DOCUMENT MICROFILMING IDENTIFICATION

G.I.-30 SEPT. 1976

GEOCRES No. 31C-143

DIST. 8 REGION

W.P. No. 89-84-00

CONT. No. 90-40

W. O. No.

STR. SITE No. 7-79

HWY. No. 401

LOCATION Hwy 401 - Prop. Sir John. A MacDonald Blvd

No. of PAGES -

OVERSIZE DRAWINGS TO BE INCLUDED WITH THIS REPORT.

REMARKS:

# ENGINEERING MATERIALS OFFICE
## FOUNDATION DESIGN SECTION

WP 89-84-00 DIST 8

HWY 401 STR SITE 7-79

Sir John A. MacDonald Blvd.
Overpass and Approaches

DISTRIBUTION

E.C. Lane (2)
T.W. Murphy
D.J. Kimmett
E. Zavitski (2)
K.G. Bassi
D. Aspinwall
T. Yakutchuk
G. Szekreny
L. Saulnier (Cover Only)
M. MacLean (Cover Only)
✓ File

GEOCRES 31C-143 DATE JAN 03 1989

FEASIBILITY FOUNDATION INVESTIGATION REPORT

FOR

Sir John A. MacDonald Blvd. Overpass and Approaches

W.P. 89-84-00, Site 7-79

Hwy. 401, District 8, Kingston

## INTRODUCTION

This report summarizes the requested preliminary foundation investigation for the structure and immediate approaches for the proposed crossing of Sir John A. MacDonald Blvd. under the existing Hwy. 401 alignment. The report applies to the area within 10 m of the proposed structure. It is intended for planning purposes. A full-scale foundation investigation will be required for design purposes.

## SITE DESCRIPTION

The site is located approximately midway between the Sydenham Road and Division Street interchanges of Hwy. 401. At this location, the surrounding topography slopes gently from north to south.

## INVESTIGATION PROCEDURES

A preliminary foundation investigation for this site was carried out between 88 06 20 and 88 06 22. A continuous flight auger machine, equipped with 82 mm I.D. hollow stem augers, B casing and a B core barrel was used.

The investigation consisted of 2 sampled boreholes accompanied by dynamic cone penetration tests plus an additional 2 independent dynamic cone penetration tests. Bedrock core samples were collected at the 2 sampled boreholes. A piezometer was installed in 1 borehole.

The boreholes are identified as BH #1 to BH #4 inclusive. The extended for depths ranging from 7.3 m to 14.4 m. BH #1 and BH #4 penetrated into bedrock, while BH #2 and BH #3 may have terminated in the overburden.

Survey details were provided by the Eastern Region Surveys and Plans Section.

The sampling program for the overburden consisted of split spoon samples at 0.8 m to 1.5 m intervals. These samples provided Standard Penetration Test (N) values for the assessment of the in situ state of compaction of the non-cohesive materials, and for an indication of shear strengths of cohesive materials. These samples also provided material for identification purposes.

The split spoon samples were supplemented by shelby tube samples collected at strategic locations within the cohesive deposits. These samples provided relatively undisturbed material for more complex laboratory evaluations.

The sampling program for the bedrock consisted of collecting cores of 1.6 m and 2.2 m respectively at the 2 sampled boreholes. These samples permitted an evaluation of the type and quality of the bedrock.

The laboratory testing program for representative samples consisted of

- grain size analyses
- natural moisture content determinations
- Atterberg limit determinations
- unconfined compression tests
- unit weight tests

## SUBSURFACE CONDITIONS

The Record of Borehole Sheets in the Appendix illustrate the subsurface conditions at the borehole locations. The locations and elevations of the boreholes, along with stratigraphical profiles based on the borehole data are shown on Drawing No. 898400-A.

Based on the preliminary foundation investigation, the site has the following generalized stratigraphy:

| | Elevation From - To | Material |
|---|---|---|
| surface | (88.3±)-85.6 | Sand Fill |
| | 85.6-82.5 | Clay to Silty Clay |
| | 82.5-78± | Clayey Silt |
| | 78±-75± | Heterogeneous Mixture of silt, sand, gravel and clay |
| | 75± | Limestone Bedrock |

The bedrock appears to dip from NE to SW. It is covered by 2 to 3 m of glacial till. The glacial till is overlain by a clayey silt deposit 1.5 m to 5 m thick, then clay to silty clay up to 4.6 m thick. The interface between the clayey silt and clay to silty clay deposit appears to be consistently at elev. 82± m. At the existing Hwy. 401 embankment, sand fill up to 2.7 m thick overlies the clay to silty clay deposit.

Following are detailed descriptions of the soil strata encountered.

Sand Fill

This non-cohesive material was encountered at all boreholes except BH #1. At these locations it extended for thicknesses ranging from 0.9 m to 2.7 m.

It has been described as sand, containing some gravel and traces of silt and clay with occasional clayey silt zones.

Based on the results of Standard Penetration Tests (N = 3 to 10) the fill is in a loose condition. However, these tests indicate the condition at the shoulders of Hwy. 401 and it is anticipated that the sand fill beneath the paved portion of Hwy. 401 is in a compact to dense state.

The results of one laboratory test indicate a natural moisture content of 4.5% and a grain size distribution as illustrated below:

| | |
|---|---|
| Gravel | 22% |
| Sand | 71% |
| Silt | 5% |
| Clay | 2% |

Clay to Silty Clay

This cohesive material was encountered at all boreholes. At these locations it extended for thicknesses ranging from 3.1 m to 4.6 m.

It has been described as clay to silty clay with traces of sand.

Based on the results of Standard Penetration Tests (N = 5 to 21) and one unconfined compression test ($C_u$ = 83 kPa at 4.5% strain), the material is in a firm to very stiff state.

Typical properties of the material, as determined by laboratory tests, are summarized below:

| | Range | Average | Median |
|---|---|---|---|
| Water Content (w) | 32.0-33.5% | 32.6% | 32.4% |
| Liquid Limit ($w_L$) | 37.0-62.5% | 53.3% | 60.7% |
| Plastic Limit ($w_P$) | 18.5-23.5% | 21.0% | 21.0% |
| Plasticity Index ($I_P$) | 18.5-41.5% | 32.3% | 37.0% |

The results of one test indicate a unit weight of 18.5 kN/m$^3$.

Figure 1 illustrates a typical plasticity distribution for this material.

Figure 2 illustrates a typical grain size distribution for this material.

Clayey Silt

This cohesive material was encountered at all boreholes. At these locations it extended for thicknesses ranging from an estimated 1.5 m to 5.0 m.

It has been described as clayey silt with traces of sand and occasional silt layers.

Based on the results of Standard Penetration Tests (N = 2 to 5) and one unconfined compression test ($C_u$ = 51 kPa at 11% strain) the material is in soft to stiff state. Field vane tests were attempted within this deposit but could not be turned from which it is inferred that there is a high percentage of silt.

Typical properties of the material, as determined by laboratory tests on two samples, are summarized below:

| | Range |
|---|---|
| Water Content ($w$) | 25.0-33.0% |
| Liquid Limit ($w_L$) | 21.5-26.5% |
| Plastic Limit ($w_P$) | 16.5-17.0% |
| Plasticity Index ($I_P$) | 5.0-9.5% |

The results of one test indicate a unit weight of 19.8 kN/m$^3$.

Figure 3 illustrates a typical plasticity distribution for this material.

Figure 4 illustrates a typical grain size distribution for this material.

Heterogeneous Mixture of Silt, Sand, Gravel and Clay

This basically non-cohesive material was encountered at all boreholes. At these locations it extended for thicknesses ranging from an estimated 1.2 m to 3.1 m.

It has been described as a heterogeneous mixture of silt, sand, gravel and clay. Although it is essentially non-cohesive, it does exhibit slight cohesion.

Based on the results of Standard Penetration Tests (N = 2 to 23), the material is in a very loose to compact state.

Typical properties of the material, as determined by laboratory tests on two samples, are summarized as follows.

| | Range |
|---|---|
| Water Content (w) | 12.0-16.0% |
| Liquid Limit ($w_L$) | 16.5-17.0% |
| Plastic Limit ($w_P$) | 12.5-13.0% |
| Plasticity Index ($I_P$) | 3.5-4.5% |

Figure 5 illustrates a typical plasticity distribution for this material.

Figure 6 illustrates a typical grain size distribution for this material.

## Limestone Bedrock

Bedrock was cored at both sampled boreholes for depths of 1.6 m and 2.2 m. Recoveries varied from 93% to 98% while RQD's varied from 75% to 80% indicating unweathered rock of good quality. Bedrock was probably encountered with the dynamic cone penetration tests at BH #2 and BH #3. However these tests may have terminated within the overburden. In any case, for planning purposes, the bedrock surface may be assumed to be at elevation at elev. 75± m.

