# DOCUMENT IMICROFILMING IDENTIFICATION

GEOCRES No. 31E-91

DIST. 13 REGION

W.P. No. 137-76-04

CONT. No. 82-44

W. O. No.

STR. SITE No. 44-30

HWY. No. 522

LOCATION Commanda Creek Bridge

No of PAGES -

OVERSIZE DRAWINGS TO BE INCLUDED WITH THIS REPORT.

REMARKS:

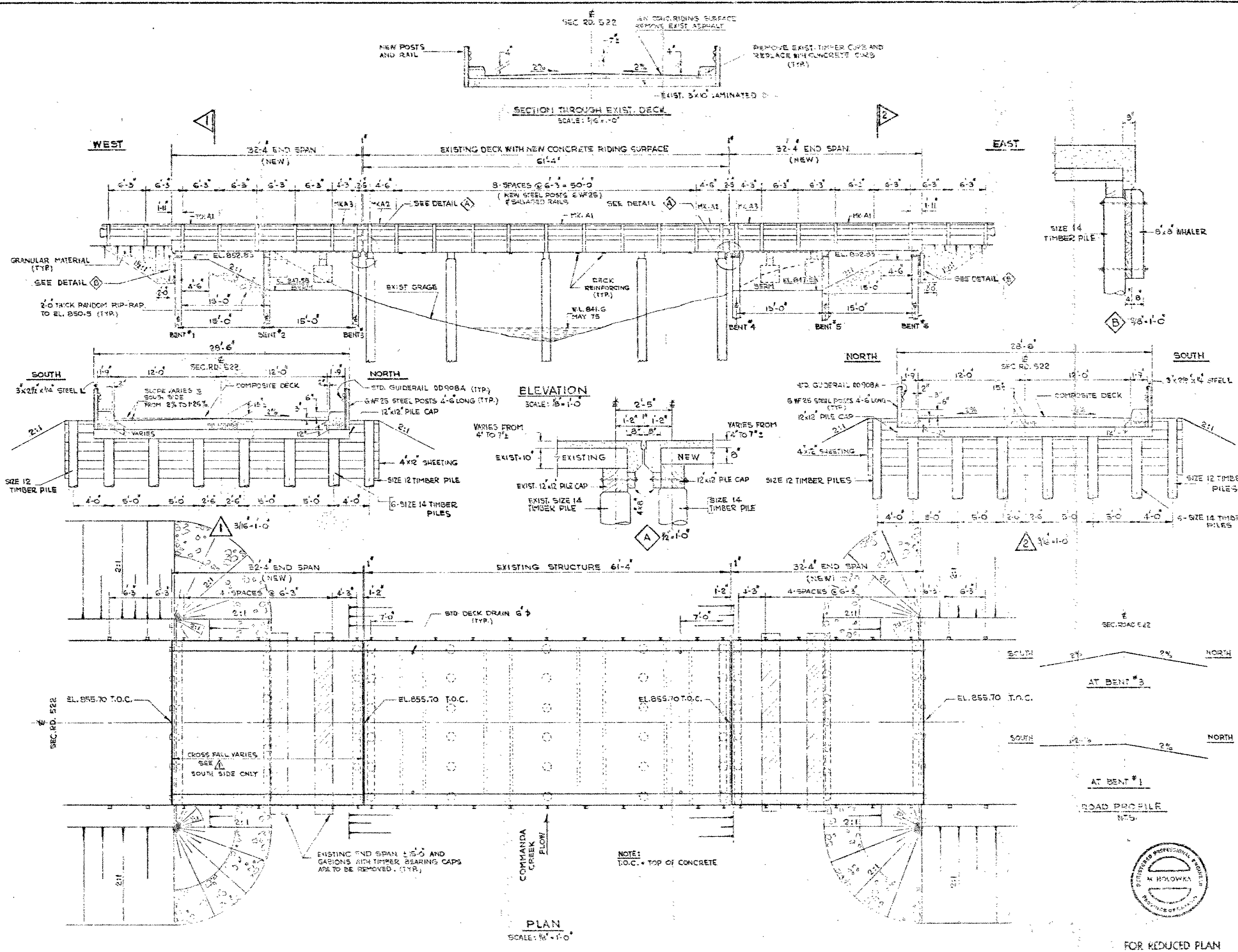
G.I.-30 SEPT. 1976

W077-11004

DIST. 13
CONT No
WP No 137-76-04

COMMANDA CREEK BRIDGE
SEC. HWY. 522
GENERAL PLAN

SHEET




NOTES:
REINFORCING STEEL GRADE 400
BAR MARKS WITH SUFFIX 'C' SHALL BE COATED BARS

CLASS OF CONCRETE
DECK & CURB ------------------ 30MPa

CLEAR COVER ON REINF. STEEL 2" (DECK SLAB)
TO ACHIEVE THE MINIMUM COVER OF 2" SPECIFIED, THE TOP LAYER SHALL BE PLACED PRIOR TO CONCRETING WITH A CLEAR COVER OF 2½", ±½" TOLERANCE.

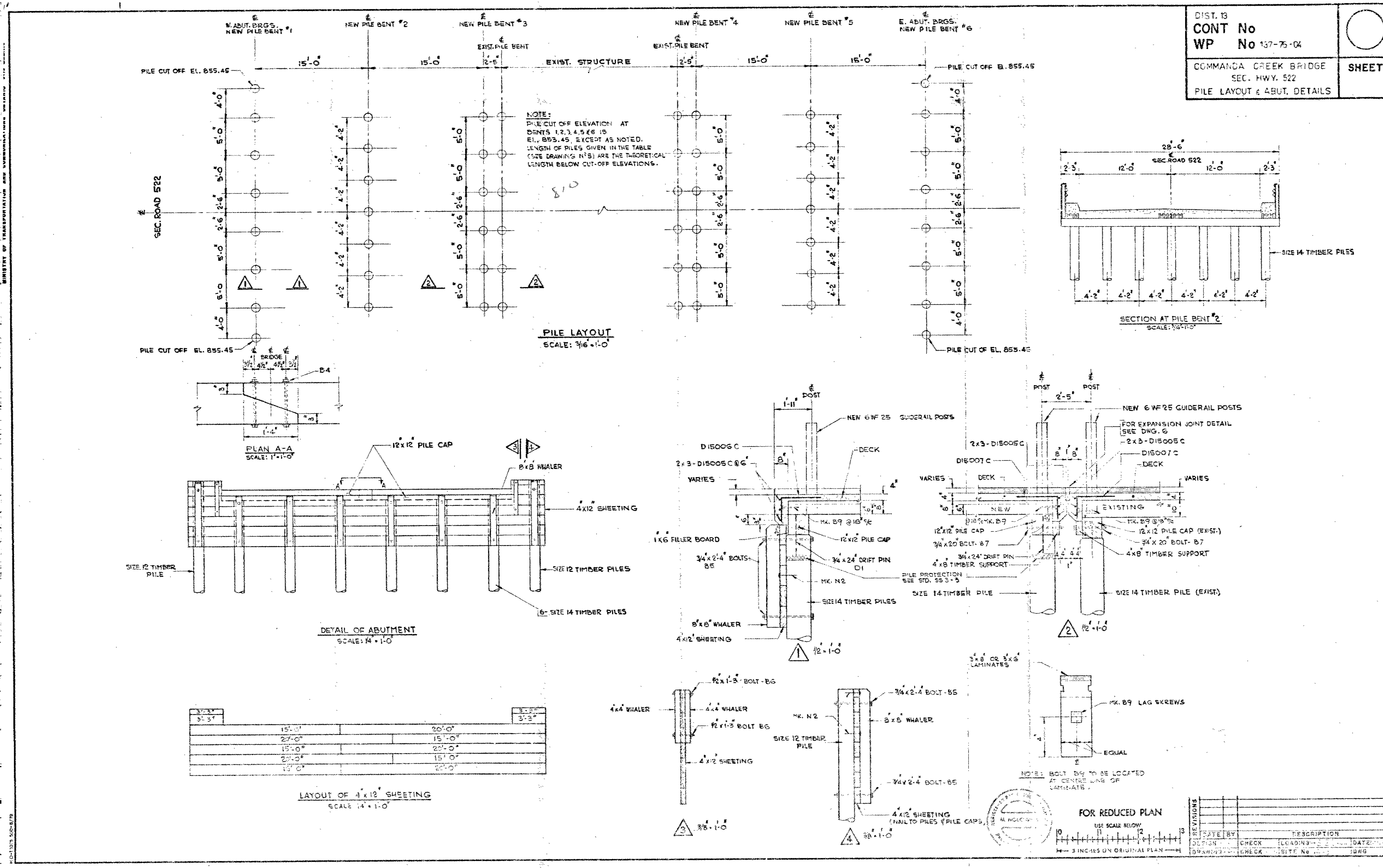
CONCRETE QUANTITIES:
CONCRETE IN DECK & CURB ------------- 57 cu.yd.

LIST OF DRAWINGS
40-43 - 1 GENERAL PLAN
2 BORE HOLE LOCATION & SOIL STRATA
3 PILE LAYOUT & ABUT. DETAILS
4 DECK
5 BILL OF MATERIALS
6 STANDARD DETAIL I

FOR REDUCED PLAN
USE SCALE BELOW
0 1 2 3
3 INCHES ON ORIGINAL PLAN

| REVISIONS | | |
|---|---|---|
| DATE | BY | DESCRIPTION |

| | | | |
|---|---|---|---|
| DESIGN | CHECK | LOADING | DATE |
| DRAWING | CHECK | SITE No | DWG |


DIST. 13
CONT No
WP No 137-75-04
COMMANDA CREEK BRIDGE
SEC. HWY. 522
PILE LAYOUT & ABUT. DETAILS
SHEET
W. ABUT. BRGS. NEW PILE BENT #1
NEW PILE BENT #2
NEW PILE BENT #3
EXIST. PILE BENT
EXIST. STRUCTURE
NEW PILE BENT #4
NEW PILE BENT #5
E. ABUT. BRGS. NEW PILE BENT #6
PILE CUT OFF EL. 855.45
SEC. ROAD 522
NOTE:
PILE CUT OFF ELEVATION AT BENTS 1,2,3,4,5 & 6 IS EL. 853.45, EXCEPT AS NOTED. LENGTH OF PILES GIVEN IN THE TABLE (SEE DRAWING N°5) ARE THE THEORETICAL LENGTH BELOW CUT-OFF ELEVATIONS.
PILE LAYOUT
SCALE: 3/16" = 1'-0"
SEC. ROAD 522
SIZE 14 TIMBER PILES
SECTION AT PILE BENT #2
PLAN A-A
SCALE: 1" = 1'-0"
12"x12" PILE CAP
8"x8" WHALER
4"x12" SHEETING
SIZE 12 TIMBER PILE
SIZE 12 TIMBER PILES
6- SIZE 14 TIMBER PILES
DETAIL OF ABUTMENT
SCALE: 1/4" = 1'-0"
LAYOUT OF 4"x12" SHEETING
SCALE 1/4" = 1'-0"
NEW 6WF25 GUIDERAIL POSTS
DECK
12"x12" PILE CAP
3/4"x24" DRIFT PIN D1
PILE PROTECTION SEE STD. SS 3-3
SIZE 14 TIMBER PILES
8"x8" WHALER
4"x12" SHEETING
1"x6" FILLER BOARD
FOR EXPANSION JOINT DETAIL SEE DNG. 6
NEW
EXISTING
12"x12" PILE CAP (EXIST.)
4"x8" TIMBER SUPPORT
SIZE 14 TIMBER PILE
SIZE 14 TIMBER PILE (EXIST.)
4"x4" WHALER
4"x12" SHEETING
SIZE 12 TIMBER PILE
4"x12" SHEETING (NAIL TO PILES & PILE CAPS)
3"x8" OR 3"x6" LAMINATES
MK. B9 LAG SCREWS
EQUAL
NOTE: BOLT B9 TO BE LOCATED AT CENTRE LINE OF LAMINATES.
FOR REDUCED PLAN
USE SCALE BELOW
3 INCHES ON ORIGINAL PLAN
REVISIONS
DATE BY
DESCRIPTION
DESIGN
DRAWN
CHECK
LOADING
SITE No
DATE
DWG

# FOUNDATION INVESTIGATION REPORT

## CONTRACT NO 82-44

Ontario
Ministry of
Transportation and
Communications

# INDEX



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 $\bar{N}$.

