

DOCUMENT. MICROFILMING IDENTIFICATION

GEOCRES No. 84 40I16-19

DIST. 4 REGION

W.P. No. 246-62-01

CONT. No. 84-66

W. O. No.

STR. SITE No. 9-126-41

HWY. No. 3

LOCATION Sandusky Creek
Crossing

No of PAGES -

=====

OVERSIZE DRAWINGS TO BE INCLUDED WITH THIS REPORT.

REMARKS:

G.I.-30 SEPT. 1976

FOUNDATION INVESTIGATION REPORT

CONTRACT NO 84 - 66



Ministry of
Transportation and
Communications

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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 report.

EXPLANATION OF TERMS USED IN REPORT

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

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

SOILS ARE DESCRIBED BY THEIR COMPOSITION AND CONSISTENCY OR DENSENESS.

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

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

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

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

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

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

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

| R Q D (%) | 0 - 25 | 25 - 50 | 50 - 75 | 75 - 90 | 90 - 100 |
|-----------|-----------|---------|---------|---------|-----------|
| | VERY POOR | POOR | FAIR | GOOD | EXCELLENT |

JOINTING AND BEDDING:

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

ABBREVIATIONS AND SYMBOLS

FIELD SAMPLING

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

STRESS AND STRAIN

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

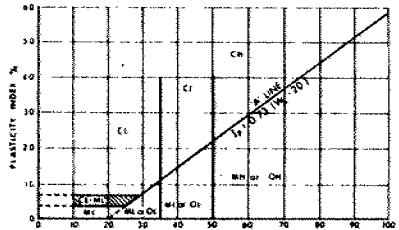
MECHANICAL PROPERTIES OF SOIL

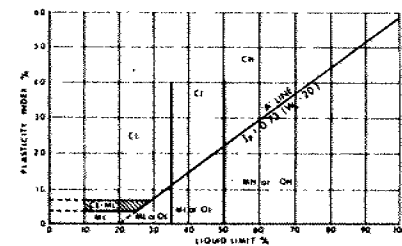
| | | |
|----------------|-------------------|--------------------------------------|
| m_v | kPa ⁻¹ | COEFFICIENT OF VOLUME CHANGE |
| C_c | 1 | COMPRESSION INDEX |
| C_s | 1 | SWELLING INDEX |
| C_α | 1 | RATE OF SECONDARY CONSOLIDATION |
| c_v | m ² /s | COEFFICIENT OF CONSOLIDATION |
| H | m | DRAINAGE PATH |
| T_v | 1 | TIME FACTOR |
| U | % | DEGREE OF CONSOLIDATION |
| σ'_{v0} | kPa | EFFECTIVE OVERBURDEN PRESSURE |
| σ'_p | kPa | PRECONSOLIDATION PRESSURE |
| τ_f | kPa | SHEAR STRENGTH |
| c' | kPa | EFFECTIVE COHESION INTERCEPT |
| ϕ' | -° | EFFECTIVE ANGLE OF INTERNAL FRICTION |
| c_u | kPa | APPARENT COHESION INTERCEPT |
| ϕ_u | -° | APPARENT ANGLE OF INTERNAL FRICTION |
| τ_r | kPa | RESIDUAL SHEAR STRENGTH |
| τ_r | kPa | REMOULDED SHEAR STRENGTH |
| S_t | 1 | SENSITIVITY = $\frac{c_u}{\tau_r}$ |

PHYSICAL PROPERTIES OF SOIL

| | | | | | | | | |
|----------------|-------------------|--------------------------------|-----------|------|---|-----------|-------------------|---|
| ρ_s | kg/m ³ | DENSITY OF SOLID PARTICLES | e | 1, % | VOID RATIO | e_{min} | 1, % | VOID RATIO IN DENSEST STATE |
| γ_s | kN/m ³ | UNIT WEIGHT OF SOLID PARTICLES | n | 1, % | POROSITY | I_D | 1 | DENSITY INDEX = $\frac{e_{max} - e}{e_{max} - e_{min}}$ |
| ρ_w | kg/m ³ | DENSITY OF WATER | w | 1, % | WATER CONTENT | D | mm | GRAIN DIAMETER |
| γ_w | kN/m ³ | UNIT WEIGHT OF WATER | S_r | % | DEGREE OF SATURATION | D_n | mm | n PERCENT - DIAMETER |
| ρ | kg/m ³ | DENSITY OF SOIL | w_L | % | LIQUID LIMIT | C_u | 1 | UNIFORMITY COEFFICIENT |
| γ | kN/m ³ | UNIT WEIGHT OF SOIL | w_p | % | PLASTIC LIMIT | h | m | HYDRAULIC HEAD OR POTENTIAL |
| ρ_d | kg/m ³ | DENSITY OF DRY SOIL | w_s | % | SHRINKAGE LIMIT | q | m ³ /s | RATE OF DISCHARGE |
| γ_d | kN/m ³ | UNIT WEIGHT OF DRY SOIL | I_p | % | PLASTICITY INDEX = $w_L - w_p$ | v | m/s | DISCHARGE VELOCITY |
| ρ_{sat} | kg/m ³ | DENSITY OF SATURATED SOIL | I_L | 1 | LIQUIDITY INDEX = $\frac{w - w_p}{I_p}$ | i | 1 | HYDRAULIC GRADIENT |
| γ_{sat} | kN/m ³ | UNIT WEIGHT OF SATURATED SOIL | I_C | 1 | CONSISTENCY INDEX = $\frac{w_L - w}{I_p}$ | k | m/s | HYDRAULIC CONDUCTIVITY |
| ρ' | kg/m ³ | DENSITY OF SUBMERGED SOIL | e_{max} | 1, % | VOID RATIO IN LOOSEST STATE | j | kN/m ³ | SEEPAGE FORCE |
| γ' | kN/m ³ | UNIT WEIGHT OF SUBMERGED SOIL | | | | | | |