## Groundwater

The groundwater elevations varied from 84.7 m at BH #4 on 88 06 20 to 80.4 m at BH #1 on 88 08 13, indicating a seasonal variation. However, for planning purposes the groundwater elevation may be assumed to be 84.5 m.

## DISCUSSION

It is proposed to construct either a 2 span bridge (23.0-23.0) or a 25 m wide overpass structure with closed abutments to carry the existing Hwy. 401 alignment over the proposed extension of Sir. John A. MacDonald Blvd. The elevation of Hwy. 401 is 88.7 while the surrounding natural ground surface is at 85± m to 86.5± m. The proposed elevation of the Sir. John A. MacDonald Blvd is 82.5± m which will require a 2.5 m to 4.0 m cut below natural ground and 6.0 m below the Hwy. 401 embankment.

## RECOMMENDATIONS

### Structure Foundations

Since there is no suitable bearing stratum at the elevation of the proposed cut, the structure should be founded on deep foundations consisting of 310 HP 110 steel H-piles, equipped with driving shoes and driven to bedrock.

The following O.H.B.D.C. loadings are recommended:

| | | |
|---|---|---|
| Factored Axial Capacity at U.L.S. | = | 1600 kN per pile |
| Axial Capacity at S.L.S. Type II | = | 1150 kN per pile |

### Earth Pressure

Backfill to structures should consist of granular material in accordance with Ministry of Transportation Standard Special Provision #109F03.

Computation of earth pressures should be in accordance with Section 6-6.1.2.1 of the O.H.B.D.C. The active condition will govern earth pressure design for the yielding condition while the at-rest condition will govern earth pressure design for the unyielding condition. The following properties for backfill are recommended for design.

| Material | $\phi$ | $\gamma$ | $K_A$ | $K_O$ |
|---|---|---|---|---|
| Granular 'A' | 35° | 22.8 $kN/m^3$ | 0.27 | 0.43 |
| Granular 'B' | 30° | 21.2 $kN/m^3$ | 0.33 | 0.50 |

Lateral Resistance

The resistance to lateral load for piles should be calculated in accordance with Section 6-8.3.8 of the O.H.B.D.C. The horizontal component of battered piles may be used to resist lateral loads.

Frost Protection

A minimum earth cover of 1.5 m, or equivalent, to the base of pile caps is required for frost protection.

Slope Stability

A preliminary slope stability analysis was carried out utilizing both Bishop's simplified total and effective stress method. Based on this analysis 2H:1V slopes will be stable for heights up to approximately 4.5 m, while a 2 m wide mid-height berm is required for embankments between 4.5 m and 6± m in height. Details of these analyses are shown in Figure 7. A more detailed analysis will be required in the design phase of this project when the configuration of the forward slopes is finalized.

Settlement

Since the proposed structure will be founded on deep foundations, and since the proposed interchange will be primarily in cut and the existing embankment for Hwy. 401 has been in place for many years, no significant settlements are anticipated for this proposal. However some minor heaving may be anticipated due to unloading.

Dewatering

This proposal requires cuts to elev. 82.5. As the anticipated groundwater elevation is 84.5 m, a temporary dewatering scheme may be required to faciliate construction and a permanent gravity drainage scheme will be required. In view of the relatively impermeable nature of the subsoil at the cut level, sump pumping will probably provide adequate temporary dewatering. If a gravity drainage system was constructed, progressing in the upstream direction, temporary drainage would be faciliated.

## MISCELLANEOUS

The field investigation for this project was carried out under the supervision of M. Schnarr, Engineering Student.

The equipment used was owned and operated by Marthon Drilling Co. Ltd.

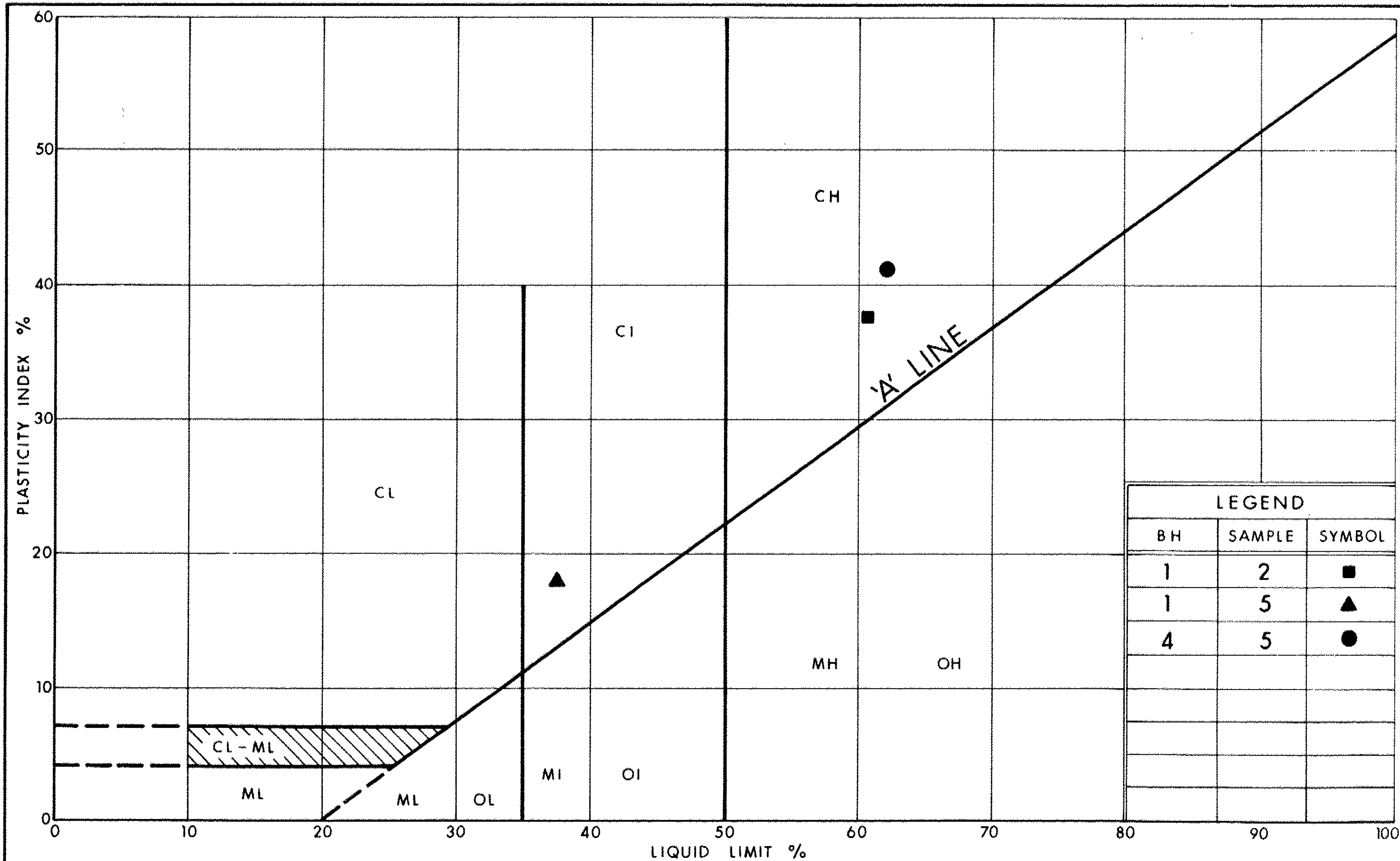
The report was written by D. Dundas, Sr. Foundations Engineer and reviewed by M. Devata, Chief Foundations Engineer.

