

GEOCRES No. 30M5-155DIST. 4 REGION W.P. No. 83-74-08CONT. No. 89-26W. O. No. STR. SITE No. HWY. No. QEWLOCATION QEW / Brant StHigh Mast lightingNo of PAGES -

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OVERSIZE DRAWINGS TO BE INCLUDED WITH THIS REPORT. REMARKS:

FOUNDATION INVESTIGATION REPORT

CONTRACT NO ~~88-15~~
89-26



Ministry of
Transportation and
Communications

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Foundation Investigation Report

For

Q.E.W. - Brant St. High Mast Light Poles

W.P. 83-74-08, Site -

District 4, Hamilton

and

Q.E.W. - Brant St. Overpass

W.P. 83-74-31, Site 10-1337-138

District 4, Hamilton

NOTE: For the purposes of this contract, this report supersedes all other reports prepared by or for the Ministry in connection with the above-noted project.

EXPLANATION OF TERMS USED IN REPORT

2

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/0.3 m) | 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:

| 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_a | 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'_{vo} | 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_i | 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 | | | | | | |

FOUNDATION INVESTIGATION REPORT

For

Q.E.W. - Brant St., Interchange

W.P. 83-74-08

District 4, Hamilton

INTRODUCTION

This report presents the results of foundation investigation performed at the above-mentioned site. Fieldwork consisted of twelve sampled boreholes, all of which were accompanied by dynamic cone penetration tests. The boreholes were advanced between 85 07 23 and 85 07 29. A track mounted auger machine was utilized for this investigation. Borings were advanced for depths ranging from 4.5 m to 6.1 m. Bedrock was cored in all twelve boreholes utilizing BXL size rock coring equipment.

SITE DESCRIPTION

The site is located just east of the Q.E.W./403 interchange at the future Q.E.W./Brant St. interchange in the City of Burlington, Regional Municipality of Halton.

As part of the proposed Q.E.W./Brant St. interchange, it is proposed to illuminate the interchange area with 12 high mast light poles. The height of the poles is anticipated to be 35 m. Note that the numbering system used to identify the boreholes is the same as that used to identify the light poles.

This site is located within the physiographic region known as the South Slope. The area is characterized by a ground moraine of limited relief. The bedrock underlying the site is a red shale with greenish siltstone of the Queenston Formation.

SUBSURFACE CONDITIONSGeneral

The boundaries of the various subsoil types are shown in the Record of Borehole Sheets located in the Appendix. The locations and elevations of the borings are also shown on these sheets. This report must be read in conjunction with the above-noted items.

The subsoil conditions are quite uniform across the site. Exposed at ground surface at all boreholes locations is a heterogeneous mixture of silty clay, sand, and gravel (glacial till). Underlying the till material is a red shale bedrock of the Queenston Formation.

The various soil types encountered are described in the following paragraphs.

Heterogeneous Mixture of Silty Clay, Sand, and Gravel (Glacial Till)

This deposit is the predominant soil type across this site. It was encountered at all borehole locations and varied in thickness from 0.6 m to 1.5 m. It is characteristic of this deposit to have occasional cobbles and boulders distributed throughout the deposit.

The results of Atterberg Limited Tests are plotted on the Plasticity Chart, Figure No. 1

The summarized test results are as follows:

| | | Range | Average | Median |
|------------------|---------------------|-------|---------|--------|
| Water Content | (w) % | 5-15 | 11 | 10 |
| Liquid Limit | (w _L) % | 21-31 | 28 | 26 |
| Plastic Limit | (w _p) % | 13-19 | 16 | 17 |
| Plasticity Index | (I _p) % | 7-15 | 12 | 11 |

The results of grain size distribution tests are plotted in envelope form on Figure No. 2 in the Appendix.

Standard Penetration Test "N" values ranged from 23 to over 55 blows per 0.3 m. The consistency of the deposit varies from stiff to hard.

Bedrock

Bedrock was proven at all boreholes by obtaining BXL rock cores. The top of the bedrock varied in elevation from 102.4 m at borehole 15 to 105.4 m at borehole 6. The bedrock is a red shale with green siltstone of the Queenston Formation. The upper portion of the bedrock is in a highly weathered state with layers of broken shale and silty clay.

The core recovery attained ranged from 15 to 100%

The Rock Quality Designation (RQD) for the bedrock ranged from 0% to 100% with a mean of 35%

A detailed description of the rock core was prepared by Mr. E. Magni, MTC Soils and Aggregate Geologist, and his report is located in the Appendix.

Groundwater

The groundwater level was found to vary between elevation 100.4 m and 106.2 m by taking overnight readings in the open boreholes. However, owing to the relatively impervious nature of the till deposit and the water used in the rock coring operation, this may not represent a true stabilized condition.



P. Payer

P. Payer, P. Eng.
Senior Foundations Engineer

K. G. Selby

K. G. Selby, P. Eng.
Chief Foundation Engineer
(West)

APPENDIX



RECORD OF BOREHOLE No 2

METRIC

W P 83-74-08 LOCATION N 4 799 960 E 278 400 ORIGINATED BY LM
DIST 4 HWY Q.E.W. BOREHOLE TYPE H.S. Auger - Cone Test COMPILED BY BR
DATUM Geodetic DATE 1985 07 26 CHECKED BY LM

| SOIL PROFILE | | | SAMPLES | | | GROUND WATER CONDITIONS | ELEVATION SCALE | DYNAMIC CONE PENETRATION RESISTANCE PLOT 20 40 60 80 100 SHEAR STRENGTH ○ UNCONFINED + FIELD VANE ● QUICK TRIAXIAL x LAB VANE | PLASTIC LIMIT W _p NATURAL MOISTURE CONTENT W LIQUID LIMIT W _L WATER CONTENT (%) 10 20 30 | UNIT WEIGHT γ | REMARKS & GRAIN SIZE DISTRIBUTION (%) GR SA SI CL | |
|--------------|--|------------|---------|-------|------------|-------------------------|-----------------|---|---|------------------|--|--|
| ELEV DEPTH | DESCRIPTION | STRAT PLOT | NUMBER | TYPE | 'N' VALUES | | | | | | | |
| 106.6 | Ground Surface | | | | | | | | | | | |
| 0.0 | | | | | | | | | | | | |
| 105.3 | Heterogeneous Mixture of Silty Clay Sand and Gravel Very Stiff to Hard | | 1 | SS | 48 | | 106 | | | | | |
| 1.3 | Bedrock | | 2 | SS | 32 | | | | | | | |
| | | | 3 | SS | 50/ | 5 cm | 104 | | | | | |
| | | | 4 | SS | 95/ | 15 cm | | | | | | |
| | Weathered Sound | | 5 | BX RC | REC 61% | | | | | | | |
| | Queenston Shale | | 6 | BX RC | REC 100% | | 102 | | | | | |
| 101.1 | | | | | | | | | | | | |
| 5.5 | End of Borehole | | | | | | 100 | | | | | |

OFFICE REPORT ON SOIL EXPLORATION



RECORD OF BOREHOLE No 3

METRIC

W P 83-74-08 LOCATION N 4 799 873 E 278 510 ORIGINATED BY LM
DIST 4 HWY Q.E.W. BOREHOLE TYPE H.S. Auger - Cone Test COMPILED BY BR
DATUM Geodetic DATE 1985 07 24 CHECKED BY Lo

| SOIL PROFILE | | | SAMPLES | | | GROUND WATER CONDITIONS | ELEVATION SCALE | DYNAMIC CONE PENETRATION RESISTANCE PLOT 20 40 60 80 100 SHEAR STRENGTH ○ UNCONFINED + FIELD VANE ● QUICK TRIAXIAL x LAB VANE | PLASTIC LIMIT W _p NATURAL MOISTURE CONTENT W LIQUID LIMIT W _L WATER CONTENT (%) 10 20 30 | UNIT WEIGHT γ | REMARKS & GRAIN SIZE DISTRIBUTION (%) GR SA SI CL | |
|--------------|--|------------|---------|-------|------------|-------------------------|-----------------|---|---|------------------|--|------------|
| ELEV DEPTH | DESCRIPTION | STRAT PLOT | NUMBER | TYPE | 'N' VALUES | | | | | | | |
| 104.2 | Ground Surface | | | | | | | | | | | |
| 0.0 | * | | | | | | 104 | | | | | |
| 103.6 | | | | | | | | | | | | |
| 0.6 | | | | | | | | | | | | |
| | Bedrock | | 1 | SS | 47 | | | | | | | |
| | | | 2 | SS | 77 | | | | | | | |
| | | | 3 | BX RC | REC 15% | | 102 | | | | | RQD = 0% |
| | Weathered Sound | | 4 | BX RC | REC 94% | | | | | | | RQD = 53% |
| | Queenston Shale | | 5 | BX RC | REC 100% | | 100 | | | | | RQD = 100% |
| 98.9 | | | | | | | | | | | | |
| 5.3 | End of Borehole | | | | | | | | | | | |
| | * Heterogeneous Mixture of Silty Clay, Sand and Gravel Stiff to Very Stiff | | | | | | 98 | | | | | |

OFFICE REPORT ON SOIL EXPLORATION

METRIC

ORIGINATED BY LM

COMPILED BY BR

CHECKED BY

+3, x5: Numbers refer to Sensitivity



RECORD OF BOREHOLE No 5

METRIC

W P 83-74-08 LOCATION N 4 799 929 E 278 656 ORIGINATED BY LM
DIST 4 HWY Q.E.W. BOREHOLE TYPE H.S. Auger - Cone Test COMPILED BY BR
DATUM Geodetic DATE 1985 07 24 CHECKED BY

| SOIL PROFILE | | SAMPLES | | | GROUND WATER CONDITIONS | ELEVATION SCALE | DYNAMIC CONE PENETRATION RESISTANCE PLOT 20 40 60 80 100 SHEAR STRENGTH ○ UNCONFINED + FIELD VANE ● QUICK TRIAXIAL x LAB VANE | PLASTIC LIMIT W _p NATURAL MOISTURE CONTENT W LIQUID LIMIT W _L | WATER CONTENT (%) 10 20 30 | UNIT WEIGHT γ | REMARKS & GRAIN SIZE DISTRIBUTION (%) GR SA SI CL |
|---------------|--|------------|--------|-------|----------------------------|-----------------|--|--|-------------------------------|------------------|--|
| ELEV DEPTH | DESCRIPTION | STRAT PLOT | NUMBER | TYPE | | | | | | | |
| 103.5 | Ground Surface | | | | | | | | | | |
| 0.0 | * | | | | | | | | | | |
| 102.9 | | | | | | | | | | | |
| 0.6 | | | | | | | | | | | |
| | Bedrock | | 1 | SS | 123 | | | | | | |
| | | | 2 | SS | 84 | | | | | | |
| | Weathered Sound | | 3 | BX RC | REC 80% | | | | | | RQD = 35% |
| | Queenston Shale | | 4 | BX RC | REC 86% | | | | | | RQD = 43% |
| | | | 5 | BX RC | REC 100% | | | | | | RQD = 77% |
| 98.7 | End of Borehole | | | | | | | | | | |
| 4.8 | * Heterogeneous Mixture of Silty Clay, Sand and Gravel Stiff to Hard | | | | | | | | | | |

OFFICE REPORT ON SOIL EXPLORATION

RECORD OF BOREHOLE No 6

METRIC

W P 83-74-08 LOCATION N 4 800 130 E 278 647 ORIGINATED BY LM
DIST 4 HWY Q.E.W. BOREHOLE TYPE H.S. Auger - Cone Test COMPILED BY BR
DATUM Geodetic DATE 1985 07 29 CHECKED BY 10

| SOIL PROFILE | | SAMPLES | | | GROUND WATER CONDITIONS | ELEVATION SCALE | DYNAMIC CONE PENETRATION RESISTANCE PLOT | PLASTIC LIMIT | NATURAL MOISTURE CONTENT | LIQUID LIMIT | UNIT WEIGHT γ | REMARKS & GRAIN SIZE DISTRIBUTION (%) GR SA SI CL | |
|--------------|---|------------|--------|-------|-------------------------|-----------------|--|-------------------------------|--------------------------|--------------|-------------------------|--|-------|
| ELEV DEPTH | DESCRIPTION | STRAT PLOT | NUMBER | TYPE | | | 'N' VALUES | 20 40 60 80 100 | w_p | W | | | w_L |
| | | | | | | | SHEAR STRENGTH ○ UNCONFINED + FIELD VANE ● QUICK TRIAXIAL x LAB VANE | WATER CONTENT (%) 10 20 30 | | | | | |
| 106.7 | Ground Surface | | | | | * | | | | | | | |
| 0.0 | Heterogeneous Mixture of Silty Clay Sand and Gravel Stiff to Very Stiff | | 1 | SS | 23 | | | | | | | | |
| 105.4 | | | | | | | | | | | | | |
| 1.3 | | | | | | | | | | | | | |
| | | | | | | | | | | | | | |
| | Bedrock | | 2 | SS | 100 | | | | ○ | | | | |
| | | | | | | | | | | | | | |
| | | | 3 | SS | 46 | | | | | | | | |
| | | | | | | | | | | | | | |
| | | | 4 | SS | 50 | 8 cm | | | | ○ | | | |
| | | | | | | | | | | | | | |
| | | | | | | | | | | | | | |
| | Weathered Sound | | 5 | BX RC | REC 92% | | | | | | | RQD = 44% | |
| | Queenston Shale | | 6 | BX RC | REC 95% | | | | | | | RQD = 65% | |
| | | | 7 | BX RC | REC 96% | | | | | | | RQD = 62% | |
| 100.6 | End of Borehole | | | | | | | | | | | | |
| 6.1 | * Grounwater Level Not Determined | | | | | | 100 | | | | | | |