**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. $\overline{CIU}$ = 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

| | |
|---|---|
| $\mu$ | COEFFICIENT OF FRICTION |
| $\delta$ | 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 |
| $\omega$ | SLOPE ANGLE-BACKFACE OF WALL |
| $\beta$ | ANGLE OF SLOPE |
| $N_\gamma, N_q, N_c$ | BEARING CAPACITY FACTORS |
| $D_f$ | DEPTH OF FOOTING |
| B,L | FOOTING DIMENSIONS |

### INDEX PROPERTIES

| | |
|---|---|
| $\gamma$ | UNIT WEIGHT OF SOIL (BULK DENSITY) |
| $\gamma_w$ | UNIT WEIGHT OF WATER |
| $\gamma_d$ | UNIT DRY WEIGHT OF SOIL (DRY DENSITY) |
| $\gamma'$ | 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 = $\frac{w - w_p}{I_p}$ |
| $I_c$ | CONSISTENCY INDEX = $\frac{w_L - w}{I_p}$ |
| $A_c$ | ACTIVITY = $\frac{I_p \text{ of soil}}{\% < 2\mu m \text{ Soil Fraction}}$ |
| Om | ORGANIC MATTER CONTENT |
| $S_r$ | DEGREE OF SATURATION |
| S | SENSITIVITY = $\frac{S_u \text{ (undisturbed)}}{S_u \text{ (remoulded)}}$ |

### STRENGTH PARAMETERS

| | |
|---|---|
| $\phi$ | ANGLE OF SHEARING RESISTANCE |
| $\tau_f$ | PEAK SHEAR STRENGTH |
| $\tau_R$ | 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 |
| $\epsilon$ | LINEAR STRAIN |
| $\gamma$ | SHEAR STRAIN |
| $\nu$ | 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 |

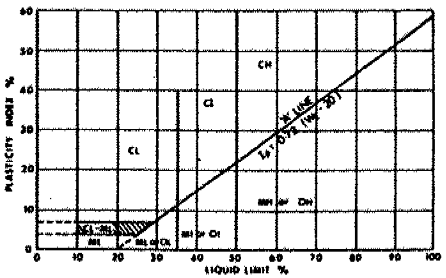
**NOTE:** EFFECTIVE STRESS PARAMETERS ARE DENOTED BY USE OF APOSTROPHE ABOVE THE SYMBOL, THUS:
$\phi'$ = EFFECTIVE ANGLE OF SHEARING RESISTANCE;
$\sigma'$ = EFFECTIVE NORMAL STRESS

### HYDRAULIC TERMS

| | |
|---|---|
| h | HYDRAULIC HEAD OR POTENTIAL |
| q | RATE OF DISCHARGE |
| v | VELOCITY OF FLOW |
| i | HYDRAULIC GRADIENT |
| j | SEEPAGE FORCE PER UNIT VOLUME |
| $\eta$ | 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) |

# EXTENDED CASAGRANDE SOIL CLASSIFICATION SYSTEM

| FIELD IDENTIFICATION PROCEDURES (EXCLUDING PARTICLES LARGER THAN 75mm (3 INCHES) AND BASING FRACTIONS ON ESTIMATED MASS) | | | | | | | GRP. SYMB. | TYPICAL NAMES | INFORMATION REQUIRED FOR DESCRIBING SOILS | LABORATORY CLASSIFICATION CRITERIA |
|---|---|---|---|---|---|---|---|---|---|---|
| COARSE GRAINED SOILS MORE THAN HALF OF MATERIAL IS LARGER THAN 75µm (No. 200 SIEVE SIZE) (75 µm IS ABOUT THE SMALLEST PARTICLE VISIBLE TO THE NAKED EYE) | GRAVELS MORE THAN HALF OF COARSE FRACTION IS LARGER THAN 5mm (NO. 4 SIEVE) | CLEAN GRAVELS (LITTLE OR NO FINES) | WIDE RANGE IN GRAIN SIZE & SUBSTANTIAL AMOUNTS OF ALL INTERMEDIATE PARTICLE SIZE | | | | GW | WELL GRADED GRAVELS, GRAVEL-SAND MIXTURES, LITTLE OR NO FINES. | GIVE TYPE; NAME, IF NECESSARY; INDICATE APPROX. % OF SAND & GRAVEL; MAX. SIZE; ANGULARITY, SURFACE CONDITION, & HARDNESS OF THE COARSE GRAINS; LOCAL OR GEOLOGIC NAME & OTHER PERTINENT DESCRIPTIVE INFORMATION; & SYMBOL IN PARENTHESIS. | USE GRAIN SIZE CURVE IN IDENTIFYING THE FRACTIONS AS GIVEN UNDER FIELD IDENTIFICATION. DETERMINE PERCENTAGES OF GRAVEL & SAND FROM GRAIN SIZE CURVE. DEPENDING ON PERCENTAGE OF FINES (FRACTION SMALLER THAN 75 µm (NO. 200 SIEVE) COARSE GRAINED SOILS ARE CLASSIFIED AS FOLLOWS: LESS THAN 5% GW, GP, SW, SP; MORE THAN 12% GM, GC, SM, SC; 5% TO 12% BORDERLINE CASES REQ. USE OF DUAL SYMBOLS. $C_u = \frac{D_{60}}{D_{10}}$ GREATER THAN 4; $C_c = \frac{(D_{30})^2}{D_{10} \times D_{60}}$ BETWEEN ONE AND 3 |
| | | | PREDOMINANTLY ONE SIZE OR A RANGE OF SIZES WITH SOME INTERMEDIATE SIZES MISSING | | | | GP | POORLY GRADED GRAVELS, GRAVEL-SAND MIXTURES; LITTLE OR NO FINES | | NOT MEETING ALL GRADATION REQUIREMENTS FOR GW |
| | | GRAVEL WITH FINES (APPRECIABLE AMOUNT OF FINES) | NON-PLASTIC FINES (FOR IDENTIFICATION PROCEDURES SEE ML BELOW) | | | | GM | SILTY GRAVELS, POORLY GRADED GRAVEL-SAND-SILT MIXTURES | | ATTERBERG LIMITS BELOW A-LINE, OR $I_p$ LESS THAN 4 — ABOVE A-LINE WITH $I_p$ BETWEEN 4 AND 7 ARE BORDERLINE CASES REQUIRING USE OF DUAL SYMBOLS |
| | | | PLASTIC FINES (FOR IDENTIFICATION PROCEDURES SEE CL BELOW) | | | | GC | CLAYEY GRAVELS, POORLY GRADED GRAVEL-SAND-CLAY MIXTURES | | ATTERBERG LIMITS ABOVE A-LINE WITH $I_p$ GREATER THAN 7 |
| | SANDS MORE THAN HALF OF COARSE FRACTION IS SMALLER THAN 5mm (NO. 4 SIEVE) | CLEAN SANDS (LITTLE OR NO FINES) | WIDE RANGE IN GRAIN SIZES & SUBSTANTIAL AMOUNTS OF ALL INTERMEDIATE PARTICLE SIZES | | | | SW | WELL GRADED SANDS, GRAVELLY SANDS; LITTLE OR NO FINES | FOR UNDISTURBED SOILS ADD INFORMATION ON STRATIFICATION, DEGREE OF COMPACTNESS, CEMENTATION, MOISTURE CONDITIONS & DRAINAGE CHARACTERISTICS. | $C_u = \frac{D_{60}}{D_{10}}$ GREATER THAN 6; $C_c = \frac{(D_{30})^2}{D_{10} \times D_{60}}$ BETWEEN ONE AND 3 |
| | | | PREDOMINANTLY ONE SIZE OR A RANGE OF SIZES WITH SOME INTERMEDIATE SIZES MISSING | | | | SP | POORLY GRADED SANDS, GRAVELLY SANDS; LITTLE OR NO FINES | | NOT MEETING ALL GRADATION REQUIREMENTS FOR SW |
| | | SANDS WITH FINES (APPRECIABLE AMOUNT OF FINES) | NON-PLASTIC FINES (FOR IDENTIFICATION PROCEDURES SEE ML BELOW) | | | | SM | SILTY SANDS, POORLY GRADED SAND-SILT MIXTURES | | ATTERBERG LIMITS BELOW A-LINE OR $I_p$ LESS THAN 4 — ABOVE A-LINE WITH $I_p$ BETWEEN 4 AND 7 ARE BORDERLINE CASES REQUIRING USE OF DUAL SYMBOLS |
| | | | PLASTIC FINES (FOR IDENTIFICATION PROCEDURES SEE CL BELOW) | | | | SC | CLAYEY SANDS, POORLY GRADED SAND-CLAY MIXTURES | | ATTERBERG LIMITS ABOVE A-LINE WITH $I_p$ GREATER THAN 7 |
| FINE GRAINED SOILS MORE THAN HALF OF MATERIAL IS SMALLER THAN 75µm (No. 200 SIEVE SIZE) | IDENTIFICATION PROCEDURES ON FRACTION SMALLER THAN 425 µm (NO. 40 SIEVE SIZE) | | | | | | | | | |
| | | | DRY STRENGTH (CRUSHING CHARACTERISTICS) | DILATANCY (REACTION TO SHAKING) | TOUGHNESS (CONSISTENCY NEAR PLASTIC LIMIT) | | | | | |
| | SILTS AND CLAYS | LIQUID LIMIT LESS THAN 35% | NONE | QUICK | NONE | | ML | INORGANIC SILTS & SANDY SILTS OF SLIGHT PLASTICITY, ROCK FLOUR | GIVE TYPE; NAME, IF NECESSARY, INDICATE DEGREE & CHARACTER OF PLASTICITY, AMOUNT & MAXIMUM SIZE OF COARSE GRAINS, COLOUR IN WET CONDITION, ODOUR, IF ANY, LOCAL OR GEOLOGIC NAME & OTHER PERTINENT DESCRIPTIVE INFORMATION & SYMBOL IN PARENTHESIS. FOR UNDISTURBED SOILS ADD INFORMATION ON STRUCTURE, STRATIFICATION, CONSISTENCY IN UNDISTURBED & REMOULDED STATES, MOISTURE & DRAINAGE CONDITIONS. | SEE PLASTICITY CHART |
| | | | MEDIUM TO HIGH | NONE TO VERY SLOW | MEDIUM | | CL | CLAYEY SILTS (INORGANIC), GRAVELLY CLAYS, SANDY CLAYS, LEAN CLAYS | | |
| | | | SLIGHT TO MEDIUM | SLOW | SLIGHT | | OL | ORGANIC SILT OF LOW PLASTICITY, ORGANIC SANDY SILTS | | |
| | | LIQUID LIMIT BETWEEN 35% AND 50% | NONE TO SLIGHT | SLOW TO QUICK | SLIGHT | | MI | INORGANIC COMPRESSIBLE SILTS OR SILTY FINE SANDS WITH SOME CLAY OF MEDIUM PLASTICITY (BELOW A-LINE) | | |
| | | | HIGH | NONE | MEDIUM TO HIGH | | CI | SILTY CLAYS (INORGANIC) OF MEDIUM PLASTICITY | | |
| | | | SLIGHT TO MEDIUM | VERY SLOW | SLIGHT | | OI | ORGANIC SILTY CLAYS OF MEDIUM PLASTICITY | | |
| | | LIQUID LIMIT GREATER THAN 50% | SLIGHT TO MEDIUM | SLOW TO NONE | MEDIUM | | MH | INORGANIC SILTS, HIGHLY COMPRESSIBLE MICACEOUS OR DIATOMACEOUS FINE SANDY OR SILTY SOILS, ELASTIC SILTS | | |
| | | | HIGH TO VERY HIGH | NONE | HIGH | | CH | CLAYS (INORGANIC) OF HIGH PLASTICITY, FAT CLAYS | | |
| | | | MEDIUM TO HIGH | NONE TO VERY SLOW | SLIGHT TO MEDIUM | | OH | ORGANIC CLAYS OF HIGH PLASTICITY | | |
| HIGHLY ORGANIC SOILS | | | READILY IDENTIFIED BY COLOUR, ODOUR, SPONGY FEEL & FREQUENTLY BY FIBROUS TEXTURE | | | | Pt | PEAT & OTHER HIGHLY ORGANIC SOILS | | |




PLASTICITY CHART
FOR LABORATORY CLASSIFICATION OF FINE GRAINED SOILS

**BOUNDARY CLASSIFICATIONS:** SOILS POSSESSING CHARACTERISTICS OF TWO GROUPS ARE DESIGNATED BY COMBINATIONS OF GROUP SYMBOLS. FOR EXAMPLE GW-GC, WELL GRADED GRAVEL-SAND MIXTURE WITH CLAY BINDER

# FOUNDATION INVESTIGATION REPORT

For

Commanda Creek Bridge
W.P. 137-76-04, Site 44-30
Hwy. 522, District 13, North Bay

## INTRODUCTION

This report contains the results of a foundation investigation carried out at the site of the above mentioned structure during the period of November 21 to November 24, 1978. The fieldwork consisted of two sampled boreholes and one augered probe hole which was accompanied by a dynamic cone penetration test. The borings were advanced by utilizing an auger machine, which was equipped with 3¼" I.D. hollow stem augers, to depths ranging between 45 and 53 feet.

## SITE DESCRIPTION

The site is located just west of the Town of Commanda where Hwy. 522 crosses Commanda Creek by means of a six span timber trestle bridge. The surrounding terrain is hilly and bush covered. At this location, Commanda Creek is a relatively fast flowing river. At the time of investigation the creek was about 20 feet wide and 3 to 5 feet deep. The approaches are about 16 to 18 feet high and are composed of loose uniform fine grained granular material (silty fine sand). The forward slopes are protected with rip-rap. However, there are scour holes in front of the east approach.

The trestle bridge was constructed in 1952 originally as a four span timber pile bent structure with 1¼:1 spill-through forward slopes. The bridge was subsequently lengthened in 1969 to six spans in order to modify the forward slopes to 2:1 because of continual surficial movements in the approaches.

The additional spans were supported at the extreme ends on a 12" x 12" timber sill on ground surface. In 1970 the end spans were further supported in the middle by gabions because of additional movements of the slopes.

## SUBSURFACE CONDITIONS

In general, subsoil at this site consists of a sequence of lacustrine deposits. Immediately below the ground surface or beneath the existing approach fills, is a 10 foot thick stratum of silty fine sand. This granular stratum is underlain by an 18 to 24 foot thick deposit of clayey silt, which in turn is followed by a further deposit of very fine sand which becomes very bouldery at a depth of 43 feet below ground surface.

The location and elevation of the boreholes are shown on Contract Drawing 44-30-2, together with a stratigraphical profile inferred from the borehole information. A description of the subsoil conditions is as follows.

### Approach Fills

The material used for construction of the approaches is mainly composed of a silty fine sand apparently obtained from local areas. From the visual observation, the silty fine sand appears to be relatively uniformly graded. As mentioned previously, the approach fills have a thickness of about 16 to 18 feet.