REGISTERED PROFESSIONAL ENGINEER
D. H. DUNDAS
88 12 21
PROVINCE OF ONTARIO

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

M. Devata, P.Eng.
Chief Foundations Engineer

# APPPENDIX



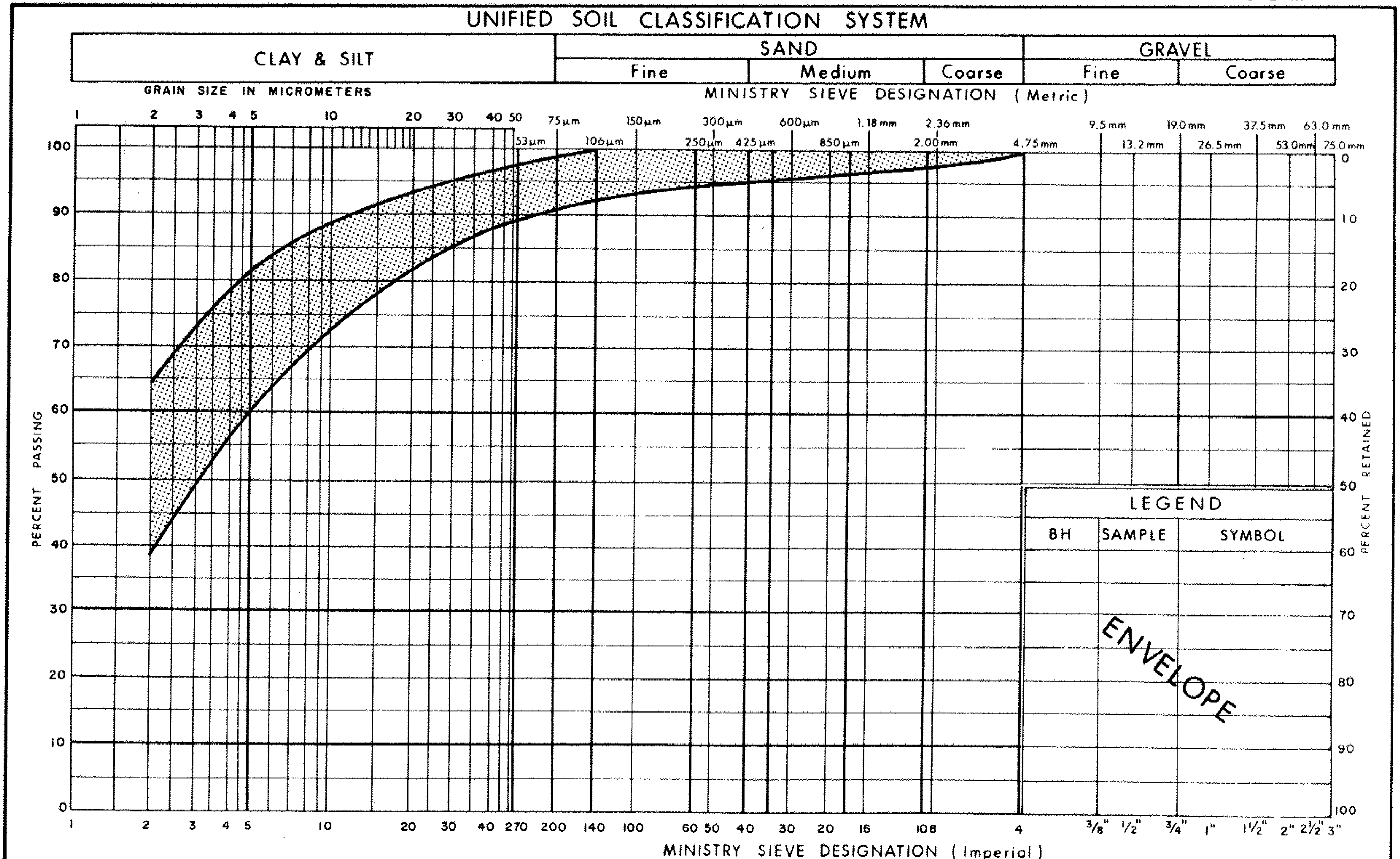

| LEGEND | | |
|---|---|---|
| BH | SAMPLE | SYMBOL |
| 1 | 2 | ■ |
| 1 | 5 | ▲ |
| 4 | 5 | ● |

Ministry of Transportation
Ontario

# PLASTICITY CHART
## CLAY TO SILTY CLAY

FIG No 1
W P 89-84-00

78 12 M



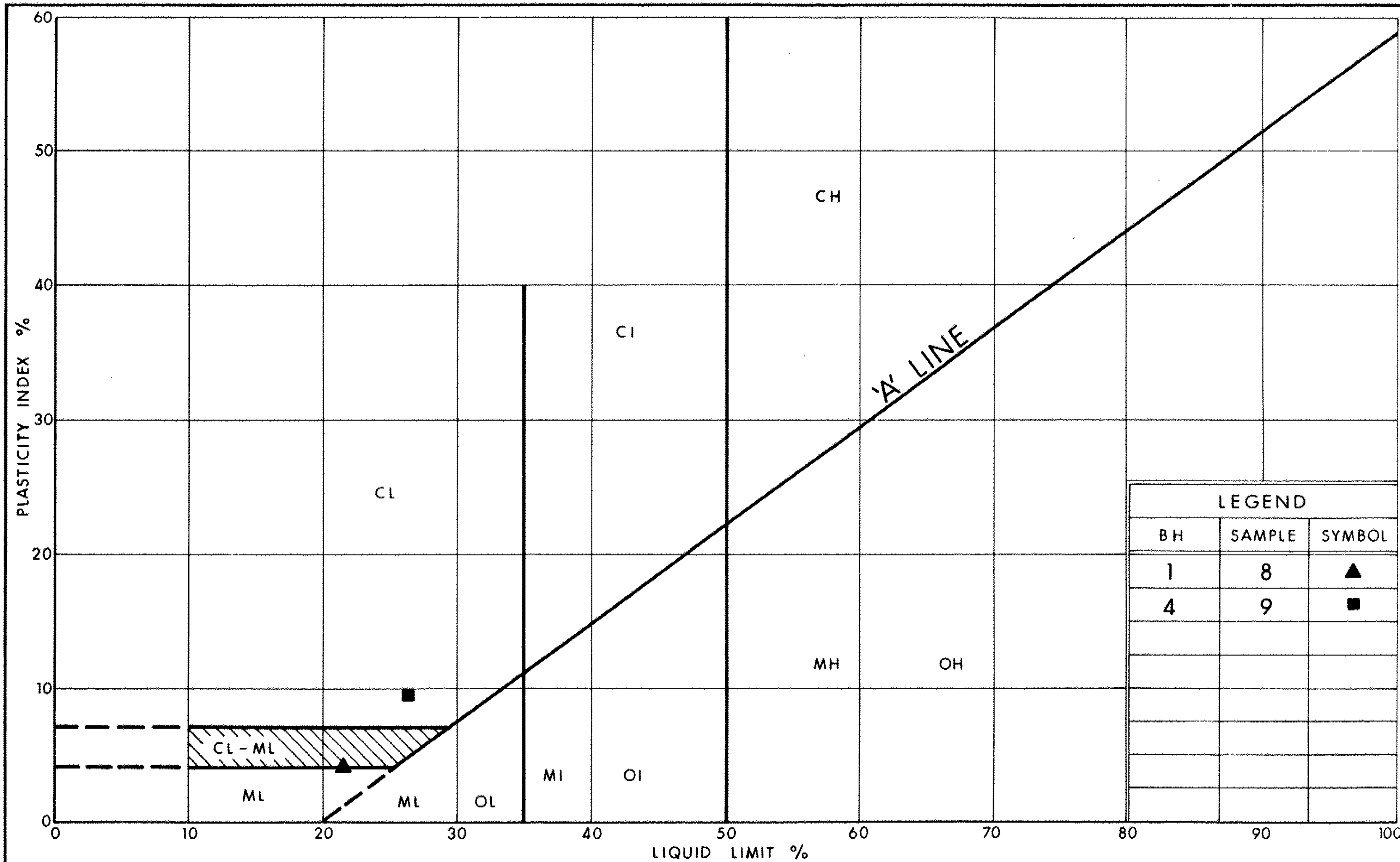

Ministry of Transportation
Ontario

# GRAIN SIZE DISTRIBUTION
# CLAY TO SILTY CLAY

FIG No 2

