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DIST. 4 REGION

W.P. No.

CONT. No.

W. O. No. 82-26025

STR. SITE No.

HWY. No. GO-ALRT

LOCATION OAKVILLE WEST EXTENSION

*OVERSIZE DRAWINGS TO BE INCLUDED WITH THIS REPORT.*

REMARKS:

# GO-ALRT

## OAKVILLE - HAMILTON SECTION

Ontario

Ministry of
Transportation and
Communications

WARNOCK HERSEY PROFESSIONAL SERVICES LTD


# OAKVILLE-HAMILTON-SECTION

## ENGINEERING MATERIALS OFFICE

## FOUNDATION DESIGN SECTION

W O 82-26025 DIST 4

HWY GO-ALRT STR SITE

Oakville Project—West Extension

- Burloak Drive C.N.R. Subway
- Burloak Drive GO-ALRT Subway

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# FOUNDATION INVESTIGATION REPORT

FOR

W.O. 82-26025
District 4 Hamilton
GO-ALRT, West Extension, Oakville Project
Burloak Drive CNR Subway
Burloak Drive GO-ALRT Subway

## INTRODUCTION

This report summarizes the results of a subsurface investigation which was carried out for the above structures by Warnock Hersey Professional Services Ltd.

The purpose of the investigation was to define the subsoil, bedrock and groundwater conditions underlying the site and evaluate the foundation conditions and geotechnical parameters relating to the design of the proposed subways.

The exploratory work was performed during the period of 84 01 19 to 84 01 25 by means of a C.M.E. 55 drill rig employing standard augers BX casing and BXL core barrel. The drillng consisted of a total of 9 cored boreholes having depths of 3.9 to 12.9 metres below prevailing grade and rock core depths of 1.5 to 10.5 metres. An additional borehole performed by Geocon Inc. within the limits of subway structures has also been incorporated into the report. This borehole was performed on 84 01 19 using standard auger, BX casing and BQ core barrel.

Standpipes were installed in selected boreholes for measurement of the groundwater table.

Borehole locations were surveyed by our staff and surface elevations referenced to a temporary geodetic bench mark.

Cont'd...../2

## Site Location

The site is located south of the Q.E.W. on Burloak Drive, which is the municipal boundary between Burlington and Oakville. The proposed C.N.R. structure will be situated essentially at the existing level crossing while the GO-ALRT structure will be some 21 meters northerly centerline to centerline.

## Geological Setting

The area is known physiographically as the Iroquois plain which encompasses a broad zone of relatively flat former lake bottom between the modern shoreline and that of glacial Lake Iroquois. The topography originated from wave erosion of the underlying Queenston Shale bedrock which has also been subject to residual weathering after exposure. The shallow overburden cover is comprised primarily of residual soils resulting from either decomposition of the shale or glacial scouring.

## SUBSURFACE CONDITIONS

### General

Individual borehole records providing a detailed description of subsurface conditions and exploratory data are contained in the appendix of this report. The accompanying drawing includes a location plan of the boreholes and several stratigraphic sections across the site. Laboratory test results are also summarized in Figures 1 and 2 of the appendix.

The subsurface conditions at the site are typically very uniform and consist of 1.3 to 2.0 meters of stiff to very hard silty clay overburden resting on weathered shale bedrock of the Queenston formation. Shale weathering is generally confined to the upper 1 to 2 meters although narrow weathered zones occur locally with depth. Fill material is also present on the site in the form of road and rail bedding which rises 1.0 to 1.5 meters above the prevailing grade. The groundwater table occurs near the weathered bedrock surface.

## OVERBURDEN

### Fill

The fill material at the site is confined to the roadway bedding and embankment material below the existing rail line. Although not explored directly by the drilling it is judged that the fill has a depth of 1.0 to 1.5 meters based on its height above the surrounding grades. Some minor surficial fill containing topsoil material has also collected in adjacent drainage ditches.

Cont'd...../3

Silty Clay (CL)

The red silty clay subsoil is a residual weathering product featuring indistinct horizontal layering grey seams and shaley zones. It extends to depths of 1.3 to 2.0 meters and varies with depth from a stiff to hard consistency. The composition of the material (Figure 2) is approximately 20% fine sand, 60% silt and 20% clay with a trace of coarser sand and gravel. The liquid limit results (Figure 1) range from 26.4 to 32.5 with plastic indices of 8.1 and 10.5 respectively. Natural moisture contents are generally in the order of 10 to 15% with a range of 9 to 18%.

Bedrock

The bedrock is red shale of the Queenston Formation, featuring typical horizontal bedding and occasional grey shale and siltstone layers. Weathering is evident within the upper 1 to 2 meters being transitional in nature and diminishing with depth. Below the weathered zone, the shale is categorized as essentially sound except for occasional layers or seams of partial weathering notably at borehole 132 between depths of 7.6 to 8.5 meters and borehole 137 between 5.7 and 6.4 meter depths. These zones appear to be local in nature without horizontal continuity.

Core recovery in all boreholes was generally 98 to 100 percent. Estimated Rock Quality Designation (RQD) varied from 13 to 100 percent typically increasing with depth except at the noted weathered zones in boreholes 132 and 137.

Groundwater

The installed standpipes indicate the position of the groundwater to be at depths of 1.2 to 1.6 meters or just slightly above the surface of the weathered shale. Some seasonal variation of the groundwater table is likely along with trapping of surface water by the relatively impermeable subsoils.

Groundwater yield through the shale was not investigated in detail by any particular testing procedure. The rock core evidence and local experience indicates that the groundwater flow through the shale is generally light, increasing to moderate along local resistant layers and discontinuities.

Cont'd...../4

## GEOTECHNICAL DISSCUSSION

### a) Background

The proposed grade separation at Burloak Drive is to include the following bridge or subway structures:

1) GO-ALRT 2 span bridge with central pier, perched abutments and wing walls.

2) C.N.R. 4 span bridge with 3 pier bents, perched abutments and wing walls.

The proposed GO-ALRT track elevation at the Burloak Drive centerline is to be 107.600 while the existing C.N.R. track will remain essentially unchanged at 106.906. The Burloak Drive profile will be lowered to a maximum of approximately 6.5 meters in the vicinity of the proposed structures.

### b) Foundations

Structural loads can be supported by means of conventional spread footing foundations resting on sound shale bedrock for which the factored bearing capacity at Ultimate Limit State will govern in accordance with the established values in Section 6.5.3 of the O.H.B.D.C. For shale rock the Factored Bearing Capacity at U.L.S. is indicated to be 1500 kPa.

Within the upper weathered zone (above elevation 103) this value however, should be reduced to 1000 kPa.

Foundation settlement will be limited to elastic compression which will be effectively negligable. Protection of the founding surface however, is required during foundation construction for which we suggest a 100 mm concrete skin slab. A minimum 1.2 meters cover must be provided over all footings for frost protection.

For calculation of sliding resistance of abutment footings, a friction coefficient of 0.47 can be assumed. If additional sliding resistance is required, the use of foundation keys or dowels can be considered.

Cont'd...../5

c) Backfill and Retaining Walls

All backfill behind retaining walls must consist of approved free draining granular material such as Granular "A" or good quality Granular "B". It should be placed in uniform lifts having a maximum thickness of 200 mm and be compacted to 95 percent Standard Proctor density. Appropriate drainage outlets must be provided through the retaining walls to prevent the build-up of hydrostatic pressure.

For the calculation of earth pressure on retaining walls and abutments, the following alternatives apply depending on the choice of backfill:

i) Granular "A" Backfill

Compute in accordance with Section 6.6.1.2 of the O.H.B.D.C. using the following parameters:

$\gamma$ = 22 KN/m$^3$
$\phi$ = 35°

ii) Granular "B" or "C" Backfill

Compute in accordance with Section 6.6.1.2.2 of the O.H.B.D.C. using the equivalent fluid pressure method. It should be noted that the "at rest" condition applies due to the unyielding nature of the foundation support.

d) Slopes

The Queenston shale bedrock will characteristically stand at relatively steep angles for the short and medium term but will be subject to surface erosion and creep as a result of weathering and slaking processes. As such, permanent slopes for the subway cut should not exceed 2 horizontal to 1 vertical to maintain stability of the slope surface. Stability with respect to deep seated rotational failure is not a consideration.

Groundwater seepage or bleeding through the shale cut will tend to be light and diminish with time. Localized zones of greater seepage may however be revealed during construction and should be assessed as to the need for any specific drainage requirements.

Approach fills for the GO-ALRT and C.N.R. rail beds should be provided with 2 to 1 side slopes and appropriate surface cover for erosion protection.

Cont'd...../6

e) Drainage

Road base drainage should be provided below Burloak Drive pavement in addition to perforated subdrains in sewer installation according to M.T.C. specification DD-820. The lowering of the water table in the immediate vicinity of the subway cut will likely preclude the need for any permanent drainage provisions to handle seepage through slopes. The drainage requirements however should be reassessed with respect to the actual conditions encountered during construction.

f) Excavation and Groundwater

It is expected that shale bedrock within the Burloak Drive cut can be ripped and excavated by means of conventional heavy equipment without the need for blasting. Local excavations particularly for footings, sewers, etc. may require the use of pneumatic rock breakers. Blasting of footing excavations however should not be permitted.

Based on the rock core evidence and our knowledge of the area it is estimated that groundwater seepage during construction will generally be light to moderate locally and readily controlled by pumping from temporary sumps.


Respectfully submitted,

WARNOCK HERSEY PROFESSIONAL SERVICES LTD.

B. D'Onofrio

B. D'Onofrio, P.Eng.
Assistant Manager
Geotechnical Services

BD:cc

# APPENDIX

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Ontario

# RECORD OF BOREHOLE No 131

METRIC

W O 82-26025 LOCATION Co-Ords N 4 805 380.5; E 284 546.0 ORIGINATED BY B.D.

DIST 4 HWY GO-ALRT BOREHOLE TYPE SS Auger BxL Core COMPILED BY B.D.

DATUM Geodetic DATE 84 01 23 CHECKED BY R.S.

| SOIL PROFILE | | | SAMPLES | | | GROUND WATER CONDITIONS | ELEVATION SCALE | DYNAMIC CONE PENETRATION RESISTANCE PLOT (20 40 60 80 100) SHEAR STRENGTH ○ UNCONFINED ● QUICK TRIAXIAL + FIELD VANE × LAB VANE | PLASTIC LIMIT Wp — NATURAL MOISTURE CONTENT W — LIQUID LIMIT $W_L$ WATER CONTENT (%) | UNIT WEIGHT $\gamma$ | REMARKS & GRAIN SIZE DISTRIBUTION (%) GR SA SI CL |
|---|---|---|---|---|---|---|---|---|---|---|---|
| ELEV / DEPTH | DESCRIPTION | STRAT PLOT | NUMBER | TYPE | 'N' VALUES | | | | | | |
| 105.4 | Ground surface | | | | | | | | | | |
| 0.0 | Topsoil and silty clay (fill) | | | | | * | 105 | | | | |
| 104.5 | Soft to firm | | 1 | SS | 6 | | | | | | |
| 0.9 | Red silty clay (Cl) occ. shaley layers | | 2 | SS | 140/280mm | | 104 | | | | |
| 103.7 | Hard | | | | | | | | | | |
| 1.7 | Bedrock Queenston Formation Red shale | | 3 | SS | 150/150mm | | | | | | |
| | Weathered | | 4 | RC | Rec 96% | | 103 | | | | |
| | Sound | | | BxL | RQD 51% | | 102 | | | | |
| 101.5 | | | | | | | | | | | |
| 3.9 | End of borehole | | | | | | | | | | |

* Water level not established

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

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

OFFICE REPORT ON SOIL EXPLORATION

Ministry of Transportation and Communications
Ontario

# RECORD OF BOREHOLE No 132

METRIC

W O 82-26025 LOCATION Co-Ords N 4 805 390.6; E 284 556.2 ORIGINATED BY B.D.

DIST 4 HWY GO-ALRT BOREHOLE TYPE SS Auger BxL Core COMPILED BY B.D.

DATUM Geodetic DATE 84 01 20 CHECKED BY R.S.

| ELEV / DEPTH | DESCRIPTION | STRAT PLOT | SAMPLES NUMBER | SAMPLES TYPE | SAMPLES 'N' VALUES | GROUND WATER CONDITIONS | ELEVATION SCALE | DYNAMIC CONE PENETRATION RESISTANCE PLOT (20 40 60 80 100) / SHEAR STRENGTH (○ UNCONFINED ● QUICK TRIAXIAL + FIELD VANE × LAB VANE) | PLASTIC LIMIT Wp / NATURAL MOISTURE CONTENT W / LIQUID LIMIT WL — WATER CONTENT (%) 10 20 30 | UNIT WEIGHT γ | REMARKS & GRAIN SIZE DISTRIBUTION (%) GR SA SI CL |
|---|---|---|---|---|---|---|---|---|---|---|---|
| 105.3 | Ground surface | | | | | | 105 | | | | |
| 0.0<br>104.8 | Topsoil & silty clay (fill) | | | | | | | | | | |
| 0.5 | Red silty clay (Cl) occ. shaley layers Hard | | 1 | SS | 43 | W. L. in standpipe | 104 | 104.1 ○ | ○ | | 0 10 60 30 |
| 103.4 | | | 2 | SS | 60/ 150 mm | | | | | | |
| 1.9 | | | 3 | SS | 100/ 50 mm | | 103 | | | | |
| | | | 4 | RC BxL | Rec 100% RQD 40% | | 102 | | | | |
| | Weathered | | 5 | RC BxL | Rec 100% RQD 45% | | 101 | | | | |
| | Sound | | | | | | 100 | | | | |
| | Bedrock Queenston Formation Red shale | | 6 | RC BxL | Rec 100% RQD 72% | | 99 | | | | |
| | | | 7 | RC BxL | Rec 100% RQD 51% | | 98 | | | | |
| | Weathered Zone | | | | | | 97 | | | | |
| | | | 8 | RC BxL | Rec 100% RQD 27% | | 96 | | | | |
| | | | 9 | RC BxL | Rec 100% RQD 90% | | 95 | | | | |
| | | | | | | | 94 | | | | |
| | | | 10 | RC BxL | Rec 90% RQD 100% | | 93 | | | | |
| 92.4 | | | | | | | | | | | |
| 12.9 | End of borehole | | | | | | | | | | |

+3, ×5 : Numbers refer to Sensitivity

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

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Ontario Ministry of Transportation and Communications

# RECORD OF BOREHOLE No 133 METRIC

W O 82-26025 LOCATION Co-Ords N 4 805 410.6; E 284 571.3 ORIGINATED BY B.D.

