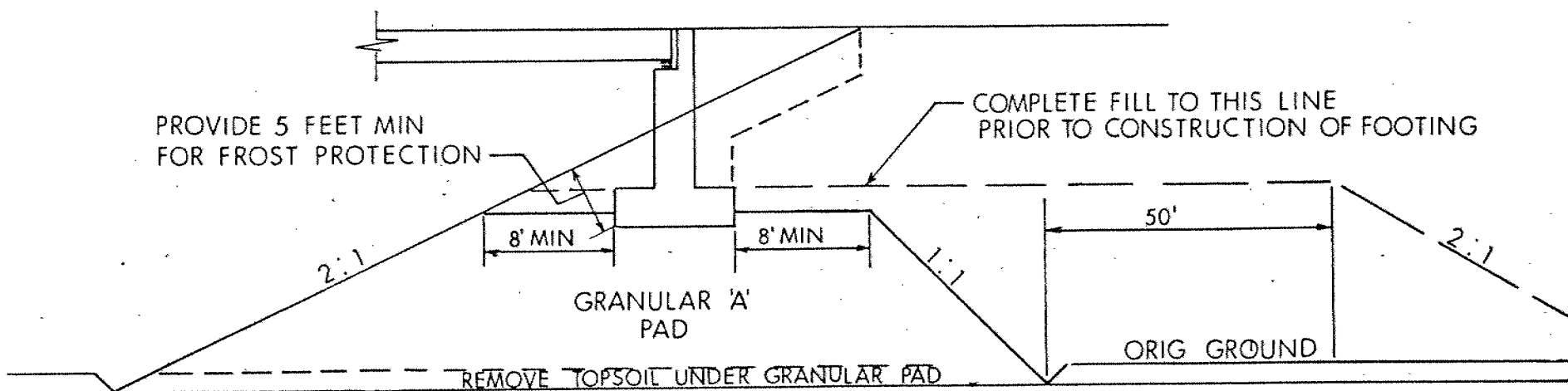
FIG No 1

WP 71-74-02

ABUTMENTS REQUIREMENTS FOUNDED ON GRANULAR PAD



X SECTION AT FACE OF ABUTMENT



LONGITUDINAL SECTION AT FACE OF WINGWALL

ABBREVIATIONS & SYMBOLS USED IN THIS REPORT

PENETRATION RESISTANCE

'N' = STANDARD PENETRATION RESISTANCE - THE NUMBER OF BLOWS REQUIRED TO ADVANCE A STANDARD SPLIT SPOON SAMPLER 12 INCHES INTO THE SUBSOIL, DRIVEN BY MEANS OF A 140 POUND HAMMER FALLING FREELY A DISTANCE OF 30 INCHES

DYNAMIC PENETRATION RESISTANCE - THE NUMBER OF BLOWS REQUIRED TO ADVANCE A 2 INCH, 60 DEGREE CONE, FITTED TO THE END OF DRILL RODS, 12 INCHES INTO THE SUBSOIL, THE DRIVING ENERGY BEING 350 FOOT POUNDS PER BLOW

DESCRIPTION OF SOIL

THE CONSISTENCY OF COHESIVE SOILS AND THE RELATIVE DENSITY OR DENSENESS OF COHESIONLESS SOILS ARE DESCRIBED IN THE FOLLOWING TERMS :-

<u>CONSISTENCY</u>	<u>CL LB/SQ. FT.</u>	<u>DENSENESS</u>	<u>'N' BLOWS / FT.</u>
VERY SOFT	0 - 250	VERY LOOSE	0 - 4
SOFT	250 - 500	LOOSE	4 - 10
FIRM	500 - 1000	COMPACT	10 - 30
STIFF	1000 - 2000	DENSE	30 - 50
VERY STIFF	2000 - 4000	VERY DENSE	> 50
HARD	> 4000		

TERMS TO BE USED IN DESCRIBING SOILS :-

TRACE < 10% , SOME 10-25% , WITH 25-40% , > 40% SILTY, SANDY, GRAVELLY, CLAYEY ETC

TYPE OF SAMPLE

S.S	SPLIT SPOON	T.W	THINWALL OPEN
W.S	WASHED SAMPLE	T.P	THINWALL PISTON
S.T.	SLOTTED TUBE SAMPLE	O.S	OESTERBERG SAMPLE
A.S.	AUGER SAMPLE	F.S	FOIL SAMPLE
C.S	CHUNK SAMPLE	R.C	ROCK CORE