W P 89-84-00

Oct 75, FF-S-21

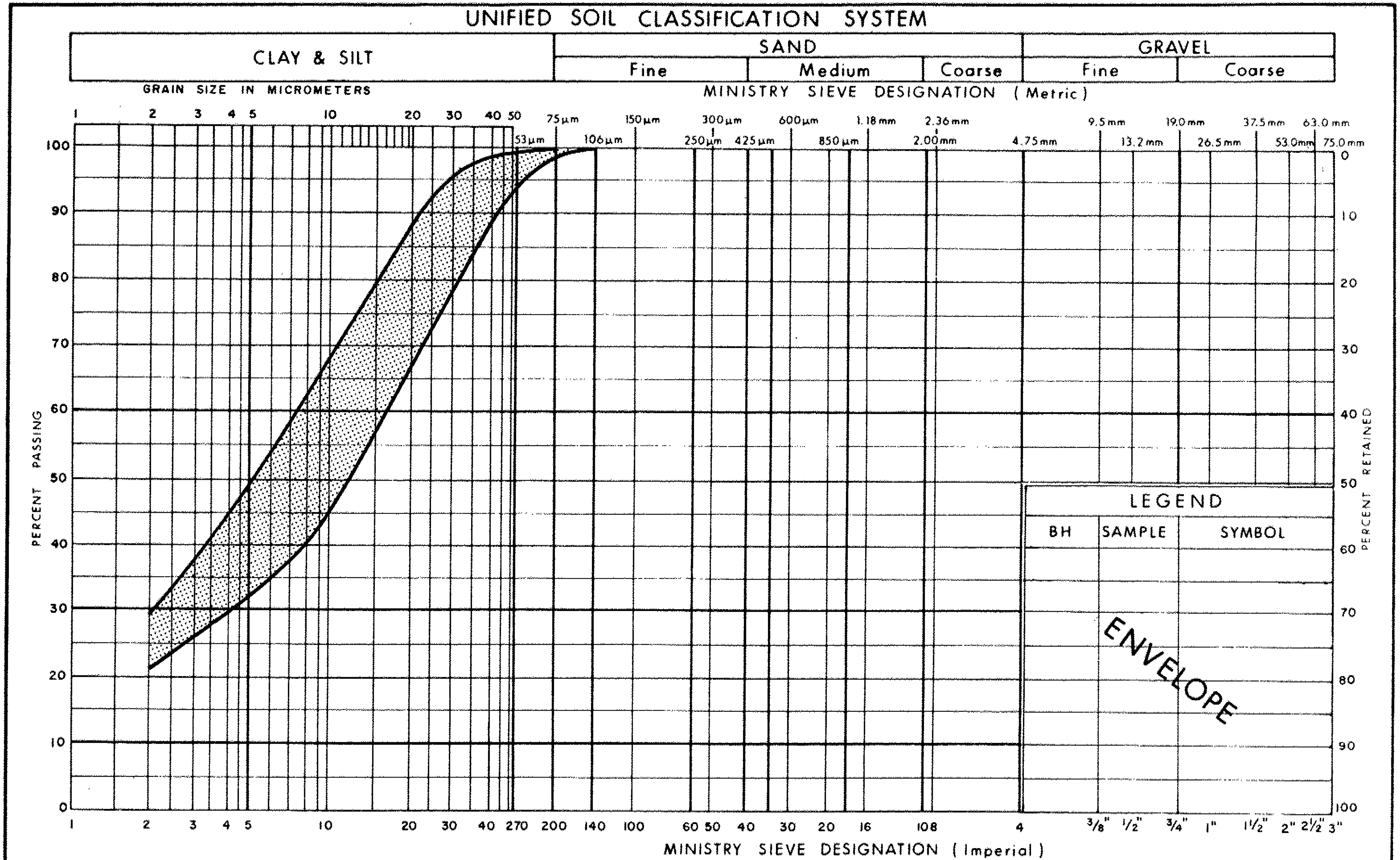



Ministry of Transportation
Ontario

# PLASTICITY CHART
# CLAYEY SILT

FIG No 3
W P 89-84-00

78 12 M




Ministry of Transportation

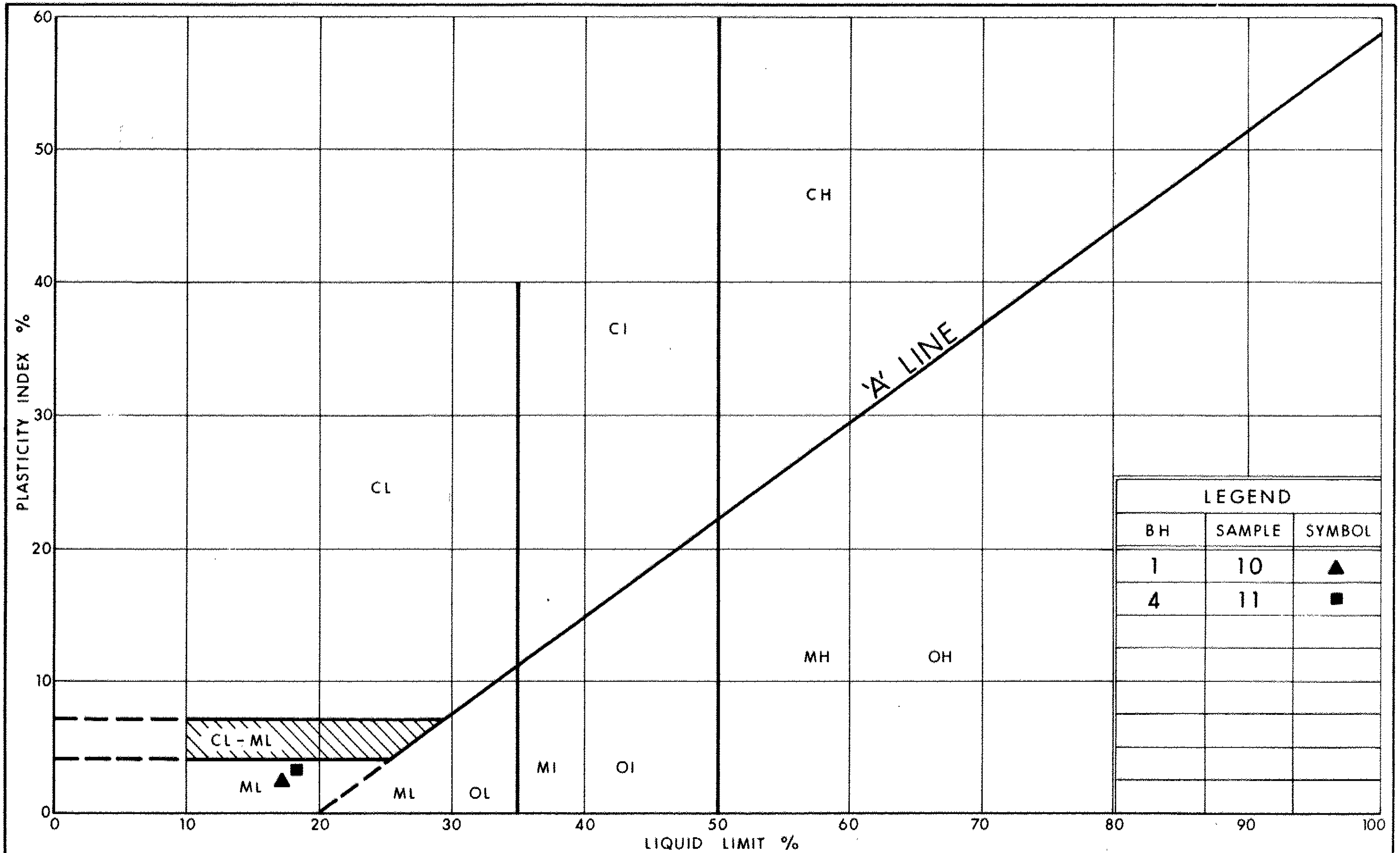
Ontario

# GRAIN SIZE DISTRIBUTION
# CLAYEY SILT

FIG No 4

W P 89-84-00

Oct 75, FF-S-21




Ministry of Transportation
Ontario

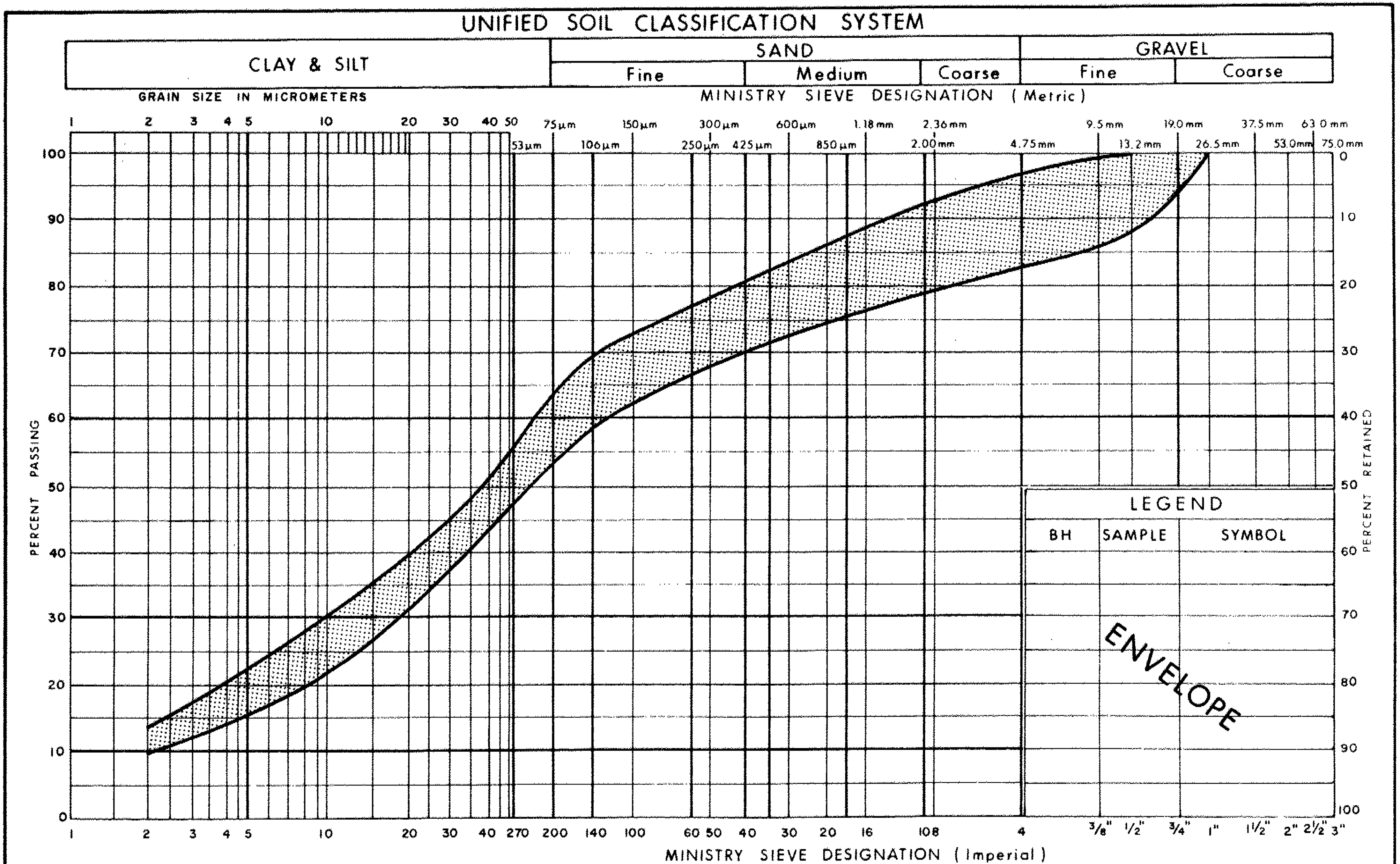
# PLASTICITY CHART

## HET MIXTURE OF

## SILT, SAND, GRAVEL & CLAY (Glacial Till)

FIG No 5

W P 89-84-00

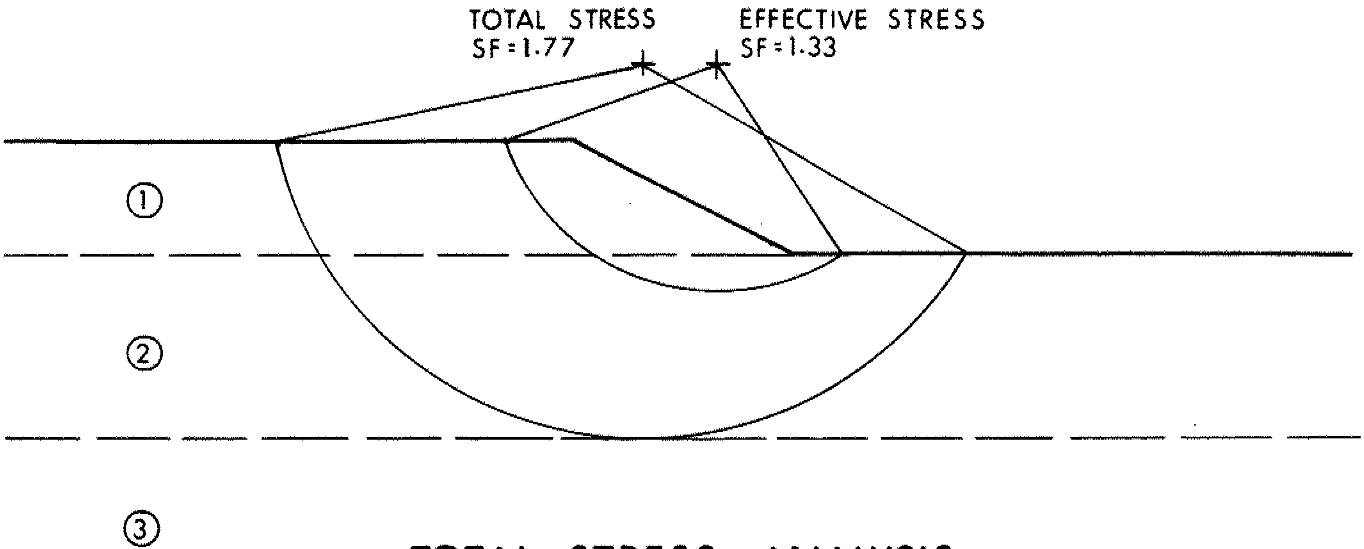



Ministry of Transportation