OFFICE REPORT ON SOIL EXPLORATION

+3, x5 : Numbers refer to Sensitivity

15 \pm 5 (%) STRAIN AT FAILURE



RECORD OF BOREHOLE No 7

METRIC

W P 83-74-08 LOCATION N 4 800 002 E 278 740 ORIGINATED BY LM
DIST 4 HWY Q.E.W. BOREHOLE TYPE H.S. Auger - Cone Test COMPILED BY BR
DATUM Geodetic DATE 1985 07 23 CHECKED BY LM

| SOIL PROFILE | | SAMPLES | | GROUND WATER CONDITIONS | ELEVATION SCALE | DYNAMIC CONE PENETRATION RESISTANCE PLOT 20 40 60 80 100 SHEAR STRENGTH ○ UNCONFINED + FIELD VANE ● QUICK TRIAXIAL x LAB VANE | PLASTIC LIMIT W _p NATURAL MOISTURE CONTENT W LIQUID LIMIT W _L | UNIT WEIGHT γ | REMARKS & GRAIN SIZE DISTRIBUTION (%) GR SA SI CL |
|--------------|--|---------|-------|-------------------------|-----------------|---|--|------------------|--|
| ELEV DEPTH | DESCRIPTION | NUMBER | TYPE | | | | | | |
| 104.0 | Ground Surface | | | | | | | | |
| 0.0 | * | | | | | | | | |
| 103.3 | | | | | | | | | |
| 0.7 | | 1 | SS | 52 | | | | | |
| | | 2 | SS | 60/2 | cm | | | | |
| | Bedrock | 3 | BX RC | REC 48% | | | | | RQD = 0% |
| | | 4 | BX RC | REC 86% | | | | | RQD = 0% |
| | Weathered Sound | | | | | | | | |
| | Queenston Shale | 5 | BX RC | REC 98% | | | | | RQD = 53% |
| 98.5 | | | | | | | | | |
| 5.5 | End of Borehole | | | | | | | | |
| | * Heterogeneous Mixture of Silty Clay, Sand and Gravel Stiff to Hard | | | | | | | | |

OFFICE REPORT ON SOIL EXPLORATION



RECORD OF BOREHOLE No 8

METRIC

W P 83-74-08 LOCATION N 4 800 165 E 278 778 ORIGINATED BY LM
DIST 4 HWY Q.E.W. BOREHOLE TYPE H.S. Auger - Cone Test COMPILED BY BR
DATUM Geodetic DATE 1985 07 29 CHECKED BY LM

| SOIL PROFILE | | | SAMPLES | | | GROUND WATER CONDITIONS | ELEVATION SCALE | DYNAMIC CONE PENETRATION RESISTANCE PLOT 20 40 60 80 100 SHEAR STRENGTH ○ UNCONFINED + FIELD VANE ● QUICK TRIAXIAL x LAB VANE | PLASTIC LIMIT W _p NATURAL MOISTURE CONTENT W LIQUID LIMIT W _L | WATER CONTENT (%) 10 20 30 | UNIT WEIGHT Y | REMARKS & GRAIN SIZE DISTRIBUTION (%) GR SA SI CL | |
|---------------|--|------------|---------|----------|-------------|----------------------------|-----------------|--|--|-------------------------------|---------------------|--|-----------|
| ELEV DEPTH | DESCRIPTION | STRAT PLOT | NUMBER | TYPE | 'N' VALUES | | | | | | | | |
| 105.7 | Ground Surface | | | | | | | | | | | | |
| 0.0 | Heterogeneous Mixture of Silty Clay Sand and Gravel Very Stiff to Hard | | 1 | SS | 46 | | | | | | | | |
| 104.2 | | | 2 | SS | 77 | | | | | | | | |
| 1.5 | Bedrock | | 3 | SS | 50/8 | | | | | | | | |
| | Weathered Sound | | 4 | BX RC | REC 92% | | | | | | | | RQD = 0% |
| | | | 5 | BX RC | REC 100% | | | | | | | | RQD = 37% |
| | Queenston Shale | | 6 | BX RC | REC 100% | | | | | | | | RQD = 69% |
| 101.2 | | | | | | | | | | | | | |
| 4.5 | End of Borehole * Groundwater Level Not Determined | | | | | | | | | | | | |

OFFICE REPORT ON SOIL EXPLORATION

RECORD OF BOREHOLE No 9

METRIC

W P 83-74-08 LOCATION N 4 800 076 E 278 836 ORIGINATED BY LM
 DIST 4 HWY Q.E.W. BOREHOLE TYPE H.S. Auger - Cone Test COMPILED BY BR
 DATUM Geodetic DATE 1985 07 23 CHECKED BY LC

| 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 | | | | | | | | |
| 104.0 | Ground Surface | | | | | | | | | | | | |
| 0.0 | Heterogeneous Mixture of Silty Clay Sand and Gravel Stiff to Hard | | 1 | SS | 55 | | | | | | | | |
| 102.7 | | | 2 | SS | 65 | | | | | | | | |
| 1.3 | Bedrock | | 3 | BX | REC | | | | | | | | |
| | Weathered Sound | | 4 | BX | REC | | | | | | | | |
| | | | | RC | 87% | | | | | | | | |
| | Queenston Shale | | 5 | BX | REC | | | | | | | | |
| | | | | RC | 98% | | | | | | | | |
| | | | 6 | BX | REC | | | | | | | | |
| | | | | RC | 86% | | | | | | | | |
| 99.0 | | | | | | | | | | | | | |
| 5.0 | End of Borehole | | | | | | | | | | | | |
| | * Groundwater Level Not Determined | | | | | | | | | | | | |

OFFICE REPORT ON SOIL EXPLORATION



RECORD OF BOREHOLE No 10

METRIC

W P 83-74-08 LOCATION N 4 800 273 E 278 946 ORIGINATED BY LM
 DIST 4 HWY Q.E.W. BOREHOLE TYPE H.S. Auger - Cone Test COMPILED BY BR
 DATUM Geodetic DATE 1985 07 29 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 | | | | | | | | |
| 105.6 | Ground Surface | | | | | | | | | | | | |
| 0.0 | Heterogeneous Mixture of Silty Clay Sand and Gravel Very Stiff to Hard | | 1 | SS | 37 | | | | | | | | |
| 104.2 | | | | | | | | | | | | | |
| 1.4 | Bedrock | | 2 | SS | 126/20 cm | | | | | | | | 33 32 25 10 |
| | Weathered Sound | | 3 | SS | 33/5 cm | | | | | | | | RQD = 41% |
| | | | 4 | BX RC | REC 97% | | | | | | | | |
| | Queenston Shale | | 5 | BX RC | REC 93% | | | | | | | | RQD = 33% |
| 100.7 | | | | | | | | | | | | | |
| 4.9 | End of Borehole | | | | | | | | | | | | |
| | * Groundwater Level Not Determined | | | | | | | | | | | | |

OFFICE REPORT ON SOIL EXPLORATION

RECORD OF BOREHOLE No 11

METRIC

W P 83-74-08 LOCATION N 4 800 272 E 279 101 ORIGINATED BY LM
 DIST 4 HWY Q.E.W. BOREHOLE TYPE H.S. Auger - Cone Test COMPILED BY BR
 DATUM Geodetic DATE 85 07 24 CHECKED BY *JD*

| SOIL PROFILE | | SAMPLES | | | GROUND WATER CONDITIONS | ELEVATION SCALE | DYNAMIC CONE PENETRATION RESISTANCE PLOT | | PLASTIC LIMIT W _p | NATURAL MOISTURE CONTENT W | LIQUID LIMIT W _L | UNIT WEIGHT Y | REMARKS & GRAIN SIZE DISTRIBUTION (%) GR SA SI CL |
|--------------|---|------------|--------|-------|-------------------------|-----------------|--|-----------------|---------------------------------|-------------------------------|--------------------------------|------------------|--|
| ELEV DEPTH | DESCRIPTION | STRAT PLOT | NUMBER | TYPE | | | 'N' VALUES | 20 40 60 80 100 | | | | | |
| 103.7 | Ground Surface | | | | | | | | | | | | |
| 0.0 | Heterogeneous Mixture of Silty Clay, Sand & Gravel, Stiff to Very Stiff | | | | | | | | | | | | |
| 102.9 | | | | | | | | | | | | | |
| 0.8 | | | | | | | | | | | | | |
| | Bedrock | | 1 | SS | 22 | | | | | | | | |
| | | | 2 | SS | 33 | 3 cm | | | | | | | |
| | Weathered Sound | | 3 | BX RC | REC 92% | | | | | | | | RQD = 50% |
| | | | 4 | BX RC | REC 94% | | | | | | | | RQD = 39% |
| | Queenston Shale | | 5 | BX RC | REC 85% | | | | | | | | RQD = 37% |
| | | | 6 | BX RC | REC 100% | | | | | | | | RQD = 61% |
| 99.0 | | | | | | | | | | | | | |
| 4.7 | End of Borehole | | | | | | | | | | | | |

OFFICE REPORT ON SOIL EXPLORATION

+3, x5: Numbers refer to Sensitivity

20
15
10
5 (%) STRAIN AT FAILURE



RECORD OF BOREHOLE No 12

METRIC

W P 83-74-08 LOCATION N 4 800 430 E 279 204 ORIGINATED BY LM
DIST 4 HWY Q.E.W. BOREHOLE TYPE H.S. Auger - Cone Test COMPILED BY BR
DATUM Geodetic DATE 1985 07 26 CHECKED BY LM

| SOIL PROFILE | | SAMPLES | | | GROUND WATER CONDITIONS | ELEVATION SCALE | DYNAMIC CONE PENETRATION RESISTANCE PLOT 20 40 60 80 100 SHEAR STRENGTH ○ UNCONFINED + FIELD VANE ● QUICK TRIAXIAL x LAB VANE | PLASTIC LIMIT W _p | NATURAL MOISTURE CONTENT W | LIQUID LIMIT W _L | UNIT WEIGHT γ | REMARKS & GRAIN SIZE DISTRIBUTION (%) GR SA SI CL |
|--------------|---|------------|--------|-------|-------------------------|-----------------|---|---------------------------------|-------------------------------|--------------------------------|------------------|--|
| ELEV DEPTH | DESCRIPTION | STRAT PLOT | NUMBER | TYPE | | | | | | | | |
| 105.9 | Ground Surface | | | | | | | | | | | |
| 0.0 | Heterogeneous Mixture of Silty Clay Sand and Gravel Stiff to Hard | | 1 | SS | 38 | | | | | | | |
| 104.4 | | | 2 | SS | 40 | | | | | | | |
| 1.5 | Bedrock | | 3 | SS | 102/20 cm | | | | | | | |
| | | | 4 | BX RC | REC 77% | | | | | | | RQD = 0% |
| | Weathered Sound | | 5 | BX RC | REC 86% | | | | | | | RQD = 0% |
| | Queenston Shale | | 6 | BX RC | REC 95% | | | | | | | RQD = 63% |
| 100.4 | | | | | | | | | | | | |
| 5.5 | End of Borehole | | | | | | | | | | | |

OFFICE REPORT ON SOIL EXPLORATION

+3, x5: Numbers refer to Sensitivity

20
15 5 (%) STRAIN AT FAILURE
10



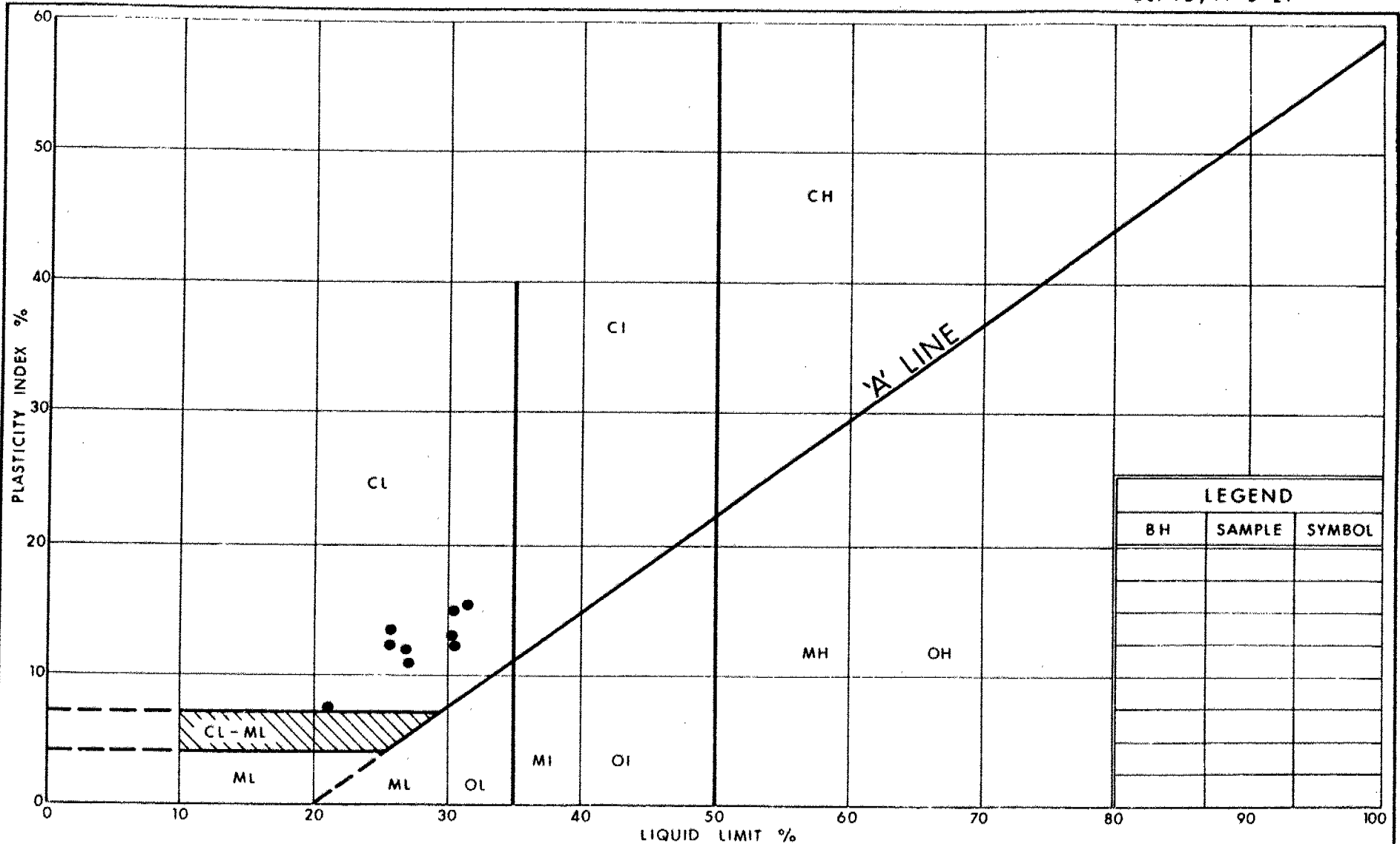
RECORD OF BOREHOLE No 15

METRIC

W P 83-74-08 LOCATION N 4 799 617 E 278 296 ORIGINATED BY LM
 DIST 4 HWY Q.E.W. BOREHOLE TYPE H.S. Auger - Cone Test COMPILED BY BR
 DATUM Geodetic DATE 1985 07 25 CHECKED BY [Signature]

| SOIL PROFILE | | | SAMPLES | | | GROUND WATER CONDITIONS | ELEVATION SCALE | DYNAMIC CONE PENETRATION RESISTANCE PLOT | | PLASTIC LIMIT W _p | NATURAL MOISTURE CONTENT W | LIQUID LIMIT W _L | UNIT WEIGHT Y | REMARKS & GRAIN SIZE DISTRIBUTION (%) GR SA SI CL |
|---------------|--|------------|---------|----------|-------------|----------------------------|-----------------|---|-------------------|------------------------------------|-------------------------------------|-----------------------------------|---------------------|--|
| ELEV DEPTH | DESCRIPTION | STRAT PLOT | NUMBER | TYPE | 'N' VALUES | | | 20 40 60 80 100 | 0 20 40 60 80 100 | | | | | |
| 103.0 | Ground Surface | | | | | | | | | | | | | |
| 0.0 | ** | | | | | * | | | | | | | | |
| 102.4 | | | | | | | | | | | | | | |
| 0.6 | Bedrock | | 1 | SS | 52 | | | | | | | | | |
| | | | 2 | SS | 98 | | | | | | | | | |
| | Weathered Sound | | 3 | EX RC | REC 98% | | | | | | | | | RQD = 10% |
| | Queenston Shale | | 4 | EX RC | REC 100% | | | | | | | | | RQD = 47% |
| 98.3 | | | | | | | | | | | | | | |
| 4.7 | End of Borehole | | | | | | | | | | | | | |
| | * Groundwater Level Not Determined | | | | | | | | | | | | | |
| | ** Heterogeneous Mixture of Silty Clay, Sand and Gravel Very Stiff to Hard | | | | | | | | | | | | | |