### Silty Fine Sand (Upper Stratum)

Beneath the approach fills or the ground surface is a layer of silty fine sand which is about 10 feet thick. Typical grain size distribution curves of the silty fine sand are shown in Figure 1. The 'N' values obtained in this material range from less than 1 blow/foot to 11 blows/foot. It is inferred from this that the relative density of the silty fine sand is very loose to compact, generally being very loose.

### Clayey Silt

This deposit underlies the stratum of silty fine sand. Its thickness increases from 18 to 24 feet in a westerly direction. Typical grain size distribution curves are shown in Figure 2.

Identity indices are summarized in a tabular form below.

| Identity Indices | | Ranges |
|---|---|---|
| Natural Moisture Content | (W%) | 29-39 |
| Liquid Limit | ($W_L$%) | 27-34 |
| Plastic Limit | ($W_p$%) | 16-21 |

The Atterberg Limits are also plotted on a Plasticity Chart (Figure 3). The results indicate that this cohesive material is inorganic and of low plasticity.

The undrained shear strengths as determined by field vane tests vary from 600 psf to 1800 psf, generally increasing with depth. It can be inferred from this that the consistency of the cohesive stratum varies from firm to stiff with depth. The clayey silt is moderately sensitive to remolding, as evidenced by a sensitivity of 2 to 4. The relatively high moisture content which is at or above the liquid limit is indicative of a compressible soil deposit.

Silty Fine Sand (Lower Stratum)

The cohesive deposit is underlain by a further granular stratum of silty fine sand which was investigated to a maximum depth of 53 feet below ground surface. This granular stratum becomes gravelly at a depth of about 40 feet and bouldery at a depth below 43 feet. All borings were terminated in the bouldery zone. Based on the 'N' values, the relative density of the silty fine sand is very loose to compact, however, in the lower portion of this stratum which becomes bouldery, the relative density is very dense.

Groundwater Conditions

The groundwater level in the boreholes was observed to be at a depth of approximately 3 feet below river bank surface, closely corresponding to the water level in the creek.

Peter J. Stuart, P. Eng.
Foundations Engineer

P. J. STUART

M. Devata, P. Eng.
Senior Foundations Engineer

January 27, 1981.

# APPENDIX

# RECORD OF BOREHOLE No 1

WP 137-76-04 LOCATION Sta. 165+56, 24.5' Lt. ORIGINATED BY BL
DIST 13 HWY 522 BOREHOLE TYPE Hollow Stem Augers COMPILED BY BL
DATUM Geodetic DATE November 21 and 22, 1978 CHECKED BY [signature]

| ELEV / DEPTH | DESCRIPTION | Sample Number | Type | 'N' Values | Ground Water Conditions | Elevation Scale | Shear Strength | Remarks & Grain Size Distribution (%) GR SA SI CL |
|---|---|---|---|---|---|---|---|---|
| 843.0 | Ground Surface | | | | | | | |
| 0.0 | Silty Fine Sand<br>Very Loose to Compact | 1 | SS | 1 | ▽ (water level symbol) | 840 | | 0 60 40 0 |
| | | 2 | SS | 11 | | | | |
| 832.5 | | 3 | SS | 11 | | | | |
| 10.5 | Clayey Silt<br>Grey<br>Firm to Stiff | 4 | SS | 7 | | 830 | s=4 | 0 2 (98) |
| | | 5 | TW | PM | | | s=3 | 0 2 78 20 |
| | | 6 | SS | 11 | | 820 | s=2 | |
| 815.0 | | | | | | | | |
| 28.0 | Very Fine<br>Silty Sand<br>Very Loose to Loose | 7 | SS | 7 | | 810 | | |
| | | 8 | SS | 2 | | | | |
| | Gravelly | 9 | SS | 100/3" Rec | | | | |
| 798.0 | Bouldery | 10 | BX | 0% | | 800 | | |
| 45.0 | End of Borehole | | | | | | | |

Dynamic Cone Penetration Resistance Plot: 20 40 60 80 100
Shear Strength: ○ Unconfined + Field Vane ● Quick Triaxial × Lab Vane — 500 1000 1500 2000 2500
Plastic Limit $W_p$, Natural Moisture Content W, Liquid Limit $W_L$ — Water Content (%) 10 20 30
Unit Weight γ

+3, ×3 : Numbers refer to Sensitivity
20 / 15 ◇ 5 / 10 (%) STRAIN AT FAILURE

OFFICE REPORT ON SOIL EXPLORATION

OFFICE REPORT ON SOIL EXPLORATION

# RECORD OF BOREHOLE No 2

WP 137-76-04 LOCATION Sta. 164+96, 25' Rt. ORIGINATED BY BL

DIST 13 HWY 522 BOREHOLE TYPE Hollow Stem Augers COMPILED BY BL

DATUM Geodetic DATE November 23, 1978 CHECKED BY d.f.

| ELEV / DEPTH | DESCRIPTION | STRAT PLOT | NUMBER | TYPE | 'N' VALUES | GROUND WATER CONDITIONS | ELEVATION SCALE | REMARKS & GRAIN SIZE DISTRIBUTION (%) GR SA SI CL |
|---|---|---|---|---|---|---|---|---|
| 845.0 | Ground Surface | | | | | | | |
| 0.0 | Silty Fine Sand<br>Very Loose to Compact | | 1 | SS | 2 | | | |
| | | | 2 | SS | 7/6" | ▽ | 840 | 0 80 (20) |
| 835.0 | | | | | | | | |
| 10.0 | Clayey Silt<br>Grey<br>Firm to Stiff | | 3 | SS | 2 | | | |
| | | | | | | | 830 | 0 1 (99) |
| | | | 4 | SS | 4 | | | |
| | | | 5 | SS | 5 | | | |
| | | | 6 | SS | 6 | | 820 | |
| | | | 7 | SS | 11 | | | |
| 811.0 | | | | | | | 810 | |
| 34.0 | Very Fine Silty Sand, Very Loose Compact | | 8 | SS | - | | | |
| | | | 9 | SS | 13 | | | |
| | Gravelly | pOd | | | | | 800 | |
| | Bouldery | 904 | 10 | SS | 100/ 3" | | | |
| 795.0 | | | | | | | | |
| 50.0 | End of Borehole<br><br>Note: Augering Met Refusal at 50 Feet on a Boulder | | | | | | | |

DYNAMIC CONE PENETRATION RESISTANCE PLOT: 20 40 60 80 100

SHEAR STRENGTH: o UNCONFINED; + FIELD VANE; ● QUICK TRIAXIAL; x LAB VANE — 500 1000 1500 2000 25000

PLASTIC LIMIT $W_p$ — NATURAL MOISTURE CONTENT $W$ — LIQUID LIMIT $W_L$; WATER CONTENT (%) 10 20 30

UNIT WEIGHT γ

Plotted values:

| Elevation (approx.) | Shear strength (field vane) | Water content |
|---|---|---|
| ~834 | | $W_p$–$W$ plotted, $W_L$ beyond chart |
| ~832 | + s=2 | |
| ~830 | | $W_p$–$W$ plotted, $W_L$ beyond chart |
| ~828 | + s=3 | |
| ~823 | + s=3 | |
| ~820 | | $W_p$–$W$ plotted, $W_L$ beyond chart |
| ~817 | + s=2 | |

$+^3$, $x^5$ : Numbers refer to Sensitivity

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

Ministry of Transportation and Communications, Ontario

HIGHWAY ENGINEERING DIVISION-ENGINEERING MATERIALS OFFICE-SOIL MECHANICS SECTION

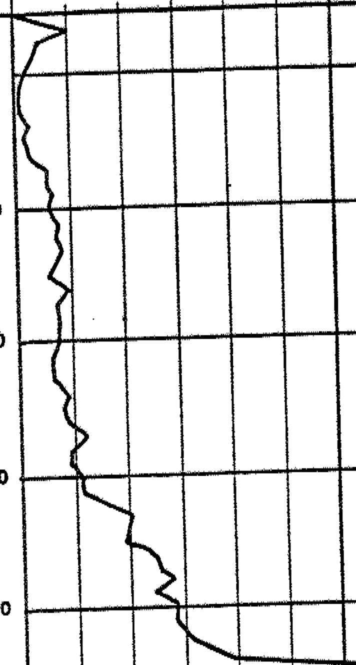
# RECORD OF BOREHOLE No 3

WP 137-76-04 LOCATION Sta. 164+96, 23.5' Lt. ORIGINATED BY BL

DIST 13 HWY 522 BOREHOLE TYPE Straight Augering and Dynamic Cone Test COMPILED BY BL

DATUM Geodetic DATE November 24, 1978 CHECKED BY [illegible]

| ELEV / DEPTH | DESCRIPTION (SOIL PROFILE) | STRAT PLOT | SAMPLES: NUMBER | TYPE | 'N' VALUES | GROUND WATER CONDITIONS | ELEVATION SCALE | DYNAMIC CONE PENETRATION RESISTANCE PLOT (20 40 60 80 100) / SHEAR STRENGTH (o UNCONFINED, • QUICK TRIAXIAL, + FIELD VANE, x LAB VANE) | PLASTIC LIMIT $W_p$ / NATURAL MOISTURE CONTENT W / LIQUID LIMIT $W_L$ — WATER CONTENT (%) | UNIT WEIGHT γ | REMARKS & GRAIN SIZE DISTRIBUTION (%) GR SA SI CL |
|---|---|---|---|---|---|---|---|---|---|---|---|
| 844.5 | Ground Surface | | | | | | | | | | |
| 0.0 | Silty Fine Sand (Inferred) | | | | | | 840 | | | | |
| 834.5 / 10.0 | Clayey Silt (Inferred) | | | | | | 830 | | | | |
| | | | | | | | 820 | | | | |
| 823.5 / 21.0 | Very Fine Silty Sand (Inferred) | | | | | | 810 | | | | |
| | | | | | | | 800 | | | | |
| | Bouldery | | | | | | | | | | |
| 791.5 / 53.0 | End of Augered Hole<br>Note: Augering Met Refusal at 53 Feet on a Boulder | | | | | | | | | | |