EXTENDED CASAGRANDE SOIL CLASSIFICATION SYSTEM

| FIELD IDENTIFICATION PROCEDURES (EXCLUDING PARTICLES LARGER THAN 75 mm 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 75 μ m (SMALLEST PARTICLE VISIBLE TO THE NAKED EYE) | GRAVELS | 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. FOR UNDISTURBED SOILS ADD INFORMATION ON STRATIFICATION, DEGREE OF COMPACTNESS, CEMENTATION, MOISTURE CONDITIONS & DRAINAGE CHARACTERISTICS. | DETERMINE PERCENTAGES OF GRAVEL & SAND FROM GRAIN SIZE CURVE. DEPENDING ON PERCENTAGE OF FINES (FRACTION SMALLER THAN 75 μ m) COARSE GRAINED SOILS ARE CLASSIFIED AS FOLLOWS: LESS THAN 5% GW, GP, SW, SP MORE THAN 12% GW, GC, SM, SC 5% TO 12% <u>BORDERLINE CASES</u> REQ. USE OF DUAL SYMBOLS | |
| | | GRAVEL WITH FINES (APPRECIABLE AMOUNT OF FINES) | PREDOMINANTLY ONE SIZE OF A RANGE OF SIZES WITH SOME INTERMEDIATE SIZES MISSING | | GP | POORLY GRADED GRAVELS, GRAVEL-SAND MIXTURES, LITTLE OR NO FINES | | C _u = $\frac{D_{60}}{D_{10}}$ GREATER THAN 4 C _c = $\frac{(D_{30})^2}{D_{10} \cdot D_{60}}$ BETWEEN ONE AND 3 NOT MEETING ALL GRADATION REQUIREMENTS FOR GW | |
| | | | NON-PLASTIC FINES (FOR IDENTIFICATION PROCEDURES SEE ML BELOW) | | GM | SILTY GRAVELS, POORLY GRADED GRAVEL-SAND-SILT MIXTURES | | ATTENBERG LIMITS BELOW A-LINE, OR I_p LESS THAN 4 | |
| | | PLASTIC FINES (FOR IDENTIFICATION PROCEDURES SEE CL BELOW) | | GC | CLAYEY GRAVELS, POORLY GRADED GRAVEL-SAND-CLAY MIXTURES | ATTENBERG LIMITS ABOVE A-LINE WITH I_p GREATER THAN 7 | | | |
| | SANDS | 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 | C _u = $\frac{D_{60}}{D_{10}}$ GREATER THAN 6 C _c = $\frac{(D_{30})^2}{D_{10} \cdot D_{60}}$ BETWEEN ONE AND 3 NOT MEETING ALL GRADATION REQUIREMENTS FOR SW | | |
| | | SANDS WITH FINES (APPRECIABLE AMOUNT OF FINES) | PREDOMINANTLY ONE SIZE OR A RANGE OF SIZES WITH SOME INTERMEDIATE SIZES MISSING | | SP | POORLY GRADED SANDS, GRAVELLY SANDS, LITTLE OR NO FINES | ATTENBERG LIMITS BELOW A-LINE OR I_p LESS THAN 4 | | |
| NON-PLASTIC FINES (FOR IDENTIFICATION PROCEDURES SEE ML BELOW) | | | SM | SILTY SANDS, POORLY GRADED SAND-SILT MIXTURES | ATTENBERG LIMITS ABOVE A-LINE WITH I_p GREATER THAN 7 | | | | |
| PLASTIC FINES (FOR IDENTIFICATION PROCEDURES SEE CL BELOW) | | SC | CLAYEY SANDS, POORLY GRADED SAND-CLAY MIXTURES | ATTENBERG LIMITS ABOVE A-LINE WITH I_p GREATER THAN 7 | | | | | |
| FINE GRAINED SOILS MORE THAN HALF OF MATERIAL IS SMALLER THAN 75 μ m (75 μ m IS ABOUT THE SMALLEST PARTICLE VISIBLE TO THE NAKED EYE) | IDENTIFICATION PROCEDURES ON FRACTION SMALLER THAN 425 μ m | | | | | | 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 AND INFORMATION ON STRUCTURE, STRATIFICATION, CONSISTENCY IN UNDISTURBED & REMOULDED STATES, MOISTURE & DRAINAGE CONDITIONS |  PLASTICITY CHART FOR LABORATORY CLASSIFICATION OF FINE GRAINED SOILS | |
| | LIQUID LIMIT LESS THAN 35% | DRY STRENGTH (CRUSHING CHARACTERISTICS) | DILATANCY (REACTION TO SHAKING) | TOUGHNESS (CONSISTENCY NEAR PLASTIC LIMIT) | ML | INORGANIC SILTS & SANDY SILTS OF SLIGHT PLASTICITY, ROCK FLOUR | | | |
| | | NONE | QUICK | NONE | CL | CLAYEY SILTS (INORGANIC), GRAVELLY CLAYS, SANDY CLAYS, CLEAN CLAYS | | | |
| | | MEDIUM TO HIGH | NONE TO VERY SLOW | MEDIUM | DL | ORGANIC SILTY OF LOW PLASTICITY, ORGANIC SANDY SILTS | | | |
| | LIQUID LIMIT BETWEEN 35% AND 50% | SLIGHT TO MEDIUM | SLOW | SLIGHT | ML | INORGANIC COMPRESSIBLE FINE SANDY SILT WITH CLAY OF MEDIUM PLASTICITY, CLAYEY SILTS | | | |
| | | NONE TO SLIGHT | SLOW TO QUICK | SLIGHT | CL | SILTY CLAYS (INORGANIC) OF MEDIUM PLASTICITY | | | |
| | | HIGH | NONE | MEDIUM TO HIGH | DL | ORGANIC SILTY CLAYS OF MEDIUM PLASTICITY | | | |
| | LIQUID LIMIT GREATER THAN 50% | SLIGHT TO MEDIUM | VERY SLOW | SLIGHT | ML | INORGANIC SILTS, HIGHLY COMPRESSIBLE MICACEOUS OR DIATOMACEOUS FINE SANDY SILTS, ELASTIC SILTS | | | |
| | | SLIGHT TO MEDIUM | SLOW TO NONE | MEDIUM | CL | CLAYS (INORGANIC) OF HIGH PLASTICITY, FAT CLAYS | | | |
| | | HIGH TO VERY HIGH | NONE | HIGH | DL | ORGANIC CLAYS OF HIGH PLASTICITY | | | |
| | SLIGHT TO MEDIUM | | SLOW TO NONE | MEDIUM | ML | INORGANIC SILTS, HIGHLY COMPRESSIBLE MICACEOUS OR DIATOMACEOUS FINE SANDY SILTS, ELASTIC SILTS | | | |
| | HIGH TO VERY HIGH | | NONE | HIGH | CL | CLAYS (INORGANIC) OF HIGH PLASTICITY, FAT CLAYS | | | |
| MEDIUM TO HIGH | | NONE TO VERY SLOW | SLIGHT TO MEDIUM | DL | ORGANIC CLAYS OF HIGH PLASTICITY | | | | |
| HIGHLY ORGANIC SOILS | | READILY IDENTIFIED BY COLOUR, ODOUR, SPONGY FEEL & FREQUENTLY BY FIBROUS TEXTURE | | | PE | 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

Relocated Sandusk Creek Crossing
W.P. 246-62-01, Site 9-126-41
Hwy. 3, District 4, Hamilton

INTRODUCTION

The results of a foundation investigation program carried out for the relocation and replacement of the existing structure at the above mentioned site are summarized in this report. The fieldwork for the proposed replacement structure commenced on 80-04-16 and consisted of 2 sampled boreholes accompanied by dynamic cone penetration tests and 2 augered probe holes. All borings were advanced to bedrock, with rock coring operations being carried out in 2 of the borings for a maximum depth of 3.0 metres.

A previous report for the replacement of the existing structure was published on 62-10-09 under Work Project No. 246-62 (Job No. 62-F-119). Field investigation for this previous report consisted of 4 sampled borings accompanied by dynamic cone penetration tests.

SITE DESCRIPTION

The relocated structure site is located some 4.5 kilometres east of Jarvis on Hwy. 3, approximately 175 metres west of the existing Sandusk Creek structure, in the Township of Walpole, Regional Municipality of Haldimand-Norfolk.

The existing concrete bridge crossing Sandusk Creek consists of a 14 metre long single span structure founded on spread footings. The structure is in reasonably good condition, showing no major signs of foundation distress.

The Sandusk Creek water course through this area is winding and poorly defined. The river itself, at the time of the site visit, was shallow and flowed slowly in a southerly direction. Topography in the general area is flat, primarily used as pastureland.

Physiographically the site is located in the Haldimand Clay Plan area which is characterized by an intermixture of clays and glacial tills. The underlying bedrock is of Palaeozoic origin consisting of hard dolomites often overlain by a series of softer rocks which include shale members. Generally the soils of this area are characterized by their heavy cohesive structure and poor drainage.

SUBSURFACE CONDITIONS

Uniform subsoil conditions were encountered across the site. Overlying the site is a firm silty clay to clay ranging to a maximum depth of 2.9 metres. Overlying bedrock is a thin veneer of silt with sand and gravel. Competent bedrock was encountered at an approximate elevation of 197.0 and proven by coring to depth of 3.0 metres.

The boundaries between the various soil types and the soil properties are shown on the attached Record of Borehole Sheets. The locations and elevations of the borings, along with an estimated stratigraphical profile based on the borehole data, are shown on Drawing No. 2 of the contract drawings.

The various subsoil types encountered are briefly described in the following paragraphs.

Silty Clay to Clay

The surficial deposit and roadway embankment material encountered over the site consists of glacio-lacustrine silty clay to clay with a trace of sand and gravel ranging in depths from 1.2 metres to 2.9 metres. Traces of organics and root structure were encountered in this deposit, particularly at and below creek water elevations. Typical grain size distribution curves from representative samples of this deposit are shown on Figure 1.

Atterberg Limit and Identity Indices testing performed on selected representative samples are summarized in the following table and plotted on the Plasticity Chart, Figure 2.

| | | <u>Range</u> | <u>Average</u> |
|-------------------------------|----------------------|--------------|----------------|
| Natural Moisture Content (w)% | | 11-39 | 32 |
| Liquid Limit | (w _L)% | 46-64 | 56 |
| Plastic Limit | (w _p)% | 20-26 | 22 |
| Plasticity Index | (I _p)% | 26-39 | 34 |
| Bulk Density | (kN/m ³) | 17.9 | |
| (one test only) | | | |

These results indicate the material to be an inorganic clay of intermediate to high plasticity (CI-CH).

The consistency of this deposit, based on a laboratory strength test and interpretation of the Standard Penetration Test 'N' values, is essentially firm.

Silt with Sand and Gravel

Immediately below the surficial cohesive deposit and overlying bedrock is a thin veneer of silt with sand and gravel. Organic sand and decomposed wood fragments were encountered in the upper portion of this deposit in one borehole. The deposit extended for a maximum thickness of 1.0 metre. Typical grain size distribution curves for this deposit are shown on Figure 3. Based on 'N' values and augering operations, the denseness of this deposit can be described as dense to very dense.

Bedrock

Competent bedrock was encountered at elevations of 196.9 and 197.1 and proven by coring for a depth of 3.0 metres. Bedrock is classified as a grey very hard limestone of fine to medium texture with chert nodules and irregular thin seams of shale. BXL rock core recovery within this rock type averaged 100%, indicating a very good to excellent rock quality.

Groundwater

Groundwater levels over the site can be assumed to reflect the prevailing creek water levels. Creek water levels at the time of investigation averaged elevation 199.0

P. Payer

P. Payer, P. Eng.
Foundations Engineer

K. G. Selby

K.G. Selby, P. Eng.
Senior Foundations Engineer

Note: The original report was prepared and signed by T.J. Kazmierowski, P. Eng.



