

G.I.-30 SEPT. 1976

GEOCRES No. 31L-41DIST. 13 REGION W.P. No. CONT. No. 80-701W. O. No. 77-50062STR. SITE No. 43-46HWY. No. LOCATION North River BridgeNo of PAGES -=====OVERSIZE DRAWINGS TO BE INCLUDED WITH THIS REPORT. REMARKS:

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NOTE: For purposes of the contract this report supercedes all other foundation reports prepared by or for the Ministry in connection with the above mentioned project.

EXPLANATION OF TERMS USED IN REPORT

'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. $\bar{C}IU$ = 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 = $\frac{I_P \text{ of soil}}{I_P \text{ of } 2\mu m \text{ Soil Fraction}}$
 O_m 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
 α_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_c OVERCONSOLIDATION RATIO (OCR)

FOUNDATION INVESTIGATION REPORT

For

North River Bridge
6.5 km East of Highway 63
W.O. 77-50062, Site 43-46
Songis Road, District 13, North Bay

INTRODUCTION

This report contains the results of a foundation investigation carried out at the above listed site from July 24, to 27, 1978. The fieldwork consisted of three sampled boreholes, one probe hole augered to refusal, and three dynamic cone penetration tests. Borings were advanced by means of continuous flight hollow stem augers, to depths from 12 to 38 feet below the existing ground surface. Bedrock was proven by obtaining up to 5 feet of BX size rock core.

SITE DESCRIPTION AND GEOLOGY

The site is located approximately 14.8 miles northeast of North Bay on Songis Road, Lot 11, Concession 1/2, Phelps Township in Nipissing District.

The North River originates some 15 miles northwest of the site and flows in a southeasterly direction with a number of tributaries joining it enroute. At the time of the field investigation the depth of water in the river varied from 0.5 to 3.0 feet. The creek bed is approximately 50 feet wide and 3 to 4 feet below the average ground surface with almost vertical banks. The river bed is strewn with boulders.

The existing structure is a six span timber bridge supported on piles.

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

Underlying the existing 2 to 4 foot thick sandy roadway fill there is a deposit of silty sand to sand with silt, the thickness of which ranges from 12 feet to 38 feet. In certain locations a layer of clayey silt to silt with slight plasticity and frequent clay seams was intercepted in the granular deposit. The thickness of the cohesive layer varies from 3 to 10 feet. The overburden is underlain by granite bedrock.

Reference should be made to the Record of Borehole Sheets which are contained in the Report Appendix. They show the boundaries between different soil types as well as a summary of all field and laboratory tests performed. Reference should also be made to Sheet 5 of the Contract Drawings which shows the location and elevation of the borings, together with a profile and sections showing inferred subsoil stratigraphy. More detailed descriptions of the major soil types encountered are given below.

Roadway Fill Material

This material is estimated to be from 2 to 4 feet thick and varies from a sand and gravel to a sand and silt. Typical grain size distribution curves for the fill material are shown on Figure 1 of the Appendix.

Standard Penetration Test 'N' values ranging from 3 to 11 indicate the fill has been subjected to poor compaction.

Silty Sand to Sand With Silt, Some Gravel

This is the predominant deposit at the site. Its thickness varies from 12 feet to 38 feet and is composed of silty sand to sand with silt, some gravel. Typical grain size distribution

of the material is shown as an envelope in Figure 2. The S.P.T. 'N' values vary randomly and considerably, ranging from 1 blow per foot to 69 blows per foot. However, the majority of the 'N' values are between 5 blows per foot and 25 blows per foot. Based on this it is estimated that the granular deposit generally has a loose to compact relative density.

In certain locations, a layer of clayey silt to silt with slight plasticity and frequent clay seams was encountered in the granular deposit. The cohesive layer has a thickness ranging from 3 to 10 feet and has a typical moisture content of 36% to 45%, a liquid limit of 30% to 40% and a plastic limit of 20% to 21%. The results of Atterberg Limit testing are plotted on the Plasticity Chart, Figure 3 indicating that the material in this layer has a low to medium plasticity. The undrained shear strength of the material as determined by field vane tests varies from 560 psf to 1600 psf indicating a consistency in the range of firm to stiff.

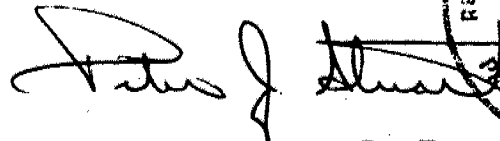
Bedrock Conditions

Underlying the sandy overburden is a granitic bedrock which was either proven by recovering BX size rock core samples or inferred from refusal to augering. The bedrock surface was found to vary from elevation 46.5 to elevation 66.8 corresponding to a depth of 12 feet to 38 feet below the ground surface. The bedrock may be described as hard and sound, with a recovery ratio and a R.Q.D. generally in excess of 90%.


Groundwater

Groundwater level observations were carried out at the time of the field investigation by measuring in the open boreholes. The observations indicate that the groundwater level is 3.0 feet to 6.5 feet below the ground surface which corresponds to a range in elevation of 74.6 feet to 78.2 feet. The water level in the river was found to be at elevation 74.5 at the

time of the foundation investigation. These observations indicate the groundwater level reflects the topography and has a slight hydraulic gradient towards the river.



Peter J. Stuart, P. Eng.
Foundations Engineer



M. Devata, P. Eng.
Senior Foundations Engineer

May 13, 1980

APPENDIX



RECORD OF BOREHOLE No 1


WO 77-50062 LOCATION Sta. 4+71, 17' Rt. of Songis Road ORIGINATED BY D.C.
DIST 13 HWY Mun. BOREHOLE TYPE Hollow Stem Auger COMPILED BY D.C.
DATUM Local DATE July 24 & 25, 1978 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 (%) |
|---------------|--|------------|---------|----------|-------------|----------------------------|-----------------|---|----|----|------------------------------------|-------------------------------------|-----------------------------------|---------------------|---|
| ELEV DEPTH | DESCRIPTION | STRAT PLOT | NUMBER | TYPE | 'N' VALUES | | | 20 | 40 | 60 | | | | | |
| 81.2 | Ground Level | | 1 | SS | 3 | | | | | | | | | | GR SA SI CL |
| 79.2 | Fill: Sand & Gravel | XX | 2 | SS | 1 | | | | | | | | | | 44 44 10 2 |
| 2.0 | Silt, Slight Plasticity Silty Sand to Sand With Silt and Gravel Occasional Boulders Very Loose to Dense | F | 3 | SS | 1 | | | | | | | | | | 0 54 40 6 |
| | | | 4 | SS | 69 | | | | | | | | | | |
| | | | 5 | SS | 32 | | | | | | | | | | |
| | | | 6 | SS | 33 | | | | | | | | | | |
| | | | 63.2 | | | | | | | | | | | | |
| 18.0 | Granite Bedrock Sound | SS | 7 | RC BX | Rec 99% | | | | | | | | | | RQD 99% |
| 56.7 | | | 8 | RC BX | Rec 100% | | | | | | | | | | RQD 100% |
| 24.5 | End of Borehole | | | | | | | | | | | | | | |



RECORD OF BOREHOLE No 2

WO 77-50062 LOCATION Sta. 4+98, 14' Rt. of Songis Road ORIGINATED BY D.C.
DIST 13 HWY Mun. BOREHOLE TYPE Solid Stem Auger COMPILED BY D.C.
DATUM Local DATE July 27, 1978 CHECKED BY _____

| SOIL PROFILE | | | SAMPLES | | | GROUND WATER CONDITIONS | ELEVATION SCALE | DYNAMIC CONE PENETRATION RESISTANCE PLOT 20 40 60 80 100 SHEAR STRENGTH ○ UNCONFINED + FIELD VANE ● QUICK TRIAXIAL x LAB VANE | PLASTIC LIMIT W _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 | | | | | | | | |
| 73.1 | Water Level | | | | | | | | | | | | |
| 0.0 | River Bottom | | | | | | | | | | | | |
| 1.0 | Augered Not Sampled | | | | | | 70 |  | | | | | |
| 59.9 | | | | | | | 60 | | | | | | |
| 13.2 | Probable Bedrock | | | | | | | | | | | | |
| | Note: Refusal to Augering at a Depth of 13.2 Feet | | | | | | | | | | | | |