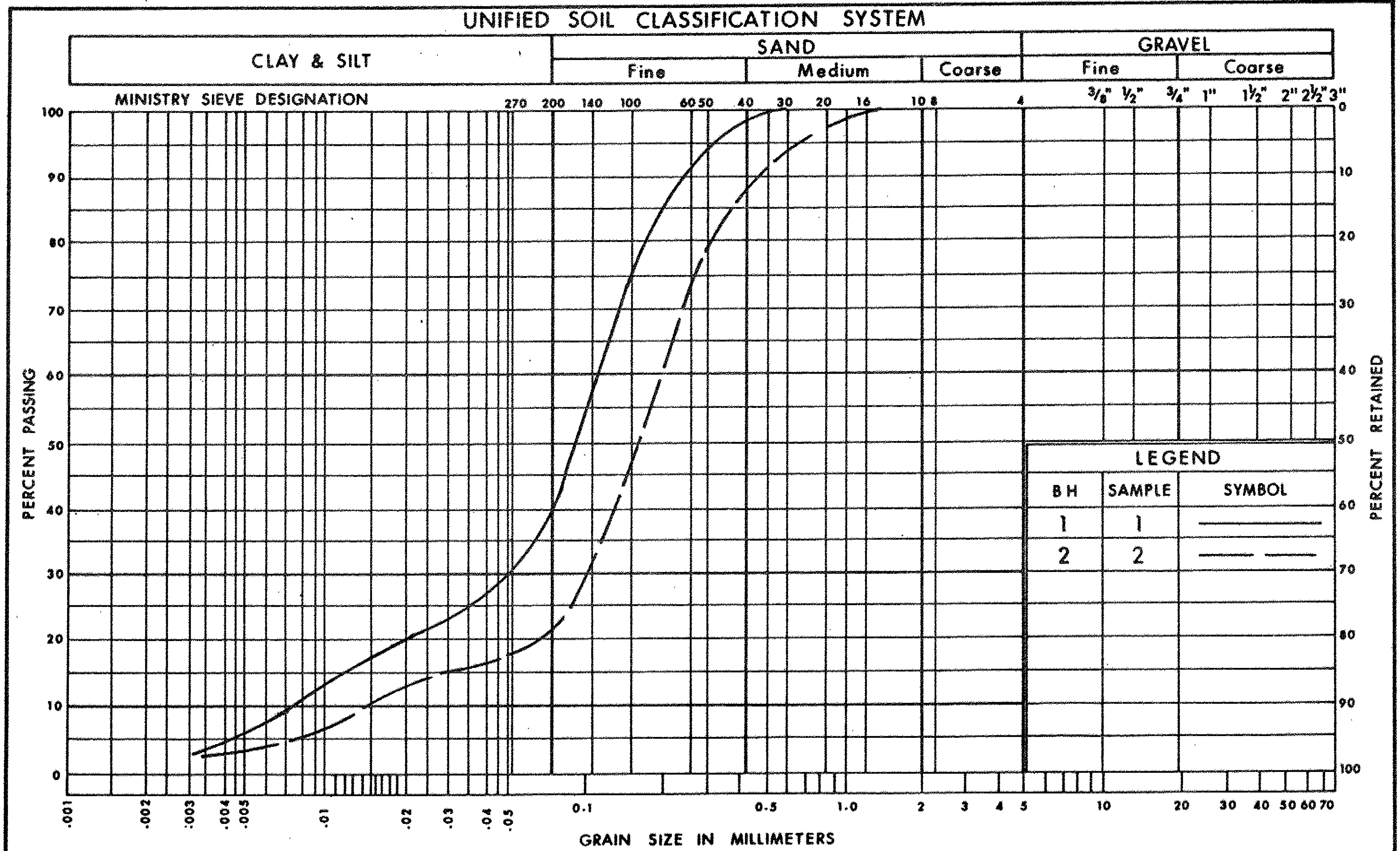


+3, x5 : Numbers refer to Sensitivity

15 ◇ 5 (20 above, 10 below) (%) STRAIN AT FAILURE

OFFICE REPORT ON 'SOIL EXPLORATION

Oct 75, FF-S-22



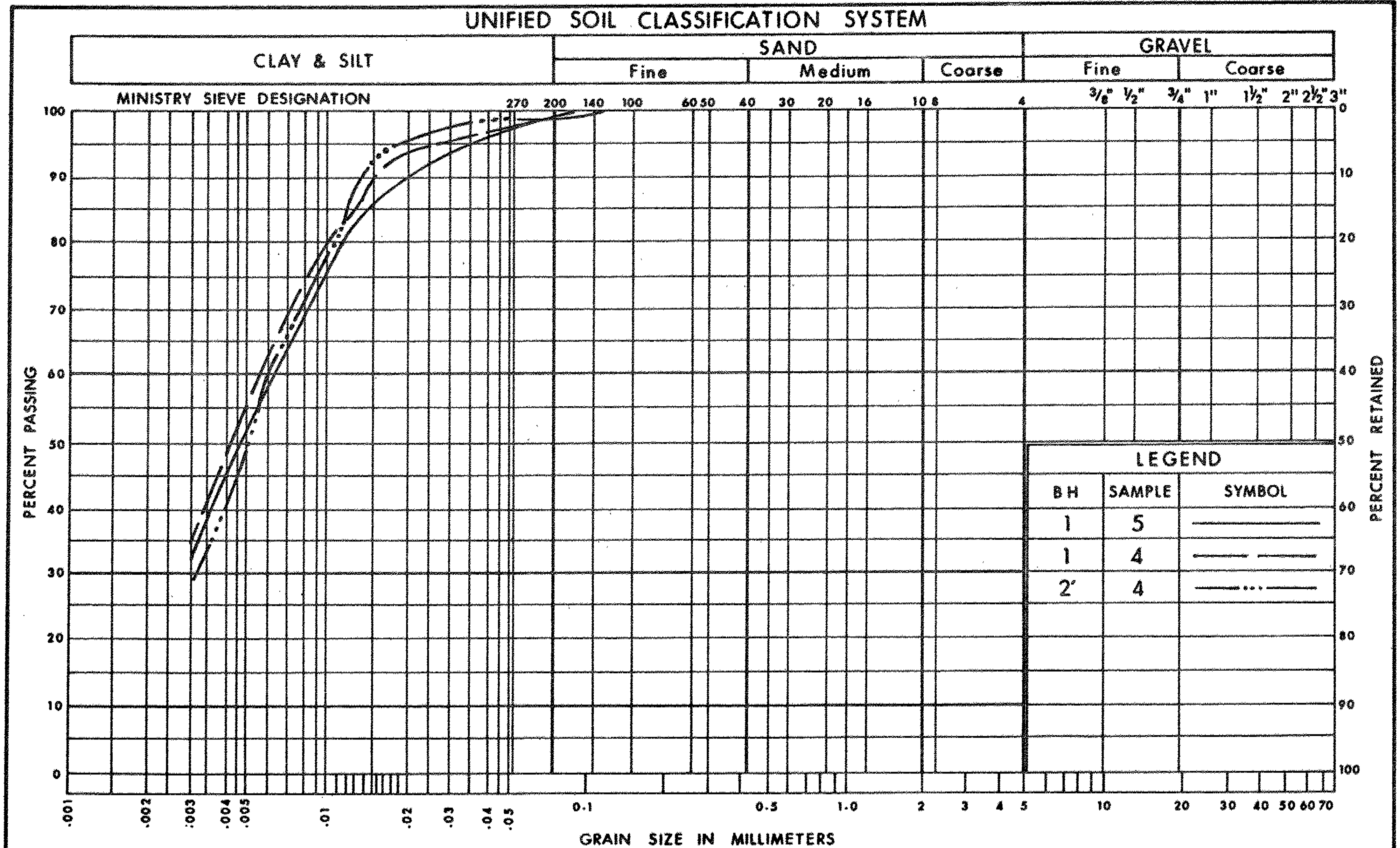

Ministry of Transportation and Communications
Ontario

# GRAIN SIZE DISTRIBUTION
# SILTY SAND

FIG No 1

WP 137-76-04

Oct 75, FF-5-22



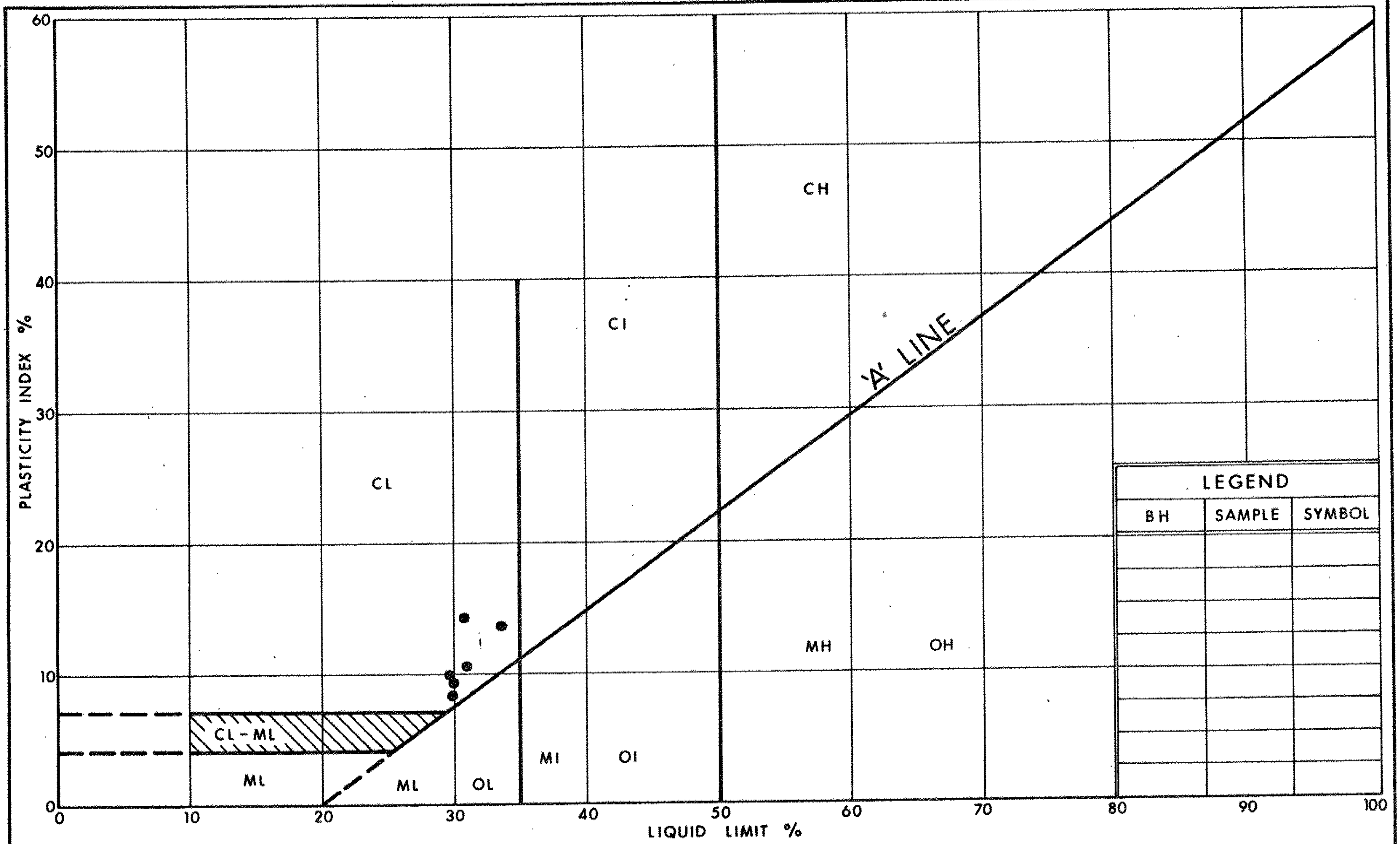

Ministry of Transportation and Communications

Ontario

# GRAIN SIZE DISTRIBUTION
# CLAYEY SILT

FIG No 2

WP 137-76-04




Ministry of Transportation and Communications
Ontario

# PLASTICITY CHART
# CLAYEY SILT

FIG No 3
WP 137-76-04

# ENGINEERING MATERIALS OFFICE

## SOIL MECHANICS SECTION

P 137-76-04

WØ ~~77-11004~~ DIST 13

HWY 522 STR SITE 44-30

Commanda Creek Bridge

DISTRIBUTION

J.C. McAllister (2)
W.J. Peck
S. McCombie
M.J. 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 | 79 02 28 | M.A |
| TUBES | — | — |
| ROCK CORES | — | — |

GEOCRES 31E-91

DATE FEB 21 1979

FOUNDATION INVESTIGATION REPORT

For

137-76-04

Commanda Creek Bridge

W.~~O. 77-110~~04, Site 44-30

Hwy. 522, District 13, North Bay

## INTRODUCTION

This report contains the results of a foundation investigation carried out at the site of the above mentioned structure during the period of November 21 to November 24, 1978. The fieldwork consisted of two sampled boreholes and one augered probe hole, which was also accompanied by a dynamic cone penetration test. The borings were advanced by utilizing an auger machine, which was equipped with 3¼" I.D. hollow stem augers, to depths ranging between 45 and 53 feet below the river bank surface.

## SITE DESCRIPTION

The site is located just west of the Town of Commanda where Hwy. 522 crosses Commanda Creek by means of a six span timber trestle bridge. The surrounding terrain is hilly and bush covered. At this location, Commanda Creek is a relatively fast flowing river. At the time of investigation the creek was about 20 feet wide and 3 to 5 feet deep. The approaches are about 16 to 18 feet high measuring in the longitudinal direction and are composed of loose uniform fine grained granular material (silty fine sand). The forward slopes are protected with rip-rap. However, there are scour holes in front of the east approach.

The trestle bridge was constructed in 1952 originally as a four span timber pile bent structure with 1¼:1 spill-through forward slopes. The bridge was subsequently lengthened in 1969 to six spans in order to modify the forward slopes to 2:1 because of continual surficial movements in the approaches.

The additional spans were supported at the extreme ends on a 12" x 12" timber sill on ground surface. In 1970 the end spans were further supported in the middle by gabions because of additional movements of the slopes.

## SUBSURFACE CONDITIONS

In general, subsoil at this site consists of a sequence of lacustrine deposits. Immediately below the ground surface or beneath the existing approach fills, is a 10 foot thick stratum of silty fine sand. This granular stratum is underlain by an 18 to 24 foot deposit of clayey silt, which in turn is followed by a further deposit of very fine sand. This lower granular stratum becomes very bouldery at a depth of 43 feet below ground surface.

The location and elevation of the boreholes are shown on Drawing 7711004-A, together with two stratigraphical sections inferred from the borehole information. A description of the subsoil conditions is as follows.

### Approach Fills

The material used for construction of the approaches is mainly composed of a silty fine sand apparently obtained from local areas. From the visual observation, the silty fine sand appears to be relatively uniformly graded. As mentioned previously, the approach fills have a thickness of about 16 to 18 feet measuring in the longitudinal direction.

### Silty Fine Sand (Upper Stratum)

Beneath the approach fills or the ground surface is a layer of silty fine sand which is about 10 feet thick. Typical grain size distribution curves of the silty fine sand are shown in Figure 1. The 'N' values obtained in this material range from less than 1 blow/foot to 11 blows/foot. It is inferred from this that the relative density of the silty fine sand is very loose to compact, generally being very loose.

### Clayey Silt

This deposit underlies the stratum of silty fine sand. Its thickness increases from 18 to 24 feet in a westerly direction. The cohesive material in this deposit is predominantly of clayey silt. Typical grain size distribution curves are shown in Figure 2.

Typical identity indices are summarized in a tabular form below.

| Identity Indices | | Ranges |
|---|---|---|
| Natural Moisture Content | (W%) | 29-39 |
| Liquid Limit | ($W_L$%) | 27-34 |
| Plastic Limit | ($W_p$%) | 16-21 |

The Atterberg limits are also plotted on a Plasticity Chart (Figure 3). The results indicate that the cohesive material is inorganic and of low plasticity.

The undrained shear strengths as determined by field vane tests vary from 600 psf to 1800 psf, generally increasing with depth. It can be inferred from this that the consistency of the cohesive stratum varies from firm to stiff with depth. The clayey silt is moderately sensitive to remolding, as evidenced by a sensitivity of 2 to 4. It also exhibits a relatively high moisture content at or above the liquid limit which is indicative of a compressible nature of the deposit.

Silty Fine Sand (Lower Stratum)

The cohesive deposit is underlain by a further granular stratum of silty fine sand which was investigated to a maximum depth of 53 feet below ground surface. This granular stratum becomes gravelly at a depth of about 40 feet and bouldery at a depth below 43 feet. All borings were terminated in the bouldery zone. Based on the 'N' values, the relative density of the silty fine sand is very loose to compact, however, in the lower portion of this stratum which becomes bouldery, the relative density is very dense.

Groundwater Conditions

Groundwater level in the boreholes was observed to be at a depth of approximately 3 feet below river bank surface, closely corresponding to the water level in the creek.