DIST 4 HWY GO-ALRT BOREHOLE TYPE SS Auger BxL Core COMPILED BY B.D.

DATUM Geodetic DATE 84 01 24 CHECKED BY R.S.

| SOIL PROFILE ELEV/DEPTH | DESCRIPTION | STRAT PLOT | SAMPLES NUMBER | TYPE | 'N' VALUES | GROUND WATER CONDITIONS | ELEVATION SCALE | DYNAMIC CONE PENETRATION RESISTANCE PLOT 20 40 60 80 100 / SHEAR STRENGTH ○ UNCONFINED ● QUICK TRIAXIAL + FIELD VANE × LAB VANE | PLASTIC LIMIT Wp / NATURAL MOISTURE CONTENT W / LIQUID LIMIT $W_L$ WATER CONTENT (%) 10 20 30 | UNIT WEIGHT γ | REMARKS & GRAIN SIZE DISTRIBUTION (%) GR SA SI CL |
|---|---|---|---|---|---|---|---|---|---|---|---|
| 105.5 | Ground surface | | | | | | | | | | |
| 105.3 | Topsoil | | | | | | | | | | |
| 0.2 | Red silty clay (Cl) occ. shaley layers Stiff to hard | | 1 | SS | 19 | W.L. in standpipe 1.42 m | 105 | 103.9 | ○ | | |
| | | | 2 | SS | 55 | | 104 | | | | |
| 103.5 | | | 3 | SS | 60/ | | | | | | |
| 2.0 | Weathered | | 4 | RC BxL | Rec 100% RQD 20% | | 103 | | | | |
| | Sound | | 5 | RC BxL | Rec 98% RQD 35% | | 102 | | | | |
| | Bedrock Queenston Formation Red shale | | | | | | 101 | | | | |
| | Weathered Zone | | 6 | RC BxL | Rec 100% RQD 30% | | 100 | | | | |
| | | | 7 | RC BxL | Rec 98% RQD 63% | | 99 | | | | |
| | | | | | | | 98 | | | | |
| | | | 8 | RC BxL | Rec 100% RQD 86% | | 97 | | | | |
| 96.0 | | | | | | | | | | | |
| 9.5 | End of borehole | | | | | | | | | | |

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+3, ×5 : Numbers refer to Sensitivity

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

Ministry of Transportation and Communications
Ontario

# RECORD OF BOREHOLE No 134 METRIC

W O 82-26025 LOCATION Co-Ords N 4 805 398.4; E 284 526.0 ORIGINATED BY B.D.
DIST 4 HWY GO-ALRT BOREHOLE TYPE SS Auger BxL Core COMPILED BY B.D.
DATUM Geodetic DATE 84 01 23 CHECKED BY R.S.

| SOIL PROFILE ELEV/DEPTH | DESCRIPTION | STRAT PLOT | SAMPLES NUMBER | TYPE | 'N' VALUES | GROUND WATER CONDITIONS | ELEVATION SCALE | DYNAMIC CONE PENETRATION RESISTANCE PLOT 20 40 60 80 100 / SHEAR STRENGTH o UNCONFINED • QUICK TRIAXIAL + FIELD VANE × LAB VANE | PLASTIC LIMIT $W_P$ NATURAL MOISTURE CONTENT W LIQUID LIMIT $W_L$ WATER CONTENT (%) 10 20 30 | UNIT WEIGHT $\gamma$ | REMARKS & GRAIN SIZE DISTRIBUTION (%) GR SA SI CL |
|---|---|---|---|---|---|---|---|---|---|---|---|
| 105.4 | Ground Surface | | | | | | | | | | |
| 105.1 | Topsoil | | | | | * | | | | | |
| 0.3 | Red silty clay (Cl) occ. shaley layers Hard | | 1 | SS | 35 | | 105 | | | | |
| | | | 2 | SS | 130 | | 104 | | | | 0 20 65 15 |
| 103.4 | | | 3 | SS | 120/125mm | | | | | | |
| 2.0 | Weathered | | 4 | RC BxL | Rec 98% RQD 45% | | 103 | | | | |
| | Sound | | | | | | 102 | | | | |
| | Bedrock Queenston Formation Red shale | | 5 | RC BxL | Rec 100% RQD 39% | | 101 | | | | |
| 100.4 | | | | | | | | | | | |
| 5.0 | End of borehole | | | | | | | | | | |

* Water level not established

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

20
15 ⊙ 5 (%) STRAIN AT FAILURE
10

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Ministry of Transportation and Communications
Ontario

# RECORD OF BOREHOLE No 135

METRIC

W O 82-26025 LOCATION Co-Ords N 4 805 416.5; E 284 518.0 ORIGINATED BY B.D.

DIST 4 HWY GO-ALRT BOREHOLE TYPE SS Auger BxL Core COMPILED BY B.D.

DATUM Geodetic DATE 84 01 23 CHECKED BY R.S.

| SOIL PROFILE | | | SAMPLES | | | GROUND WATER CONDITIONS | ELEVATION SCALE | DYNAMIC CONE PENETRATION RESISTANCE PLOT (20 40 60 80 100) / SHEAR STRENGTH (○ UNCONFINED ● QUICK TRIAXIAL + FIELD VANE × LAB VANE) | PLASTIC LIMIT Wp / 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 | | | | | | |
| 105.5 | Ground surface | | | | | | | | | | |
| 105.2 | Topsoil | | | | | * | | | | | |
| 0.3 | Red silty clay (Cl) occ. shaley layers Hard | | 1 | SS | 41 | | 105 | | | | |
| | | | 2 | SS | 75 | | 104 | | | | |
| 103.5 | | | 3 | SS | 100/ 125 mm | | | | | | |
| 2.0 | Weathered | | 4 | RC BxL | Rec 98% RQD 27% | | 103 | | | | |
| | Sound | | | | | | | | | | |
| | Bedrock Queenston Formation Red shale | | 5 | RC BxL | Rec 100% RQD 69% | | 102 | | | | |
| 100.5 | | | | | | | 101 | | | | |
| 5.0 | End of borehole | | | | | | | | | | |

* Water level not established

+3, ×5 : Numbers refer to Sensitivity

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

OFFICE REPORT ON SOIL EXPLORATION

Ministry of Transportation and Communications Ontario

# RECORD OF BOREHOLE No 136

METRIC

W O 82-26025 LOCATION Co-Ords N 4 805 445.8; E 284 562.4 ORIGINATED BY B.D.

DIST 4 HWY GO-ALRT BOREHOLE TYPE SS Auger BxL Core COMPILED BY B.D.

DATUM Geodetic DATE 84 01 24 CHECKED BY R.S.

| SOIL PROFILE | | | SAMPLES | | | GROUND WATER CONDITIONS | ELEVATION SCALE | DYNAMIC CONE PENETRATION RESISTANCE PLOT (20 40 60 80 100) / SHEAR STRENGTH (○ UNCONFINED ● QUICK TRIAXIAL + FIELD VANE × LAB VANE) | PLASTIC LIMIT Wp / NATURAL MOISTURE CONTENT W / LIQUID LIMIT $W_L$ — WATER CONTENT (%) (10 20 30) | UNIT WEIGHT γ | REMARKS & GRAIN SIZE DISTRIBUTION (%) |
|---|---|---|---|---|---|---|---|---|---|---|---|
| ELEV / DEPTH | DESCRIPTION | STRAT PLOT | NUMBER | TYPE | 'N' VALUES | | | | | | GR SA SI CL |
| 105.3 | Ground surface | | | | | | | | | | |
| 105.0 | Topsoil | | | | | * | 105 | | | | |
| 0.3 | Red silty clay (Cl) occ. shaley layers Stiff to hard | | 1 | SS | 16 | | | | ○ — | | |
| 103.6 | | | 2 | SS | 85 | | 104 | | ○ | | 3 31 53 13 |
| 1.7 | Weathered | | 3 | RC BxL | Rec 99% RQD 32% | | 103 | | | | |
| | Sound | | | | | | 102 | | | | |
| 100.4 | | | 4 | RC BxL | Rec 100% RQD 33% | | 101 | | | | |
| 4.9 | End of borehole | | | | | | | | | | |

* Water level not established

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

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

OFFICE REPORT ON SOIL EXPLORATION

Ministry of Transportation and Communications
Ontario

# RECORD OF BOREHOLE No 137

METRIC

W O 82-26025 LOCATION Co-Ords N 4 805 437.5; E 284 545.0 ORIGINATED BY B.D.

DIST 4 HWY GO-ALRT BOREHOLE TYPE SS Auger BxL Core COMPILED BY B.D.

DATUM Geodetic DATE 84 01 19 CHECKED BY R.S.

| SOIL PROFILE ELEV/DEPTH | DESCRIPTION | STRAT PLOT | SAMPLES NUMBER | TYPE | 'N' VALUES | GROUND WATER CONDITIONS | ELEVATION SCALE | DYNAMIC CONE PENETRATION RESISTANCE PLOT 20 40 60 80 100 / SHEAR STRENGTH ○ 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 |
|---|---|---|---|---|---|---|---|---|---|---|---|
| 105.7 | Ground surface | | | | | | | | | | |
| 105.4 | Topsoil | | | | | | | | | | |
| 0.3 | Red silty clay (Cl) occ. shaley seams Hard | | 1 | SS | 28 | W.L. in standpipe | 105 | 104.4 | | | |
| 103.9 | | | 2 | SS | 110/28 m m | | 104 | | | | |
| 1.8 | Weathered | | 3 | SS | 80/50 mm | | | | | | |
| | Sound | | 4 | BxL | 100% | | | | | | |
| | Bedrock Queenston Formation Red shale | | 5 | RC BxL | Rec 100% RQD 34% | | 103 | | | | |
| | | | 6 | RC BxL | Rec 100% RQD 56% | | 102 | | | | |
| | Weathered Zone | | 7 | RC BxL | Rec 100% RQD 13% | | 101 | | | | |
| | | | 8 | RC BxL | Rec 100% RQD 64% | | 100 | | | | |
| | | | 9 | RC BxL | Rec 100% RQD 69% | | 99 | | | | |
| | | | 10 | RC BxL | Rec 100% RQD 100% | | 98 | | | | |
| 94.6 | | | | | | | 97 | | | | |
| | | | | | | | 96 | | | | |
| | | | | | | | 95 | | | | |
| 11.1 | End of borehole | | | | | | | | | | |

+3, x5 : Numbers refer to Sensitivity

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

OFFICE REPORT ON SOIL EXPLORATION

Ministry of Transportation and Communications Ontario

# RECORD OF BOREHOLE No 138 METRIC

W O 82-26025 LOCATION Co-Ords N 4 805 452.2; E 284 545.0 ORIGINATED BY B.D.

DIST 4 HWY GO-ALRT BOREHOLE TYPE SS Auger BxL Core COMPILED BY B.D.

DATUM Geodetic DATE 84 01 24 CHECKED BY R.S.

| SOIL PROFILE | | | SAMPLES | | | GROUND WATER CONDITIONS | ELEVATION SCALE | DYNAMIC CONE PENETRATION RESISTANCE PLOT (20 40 60 80 100) SHEAR STRENGTH: ○ UNCONFINED ● QUICK TRIAXIAL + FIELD VANE × LAB VANE | PLASTIC LIMIT Wp — NATURAL MOISTURE CONTENT W — LIQUID LIMIT $W_L$ WATER CONTENT (%) 10 20 30 | UNIT WEIGHT γ | REMARKS & GRAIN SIZE DISTRIBUTION (%) |
|---|---|---|---|---|---|---|---|---|---|---|---|
| ELEV / DEPTH | DESCRIPTION | STRAT PLOT | NUMBER | TYPE | 'N' VALUES | | | | | | GR SA SI CL |
| 105.7 | Ground surface | | | | | | | | | | |
| 105.5 | Topsoil | | | | | | | | | | |
| 0.2 | Red silty clay (Cl)<br>occ. shaley seams<br>Very stiff to hard | | 1 | SS | 25 | * | 105 | | ○ | | 0 13 68 19 |
| | | | 2 | SS | 65 | | 104 | | | | |
| 103.7 | | | 3 | SS | 145/190 mm | | | | | | |
| 2.0 | Weathered<br>Sound | | 4 | RC<br>BxL | Rec 99%<br>RQD 46% | | 103 | | | | |
| | Bedrock<br>Queenston Formation<br>Red shale | | 5 | RC<br>BxL | Rec 100%<br>RQD 42% | | 102 | | | | |
| 100.7 | Weathered Zone | | | | | | 101 | | | | |
| 5.0 | End of borehole<br><br>* Water level not established | | | | | | | | | | |

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

15 20 5 10 (%) STRAIN AT FAILURE

OFFICE REPORT ON SOIL EXPLORATION

Ontario Ministry of Transportation and Communications

# RECORD OF BOREHOLE No 139 METRIC

W O 82-26025 LOCATION Co-Ords N 4 805 424.5; E 284 582.7 ORIGINATED BY B.D.

DIST 4 HWY GO-ALRT BOREHOLE TYPE SS Auger BxL Core COMPILED BY B.D.