OFFICE REPORT ON SOIL EXPLORATION

RECORD OF BOREHOLE No 3

WO 77-50062 LOCATION Sta. 5+28, 15' Rt. of Songis Road ORIGINATED BY D.C.
DIST 13 HWY Mun. BOREHOLE TYPE Hollow Stem Auger COMPILED BY D.C.
DATUM Local DATE July 27, 1978 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 (%) |
|---------------|--|------------|---------|------|------------|----------------------------|-----------------|---|----|----|----|-----|------------------------------------|-------------------------------------|-----------------------------------|---------------------|---|
| ELEV DEPTH | DESCRIPTION | STRAT PLOT | NUMBER | TYPE | 'N' VALUES | | | 20 | 40 | 60 | 80 | 100 | | | | | |
| 73.0 | Water Level | | | | | | | | | | | | | | | | |
| 0.0 | River Bottom | | | | | | | | | | | | | | | | |
| 1.5 | Silty Sand to Sand With Silt Some Gravel and Occasional Cobbles Compact | | 1 | SS | 14 | | 70 | | | | | | | | | | 21 57 21 1 |
| | | | 2 | SS | 18 | | | | | | | | | | | | |
| | | | 3 | SS | 14 | | 60 | | | | | | | | | | |
| | | | 4 | SS | 25 | | | | | | | | | | | | |
| | | | 5 | SS | 25 | | | | | | | | | | | | 4 75 (21) |
| 51.0 | | | 6 | SS | 13/ | 6" | | | | | | | | | | | |
| 22.0 | Probable Bedrock End of Borehole Note: Refusal to Augering at a Depth of 22 Feet | | | | | | | | | | | | | | | | |

OFFICE REPORT ON SOIL EXPLORATION

+3, x5: Numbers refer to
Sensitivity

20
15 + 5 (%) STRAIN AT FAILURE
10

RECORD OF BOREHOLE No 4

WO 77-50062 LOCATION Sta. 5+70, 22' Lt. E Songis Road ORIGINATED BY D.C.
DIST 13 HWY Mun. BOREHOLE TYPE Hollow Stem Auger COMPILED BY D.C.
DATUM Local DATE July 26, 1978 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 | | | | |
| 84.2 | Ground Level | | 1 | SS | 3 | | | | | | | | | | | |
| 0.0 | Fill: Sand and Silt | | 2 | SS | 11 | | 80 | | | | | | | | | 2 83 (15) |
| 80.2 | | | 3 | SS | 5 | | | | | | | | | | | |
| 4.0 | Silty Sand to Sand With Silt, Some Gr. | | 4 | TW | PH | | | | | | | | | | | |
| | Clayey Silt to Silt of Slight Plasticity Frequent Pockets and Seams of Clay | | 5 | TW | PH | | | | | | | | | | | |
| | | | 6 | SS | 2 | | 70 | | | | | | | | | 0 0 76 24 |
| | | | 7 | SS | 3 | | | | | | | | | | | |
| | | | 8 | SS | 25 | | | | | | | | | | | |
| | Very Loose to Compact | | 9 | SS | 22 | | 60 | | | | | | | | | 8 72 19 1 |
| | | | 10 | SS | 18 | | | | | | | | | | | |
| 46.2 | | | 11 | SS | 13 | | 50 | | | | | | | | | |
| 38.0 | Granite Bedrock | | 12 | RC | Rec | | | | | | | | | | | RQD 88% |
| 41.7 | Sound | | | BX | 88% | | | | | | | | | | | |
| 42.5 | End of Borehole | | | | | | | | | | | | | | | |

+3, x⁵: Numbers refer to
Sensitivity

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

OFFICE REPORT ON SOIL EXPLORATION



RECORD OF BOREHOLE No 5

WO 77-50062 LOCATION Sta. 4+71, 54' Lt. of Songis Road ORIGINATED BY D.C.
DIST 13 HWY Mun. BOREHOLE TYPE Hollow Stem Auger COMPILED BY D.C.
DATUM Geodetic DATE July 25, 1978 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 | | | | | |
| 81.1 | Ground Level | | 1 | SS | 4 | | | | | | | | | | | GR SA SI CL |
| 0.0 | Sand With Silt & Some Gravel | | 2 | SS | 3 | | | | | | | | | | | |
| | Silt, Slight Plasticity With Frequent Clay Seams | | 3 | SS | 2 | | | | | | | | | | | 0 16 80 4 |
| | | | 4 | SS | 8 | | | | | | | | | | | |
| 66.8 | Very Loose to Dense Probable Bedrock | | 5 | SS | 69 | | | | | | | | | | | |
| 14.3 | End of Borehole | | | | | | | | | | | | | | | |
| | Note: 1. Water Level Not Established 2. Refusal to Augering at a Depth of 14.3 Feet | | | | | | | | | | | | | | | |

OFFICE REPORT ON SOIL EXPLORATION



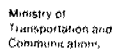
RECORD OF BOREHOLE No 6

WO 77-50062 LOCATION Sta. 4+71, 22' Lt. of Songis Road ORIGINATED BY D.C.
DIST 13 HWY Mun. BOREHOLE TYPE Cone Test COMPILED BY D.C.
DATUM Local DATE July 24 & 25, 1978 CHECKED BY

| SOIL PROFILE | | SAMPLES | | | GROUND WATER CONDITIONS | ELEVATION SCALE | DYNAMIC CONE PENETRATION RESISTANCE PLOT 20 40 60 80 100 SHEAR STRENGTH ○ UNCONFINED + FIELD VANE ● QUICK TRIAXIAL x LAB VANE | PLASTIC LIMIT W _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 | | | | | | | | |
| 82.5 | Ground Level | | | | | | | | | | | |
| 0.0 | | | | | | 80 | | | | | | |
| | | | | | | 70 | | | | | | |
| 66.5 | | | | | | | | | | | | |
| 16.0 | End of Cone Test | | | | | | | | | | | |

+3, x5 : Numbers refer to
Sensitivity

20
15 5 (%) STRAIN AT FAILURE
10



WO 77-50062 LOCATION Sta. 5470, 14' Rt. @ Songis Road ORIGINATED BY D.C.
DIST 13 HWY Mun. BOREHOLE TYPE Cone Test COMPILED BY D.C.
DATUM Local DATE July , 1978 CHECKED BY _____

| SOIL PROFILE | | SAMPLES | | | GROUND WATER CONDITIONS | ELEVATION SCALE | DYNAMIC CONE PENETRATION RESISTANCE PLOT | | PLASTIC NATURAL LIQUID LIMIT MOISTURE LIMIT CONTENT | | | UNIT WEIGHT Y | REMARKS & GRAIN SIZE DISTRIBUTION (%) GR SA SI CL |
|---------------|------------------|------------|--------|------|----------------------------|-----------------|---|-----------------|---|-------------------|--|-------------------------|--|
| ELEV DEPTH | DESCRIPTION | STRAT PLOT | NUMBER | TYPE | | | 'N' VALUES | 20 40 60 80 100 | Wp W Wl | WATER CONTENT (%) | | | |
| 83.7 | Ground Level | | | | | | | | | | | | |
| 0.0 | | | | | | | | | | | | | |
| 50.7 | | | | | | | | | | | | | |
| 33.0 | End of Cone Test | | | | | | | | | | | | |