## DISCUSSION AND RECOMMENDATIONS

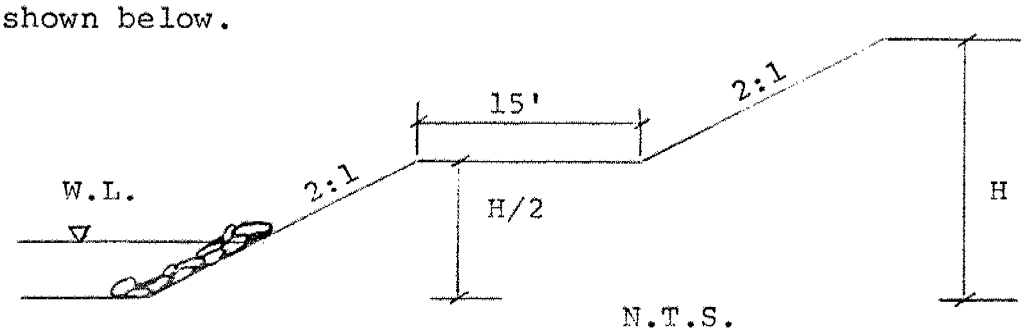
The portions of the approaches in the immediate vicinity of the structure are known to have been subjected to ground movements for a number of years. As a result of this, the Regional Structural Section has requested this office to undertake an investigation to determine the probable causes for the ground movements and also to provide recommendations for remedial measures. In our investigation, we have determined the subsurface conditions existing at the site and further reviewed all the available inspection records on the structure. The subsurface conditions were described elsewhere in this report. The inspection records pertaining to the performance of the approaches are summarized in a chronological order as follows.

| Year | Observation |
|---|---|
| 1952 | Bridge was built as a 4 span timber pile bent structure with 1¼:1 spill-through forward slopes protected with rip-rap. |
| 1954-1960 | Several inspection reports indicate that the bridge and the approaches were performing satisfactorily. |
| 1962 | Debris jammed up against pier bents located in the creek. |
| 1964 | Approach fills spilled through end bents and shoved the adjacent pier pile bents. |
| 1966-1968 | Similar observations as noted in 1964 and the situation appeared to be worsening. |
| 1969 | Bridge was lengthened from 4 spans to 6 spans and the forward slopes were modified to 2:1. The additional spans were supported at the extreme ends on a 12" x 12" timber sill placed on ground surface. The forward slopes were protected with rip-rap up to the high water level. |
| 1970 | The end spans added in 1969 were further supported in the middle by gabions because of continual ground movements in the forward slopes of the approaches. |

According to the results of our stability analysis and the inspection records, it is believed that the ground movements are not due to deep seated instability or the overstressing of the underlying cohesive subsoil. Rather, these ground movements are largely caused by the surficial instability of the approach fills and the improper mode of supports for the end spans. The approach fill material, being composed of uniformly graded fine grained granular soil, is difficult to compact. Further, such material is susceptible to surficial erosion. The slope angle of 1¼:1 originally adopted for the forward slopes of the approaches is undoubtedly too steep for such fill material to remain stable when it is saturated with surface water. The subsequent movements of the end spans of the bridge noted after the forward slopes had been modified to 2:1 can be attributed to the improper mode of supports for the end spans. In our opinion, the supporting system adopted here is not the most desirable one since the supporting system was placed right on the ground surface immediately behind the slopes without proper keying. Such supports do not have adequate resistance against lateral forces and further, are very vulnerable to frost action, erosion and traffic impact.

To minimize the loss of ground and ground movements, the following recommendations should be adopted:

1. If the present length of the bridge is to be maintained, then the existing approach fill material for a minimum distance of 50 feet behind the structure should be replaced with properly compacted well graded granular material. Alternatively, the existing approaches consisting of loosely placed uniform fine grained material should be flattened to an overall slope of 2 3/4:1 in the longitudinal direction. This can also be achieved by incorporating a 15 foot wide berm at mid-height as shown below.




2. The forward slopes should be protected from scour with rip-rap up to the high high water level. Existing scour holes adjacent to the approaches should be backfilled with rip-rap.

3. Remove the existing end supports consisting of 12" x 12" timber sills which were constructed on the top of the existing slopes. Remove also the temporary gabion supports which were placed in the middle of the end span.

4. If the structure is lengthened a new pile bent will be required on either side of the creek at the location of the existing end supports. The recommendations for the pile bents are given in the sequel.

5. Construct new abutments. In the case of a flatter forward slope, without any removal of the existing fill material, the structure will have to be lengthened by some 15 feet at either end. However, if the approaches are excavated and replaced with well compacted granular material, the new abutments can be located at the present end supports. In either case, the abutments should be constructed in such a manner that they should have a 6 foot high wall. Such walls can be composed of timber lagging placed against the last row of piles to prevent any washout of material in the longitudinal direction.

6. Backfill behind the abutments should be composed of free draining granular material. The abutments should be designed to withstand the lateral earth pressure behind these units. It should be noted that the passive resistance offered by the material in front of the abutment wall should be neglected in the design.

7. The new pier bents and the new abutment bents should be supported on #14 treated timber friction piles. The allowable capacity should be based on the depth of penetration into the natural ground and can be determined from the following table.

| Tip Elevation (ft.) | Allowable Load (tons/pile) |
|---|---|
| 810 | 13.5 |
| 808 | 14.5 |
| 806 | 16.0 |
| 804 | 18.0 |

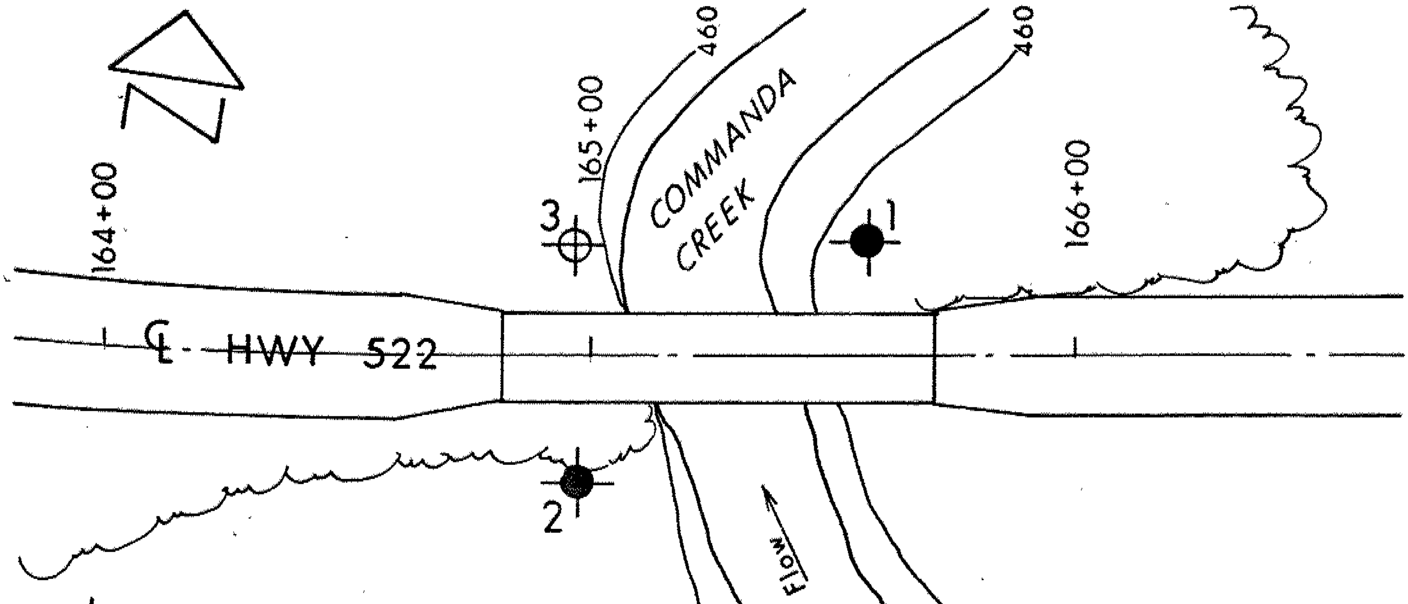
B. Ly

B. Ly, P. Eng.
Senior Engineer

M. Devata

M. Devata, P. Eng.
Supervising Engineer

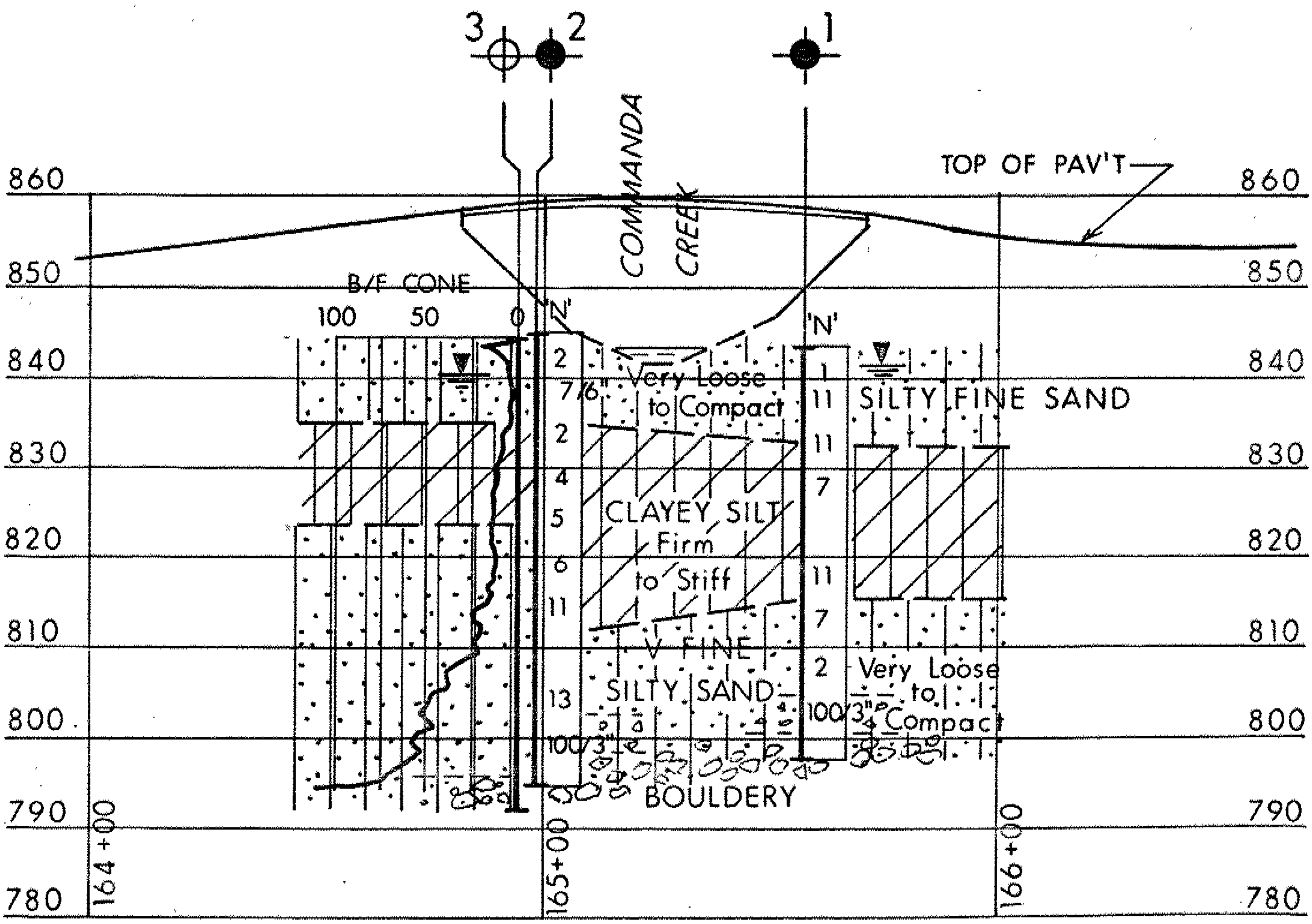
APPENDIX




BORE HOLE
DYNAMIC CONE TEST & STRAIGHT AUGERING

PLAN

SCALE 1" = 40'




PROFILE

COMMANDA CREEK BRIDGE

WP 137-76-04

~~WO 77-11004~~

SITE 44-30

DIST 13

SCALE HOR 1" = 40'
VERT 1" = 20'

Ministry of Transportation and Communications
Ontario

HIGHWAY ENGINEERING DIVISION - ENGINEERING MATERIALS OFFICE - SOIL MECHANICS SECTION

# RECORD OF BOREHOLE No 1

WP 137-76-04

W O 77-11004    LOCATION Sta. 165+56, 24.5' Lt.    ORIGINATED BY BL
DIST 13 HWY 522    BOREHOLE TYPE Hollow Stem Augers    COMPILED BY BL
DATUM Geodetic    DATE November 21 and 22, 1978    CHECKED BY [signature]

| ELEV / DEPTH | DESCRIPTION | STRAT PLOT | NUMBER | TYPE | 'N' VALUES | GROUND WATER CONDITIONS | ELEVATION SCALE | SHEAR STRENGTH | WATER CONTENT (%) | UNIT WEIGHT γ | REMARKS & GRAIN SIZE DISTRIBUTION (%) GR SA SI CL |
|---|---|---|---|---|---|---|---|---|---|---|---|
| 843.0 | Ground Surface | | | | | | | | | | |
| 0.0 | Silty Fine Sand Very Loose to Compact | | 1 | SS | 1 | ▼ | 840 | | | | 0 60 40 0 |
| | | | 2 | SS | 11 | | | | | | |
| 832.5 | | | 3 | SS | 11 | | | | | | |
| 10.5 | Clayey Silt Grey Firm to Stiff | | | | | | 830 | | | | |
| | | | 4 | SS | 7 | | | | | | 0 2 (98) |
| | | | | | | | | + s=4 | | | |
| | | | 5 | TW | PM | | | | | | 0 2 78 20 |
| | | | | | | | 820 | + s=3 | | | |
| 815.0 | | | 6 | SS | 11 | | | | | | |
| 28.0 | Very Fine Silty Sand Very Loose to Loose | | | | | | | + s=2 | | | |
| | | | 7 | SS | 7 | | | | | | |
| | | | | | | | 810 | | | | |
| | | | 8 | SS | 2 | | | | | | |
| | Gravelly | | 9 | SS | 100/ 3" Rec | | | | | | |
| 798.0 | Bouldery | | 10 | BX | 0% | | 800 | | | | |
| 45.0 | End of Borehole | | | | | | | | | | |