DATUM Geodetic DATE 84 01 25 CHECKED BY B.D.

| SOIL PROFILE | | | SAMPLES | | | GROUND WATER CONDITIONS | ELEVATION SCALE | DYNAMIC CONE PENETRATION RESISTANCE PLOT (20 40 60 80 100) / SHEAR STRENGTH (○ UNCONFINED ● QUICK TRIAXIAL + FIELD VANE × LAB VANE) | PLASTIC LIMIT Wp / NATURAL MOISTURE CONTENT W / LIQUID LIMIT WL — 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 | | | | | | |
| 105.3 | Ground surface | | | | | | | | | | |
| 0.0<br>104.8 | Topsoil and clay (fill) | | | | | * | 105 | | | | |
| 0.5 | Red silty clay (Cl)<br>Firm to hard | | 1 | SS | 12 | | | | | | |
| 103.7 | | | 2 | SS | 136/230mm | | 104 | | ○ ⊢ | | |
| 1.6 | Weathered<br>Sound | | 3 | RC<br>BxL | Rec 98%<br>RQD 43% | | 103 | | | | |
| | Bedrock<br>Queenston Formation<br>Red shale | | 4 | RC<br>BxL | Rec 100%<br>RQD 43% | | 102 | | | | |
| 100.8 | | | | | | | 101 | | | | |
| 4.5 | End of borehole<br><br>* Water level not established | | | | | | | | | | |

OFFICE REPORT ON SOIL EXPLORATION

+3, ×5 : Numbers refer to Sensitivity

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

# RECORD OF BOREHOLE No 3 (Done by GEOCON INC) METRIC

W O 82-26025 LOCATION Co-Ords N 4 805 419.5; E 284 531.2 ORIGINATED BY B.D.

DIST 4 HWY GO-ALRT BOREHOLE TYPE St Auger + BQ COMPILED BY B.D.

DATUM Geodetic DATE 84 01 19 CHECKED BY R.S.

| SOIL PROFILE | | | SAMPLES | | | GROUND WATER CONDITIONS | ELEVATION SCALE | DYNAMIC CONE PENETRATION RESISTANCE PLOT (20 40 60 80 100) SHEAR STRENGTH: o UNCONFINED, • QUICK TRIAXIAL, + FIELD VANE, × 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 | | | | | | |
| 105.4 | Ground surface | | | | | | | | | | |
| 105.1 | Topsoil | | | | | * | 105 | | | | |
| 0.3 | Red silty clay (Cl) occ. shaley layers | | | | | | | | | | |
| 104.1 | Hard | | 1 | SS | 34 | | 104 | | | | |
| 1.3 | Weathered | | 2 | SS | 53/130 mm | | 103 | | | | |
| | Sound | | | | | | | | | | |
| | Bedrock Queenston Formation Red shale | | 3 | RC BxL | Rec 88% RQD 82% | | 102 | | | | |
| | | | 4 | RC BxL | Rec 100% RQD 80% | | 101 | | | | |
| | | | | | | | 100 | | | | |
| | | | 5 | RC BxL | Rec 83% RQD 72% | | 99 | | | | |
| | | | | | | | 98 | | | | |
| | | | 6 | RC BxL | Rec 78% RQD 78% | | 97 | | | | |
| 96.2 | | | | | | | | | | | |
| 9.2 | End of borehole | | | | | | | | | | |

* Water level not established

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

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

OFFICE REPORT ON SOIL EXPLORATION

TABLE 1

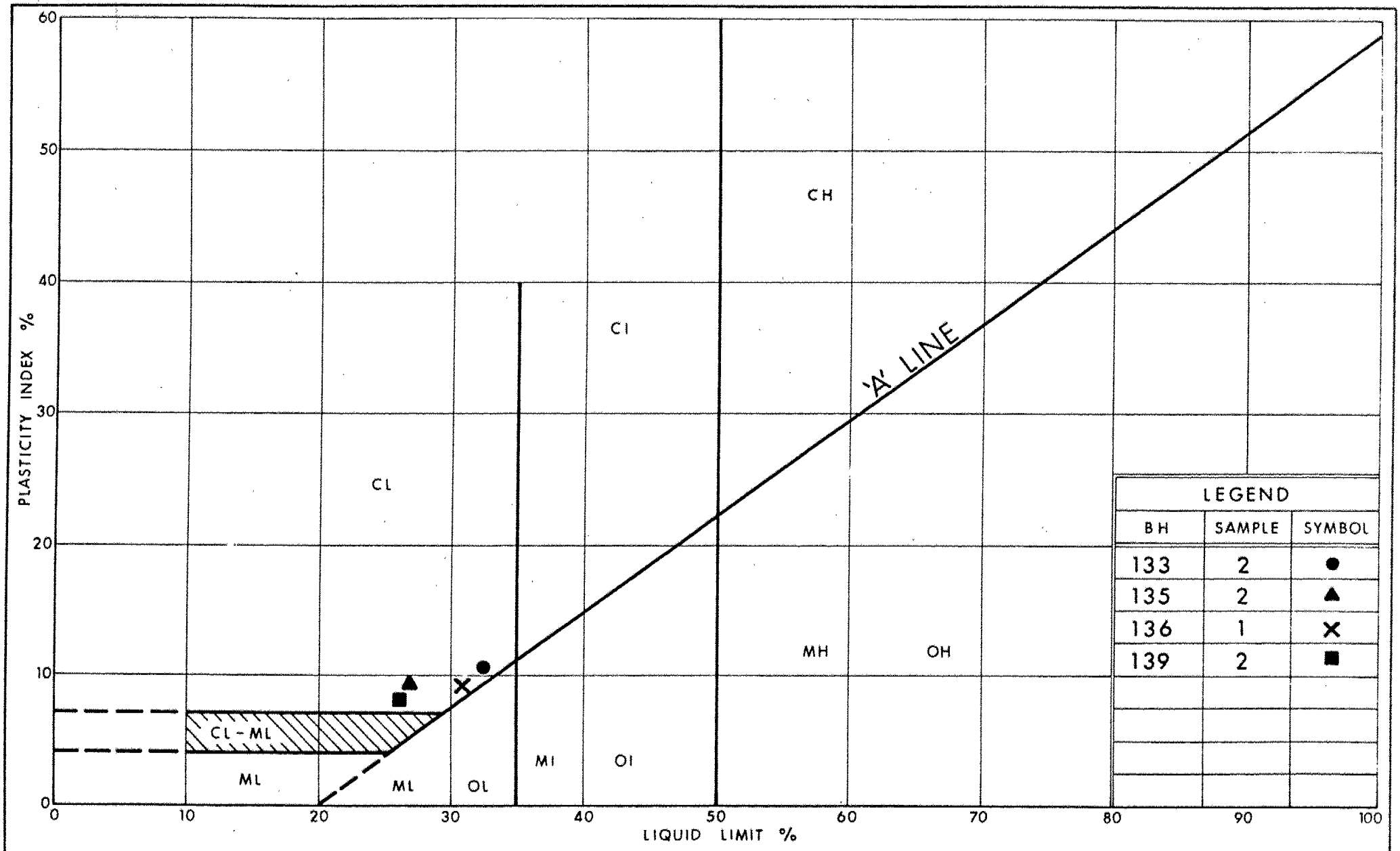
DESCRIPTION OF ROCK CORE - BURLOAK DRIVE

| BOREHOLE NUMBER | CORE RECOVERY | | | CORE DESCRIPTION | |
|---|---|---|---|---|---|
| | DEPTH (m) | % | RQD | DEPTH (m) | DESCRIPTION |
| 131 | 2.3 - 3.9 | 96 | 51 | 2.3 - 2.9 | Shale, red (Queenston Fm), moderately weathered |
| | | | | 2.9 - 3.9 | Shale, red (Queenston Fm), slightly weathered to sound |
| 132 | 2.3 - 3.9 | 100 | 40 | 2.3 - 2.9 | Shale, red (Queenston Fm), highly weathered |
| | 3.9 - 5.4 | 100 | 45 | 2.9 - 4.2 | Shale, red (Queenston Fm), slightly weathered |
| | 5.4 - 6.8 | 100 | 72 | | |
| | 6.8 - 8.4 | 98 | 51 | 4.2 - 7.6 | Shale, red (Queenston Fm), sound |
| | 8.4 - 9.8 | 100 | 27 | 7.6 - 8.5 | Shale, red (Queenston Fm), moderately weathered |
| | 9.8 - 11.4 | 100 | 90 | | |
| | 11.4 - 12.9 | 90 | 100 | 8.5 - 12.9 | Shale, red (Queenston Fm), sound |
| 133 | 2.0 - 3.5 | 100 | 20 | 2.0 - 3.4 | Shale, red (Queenston Fm), highly to moderately weathered |
| | 3.5 - 5.0 | 98 | 35 | 3.4 - 3.7 | Shale, red (Queenston Fm), slightly weathered |
| | 5.0 - 6.4 | 100 | 30 | | |
| | 6.4 - 7.9 | 98 | 63 | 4.5 - 9.5 | Shale, red (Queenston Fm), sound |
| | 7.9 - 9.5 | 100 | 86 | 5.5 - 5.7 | Shale, red (Queenston Fm), moderately weathered layer |
| 134 | 2.0 - 3.5 | 98 | 45 | 2.0 - 3.0 | Shale, red (Queenston Fm), moderate to slightly weathered |
| | 3.5 - 5.0 | 100 | 39 | 3.0 - 5.0 | Shale, red (Queenston Fm), sound |
| 135 | 2.0 - 3.5 | 98 | 27 | 2.0 - 3.2 | Shale, red (Queenston Fm), moderate to slightly weathered |
| | 3.5 - 5.0 | 100 | 69 | 3.2 - 5.0 | Shale, red (Queenston Fm), sound |

TABLE 1 - Continued

DESCRIPTION OF ROCK CORE - BURLOAK DRIVE

| BOREHOLE NUMBER | CORE RECOVERY | | | CORE DESCRIPTION | |
|---|---|---|---|---|---|
| | DEPTH (m) | % | RQD | DEPTH (m) | DESCRIPTION |
| 136 | 1.8 - 3.3 | 79 | 32 | 1.8 - 2.7 | Shale, red (Queenston Fm), moderate to lightly weathered |
| | 3.3 - 4.9 | 100 | 33 | | Shale, red (Queenston Fm), sound |
| 137 | 2.3 - 2.5 | 100 | 0 | 2.3 - 2.5 | Shale, red (Queenston Fm), highly weathered |
| | 2.5 - 3.9 | 100 | 34 | 2.5 - 5.7 | Shale, red (Queenston Fm), sound |
| | 3.9 - 5.4 | 100 | 56 | | |
| | 5.4 - 6.9 | 100 | 13 | 5.7 - 6.4 | Shale, red (Queenston Fm), moderately weathered |
| | 6.9 - 8.4 | 100 | 64 | | |
| | 8.4 - 9.9 | 100 | 69 | 6.4 - 11.1 | Shale, red (Queenston Fm), sound |
| | 9.9 - 11.1 | 100 | 100 | | |
| 138 | 2.0 - 3.5 | 99 | 46 | 2.0 - 3.2 | Shale, red (Queenston Fm), moderate to lightly weathered |
| | 3.5 - 5.0 | 100 | 42 | 3.2 - 4.5 | Shale, red (Queenston Fm), slightly weathered to sound |
| | | | | 4.5 - 5.0 | Shale, red (Queenston Fm), moderately weathered |
| 139 | 1.7 - 3.0 | 98 | 43 | 1.7 - 2.6 | Shale, red (Queenston Fm), moderate to slightly weathered |
| | 3.0 - 4.5 | 100 | 72 | 2.6 - 4.5 | Shale, red (Queenston Fm), sound |
| Geocon 3 | 3.0 - 4.6 | 88 | 82 | 3.0 - 9.2 | Shale, red (Queenston Fm), sound |
| | 4.6 - 6.1 | 100 | 80 | | |
| | 6.7 - 7.6 | 98 | 72 | | |
| | 7.6 - 7.2 | 78 | 78 | | |

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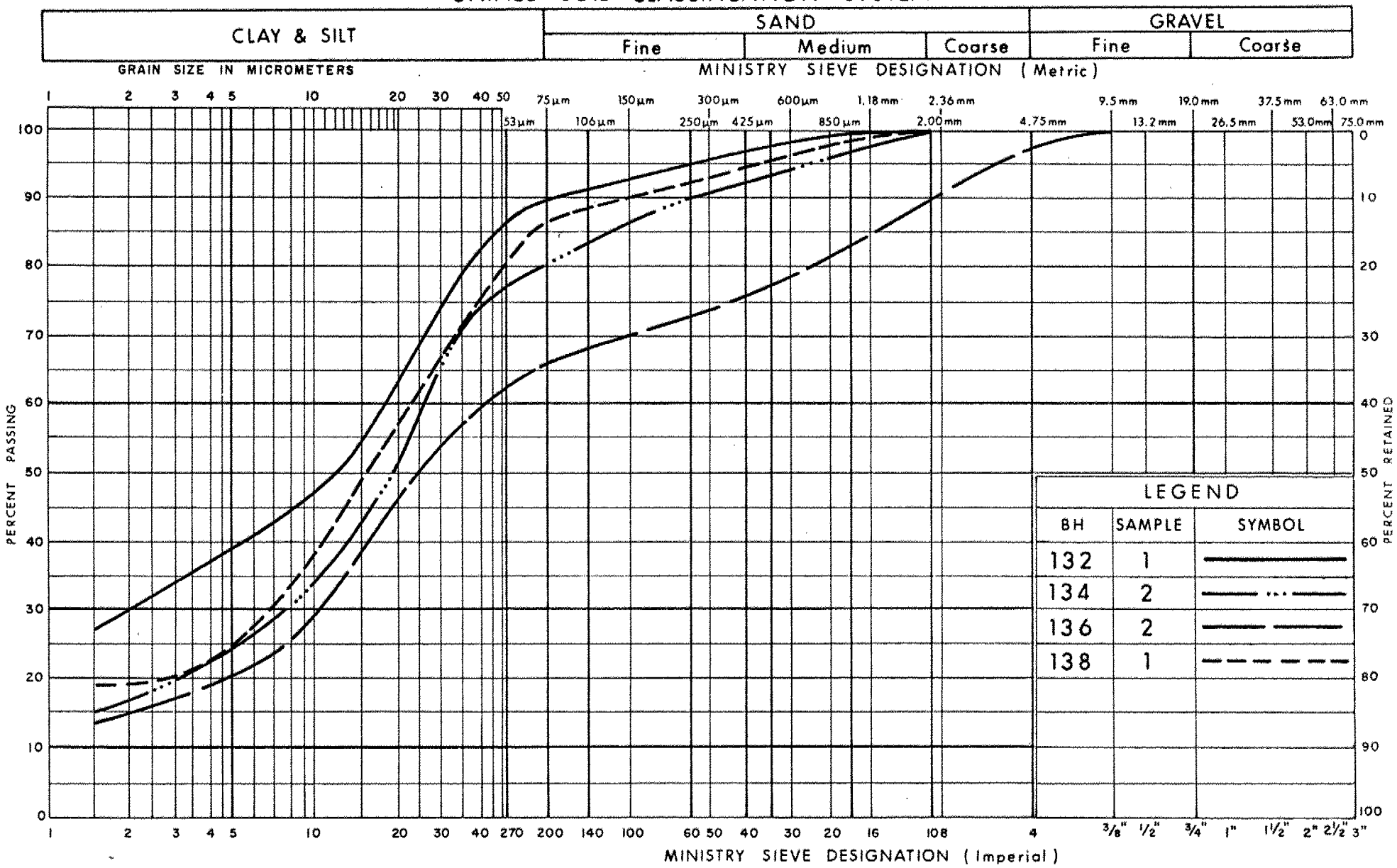
Ontario

# PLASTICITY CHART
## SILTY CLAY

FIG No 1
WO 82-26025

# UNIFIED SOIL CLASSIFICATION SYSTEM

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Ontario

## GRAIN SIZE DISTRIBUTION
## SILTY CLAY

FIG No 2
WO 82-26025

# EXPLANATION OF TERMS USED IN REPORT

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

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

SOILS ARE DESCRIBED BY THEIR COMPOSITION AND CONSISTENCY OR DENSENESS.