RECORD OF BOREHOLE No 1

7

W P 246-62-01 LOCATION Sta. 17+339 5.0 m Rt. ORIGINATED BY BL
DIST 4 HWY 3 BOREHOLE TYPE Solid Auger BXL Core COMPILED BY BL
DATUM Geodetic DATE 80-04-16 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 10 20 30 40 50 | PLASTIC LIMIT W _p NATURAL MOISTURE CONTENT W LIQUID LIMIT W _L WATER CONTENT (%) 20 40 60 | UNIT WEIGHT γ kN/m ³ | REMARKS & GRAIN SIZE DISTRIBUTION (%) GR SA SI CL |
|----------------|--|-------------|---------|------|------------|----------------------------|-----------------|--|---|---------------------------------------|--|
| ELEV. DEPTH | DESCRIPTION | STRAT. PLOT | NUMBER | TYPE | 'N' VALUES | | | | | | |
| 200.6 | Ground Level | | | | | | | | | | |
| 0.0 | Silty Clay to Clay Trace of Sand, Gravel, and Organics Med. to High Plasticity Firm | Fill | 1 | SS | 8 | | 200 | | | | 18 12 36 34 |
| 197.7 | Silt with Gravel & Sand | | 2 | SS | 13 | | 198 | | | | 0-26-60-24 0- 7-48-25 |
| 2.9 | | | 3 | TW | PH | | | | | 17.9 | |
| 196.9 | | | 4 | SS | 37/ | 230 mm | | | | Om=3.11 | 34-21-40- 5 |
| 3.7 | Limestone Bedrock | | 5 | RC | 100% | | | | | | |
| | Fine to Med. Texture | | 6 | RC | 100% | | 196 | | | | |
| | Very Hard Occ. Shale Seams | | 7 | RC | 100% | | | | | | |
| 194.0 | | | | | | | 194 | | | | |
| 6.6 | End of Borehole | | | | | | | | | | |
| | Note: Water Level Not Established at Time of Investigation | | | | | | | | | | |

+3, x5: Numbers refer to
Sensitivity

20
15 5 (%) STRAIN AT FAILURE
10

RECORD OF BOREHOLE No 4

8

W P 246-62-01 LOCATION Sta 17+354 12 m Lt. ORIGINATED BY BL
DIST 4 HWY 3 BOREHOLE TYPE Solid Augers BXL Core COMPILED BY BL
DATUM Geodetic DATE 80-04-17 CHECKED BY

| SOIL PROFILE | | | SAMPLES | | | GROUND WATER CONDITIONS | ELEVATION SCALE | DYNAMIC CONE PENETRATION RESISTANCE PLOT 20 40 60 80 100 | 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 | | | | | | | | |
| 199.3 | Ground Level | | | | | | | | | | | | |
| 0.0 | Silty Clay to Clay | | 1 | SS | 6 | | | | | | | | |
| | Trace of Sand | | 2 | SS | 8 | | | | | | | | |
| 198.1 | Med. to High Plasticity Firm | | | | | | | | | | | | 0- 2-62-36 |
| 1.2 | Silt with Organics | | 3 | TW | PH | | | | | | | | 11-72-10- 7 |
| 197.1 | Sand and Gravel | | 4 | SS | 39 | 230 mm | | | | | | | 26-27-39- 8 |
| 2.2 | Limestone Bedrock | | 5 | RC | 100% | | | | | | | | |
| | Fine to Med. Texture | | 6 | RC | 100% | | | | | | | | |
| | Occ. Shale Seams | | | | | | | | | | | | |
| | Very Hard | | 7 | RC | 100% | | | | | | | | |
| 194.1 | End of Borehole | | | | | | | | | | | | |
| 5.2 | Note: Water Level Not Established. | | | | | | | | | | | | |

OFFICE REPORT ON SOIL EXPLORATION



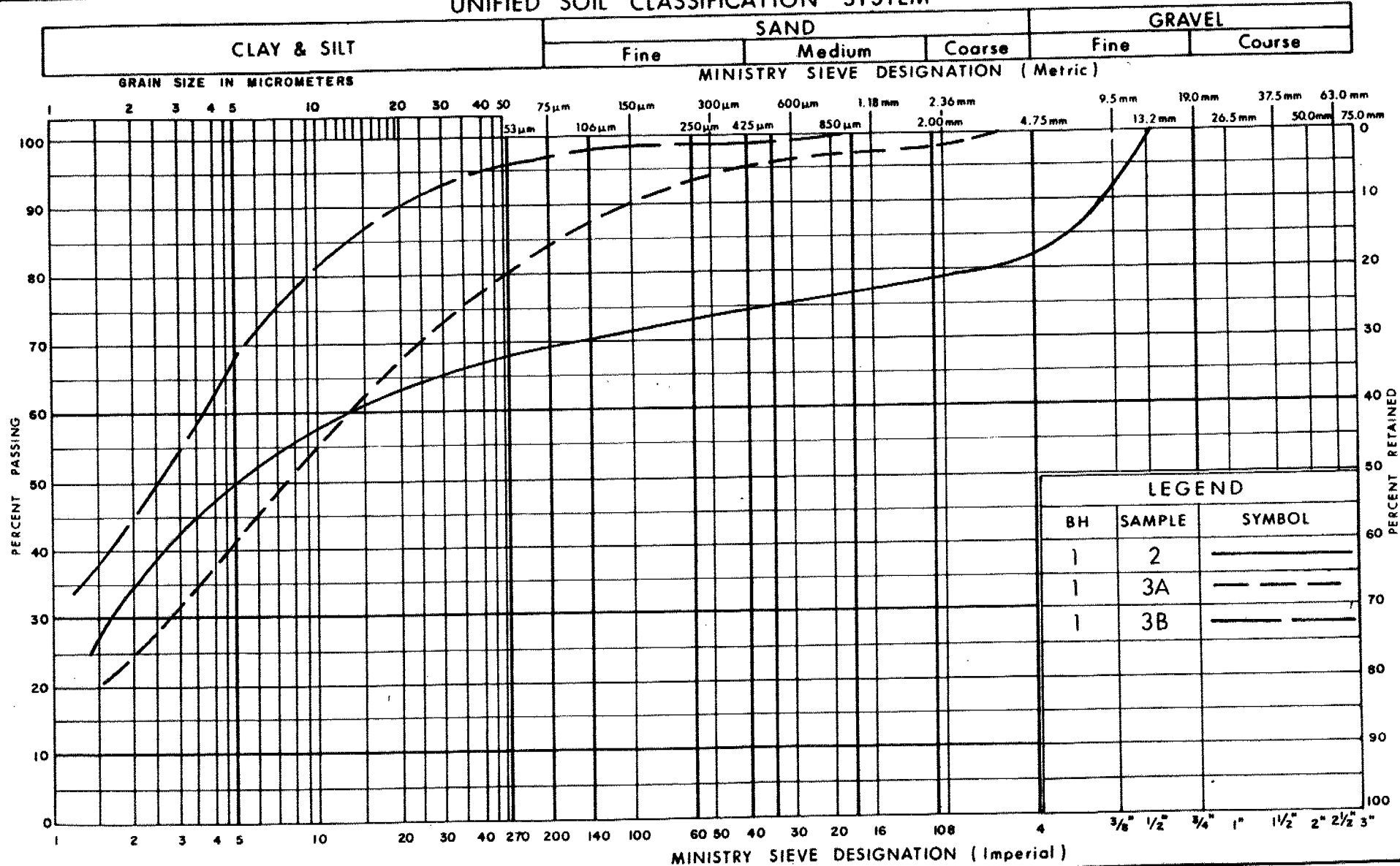
5

W P 246-62-01 LOCATION Sta. 17+353 4.5 m Rt. ORIGINATED BY BL
DIST 4 HWY 3 BOREHOLE TYPE Solid Augers COMPILED BY TJK
DATUM Geodetic DATE 80-04-16 CHECKED BY _____

[illegible]