DYNAMIC CONE PENETRATION RESISTANCE PLOT: 20 40 60 80 100
SHEAR STRENGTH: O UNCONFINED + FIELD VANE ● QUICK TRIAXIAL × LAB VANE 500 1000 1500 2000 2500
PLASTIC LIMIT $W_p$ — NATURAL MOISTURE CONTENT W — LIQUID LIMIT $W_L$; WATER CONTENT (%) 10 20 30

$+^3$, $\times^5$ : Numbers refer to Sensitivity    15 -◇- 5 (%) STRAIN AT FAILURE (20 above, 10 below)

OFFICE REPORT ON SOIL EXPLORATION

Ministry of Transportation and Communications
Ontario

HIGHWAY ENGINEERING DIVISION-ENGINEERING MATERIALS OFFICE-SOIL MECHANICS SECTION

# RECORD OF BOREHOLE No 2

WP 137-76-04

W O ~~77-11004~~ LOCATION Sta. 164+96, 25' Rt. ORIGINATED BY BL

DIST 13 HWY 522 BOREHOLE TYPE Hollow Stem Augers COMPILED BY BL

DATUM Geodetic DATE November 23, 1978 CHECKED BY [signature]

| ELEV / DEPTH | SOIL PROFILE: DESCRIPTION | SAMPLES: NUMBER | TYPE | 'N' VALUES | GROUND WATER CONDITIONS | ELEVATION SCALE | SHEAR STRENGTH (+ FIELD VANE) | WATER CONTENT (%) | REMARKS & GRAIN SIZE DISTRIBUTION (%) GR SA SI CL |
|---|---|---|---|---|---|---|---|---|---|
| 845.0 | Ground Surface | | | | | | | | |
| 0.0 | Silty Fine Sand<br>Very Loose to Compact | 1 | SS | 2 | | | | | |
| | | 2 | SS | 7/6" | water level | 840 | | | 0 80 (20) |
| 835.0 | | | | | | | | | |
| 10.0 | Clayey Silt<br>Grey<br>Firm to Stiff | 3 | SS | 2 | | | + s=2 | Wp–W–WL plotted | |
| | | 4 | SS | 4 | | 830 | + s=3 | Wp–W–WL plotted | 0 1 (99) |
| | | 5 | SS | 5 | | | + s=3 | | |
| | | 6 | SS | 6 | | 820 | + s=2 | Wp–W–WL plotted | |
| | | 7 | SS | 11 | | | | | |
| 811.0 | | | | | | | | | |
| 34.0 | Very Fine Silty Sand, Very Loose Compact | 8 | SS | - | | 810 | | | |
| | | 9 | SS | 13 | | | | | |
| | Gravelly | 10 | SS | 100/3" | | 800 | | | |
| | Bouldery | | | | | | | | |
| 795.0 | | | | | | | | | |
| 50.0 | End of Borehole<br>Note: Augering Met Refusal at 50 Feet on a Boulder | | | | | | | | |

DYNAMIC CONE PENETRATION RESISTANCE PLOT: 20 40 60 80 100

SHEAR STRENGTH: O UNCONFINED, + FIELD VANE, ● QUICK TRIAXIAL, × LAB VANE — 500 1000 1500 2000 25000

PLASTIC LIMIT Wp, NATURAL MOISTURE CONTENT W, LIQUID LIMIT WL — WATER CONTENT (%) 10 20 30

UNIT WEIGHT γ

OFFICE REPORT ON SOIL EXPLORATION

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

15 ⟡ 5 (%) STRAIN AT FAILURE (20 above, 10 below)

WP 137-76-02

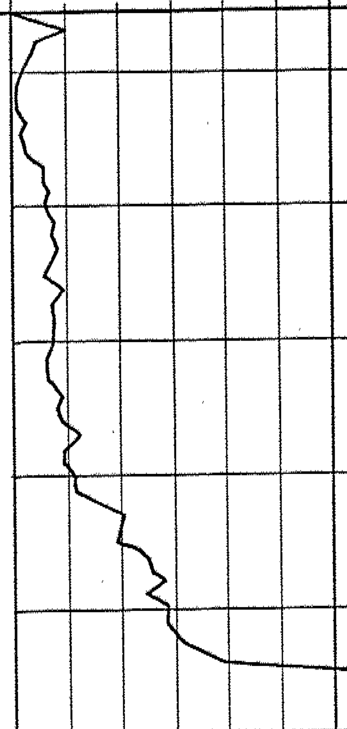
# RECORD OF BOREHOLE No 3

W O ~~77-11004~~ LOCATION Sta. 164+96, 23.5' Lt. ORIGINATED BY BL

DIST 13 HWY 522 BOREHOLE TYPE Straight Augering and Dynamic Cone Test COMPILED BY BL

DATUM Geodetic DATE November 24, 1978 CHECKED BY [signature]

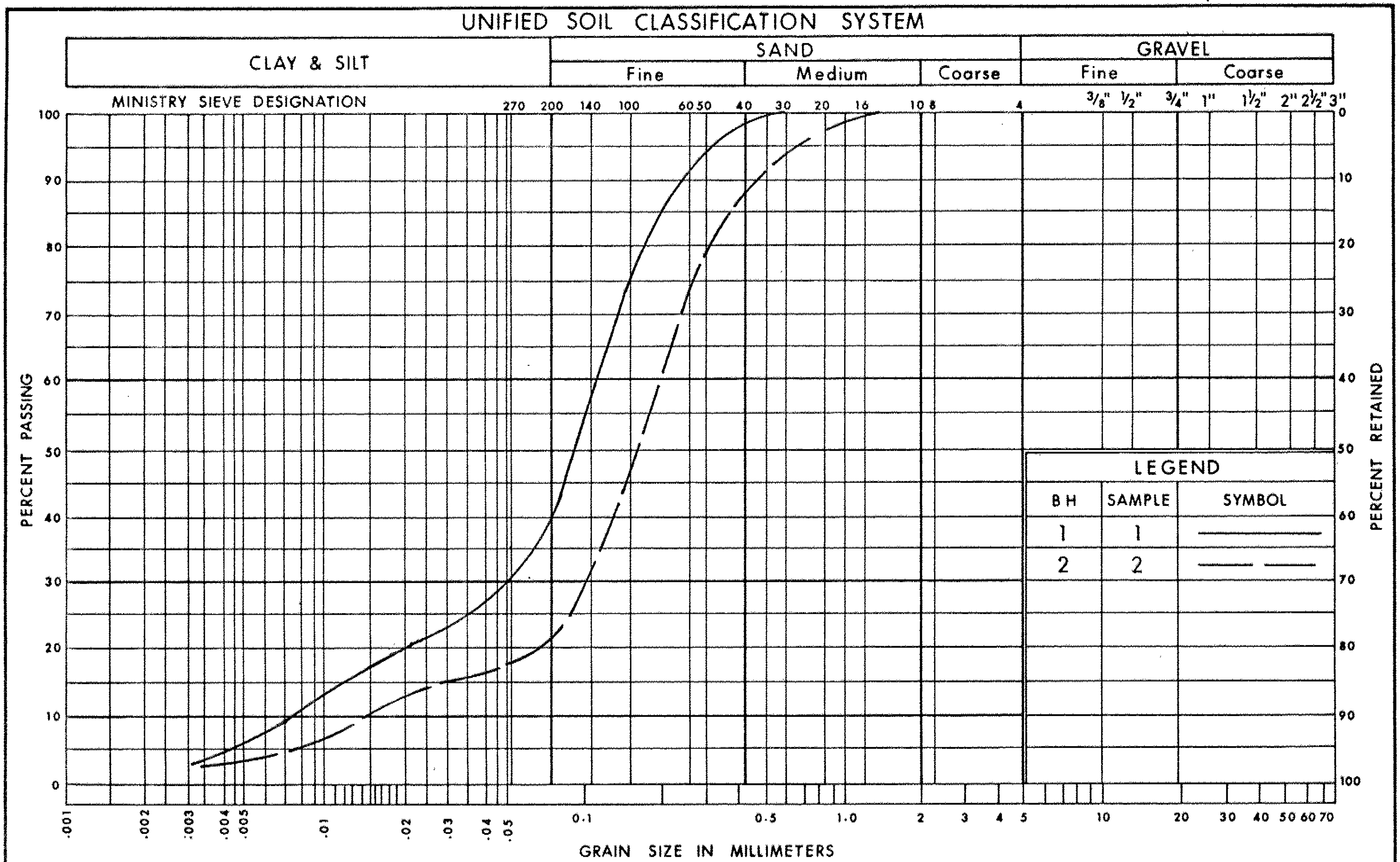
| SOIL PROFILE: ELEV DEPTH | SOIL PROFILE: DESCRIPTION | STRAT PLOT | SAMPLES: NUMBER | SAMPLES: TYPE | SAMPLES: 'N' VALUES | GROUND WATER CONDITIONS | ELEVATION SCALE | DYNAMIC CONE PENETRATION RESISTANCE PLOT (20 40 60 80 100) / SHEAR STRENGTH (o UNCONFINED, + FIELD VANE, ● QUICK TRIAXIAL, × LAB VANE) | PLASTIC LIMIT Wp, NATURAL MOISTURE CONTENT W, LIQUID LIMIT WL — WATER CONTENT (%) | UNIT WEIGHT γ | REMARKS & GRAIN SIZE DISTRIBUTION (%) GR SA SI CL |
|---|---|---|---|---|---|---|---|---|---|---|---|
| 844.5 | Ground Surface | | | | | | | | | | |
| 0.0 | Silty Fine Sand (Inferred) | | | | | | 840 | | | | |
| 834.5 | | | | | | | | | | | |
| 10.0 | Clayey Silt (Inferred) | | | | | | 830 | | | | |
| | | | | | | | 820 | | | | |
| 823.5 | | | | | | | | | | | |
| 21.0 | Very Fine Silty Sand (Inferred) | | | | | | 810 | | | | |
| | | | | | | | 800 | | | | |
| | Bouldery | | | | | | | | | | |
| 791.5 | | | | | | | | | | | |
| 53.0 | End of Augered Hole<br>Note: Augering Met Refusal at 53 Feet on a Boulder | | | | | | | | | | |



+3, ×5 : Numbers refer to Sensitivity

15 -◇- 5 (20 above, 10 below) (%) STRAIN AT FAILURE

Oct 75, FF-S-22

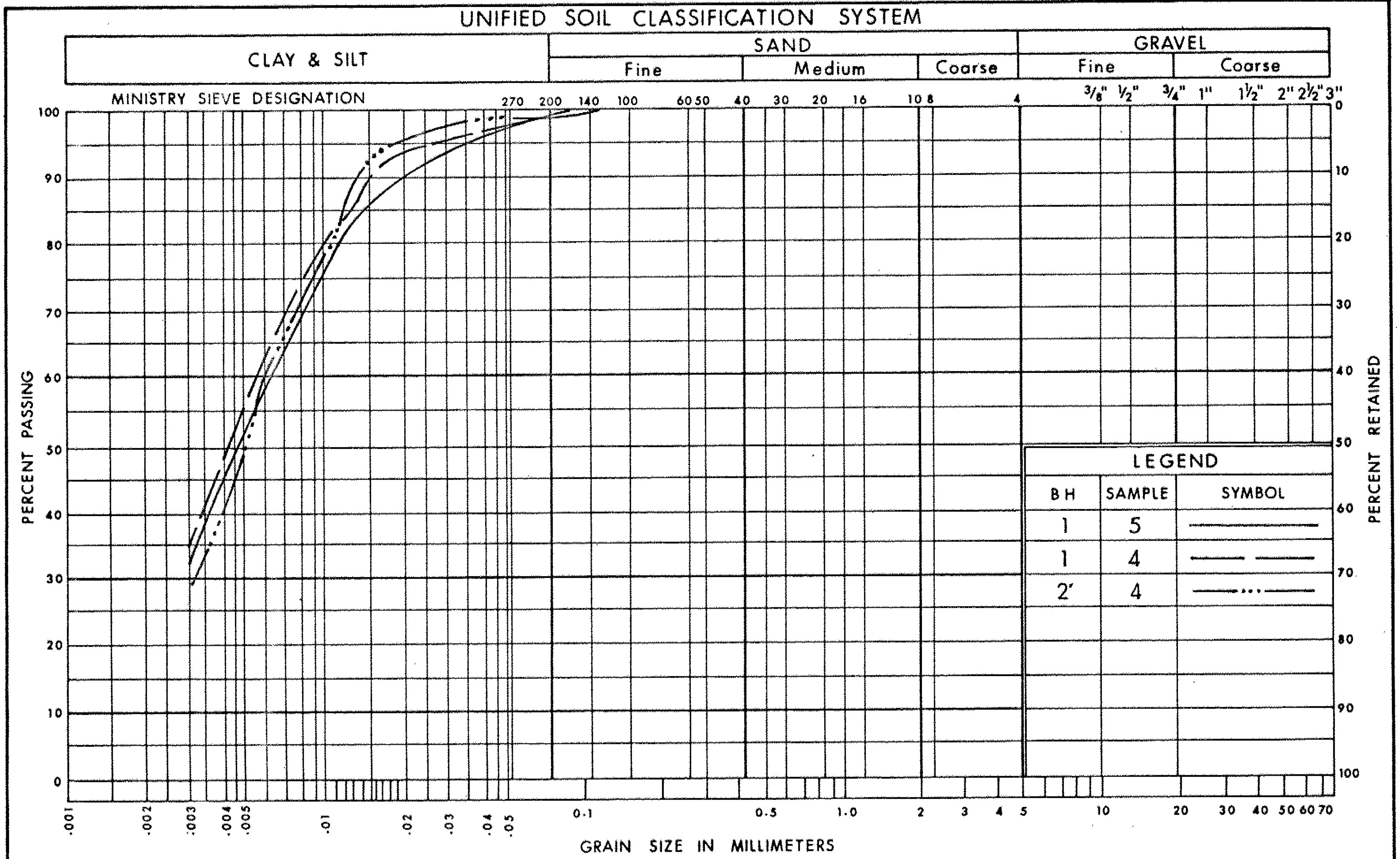



Ministry of Transportation and Communications
Ontario
ENGINEERING SERVICES BRANCH