OFFICE REPORT ON SOIL EXPLORATION

Ministry of
Transportation and
Communications

PLASTICITY CHART
HETEROGENEOUS MIXTURE OF SILTY CLAY, SAND & GRAVEL

FIG No 1

W P 83-74-08



GRAIN SIZE DISTRIBUTION

HETEROGENEOUS MIXTURE OF SILTY CLAY, SAND & GRAVEL

W P 83-74-08

DESCRIPTION OF ROCK CORE - W.P. 83-74-08

| BOREHOLE NUMBER | | | | CORE DESCRIPTION | |
|--------------------|---------------------------------|-----------------|----------------|------------------|---|
| | DEPTH (m) | % CR* | % RQD* | DEPTH (m) | DESCRIPTION |
| 2 | 3.00 - 3.96 - 5.51 | 61 103 | 0 79 | 3.00 - 3.66 | Shale, red, highly weathered (clayey) |
| | | | | 3.66 - 3.96 | Siltstone, green (75%), slightly weathered, very closely spaced joints, with shale, red (25%) |
| | | | | 3.96 - 5.51 | Shale, red (75%), unweathered, medium spaced joints, with siltstone, green (25%), in 25 to 75 mm layers |
| 3 | 2.13 - 2.46 - 4.04 - 5.26 | 15 94 100 | 0 53 100 | 2.13 - 2.90 | Shale, red (90%), highly weathered, very closely spaced joints, with siltstone, green (10%) in a 50 mm layer; high core loss zone |
| | | | | 2.90 - 5.26 | Shale, red (85%), unweathered, medium spaced joints, with siltstone, green (15%) in 25 to 75 mm layers |
| 4 | 2.34 - 2.62 - 4.00 - 5.08 | 82 96 98 | 0 19 47 | 2.34 - 3.68 | Shale, red (95%), moderately weathered, closely spaced joints, with siltstone, green (5%) in a 50 mm layer |
| | | | | 3.68 - 5.08 | Shale, red (75%), slightly weathered becoming unweathered, medium spaced joints, with siltstone, green (25%) in 25 to 100 mm layers |
| 5 | 1.88 - 2.39 - 3.99 - 4.78 | 80 86 100 | 35 43 77 | 1.88 - 2.06 | Soil |
| | | | | 2.06 - 2.54 | Shale, red (100%), slightly weathered with moderately weathered sections, closely spaced joints |
| | | | | 2.54 - 4.78 | Shale, red (70%), unweathered, medium spaced joints, with siltstone, green (30%), in 25 to 100 mm layers |

* CR = CORE RECOVERY ; RQD = ROCK QUALITY DESIGNATION

DESCRIPTION OF ROCK CORE - W.P.

83-74-08

| BOREHOLE NUMBER | | | | CORE DESCRIPTION | |
|--------------------|-------------|-------|--------|------------------|---|
| | DEPTH (m) | % CR* | % RQD* | DEPTH (m) | DESCRIPTION |
| 6 | 3.61 - 4.52 | 92 | 44 | 3.61 - 3.71 | Shale, highly weathered |
| | - 5.46 | 95 | 65 | 3.71 - 6.12 | Shale, red (80%), unweathered, medium spaced joints, with siltstone, green (20%) in 25 to 100 mm layers |
| | - 6.12 | 96 | 62 | | |
| 7 | 1.80 - 2.44 | 48 | 0 | 1.80 - 4.17 | Shale, red (90%), moderately weathered with highly weathered sections, with siltstone, green (10%) in 25 to 75 mm layers |
| | - 3.91 | 86 | 0 | 4.17 - 5.44 | Shale, red (85%), unweathered, medium spaced joints, with siltstone, green (15%), in 25 to 100 mm layer |
| | - 5.44 | 98 | 53 | | |
| 8 | 2.29 - 2.95 | 92 | 0 | 2.29 - 2.95 | Shale, red (85%), slightly weathered, very closely spaced joints, with siltstone, green (15%) in 25 to 50 mm layers |
| | - 3.91 | 100 | 37 | 2.95 - 4.57 | Shale, red (90%), unweathered, medium spaced joints, with siltstone, green (10%) in 25 to 75 mm layers |
| | - 4.57 | 100 | 69 | | |
| 9 | 1.22 - 2.06 | 39 | 0 | 1.22 - 2.06 | Shale, red, highly weathered, very closely spaced joints; high core loss zone |
| | - 2.44 | 87 | 33 | 2.06 - 2.92 | Shale, red (95%), slightly weathered, closely spaced joints, with siltstone, green (5%), in 100 mm layer |
| | - 4.00 | 98 | 21 | | |
| | - 4.93 | 86 | 49 | 2.92 - 4.93 | Shale, red (90%), unweathered, medium spaced joints, with siltstone, green (10%) in 25 to 75 mm layers |
| 10 | 2.26 - 3.73 | 97 | 41 | 2.26 - 2.49 | Shale, red, highly weathered (clayey) |
| | - 4.88 | 93 | 33 | 2.49 - 4.88 | Shale, red (85%), slightly weathered becoming unweathered, medium spaced joints, with siltstone, green (15%) in 25 to 100 mm layers |

* CR = CORE RECOVERY ; RQD = ROCK QUALITY DESIGNATION

DESCRIPTION OF ROCK CORE - W.P. 83-74-08

| BOREHOLE NUMBER | | | | CORE DESCRIPTION | |
|--------------------|-------------|-------|--------|------------------|--|
| | DEPTH (m) | % CR* | % RQD* | DEPTH (m) | DESCRIPTION |
| 11 | 2.08 - 2.39 | 92 | 50 | 2.08 - 2.54 | Shale, red (100%), slightly weathered, very closely spaced joints |
| | - 3.30 | 94 | 39 | | |
| | - 3.99 | 85 | 37 | 2.54 - 4.70 | Shale, red (90%), unweathered, medium spaced joints, with siltstone, green (10%) in 25 to 75 mm layers |
| | - 4.70 | 100 | 61 | | |
| 12 | 2.74 - 3.40 | 77 | 0 | 2.74 - 3.96 | Shale, red (80%), moderately weathered, very closely spaced joints, with siltstone, green (20%), slightly weathered in 25 to 50 mm layers |
| | - 3.96 | 86 | 0 | | |
| | - 5.49 | 95 | 63 | 3.96 - 5.49 | Shale, red (60%), unweathered, medium spaced joints, with siltstone, green (40%) in 25 to 100 mm layers |
| | | | | | |
| 15 | 2.13 - 3.63 | 98 | 10 | 2.13 - 2.74 | Shale, red (80%), slightly weathered, closely spaced joints, with siltstone, green (20%) in 25 to 50 mm layers |
| | - 4.72 | 100 | 47 | | |
| | | | | 2.74 - 4.72 | Shale, red (80%), slightly weathered and unweathered, closely spaced to medium spaced joints, with siltstone, green (20%) in 25 to 100 mm layers |
| | | | | | |
| | | | | | |

* CR = CORE RECOVERY ; RQD = ROCK QUALITY DESIGNATION

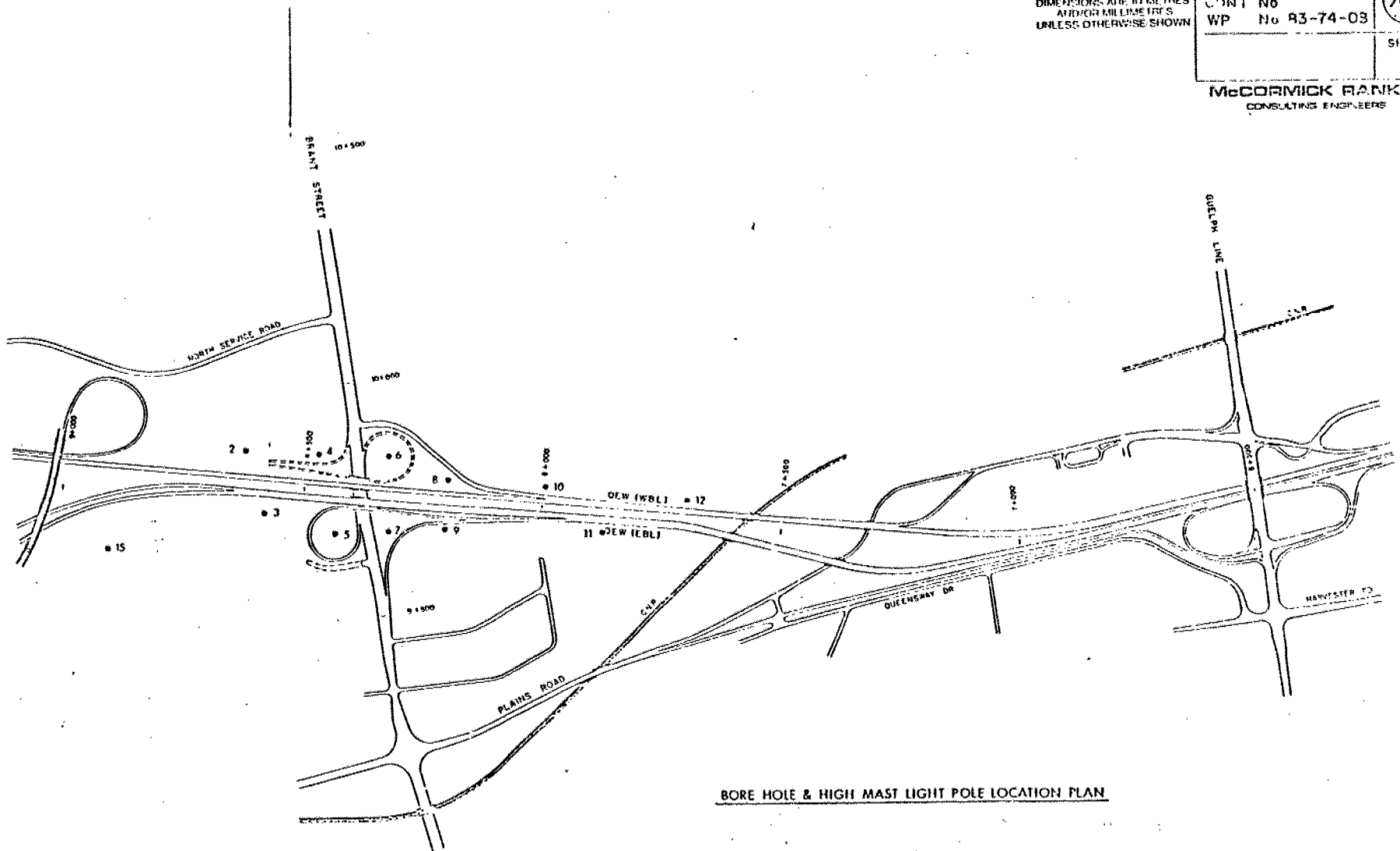
METRIC
DIMENSIONS ARE IN METRES
AND/OR MILLIMETRES
UNLESS OTHERWISE SHOWN

PLATE No
CONT No
WP No 93-74-03



SHEET

MCCORMICK RANKIN
CONSULTING ENGINEERS



BORE HOLE & HIGH MAST LIGHT POLE LOCATION PLAN

SCALE
1" = 100'

FOUNDATION INVESTIGATION REPORT
For
Q.E.W. - Brant Street Overpass
W.P. 83-74-31, Site 10-1337-138
District 4, Hamilton

INTRODUCTION

This report summarizes the factual information obtained from a foundation investigation carried out at the above-mentioned location between 85 01 31 and 85 02 07. The fieldwork consisted of six boreholes and six accompanying dynamic cone penetration tests. The borings were advanced by a continuous flight auger machine mounted on a muskeg vehicle equipped with solid stem augers and BX size rock coring equipment.

SITE DESCRIPTION

The site is located at the intersection of Q.E.W. and Brant Street, in the City of Burlington, Regional Municipality of Halton.

This area is located in the physiographic region referred to as the Iroquois Plain, characterized by red shale bedrock covered by a shallow layer of soil. The surrounding terrain is relatively flat, with the exception of man made earthworks (Highways).

SUBSURFACE CONDITIONS

General

Two types of deposit were encountered at this location. The overburden, ranging in thickness from 0.3 m to 1.8 m is a heterogeneous mixture of silty clay, sand and gravel (glacial till). The second deposit is a red shale bedrock. The top 0.4 m to 2.9 m of the bedrock is in a highly weathered state.