Ontario

# GRAIN SIZE DISTRIBUTION
## HET MIXTURE OF
## SILT, SAND, GRAVEL & CLAY (Glacial Till)

FIG No 6

W P 89-84-00



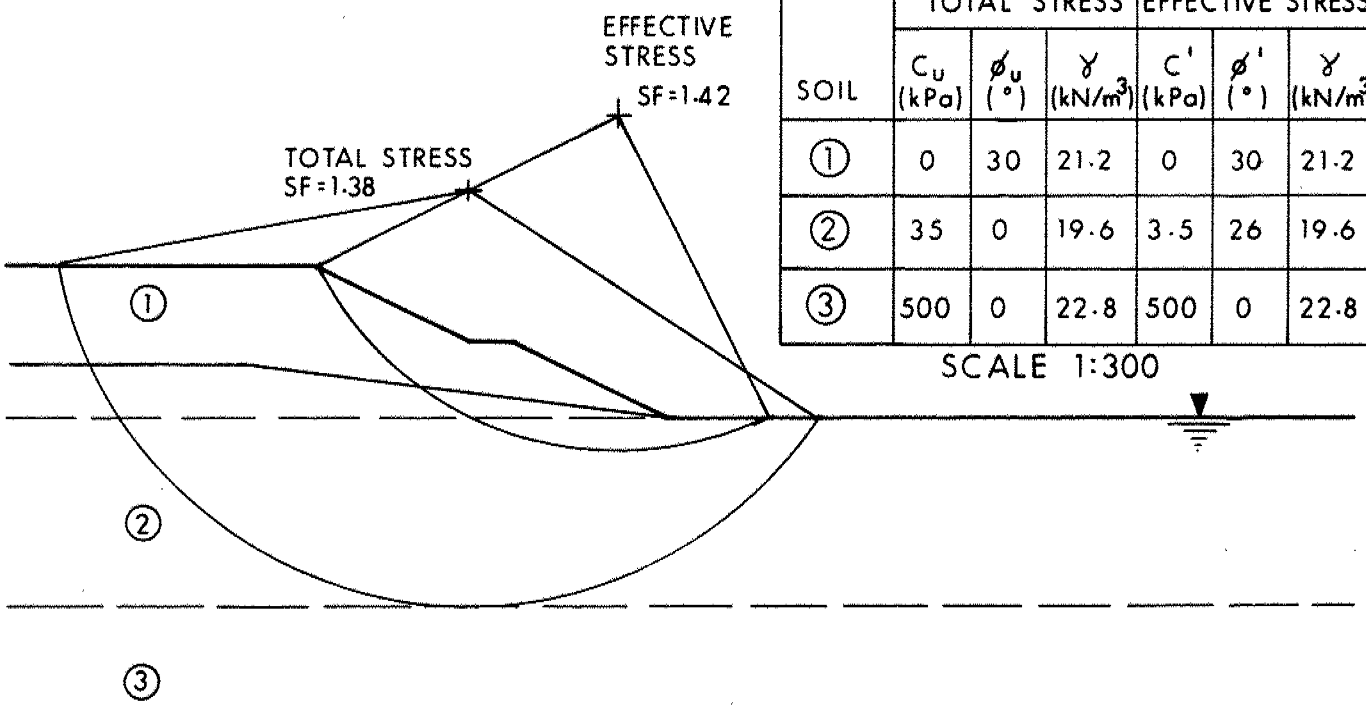

## TOTAL STRESS ANALYSIS
## 4.5m EMBANKMENT

Fig 7A

SOIL PARAMETERS

| SOIL | TOTAL STRESS $C_u$ (kPa) | TOTAL STRESS $\phi_u$ (°) | TOTAL STRESS $\gamma$ (kN/m³) | EFFECTIVE STRESS $C'$ (kPa) | EFFECTIVE STRESS $\phi'$ (°) | EFFECTIVE STRESS $\gamma$ (kN/m³) |
|---|---|---|---|---|---|---|
| ① | 0 | 30 | 21.2 | 0 | 30 | 21.2 |
| ② | 35 | 0 | 19.6 | 3.5 | 26 | 19.6 |
| ③ | 500 | 0 | 22.8 | 500 | 0 | 22.8 |