+3, x5: Numbers refer to Sensitivity

UNIFIED SOIL CLASSIFICATION SYSTEM

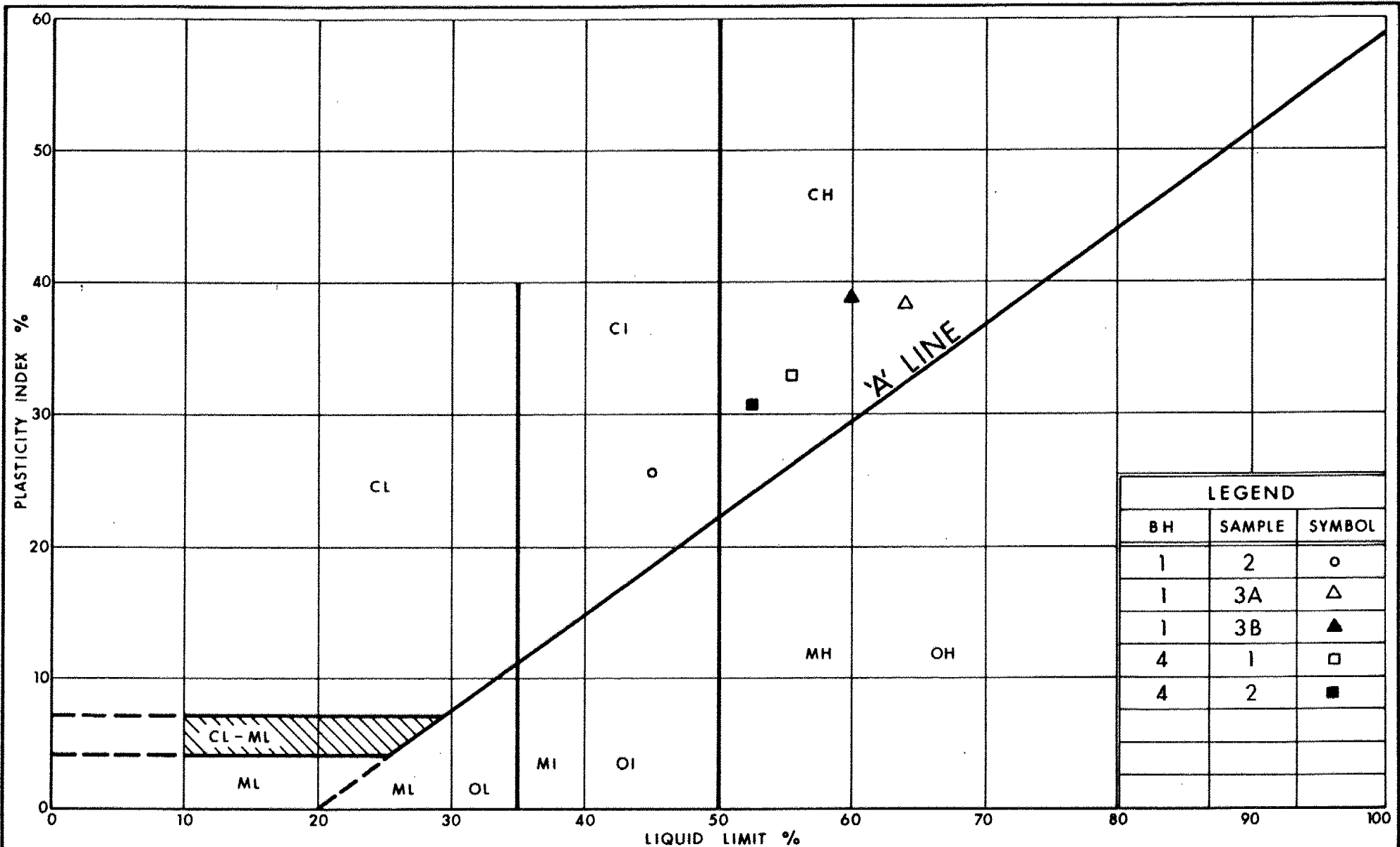


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GRAIN SIZE DISTRIBUTION
SILTY CLAY TO CLAY
TRACE OF SAND & GRAVEL

FIG No 1

W P 246-62-01



Ontario

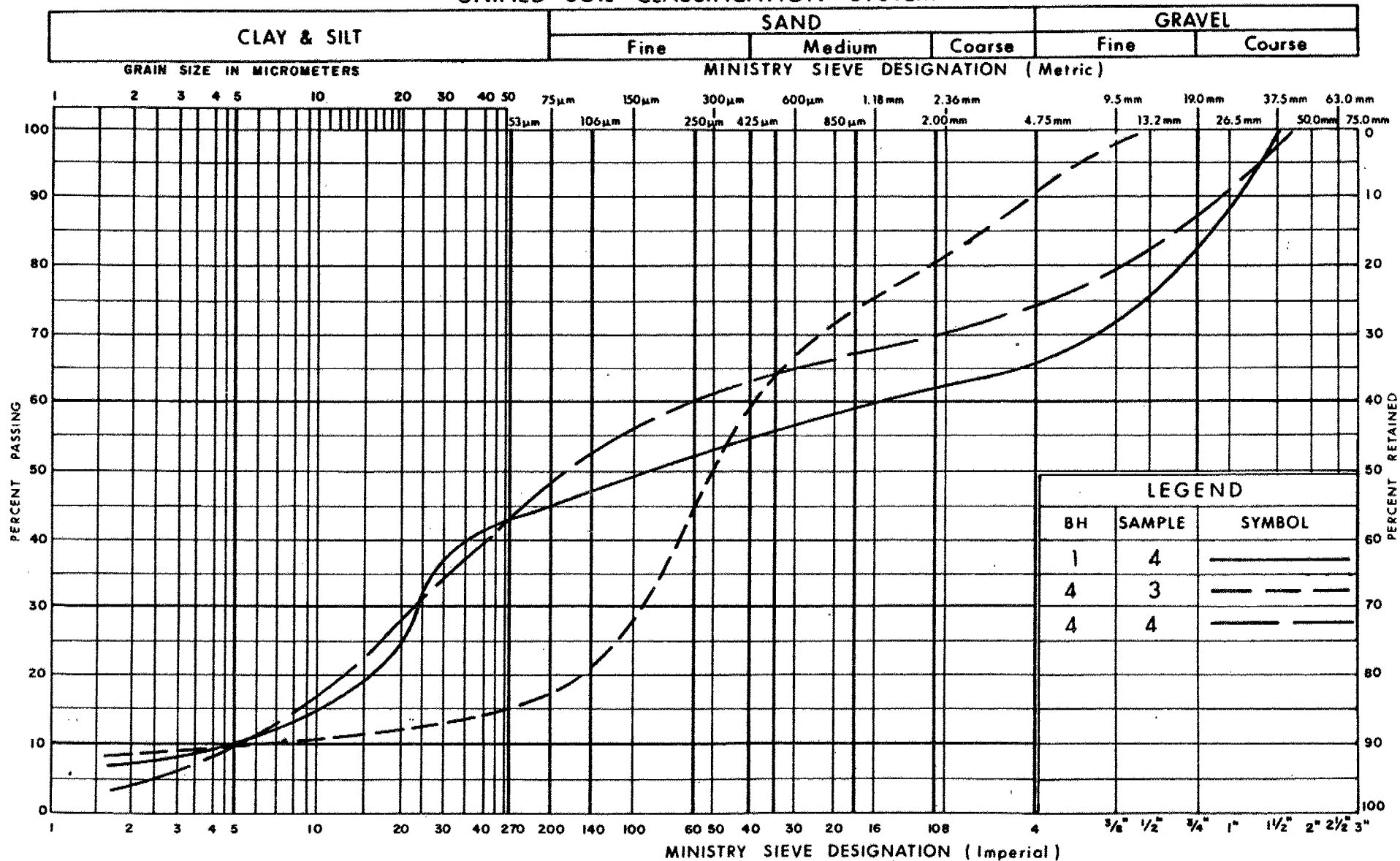
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PLASTICITY CHART SILTY CLAY TO CLAY

FIG No 2

W.P. 246-62-01

UNIFIED SOIL CLASSIFICATION SYSTEM



Ontario

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Communications

GRAIN SIZE DISTRIBUTION
SILT
WITH SAND & GRAVEL

FIG No 3

W P 246-62-01

ENGINEERING MATERIALS OFFICE
PAVEMENT & FOUNDATION DESIGN SECTION

246-62-01
WP ~~95-77-01~~

DIST #4

HWY #3

STR SITE ~~9-41~~

9-126-41

Relocated Sandusk Creek Crossing

DISTRIBUTION

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FOUNDATION INVESTIGATION REPORT

For

Relocated Sandusk Creek Crossing
W.P. 95-77-01, Site 9-41
Hwy. 3, District 4, Hamilton

INTRODUCTION

The results of a foundation investigation program carried out for the relocation and replacement of the existing structure at the above mentioned site are summarized in this report. The fieldwork for the proposed replacement structure commenced on 80-04-16 and consisted of 2 sampled boreholes accompanied by dynamic cone penetration tests and 2 augered probe holes. All borings were advanced to bedrock, with rock coring operations being carried out in 2 of the borings for a maximum depth of 3.0 metres.

A previous report for the replacement of the existing structure was published on 62-10-09 under Work Project No. 246-62 (Job No. 62-F-119). Field investigation for this previous report consisted of 4 sampled borings accompanied by dynamic cone penetration tests.

SITE DESCRIPTION

The relocated structure site is located some 4.5 kilometres east of Jarvis on Hwy. 3, approximately 175 metres west of the existing Sandusk Creek structure, in the Township of Walpole, Regional Municipality of Halldimand-Norfolk.

The existing concrete bridge crossing Sandusk Creek consists of a 14 metre long single span structure founded on spread footings. The structure is in reasonably good condition, showing no major signs of foundation distress.

The Sandusk Creek water course through this area is winding and poorly defined. The river itself, at the time of the site visit, was shallow and flowed slowly in a southerly direction. Topography in the general area is flat, primarily used as pastureland.

Physiographically the site is located in the Haldimand Clay Plain area which is characterized by an intermixture of clays and glacial tills. The underlying bedrock is of Palaeozoic origin consisting of hard dolomites often overlain by a series of softer rocks which include shale members. Generally the soils of this area are characterized by their heavy cohesive structure and poor drainage.

SUBSURFACE CONDITIONS

Uniform subsoil conditions were encountered across the site. Overlying the site is a firm silty clay to clay ranging to a maximum depth of 2.9 metres. Overlying bedrock is a thin veneer of silt with sand and gravel. Competent bedrock was encountered at an approximate elevation of 197.0 and proven by coring to depths of 3.0 metres.

The boundaries between the various soil types and the soil properties are shown on the attached Record of Borehole Sheets. The locations and elevations of the borings, along with an estimated stratigraphical profile based on the borehole data, are shown on Drawing No. 957701-A.

The various subsoil types encountered are briefly described in the following paragraphs.

Silty Clay to Clay

The surficial deposit and roadway embankment material encountered over the site consists of glacio-lacustrine silty clay to clay with a trace of sand and gravel ranging in depths from 1.2 metres to 2.9 metres. Traces of organics and root structure were encountered in this deposit, particularly at and below creek water elevations. Typical grain size distribution curves from representative samples of this deposit are shown on Figure 1.