P.H. SAMPLE ADVANCED HYDRAULICALLY

P.M. SAMPLE ADVANCED MANUALLY

SOIL TESTS

U	UNCONFINED COMPRESSION	L.V.	LABORATORY VANE
UU	UNCONSOLIDATED UNDRAINED TRIAXIAL	F.V	FIELD VANE
CIU	CONSOLIDATED ISOTROPIC UNDRAINED TRIAXIAL	C	CONSOLIDATION
CID	" " DRAINED "	S	SENSITIVITY
CAU	" ANISOTROPIC UNDRAINED "		
CAD	" " DRAINED "		

ABBREVIATIONS & SYMBOLS USED IN THIS REPORT

SOIL PROPERTIES

γ	UNIT WEIGHT OF SOIL (BULK DENSITY)
γ_s	UNIT WEIGHT OF SOLID PARTICLES
γ_w	UNIT WEIGHT OF WATER
γ_d	UNIT DRY WEIGHT OF SOIL (DRY DENSITY)
γ'	UNIT WEIGHT OF SUBMERGED SOIL
G	SPECIFIC GRAVITY OF SOLID PARTICLES $G = \frac{\gamma_s}{\gamma_w}$
e	VOID RATIO
n	POROSITY
w	WATER CONTENT
S_r	DEGREE OF SATURATION
w_L	LIQUID LIMIT
w_p	PLASTIC LIMIT
I_p	PLASTICITY INDEX
w_s	SHRINKAGE LIMIT
I_L	LIQUIDITY INDEX $= \frac{w - w_p}{I_p}$
I_C	CONSISTENCY INDEX $= \frac{w_L - w}{I_p}$
e_{max}	VOID RATIO IN LOOSEST STATE
e_{min}	VOID RATIO IN DENSEST STATE
I_D	DENSITY INDEX $= \frac{e_{max} - e}{e_{max} - e_{min}}$
	RELATIVE DENSITY D_r IS ALSO USED
h	HYDRAULIC HEAD OR POTENTIAL
q	RATE OF DISCHARGE
v	VELOCITY OF FLOW
i	HYDRAULIC GRADIENT
k	COEFFICIENT OF PERMEABILITY
j	SEEPAGE FORCE PER UNIT VOLUME
m_v	COEFFICIENT OF VOLUME CHANGE $= \frac{-\Delta e}{(1+e)\Delta\sigma}$
c_v	COEFFICIENT OF CONSOLIDATION
C_α	COMPRESSION INDEX $= \frac{\Delta e}{\Delta \log_{10} \sigma}$
T_v	TIME FACTOR $= \frac{c_v t}{d^2}$ (d, DRAINAGE PATH)
U	DEGREE OF CONSOLIDATION
τ_f	SHEAR STRENGTH
c'	EFFECTIVE COHESION
ϕ'	EFFECTIVE ANGLE OF SHEARING RESISTANCE, OR FRICTION
c_u	APPARENT COHESION
ϕ_u	APPARENT ANGLE OF SHEARING RESISTANCE, OR FRICTION
μ	COEFFICIENT OF FRICTION
S_t	SENSITIVITY

GENERAL

π	= 3.1416
e	BASE OF NATURAL LOGARITHMS 2.7183
$\log_e a$ OR $\ln a$	NATURAL LOGARITHM OF a
$\log_{10} a$ OR $\log a$	LOGARITHM OF a TO BASE 10
t	TIME
g	ACCELERATION DUE TO GRAVITY
V	VOLUME
W	WEIGHT
M	MOMENT
F	FACTOR OF SAFETY

STRESS AND STRAIN

u	PORE PRESSURE
σ	NORMAL STRESS
σ^t	NORMAL EFFECTIVE STRESS ($\bar{\sigma}$ IS ALSO USED)
τ	SHEAR STRESS
ϵ	LINEAR STRAIN
γ	SHEAR STRAIN
ν	POISSON'S RATIO (μ IS ALSO USED)
E	MODULUS OF LINEAR DEFORMATION (YOUNG'S MODULUS)
G	MODULUS OF SHEAR DEFORMATION
K	MODULUS OF COMPRESSIBILITY
η	COEFFICIENT OF VISCOSITY