SCALE 1:300




## TOTAL STRESS ANALYSIS
## 6m EMBANKMENT

Fig 7B

WP 89-84-00

# 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 |
| $\sigma$ | kPa | TOTAL NORMAL STRESS |
| $\sigma'$ | kPa | EFFECTIVE NORMAL STRESS |
| $\tau$ | kPa | SHEAR STRESS |
| $\sigma_1, \sigma_2, \sigma_3$ | kPa | PRINCIPAL STRESSES |
| $\epsilon$ | % | LINEAR STRAIN |
| $\epsilon_1, \epsilon_2, \epsilon_3$ | % | PRINCIPAL STRAINS |
| E | kPa | MODULUS OF LINEAR DEFORMATION |
| G | kPa | MODULUS OF SHEAR DEFORMATION |
| $\mu$ | 1 | COEFFICIENT OF FRICTION |

### MECHANICAL PROPERTIES OF SOIL

| | | |
|---|---|---|
| $m_v$ | $kPa^{-1}$ | COEFFICIENT OF VOLUME CHANGE |
| $C_c$ | 1 | COMPRESSION INDEX |
| $C_s$ | 1 | SWELLING INDEX |
| $C_\alpha$ | 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 |
| $\sigma'_{vo}$ | kPa | EFFECTIVE OVERBURDEN PRESSURE |
| $\sigma'_p$ | kPa | PRECONSOLIDATION PRESSURE |
| $\tau_f$ | kPa | SHEAR STRENGTH |
| $c'$ | kPa | EFFECTIVE COHESION INTERCEPT |
| $\phi'$ | -° | EFFECTIVE ANGLE OF INTERNAL FRICTION |
| $c_u$ | kPa | APPARENT COHESION INTERCEPT |
| $\phi_u$ | -° | APPARENT ANGLE OF INTERNAL FRICTION |
| $\tau_R$ | kPa | RESIDUAL SHEAR STRENGTH |
| $\tau_r$ | kPa | REMOULDED SHEAR STRENGTH |
| $S_t$ | 1 | SENSITIVITY $= \frac{c_u}{\tau_r}$ |

### PHYSICAL PROPERTIES OF SOIL

| | | |
|---|---|---|
| $\rho_s$ | $kg/m^3$ | DENSITY OF SOLID PARTICLES |
| $\gamma_s$ | $kN/m^3$ | UNIT WEIGHT OF SOLID PARTICLES |
| $\rho_w$ | $kg/m^3$ | DENSITY OF WATER |
| $\gamma_w$ | $kN/m^3$ | UNIT WEIGHT OF WATER |
| $\rho$ | $kg/m^3$ | DENSITY OF SOIL |
| $\gamma$ | $kN/m^3$ | UNIT WEIGHT OF SOIL |
| $\rho_d$ | $kg/m^3$ | DENSITY OF DRY SOIL |
| $\gamma_d$ | $kN/m^3$ | UNIT WEIGHT OF DRY SOIL |
| $\rho_{sat}$ | $kg/m^3$ | DENSITY OF SATURATED SOIL |
| $\gamma_{sat}$ | $kN/m^3$ | UNIT WEIGHT OF SATURATED SOIL |
| $\rho'$ | $kg/m^3$ | DENSITY OF SUBMERGED SOIL |
| $\gamma'$ | $kN/m^3$ | UNIT WEIGHT OF SUBMERGED SOIL |
| e | 1, % | VOID RATIO |
| n | 1, % | POROSITY |
| w | 1, % | WATER CONTENT |
| $S_r$ | % | DEGREE OF SATURATION |
| $w_L$ | % | LIQUID LIMIT |
| $w_P$ | % | PLASTIC LIMIT |
| $w_S$ | % | SHRINKAGE LIMIT |
| $I_P$ | % | PLASTICITY INDEX $= w_L - w_P$ |
| $I_L$ | 1 | LIQUIDITY INDEX $= \frac{w - w_P}{I_P}$ |
| $I_C$ | 1 | CONSISTENCY INDEX $= \frac{w_L - w}{I_P}$ |
| $e_{max}$ | 1, % | VOID RATIO IN LOOSEST STATE |
| $e_{min}$ | 1, % | VOID RATIO IN DENSEST STATE |
| $I_D$ | 1 | DENSITY INDEX $= \frac{e_{max} - e}{e_{max} - e_{min}}$ |
| D | mm | GRAIN DIAMETER |
| $D_n$ | mm | n PERCENT - DIAMETER |
| $C_u$ | 1 | UNIFORMITY COEFFICIENT |
| h | m | HYDRAULIC HEAD OR POTENTIAL |
| q | $m^3/s$ | RATE OF DISCHARGE |
| v | m/s | DISCHARGE VELOCITY |
| i | 1 | HYDRAULIC GRADIENT |
| k | m/s | HYDRAULIC CONDUCTIVITY |
| j | $kN/m^3$ | SEEPAGE FORCE |

Ministry of Transportation Ontario

# RECORD OF BOREHOLE No 1 METRIC

W P 89-84-00 LOCATION Co-ords. N 4 903 352.5; E 303 274.5 ORIGINATED BY MS

DIST 8 HWY 401 BOREHOLE TYPE H-S Auger, BX Rock Core & Cone Test COMPILED BY MS

DATUM Geodetic DATE 88 06 22 CHECKED BY DD

| ELEV / DEPTH | DESCRIPTION | NUMBER | TYPE | 'N' VALUES | GROUND WATER CONDITIONS | UNIT WEIGHT γ kN/m³ | GRAIN SIZE DISTRIBUTION (%) GR SA SI CL |
|---|---|---|---|---|---|---|---|
| 86.9 | Ground Surface | | | | | | |
| 0.0 | Clay to Silty Clay, Trace Sand, Firm to Very Stiff (Lacustrine) | 1 | SS | 21 | | | |
| | | 2 | SS | 12 | | | 0 1 54 45 |
| | | 3 | SS | 5 | Seal | | |
| | | 4 | SS | 5 | | | |
| 82.3 | | 5 | TW | PH | | 18.5 | 0 3 57 40 |
| 4.6 | Clayey Silt, Trace Sand, Occ. Silt Layers, Soft to Stiff (Lacustrine) | 6 | SS | 2 | | | |
| | | 7 | SS | 2 | 88 08 13 | | |
| | | 8 | TW | PH | | 19.8 | 0 1 77 22 |
| 77.3 | | 9 | SS | 5 | | | |
| 9.6 | Heterogeneous Mixture of Silt, Sand, Gravel and Clay, Compact (Glacial Till) | 10 | SS | 23 | Piezometer | | 3 32 51 14 |
| 74.4 | | 11 | SS | 120 | | | |
| 12.5 | Limestone Bedrock Unweathered | 12 | RC | REC 98% | | | |
| 72.8 / 14.1 | End of Borehole | | | | | | |

ELEVATION SCALE: 86, 84, 82, 80, 78, 76, 74

DYNAMIC CONE PENETRATION RESISTANCE PLOT: 20 40 60 80 100

SHEAR STRENGTH kPa: O UNCONFINED; + FIELD VANE; ● QUICK TRIAXIAL; × LAB VANE — 20 40 60 80 100

PLASTIC LIMIT $W_p$ — NATURAL MOISTURE CONTENT W — LIQUID LIMIT $W_L$; WATER CONTENT (%) 20 40 60

OFFICE REPORT ON SOIL EXPLORATION

+3, ×5 : Numbers refer to Sensitivity

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

Ministry of Transportation Ontario

# RECORD OF BOREHOLE No 2 METRIC

W P 89-84-00 LOCATION Co-ords. N 4 903 308.5; E 303 279.5 ORIGINATED BY MS

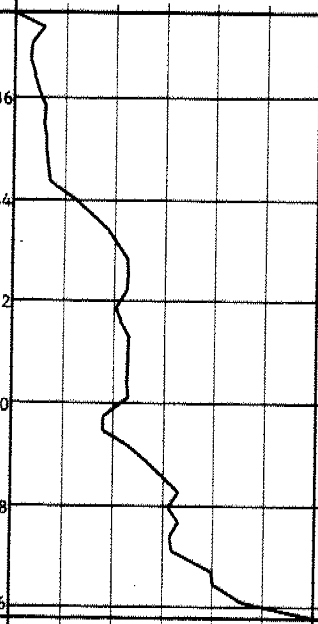
DIST 8 HWY 401 BOREHOLE TYPE Cone Penetration Test COMPILED BY MS