Atterberg Limit and Identity Indice testing performed on selected representative samples are summarized in the following table and plotted on the Plasticity Chart, Figure 2.

| | | <u>Range</u> | <u>Average</u> |
|-------------------------------------|--|--------------|----------------|
| Natural Moisture Content (w)% | | 11-39 | 32 |
| Liquid Limit (w _L)% | | 46-64 | 56 |
| Plastic Limit (w _p)% | | 20-26 | 22 |
| Plasticity Index (I _p)% | | 26-39 | 34 |
| Bulk Density (kN/m ³) | | 114 | |

These results indicate the material to be an inorganic clay of intermediate to high plasticity (CI-CH).

The consistency of this deposit, based on a laboratory strength test and interpretation of the Standard Penetration Test 'N' values, is essentially firm.

Silt With Sand and Gravel

Immediately below the surficial cohesive deposit and overlying bedrock is a thin veneer of silt with sand and gravel. Organic sand and decomposed wood fragments were encountered in the upper portion of this deposit in one borehole. The deposit extended for a maximum thickness of 1.0 metres. Typical grain size distribution curves for this deposit are shown on Figure 3. Based on 'N' values and augering operations, the denseness of this deposit can be described as dense to very dense.

Bedrock

Competent bedrock was encountered at elevations of 196.9 and 197.1 and proven by coring for a depth of 3.0 metres. Bedrock is classified as a grey very hard limestone of fine to medium texture with chert nodules and irregular thin seams of shale. BXL rock core recovery within this rock type averaged 100%, indicating a very good to excellent rock quality.

Groundwater

Groundwater levels over the site can be assumed to reflect the prevailing creek water levels. Creek water levels at the time of investigation averaged elevation 199.0.

DISCUSSION AND RECOMMENDATIONS

Present planning requirements call for the improvement of the existing Hwy. 3/Sandusk Creek Rd. intersection which will necessitate the channelization and relocation of the existing Sandusk Creek crossing some 175 metres west of the existing. A 10 x 14 metre single span structure is proposed. In addition, a one metre grade raise for Hwy. 3 at the proposed crossing is also contemplated.

In view of the relatively shallow surficial deposits overlying competent bedrock in the area, our recommendations pertaining to the foundations and earthworks for the replacement structure are as follows:

Structure Foundations

The abutments for the proposed replacement structure should be founded on spread footings carried down to competent bedrock. For design purposes, footings founded on competent bedrock at an approximate elevation of 197.0± can be designed for an allowable bearing pressure of 1,000 kPa, which should be sufficient for this type of structure provided all weathered or loosen material is completely removed from the rock surface.

In order to resist lateral forces acting on the abutment wall and foundations, frictional forces between the footing base and bedrock surface can be calculated assuming a coefficient of friction of ~~0.75~~ ^{0.45 = $\tan 25^\circ$} against sliding. Backfill behind the abutments should be composed of well compacted free-draining granular material with provisions made for adequate drainage. The lateral earth pressure exerted on the abutment walls by the granular backfill can be computed assuming a unit weight of 20 kN/m³ for the backfill and a coefficient of earth pressure of:

$K_a = 0.35$ for the "active" case where rotation or translation about the base is allowed.

$K_o = 0.5$ for the "at rest" case where no rotation or translation about the base is permitted.

In consideration of the presence of the granular stratum overlying bedrock, provisions should include an appropriately designed

dewatering system to insure placement of concrete in the 'dry'. This may be achieved by a properly constructed steel sheeting box and pumping from sumps to control seepage at the bottom of the excavation. Alternatively, tremie concrete could be utilized as a tremie seal or plug to effectively prevent water inflow at the base of the sheeting.

Construction Considerations

All rock surfaces within the planned limits of the foundations should be clean, free from any muck and loose rock fragments, prior to concrete placement for the footings.

Any variations in bedrock surface along the length of the abutment footing can be levelled out through the use of a mass concrete levelling pad.

Approaches

No stability problems are anticipated for embankment slopes provided they are constructed not steeper than 2:1. All organic and/or deleterious material within the plan limits of the approach embankments should be subexcavated for their full depth and backfilled with well compacted granular material.

Adequate precautions should be taken to protect the creek banks and approach embankments from creek scour action. This may be achieved by a suitably placed rip-rap scheme.

MISCELLANEOUS

The fieldwork for this investigation was performed under the supervision of Mr. B. Little, Student Technician. The equipment was owned and operated by Atcost Soil Drilling Inc., Concord.

This report was written by Mr. T.J. Kazmierowski, Project Foundations Engineer, and reviewed by Mr. K. Selby, Senior Foundations Engineer.



A handwritten signature in dark ink, appearing to read "Tom Kazmierowski", written over the printed name and title.

T.J. Kazmierowski, P. Eng.
Project Foundations Engineer

A handwritten signature in dark ink, appearing to read "K. Selby", written over the printed name and title.

K.G. Selby, P. Eng.
Senior Foundations Engineer

June 11, 1980.

RECORD OF BOREHOLE No 1

W P 95-77-01 LOCATION Sta. 17 & 991.0 5.0 m Rt. ORIGINATED BY BL
DIST 4 HWY 3 BOREHOLE TYPE Solid Auger BXL Core COMPILED BY BL
DATUM Geodetic DATE 80-04-16 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 kN/m ³ | REMARKS & GRAIN SIZE DISTRIBUTION (%) GR SA SI CL |
|---------------|--|------------|---------|------|------------|----------------------------|-----------------|---|----------------|--------------------------------|-----------------|--|--|
| ELEV DEPTH | DESCRIPTION | STRAT PLOT | NUMBER | TYPE | 'N' VALUES | | | 20 40 60 80 100 | W _p | W | W _L | | |
| 200.6 | Ground Level | | | | | | | | | | | | |
| 0.0 | Silty Clay to Clay Trace of Sand, Gravel, and Organics Med. to High Plasticity Firm | Fill | 1 | SS | 8 | | 200 | | | | | | 18 12 36 34 |
| | | | 2 | SS | 13 | | | | | | | | 0-26-60-24 |
| 197.7 | | | 3 | TW | PH | | 198 | | | | | 17.9 | 0- 7-48-25 |
| 2.9 | Silt with Gravel & Sand | | 4 | SS | 37/ | 230 mm | | | | | | | 34-21-40- 5 |
| 196.9 | | | | | | | | | | | | | |
| 3.6 | Limestone Bedrock | | 5 | RC | 100% | | | | | | | | |
| | Fine to Med. Texture | | 6 | RC | 100% | | 196 | | | | | | |
| | Very Hard Occ. Shale Seams | | 7 | RC | 100% | | | | | | | | |
| 194.0 | | | | | | | | | | | | | |
| 6.6 | End of Borehole | | | | | | 194 | | | | | | |
| | Note: Water Level Not Established at Time of Investigation | | | | | | | | | | | | |

OFFICE REPORT ON SOIL EXPLORATION

+3, x5: Numbers refer to
Sensitivity

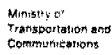
20
15
10
5 (%) STRAIN AT FAILURE

RECORD OF BOREHOLE No 4

W P 95-77-01 LOCATION Sta. 17 & 975.0 12 m Lt. ORIGINATED BY BL
DIST 4 HWY 3 BOREHOLE TYPE Solid Augers BXL Core COMPILED BY BL
DATUM Geodetic DATE 80-04-17 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 | | | | |
| 199.3 | Ground Level | | | | | | | | | | | | | | |
| 0.0 | Silty Clay to Clay | | 1 | SS | 6 | | | | | | | | | | |
| 198.0 | Trace of Sand | | 2 | SS | 8 | | | | | | | | | | 0- 2-62-36 |
| 1.2 | Med. to High Plasticity Firm | | | | | | | | | | | | | | |
| | Silt with Organics | | 3 | TW | PH | | | | | | | | | | 11-72-10- 7 |
| 197.1 | Sand and Gravel | | 4 | SS | 39 | 230 mm | | | | | | | | | 26-27-39- 8 |
| 2.2 | Limestone Bedrock | | 5 | RC | 100% | | | | | | | | | | |
| | Fine to Med. Texture Occ. Shale Seams | | 6 | RC | 100% | | | | | | | | | | |
| | Very Hard | | 7 | RC | 100% | | | | | | | | | | |
| 194.1 | End of Borehole | | | | | | | | | | | | | | |
| 5.2 | Note: Water Level Not Established. | | | | | | | | | | | | | | |

OFFICE REPORT ON SOIL EXPLORATION



WP 95-77-01 LOCATION Sta. 17 & 976.5 4.5 m Rt. ORIGINATED BY BL
DIST 4 HWY 3 BOREHOLE TYPE Solid Augers COMPILED BY TIJ
DATUM Geodetic DATE 80-04-16 CHECKED BY _____