EARTH PRESSURE

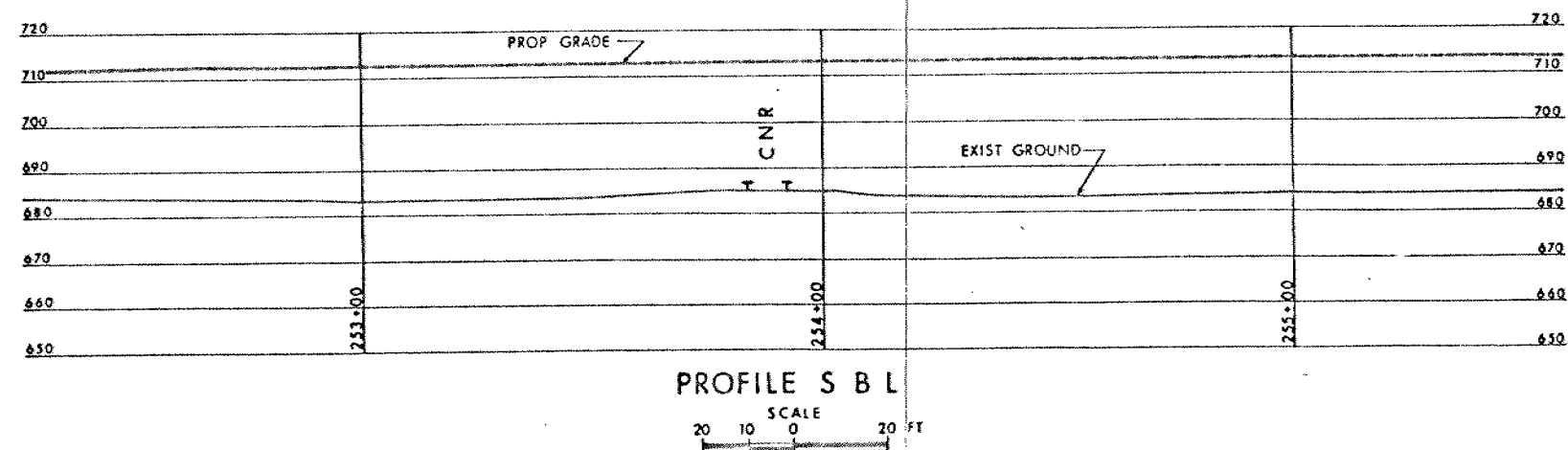
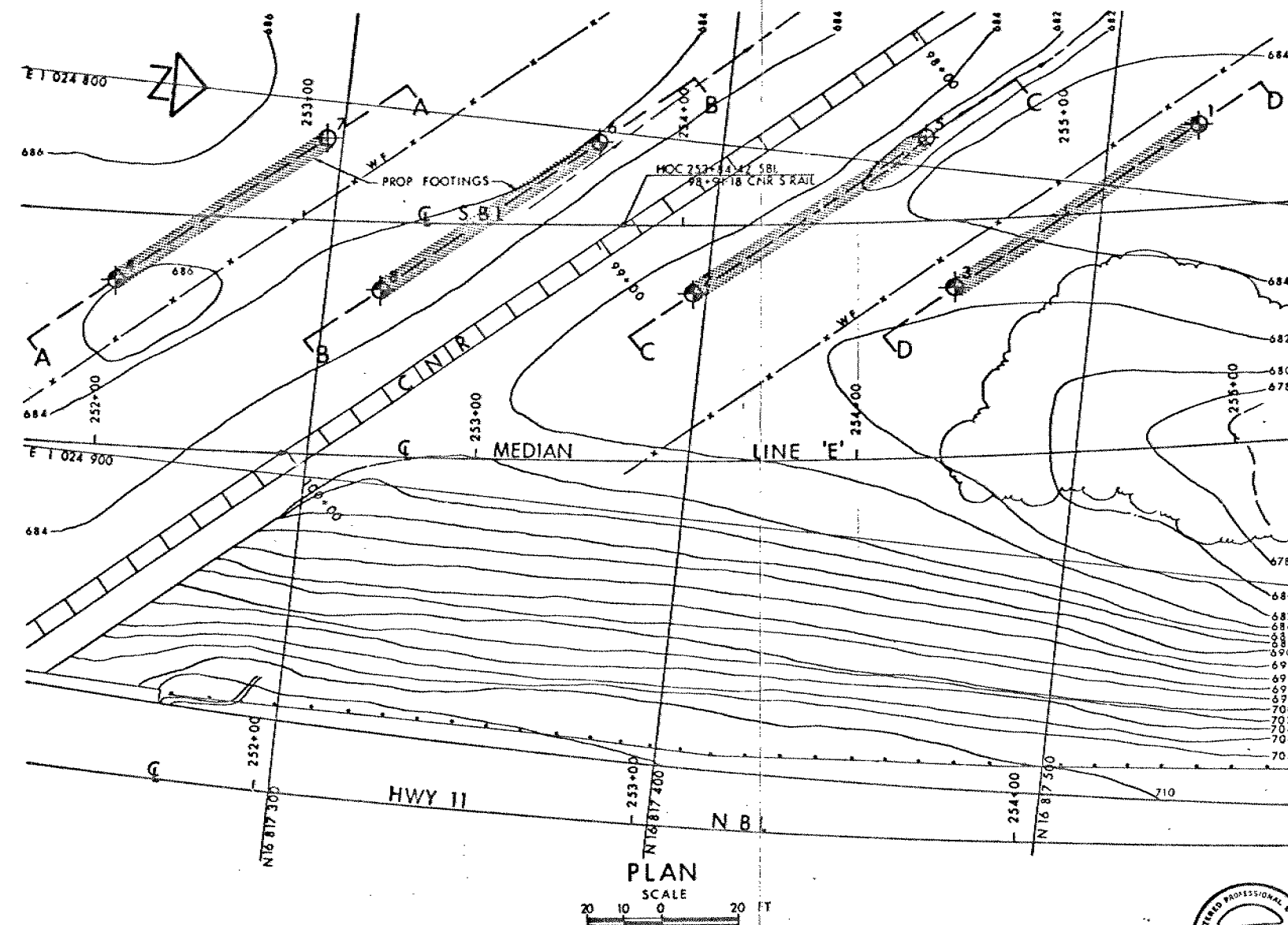
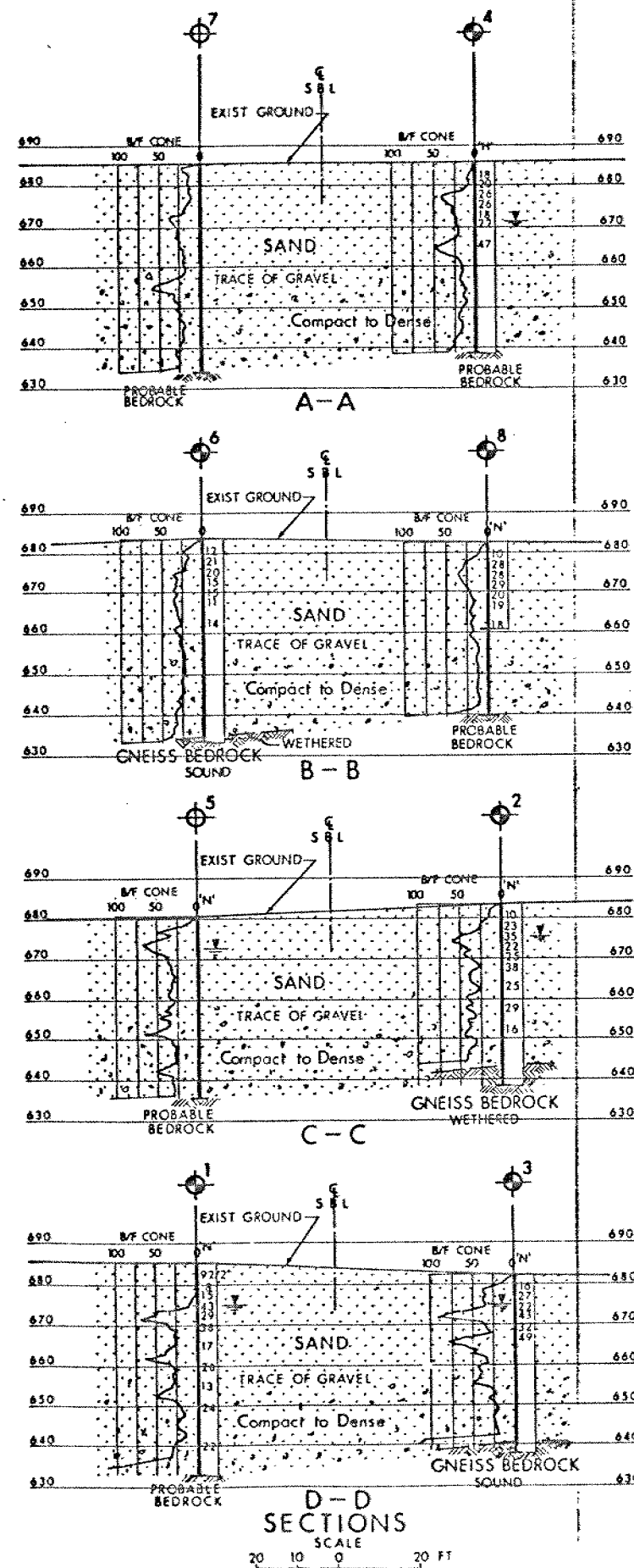
d	DISTANCE FROM TOP OF WALL TO POINT OF APPLICATION OF PRESSURE
δ	ANGLE OF WALL FRICTION
K	DIMENSIONLESS COEFFICIENT TO BE USED WITH VARIOUS SUFFIXES IN EXPRESSIONS REFERRING TO NORMAL STRESS ON WALLS
K_0	COEFFICIENT OF EARTH PRESSURE AT REST