⁺₃, ⁺₅ : Numbers refer to Sensitivity

20
15 ϕ 5 (%) STRAIN AT FAILURE
10

OFFICE. REPORT ON SOIL EXPLORATION



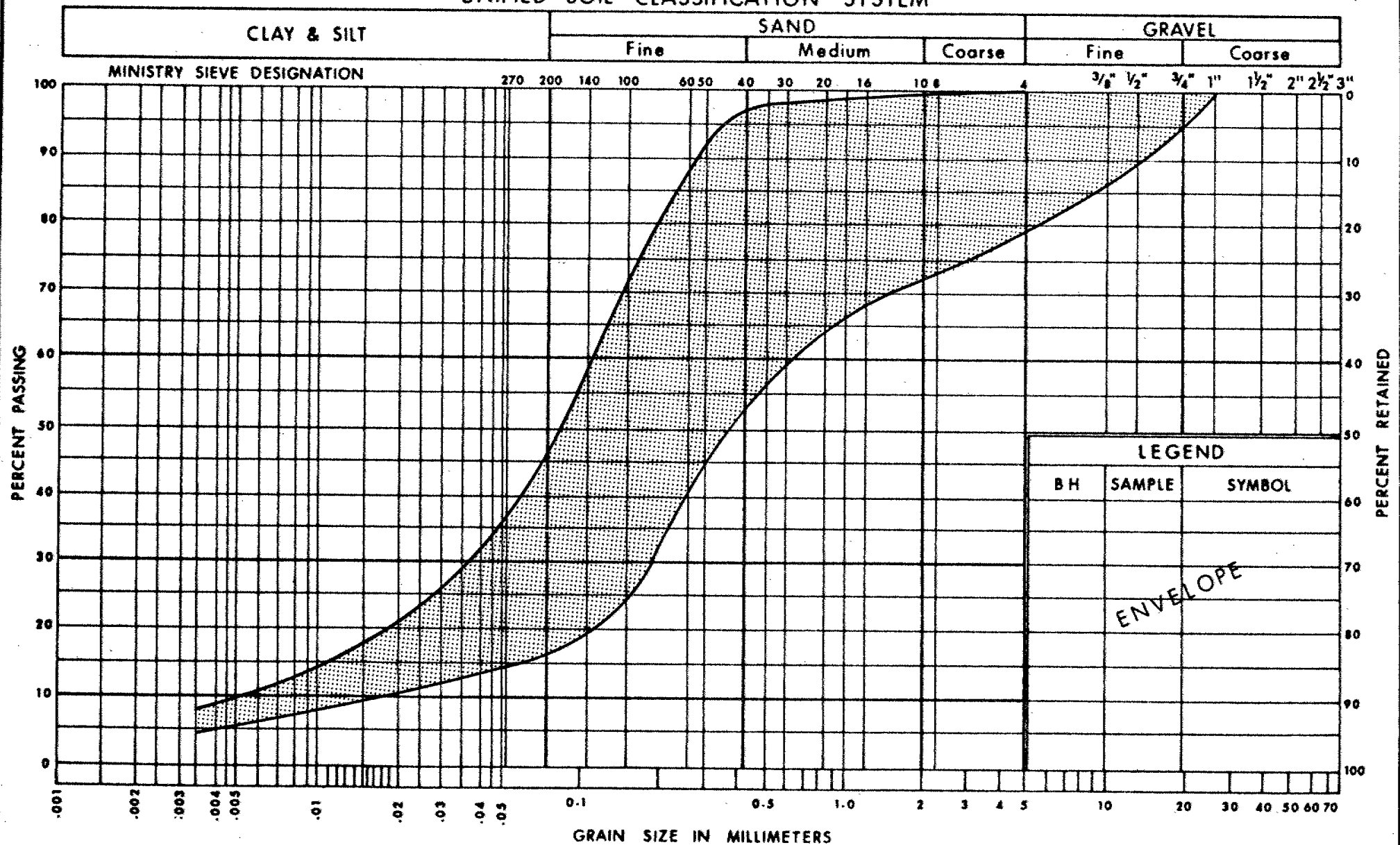
WO 77 - 50062



Ontario

**Ministry of
Transportation and
Communications**

UNIFIED SOIL CLASSIFICATION SYSTEM

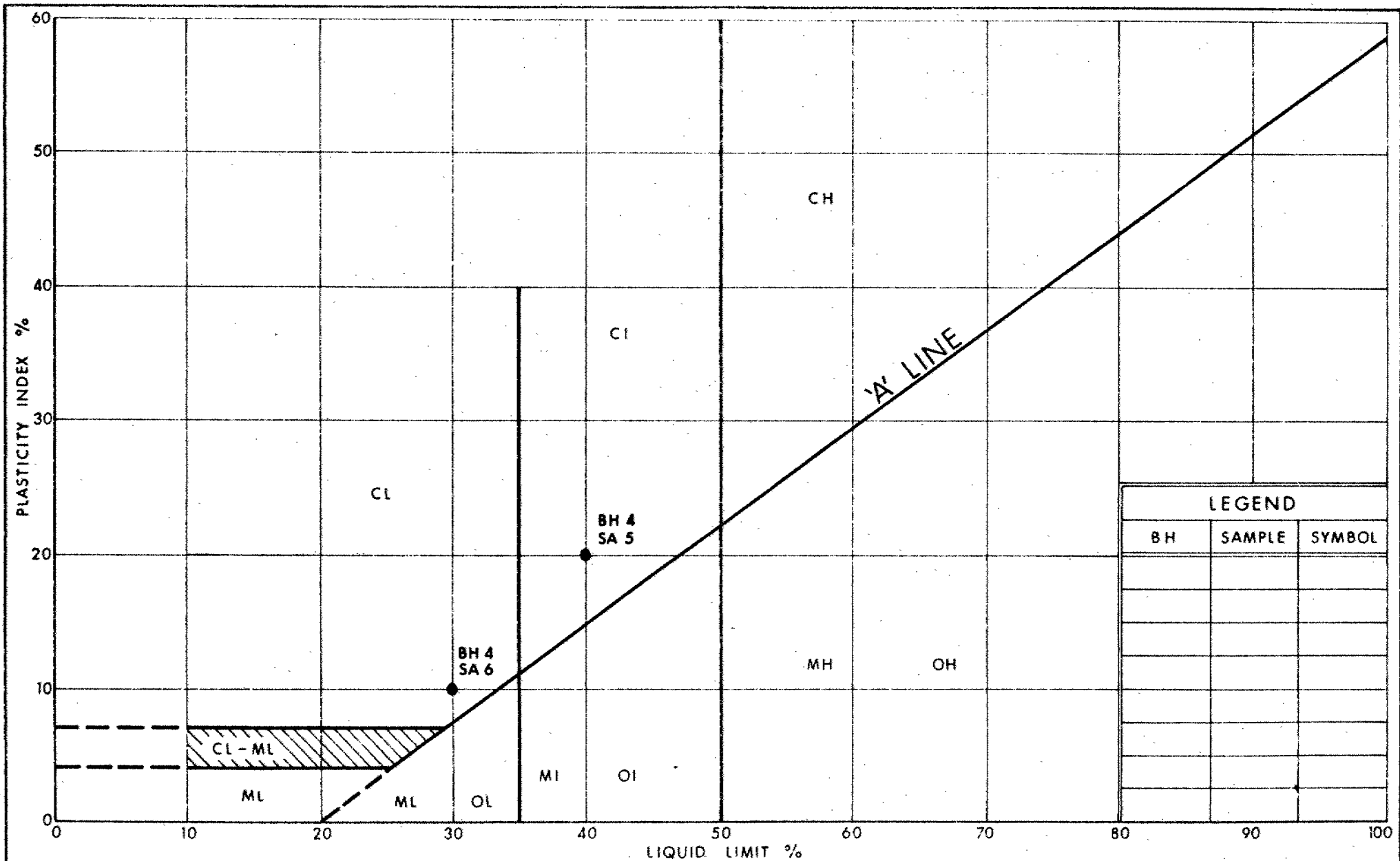


Ministry of
Transportation and
Communications

GRAIN SIZE DISTRIBUTION
SILTY SAND TO SAND
WITH SILT, SOME GRAVEL

FIG No 2

W O 77-50062



Ontario

 Ministry of
Transportation and
Communications

PLASTICITY CHART CLAYEY SILT TO SILT OF SLIGHT PLASTICITY

FIG No 3

WO 77-50062

ENGINEERING MATERIALS OFFICE
SOIL MECHANICS SECTION

WO 77-50062 DIST 13
HWY N/A STR SITE 43-46
North River Bridge

DISTRIBUTION

J.C. McAllister (2)
W.J. Peck
S. McCombie
J.M. Bernhardt (2)

E. Van Beilen
G.A. Wrong
B.J. Giroux
R.S. Pillar

R. Hore

L. Argo)
J. Anderson) cover only
G. Sloan)

Files ✓

| SAMPLE DISPOSITION NOTICE | | |
|---------------------------|---------------|------------|
| TYPE | DISCARD AFTER | RECOMM. BY |
| JARS | 78 09 30 | BL |
| TUBES | 78 09 30 | BL |
| ROCK CORES | 78 09 30 | BL |

FOUNDATION INVESTIGATION REPORT

For

North River Bridge
Lot 11, Con. 1/2, Phelps Township
W.O. 77-50062, Site 43-46
Songis Road, District 13, North Bay

INTRODUCTION

This report contains the results of a foundation investigation carried out from July 24, 1978 to July 27, 1978 by the Soil Mechanics Section at the above mentioned site. The fieldwork consisted of three sampled boreholes, one probe hole augered to refusal, and three dynamic cone penetration tests. Borings were advanced by means of continuous flight hollow stem augers to depths of 12 to 38 feet below the existing ground surface. Bedrock was proven by obtaining up to 5 feet of BX size rock core samples.