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

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

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

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

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

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

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

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

JOINTING AND BEDDING:

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

# ABBREVIATIONS AND SYMBOLS

## FIELD SAMPLING

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

## STRESS AND STRAIN

| | | |
|---|---|---|
| $u_w$ | kPa | PORE WATER PRESSURE |
| $r_u$ | 1 | PORE PRESSURE RATIO |
| $\sigma$ | 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 |

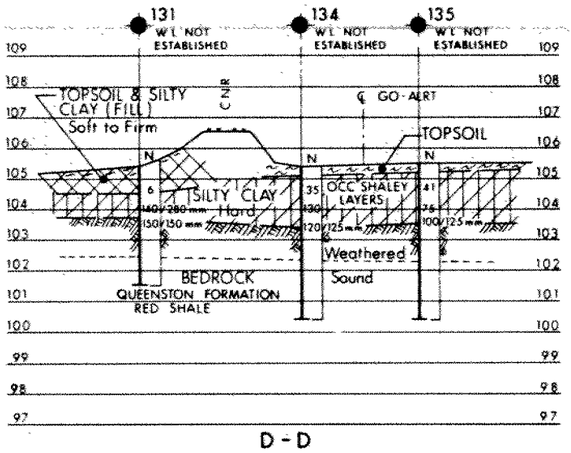
## MECHANICAL PROPERTIES OF SOIL

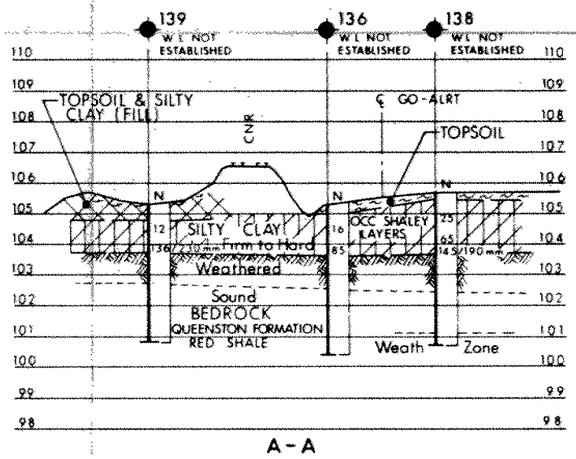
| | | |
|---|---|---|
| $m_v$ | $kPa^{-1}$ | COEFFICIENT OF VOLUME CHANGE |
| $C_c$ | 1 | COMPRESSION INDEX |
| $C_s$ | 1 | SWELLING INDEX |
| $C_\alpha$ | 1 | RATE OF SECONDARY CONSOLIDATION |
| $c_v$ | $m^2/s$ | COEFFICIENT OF CONSOLIDATION |
| H | m | DRAINAGE PATH |
| $T_v$ | 1 | TIME FACTOR |
| 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 = $\frac{c_u}{\tau_r}$ |

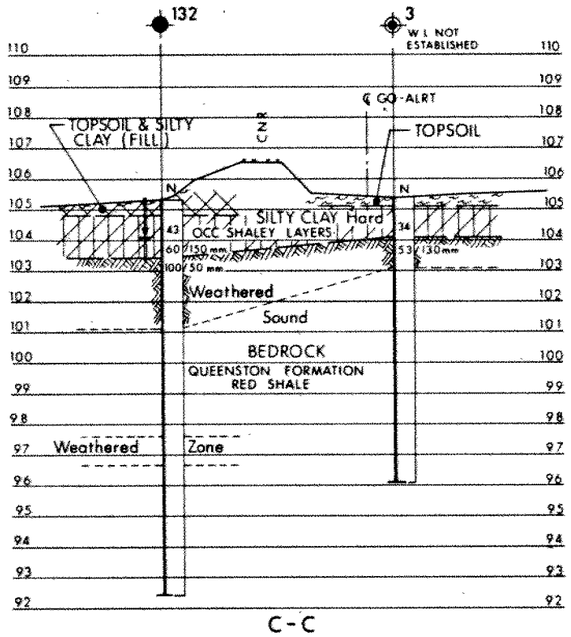
## PHYSICAL PROPERTIES OF SOIL

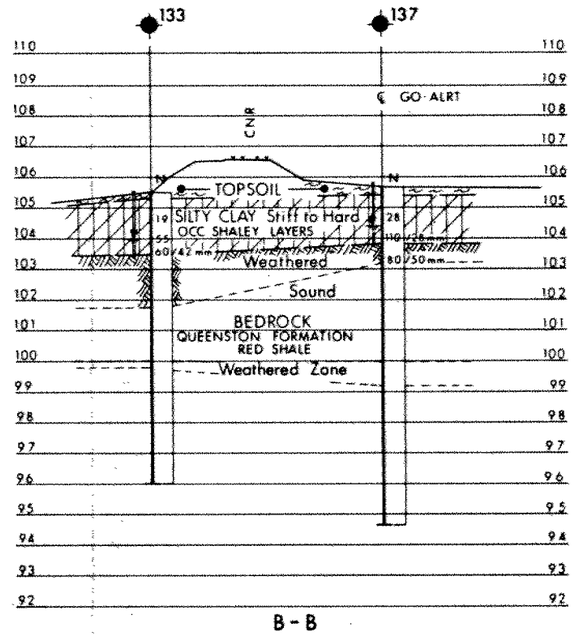
| | | |
|---|---|---|
| $\rho_s$ | $kg/m^3$ | DENSITY OF SOLID PARTICLES |
| $\gamma_s$ | $kN/m^3$ | UNIT WEIGHT OF SOLID PARTICLES |
| $\rho_w$ | $kg/m^3$ | DENSITY OF WATER |
| $\gamma_w$ | $kN/m^3$ | UNIT WEIGHT OF WATER |
| $\rho$ | $kg/m^3$ | DENSITY OF SOIL |
| $\gamma$ | $kN/m^3$ | UNIT WEIGHT 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 |



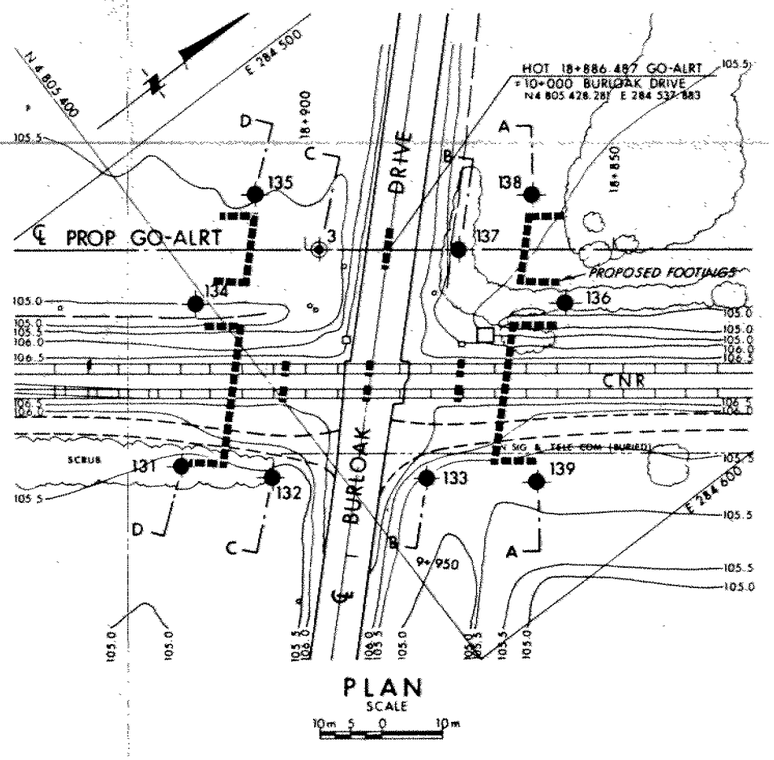



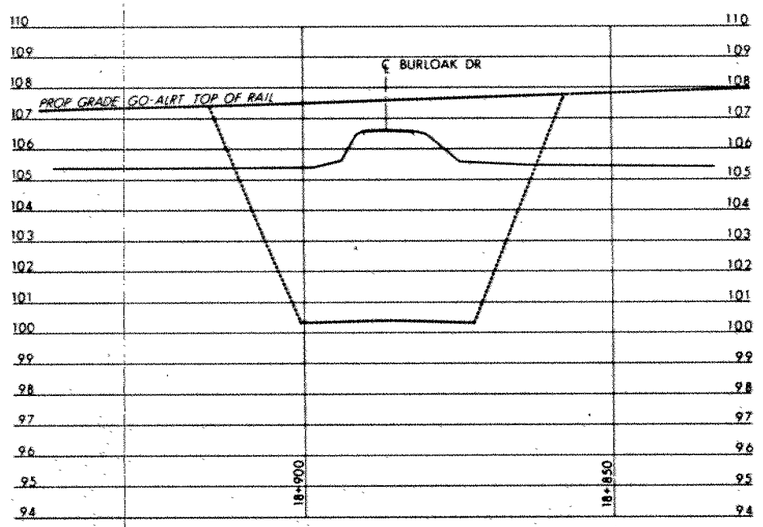




## SECTIONS

SCALE
10m 5 0 10 m Hor
2 1 0 2 m Vert



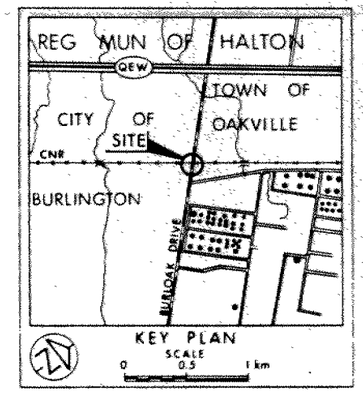




## ℄ PROFILE GO-ALRT

SCALE
10m 5 0 10m Hor
2m 1 0 2m Vert

METRIC

ALL DIMENSIONS SHOWN ARE IN METRES AND/OR MILLIMETRES UNLESS OTHERWISE NOTED.




### 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 84 01
  W.L. Not Established in Bore Holes 131, 134, 135, 136, 138, 139 and 3
- Bore Hole done by Geocon Inc 84 01 19
- W.L. in Standpipe

| No | ELEVATION | CO-ORDINATES NORTH | EAST |
|---|---|---|---|
| 131 | 105.4 | 4 805 380.5 | 284 546.0 |
| 132 | 105.3 | 4 805 390.6 | 284 556.2 |
| 133 | 105.5 | 4 805 410.6 | 284 571.3 |
| 134 | 105.4 | 4 805 398.4 | 284 526.0 |
| 135 | 105.5 | 4 805 416.5 | 284 518.0 |
| 136 | 105.3 | 4 805 445.8 | 284 562.4 |
| 137 | 105.7 | 4 805 437.5 | 284 545.0 |
| 138 | 105.7 | 4 805 452.2 | 284 545.0 |
| 139 | 105.3 | 4 805 424.5 | 284 582.7 |
| 3 | 105.4 | 4 805 419.5 | 284 531.2 |

Geocres No

**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.

GO-ALRT REF PD 2-300-1

| REFERENCE DRAWINGS | | REVISIONS | | |
|---|---|---|---|---|
| | | | | |

| DRAWN BY: J.T. 84 02 17 | DESIGNED BY: B.D. |
|---|---|
| CHK'D BY: B.D. | APPROVED BY: |
| SCALE: AS SHOWN | FULL SIZE ONLY |

REGISTERED PROFESSIONAL ENGINEER B. D'ONOFRIO PROVINCE OF ONTARIO

WARNOCK HERSEY PROFESSIONAL SERVICES LTD

GO-ALRT
Ministry of Transportation and Communications
OAKVILLE PROJECT-WEST EXTENSION
PROJECT MANAGER

HALTON REGION
BURLOAK DRIVE SUBWAY
BORE HOLE LOCATIONS & SOIL STRATA
STA 18+886.487

| CONTRACT NO | DWG NO | REV | SHEET |
|---|---|---|---|
| | | | |

DOCUMENT MICROFILMING IDENTIFICATION

G.I.-30 SEPT. 1976

GEOCRES No. 30M5-145

DIST. 4 REGION

W.P. No.

CONT. No.