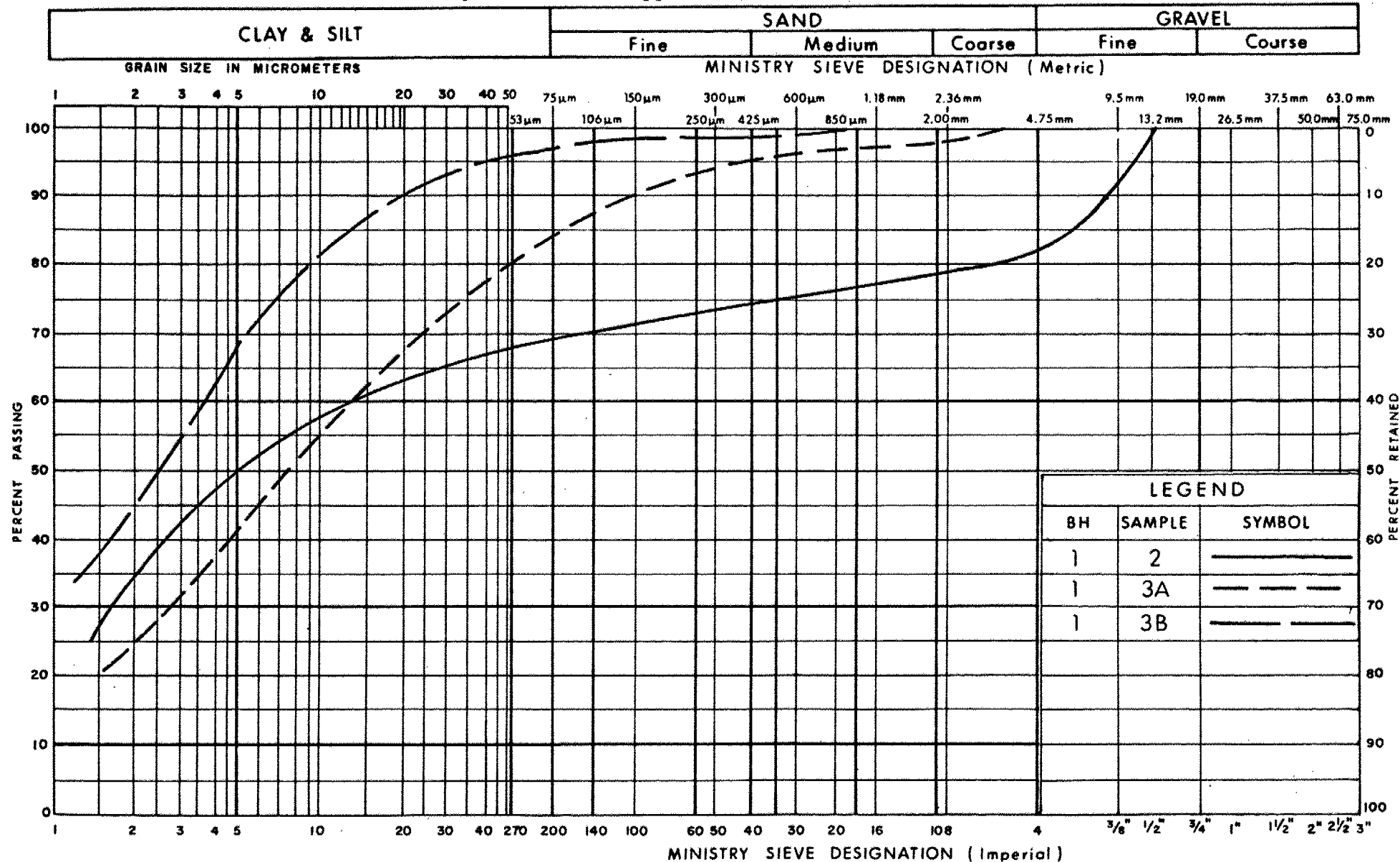
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+3, x⁵ : Numbers refer to Sensitivity