SITE DESCRIPTION AND GEOLOGY

The site is located approximately 14.8 miles northeast of North Bay on Songis Road, Lot 11, Concession 1/2, Phelps Township in Nipissing District.

The North River originates some 15 miles northwest of the site and flows in a southeasterly direction with a number of tributaries joining it enroute. At the time of the field investigation the depth of water in the river varied from 0.5 to 3.0 feet. The creek bed is approximately 50 feet wide and 3 to 4 feet below the average ground surface with almost vertical banks. The river bed is strewn with boulders.

The existing structure is a six span timber bridge supported on piles.

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

Underneath the existing 2 to 4 foot thick sandy roadway fill material the site is underlain by a deposit of silty sand to sand with silt, the thickness of which ranges from 12 feet to 38 feet. In certain locations a layer of clayey silt to silt with slight plasticity and frequent clay seams was intercepted in the granular deposit. The thickness of the cohesive layer varies from 3 to 10 feet approximately. The overburden is underlain by granite bedrock.

Detailed descriptions of the various subsoil encountered are shown in the Borehole Record Sheets. The location and elevation of the borings are shown on Drawing No. 77-50062A. Stratigraphical sections based on borehole data are shown on Drawing No. 77-50062B. A description of the subsoil conditions is as follows.

Roadway Fill Material

This material is estimated to be from 2 to 4 feet thick and varies from a sand and gravel to a sand and silt. Typical grain size distribution curves for the fill material are shown on Figure 1 of the Appendix.

Standard Penetration Test 'N' values ranging from 3 to 11 indicate the fill has been subjected to poor compaction.

Silty Sand to Sand With Silt, Some Gravel

This is the predominant deposit at the site. Its thickness varies from 12 feet to 38 feet and it is composed of silty sand to sand with silt, some gravel. Typical grain size distribution of the material is shown in an envelope form on Figure 2. The S.P.T. 'N' values vary randomly and considerably, ranging from 1 blow per foot to 69 blows per foot. However, the majority of the 'N' values are between 5 blows per foot and 25 blows per foot. Based on this it is estimated that the granular deposit generally has a loose to compact relative density.

In certain locations, a layer of clayey silt to silt with slight plasticity and frequent clay seams was encountered in the granular deposit. The cohesive layer has a thickness ranging from 3 to 10 feet and has a typical moisture content of 36% to 45%, a liquid limit of 30% to 40% and a plastic limit of 20% to 21%. The

results of the Atterberg limit testing are also plotted on the Plasticity Chart, Figure 3 indicating that the material in this layer has a low to medium plasticity. The undrained shear strength of the material as determined by field vane tests varies from 560 psf to 1600 psf indicating a consistency in the range of firm to stiff.

Bedrock Conditions

Underlying the sandy overburden is a granitic bedrock which is either proven by recovering BX size rock core samples or inferred from refusal to augering. Bedrock surface was found to vary from elevation 46.5 to elevation 66.8 corresponding to a depth of 12 feet to 38 feet below the ground surface. The bedrock may be described as hard and sound, with a recovery ratio and a R.Q.D. generally in excess of 90%.

Groundwater

Groundwater level observations were carried out at the time of the field investigation by measuring in the open boreholes. The observations indicate that the groundwater level is 3.0 feet to 6.5 feet below the ground surface which corresponds to a range in elevation of 74.6 feet to 78.2 feet. The water level in the river was found to be at elevation 74.5 at the time of the foundation investigation. These observations indicate the groundwater level reflects the topography and has a slight hydraulic gradient towards the river.

DISCUSSION AND RECOMMENDATIONS

The Ministry is considering to replace the existing timber bridge at the crossing of Songis Road and the North River, on Lot 11, Conc. 1/2 of Phelps Township. The proposed scheme calls for a 90 foot long structure consisting of three 30 foot spans. The reconstruction will also incorporate a raise in the profile grade of Songis Road in the order of two feet.

Our recommendations for the structure foundations and the related earthworks are as follows.

Structure Foundations

The overburden material will not provide adequate support to found the structure on spread footings without excessive differential settlements. In light of this it is recommended that the proposed new structure be supported on end bearing steel H piles or tube piles driven to bedrock surface. These piles can be designed for their maximum allowable structural capacity. Due to the sloping nature of the bedrock surface and its variable elevation the piles should be fitted with Oslo points and installed in the appropriate manner according to M.T.C. specifications to ensure proper keying of the piles into the bedrock. The following elevations are provided for the estimation of pile lengths.

| <u>Foundation</u> | <u>Estimated Pile Tip Elevation (Local Datum)</u> |
|-------------------|---|
| West Abutment | 66 feet (north side) |
| | 63 feet (south side) |
| West Pier | 60 feet |
| East Pier | 51 feet |
| East Abutment | 46 feet (north side) |
| | 50 feet (south side) |

The pile caps should have a minimum of 6 feet of earth cover for frost protection purposes.

A temporary dewatering scheme may be required for the construction of the pier pile caps if they are situated below the water level. Dewatering can be achieved by means of interlocking steel sheeting. However, dewatering may not be required if the piers are supported by tube piles which extend above the water level and are capped at the underside of the bridge deck.

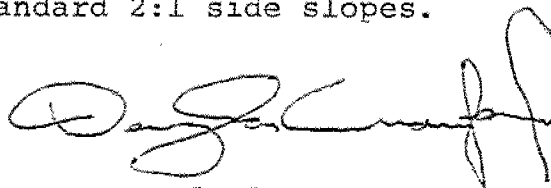
To prevent the build-up of hydrostatic pressure behind the abutment, free draining granular material should be used for backfill behind the retaining wall as per current M.T.C. standards. For estimating the earth pressure on the abutments due to the granular backfill a coefficient of active earth pressure (K_a) of 0.3 may be used if some movement at the top of the abutment is permitted, whereas if no movement at the top of the abutment is anticipated a coefficient of earth pressure at rest (k_o) of 0.5 may be used for design purposes.

Approaches

The profile grade is to be raised by only two feet. No stability problems for the approaches are anticipated.

Detour

According to the Region a temporary detour will be required during construction of the structure. The detour is to be constructed some 50 feet north of Songis Road. It is understood that the profile grade of the detour will be kept to an elevation not higher than the existing roadway. If such is the case, the detour can be constructed with standard 2:1 side slopes.