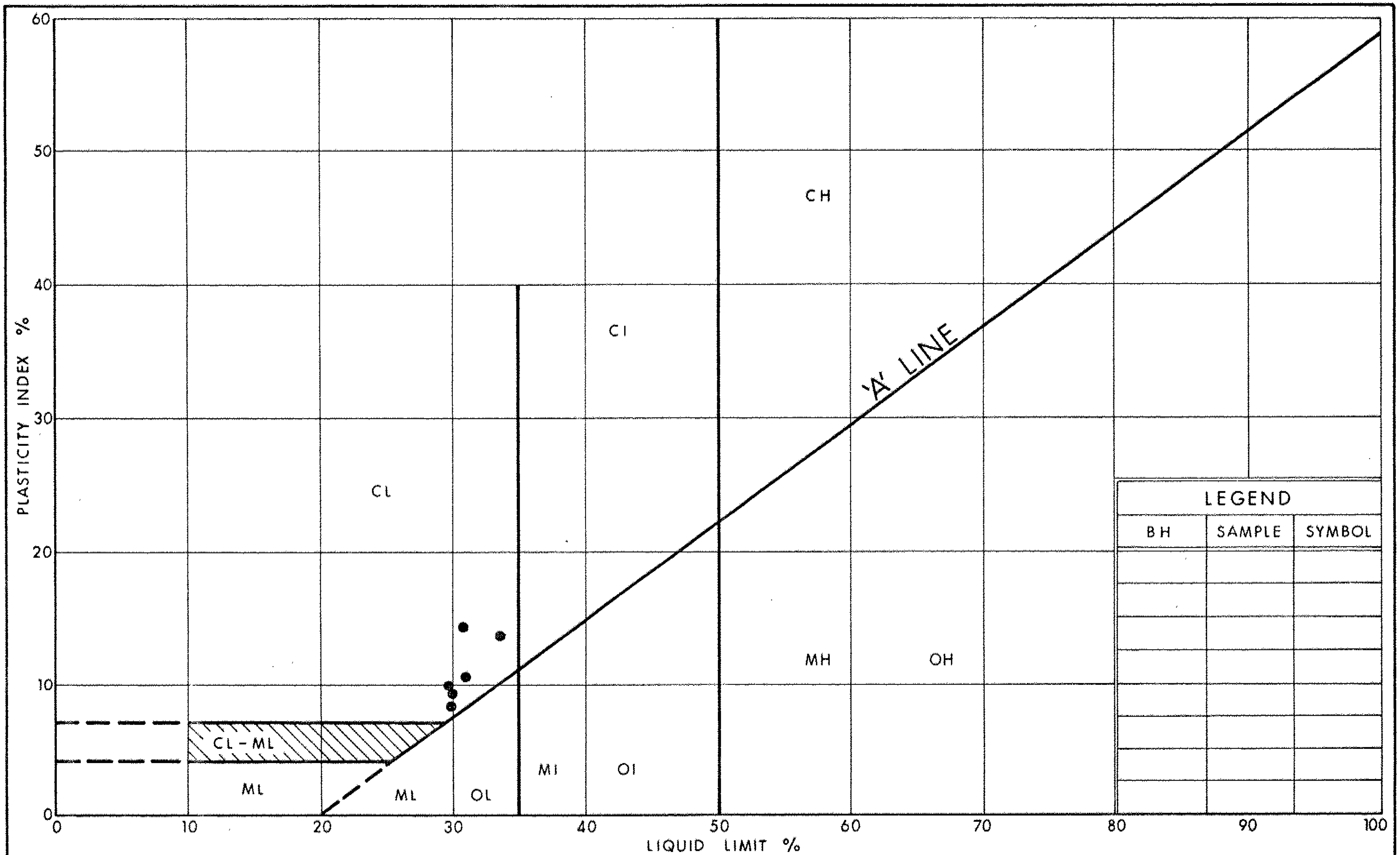
# GRAIN SIZE DISTRIBUTION
# SILTY SAND

FIG No 1

W O 77-11004




| Ministry of Transportation and Communications, Ontario<br>ENGINEERING SERVICES BRANCH | GRAIN SIZE DISTRIBUTION<br>CLAYEY SILT | FIG No 2<br>WO 77-11004 |
|---|---|---|




| | | |
|---|---|---|
| Ministry of Transportation and Communications<br>Ontario<br>ENGINEERING SERVICES BRANCH | PLASTICITY CHART<br>CLAYEY SILT | FIG No 3<br>WO 77-11004 |

# 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 $\overline{N}$.

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. $\overline{CIU}$ = 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

- $\mu$ COEFFICIENT OF FRICTION
- $\delta$ 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
- $\omega$ SLOPE ANGLE-BACKFACE OF WALL
- $\beta$ ANGLE OF SLOPE
- $N_\gamma, N_q, N_c$ BEARING CAPACITY FACTORS
- $D_f$ DEPTH OF FOOTING
- B,L FOOTING DIMENSIONS

### INDEX PROPERTIES

- $\gamma$ UNIT WEIGHT OF SOIL (BULK DENSITY)
- $\gamma_w$ UNIT WEIGHT OF WATER
- $\gamma_d$ UNIT DRY WEIGHT OF SOIL (DRY DENSITY)
- $\gamma'$ 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 = $\frac{w - w_P}{I_P}$
- $I_c$ CONSISTENCY INDEX = $\frac{w_L - w}{I_P}$
- $A_c$ ACTIVITY = $\frac{I_p \text{ of soil}}{\% < 2\mu m \text{ Soil Fraction}}$
- Om ORGANIC MATTER CONTENT
- $S_r$ DEGREE OF SATURATION
- S SENSITIVITY = $\frac{S_u \text{ (undisturbed)}}{S_u \text{ (remoulded)}}$

### STRENGTH PARAMETERS

- $\phi$ ANGLE OF SHEARING RESISTANCE
- $\tau_f$ PEAK SHEAR STRENGTH
- $\tau_R$ 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
- $\epsilon$ LINEAR STRAIN
- $\gamma$ SHEAR STRAIN
- $\nu$ 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:
$\phi'$ = EFFECTIVE ANGLE OF SHEARING RESISTANCE;
$\sigma'$ = 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
- $\eta$ 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
- $C_r$ OVERCONSOLIDATION RATIO (OCR)

Mr. E. Van Beilen 1980-06-04
Head, North/Northwestern Section
Structural Office
West Building

From: Pavement & Foundation Design Section
Room 313, Central Building
Downsview

Re: Commanda Creek Bridge
W.P. 137-76-04, Site 44-30
Hwy. 522, Dist. 13, North Bay

A review of the final drawings for this structure leads to the following comments.

1) All piles should be specified as treated timber piles.

2) A driving note on the drawing should specify the tip elevation to which the piles are to be driven.

3) No reinforcement of the pile tips, as shown on SS 3-3, is required.

Peter J. Stuart
Foundations Engineer
For:
M. Devata
Senior Foundations Engineer

:ea

Ministry of Transportation and Communications
Ontario

# Memorandum

To: Mr. C. Mirza
Soils Mechanics Section
West Building, Downsview

From: Engineering & Right-of-Way Office
Structural Section
Northern Region

Attention: Mr. B. L. Ly

Date: 78 09 26

Our File Ref.

In Reply to

W-0-77-11004

Subject: Commanda Creek Bridge
Highway 522
Site 44-30
District #13, North Bay

Enclosed please find two prints of plotted profiles and cross-sections of the highway and creek at the subject site. for your information.

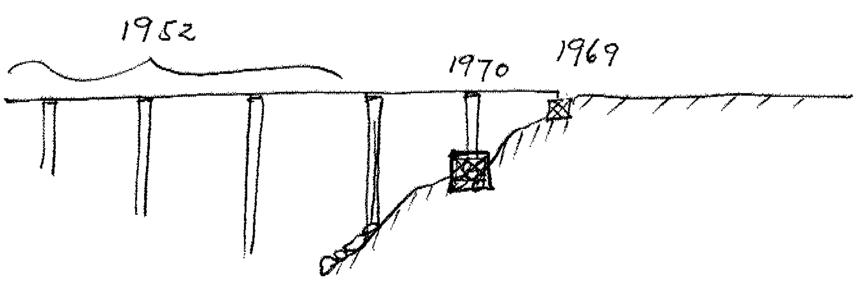
The original four span timber pile bent structure with longitudinal laminated timber deck, built in 1952, was lengthened in 1969 at both ends, by adding 15 foot simple longitudinal timber deck end spans, founded at one end on the original abutment bents and on one layer of gabion baskets with timber bearing cap at the other end. The new end spans were further strengthened in 1969-70 by placing mid-span support timbers on gabions. The addition of the end spans was necessitated by the continual settlement of the approach roadway and the horizontal displacement of piles in the original structure due to pressure from shifting approach slopes.

As can be noted from the highway profile, the approach spans have settled and are continuing to settle, causing excessive vehicle impact on the structure, although horizontal pressure on the timber piling has been somewhat relieved.

Preliminary consideration by the Region for long-term corrective improvement of the site include the following proposals:-

a) Removal of added end spans and gabions in stages to maintain one lane of traffic. Drive timber piles and construct a bent adjacent to original timber abutment and another one or more bents at approximately fifteen foot centres from this and installing new superstructure with re-graded abutment front slopes.

b) As above, except for installation of rock filled timber cribs as approach end of spans support, in place of timber bents.



We request your advice as to the appropriate long term resolution based upon the above, or other system you may feel suitable, including length of extensions required and type of foundations needed, in order to stabilize the approaches and negate the effect of sub-soil pressure on the structure throughout.

H. W. CECIL RAHN
FOR:
J. C. McALLISTER
HEAD, STRUCTURAL SECTION

HWCR/JCMcA/tt

cc: E. VanBeilen
D. J. Armatage
D. S. Cornell

Mr. J. McAllister, Head
Structural Section
Northern Region, North Bay

Soil Mechanics Section
Engineering Materials Office
West Building, Downsview

77 11 16

Re: Commanda Creek Bridge
W.O. 77-11004,/Site 44-30
Hwy. 522, District 13, North Bay

At the Regional Structural Section's request, the undersigned visited the site on October 25, 1977, accompanied by Mr. C. Rahn from the Region. Our observations and comments are as follows:

The existing structure is supported on timber pile bents, except at both ends where the deck is resting on a 12" x 12" timber sill on ground surface. In addition, each end span is supported in the centre by two 12" x 12" timber sills on 3' x 3' x 6' rock-filled gabions, which are also placed on the ground surface. In our opinion, such a foundation scheme is not desirable because being placed on ground surface, these supports do not have adequate resistance against lateral forces and are vulnerable to frost action and erosion. We recommend that the end spans should be supported on either timber piles or rockfilled timber cribs which should be founded at a depth of at least 6 feet below ground surface. These recommendations are given for your preliminary studies only. When a foundation scheme has been decided on, a detailed foundation investigation should be carried out in order to provide pertinent information for the design of the structure foundations and the approaches.

B. Ly

B. Ly
Senior Engineer

For: M. Devata
Supervising Engineer

BL/gs

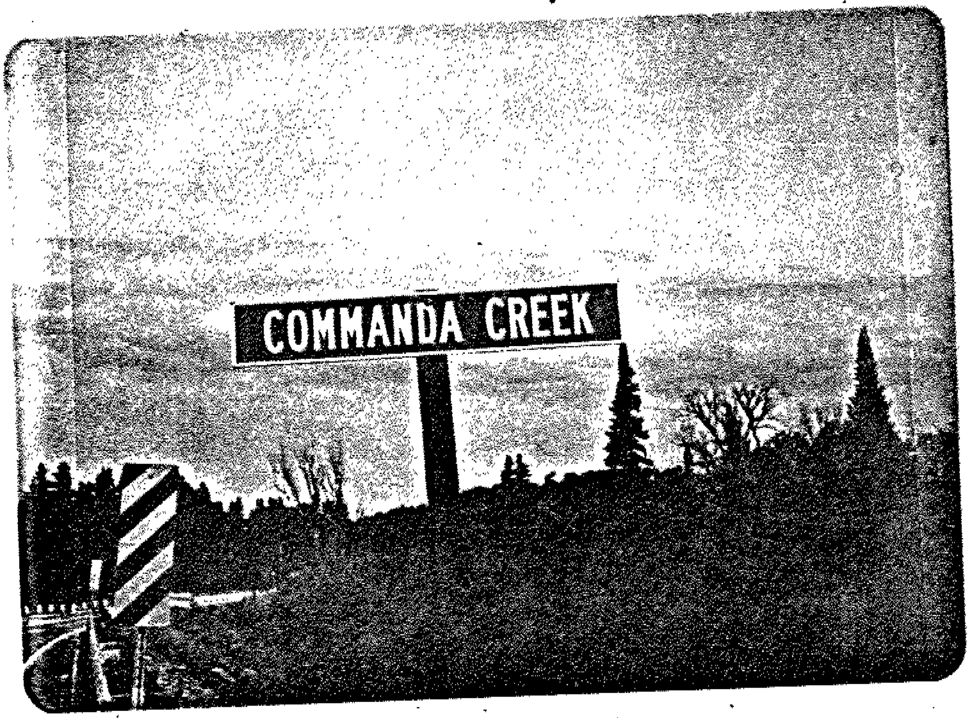
cc: Files

Film #
Taken by: HSB

SITE NO: 44-30
NAME OF STRUCTURE: mmanda Ck.