W. O. No. 82-26025

STR. SITE No.

HWY. No. GO-ALRT

LOCATION OAKVILLE WEST EXTENSION

*OVERSIZE DRAWINGS TO BE INCLUDED WITH THIS REPORT.*

REMARKS:

# GO-ALRT

## OAKVILLE - HAMILTON SECTION

Ontario

Ministry of
Transportation and
Communications

WARNOCK HERSEY PROFESSIONAL SERVICES LTD


# OAKVILLE-HAMILTON-SECTION

## ENGINEERING MATERIALS OFFICE

## FOUNDATION DESIGN SECTION

W O 82-26025 DIST 4

HWY GO-ALRT STR SITE

Oakville Project—West Extension

- Burloak Drive C.N.R. Subway
- Burloak Drive GO-ALRT Subway

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# FOUNDATION INVESTIGATION REPORT

FOR

W.O. 82-26025
District 4 Hamilton
GO-ALRT, West Extension, Oakville Project
Burloak Drive CNR Subway
Burloak Drive GO-ALRT Subway

## INTRODUCTION

This report summarizes the results of a subsurface investigation which was carried out for the above structures by Warnock Hersey Professional Services Ltd.

The purpose of the investigation was to define the subsoil, bedrock and groundwater conditions underlying the site and evaluate the foundation conditions and geotechnical parameters relating to the design of the proposed subways.

The exploratory work was performed during the period of 84 01 19 to 84 01 25 by means of a C.M.E. 55 drill rig employing standard augers BX casing and BXL core barrel. The drillng consisted of a total of 9 cored boreholes having depths of 3.9 to 12.9 metres below prevailing grade and rock core depths of 1.5 to 10.5 metres. An additional borehole performed by Geocon Inc. within the limits of subway structures has also been incorporated into the report. This borehole was performed on 84 01 19 using standard auger, BX casing and BQ core barrel.

Standpipes were installed in selected boreholes for measurement of the groundwater table.

Borehole locations were surveyed by our staff and surface elevations referenced to a temporary geodetic bench mark.

Cont'd...../2

## Site Location

The site is located south of the Q.E.W. on Burloak Drive, which is the municipal boundary between Burlington and Oakville. The proposed C.N.R. structure will be situated essentially at the existing level crossing while the GO-ALRT structure will be some 21 meters northerly centerline to centerline.

## Geological Setting

The area is known physiographically as the Iroquois plain which encompasses a broad zone of relatively flat former lake bottom between the modern shoreline and that of glacial Lake Iroquois. The topography originated from wave erosion of the underlying Queenston Shale bedrock which has also been subject to residual weathering after exposure. The shallow overburden cover is comprised primarily of residual soils resulting from either decomposition of the shale or glacial scouring.

## SUBSURFACE CONDITIONS

### General

Individual borehole records providing a detailed description of subsurface conditions and exploratory data are contained in the appendix of this report. The accompanying drawing includes a location plan of the boreholes and several stratigraphic sections across the site. Laboratory test results are also summarized in Figures 1 and 2 of the appendix.

The subsurface conditions at the site are typically very uniform and consist of 1.3 to 2.0 meters of stiff to very hard silty clay overburden resting on weathered shale bedrock of the Queenston formation. Shale weathering is generally confined to the upper 1 to 2 meters although narrow weathered zones occur locally with depth. Fill material is also present on the site in the form of road and rail bedding which rises 1.0 to 1.5 meters above the prevailing grade. The groundwater table occurs near the weathered bedrock surface.

## OVERBURDEN

### Fill

The fill material at the site is confined to the roadway bedding and embankment material below the existing rail line. Although not explored directly by the drilling it is judged that the fill has a depth of 1.0 to 1.5 meters based on its height above the surrounding grades. Some minor surficial fill containing topsoil material has also collected in adjacent drainage ditches.

Cont'd...../3

Silty Clay (CL)

The red silty clay subsoil is a residual weathering product featuring indistinct horizontal layering grey seams and shaley zones. It extends to depths of 1.3 to 2.0 meters and varies with depth from a stiff to hard consistency. The composition of the material (Figure 2) is approximately 20% fine sand, 60% silt and 20% clay with a trace of coarser sand and gravel. The liquid limit results (Figure 1) range from 26.4 to 32.5 with plastic indices of 8.1 and 10.5 respectively. Natural moisture contents are generally in the order of 10 to 15% with a range of 9 to 18%.

Bedrock

The bedrock is red shale of the Queenston Formation, featuring typical horizontal bedding and occasional grey shale and siltstone layers. Weathering is evident within the upper 1 to 2 meters being transitional in nature and diminishing with depth. Below the weathered zone, the shale is categorized as essentially sound except for occasional layers or seams of partial weathering notably at borehole 132 between depths of 7.6 to 8.5 meters and borehole 137 between 5.7 and 6.4 meter depths. These zones appear to be local in nature without horizontal continuity.

Core recovery in all boreholes was generally 98 to 100 percent. Estimated Rock Quality Designation (RQD) varied from 13 to 100 percent typically increasing with depth except at the noted weathered zones in boreholes 132 and 137.

Groundwater

The installed standpipes indicate the position of the groundwater to be at depths of 1.2 to 1.6 meters or just slightly above the surface of the weathered shale. Some seasonal variation of the groundwater table is likely along with trapping of surface water by the relatively impermeable subsoils.

Groundwater yield through the shale was not investigated in detail by any particular testing procedure. The rock core evidence and local experience indicates that the groundwater flow through the shale is generally light, increasing to moderate along local resistant layers and discontinuities.

Cont'd...../4

## GEOTECHNICAL DISSCUSSION

### a) Background

The proposed grade separation at Burloak Drive is to include the following bridge or subway structures:

1) GO-ALRT 2 span bridge with central pier, perched abutments and wing walls.

2) C.N.R. 4 span bridge with 3 pier bents, perched abutments and wing walls.

The proposed GO-ALRT track elevation at the Burloak Drive centerline is to be 107.600 while the existing C.N.R. track will remain essentially unchanged at 106.906. The Burloak Drive profile will be lowered to a maximum of approximately 6.5 meters in the vicinity of the proposed structures.

### b) Foundations

Structural loads can be supported by means of conventional spread footing foundations resting on sound shale bedrock for which the factored bearing capacity at Ultimate Limit State will govern in accordance with the established values in Section 6.5.3 of the O.H.B.D.C. For shale rock the Factored Bearing Capacity at U.L.S. is indicated to be 1500 kPa.

Within the upper weathered zone (above elevation 103) this value however, should be reduced to 1000 kPa.

Foundation settlement will be limited to elastic compression which will be effectively negligable. Protection of the founding surface however, is required during foundation construction for which we suggest a 100 mm concrete skin slab. A minimum 1.2 meters cover must be provided over all footings for frost protection.

For calculation of sliding resistance of abutment footings, a friction coefficient of 0.47 can be assumed. If additional sliding resistance is required, the use of foundation keys or dowels can be considered.

Cont'd...../5

c) Backfill and Retaining Walls

All backfill behind retaining walls must consist of approved free draining granular material such as Granular "A" or good quality Granular "B". It should be placed in uniform lifts having a maximum thickness of 200 mm and be compacted to 95 percent Standard Proctor density. Appropriate drainage outlets must be provided through the retaining walls to prevent the build-up of hydrostatic pressure.

For the calculation of earth pressure on retaining walls and abutments, the following alternatives apply depending on the choice of backfill:

i) Granular "A" Backfill

Compute in accordance with Section 6.6.1.2 of the O.H.B.D.C. using the following parameters:

$\gamma$ = 22 KN/m$^3$
$\phi$ = 35°

ii) Granular "B" or "C" Backfill

Compute in accordance with Section 6.6.1.2.2 of the O.H.B.D.C. using the equivalent fluid pressure method. It should be noted that the "at rest" condition applies due to the unyielding nature of the foundation support.

d) Slopes

The Queenston shale bedrock will characteristically stand at relatively steep angles for the short and medium term but will be subject to surface erosion and creep as a result of weathering and slaking processes. As such, permanent slopes for the subway cut should not exceed 2 horizontal to 1 vertical to maintain stability of the slope surface. Stability with respect to deep seated rotational failure is not a consideration.

Groundwater seepage or bleeding through the shale cut will tend to be light and diminish with time. Localized zones of greater seepage may however be revealed during construction and should be assessed as to the need for any specific drainage requirements.

Approach fills for the GO-ALRT and C.N.R. rail beds should be provided with 2 to 1 side slopes and appropriate surface cover for erosion protection.

Cont'd...../6

e) Drainage

Road base drainage should be provided below Burloak Drive pavement in addition to perforated subdrains in sewer installation according to M.T.C. specification DD-820. The lowering of the water table in the immediate vicinity of the subway cut will likely preclude the need for any permanent drainage provisions to handle seepage through slopes. The drainage requirements however should be reassessed with respect to the actual conditions encountered during construction.

f) Excavation and Groundwater

It is expected that shale bedrock within the Burloak Drive cut can be ripped and excavated by means of conventional heavy equipment without the need for blasting. Local excavations particularly for footings, sewers, etc. may require the use of pneumatic rock breakers. Blasting of footing excavations however should not be permitted.

Based on the rock core evidence and our knowledge of the area it is estimated that groundwater seepage during construction will generally be light to moderate locally and readily controlled by pumping from temporary sumps.


Respectfully submitted,

WARNOCK HERSEY PROFESSIONAL SERVICES LTD.

B. D'Onofrio

B. D'Onofrio, P.Eng.
Assistant Manager
Geotechnical Services

BD:cc

# APPENDIX

Ministry of Transportation and Communications
Ontario

# RECORD OF BOREHOLE No 131

METRIC

W O 82-26025 LOCATION Co-Ords N 4 805 380.5; E 284 546.0 ORIGINATED BY B.D.

DIST 4 HWY GO-ALRT BOREHOLE TYPE SS Auger BxL Core COMPILED BY B.D.

DATUM Geodetic DATE 84 01 23 CHECKED BY R.S.

| SOIL PROFILE | | | SAMPLES | | | GROUND WATER CONDITIONS | ELEVATION SCALE | DYNAMIC CONE PENETRATION RESISTANCE PLOT (20 40 60 80 100) SHEAR STRENGTH ○ UNCONFINED ● QUICK TRIAXIAL + FIELD VANE × LAB VANE | PLASTIC LIMIT Wp — NATURAL MOISTURE CONTENT W — LIQUID LIMIT $W_L$ WATER CONTENT (%) | UNIT WEIGHT $\gamma$ | REMARKS & GRAIN SIZE DISTRIBUTION (%) GR SA SI CL |
|---|---|---|---|---|---|---|---|---|---|---|---|
| ELEV / DEPTH | DESCRIPTION | STRAT PLOT | NUMBER | TYPE | 'N' VALUES | | | | | | |
| 105.4 | Ground surface | | | | | | | | | | |
| 0.0 | Topsoil and silty clay (fill) | | | | | * | 105 | | | | |
| 104.5 | Soft to firm | | 1 | SS | 6 | | | | | | |
| 0.9 | Red silty clay (Cl) occ. shaley layers | | 2 | SS | 140/280mm | | 104 | | | | |
| 103.7 | Hard | | | | | | | | | | |
| 1.7 | Bedrock Queenston Formation Red shale | | 3 | SS | 150/150mm | | | | | | |
| | Weathered | | 4 | RC | Rec 96% | | 103 | | | | |
| | Sound | | | BxL | RQD 51% | | 102 | | | | |
| 101.5 | | | | | | | | | | | |
| 3.9 | End of borehole | | | | | | | | | | |

* Water level not established

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

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

OFFICE REPORT ON SOIL EXPLORATION

Ministry of Transportation and Communications
Ontario

# RECORD OF BOREHOLE No 132

METRIC

W O 82-26025 LOCATION Co-Ords N 4 805 390.6; E 284 556.2 ORIGINATED BY B.D.

DIST 4 HWY GO-ALRT BOREHOLE TYPE SS Auger BxL Core COMPILED BY B.D.

DATUM Geodetic DATE 84 01 20 CHECKED BY R.S.

| ELEV / DEPTH | DESCRIPTION | STRAT PLOT | SAMPLES NUMBER | SAMPLES TYPE | SAMPLES 'N' VALUES | GROUND WATER CONDITIONS | ELEVATION SCALE | DYNAMIC CONE PENETRATION RESISTANCE PLOT (20 40 60 80 100) / SHEAR STRENGTH (○ UNCONFINED ● QUICK TRIAXIAL + FIELD VANE × LAB VANE) | PLASTIC LIMIT Wp / NATURAL MOISTURE CONTENT W / LIQUID LIMIT WL — WATER CONTENT (%) 10 20 30 | UNIT WEIGHT γ | REMARKS & GRAIN SIZE DISTRIBUTION (%) GR SA SI CL |
|---|---|---|---|---|---|---|---|---|---|---|---|
| 105.3 | Ground surface | | | | | | 105 | | | | |
| 0.0<br>104.8 | Topsoil & silty clay (fill) | | | | | | | | | | |
| 0.5 | Red silty clay (Cl) occ. shaley layers Hard | | 1 | SS | 43 | W. L. in standpipe | 104 | 104.1 ○ | ○ | | 0 10 60 30 |
| 103.4 | | | 2 | SS | 60/ 150 mm | | | | | | |
| 1.9 | | | 3 | SS | 100/ 50 mm | | 103 | | | | |
| | | | 4 | RC BxL | Rec 100% RQD 40% | | 102 | | | | |
| | Weathered | | 5 | RC BxL | Rec 100% RQD 45% | | 101 | | | | |
| | Sound | | | | | | 100 | | | | |
| | Bedrock Queenston Formation Red shale | | 6 | RC BxL | Rec 100% RQD 72% | | 99 | | | | |
| | | | 7 | RC BxL | Rec 100% RQD 51% | | 98 | | | | |
| | Weathered Zone | | | | | | 97 | | | | |
| | | | 8 | RC BxL | Rec 100% RQD 27% | | 96 | | | | |
| | | | 9 | RC BxL | Rec 100% RQD 90% | | 95 | | | | |
| | | | | | | | 94 | | | | |
| | | | 10 | RC BxL | Rec 90% RQD 100% | | 93 | | | | |
| 92.4 | | | | | | | | | | | |
| 12.9 | End of borehole | | | | | | | | | | |

+3, ×5 : Numbers refer to Sensitivity

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

OFFICE REPORT ON SOIL EXPLORATION

Ontario Ministry of Transportation and Communications

# RECORD OF BOREHOLE No 133 METRIC

W O 82-26025 LOCATION Co-Ords N 4 805 410.6; E 284 571.3 ORIGINATED BY B.D.