The boundaries of the various strata together with the field and laboratory tests are plotted on the Record of Borehole Sheets located in the Appendix. The borings locations and elevations, along with the estimated stratigraphical profiles based on borehole data are shown on Drawing No.2 of the Contract Dwg. A description of the different strata encountered is given below.

Heterogeneous Mixture of Silty Clay,
Sand and Gravel (Glacial Till)

Immediately below a thin layer of top soil a material identified as till (glacial till) was encountered at all borehole locations. The thickness of this zone ranged from 0.3 m to 1.8 m. The material composing this strata consists of a heterogeneous mixture of silty clay, sand and gravel. The matrix of this deposit is basically cohesive in nature - i.e. silty clay binding coarser particles.

A plot of the Liquid Limit versus Plastic Index, (see Figure No. 1), shows the majority of the points to fall within the CL zone. The physical properties of this material as determined by laboratory tests are as follows:

| | | Range = | Average |
|--------------------------|---------------------|---------|---------|
| Natural Moisture Content | (w) % | 7-14 | 12 |
| Liquid Limit | (w _L) % | 25-41 | 32 |
| Plastic Limit | (w _p) % | 17-22 | 19 |
| Plastic Index | (I _p) % | 9-20 | 13 |

The results of the grain size distribution test are shown in an envelope form, on Figure No. 2, of the Appendix.

Standard Penetration Tests carried out within the deposit gave 'N' values from 22 to over 100 blows per 30 cm. The consistency of the deposit ranges from very stiff to hard.

Bedrock

Bedrock was proven in all six boreholes by obtaining up to 3.1 m of BX rock cores. The top of the bedrock ranged from elevation 104.5 to 102.2. The bedrock is a red shale with green siltstone (approximately 80% shale, 20% siltstone) of the Queenston formation. The upper 0.4 m to 2.9 m is in a highly weathered state, with layers of broken shale and red clay. In each of the borings, split spoon samples of the weathered portion of the bedrock were recovered before augering was terminated.

The core recovery attained varied from 87% to 100%.

Rock Quantity Designation (RQD) for the coring ranged from 52% to 95% with the mean being 75%.

A detailed description of the rock core was prepared by Mr. E. Magni, M.T.O. Geologist, and his report is located in the Appendix.

Groundwater Conditions

No groundwater levels were observed during the field investigations. However, an additional borehole was augered (adjacent to borehole 6) to elevation 102 and no groundwater was observed.



P. Payer
P. Payer, P. Eng.
Sr. Foundations Engineer

K.G. Selby
K.G. Selby, P. Eng.
Chief Foundations Engineer
(West)

APPENDIX



RECORD OF BOREHOLE No 1

METRIC 29

W P 83-74-31 LOCATION Co-ords. N 4 800 072.5 E 278 647.0 ORIGINATED BY DG
DIST 4 W. by Q.E.W. BOREHOLE TYPE Cont. Flight Auger (S.A.), Coring BX, Cone Test COMPILED BY MJK
DATUM Geodetic DATE 85 01 31 CHECKED BY

| SOIL PROFILE | | SAMPLES | | | GROUND WATER CONDITIONS | ELEVATION SCALE | DYNAMIC CONE PENETRATION RESISTANCE PLOT 20 40 60 80 100 | SHEAR STRENGTH ○ UNCONFINED + FIELD VANE ● QUICK TRIAXIAL x LAB VANE | PLASTIC LIMIT W _p NATURAL MOISTURE CONTENT W LIQUID LIMIT W _L WATER CONTENT (%) 10 20 30 | UNWEIGHTED Y | REMARKS & GRAIN SIZE DISTRIBUTION (%) GR SA SI CL |
|----------------|---|-------------|--------|----------|----------------------------|-----------------|--|--|---|-----------------|--|
| ELEV. DEPTH | DESCRIPTION | STRAT. PLOT | NUMBER | TYPE | | | | | | | |
| 105.7 | Ground Level | | | | | | | | | | |
| 0.0 | | | | | | | | | | | |
| 104.3 | Heterogeneous Mix-ure of Silty Clay Sand and Gravel Hard Glacial Till | | 1 | SS | 39 | | | | | | 0 8 72 20 |
| 1.4 | | | 2 | SS | 100 | 28 cm | | | | | |
| | Bedrock | | 3 | SS | 100 | 14 cm | | | | | |
| | Red Shale | | 4 | SS | 100 | 10 cm | | | | | |
| | Weathered Sound | | 5 | RC BX | REC 88% | | | | | | RQD 63% |
| | | | 6 | RC BX | REC 100% | | | | | | RQD 64% |
| 99.6 | | | | | | | | | | | |
| 6.1 | End of Borehole | | | | | | | | | | |
| | * Groundwater Level Not Observed | | | | | | | | | | |

+3, x5: Numbers refer to
Sensitivity

20
15 5 (%) STRAIN AT FAILURE
10

OFFICIAL RECORD OF WORK INFORMATION

RECORD OF BOREHOLE No 2

METRIC 30

W P 83-74-31 LOCATION Co-ords. N 4 800 054.5 E 278 618.5 ORIGINATED BY DG
 DIST HWY Q.E.W. BOREHOLE TYPE Cont. Flight Auger (S.A.) Coring BX, Cone Test COMPILED BY MJK
 DATUM Geodetic DATE 85 02 01-05 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 | | | VALUES | 20 40 60 80 100 | | | | | |
| | | | | | | | ○ UNCONFINED + FIELD VANE ● QUICK TRIAXIAL x LAB VANE | | | | | | |
| | | | | | | | | | | | | | |
| 105.9 | | | | | | | | | | | | | |
| 0.0 | Heterogeneous Mixture of Silty Clay Sand and Gravel Very Stiff Glacial Till | | 1 | SS | 22 | | | | | | | | 5 9 54 32 |
| 104.5 | | | 2 | SS | 78 | | | | | | | | |
| 1.4 | Bedrock | | 3 | SS | 100/ | 23 cm | | | | | | | |
| | Red Shale | | 4 | SS | 100/ | 5 cm | | | | | | | |
| | Weathered Sound | | 5 | RC BX | REC 98% | | | | | | | | RQD 77% |
| | | | 6 | RC BX | REC 87% | | | | | | | | RQD 88% |
| 100.0 | | | | | | | | | | | | | |
| 5.9 | End of Borehole | | | | | | | | | | | | |
| | * Groundwater Level Not Observed | | | | | | | | | | | | |



RECORD OF BOREHOLE No 3

METRIC 31

W P 83-74-31 LOCATION Co-ords. N 4 800 046.5 E 278 605.0 ORIGINATED BY DG
DIST 4 HWY Q.E.W. BOREHOLE TYPE Cont. Flight Auger (S.A.), Coring BX, Cone Test COMPILED BY MJK
DATUM Geodetic DATE 85 02 01-04 CHECKED BY

| SOIL PROFILE | | | SAMPLES | | | GROUND WATER CON'DITIONS | ELEVATION SCALE | DYNAMIC CONE PENETRATION RESISTANCE PLOT 20 40 60 80 100 SHEAR STRENGTH ○ UNCONSOLIDATED + FIELD VANE ● QUICK TRIAXIAL x LAB VANE | PLASTIC LIMIT W _p NATURAL MOISTURE CONTENT W LIQUID LIMIT W _L WATER CONTENT (%) 10 20 30 | UNIT WEIGHT γ | REMARKS & GRAIN SIZE DISTRIBUTION (%) GR SA SI CL |
|---------------|---|------------|---------|----------|-------------|-----------------------------|-----------------|--|---|---------------------|--|
| ELEV DEPTH | DESCRIPTION | STRAT PLOT | NUMBER | TYPE | 'N' VALUES | | | | | | |
| 105.8 | Ground Level | | | | | | | | | | |
| 0.0 | Heterogeneous Mixture of Silty Clay Sand and Gravel Very Stiff Glacial Till | | 1 | SS | 22 | | | | | | 5 9 52 34 |
| 104.4 | | | 2 | SS | 80 | | | | | | |
| 1.4 | Bedrock Red Shale | | 3 | SS | 100 | 15 cm | | | | | |
| | | | 4 | SS | 100 | 18 cm | | | | | |
| | Weathered Sound | | 5 | RC BX | REC 96% | | | | | | RQD 79% |
| | | | 6 | RC BX | REC 100% | | | | | | RQD 98% |
| 99.4 | End of Borehole | | | | | | | | | | |
| 6.4 | * Groundwater Level Not Observed | | | | | | | | | | |

OFFICE RECORD ON SOIL EXPLORATION



RECORD OF BOREHOLE No 4

METRIC 32

W P 83-74-31 LOCATION Co-ords. N 4 799 994.5 E 278 658.5 ORIGINATED BY LM
DIST 4 HWY Q.E.W. BOREHOLE TYPE Cont. Flight Auger (S.) Coring BX, Cone Test COMPILED BY MJK
DATUM Geodetic DATE 85 02 05-06 CHECKED BY LM

| SOIL PROFILE | | | SAMPLES | | | GROUND WATER CONDITIONS | ELEVATION SCALE | DYNAMIC CONE PENETRATION RESISTANCE PLOT 20 40 60 80 100 SHEAR STRENGTH O UNCONFINED + FIELD VANE X QUICK TRIAXIAL X LAB VANE | PLASTIC LIMIT W _p NATURAL MOISTURE CONTENT V _n LIQUID LIMIT W _L WATER CONTENT (%) 10 20 30 | UNIT WEIGHT Y | REMARKS & GRAIN SIZE DISTRIBUTION (%) GR SA SI CL |
|--------------|---|------------|---------|-------|------------|-------------------------|-----------------|---|--|------------------|--|
| ELEV DEPTH | DESCRIPTION | STRAT PLOT | NUMBER | TYPE | 'N' VALUES | | | | | | |
| 104.8 | Ground Level | | | | | | | | | | |
| 0.0 | Heterogeneous Mixture of Silty Clay Sand and Gravel Very Stiff Glacial Till | | 1 | SS | 26 | | | | | | 0 3 61 36 |
| 103.4 | | | | | | | | | | | |
| 1.4 | Bedrock Red Shale | | 2 | SS | 100/ | 30 cm | | | | | |
| | | | 3 | SS | 100/ | 14 cm | | | | | |
| | Weathered Sound | | 4 | RC BX | REC 93% | | | | | | RQD 59% |
| | | | 5 | RC BX | REC 100% | | | | | | RQD 95% |
| 98.6 | End of Borehole | | | | | | | | | | |
| 6.2 | * Groundwater Level Not Observed | | | | | | | | | | |



RECORD OF BOREHOLE No 5

METRIC

33

W P 83-74-31 LOCATION Co-ords. N 4 800 004.5 E 278 674.5 ORIGINATED BY DG
DIST 4 HWY QEW BOREHOLE TYPE Cont. Flight Auger (S.A.) Coring BX, Cone Test COMPILED BY MJK
DATUM Geodetic DATE 85 01 06 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 | UNIT WEIGHT Y | REMARKS & GRAIN SIZE DISTRIBUTION (%) GR SA SI CL |
|---------------|---|------------|--------|------|-------------------------|-----------------|--|----|---------------------------------|-------------------------------|--------------|------------------|--|
| ELEV DEPTH | DESCRIPTION | STRAT PLOT | NUMBER | TYPE | | | 'N' VALUES | 20 | | | | | |
| 104.0 | Ground Level | | | | | | | | | | | | |
| 0.0 | Heterogeneous Mixture of Silty Clay Sand and Gravel Hard Glacial Till | | 1 | SS | 64 | | | | | | | | 8 7 64 21 |
| 102.2 | | | 2 | SS | 100/ | 23 cm | | | | | | | |
| 1.8 | Bedrock Weathered Sound | | 3 | RC | REC 91% | | | | | | | | 1.4 52% |
| | Red Shale | | 4 | RC | 100% | | | | | | | | RQD 86% |
| 99.0 | End of Borehole | | | | | | | | | | | | |
| 5.0 | * Groundwater Level Not Observed | | | | | | | | | | | | |

+3, x5: Numbers refer to
Sensitivity

20
15 5 (%) STRAIN AT FAILURE
10

RECORD OF BOREHOLE No 6

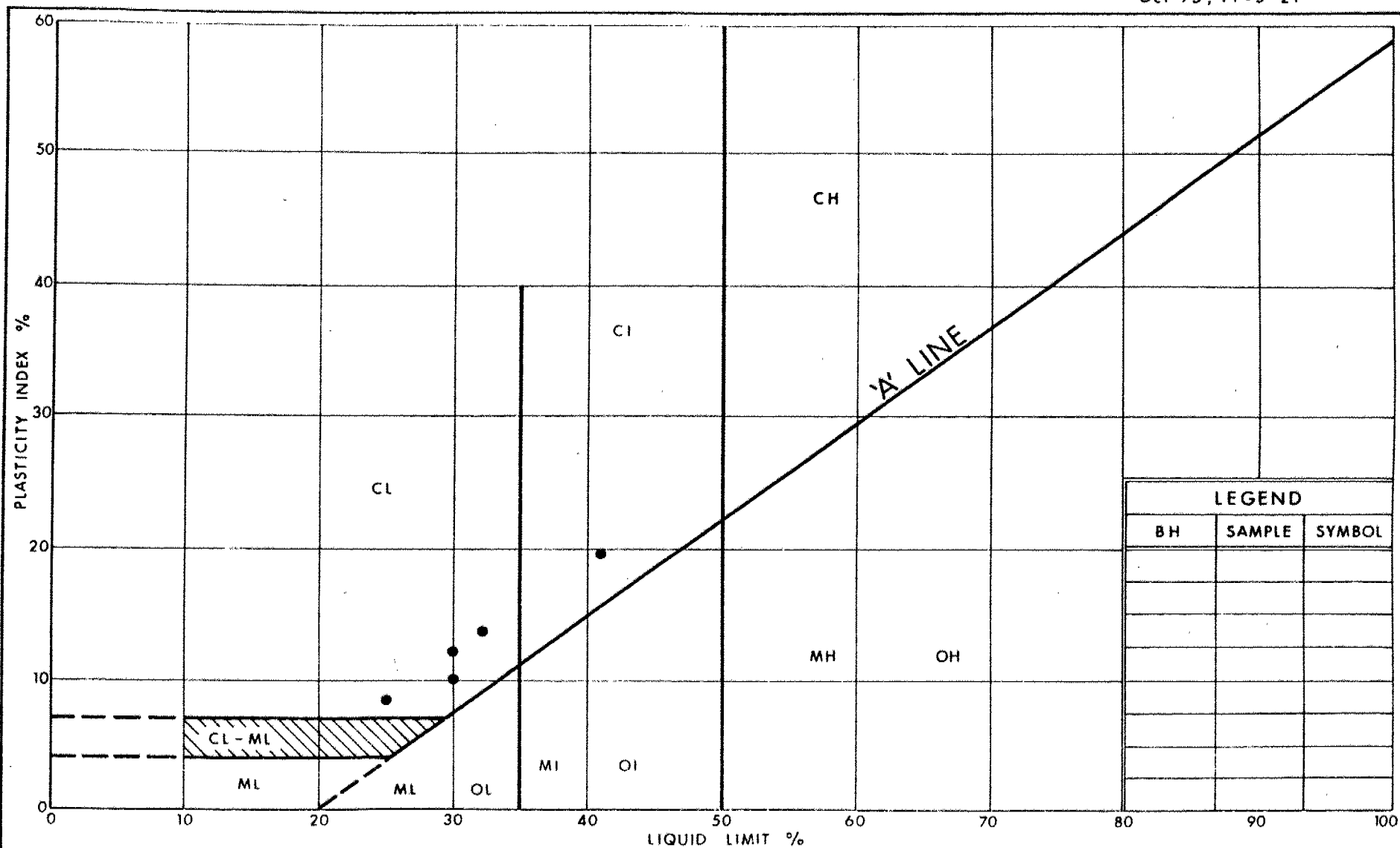
METRIC 34

W P 83-74-31 LOCATION Co-ords. N 4 800 020.0 E 278 698.5 ORIGINATED BY DG
 DIST 4 HWY Q.E.W. BOREHOLE TYPE Cont. Flight Auger (S.A.) Coring BX, Cone Test COMPILED BY MJR
 DATUM Geodetic DATE 85 01 07 CHECKED BY