HIGHWAY: 522
DISTRICT: 13
DATE: July 1976.



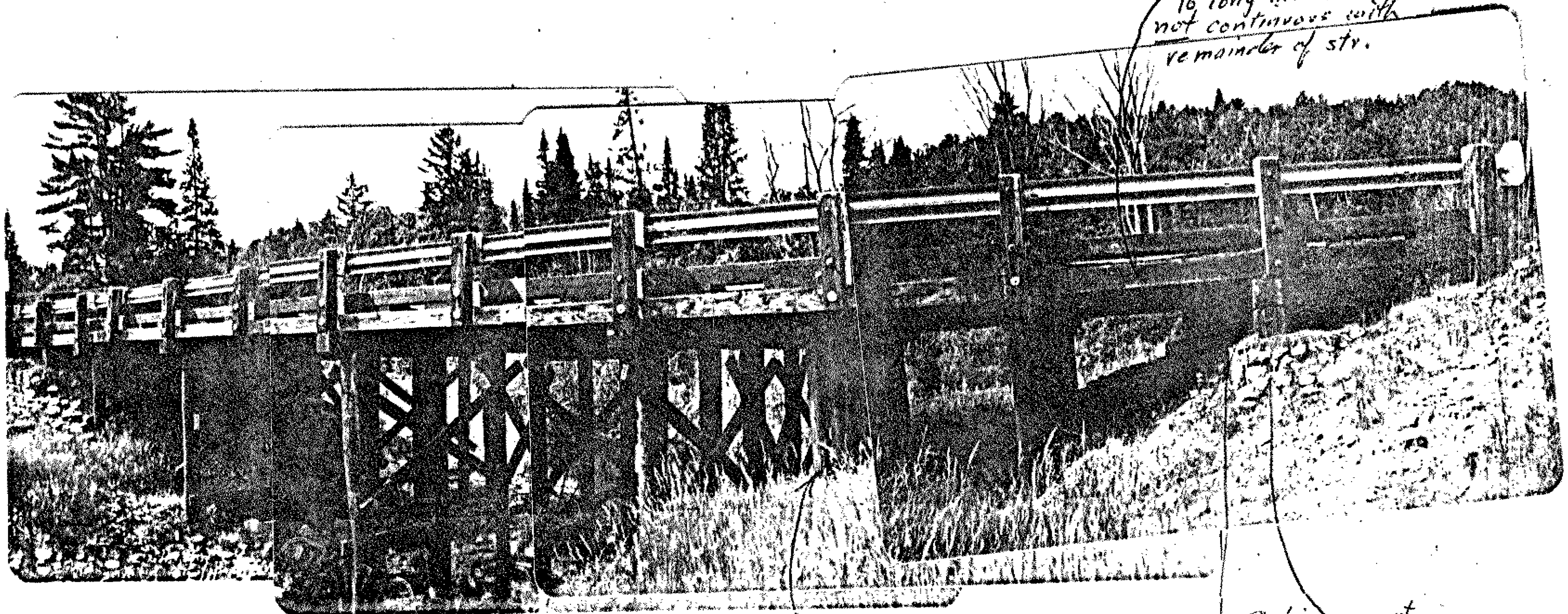

Grader blade reinforcing to deck underside.

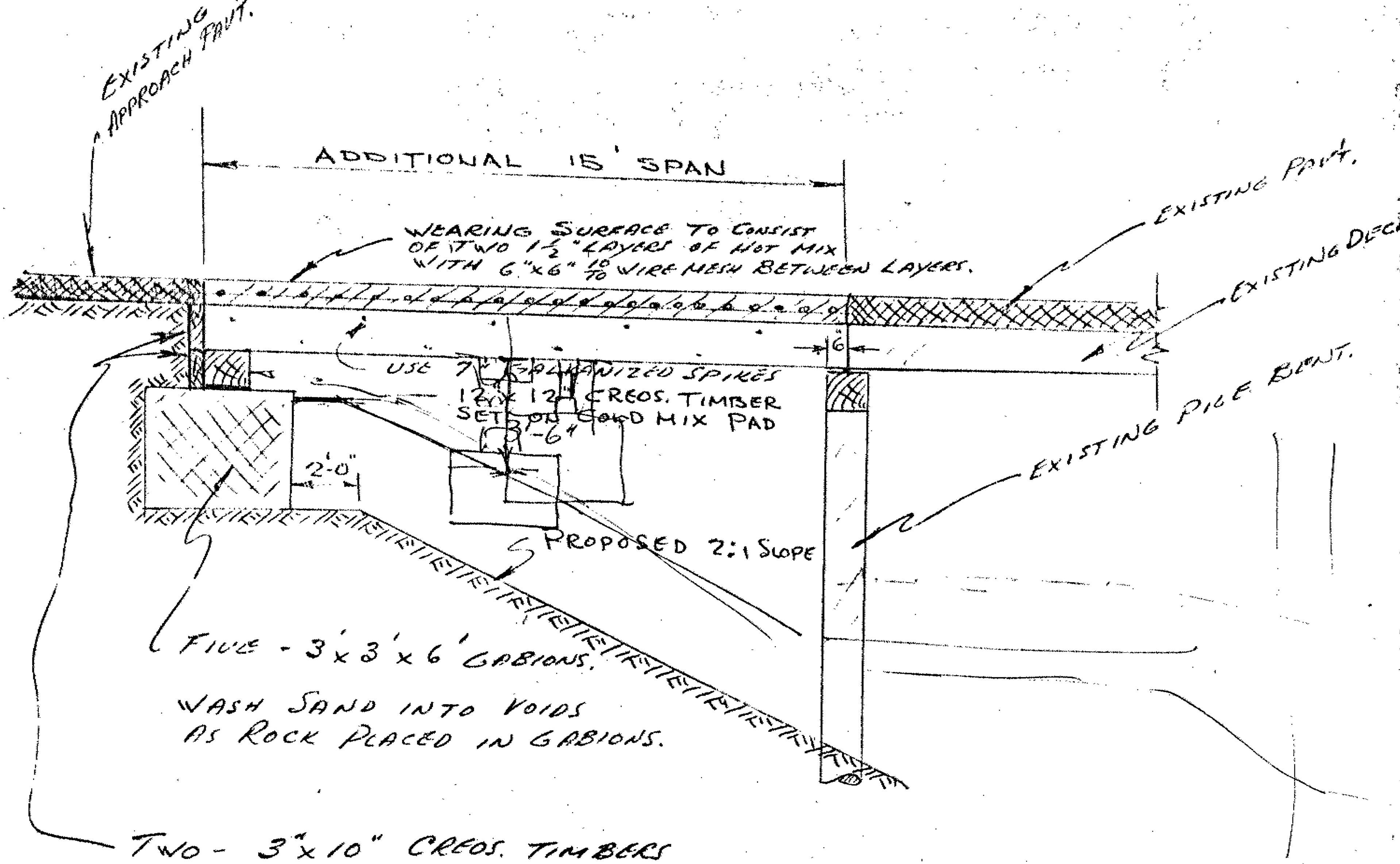
Un-treated timber additional bent added by Bridge Crew in 1975.

SITE NO: 44-30
NAME OF STRUCTURE: Commanda Cr.

HIGHWAY: 522
DISTRICT: 13
DATE: July 1976

Film #
Taken by: H.B.






SUGGESTED ABUT. SEAT & WEARING SURFACE FOR

COMMANDA CK. BR.

HWY 522 SITE INDEX :- 44-30

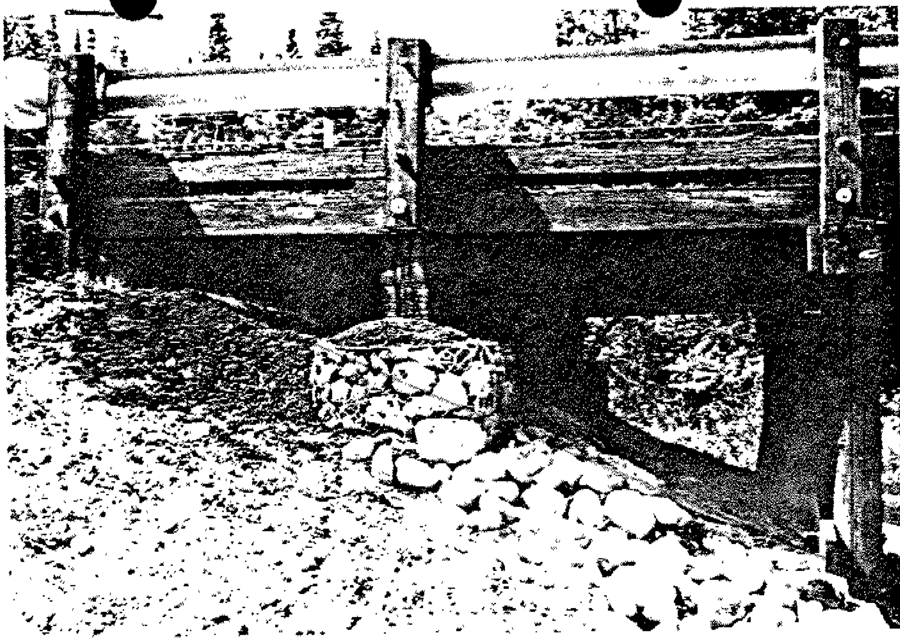
DIST. 13 NORTH BAY.

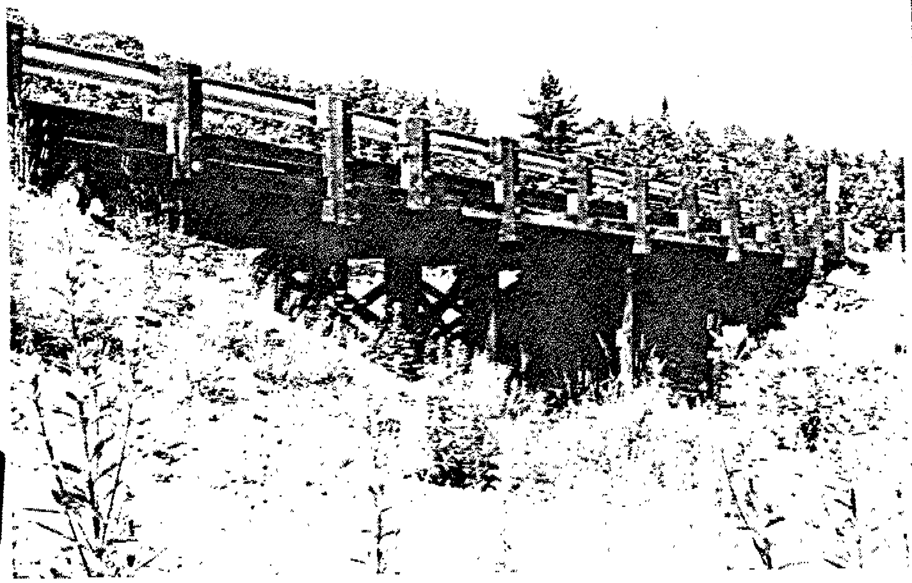
979
~~Film~~ #148

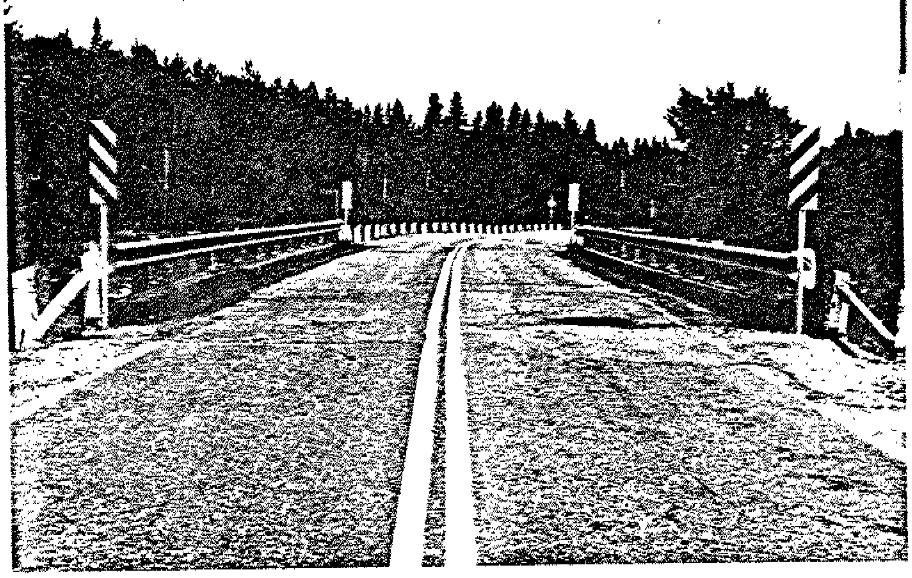
Commando Creek Bridge
Hwy. 522, Dist 13

41-30.

Commando Creek Bridge 44-50







Commando Creek Bridge 41-30