FOUNDATIONS

B	BREADTH OF FOUNDATION
L	LENGTH OF FOUNDATION
D	DEPTH OF FOUNDATION BENEATH GROUND
N	DIMENSIONLESS COEFFICIENT USED WITH A SUFFIX APPLYING TO SPECIFIC GRAVITY, DEPTH AND COHESION ETC. IN THE FORMULA FOR BEARING CAPACITY
k_s	MODULUS OF SUBGRADE REACTION

SLOPES

H	VERTICAL HEIGHT OF SLOPE
D	DEPTH BELOW TOE OF SLOPE TO HARD STRATUM
β	ANGLE OF SLOPE TO HORIZONTAL



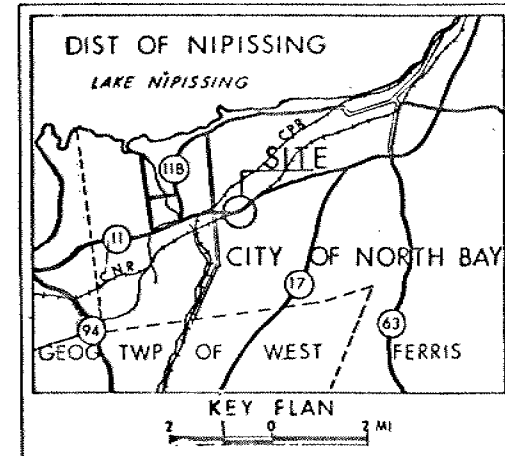
CONT No
WP No 71-74-02

PROP CROSSING CNR & HWY 11 SBL

BORE HOLE LOCATIONS & SOIL STRATA



SHEET



- LEGEND**
- Bore Hole
 - Dynamic Cone Penetration Test (Cone)
 - Bore Hole & Cone
 - Blows/ft (Std Pen Test 350 ft lbs energy)
 - CONE Blows/ft (60° Cone, 350 ft lbs energy)
 - WL at time of investigation NOV & DEC 1976
NO WL established BH No 6 & 7 & 8

No	ELEVATION	CO-ORDINATES	
		NORTH	EAST
1	685.7	16 817 523	1 024 782
2	683.3	817 396	024 841
3	682.4	817 464	024 832
4	686.5	817 245	024 853
5	680.4	817 452	024 793
6	683.9	817 367	024 803
7	685.9	817 296	024 810
8	683.2	817 314	024 849

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

REVISIONS	DATE	BY	DESCRIPTION

REF PLAN E-5068-1 JAN 1977

MAY No 11, SBL
SLANDMAN CHECKED DATE 09.02.77
EXPANDED CHECKED DATE 11.11.77
DSF 13
SITE 43-058
TWO 714 A