| SOIL PROFILE | | SAMPLES | | | GROUND WATER CONDITIONS | ELEVATION SCALE | DYNAMIC CONE PENETRATION RESISTANCE PLOT | | PLASTIC LIMIT NATURAL MC CONTENT LIQUID LIMIT | | | UNIT WEIGHT Y | REMARKS & GRAIN SIZE DISTRIBUTION (%) GR SA SI CL |
|---------------|-------------------------------------|------------|--------|-------------------|----------------------------|--------------------|---|-----------------|---|----------|--|---------------------|--|
| ELEV DEPTH | DESCRIPTION | STRAT PLOT | NUMBER | TYPE | | | 'N' VALUES | 20 40 60 80 100 | Wp W WL | 10 20 30 | | | |
| 104.8 | Ground Level | | | | | | | | | | | | |
| 0.0 | Het. Mix. of Silty Clay | | | | | | | | | | | | |
| 104.5 | Sand & Grav. V. Stiff Till | | | | | | | | | | | | |
| 0.3 | | | | | | | | | | | | | |
| | Bedrock | | 1 | SS | 49 | | | | | | | | 0 3 74 23 |
| | For. Shale | | 2 | SS | 100/ | 28 cm | | | | | | | |
| | Weathered Sound | | 3 | SS | 100/ | 2 cm | | | | | | | |
| | | | 4 | RC REC BX 100% | | | | | | | | | RQD 71 % |
| | | | 5 | RC REC BX 100% | | | | | | | | | RQD 86 % |
| 98.7 | End of Borehole | | | | | | | | | | | | |
| 6.1 | * Groundwater Level Not Observed | | | | | | | | | | | | |

+3, x5: Numbers refer to Sensitivity 20 15 10 5 (%) STRAIN AT FAILURE

OFFICE REPORT ON SOIL EXPLORATION



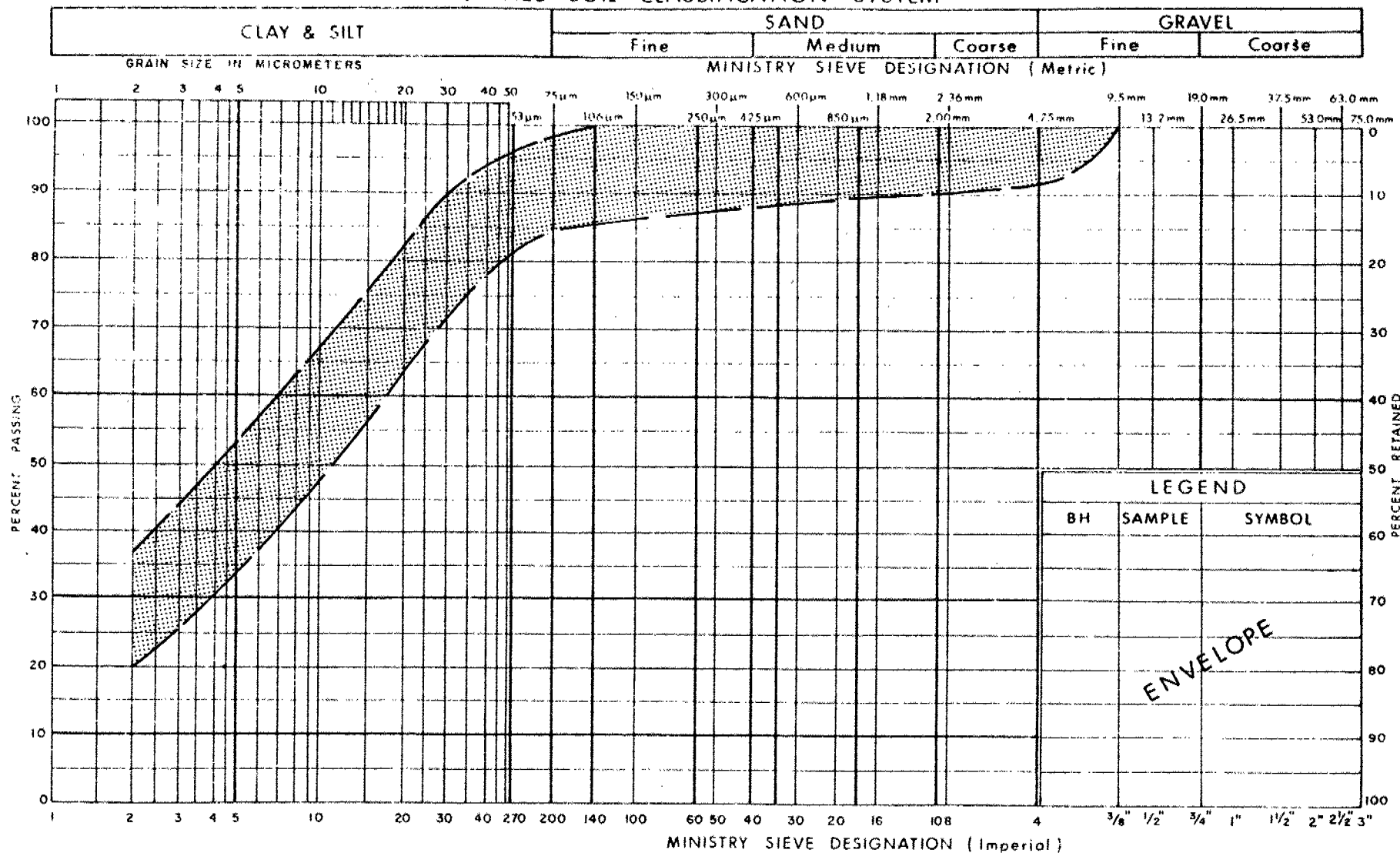
Ministry of
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Communications

PLASTICITY CHART
HETEROGENEOUS MIXTURE OF SILTY CLAY, SAND & GRAVEL
 (Glacial Till)

FIG No 1

W P 83-74-31

UNIFIED SOIL CLASSIFICATION SYSTEM



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GRAIN SIZE DISTRIBUTION
HETEROGENEOUS MIXTURE OF SILTY CLAY, SAND & GRAVEL
(Glacial Till)

FIG No 2

W P 83-74-31

DESCRIPTION OF ROCK CORE - W.P. 83-74-31

| BOREHOLE NUMBER | | | | CORE DESCRIPTION | |
|--------------------|-----------|--------|---------|------------------|--|
| | DEPTH (m) | % CR * | % RQD * | DEPTH (m) | DESCRIPTION |
| 1 | 3.28-4.70 | 88 | 63 | 3.28-3.45 | Assumed zone of core loss |
| | 4.70-6.12 | 100 | 64 | 3.45-6.12 | Shale (80%), red, unweathered, medium spaced joints, with siltstone (20%), green, unweathered; 5.46 m to 5.57 m highly weathered zone in shale |
| 2 | 3.15-4.50 | 98 | 77 | 3.15-5.84 | Shale (75%), red, unweathered, medium spaced joints, with siltstone (25%), green, unweathered |
| | 4.50-5.84 | 87 | 68 | | |
| 3 | 3.53-4.95 | 96 | 79 | 3.53-6.4 | Shale (80%), red, unweathered, medium spaced joints, with siltstone (20%), green, unweathered; 5.54 m to 5.56 m highly weathered shale zone |
| | 4.95-6.40 | 100 | 98 | | |
| 4 | 3.25-4.75 | 93 | 59 | 3.25-3.56 | Shale (100%), red, slightly weathered, very closely spaced joints |
| | 5.75-6.22 | 100 | 95 | 3.56-6.22 | Shale (80%), red, unweathered, medium spaced joints, with siltstone (20%), green, unweathered |
| 5 | 1.98-3.45 | 91 | 52 | 1.98-2.21 | Assumed zone of core loss |
| | 3.45-4.95 | 100 | 88 | 2.21-4.95 | Shale (80%), red, unweathered, medium spaced joints, with siltstone (20%), green, unweathered |
| 6 | 3.15-4.57 | 100 | 71 | 3.15-6.07 | Shale (90%), red, unweathered, medium spaced joints, with siltstone (10%), green, unweathered |
| | 4.57-6.07 | 100 | 86 | | |

* CR = CORE RECOVERY ; RQD = ROCK QUALITY DESIGNATION



Ministry of
Transportation and
Communications

foundation investigation and design report

ENGINEERING MATERIALS OFFICE
FOUNDATION DESIGN SECTION

CONT 89-26

WP 83-74-08

DIST 4

HWY Q.E.W.

STR SITE

High Mast Lighting
Q.E.W. - Brant St., Interchange

DISTRIBUTION

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FOUNDATION INVESTIGATION REPORT

For

High Mast Lighting

Q.E.W. - Brant St., Interchange

W.P. 83-74-08

District 4, Burlington

INTRODUCTION

This report presents the results of foundation investigation performed at the above-mentioned site. Fieldwork consisted of twelve sampled boreholes, all of which were accompanied by dynamic cone penetration tests. The boreholes were advanced between 85 07 23 and 85 07 29. A track mounted auger machine was utilized for this investigation. Borings were advanced for depths ranging from 4.5 m to 6.1 m. Bedrock was cored in all twelve boreholes utilizing BXL size rock coring equipment.

SITE DESCRIPTION

The site is located just east of the Q.E.W./403 interchange at the future Q.E.W./Brant St. interchange in the City of Burlington, Regional Municipality of Halton.

As part of the proposed Q.E.W./Brant St. interchange, it is proposed to illuminate the interchange area with 12 high mast light poles. The height of the poles is anticipated to be 35 m. Note that the numbering system used to identify the boreholes is the same as that used to identify the light poles.

This site is located within the physiographic region known as the South Slope. The area is characterized by a ground moraine of limited relief. The bedrock underlying the site is a red shale with greenish siltstone of the Queenston Formation.

SUBSURFACE CONDITIONS

General

The boundaries of the various subsoil types are shown in the Record of Borehole Sheets located in the Appendix. The locations and elevations of the borings are also shown on these sheets. This report must be read in conjunction with the above-noted items.

The subsoil conditions are quite uniform across the site. Exposed at ground surface at all boreholes locations is a heterogeneous mixture of silty clay, sand, and gravel (glacial till). Underlying the till material is a red shale bedrock of the Queenston Formation.

The various soil types encountered are described in the following paragraphs.

Heterogeneous Mixture of Silty Clay, Sand, and Gravel (Glacial Till)

This deposit is the predominant soil type across this site. It was encountered at all borehole locations and varied in thickness from 0.6 m to 1.5 m. It is characteristic of this deposit to have occasional cobbles and boulders distributed throughout the deposit.

The results of Atterberg Limit and water content testing are plotted in envelope form on the Plasticity Chart, Figure No. 1, and are summarized as follows:

| | | Range | Average | Median |
|------------------|---------------------|-------|---------|--------|
| Water Content | (w) % | 5-15 | 11 | 10 |
| Liquid Limit | (w _L) % | 21-31 | 28 | 26 |
| Plastic Limit | (w _p) % | 13-19 | 16 | 17 |
| Plasticity Index | (I _p) % | 7-15 | 12 | 11 |

The results of grain size distribution tests are plotted in envelope form on Figure No. 2 in the Appendix.

Standard Penetration Test 'N' values ranged from 23 to over 55 blows per 0.3 m which indicates that the consistency of the deposit varies from stiff to hard.

Bedrock

Bedrock was proven at all boreholes by obtaining BXL rock cores. The top of the bedrock varied in elevation from 102.4 m at borehole 15 to 105.4 m at borehole 6. The bedrock is a red shale with green siltstone of the Queenston Formation. The upper portion of the bedrock is in a highly weathered state with layers of broken shale and silty clay.

The core recovery attained ranged from 15 to 100%.

The Rock Quality Designation (RQD) for the bedrock ranged from 0% to 100% with a mean of 35%.

A detailed description of the rock core was prepared by Mr. E. Magni, MTC Soils and Aggregate Geologist, and his report is located in the Appendix.

Groundwater

The groundwater level was found to vary between elevation 100.4 m and 106.2 m by taking overnight readings in the open boreholes. However, owing to the relatively impervious nature of the till deposit and the water used in the rock coring operation, this may not represent a true stabilized condition.