DATUM Geodetic DATE 88 06 20 CHECKED BY DD

| ELEV / DEPTH | SOIL PROFILE – DESCRIPTION | STRAT PLOT | SAMPLES: NUMBER | TYPE | 'N' VALUES | GROUND WATER CONDITIONS | ELEVATION SCALE |
|---|---|---|---|---|---|---|---|
| 87.7 | Ground Surface | | | | | | |
| 0.0 | Probable Sand Fill | | | | | | |
| 85.6 / 2.1 | Probable Clay to Silty Clay | | | | | | 86 |
| | | | | | | | 84 |
| 81.9 / 5.8 | Probable Clayey Silt | | | | | | 82 |
| 79.5 / 8.2 | Probable Heterogeneous Mixture of Silt, Sand, Gravel and Clay (Glacial Till) | | | | | | 80 |
| | | | | | | | 78 |
| 75.8 / 11.9 | End of Cone Test<br>Probable Bedrock | | | | | | 76 |

DYNAMIC CONE PENETRATION RESISTANCE PLOT (20, 40, 60, 80, 100)

SHEAR STRENGTH kPa: O UNCONFINED; + FIELD VANE; ● QUICK TRIAXIAL; × 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

OFFICE REPORT ON SOIL EXPLORATION

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

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

Ministry of Transportation Ontario

# RECORD OF BOREHOLE No 3

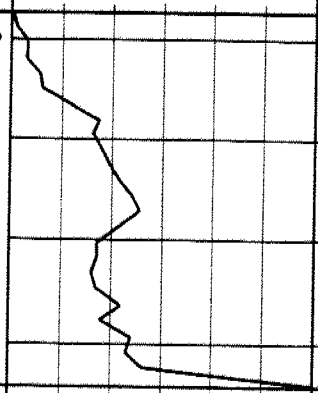
METRIC

W P 89-84-00 LOCATION Co-ords. N 4 903 327.9; E 303 336.6 ORIGINATED BY MS

DIST 8 HWY 401 BOREHOLE TYPE Cone Penetration Test COMPILED BY MS

DATUM Geodetic DATE 88 06 22 CHECKED BY DD

| SOIL PROFILE | | | SAMPLES | | | GROUND WATER CONDITIONS | ELEVATION SCALE | DYNAMIC CONE PENETRATION RESISTANCE PLOT (20 40 60 80 100); SHEAR STRENGTH kPa: ○ UNCONFINED, + FIELD VANE, ● QUICK TRIAXIAL, × LAB VANE | PLASTIC LIMIT Wp, NATURAL MOISTURE CONTENT W, LIQUID LIMIT WL; WATER CONTENT (%) | UNIT WEIGHT γ | REMARKS & GRAIN SIZE DISTRIBUTION (%) GR SA SI CL |
|---|---|---|---|---|---|---|---|---|---|---|---|
| ELEV / DEPTH | DESCRIPTION | STRAT PLOT | NUMBER | TYPE | 'N' VALUES | | | | | | |
| 86.5 | Ground Surface | | | | | | | | | | |
| 0.0 / 85.6 | Probable Sand Fill | | | | | | 86 | | | | |
| 0.9 | Probable Clay to Silty Clay | | | | | | 84 | | | | |
| 81.9 / 4.6 | Probable Clayey Silt | | | | | | 82 | | | | |
| 80.4 / 6.1 | Probable Het.Mixture Silt, Sand, Gravel and Clay (Glacial Till) | | | | | | 80 | | | | |
| 79.2 / 7.3 | End of Cone Test Probable Bedrock | | | | | | | | | | |



OFFICE REPORT ON SOIL EXPLORATION

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

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

Ministry of Transportation
Ontario

# RECORD OF BOREHOLE No 4

METRIC

W P 89-84-00 LOCATION Co-ords. N 4 903 285.3; E 303 342.0 ORIGINATED BY MS

DIST 8 HWY 401 BOREHOLE TYPE H-S Auger, BX Rock Core & Cone Test COMPILED BY MS

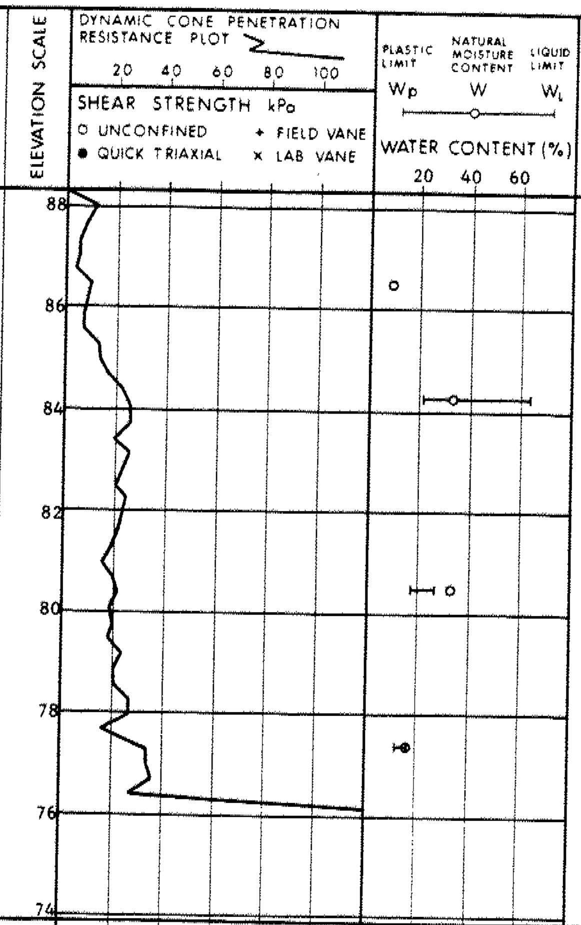
DATUM Geodetic DATE 88 06 20 CHECKED BY DD

## SOIL PROFILE

| ELEV / DEPTH | DESCRIPTION |
|---|---|
| 88.3 | Ground Surface |
| 0.0 | Sand, Some Gravel, Trace Silt and Clay, Occ. Clayey Silt Zones, Loose (Fill) |
| 85.6 / 2.7 | Clay to Silty Clay, Trace Sand, Firm to Stiff (Lacustrine) |
| 82.5 / 5.8 | Clayey Silt, Trace Sand, Occ. Silt Layers, Soft to Firm (Lacustrine) |
| 79.2 / 9.1 | Heterogeneous Mixture of Silt, Sand, Gravel and Clay, Very Loose (Glacial Till) |
| 76.1 / 12.2 | Limestone Bedrock Unweathered |
| 73.9 / 14.4 | End of Borehole |

## SAMPLES

| NUMBER | TYPE | 'N' VALUES | GROUND WATER CONDITIONS | REMARKS & GRAIN SIZE DISTRIBUTION (%) GR SA SI CL |
|---|---|---|---|---|
| 1 | SS | 8 | | |
| 2 | SS | 10 | | 22 71 5 2 |
| 3 | SS | 3 | | |
| 4 | SS | 8 | | |
| 5 | SS | 14 | | 0 7 30 63 |
| 6 | SS | 10 | | |
| 7 | SS | 7 | | |
| 8 | SS | 5 | | |
| 9 | SS | 4 | | 0 1 71 28 |
| 10 | SS | 2 | | |
| 11 | SS | 3 | | 17 25 44 14 |
| 12 | SS | 120/0 cm | | |
| 13 | RC | REC 83% | | |
| 14 | RC | REC 93% | | |