D. Crawford
Student Technician

B. Ly
B. Ly, P. Eng.
Senior Engineer

September, 1978

APPENDIX



RECORD OF BOREHOLE No 1

WO 77-50062 LOCATION Sta. 4+71, 17' Rt. of Songis Road ORIGINATED BY D.C.
DIST 13 HWY Mun. BOREHOLE TYPE Hollow Stem Auger COMPILED BY D.C.
DATUM Local DATE July 24 & 25, 1978 CHECKED BY _____

| SOIL PROFILE | | | SAMPLES | | | GROUND WATER CONDITIONS | ELEVATION SCALE | DYNAMIC CONE PENETRATION RESISTANCE PLOT | | | | | PLASTIC LIMIT Wp | NATURAL MOISTURE CONTENT W | LIQUID LIMIT Wl | UNIT WEIGHT γ | REMARKS & GRAIN SIZE DISTRIBUTION (%) | | | |
|---------------|--|------------|---------|----------|-------------|----------------------------|-----------------|--|----|--|--|--|------------------------|-------------------------------------|-----------------------|---------------------|---|-------------------|--|---------|
| ELEV DEPTH | DESCRIPTION | STRAT PLOT | NUMBER | TYPE | 'N' VALUES | | | SHEAR STRENGTH | | | | | | | | | | WATER CONTENT (%) | | |
| | | | | | | | | ○ UNCONFINED + FIELD VANE ● QUICK TRIAXIAL x LAB VANE | | | | | | | | | | 10 20 30 | | |
| 81.2 | Ground Level | | 1 | SS | 3 | | 80 | | | | | | | | | | GR SA SI CL 44 44 10 2 | | | |
| 79.2 | Fill: Sand & Gravel | X | 2 | SS | 1 | | | | | | | | | | | | | | | |
| 2.0 | Silt, Slight Plasticity Silty Sand to Sand With Silt and Gravel Occasional Boulders Very Loose to Dense | | 3 | SS | 1 | | | | | | | | | | | | | 0 54 40 6 | | |
| | | | 4 | SS | 69 | | | | | | | | | | | | | | | |
| | | | 5 | SS | 32 | | | | | | | | | | | | | | | |
| | | | 6 | SS | 33 | | | | | | | | | | | | | | | |
| 63.2 | | | | | | | | 70 | | | | | | | | | | | | |
| 18.0 | Granite Bedrock Sound | | 7 | RC BX | Rec 99% | | | | 60 | | | | | | | | | | | RQD 99% |
| 56.7 | | | 8 | RC LX | Rec 100% | | | | | | | | | | | | RQD 100% | | | |
| 24.5 | End of Borehole | | | | | | | | | | | | | | | | | | | |

+³, x⁵: Numbers refer to
Sensitivity

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



RECORD OF BOREHOLE No 2

WO 77-50062 LOCATION Sta. 4+98, 14' Rt. of Songis Road ORIGINATED BY D.C.
DIST 13 HWY Mun. BOREHOLE TYPE Solid Stem Auger COMPILED BY D.C.
DATUM Local DATE July 27, 1978 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 (%) GR SA SI CL |
|---------------|---|------------|---------|------|------------|----------------------------|--------------------|---|----|----|----|-----|------------------------------------|-------------------------------------|-----------------------------------|---------------------|--|
| ELEV DEPTH | DESCRIPTION | STRAT PLOT | NUMBER | TYPE | 'N' VALUES | | | 20 | 40 | 60 | 80 | 100 | | | | | |
| 73.1 | Water Level | | | | | | | | | | | | | | | | |
| 0.0 | River Bottom | | | | | | | | | | | | | | | | |
| 1.0 | Augered | | | | | | | | | | | | | | | | |
| | Not Sampled | | | | | | | | | | | | | | | | |
| 59.9 | | | | | | | | | | | | | | | | | |
| 13.2 | Probable Bedrock | | | | | | | | | | | | | | | | |
| | Note: Refusal to Augering at a Depth of 13.2 Feet | | | | | | | | | | | | | | | | |

+3, x⁵: Numbers refer to
Sensitivity

20
15-5 (%) STRAIN AT FAILURE
10



RECORD OF BOREHOLE No 3

WO 77-50062 LOCATION Sta. 5+28, 15' Rt. of Songis Road ORIGINATED BY D.C.
DIST 13 HWY Mun. BOREHOLE TYPE Hollow Stem Auger COMPILED BY D.C.
DATUM Local DATE July 27, 1978 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 | | | | | |
| 73.0 | Water Level | | | | | | | | | | | | | | | | |
| 0.0 | River Bottom | | | | | | | | | | | | | | | | |
| 1.5 | Silty Sand to Sand With Silt Some Gravel and Occasional Cobbles Compact | | 1 | SS | 14 | | 70 | | | | | | | o | | | 21 57 21 1 |
| | | | 2 | SS | 18 | | | | | | | | | | | | |
| | | | 3 | SS | 14 | | 60 | | | | | | | | | | |
| | | | 4 | SS | 25 | | | | | | | | | | | | |
| | | | 5 | SS | 25 | | | | | | | | | o | | | 4 75 (21) |
| 51.0 | | | 6 | SS | 13/ | 6" | | | | | | | | | | | |
| 22.0 | Probable Bedrock End of Borehole Note: Refusal to Augering at a Depth of 22 Feet | | | | | | | | | | | | | | | | |

+3, x5: Numbers refer to
Sensitivity

20
15 5 (%) STRAIN AT FAILURE
10



RECORD OF BOREHOLE No 4

WO 77-50062 LOCATION Sta. 5+70, 22' Lt. E Songis Road ORIGINATED BY D.C.
DIST 13 HWY Mun. BOREHOLE TYPE Hollow Stem Auger COMPILED BY D.C.
DATUM Local DATE July 26, 1978 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 | | | | | | | | | |
| | | | | | | | | SHEAR STRENGTH | | | | | WATER CONTENT (%) | | | | |
| | | | | | | | | | | | | | | | | | |
| 84.2 | Ground Level | | 1 | SS | 3 | | | | | | | | | | | | |
| 0.0 | Fill: Sand and Silt | | 2 | SS | 11 | | | | | | | | | | | | 2 83 (15) |
| 80.2 | | | 3 | SS | 5 | | | | | | | | | | | | |
| 4.0 | Silty Sand to Sand With Silt, Some Gr. | | 4 | TW | PH | | | | | | | | | | | | |
| | Clayey Silt to Silt of Slight Plasticity Frequent Pockets and Seams of Clay | | 5 | TW | PH | | | | | | | | | | | | |
| | | | 6 | SS | 2 | | | | | | | | | | | | 0 0 76 24 |
| | | | 7 | SS | 3 | | | | | | | | | | | | |
| | | | 8 | SS | 25 | | | | | | | | | | | | |
| | Very Loose to Compact | | 9 | SS | 22 | | | | | | | | | | | | |
| | | | 10 | SS | 18 | | | | | | | | | | | | 8 72 19 1 |
| | | | 11 | SS | 13 | | | | | | | | | | | | |
| 46.2 | | | 12 | RC | Rec | | | | | | | | | | | | |
| 38.0 | Granite Bedrock | | | BX | 88% | | | | | | | | | | | | RQD 88% |
| 41.7 | Sound | | | | | | | | | | | | | | | | |
| 42.5 | End of Borehole | | | | | | | | | | | | | | | | |

+3, x5: Numbers refer to
Sensitivity

20
15 5 (%) STRAIN AT FAILURE
10

OFFICE REPORT ON SOIL EXAMINATION



RECORD OF BOREHOLE No 5

WO 77-50062 LOCATION Sta. 4+71, 54' Lt. of Songis Road ORIGINATED BY D.C.
DIST 13 HWY Mun. BOREHOLE TYPE Hollow Stem Auger COMPILED BY D.C.
DATUM Geodetic DATE July 25, 1978 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 | | | | | |
| 81.1 | Ground Level | | 1 | SS | 4 | | 80 | | | | | | | | | | |
| 0.0 | Sand With Silt & Some Gravel | | 2 | SS | 3 | | | | | | | | | | | | |
| | Silt, Slight Plasticity With Frequent Clay Seams | | 3 | SS | 2 | | | | | | | | | | | | |
| | | | 4 | SS | 8 | | | | | | | | | | | | |
| 66.8 | Very Loose to Dense Probable Bedrock | | 5 | SS | 69 | | 70 | | | | | | | | | | 0 16 80 4 |
| 14.3 | End of Borehole Note: 1. Water Level Not Established 2. Refusal to Augering at a Depth of 14.3 Feet | | | | | | | | | | | | | | | | |