DISCUSSION AND RECOMMENDATIONS

As part of the construction of the Q.E.W./Brant St. interchange, it is proposed to illuminate the interchange area with a total of 12 high mast light poles. The height of each pole is anticipated to be 35 m.

Conventional spread footings for these light poles would likely be quite expensive. However, high mast light poles have been installed economically in many areas of North America and Europe using a design method proposed by B. B. Broms and others in which the poles are supported on a concrete caisson pile. The Structural Office has decided to adopt this same method described by Broms in two separate papers; Broms, B. B. "Lateral Resistance of Piles in Cohesive Soils", Journal of the Soils Mechanics and Foundations Division, ASCE, Vol. 90, No. SM2, Paper 3825, MARCH 1964; and "Lateral Resistance of Piles in Cohesionless Soils", Journal of the Soil Mechanics and Foundations Division, ASCE, Vol. 90, No. SM3, Paper 3909, MAY 1964.

In the following paragraphs, the feasibility of constructing concrete caissons at the site is discussed and the various parameters to be used in the caisson design are provided.

It is understood that all of the poles will be installed in the original ground in areas where no significant amount of fill will be placed.

At all locations, the subsoil conditions are quite similar as shown on the borehole logs. (Note that the borehole numbers correspond to the pole numbers). Given the soil conditions at this site, the caissons will be located partly in overburden and partly in shale bedrock. In all cases, the material located within the zone of frost protection, (1.2 m) should be neglected in the calculation of lateral resistance. Since the maximum depth of till is 1.5 m, this material can be ignored in the calculation of lateral resistance.

For this site, the coefficient of horizontal subgrade reaction should be computed in accordance with the following formula: (The design parameters are presented in Imperial Units, since the design example provided by the Structural Office used Imperial Units throughout).

$$K_h = \frac{n_1 n_2 80 q_u}{D}$$

Where:

K_h - coefficient of horizontal subgrade reaction (lb./in.³)

D - diameter of concrete caisson pile (in.)

n_1 - coefficient as defined below:

Unconfined Compressive Strength

| q_u (psi) | n_1 |
|-----------------|-------|
| Less than 7 | 0.32 |
| 7 to 28 | 0.36 |
| Greater than 28 | 0.40 |

n_2 - coefficient based on pile material = 1.15 for concrete

q_u - unconfined compressive strength (psi)

For this site the following parameters are recommended:

| Material | Unconfined Compressive Strength q_u (psi) | Unit Weight (lb./ft. ³) |
|-----------------|---|-------------------------------------|
| Weathered Shale | 145 | 150 |
| Sound Shale | 1450 | 165 |

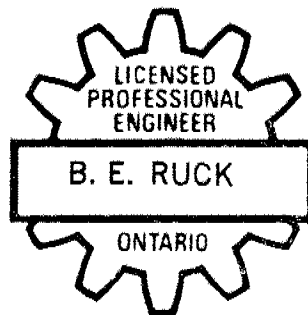
For rock anchors installed in the sound shale bedrock, an ultimate bond strength of 80 psi should be assumed to apply.

CAISSON CONSTRUCTION

Conditions at this site are favourable for the construction of concrete caissons utilizing conventional augering equipment. Seepage into the augered holes is not anticipated to be a major problem. Augered holes should stand up without support for several hours, however, concrete should be placed within 12 hours after augering to prevent degradation of the exposed shale bedrock.

MISCELLANEOUS

Fieldwork for this project was carried out under the supervision of Mr. L. Marsiglio, Student Engineer using equipment owned and operated by Atcost Soil Drilling, Concord, Ontario. This report was written by Mr. B. E. Ruck, Project Foundation Engineer and reviewed by Mr. K. G. Selby, Chief Foundation Engineer (West).



Brian Ruck

B. E. Ruck, P. Eng.
Project Foundations Engineer

K. G. Selby

K. G. Selby, P. Eng.
Chief Foundation Engineer (West)

AUGUST 1985

APPENDIX

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:

| 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

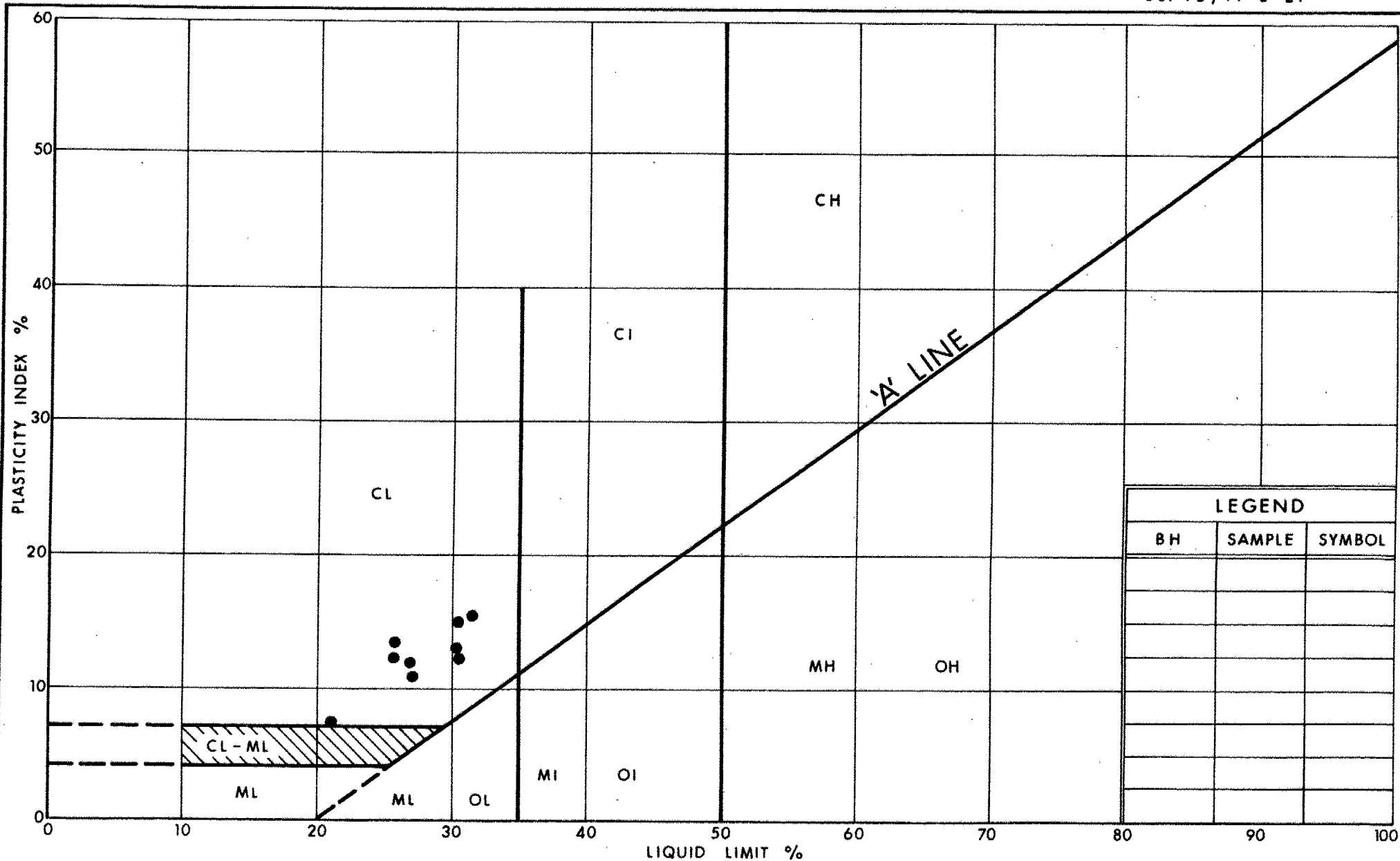
| | | |
|--------------------------------------|-----|-------------------------------|
| u_w | kPa | PORE WATER PRESSURE |
| r_u | 1 | PORE PRESSURE RATIO |
| σ | kPa | TOTAL NORMAL STRESS |
| σ' | kPa | EFFECTIVE NORMAL STRESS |
| τ | kPa | SHEAR STRESS |
| $\sigma_1, \sigma_2, \sigma_3$ | kPa | PRINCIPAL 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 | | | | | | |

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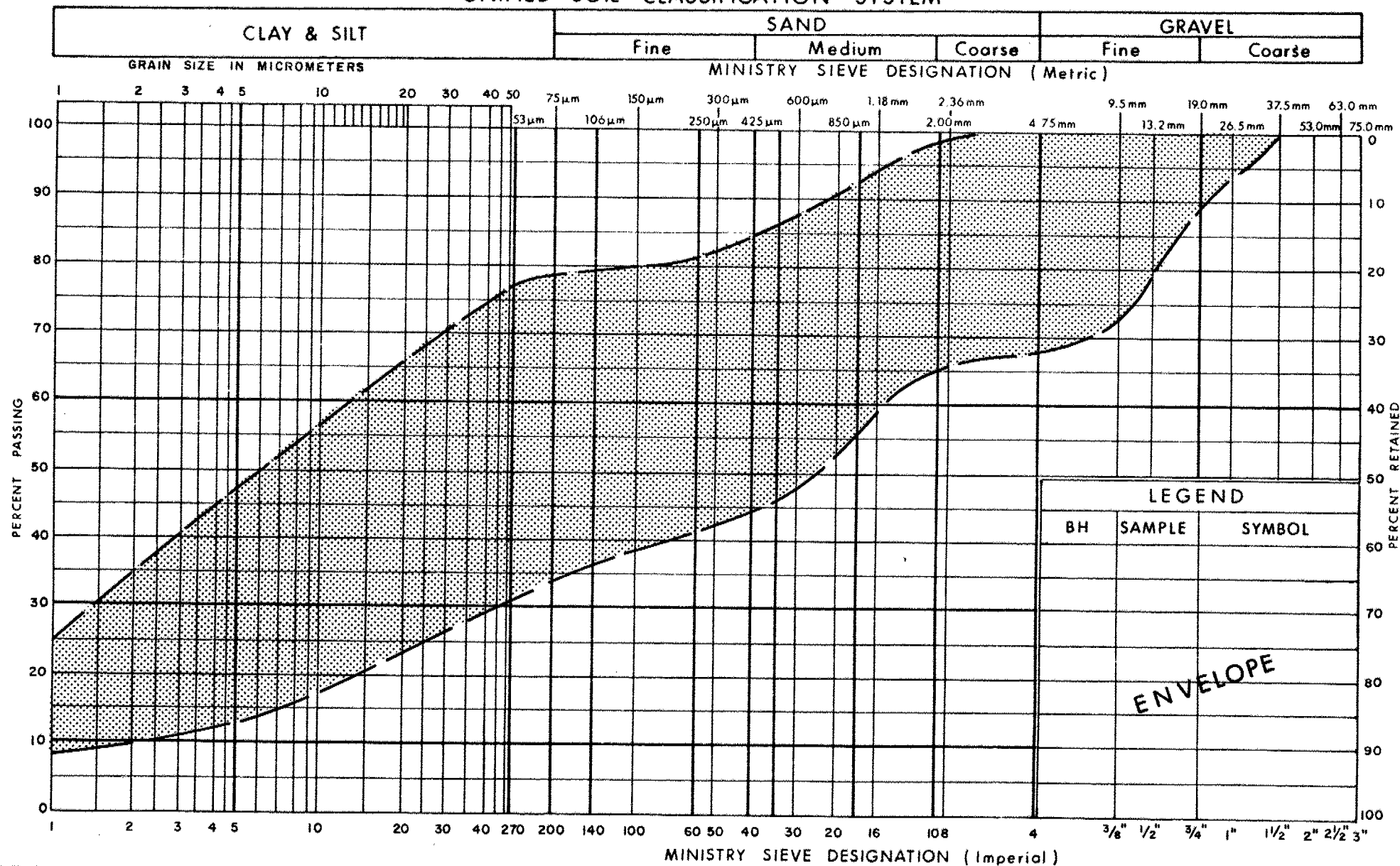
PLASTICITY CHART

HETEROGENEOUS MIXTURE OF SILTY CLAY, SAND & GRAVEL

FIG No 1

W P 83-74-08

UNIFIED SOIL CLASSIFICATION SYSTEM



Ontario

**Ministry of
Transportation and
Communications**

GRAIN SIZE DISTRIBUTION

HETEROGENEOUS MIXTURE OF SILTY CLAY, SAND & GRAVEL

FIG No 2

W P 83-74-08

DESCRIPTION OF ROCK CORE - W.P. 83-74-08

| BOREHOLE NUMBER | | | | CORE DESCRIPTION | |
|--------------------|---------------------------------|-----------------|----------------|------------------|---|
| | DEPTH (m) | % CR* | % RQD* | DEPTH (m) | DESCRIPTION |
| 2 | 3.00 - 3.96 - 5.51 | 61 103 | 0 79 | 3.00 - 3.66 | Shale, red, highly weathered (clayey) |
| | | | | 3.66 - 3.96 | Siltstone, green (75%), slightly weathered, very closely spaced joints, with shale, red (25%) |
| | | | | 3.96 - 5.51 | Shale, red (75%), unweathered, medium spaced joints, with siltstone, green (25%), in 25 to 75 mm layers |
| 3 | 2.13 - 2.46 - 4.04 - 5.26 | 15 94 100 | 0 53 100 | 2.13 - 2.90 | Shale, red (90%), highly weathered, very closely spaced joints, with siltstone, green (10%) in a 50 mm layer; high core loss zone |
| | | | | 2.90 - 5.26 | Shale, red (85%), unweathered, medium spaced joints, with siltstone, green (15%) in 25 to 75 mm layers |
| 4 | 2.34 - 2.62 - 4.00 - 5.08 | 82 96 98 | 0 19 47 | 2.34 - 3.68 | Shale, red (95%), moderately weathered, closely spaced joints, with siltstone, green (5%) in a 50 mm layer |
| | | | | 3.68 - 5.08 | Shale, red (75%), slightly weathered becoming unweathered, medium spaced joints, with siltstone, green (25%) in 25 to 100 mm layers |
| 5 | 1.88 - 2.39 - 3.99 - 4.78 | 80 86 100 | 35 43 77 | 1.88 - 2.06 | Soil |
| | | | | 2.06 - 2.54 | Shale, red (100%), slightly weathered with moderately weathered sections, closely spaced joints |
| | | | | 2.54 - 4.78 | Shale, red (70%), unweathered, medium spaced joints, with siltstone, green (30%), in 25 to 100 mm layers |

* CR = CORE RECOVERY ; RQD = ROCK QUALITY DESIGNATION

DESCRIPTION OF ROCK CORE - W.P.