OFFICE REPORT ON SOIL EXPLORATION

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

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

MINISTRY OF TRANSPORTATION AND COMMUNICATIONS, ONTARIO PH-D-207 82 04

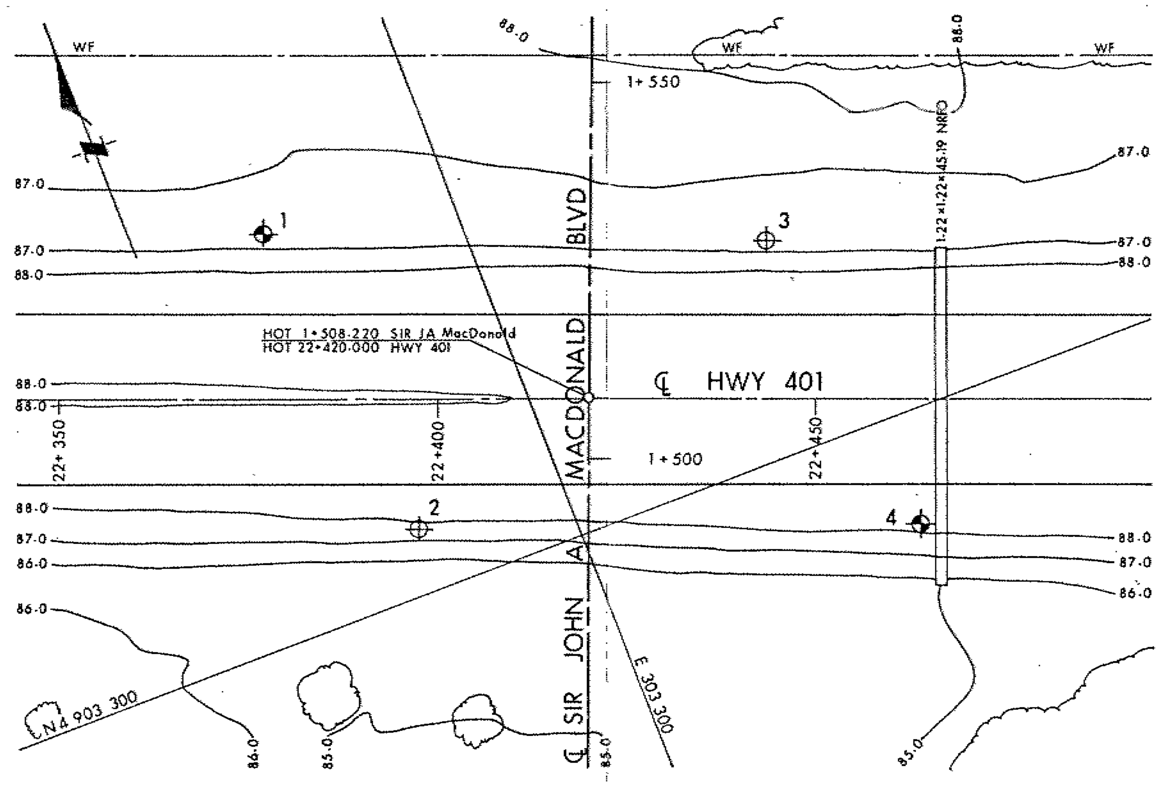
# METRIC

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

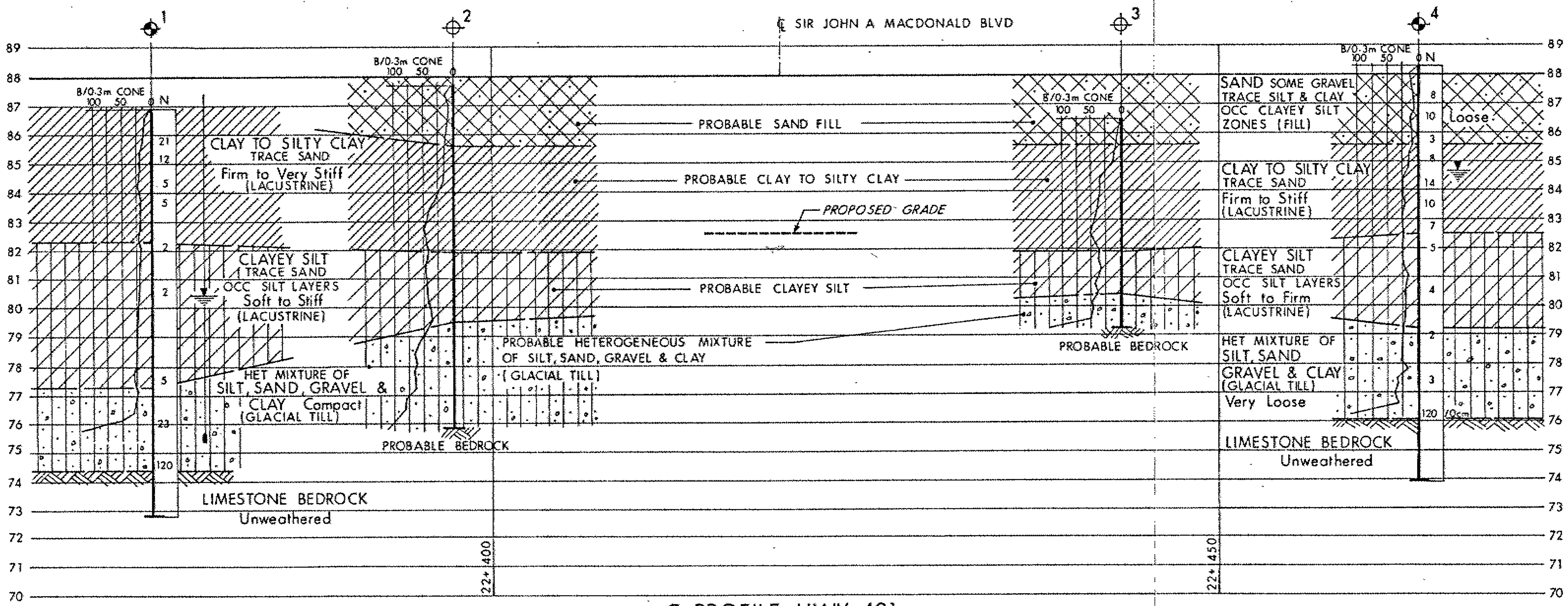
CONT No
WP No 89-84-00

HWY 401 &
SIR JOHN A MACDONALD BLVD
BORE HOLE LOCATIONS & SOIL STRATA

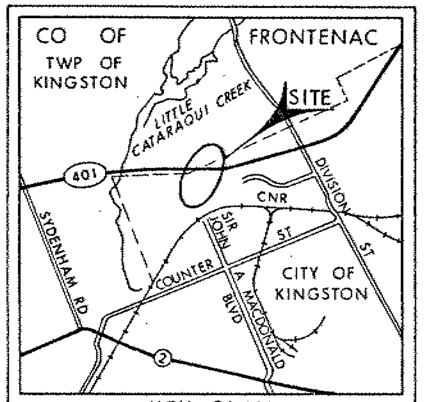
SHEET




PLAN
SCALE
10m 5 0 10m




℄ PROFILE HWY 401
SCALE
4m 2 0 4m Hor
2m 1 0 2m Vert




KEY PLAN
SCALE
1km 0 1km

## LEGEND

- Bore Hole
- Dynamic Cone Penetration Test (Cone)
- Bore Hole & Cone
- N — Blows/0.3m (Std Pen Test, 475 J/blow)
- CONE — Blows/0.3m (60° Cone, 475 J/blow)
- W L at time of investigation 88 06 and 88 08
- W L in Piezometer

| No | ELEVATION | CO-ORDINATES NORTH | EAST |
|---|---|---|---|
| 1 | 86.9 | 4 903 352.5 | 303 274.5 |
| 2 | 87.7 | 4 903 308.5 | 303 279.5 |
| 3 | 86.5 | 4 903 327.9 | 303 336.6 |
| 4 | 88.3 | 4 903 285.3 | 303 342.0 |

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

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

| REV. | DATE | BY | DESCRIPTION |
|---|---|---|---|

Geocres No 31C-143

| | | | |
|---|---|---|---|
| HWY No 401 | | | DIST 8 |
| SUBM'D DD | CHECKED | DATE 88 12 22 | SITE 7-79 |
| DRAWN DT | CHECKED CP | APPROVED | DWG 898400-A |

# memorandum

Ontario

To: H.K. Jagasia
Design Engineer
Structural Office

Date: 1989 06 06

From: Foundation Design Section
Room 315, Central Building

RE: Preliminary Drawing Review
Sir John A. MacDonald Blvd. Overpass
and Approaches
W.P. 89-84-00, Site 7-79
Hwy. 401, District 8, Kingston

We have reviewed the preliminary drawing #P1, dated May 30, 1989, for this project and have no comments at this time. However, as you are aware this design has been based on a preliminary foundation report and is thus subject to change when the Foundation Investigation and Design Report is finalized. Please resubmit the drawing for comments after you have updated the design in accordance with this report.

If there are any questions, please advise.

D.H. Dundas

D.H. Dundas, P. Eng.
Sr. Foundation Engineer

for

M. Devata, P. Eng.
Chief Foundation Engineer

MD/DHD/sp

# memorandum

Ontario

To: E.C. Lane
Head, Structural Section
Eastern Region

Date: 1989 01 11

Atten: H.S. Kleywegt, Structural Engineer

From: Foundation Design Section
Room 315, Central Building

RE: Sir John A. MacDonald Blvd. Overpass
and Approaches
W.P. 89-84-00, Site 7-79
Hwy. 401, District 8, Kingston

Further to your memo dated 89 01 09, this will document the comments provided in our telephone conversation of 89 01 03, regarding the suitability of closed type abutments at this site.

Based on the preliminary investigation there is a possibility that slope stability problems may preclude the construction of closed type abutments. This situation can be verified during the foundation investigation for this project.

If there are any questions, please advise.

D.H. Dundas

D.H. Dundas, P. Eng.
Sr. Foundation Engineer

DHD/mmj