*3, x5: Numbers refer to
Sensitivity

20
15 5 (%) STRAIN AT FAILURE
10

RECORD OF BOREHOLE No 6

WO 77-50062 LOCATION Sta. 4+71, 22' Lt. of Songis Road ORIGINATED BY D.C.
DIST 13 HWY Mun. BOREHOLE TYPE Cone Test COMPILED BY D.C.
DATUM Local DATE July 24 & 25, 1978 CHECKED BY _____

| SOIL PROFILE | | | SAMPLES | | | GROUND WATER CONDITIONS | ELEVATION SCALE | DYNAMIC CONE PENETRATION RESISTANCE PLOT | | PLASTIC LIMIT NATURAL MOISTURE CONTENT LIQUID LIMIT | | | UNIT WEIGHT γ | REMARKS & GRAIN SIZE DISTRIBUTION (%) |
|---------------|------------------|------------|---------|------|------------|----------------------------|-----------------|---|----|---|----|-----|----------------------------|---|
| ELEV DEPTH | DESCRIPTION | STRAT PLOT | NUMBER | TYPE | 'N' VALUES | | | 20 | 40 | 60 | 80 | 100 | | |
| 82.5 | Ground Level | | | | | | | | | | | | | |
| 0.0 | | | | | | | 80 | | | | | | | |
| 66.5 | | | | | | | 70 | | | | | | | |
| 16.0 | End of Cone Test | | | | | | | | | | | | | |

+3, x5 : Numbers refer to Sensitivity

15 ϕ 5 (%) STRAIN AT FAILURE

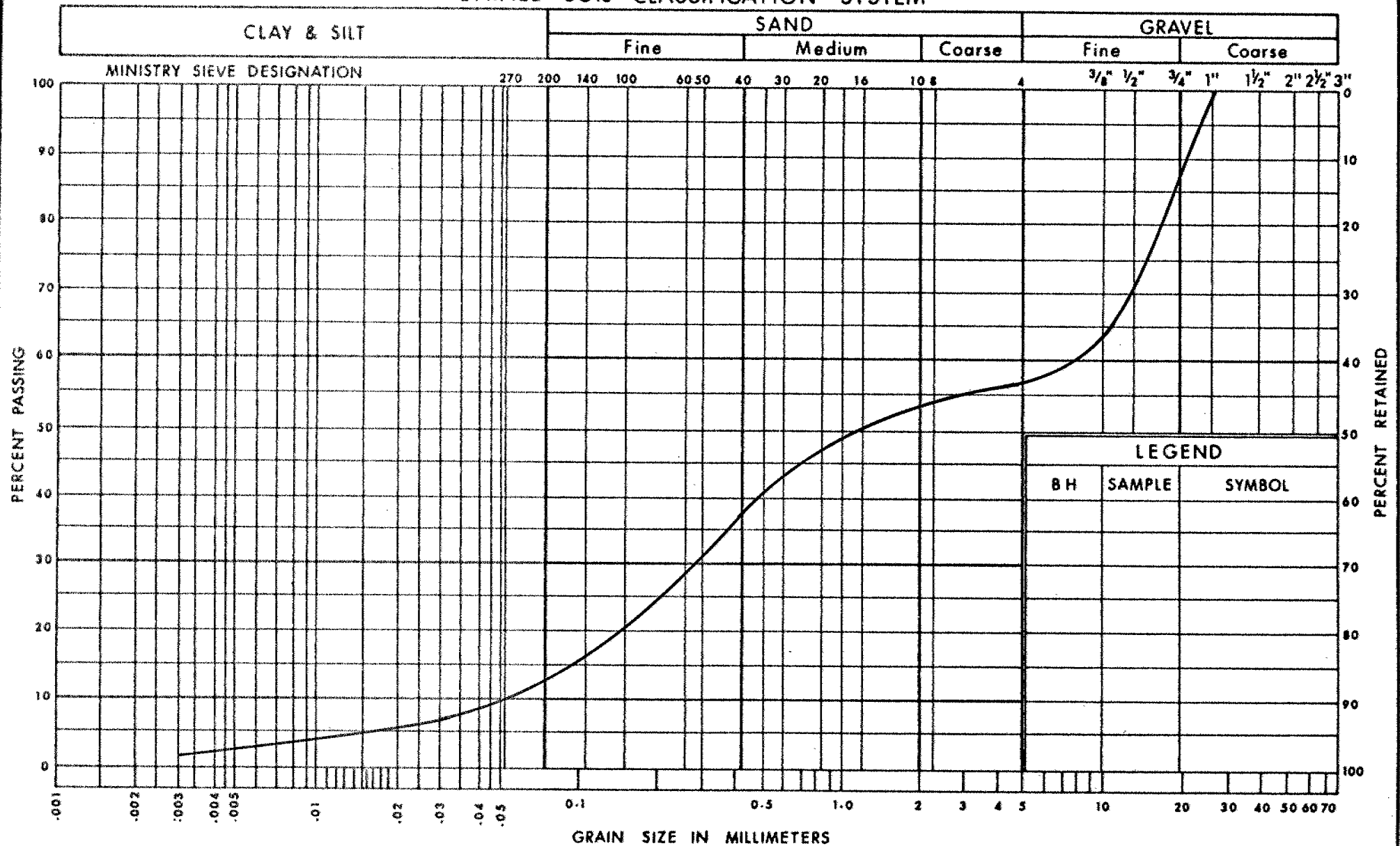


RECORD OF BOREHOLE No 7

WO 77-50062 LOCATION Sta. 5+70, 14' Rt. @ Songis Road ORIGINATED BY D.C.
DIST 13 HWY Mun. BOREHOLE TYPE Cone Test COMPILED BY D.C.
DATUM Local DATE July, 1978 CHECKED BY _____

| SOIL PROFILE | | | SAMPLES | | | GROUND WATER CONDITIONS | ELEVATION SCALE | DYNAMIC CONE PENETRATION RESISTANCE PLOT 20 40 60 80 100 SHEAR STRENGTH ○ UNCONFINED + FIELD VANE ● QUICK TRIAXIAL x LAB VANE | PLASTIC LIMIT W _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 | | | | | | | | |
| 83.7 0.0 | Ground Level | | | | | | | | | | | | |
| 50.7 | | | | | | | | | | | | | |
| 33.0 | End of Cone Test | | | | | | | | | | | | |

UNIFIED SOIL CLASSIFICATION SYSTEM



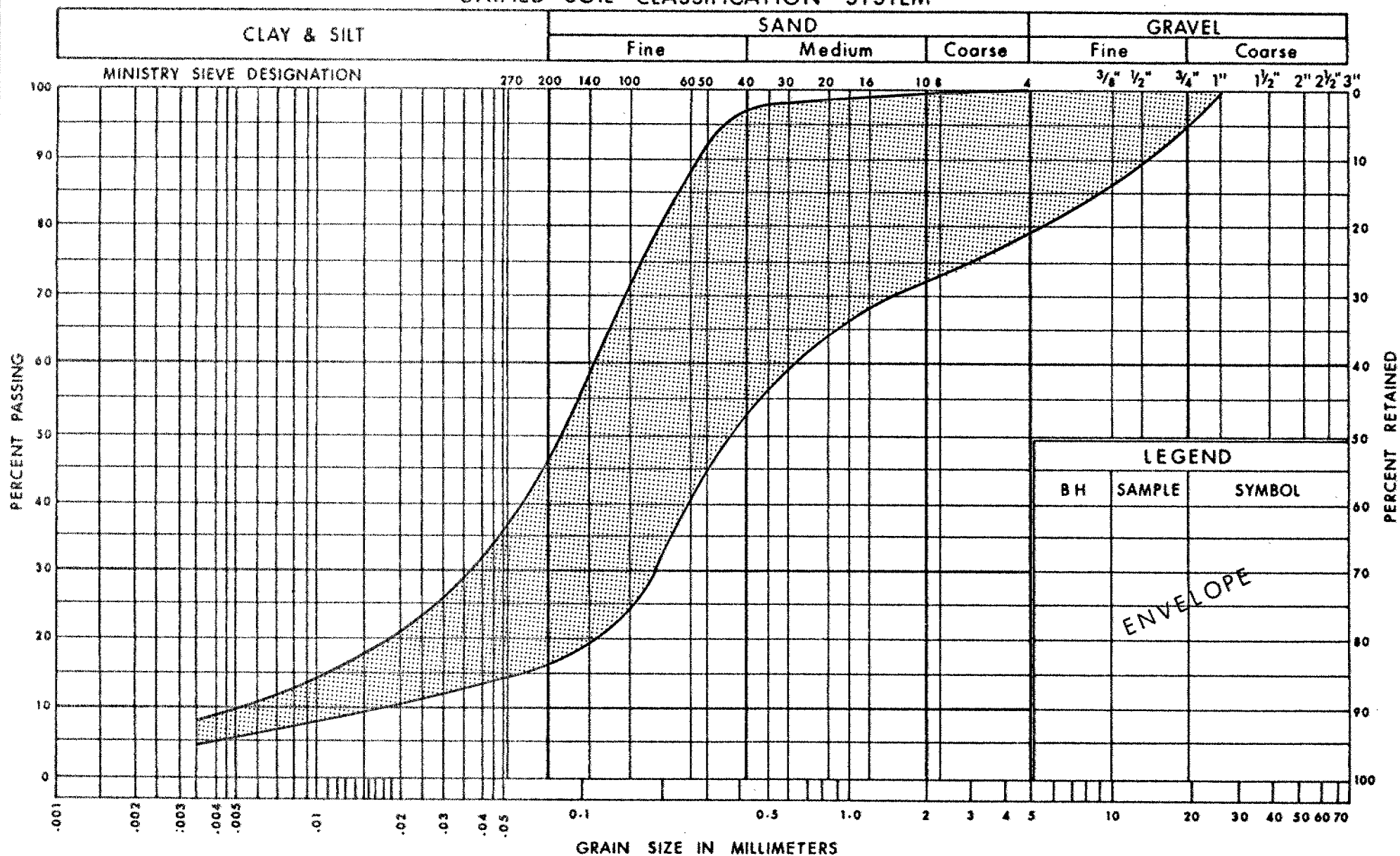
Ministry of
Transportation and
Communications