83-74-08

| BOREHOLE NUMBER | | | | CORE DESCRIPTION | |
|--------------------|-------------|-------|--------|------------------|---|
| | DEPTH (m) | % CR* | % RQD* | DEPTH (m) | DESCRIPTION |
| 6 | 3.61 - 4.52 | 92 | 44 | 3.61 - 3.71 | Shale, highly weathered |
| | - 5.46 | 95 | 65 | 3.71 - 6.12 | Shale, red (80%), unweathered, medium spaced joints, with siltstone, green (20%) in 25 to 100 mm layers |
| | - 6.12 | 96 | 62 | | |
| 7 | 1.80 - 2.44 | 48 | 0 | 1.80 - 4.17 | Shale, red (90%), moderately weathered with highly weathered sections, with siltstone, green (10%) in 25 to 75 mm layers |
| | - 3.91 | 86 | 0 | 4.17 - 5.44 | Shale, red (85%), unweathered, medium spaced joints, with siltstone, green (15%), in 25 to 100 mm layer |
| | - 5.44 | 98 | 53 | | |
| 8 | 2.29 - 2.95 | 92 | 0 | 2.29 - 2.95 | Shale, red (85%), slightly weathered, very closely spaced joints, with siltstone, green (15%) in 25 to 50 mm layers |
| | - 3.91 | 100 | 37 | 2.95 - 4.57 | Shale, red (90%), unweathered, medium spaced joints, with siltstone, green (10%) in 25 to 75 mm layers |
| | - 4.57 | 100 | 69 | | |
| 9 | 1.22 - 2.06 | 39 | 0 | 1.22 - 2.06 | Shale, red, highly weathered, very closely spaced joints; high core loss zone |
| | - 2.44 | 87 | 33 | 2.06 - 2.92 | Shale, red (95%), slightly weathered, closely spaced joints, with siltstone, green (5%), in 100 mm layer |
| | - 4.00 | 98 | 21 | | |
| | - 4.93 | 86 | 49 | 2.92 - 4.93 | Shale, red (90%), unweathered, medium spaced joints, with siltstone, green (10%) in 25 to 75 mm layers |
| 10 | 2.26 - 3.73 | 97 | 41 | 2.26 - 2.49 | Shale, red, highly weathered (clayey) |
| | - 4.88 | 93 | 33 | 2.49 - 4.88 | Shale, red (85%), slightly weathered becoming unweathered, medium spaced joints, with siltstone, green (15%) in 25 to 100 mm layers |

* CR = CORE RECOVERY ; RQD = ROCK QUALITY DESIGNATION

DESCRIPTION OF ROCK CORE - W.P. 83-74-08

| BOREHOLE NUMBER | | | | CORE DESCRIPTION | |
|--------------------|-------------|-------|--------|------------------|--|
| | DEPTH (m) | % CR* | % RQD* | DEPTH (m) | DESCRIPTION |
| 11 | 2.08 - 2.39 | 92 | 50 | 2.08 - 2.54 | Shale, red (100%), slightly weathered, very closely spaced joints |
| | - 3.30 | 94 | 39 | | |
| | - 3.99 | 85 | 37 | | |
| | - 4.70 | 100 | 61 | 2.54 - 4.70 | Shale, red (90%), unweathered, medium spaced joints, with siltstone, green (10%) in 25 to 75 mm layers |
| 12 | 2.74 - 3.40 | 77 | 0 | 2.74 - 3.96 | Shale, red (80%), moderately weathered, very closely spaced joints, with siltstone, green (20%), slightly weathered in 25 to 50 mm layers |
| | - 3.96 | 86 | 0 | | |
| | - 5.49 | 95 | 63 | | |
| | | | | 3.96 - 5.49 | Shale, red (60%), unweathered, medium spaced joints, with siltstone, green (40%) in 25 to 100 mm layers |
| 15 | 2.13 - 3.63 | 98 | 10 | 2.13 - 2.74 | Shale, red (80%), slightly weathered, closely spaced joints, with siltstone, green (20%) in 25 to 50 mm layers |
| | - 4.72 | 100 | 47 | | |
| | | | | | |
| | | | | 2.74 - 4.72 | Shale, red (80%), slightly weathered and unweathered, closely spaced to medium spaced joints, with siltstone, green (20%) in 25 to 100 mm layers |
| | | | | | |

* CR = CORE RECOVERY ; RQD = ROCK QUALITY DESIGNATION

METRIC

W P 83-74-08 LOCATION N 4 799 960 E 278 400 ORIGINATED BY LM
DIST 4 HWY Q.E.W. BOREHOLE TYPE H.S. Auger - Cone Test COMPILED BY BR
DATUM Geodetic DATE 1985 07 26 CHECKED BY [Signature]

[illegible]

+3, x5 : Numbers refer to Sensitivity

15 \pm 5 (%) STRAIN AT FAILURE



RECORD OF BOREHOLE No 3

METRIC

W P 83-74-08 LOCATION N 4 799 873 E 278 510 ORIGINATED BY LM
DIST 4 HWY Q.E.W. BOREHOLE TYPE H.S. Auger - Cone Test COMPILED BY BR
DATUM Geodetic DATE 1985 07 24 CHECKED BY So

| 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 | | | | | |
| 104.2 | Ground Surface | | | | | | | | | | | | | |
| 0.0 | * | | | | | | | | | | | | | |
| 103.6 | | | | | | | | | | | | | | |
| 0.6 | | | | | | | | | | | | | | |
| | Bedrock | | 1 | SS | 47 | | | | | | | | | |
| | | | 2 | SS | 77 | | | | | | | | | |
| | | | 3 | BX RC | REC 15% | | | | | | | | | |
| | Weathered Sound | | 4 | BX RC | REC 94% | | | | | | | | | |
| | Queenston Shale | | 5 | BX RC | REC 100% | | | | | | | | | |
| 98.9 | | | | | | | | | | | | | | |
| 5.3 | End of Borehole | | | | | | | | | | | | | |
| | * Heterogeneous Mixture of Silty Clay, Sand and Gravel Stiff to Very Stiff | | | | | | | | | | | | | |

+³, x⁵: Numbers refer to
Sensitivity

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

RECORD OF BOREHOLE No 4

METRIC

W P 83-74-08 LOCATION N 4 800 046 E 278 525 ORIGINATED BY LM
DIST 4 HWY Q.E.W. BOREHOLE TYPE H.S. Auger - Cone Test COMPILED BY BR
DATUM Geodetic DATE 1985 07 25 CHECKED BY [Signature]

CHECKED BY

[illegible]

+3, x5 : Numbers refer to Sensitivity

20
15 ϕ 5 (%) STRAIN AT FAILURE
10



RECORD OF BOREHOLE No 5

METRIC

W P 83-74-08 LOCATION N 4 799 929 E 278 656 ORIGINATED BY LM
DIST 4 HWY Q.E.W. BOREHOLE TYPE H.S. Auger - Cone Test COMPILED BY BR
DATUM Geodetic DATE 1985 07 24 CHECKED BY 10

| SOIL PROFILE | | | SAMPLES | | | GROUND WATER CONDITIONS | ELEVATION SCALE | DYNAMIC CONE PENETRATION RESISTANCE PLOT 20 40 60 80 100 SHEAR STRENGTH ○ UNCONFINED + FIELD VANE ● QUICK TRIAXIAL x LAB VANE | PLASTIC LIMIT W _p NATURAL MOISTURE CONTENT W LIQUID LIMIT W _L WATER CONTENT (%) 10 20 30 | UNIT WEIGHT γ | REMARKS & GRAIN SIZE DISTRIBUTION (%) GR SA SI CL |
|---------------|--|------------|---------|----------|-------------|----------------------------|-----------------|--|---|---------------------|--|
| ELEV DEPTH | DESCRIPTION | STRAT PLOT | NUMBER | TYPE | 'N' VALUES | | | | | | |
| 103.5 | Ground Surface | | | | | | | | | | |
| 0.0 | * | | | | | | | | | | |
| 102.9 | | | | | | | | | | | |
| 0.6 | | | | | | | | | | | |
| | Bedrock | | 1 | SS | 123 | | | | | | |
| | | | 2 | SS | 84 | 17 cm | | | | | |
| | Weathered Sound | | 3 | BX RC | REC 80% | | | | | | RQD = 35% |
| | Queenston Shale | | 4 | BX RC | REC 86% | | | | | | RQD = 43% |
| | | | 5 | BX RC | REC 100% | | | | | | RQD = 77% |
| 98.7 | End of Borehole | | | | | | | | | | |
| 4.8 | * Heterogeneous Mixture of Silty Clay, Sand and Gravel Stiff to Hard | | | | | | | | | | |



RECORD OF BOREHOLE No 6

METRIC

W P 83-74-08 LOCATION N 4 800 130 E 278 647 ORIGINATED BY LM
DIST 4 HWY Q.E.W. BOREHOLE TYPE H.S. Auger - Cone Test COMPILED BY BR
DATUM Geodetic DATE 1985 07 29 CHECKED BY [Signature]

| SOIL PROFILE | | | SAMPLES | | | GROUND WATER CONDITIONS | ELEVATION SCALE | DYNAMIC CONE PENETRATION RESISTANCE PLOT | | PLASTIC LIMIT W _p | NATURAL MOISTURE CONTENT W | LIQUID LIMIT W _L | UNIT WEIGHT γ | REMARKS & GRAIN SIZE DISTRIBUTION (%) GR SA SI CL |
|--------------|---|------------|---------|-------|------------|-------------------------|-----------------|--|----------------|---------------------------------|-------------------------------|--------------------------------|------------------|--|
| ELEV DEPTH | DESCRIPTION | STRAT PLOT | NUMBER | TYPE | 'N' VALUES | | | 20 40 60 80 100 | SHEAR STRENGTH | | | | | |
| | | | | | | | | ○ UNCONFINED + FIELD VANE ● QUICK TRIAXIAL x LAB VANE | | | | | | |
| 106.7 | Ground Surface | | | | | | | | | | | | | |
| 0.0 | Heterogeneous Mixture of Silty Clay Sand and Gravel Stiff to Very Stiff | | 1 | SS | 23 | | 106 | | | | | | | |
| 105.4 | | | 2 | SS | 100 | | | | | | | | | |
| 1.3 | Bedrock | | 3 | SS | 46 | | 104 | | | | | | | |
| | Weathered Sound | | 4 | SS | 50/8 | cm | | | | | | | | |
| | Queenston Shale | | 5 | BX RC | REC 92% | | 102 | | | | | | | RQD = 44% |
| | | | 6 | BX RC | REC 95% | | | | | | | | | RQD = 65% |
| | | | 7 | BX RC | REC 96% | | | | | | | | | RQD = 62% |
| 100.6 | End of Borehole | | | | | | | | | | | | | |
| 6.1 | * Groundwater Level Not Determined | | | | | | 100 | | | | | | | |

+³, x⁵: Numbers refer to Sensitivity

20
15 5 (%) STRAIN AT FAILURE
10



RECORD OF BOREHOLE No 7

METRIC

W P 83-74-08 LOCATION N 4 800 002 E 278 740 ORIGINATED BY LM
DIST 4 HWY Q.E.W. BOREHOLE TYPE H.S. Auger - Cone Test COMPILED BY BR
DATUM Geodetic DATE 1985 07 23 CHECKED BY LM

| SOIL PROFILE | | | SAMPLES | | | GROUND WATER CONDITIONS | ELEVATION SCALE | DYNAMIC CONE PENETRATION RESISTANCE PLOT | | PLASTIC LIMIT W _p | NATURAL MOISTURE CONTENT W | LIQUID LIMIT W _L | UNIT WEIGHT γ | REMARKS & GRAIN SIZE DISTRIBUTION (%) GR SA SI CL |
|--------------|---|------------|---------|-------|------------|-------------------------|-----------------|--|----------------|---------------------------------|-------------------------------|--------------------------------|------------------|--|
| ELEV DEPTH | DESCRIPTION | STRAT PLOT | NUMBER | TYPE | 'N' VALUES | | | 20 40 60 80 100 | SHEAR STRENGTH | | | | | |
| 104.0 | Ground Surface | | | | | | | | | | | | | |
| 0.0 | * | | | | | | | | | | | | | |
| 103.3 | | | | | | | | | | | | | | |
| 0.7 | | | 1 | SS | 52 | | | | | | | | | |
| | | | 2 | SS | 60 | 2 cm | | | | | | | | |
| | Bedrock | | 3 | BX RC | REC 48% | | 102 | | | | | | | RQD = 0% |
| | | | 4 | BX RC | REC 86% | | | | | | | | | RQD = 0% |
| | Weathered Sound | | | | | | 100 | | | | | | | |
| | Queenston Shale | | 5 | BX RC | REC 98% | | | | | | | | | RQD = 53% |
| 98.5 | | | | | | | | | | | | | | |
| 5.5 | End of Borehole | | | | | | | | | | | | | |
| | * Heterogeneous Mixture of Silty Clay, Sand and Gravel Stiff to Hard | | | | | | 98 | | | | | | | |

+³, x⁵: Numbers refer to Sensitivity

20
15
10
5 (%) STRAIN AT FAILURE



RECORD OF BOREHOLE No 8

METRIC

W P 83-74-08 LOCATION N 4 800 165 E 278 778 ORIGINATED BY LM
DIST 4 HWY Q.E.W. BOREHOLE TYPE H.S. Auger - Cone Test COMPILED BY BR
DATUM Geodetic DATE 1985 07 29 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 | | | | | | | | |
| 105.7 | Ground Surface | | | | | | | | | | | | |
| 0.0 | Heterogeneous Mixture of Silty Clay Sand and Gravel Very Stiff to Hard | | 1 | SS | 46 | | | | | | | | |
| 104.2 | | | | | | | | | | | | | |
| 1.5 | Bedrock | | 2 | SS | 77 | | | | | | | | |
| | Weathered Sound | | 3 | SS | 50/8 cm | | | | | | | | |
| | | | 4 | BX RC | REC 92% | | | | | | | | RQD = 0% |
| | Queenston Shale | | 5 | BX RC | REC 100% | | | | | | | | RQD = 37% |
| 101.2 | | | 6 | BX RC | REC 100% | | | | | | | | RQD = 69% |
| 4.5 | End of Borehole * Groundwater Level Not Determined | | | | | | | | | | | | |



RECORD OF BOREHOLE No 9

METRIC

W P 83-74-08

LOCATION N 4 800 076 E 278 836

ORIGINATED BY LM

DIST 4 HWY Q.E.W.