DIST 4 HWY GO-ALRT BOREHOLE TYPE SS Auger BxL Core COMPILED BY B.D.

DATUM Geodetic DATE 84 01 24 CHECKED BY R.S.

| SOIL PROFILE ELEV/DEPTH | DESCRIPTION | STRAT PLOT | SAMPLES NUMBER | TYPE | 'N' VALUES | GROUND WATER CONDITIONS | ELEVATION SCALE | DYNAMIC CONE PENETRATION RESISTANCE PLOT 20 40 60 80 100 / SHEAR STRENGTH ○ UNCONFINED ● QUICK TRIAXIAL + FIELD VANE × LAB VANE | PLASTIC LIMIT Wp / NATURAL MOISTURE CONTENT W / LIQUID LIMIT $W_L$ WATER CONTENT (%) 10 20 30 | UNIT WEIGHT γ | REMARKS & GRAIN SIZE DISTRIBUTION (%) GR SA SI CL |
|---|---|---|---|---|---|---|---|---|---|---|---|
| 105.5 | Ground surface | | | | | | | | | | |
| 105.3 | Topsoil | | | | | | | | | | |
| 0.2 | Red silty clay (Cl) occ. shaley layers Stiff to hard | | 1 | SS | 19 | W.L. in standpipe 1.42 m | 105 | 103.9 | ○ | | |
| | | | 2 | SS | 55 | | 104 | | | | |
| 103.5 | | | 3 | SS | 60/ | | | | | | |
| 2.0 | Weathered | | 4 | RC BxL | Rec 100% RQD 20% | | 103 | | | | |
| | Sound | | 5 | RC BxL | Rec 98% RQD 35% | | 102 | | | | |
| | Bedrock Queenston Formation Red shale | | | | | | 101 | | | | |
| | Weathered Zone | | 6 | RC BxL | Rec 100% RQD 30% | | 100 | | | | |
| | | | 7 | RC BxL | Rec 98% RQD 63% | | 99 | | | | |
| | | | | | | | 98 | | | | |
| | | | 8 | RC BxL | Rec 100% RQD 86% | | 97 | | | | |
| 96.0 | | | | | | | | | | | |
| 9.5 | End of borehole | | | | | | | | | | |

OFFICE REPORT ON SOIL EXPLORATION

+3, ×5 : Numbers refer to Sensitivity

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

Ministry of Transportation and Communications
Ontario

# RECORD OF BOREHOLE No 134 METRIC

W O 82-26025 LOCATION Co-Ords N 4 805 398.4; E 284 526.0 ORIGINATED BY B.D.
DIST 4 HWY GO-ALRT BOREHOLE TYPE SS Auger BxL Core COMPILED BY B.D.
DATUM Geodetic DATE 84 01 23 CHECKED BY R.S.

| SOIL PROFILE ELEV/DEPTH | DESCRIPTION | STRAT PLOT | SAMPLES NUMBER | TYPE | 'N' VALUES | GROUND WATER CONDITIONS | ELEVATION SCALE | DYNAMIC CONE PENETRATION RESISTANCE PLOT 20 40 60 80 100 / SHEAR STRENGTH o UNCONFINED • QUICK TRIAXIAL + FIELD VANE × LAB VANE | PLASTIC LIMIT $W_P$ NATURAL MOISTURE CONTENT W LIQUID LIMIT $W_L$ WATER CONTENT (%) 10 20 30 | UNIT WEIGHT $\gamma$ | REMARKS & GRAIN SIZE DISTRIBUTION (%) GR SA SI CL |
|---|---|---|---|---|---|---|---|---|---|---|---|
| 105.4 | Ground Surface | | | | | | | | | | |
| 105.1 | Topsoil | | | | | * | | | | | |
| 0.3 | Red silty clay (Cl) occ. shaley layers Hard | | 1 | SS | 35 | | 105 | | | | |
| | | | 2 | SS | 130 | | 104 | | | | 0 20 65 15 |
| 103.4 | | | 3 | SS | 120/125mm | | | | | | |
| 2.0 | Weathered | | 4 | RC BxL | Rec 98% RQD 45% | | 103 | | | | |
| | Sound | | | | | | 102 | | | | |
| | Bedrock Queenston Formation Red shale | | 5 | RC BxL | Rec 100% RQD 39% | | 101 | | | | |
| 100.4 | | | | | | | | | | | |
| 5.0 | End of borehole | | | | | | | | | | |

* Water level not established

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

20
15 ⊙ 5 (%) STRAIN AT FAILURE
10

OFFICE REPORT ON SOIL EXPLORATION

Ministry of Transportation and Communications
Ontario

# RECORD OF BOREHOLE No 135

METRIC

W O 82-26025 LOCATION Co-Ords N 4 805 416.5; E 284 518.0 ORIGINATED BY B.D.

DIST 4 HWY GO-ALRT BOREHOLE TYPE SS Auger BxL Core COMPILED BY B.D.

DATUM Geodetic DATE 84 01 23 CHECKED BY R.S.

| SOIL PROFILE | | | SAMPLES | | | GROUND WATER CONDITIONS | ELEVATION SCALE | DYNAMIC CONE PENETRATION RESISTANCE PLOT (20 40 60 80 100) / SHEAR STRENGTH (○ UNCONFINED ● QUICK TRIAXIAL + FIELD VANE × LAB VANE) | PLASTIC LIMIT Wp / 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 | | | | | | |
| 105.5 | Ground surface | | | | | | | | | | |
| 105.2 | Topsoil | | | | | * | | | | | |
| 0.3 | Red silty clay (Cl) occ. shaley layers Hard | | 1 | SS | 41 | | 105 | | | | |
| | | | 2 | SS | 75 | | 104 | | | | |
| 103.5 | | | 3 | SS | 100/ 125 mm | | | | | | |
| 2.0 | Weathered | | 4 | RC BxL | Rec 98% RQD 27% | | 103 | | | | |
| | Sound | | | | | | | | | | |
| | Bedrock Queenston Formation Red shale | | 5 | RC BxL | Rec 100% RQD 69% | | 102 | | | | |
| 100.5 | | | | | | | 101 | | | | |
| 5.0 | End of borehole | | | | | | | | | | |

* Water level not established

+3, ×5 : Numbers refer to Sensitivity

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

OFFICE REPORT ON SOIL EXPLORATION

Ministry of Transportation and Communications Ontario

# RECORD OF BOREHOLE No 136

METRIC

W O 82-26025 LOCATION Co-Ords N 4 805 445.8; E 284 562.4 ORIGINATED BY B.D.

DIST 4 HWY GO-ALRT BOREHOLE TYPE SS Auger BxL Core COMPILED BY B.D.

DATUM Geodetic DATE 84 01 24 CHECKED BY R.S.

| SOIL PROFILE | | | SAMPLES | | | GROUND WATER CONDITIONS | ELEVATION SCALE | DYNAMIC CONE PENETRATION RESISTANCE PLOT (20 40 60 80 100) / SHEAR STRENGTH (○ UNCONFINED ● QUICK TRIAXIAL + FIELD VANE × LAB VANE) | PLASTIC LIMIT Wp / NATURAL MOISTURE CONTENT W / LIQUID LIMIT $W_L$ — WATER CONTENT (%) (10 20 30) | UNIT WEIGHT γ | REMARKS & GRAIN SIZE DISTRIBUTION (%) |
|---|---|---|---|---|---|---|---|---|---|---|---|
| ELEV / DEPTH | DESCRIPTION | STRAT PLOT | NUMBER | TYPE | 'N' VALUES | | | | | | GR SA SI CL |
| 105.3 | Ground surface | | | | | | | | | | |
| 105.0 | Topsoil | | | | | * | 105 | | | | |
| 0.3 | Red silty clay (Cl) occ. shaley layers Stiff to hard | | 1 | SS | 16 | | | | ○ — | | |
| 103.6 | | | 2 | SS | 85 | | 104 | | ○ | | 3 31 53 13 |
| 1.7 | Weathered | | 3 | RC BxL | Rec 99% RQD 32% | | 103 | | | | |
| | Sound | | | | | | 102 | | | | |
| 100.4 | | | 4 | RC BxL | Rec 100% RQD 33% | | 101 | | | | |
| 4.9 | End of borehole | | | | | | | | | | |

* Water level not established

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

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

OFFICE REPORT ON SOIL EXPLORATION

Ministry of Transportation and Communications
Ontario

# RECORD OF BOREHOLE No 137

METRIC

W O 82-26025 LOCATION Co-Ords N 4 805 437.5; E 284 545.0 ORIGINATED BY B.D.

DIST 4 HWY GO-ALRT BOREHOLE TYPE SS Auger BxL Core COMPILED BY B.D.

DATUM Geodetic DATE 84 01 19 CHECKED BY R.S.

| SOIL PROFILE ELEV/DEPTH | DESCRIPTION | STRAT PLOT | SAMPLES NUMBER | TYPE | 'N' VALUES | GROUND WATER CONDITIONS | ELEVATION SCALE | DYNAMIC CONE PENETRATION RESISTANCE PLOT 20 40 60 80 100 / SHEAR STRENGTH ○ 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 |
|---|---|---|---|---|---|---|---|---|---|---|---|
| 105.7 | Ground surface | | | | | | | | | | |
| 105.4 | Topsoil | | | | | | | | | | |
| 0.3 | Red silty clay (Cl) occ. shaley seams Hard | | 1 | SS | 28 | W.L. in standpipe | 105 | 104.4 | | | |
| 103.9 | | | 2 | SS | 110/28 m m | | 104 | | | | |
| 1.8 | Weathered | | 3 | SS | 80/50 mm | | | | | | |
| | Sound | | 4 | BxL | 100% | | | | | | |
| | Bedrock Queenston Formation Red shale | | 5 | RC BxL | Rec 100% RQD 34% | | 103 | | | | |
| | | | 6 | RC BxL | Rec 100% RQD 56% | | 102 | | | | |
| | Weathered Zone | | 7 | RC BxL | Rec 100% RQD 13% | | 101 | | | | |
| | | | 8 | RC BxL | Rec 100% RQD 64% | | 100 | | | | |
| | | | 9 | RC BxL | Rec 100% RQD 69% | | 99 | | | | |
| | | | 10 | RC BxL | Rec 100% RQD 100% | | 98 | | | | |
| 94.6 | | | | | | | 97 | | | | |
| | | | | | | | 96 | | | | |
| | | | | | | | 95 | | | | |
| 11.1 | End of borehole | | | | | | | | | | |

+3, x5 : Numbers refer to Sensitivity

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

OFFICE REPORT ON SOIL EXPLORATION

Ministry of Transportation and Communications Ontario

# RECORD OF BOREHOLE No 138 METRIC

W O 82-26025 LOCATION Co-Ords N 4 805 452.2; E 284 545.0 ORIGINATED BY B.D.

DIST 4 HWY GO-ALRT BOREHOLE TYPE SS Auger BxL Core COMPILED BY B.D.

DATUM Geodetic DATE 84 01 24 CHECKED BY R.S.

| SOIL PROFILE | | | SAMPLES | | | GROUND WATER CONDITIONS | ELEVATION SCALE | DYNAMIC CONE PENETRATION RESISTANCE PLOT (20 40 60 80 100) SHEAR STRENGTH: ○ UNCONFINED ● QUICK TRIAXIAL + FIELD VANE × LAB VANE | PLASTIC LIMIT Wp — NATURAL MOISTURE CONTENT W — LIQUID LIMIT $W_L$ WATER CONTENT (%) 10 20 30 | UNIT WEIGHT γ | REMARKS & GRAIN SIZE DISTRIBUTION (%) |
|---|---|---|---|---|---|---|---|---|---|---|---|
| ELEV / DEPTH | DESCRIPTION | STRAT PLOT | NUMBER | TYPE | 'N' VALUES | | | | | | GR SA SI CL |
| 105.7 | Ground surface | | | | | | | | | | |
| 105.5 | Topsoil | | | | | | | | | | |
| 0.2 | Red silty clay (Cl)<br>occ. shaley seams<br>Very stiff to hard | | 1 | SS | 25 | * | 105 | | ○ | | 0 13 68 19 |
| | | | 2 | SS | 65 | | 104 | | | | |
| 103.7 | | | 3 | SS | 145/190 mm | | | | | | |
| 2.0 | Weathered<br>Sound | | 4 | RC<br>BxL | Rec 99%<br>RQD 46% | | 103 | | | | |
| | Bedrock<br>Queenston Formation<br>Red shale | | 5 | RC<br>BxL | Rec 100%<br>RQD 42% | | 102 | | | | |
| 100.7 | Weathered Zone | | | | | | 101 | | | | |
| 5.0 | End of borehole<br><br>* Water level not established | | | | | | | | | | |

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

15 20 5 10 (%) STRAIN AT FAILURE

OFFICE REPORT ON SOIL EXPLORATION

Ontario Ministry of Transportation and Communications

# RECORD OF BOREHOLE No 139 METRIC

W O 82-26025 LOCATION Co-Ords N 4 805 424.5; E 284 582.7 ORIGINATED BY B.D.

DIST 4 HWY GO-ALRT BOREHOLE TYPE SS Auger BxL Core COMPILED BY B.D.