20
15 ϕ 5 (%) STRAIN AT FAILURE
10

OFFICE REPORT ON SOIL EXPLORATION

UNIFIED SOIL CLASSIFICATION SYSTEM



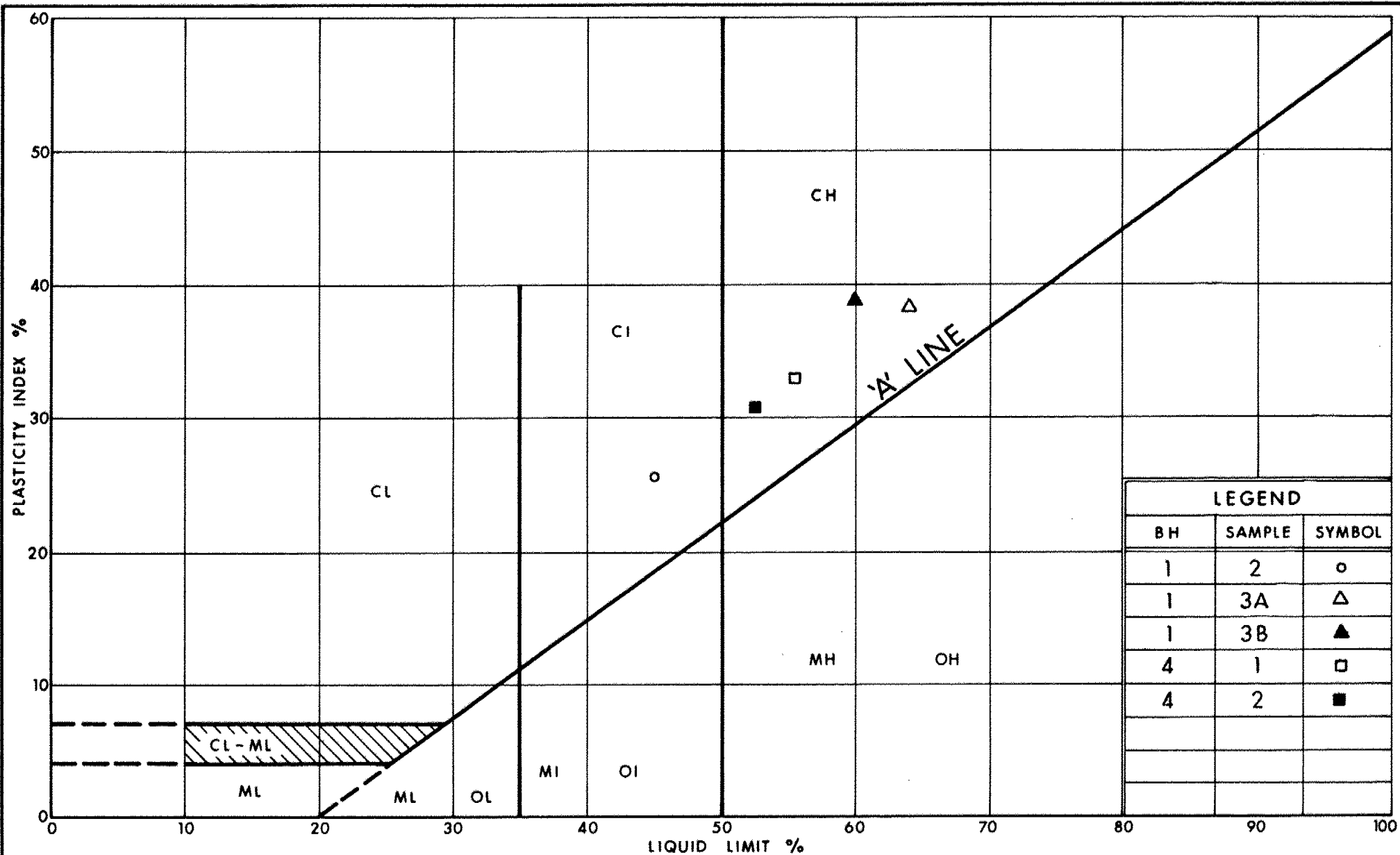
Ontario

 Ministry of
Transportation and
Communications

GRAIN SIZE DISTRIBUTION
SILTY CLAY TO CLAY
 TRACE OF SAND & GRAVEL

FIG No 1

W P 95-77-01



Ontario

 Ministry of
Transportation and
Communications

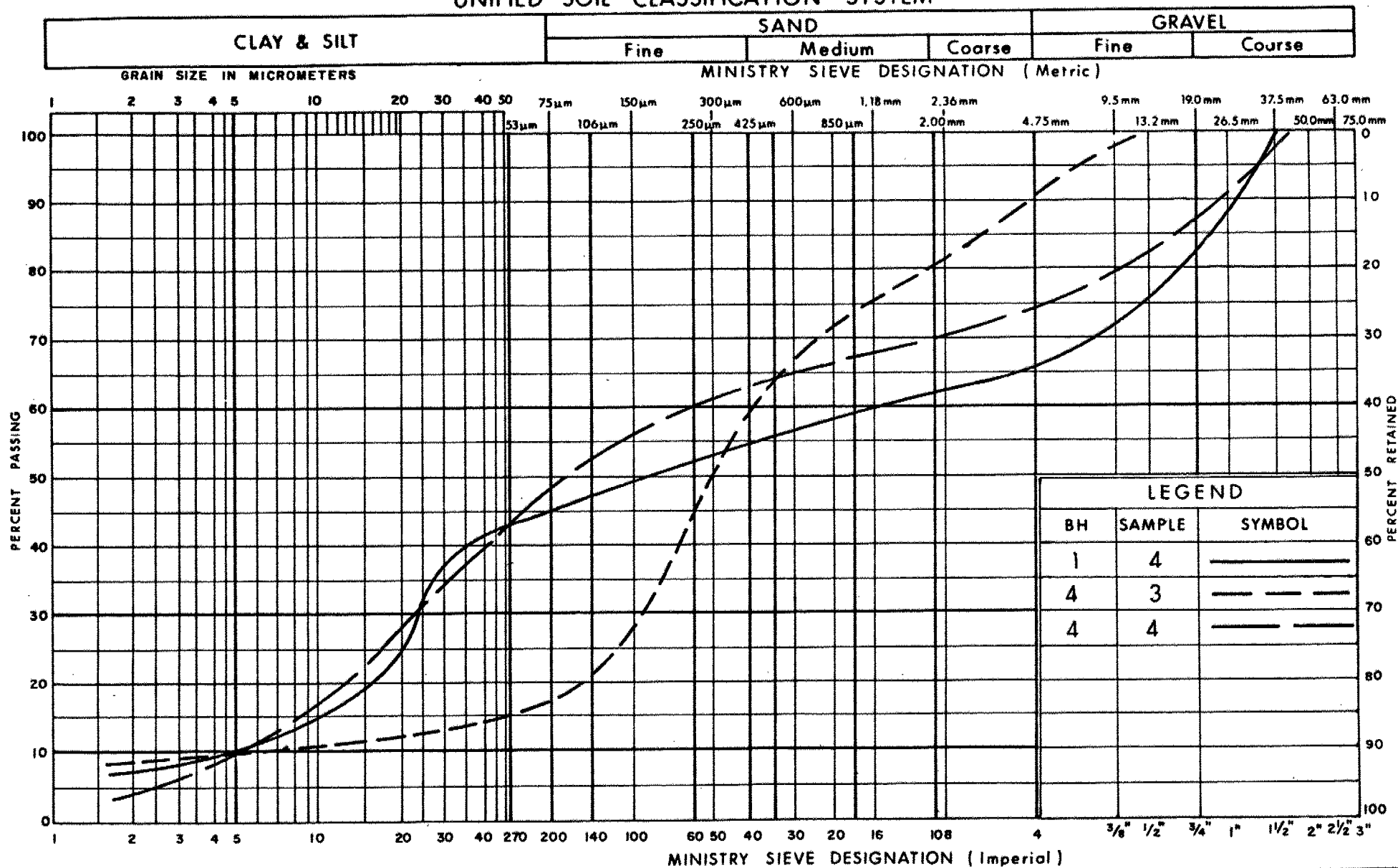
ENGINEERING SERVICES BRANCH

PLASTICITY CHART SILTY CLAY TO CLAY

FIG No 2

W P 95-77-01

UNIFIED SOIL CLASSIFICATION SYSTEM



GRAIN SIZE DISTRIBUTION
SILT
WITH SAND & GRAVEL

FIG No 3

W P 95-77-01



Ontario

Ministry of
Transportation and
Communications

EXPLANATION OF TERMS USED IN REPORT

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

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

SOILS ARE DESCRIBED BY THEIR COMPOSITION AND CONSISTENCY OR DENSENESS.

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

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

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

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

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

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

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

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

JOINTING AND BEDDING:

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

ABBREVIATIONS AND SYMBOLS

FIELD SAMPLING

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

STRESS AND STRAIN

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

MECHANICAL PROPERTIES OF SOIL

| | | |
|----------------|------------|--------------------------------------|
| m_v | kPa^{-1} | COEFFICIENT OF VOLUME CHANGE |
| C_c | 1 | COMPRESSION INDEX |
| C_s | 1 | SWELLING INDEX |
| C_α | 1 | RATE OF SECONDARY CONSOLIDATION |
| c_v | m^2/s | COEFFICIENT OF CONSOLIDATION |
| H | m | DRAINAGE PATH |
| T_v | 1 | TIME FACTOR |
| U | % | DEGREE OF CONSOLIDATION |
| σ'_{v0} | kPa | EFFECTIVE OVERBURDEN PRESSURE |
| σ'_p | kPa | PRECONSOLIDATION PRESSURE |
| τ_f | kPa | SHEAR STRENGTH |
| c' | kPa | EFFECTIVE COHESION INTERCEPT |
| ϕ' | -° | EFFECTIVE ANGLE OF INTERNAL FRICTION |
| c_u | kPa | APPARENT COHESION INTERCEPT |
| ϕ_u | -° | APPARENT ANGLE OF INTERNAL FRICTION |
| τ_R | kPa | RESIDUAL SHEAR STRENGTH |
| τ_r | kPa | REMOULDED SHEAR STRENGTH |
| S_t | 1 | SENSITIVITY = $\frac{c_u}{\tau_r}$ |

PHYSICAL PROPERTIES OF SOIL

| | | | | | | | | |
|----------------|----------|--------------------------------|-----------|------|---|-----------|----------|---|
| ρ_s | kg/m^3 | DENSITY OF SOLID PARTICLES | e | 1, % | VOID RATIO | e_{min} | 1, % | VOID RATIO IN DENSEST STATE |
| γ_s | kN/m^3 | UNIT WEIGHT OF SOLID PARTICLES | n | 1, % | POROSITY | I_D | 1 | DENSITY INDEX = $\frac{e_{max} - e}{e_{max} - e_{min}}$ |
| ρ_w | kg/m^3 | DENSITY OF WATER | w | 1, % | WATER CONTENT | D | mm | GRAIN DIAMETER |
| γ_w | kN/m^3 | UNIT WEIGHT OF WATER | S_r | % | DEGREE OF SATURATION | D_n | mm | n PERCENT - DIAMETER |
| ρ | kg/m^3 | DENSITY OF SOIL | w_L | % | LIQUID LIMIT | C_u | 1 | UNIFORMITY COEFFICIENT |
| γ | kN/m^3 | UNIT WEIGHT OF SOIL | w_p | % | PLASTIC LIMIT | h | m | HYDRAULIC HEAD OR POTENTIAL |
| ρ_d | kg/m^3 | DENSITY OF DRY SOIL | w_s | % | SHRINKAGE LIMIT | q | m^3/s | RATE OF DISCHARGE |
| γ_d | kN/m^3 | UNIT WEIGHT OF DRY SOIL | I_p | % | PLASTICITY INDEX = $w_L - w_p$ | v | m/s | DISCHARGE VELOCITY |
| ρ_{sat} | kg/m^3 | DENSITY OF SATURATED SOIL | I_L | 1 | LIQUIDITY INDEX = $\frac{w - w_p}{I_p}$ | i | 1 | HYDRAULIC GRADIENT |
| γ_{sat} | kN/m^3 | UNIT WEIGHT OF SATURATED SOIL | I_C | 1 | CONSISTENCY INDEX = $\frac{w_L - w}{I_p}$ | k | m/s | HYDRAULIC CONDUCTIVITY |
| ρ' | kg/m^3 | DENSITY OF SUBMERGED SOIL | e_{max} | 1, % | VOID RATIO IN LOOSEST STATE | j | kN/m^3 | SEEPAGE FORCE |
| γ' | kN/m^3 | UNIT WEIGHT OF SUBMERGED SOIL | | | | | | |