BOREHOLE TYPE H.S. Auger - Cone Test

COMPILED BY BR

DATUM Geodetic

DATE 1985 07 23

CHECKED BY

| SOIL PROFILE | | | SAMPLES | | | GROUND WATER CONDITIONS | ELEVATION SCALE | DYNAMIC CONE PENETRATION RESISTANCE PLOT 20 40 60 80 100 SHEAR STRENGTH ○ UNCONFINED + FIELD VANE ● QUICK TRIAXIAL x LAB VANE | PLASTIC LIMIT W _p NATURAL MOISTURE CONTENT W LIQUID LIMIT W _L WATER CONTENT (%) 10 20 30 | UNIT WEIGHT γ | REMARKS & GRAIN SIZE DISTRIBUTION (%) GR SA SI CL |
|--------------|---|------------|---------|-------|------------|-------------------------|-----------------|---|---|------------------|--|
| ELEV DEPTH | DESCRIPTION | STRAT PLOT | NUMBER | TYPE | 'N' VALUES | | | | | | |
| 104.0 | Ground Surface | | | | | | | | | | |
| 0.0 | Heterogeneous Mixture of Silty Clay Sand and Gravel Stiff to Hard | | 1 | SS | 55 | | | | | | |
| 102.7 | Bedrock | | 2 | SS | 65 | 10 cm | | | | | |
| 1.3 | Weathered Sound | | 3 | BX RC | 39% | | | | | | RQD = 0% |
| | | | 4 | BX RC | 87% | | | | | | RQD = 33% |
| | Queenston Shale | | 5 | BX RC | 98% | | | | | | RQD = 21% |
| | | | 6 | BX RC | 86% | | | | | | RQD = 49% |
| 99.0 | End of Borehole | | | | | | | | | | |
| 5.0 | * Groundwater Level Not Determined | | | | | | | | | | |



RECORD OF BOREHOLE No 10

METRIC

W P 83-74-08 LOCATION N 4 800 273 E 278 946 ORIGINATED BY LM
DIST 4 HWY Q.E.W. BOREHOLE TYPE H.S. Auger - Cone Test COMPILED BY BR
DATUM Geodetic DATE 1985 07 29 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 | | | | | |
| 105.6 | Ground Surface | | | | | | | | | | | | | | | | |
| 0.0 | Heterogeneous Mixture of Silty Clay Sand and Gravel Very Stiff to Hard | | 1 | SS | 37 | * | | | | | | | | | | | |
| 104.2 | | | | | | | | | | | | | | | | | |
| 1.4 | Bedrock | | 2 | SS | 126/20 cm | | 104 | | | | | | | | | | 33 32 25 10 |
| | Weathered Sound | | 3 | SS | 117/5 cm | | | | | | | | | | | | |
| | | | 4 | BX RC | REC 97% | | | | | | | | | | | | RQD = 41% |
| | Queenston Shale | | 5 | BX RC | REC 93% | | 102 | | | | | | | | | | RQD = 33% |
| 100.7 | | | | | | | | | | | | | | | | | |
| 4.9 | End of Borehole | | | | | | | | | | | | | | | | |
| | * Groundwater Level Not Determined | | | | | | | | | | | | | | | | |

+3, x5 : Numbers refer to
Sensitivity

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



RECORD OF BOREHOLE No 11

METRIC

W P 83-74-08 LOCATION N 4 800 272 E 279 101 ORIGINATED BY LM
DIST 4 HWY Q.E.W. BOREHOLE TYPE H.S. Auger - Cone Test COMPILED BY BR
DATUM Geodetic DATE 85 07 24 CHECKED BY LD

| SOIL PROFILE | | | SAMPLES | | | GROUND WATER CONDITIONS | ELEVATION SCALE | DYNAMIC CONE PENETRATION RESISTANCE PLOT | | PLASTIC LIMIT W _p | NATURAL MOISTURE CONTENT W | LIQUID LIMIT W _L | UNIT WEIGHT γ | REMARKS & GRAIN SIZE DISTRIBUTION (%) GR SA SI CL |
|---------------|--|------------|---------|----------|-------------|----------------------------|-----------------|---|----------------|------------------------------------|-------------------------------------|-----------------------------------|---------------------|--|
| ELEV DEPTH | DESCRIPTION | STRAT PLOT | NUMBER | TYPE | 'N' VALUES | | | 20 40 60 80 100 | SHEAR STRENGTH | | | | | |
| 103.7 | Ground Surface | | | | | | | | | | | | | |
| 0.0 | Heterogeneous Mixture of Silty Clay, Sand & Gravel, Stiff to Very Stiff | | | | | | | | | | | | | |
| 102.9 | | | | | | | | | | | | | | |
| 0.8 | | | | | | | | | | | | | | |
| | Bedrock | | 1 | SS | 22 | | | | | | | | | |
| | | | 2 | SS | 53 | 3 cm | | | | | | | | |
| | Weathered Sound | | 3 | BX RC | REC 92% | | | | | | | | | RQD = 50% |
| | | | 4 | BX RC | REC 94% | | | | | | | | | RQD = 39% |
| | Queenston Shale | | 5 | BX RC | REC 85% | | | | | | | | | RQD = 37% |
| | | | 6 | BX RC | REC 100% | | | | | | | | | RQD = 61% |
| 99.0 | | | | | | | | | | | | | | |
| 4.7 | End of Borehole | | | | | | | | | | | | | |

+3, x5 : Numbers refer to
Sensitivity

20
15
10
5 (% STRAIN AT FAILURE



RECORD OF BOREHOLE No 12

METRIC

W P 83-74-08 LOCATION N 4 800 430 E 279 204 ORIGINATED BY LM
DIST 4 HWY Q.E.W. BOREHOLE TYPE H.S. Auger - Cone Test COMPILED BY BR
DATUM Geodetic DATE 1985 07 26 CHECKED BY *LM*

| SOIL PROFILE | | | SAMPLES | | | GROUND WATER CONDITIONS | ELEVATION SCALE | DYNAMIC CONE PENETRATION RESISTANCE PLOT | | PLASTIC LIMIT W _p | NATURAL MOISTURE CONTENT W | LIQUID LIMIT W _L | UNIT WEIGHT γ | REMARKS & GRAIN SIZE DISTRIBUTION (%) GR SA SI CL |
|---------------|---|------------|---------|----------|------------|----------------------------|-----------------|--|----------------|------------------------------------|-------------------------------------|-----------------------------------|---------------------|--|
| ELEV DEPTH | DESCRIPTION | STRAT PLOT | NUMBER | TYPE | 'N' VALUES | | | 20 40 60 80 100 | SHEAR STRENGTH | | | | | |
| | | | | | | | | ○ UNCONFINED + FIELD VANE ● QUICK TRIAXIAL x LAB VANE | | | | | | |
| 105.9 | Ground Surface | | | | | | | | | | | | | |
| 0.0 | Heterogeneous Mixture of Silty Clay Sand and Gravel Stiff to Hard | | 1 | SS | 38 | | | | | | | | | |
| 104.4 | | | 2 | SS | 40 | | | | | | | | | |
| 1.5 | Bedrock | | 3 | SS | 102/20 cm | | | | | | | | | |
| | | | 4 | BX RC | REC 77% | | | | | | | | | RQD = 0% |
| | Weathered Sound | | 5 | BX RC | REC 86% | | | | | | | | | RQD = 0% |
| | Queenston Shale | | 6 | BX RC | REC 95% | | | | | | | | | RQD = 63% |
| 100.4 | | | | | | | | | | | | | | |
| 5.5 | End of Borehole | | | | | | | | | | | | | |

+3, x5: Numbers refer to
Sensitivity

20
15 5 (%) STRAIN AT FAILURE
10



RECORD OF BOREHOLE No 15

METRIC

W P 83-74-08 LOCATION N 4 799 617 E 278 296 ORIGINATED BY LM
DIST 4 HWY Q.E.W. BOREHOLE TYPE H.S. Auger - Cone Test COMPILED BY BR
DATUM Geodetic DATE 1985 07 25 CHECKED BY so

| SOIL PROFILE | | | SAMPLES | | | GROUND WATER CONDITIONS | ELEVATION SCALE | DYNAMIC CONE PENETRATION RESISTANCE PLOT 20 40 60 80 100 SHEAR STRENGTH ○ UNCONFINED + FIELD VANE ● QUICK TRIAXIAL x LAB VANE | PLASTIC LIMIT W _p NATURAL MOISTURE CONTENT W LIQUID LIMIT W _L WATER CONTENT (%) 10 20 30 | UNIT WEIGHT γ | REMARKS & GRAIN SIZE DISTRIBUTION (%) GR SA SI CL |
|--------------|--|------------|---------|-------|------------|-------------------------|-----------------|---|---|------------------|--|
| ELEV DEPTH | DESCRIPTION | STRAT PLOT | NUMBER | TYPE | 'N' VALUES | | | | | | |
| 103.0 | Ground Surface | | | | | | | | | | |
| 0.0 | ** | | | | | * | | | | | |
| 102.4 | | | | | | | | | | | |
| 0.6 | | | | | | | | | | | |
| | Bedrock | | 1 | SS | 52 | | | | | | |
| | | | 2 | SS | 98 | | | | | | |
| | Weathered Sound | | 3 | BX RC | REC 98% | | | | | | RQD = 10% |
| | Queenston Shale | | 4 | BX RC | REC 100% | | | | | | RQD = 47% |
| 98.3 | | | | | | | | | | | |
| 4.7 | End of Borehole | | | | | | | | | | |
| | * Groundwater Level Not Determined | | | | | | | | | | |
| | ** Heterogeneous Mixture of Silty Clay, Sand and Gravel Very Stiff to Hard | | | | | | | | | | |

+3, x5: Numbers refer to Sensitivity

20
15 5 (%) STRAIN AT FAILURE
10

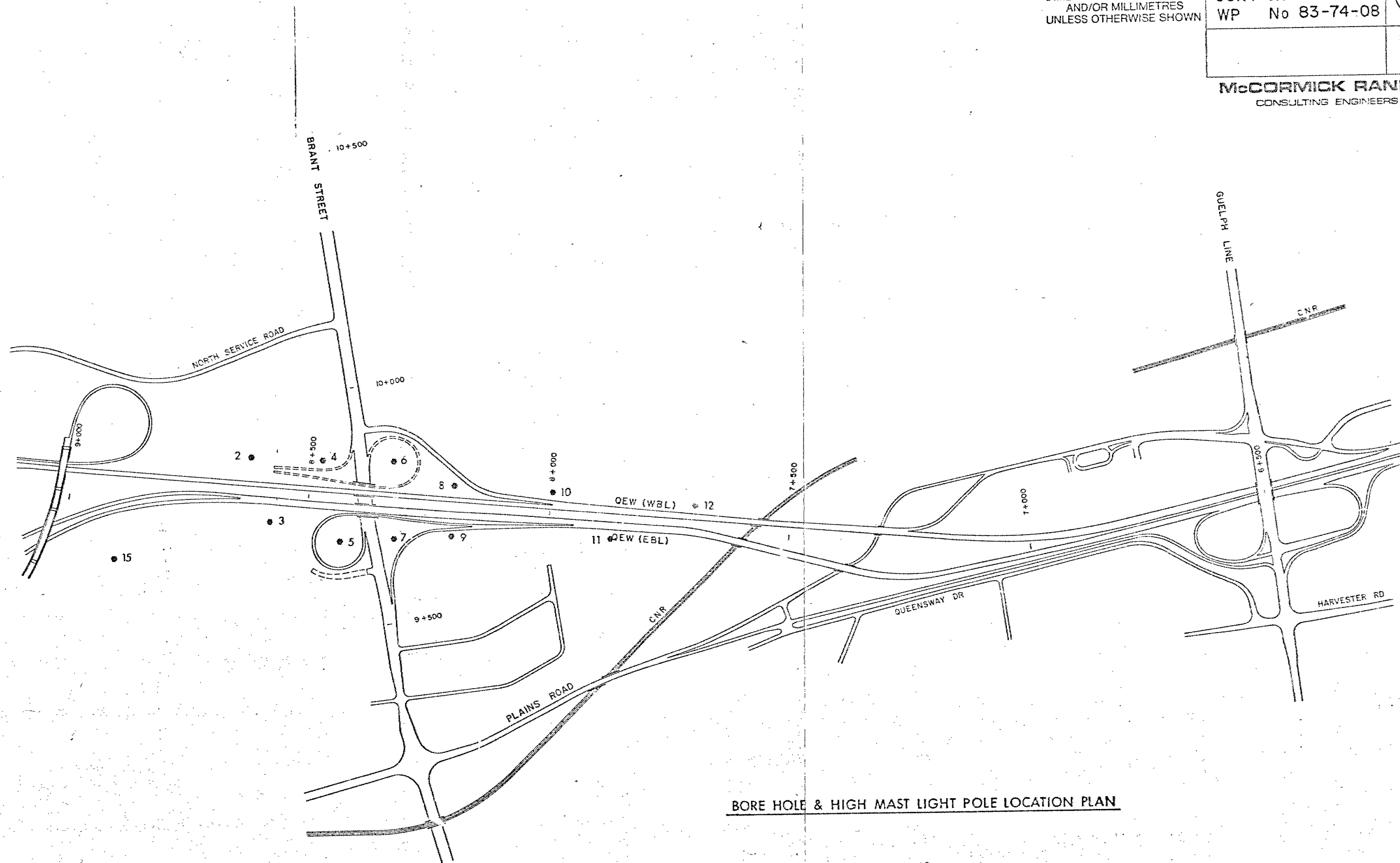
METRIC
 DIMENSIONS ARE IN METRES
 AND/OR MILLIMETRES
 UNLESS OTHERWISE SHOWN

PLATE No
 CONT No
 WP No 83-74-08



SHEET

MCCORMICK RANKIN
 CONSULTING ENGINEERS



BORE HOLE & HIGH MAST LIGHT POLE LOCATION PLAN

SCALE
 50m 0 100m