DATUM Geodetic DATE 84 01 25 CHECKED BY B.D.

| SOIL PROFILE | | | SAMPLES | | | GROUND WATER CONDITIONS | ELEVATION SCALE | DYNAMIC CONE PENETRATION RESISTANCE PLOT (20 40 60 80 100) / SHEAR STRENGTH (○ UNCONFINED ● QUICK TRIAXIAL + FIELD VANE × LAB VANE) | PLASTIC LIMIT Wp / NATURAL MOISTURE CONTENT W / LIQUID LIMIT WL — 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 | | | | | | |
| 105.3 | Ground surface | | | | | | | | | | |
| 0.0<br>104.8 | Topsoil and clay (fill) | | | | | * | 105 | | | | |
| 0.5 | Red silty clay (Cl)<br>Firm to hard | | 1 | SS | 12 | | | | | | |
| 103.7 | | | 2 | SS | 136/230mm | | 104 | | ○ ⊢ | | |
| 1.6 | Weathered<br>Sound | | 3 | RC<br>BxL | Rec 98%<br>RQD 43% | | 103 | | | | |
| | Bedrock<br>Queenston Formation<br>Red shale | | 4 | RC<br>BxL | Rec 100%<br>RQD 43% | | 102 | | | | |
| 100.8 | | | | | | | 101 | | | | |
| 4.5 | End of borehole<br><br>* Water level not established | | | | | | | | | | |

OFFICE REPORT ON SOIL EXPLORATION

+3, ×5 : Numbers refer to Sensitivity

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

# RECORD OF BOREHOLE No 3 (Done by GEOCON INC) METRIC

W O 82-26025 LOCATION Co-Ords N 4 805 419.5; E 284 531.2 ORIGINATED BY B.D.

DIST 4 HWY GO-ALRT BOREHOLE TYPE St Auger + BQ COMPILED BY B.D.

DATUM Geodetic DATE 84 01 19 CHECKED BY R.S.

| SOIL PROFILE | | | SAMPLES | | | GROUND WATER CONDITIONS | ELEVATION SCALE | DYNAMIC CONE PENETRATION RESISTANCE PLOT (20 40 60 80 100) SHEAR STRENGTH: o UNCONFINED, • QUICK TRIAXIAL, + FIELD VANE, × 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 | | | | | | |
| 105.4 | Ground surface | | | | | | | | | | |
| 105.1 | Topsoil | | | | | * | 105 | | | | |
| 0.3 | Red silty clay (Cl) occ. shaley layers | | | | | | | | | | |
| 104.1 | Hard | | 1 | SS | 34 | | 104 | | | | |
| 1.3 | Weathered | | 2 | SS | 53/130 mm | | 103 | | | | |
| | Sound | | | | | | | | | | |
| | Bedrock Queenston Formation Red shale | | 3 | RC BxL | Rec 88% RQD 82% | | 102 | | | | |
| | | | 4 | RC BxL | Rec 100% RQD 80% | | 101 | | | | |
| | | | | | | | 100 | | | | |
| | | | 5 | RC BxL | Rec 83% RQD 72% | | 99 | | | | |
| | | | | | | | 98 | | | | |
| | | | 6 | RC BxL | Rec 78% RQD 78% | | 97 | | | | |
| 96.2 | | | | | | | | | | | |
| 9.2 | End of borehole | | | | | | | | | | |

* Water level not established

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

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

OFFICE REPORT ON SOIL EXPLORATION

TABLE 1

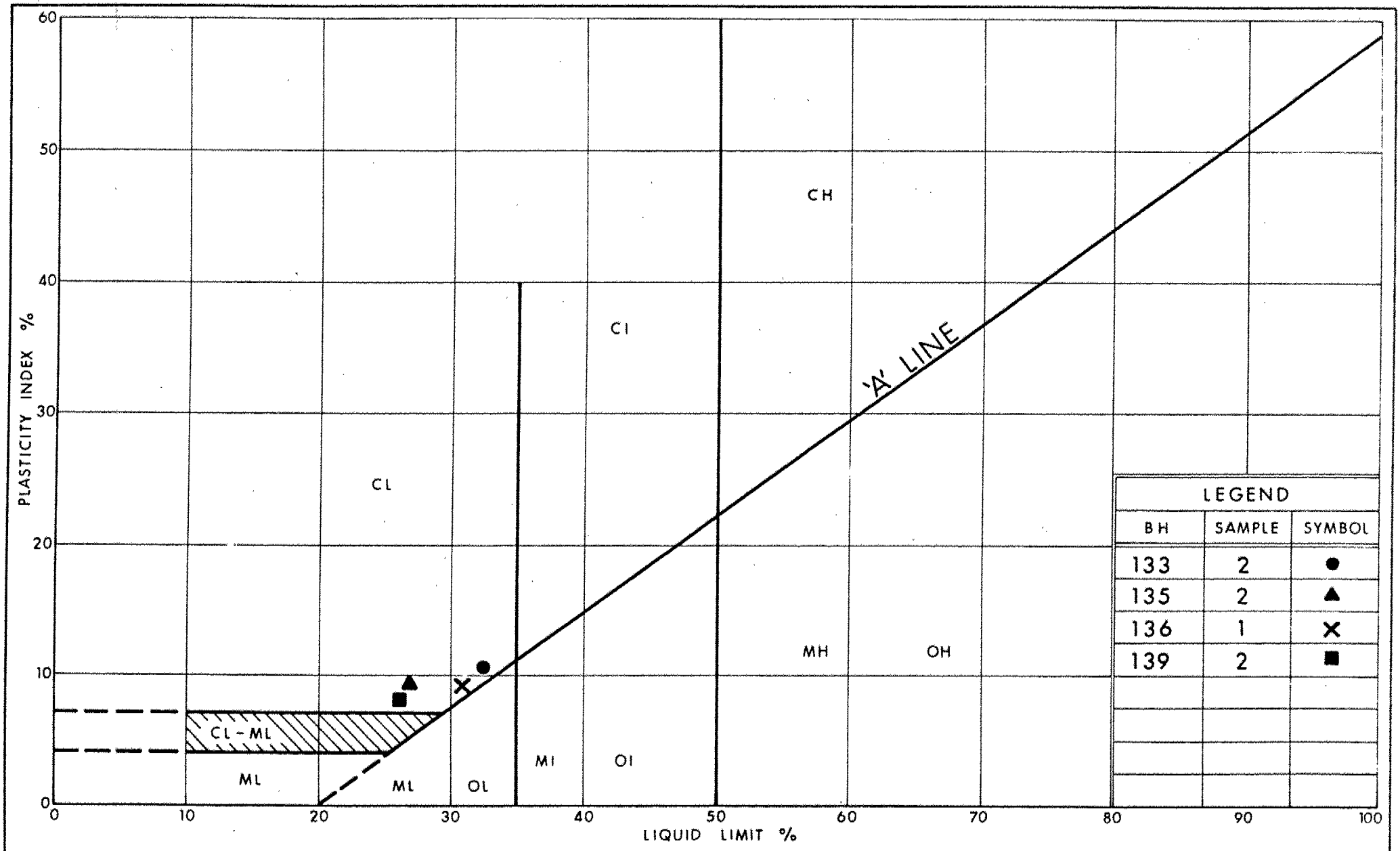
DESCRIPTION OF ROCK CORE - BURLOAK DRIVE

| BOREHOLE NUMBER | CORE RECOVERY | | | CORE DESCRIPTION | |
|---|---|---|---|---|---|
| | DEPTH (m) | % | RQD | DEPTH (m) | DESCRIPTION |
| 131 | 2.3 - 3.9 | 96 | 51 | 2.3 - 2.9 | Shale, red (Queenston Fm), moderately weathered |
| | | | | 2.9 - 3.9 | Shale, red (Queenston Fm), slightly weathered to sound |
| 132 | 2.3 - 3.9 | 100 | 40 | 2.3 - 2.9 | Shale, red (Queenston Fm), highly weathered |
| | 3.9 - 5.4 | 100 | 45 | 2.9 - 4.2 | Shale, red (Queenston Fm), slightly weathered |
| | 5.4 - 6.8 | 100 | 72 | | |
| | 6.8 - 8.4 | 98 | 51 | 4.2 - 7.6 | Shale, red (Queenston Fm), sound |
| | 8.4 - 9.8 | 100 | 27 | 7.6 - 8.5 | Shale, red (Queenston Fm), moderately weathered |
| | 9.8 - 11.4 | 100 | 90 | | |
| | 11.4 - 12.9 | 90 | 100 | 8.5 - 12.9 | Shale, red (Queenston Fm), sound |
| 133 | 2.0 - 3.5 | 100 | 20 | 2.0 - 3.4 | Shale, red (Queenston Fm), highly to moderately weathered |
| | 3.5 - 5.0 | 98 | 35 | 3.4 - 3.7 | Shale, red (Queenston Fm), slightly weathered |
| | 5.0 - 6.4 | 100 | 30 | | |
| | 6.4 - 7.9 | 98 | 63 | 4.5 - 9.5 | Shale, red (Queenston Fm), sound |
| | 7.9 - 9.5 | 100 | 86 | 5.5 - 5.7 | Shale, red (Queenston Fm), moderately weathered layer |
| 134 | 2.0 - 3.5 | 98 | 45 | 2.0 - 3.0 | Shale, red (Queenston Fm), moderate to slightly weathered |
| | 3.5 - 5.0 | 100 | 39 | 3.0 - 5.0 | Shale, red (Queenston Fm), sound |
| 135 | 2.0 - 3.5 | 98 | 27 | 2.0 - 3.2 | Shale, red (Queenston Fm), moderate to slightly weathered |
| | 3.5 - 5.0 | 100 | 69 | 3.2 - 5.0 | Shale, red (Queenston Fm), sound |

TABLE 1 - Continued

DESCRIPTION OF ROCK CORE - BURLOAK DRIVE

| BOREHOLE NUMBER | CORE RECOVERY | | | CORE DESCRIPTION | |
|---|---|---|---|---|---|
| | DEPTH (m) | % | RQD | DEPTH (m) | DESCRIPTION |
| 136 | 1.8 - 3.3 | 79 | 32 | 1.8 - 2.7 | Shale, red (Queenston Fm), moderate to lightly weathered |
| | 3.3 - 4.9 | 100 | 33 | | Shale, red (Queenston Fm), sound |
| 137 | 2.3 - 2.5 | 100 | 0 | 2.3 - 2.5 | Shale, red (Queenston Fm), highly weathered |
| | 2.5 - 3.9 | 100 | 34 | 2.5 - 5.7 | Shale, red (Queenston Fm), sound |
| | 3.9 - 5.4 | 100 | 56 | | |
| | 5.4 - 6.9 | 100 | 13 | 5.7 - 6.4 | Shale, red (Queenston Fm), moderately weathered |
| | 6.9 - 8.4 | 100 | 64 | | |
| | 8.4 - 9.9 | 100 | 69 | 6.4 - 11.1 | Shale, red (Queenston Fm), sound |
| | 9.9 - 11.1 | 100 | 100 | | |
| 138 | 2.0 - 3.5 | 99 | 46 | 2.0 - 3.2 | Shale, red (Queenston Fm), moderate to lightly weathered |
| | 3.5 - 5.0 | 100 | 42 | 3.2 - 4.5 | Shale, red (Queenston Fm), slightly weathered to sound |
| | | | | 4.5 - 5.0 | Shale, red (Queenston Fm), moderately weathered |
| 139 | 1.7 - 3.0 | 98 | 43 | 1.7 - 2.6 | Shale, red (Queenston Fm), moderate to slightly weathered |
| | 3.0 - 4.5 | 100 | 72 | 2.6 - 4.5 | Shale, red (Queenston Fm), sound |
| Geocon 3 | 3.0 - 4.6 | 88 | 82 | 3.0 - 9.2 | Shale, red (Queenston Fm), sound |
| | 4.6 - 6.1 | 100 | 80 | | |
| | 6.7 - 7.6 | 98 | 72 | | |
| | 7.6 - 7.2 | 78 | 78 | | |