METRIC

NOTE:
DIMENSIONS ARE IN METRES
AND/OR MILLIMETRES UNLESS
OTHERWISE SHOWN. STATIONS
IN KILOMETRES + METRES

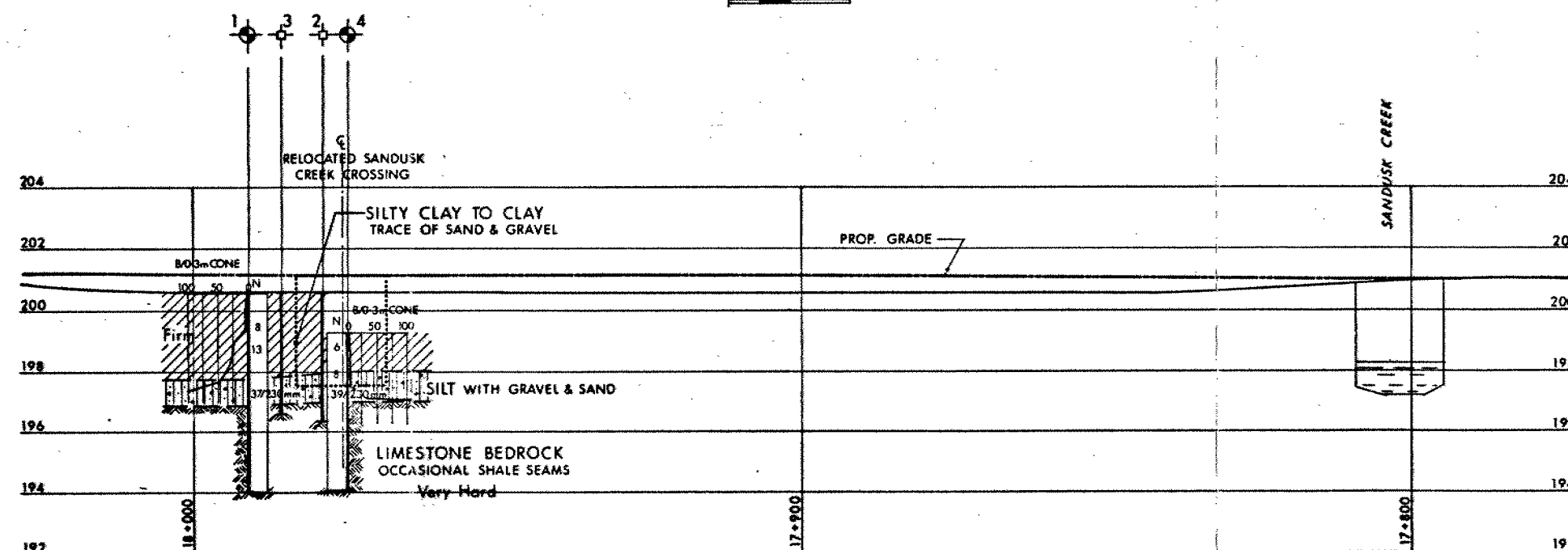
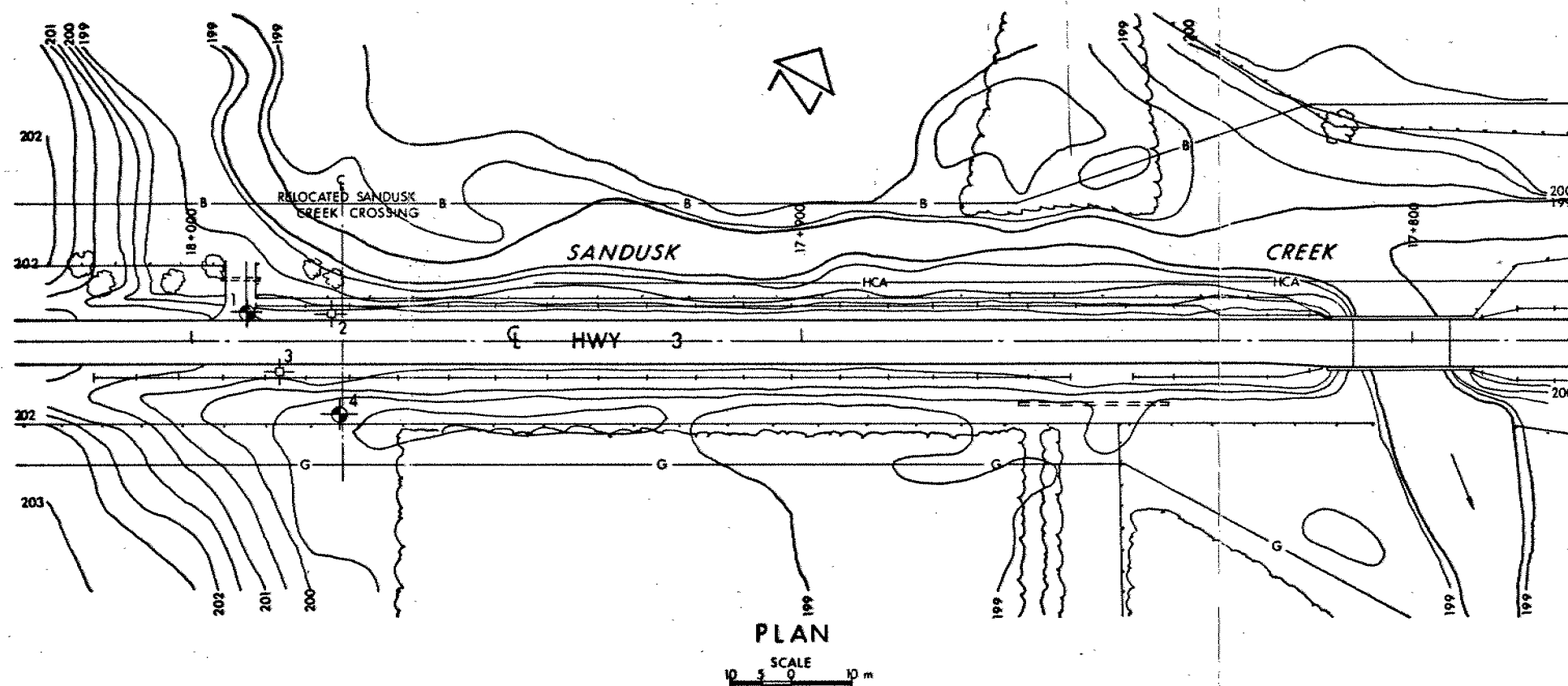
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WP No 95-77-01

RELOCATED SANDUSK CREEK

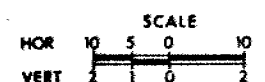
BORE HOLE LOCATIONS & SOIL STRATA



SHEET



PROFILE HWY No 3



LEGEND

- ◆ Bore Hole
- ⊕ Dynamic Cone Penetration Test (Cone)
- ⊕ Bore Hole & Cone
- N Blows/0.3m (Std Pen Test, 475 J/blow)
- CONE Blows/0.3m (60° Cone, 475 J/blow)
- ⬇ WL at time of investigation
- ⬇ Not established
- ⊕ PROBEHOLE

| No | ELEVATION | STATION | OFFSET |
|------------|-----------|----------|----------|
| 1 | 200.6 | 17+991.0 | 5.0 RT. |
| 4 | 199.3 | 17+975.0 | 12.0 LT. |
| PROBEHOLES | | | |
| 2 | 200.6 | 17+976.5 | 4.5 RT. |
| 3 | 200.6 | 17+985.5 | 5.0 LT. |

NOTE

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

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

Geocres No 40116-19

| | | | |
|-----------|---------|---------------|--------------|
| HWY No 3 | CHECKED | DATE 80 05 21 | DIST 4 |
| SUBMITTAL | CHECKED | APPROVED | SITE 9-41 |
| DRAWN | CHECKED | APPROVED | DWG 957701-A |



memorandum



To: G. C. E. Burkhardt,
Head,
Structural Section,
Central Region

Date: 81 12 22

From: Pavement & Foundation Design Section,
Room 315, Central Building,
Downsview, Ontario

Re: W. P. 246-62-01, Site 9-126-41
Sandusk Creek Crossing at Highway 3
District 4, Hamilton

The submitted preliminary drawing has been reviewed. There is no comment from this Section.

D. H. Dundas
D. H. Dundas, P. Eng.,
Project Foundations Engineer

DHD/bd

To: Mr. G.C.E. Burkhardt
Head, Structural Section
Central Region

Date: 1980-05-07

Attention: M.D. Bendayan

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

Re: Foundation Recommendation for
Relocated Sandusk Creek Crossing, Hwy. 3
W.P. ~~95-77-01~~, Site ~~9-41~~
~~246-65-1~~, District 4, Hamilton ~~3-126-41~~

As per your request, we have completed the foundation investigation fieldwork for the above mentioned project and are hereby forwarding to you a brief description of the subsurface conditions encountered along with preliminary recommendations regarding the design of the foundations and related earthworks. The complete Foundation Investigation and Design Report will be submitted at a later date.

Subsurface Conditions

Fieldwork at this location consisted of 2 sampled boreholes accompanied by dynamic cone penetration tests and 2 augered probe holes. All borings were advanced to bedrock, with rock coring operations being carried out in 2 of the borings.

The surficial deposit overlying the site consists of 1.2 to 2.9 metres of a firm silty clay of medium plasticity with a trace of some sand and gravel. Underlying this cohesive deposit and overlying bedrock is a thin veneer of silt with sand and gravel ranging in thickness from 0.7 to 1.0 metres. Competent bedrock was encountered at depths ranging from 2.2 to 4.0 metres, corresponding to elevations 197.15 to 196.57 respectively. Bedrock was proven by coring for depths of up to 3.5 metres and is classified as a very hard, fine to medium textured limestone with occasional shale seams.

Groundwater levels in the area can be assumed to reflect existing creek water levels.

Discussion and Recommendations

Present planning requirements call for the improvement of the existing Hwy. 3/Sandusk Creek Rd. intersection which will necessitate the channelization and relocation of the existing Sandusk Creek crossing some 600 feet west of the existing. A 10 metre wide single span structure is proposed. In addition, a 5 feet grade raise for Hwy. 3 at the proposed crossing is also contemplated.

In view of the proximity of competent bedrock to ground surface, it is recommended that the abutments be founded on spread footings carried down to competent bedrock. For preliminary design purposes, footings founded on competent bedrock at approximate elevation of 196.9+ can be designed for an allowable bearing pressure of 1000 kPa, which should be sufficient for this type of structure.

In order to resist lateral forces acting on the abutment wall and foundations, frictional forces between the footing base and bedrock surface can be calculated assuming a coefficient of friction of 0.75 against sliding. Backfill behind the abutments should be composed of well compacted free-draining granular material with provisions made for adequate drainage. The lateral earth pressure exerted on the abutment walls by the granular backfill can be computed assuming a unit weight of 20 kN/m³ for the backfill and a coefficient of earth pressure of:

$K_a = 0.35$ for the "active" case where rotation or translation about the base is allowed.

$K_o = 0.5$ for the "at rest" case where no rotation or translation about the base is permitted.

Due to the presence of the granular stratum overlying bedrock, provisions will be required for a dewatering system to insure placement of concrete in the 'dry'. This may be achieved by a properly constructed steel sheeting box and pumping from sumps to control seepage at the bottom of the excavation. Alternatively, tremie concrete could be utilized as a tremie seal to effectively prevent water inflow at the base of the sheeting.

No stability problems are anticipated for embankment slopes provided they are constructed not steeper than 2:1. Adequate precautions should be taken to protect the creek banks and approach embankments from creek scour action. This may be achieved by suitably placed rip-rap.

Please feel free to contact this section should further information or clarification be required.

M. Maclean

for

T. Kazmierowski
Project Foundations Engineer

TK:ea