GRAIN SIZE DISTRIBUTION
FILL
SAND & GRAVEL

FIG No 1

WO 77-50062

UNIFIED SOIL CLASSIFICATION SYSTEM



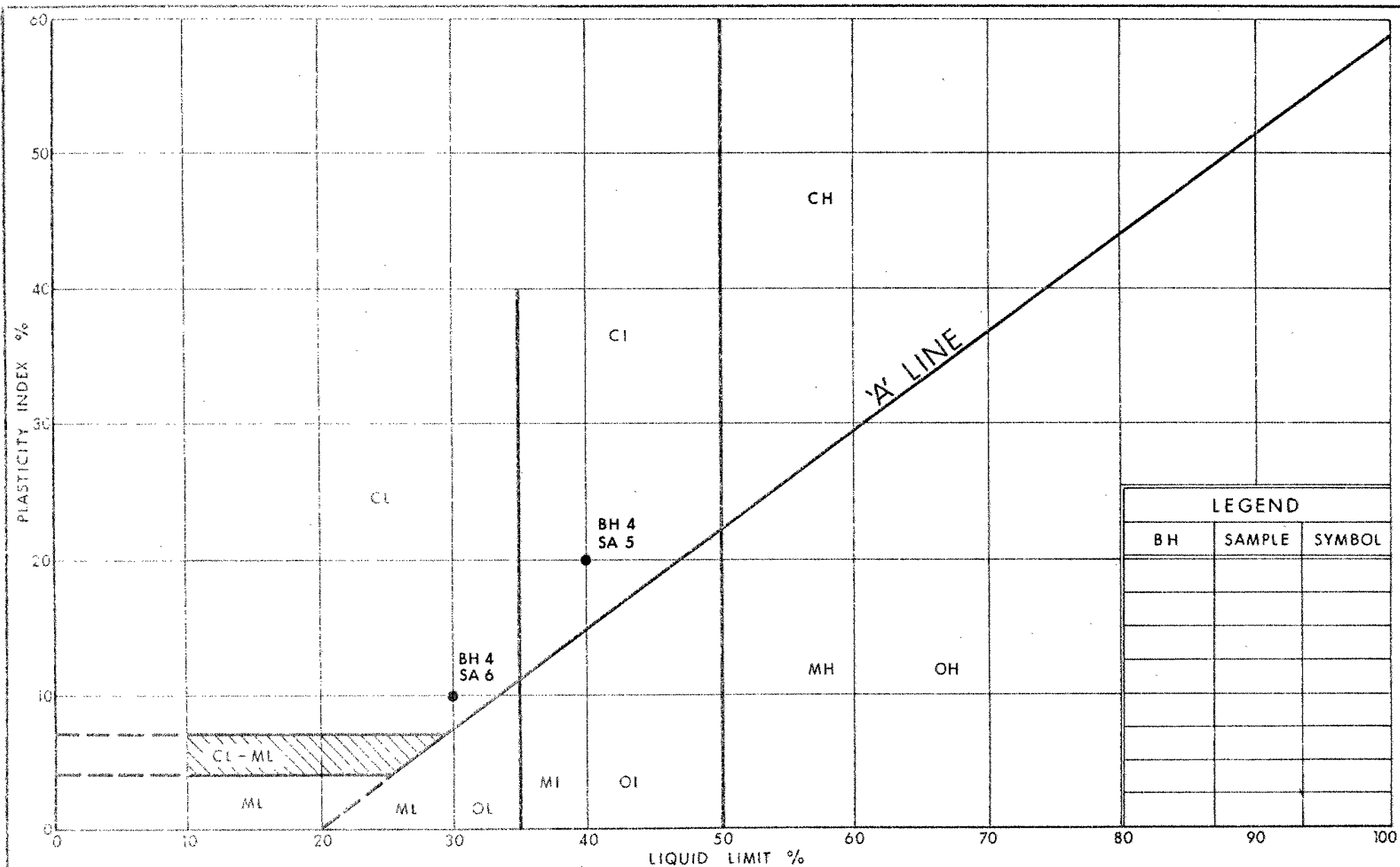
Ontario

 Ministry of
Transportation and
Communications

GRAIN SIZE DISTRIBUTION
SILTY SAND TO SAND
WITH SILT, SOME GRAVEL

FIG No 2

W O 77-50062



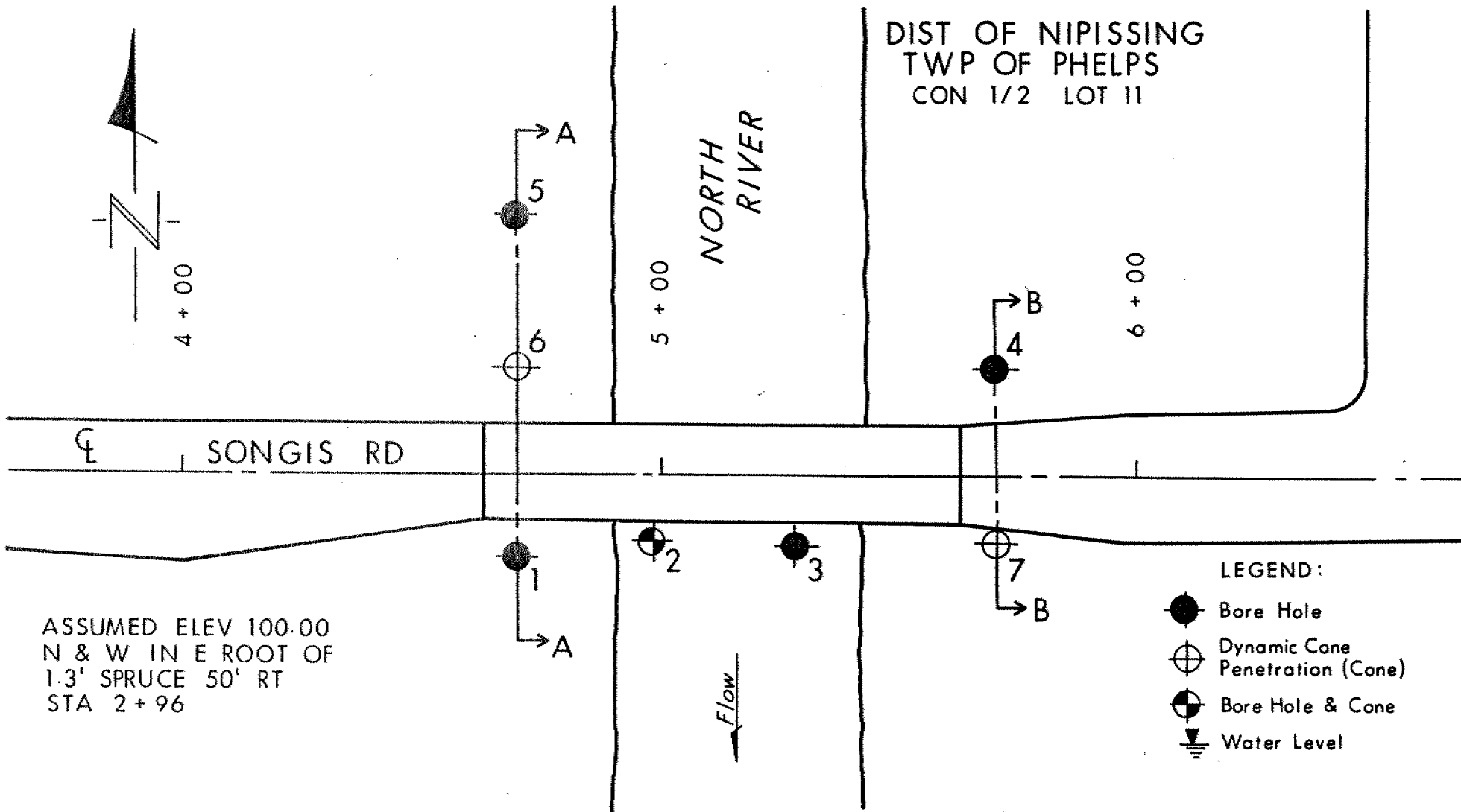
Ontario

Ministry of
Transportation and
Communications

PLASTICITY CHART
CLAYEY SILT TO SILT OF
SLIGHT PLASTICITY

FIG No 3

WO 77-50062

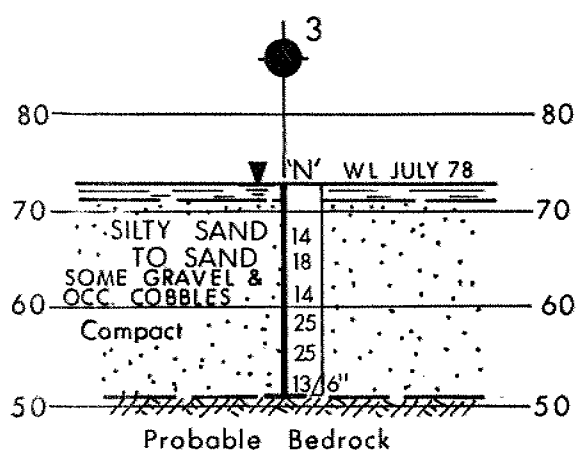
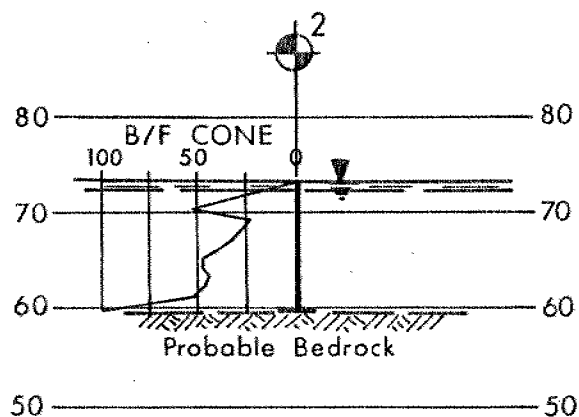
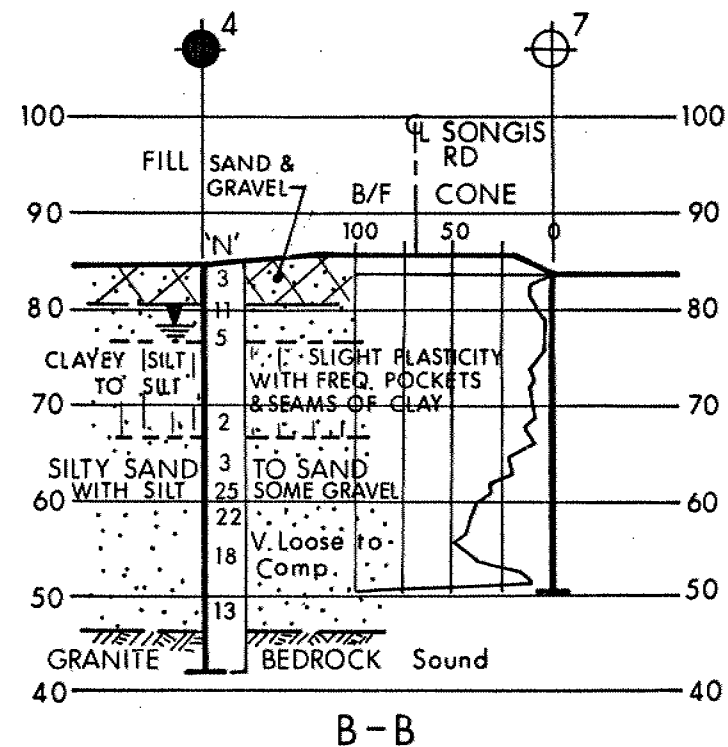
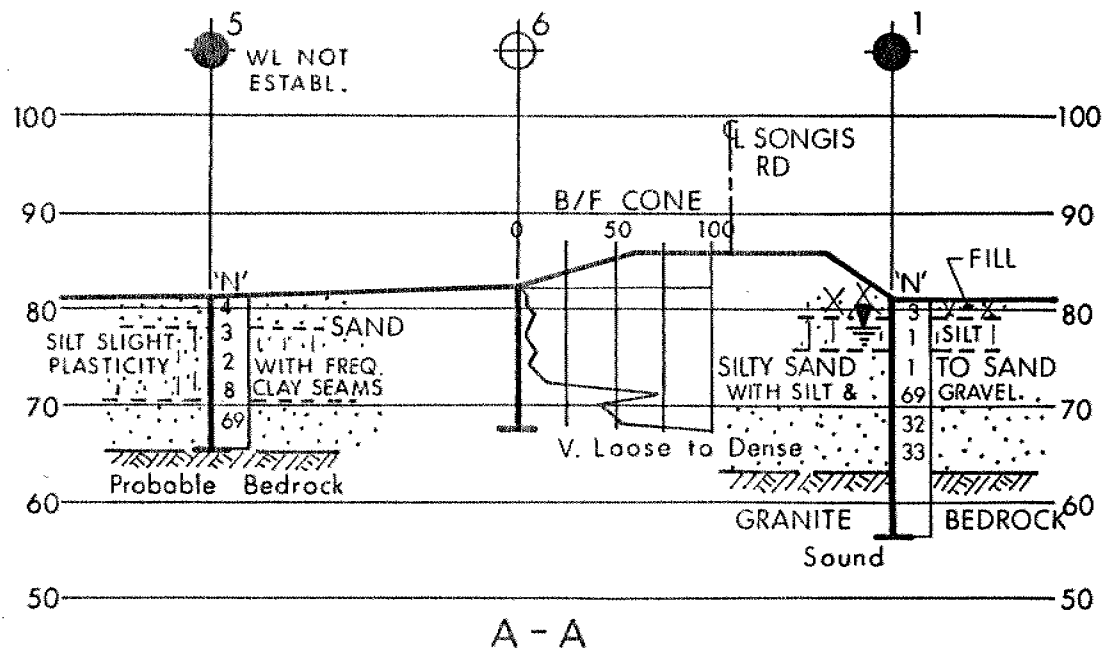


PLAN
SCALE
1" = 30'

NORTH RIVER BRIDGE

DIST 13 NORTH BAY
WO 77-50062
SITE 43-46

DWG NO 77-50062-B



SECTIONS

SCALE

1" = 20'

WO 77-50062

DWG NO. 77-50062-B

EXPLANATION OF TERMS USED IN REPORT

'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. $C\bar{U}$ = 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_q, N_c, N_{γ} 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 = $\frac{I_P \text{ of soil}}{I_P \text{ of } 2\mu m \text{ Soil Fraction}}$
 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
 u, n STABILITY COEFFICIENTS
 A, B PORE PRESSURE COEFFICIENTS

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
 e_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_c OVERCONSOLIDATION RATIO (OCR)
 σ' EFFECTIVE STRESS

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