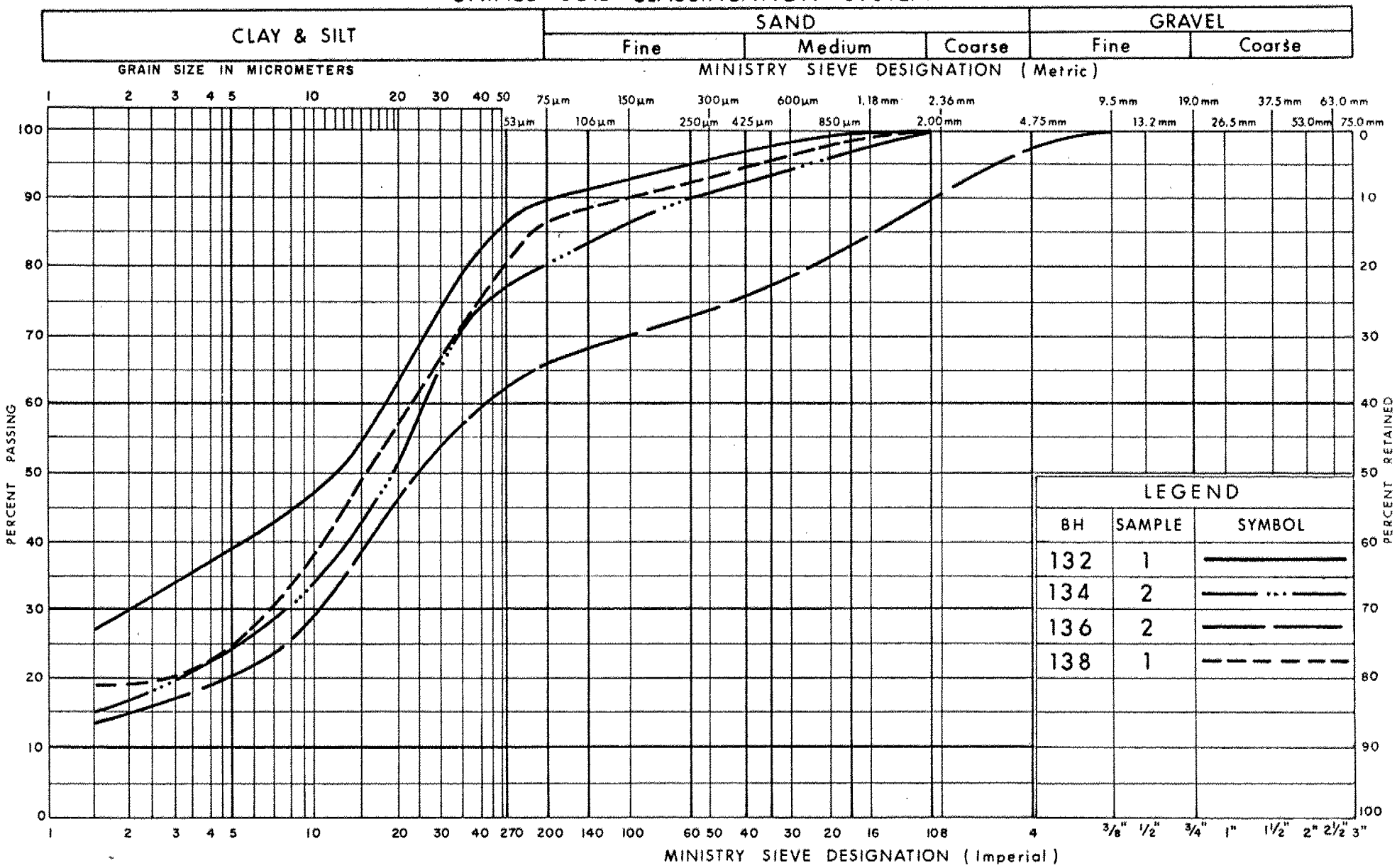



Ministry of Transportation and Communications
Ontario

# PLASTICITY CHART
## SILTY CLAY

FIG No 1
WO 82-26025

# UNIFIED SOIL CLASSIFICATION SYSTEM




Ministry of Transportation and Communications
Ontario

## GRAIN SIZE DISTRIBUTION
## SILTY CLAY

FIG No 2
WO 82-26025

# EXPLANATION OF TERMS USED IN REPORT

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

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

SOILS ARE DESCRIBED BY THEIR COMPOSITION AND CONSISTENCY OR DENSENESS.

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

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

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

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

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

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

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

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

JOINTING AND BEDDING:

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

# ABBREVIATIONS AND SYMBOLS

## FIELD SAMPLING

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

## STRESS AND STRAIN

| | | |
|---|---|---|
| $u_w$ | kPa | PORE WATER PRESSURE |
| $r_u$ | 1 | PORE PRESSURE RATIO |
| $\sigma$ | 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 |

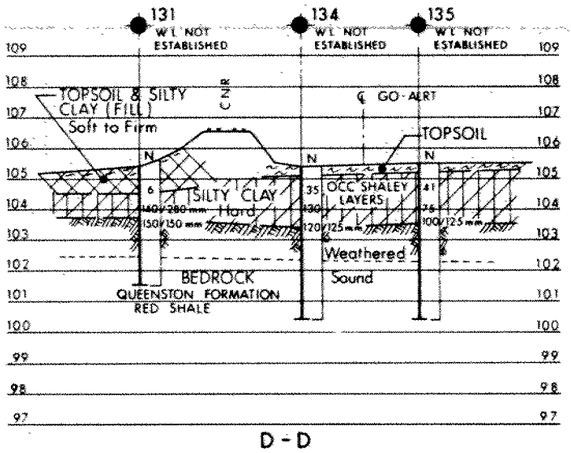
## MECHANICAL PROPERTIES OF SOIL

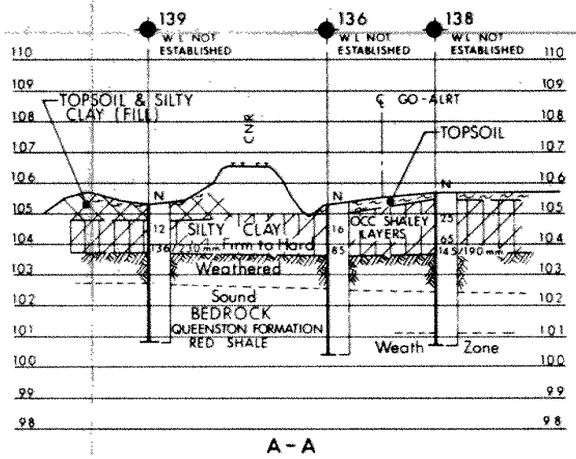
| | | |
|---|---|---|
| $m_v$ | $kPa^{-1}$ | COEFFICIENT OF VOLUME CHANGE |
| $C_c$ | 1 | COMPRESSION INDEX |
| $C_s$ | 1 | SWELLING INDEX |
| $C_\alpha$ | 1 | RATE OF SECONDARY CONSOLIDATION |
| $c_v$ | $m^2/s$ | COEFFICIENT OF CONSOLIDATION |
| H | m | DRAINAGE PATH |
| $T_v$ | 1 | TIME FACTOR |
| 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 = $\frac{c_u}{\tau_r}$ |

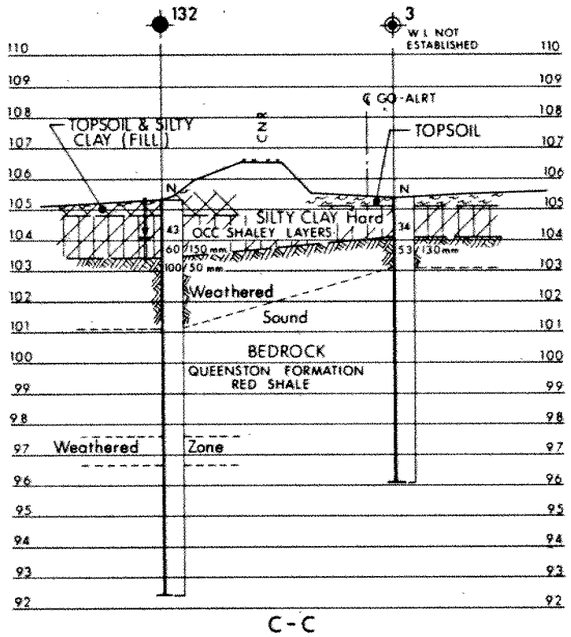
## PHYSICAL PROPERTIES OF SOIL

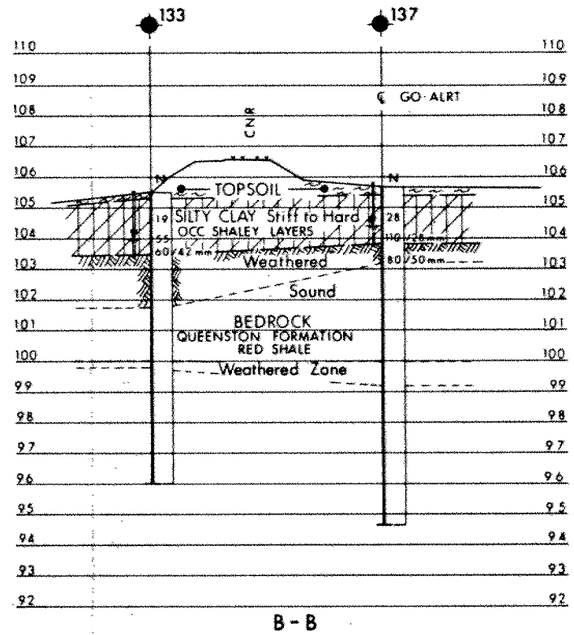
| | | |
|---|---|---|
| $\rho_s$ | $kg/m^3$ | DENSITY OF SOLID PARTICLES |
| $\gamma_s$ | $kN/m^3$ | UNIT WEIGHT OF SOLID PARTICLES |
| $\rho_w$ | $kg/m^3$ | DENSITY OF WATER |
| $\gamma_w$ | $kN/m^3$ | UNIT WEIGHT OF WATER |
| $\rho$ | $kg/m^3$ | DENSITY OF SOIL |
| $\gamma$ | $kN/m^3$ | UNIT WEIGHT 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 |



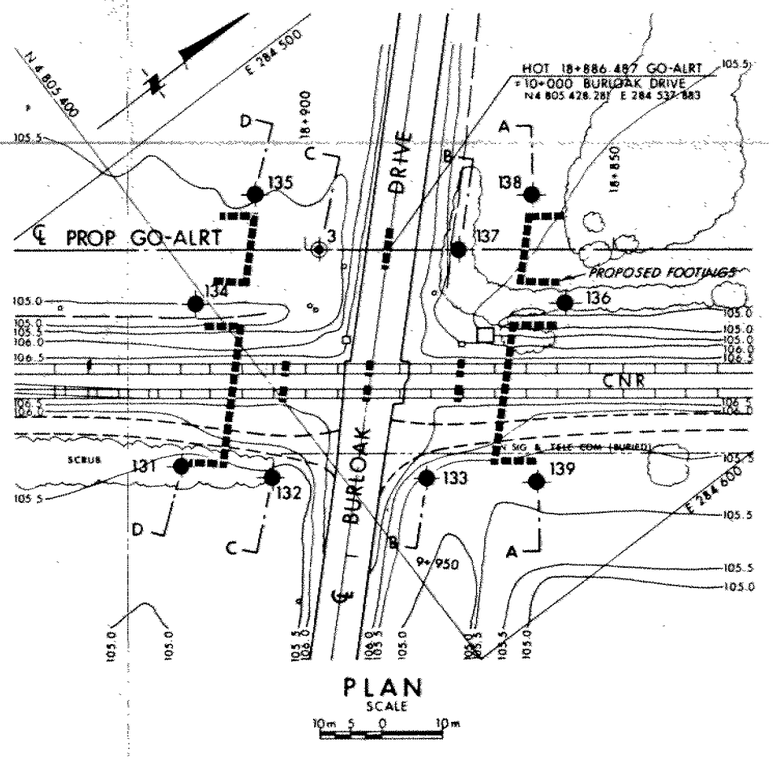



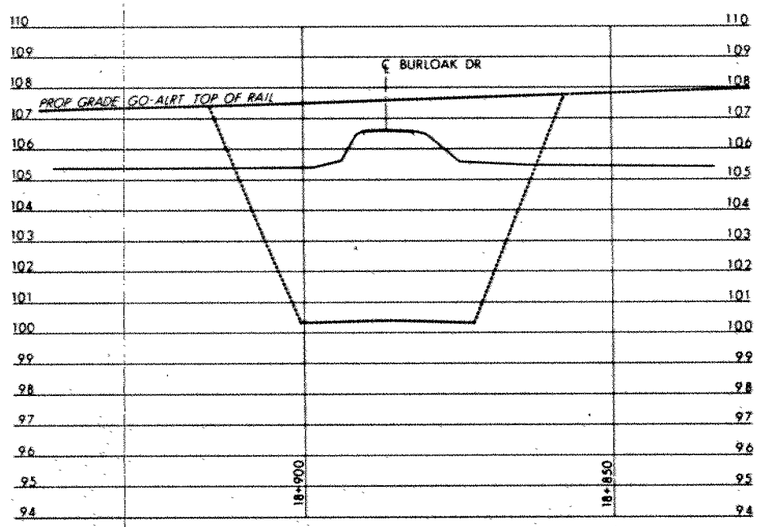




## SECTIONS

SCALE
10m 5 0 10 m Hor
2 1 0 2 m Vert



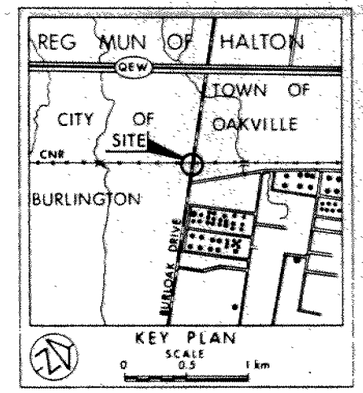




## ℄ PROFILE GO-ALRT

SCALE
10m 5 0 10m Hor
2m 1 0 2m Vert

METRIC

ALL DIMENSIONS SHOWN ARE IN METRES AND/OR MILLIMETRES UNLESS OTHERWISE NOTED.




### 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 84 01
  W.L. Not Established in Bore Holes 131, 134, 135, 136, 138, 139 and 3
- Bore Hole done by Geocon Inc 84 01 19
- W.L. in Standpipe

| No | ELEVATION | CO-ORDINATES NORTH | EAST |
|---|---|---|---|
| 131 | 105.4 | 4 805 380.5 | 284 546.0 |
| 132 | 105.3 | 4 805 390.6 | 284 556.2 |
| 133 | 105.5 | 4 805 410.6 | 284 571.3 |
| 134 | 105.4 | 4 805 398.4 | 284 526.0 |
| 135 | 105.5 | 4 805 416.5 | 284 518.0 |
| 136 | 105.3 | 4 805 445.8 | 284 562.4 |
| 137 | 105.7 | 4 805 437.5 | 284 545.0 |
| 138 | 105.7 | 4 805 452.2 | 284 545.0 |
| 139 | 105.3 | 4 805 424.5 | 284 582.7 |
| 3 | 105.4 | 4 805 419.5 | 284 531.2 |

Geocres No

**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.

GO-ALRT REF PD 2-300-1

| REFERENCE DRAWINGS | | REVISIONS | | |
|---|---|---|---|---|
| | | | | |

| DRAWN BY: J.T. 84 02 17 | DESIGNED BY: B.D. |
|---|---|
| CHK'D BY: B.D. | APPROVED BY: |
| SCALE: AS SHOWN | FULL SIZE ONLY |

REGISTERED PROFESSIONAL ENGINEER B. D'ONOFRIO PROVINCE OF ONTARIO

WARNOCK HERSEY PROFESSIONAL SERVICES LTD

GO-ALRT
Ministry of Transportation and Communications
OAKVILLE PROJECT-WEST EXTENSION
PROJECT MANAGER

HALTON REGION
BURLOAK DRIVE SUBWAY
BORE HOLE LOCATIONS & SOIL STRATA
STA 18+886.487

| CONTRACT NO | DWG NO | REV | SHEET |
|---|---|---|---|
| | | | |