DOCUMENT MICROFILMING IDENTIFICATION

G.I.-30 SEPT. 1976

GEOCRES No. 40P6-17

DIST. 3 REGION

W.P. No. 259-88-01

CONT. No. 92-11

W. O. No.

STR. SITE No. 25-352

HWY. No. 8

LOCATION Hwy 8, 5 km E of Mitchell S.S.M.P. Arch Replacement

No OF PAGES -

OVERSIZE DRAWINGS TO BE INCLUDED WITH THIS REPORT.

REMARKS:

FILE

Ministry
of
Transportation
Ontario

FOUNDATION DESIGN SECTION

foundation investigation and design report

ENGINEERING MATERIALS OFFICE
FOUNDATION DESIGN SECTION

WP 259-88-01 DIST 3

HWY 8 STR SITE 25-352

Thiel Field Drain No. 4
Culvert Replacement

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GEOCRES 40P6-17

DATE JUN 18 1990

FOUNDATION INVESTIGATION REPORT
For
Thiel Field Drain No. 4
Culvert Replacement
W.P. 259-88-01, Site 25-352
Highway 8, District 3, Stratford

INTRODUCTION

This report contains the results of a site investigation carried out at the above mentioned site to provide information for the design and construction of the proposed replacement culvert.

The field work for this project was carried out on 90 03 05 & 06, and comprised of two sampled boreholes and Dynamic Cone Penetration Test adjacent to these boreholes.

Boreholes were advanced to a maximum depth of 14.0 m below the existing Highway 8 shoulder level (El. 334.8 m) using continuous flight solid stem auger.

SITE DESCRIPTION

The site under investigation is located about 5 km east of Mitchel along Hwy. 8 at the boundary of Fullarton Township and Logan Township.

The topography of the site is generally flat and the stretch of Hwy. 8 between Mitchel and Stratford is located in part of the Physiographic region known as the "Stratford Till Plain", which is crossed by several till moraines. The till in this area is described as being a fairly uniform brown calcareous silty clay, probably a good deal of it coming from previously deposited varved clays of the Lake Huron basin. In addition, the silt and clay contents vary within certain limits and so does the stoniness.

The existing culvert is about 29.2 m long structural steel pipe-arch of 5.1 m span and 3.1 m rise. The culvert is temporarily supported at the crown to avoid further distress.

SUBSURFACE CONDITIONS

The underlying subsoil at this site consists of embankment fill underlain by natural soil composed of clayey silt which overlies glacial deposit. As indicated in the geological history of the area, the clayey silt deposit encountered on top is apparently of lacustrine formation. For classification purposes, the soils encountered at this site can be divided in to three different zones:

a) Layers of sand & silt (Fill)
b) Clayey Silt
c) Heterogeneous Mixture of Gravel, Sand, Silt and Clay (Glacial Till)

The soils encountered during the course of the investigation, together with the field and laboratory test results are shown on the Record of Borehole sheets contained in the Appendix of this report. A stratigraphical profile is shown on Drawing No. 2598801-A. This drawing also shows the locations and elevations of the borings. Description of the strata encountered are given below.

Layers of Sand & Silt (Fill)

This fill which was placed to raise the finished grade of the Hwy. 8 consists of 1.3 m to 2.1 m of sand (Granular "A" or "B"). The Standard Penetration Test results indicate that this granular fill is in a compact state of compaction.

The granular material is underlain by 1.3 m to 1.6 m of fill containing silt and organic silt with varying proportions of sand and clay. The Standard Penetration Test Values in this fill varies over a wide range (8 blows/30 cm to 53 blows/30 cm).

Clayey Silt

The embankment fill is underlain by this deposit. The thickness of this clayey silt deposit is observed to be in the range of 5.6 m to 5.8 m and

extends to elevation 340.1 to 339.7 m. The Grain Size Distribution Test carried out on representative soil samples are shown on Figure 1 in an envelope form. The results of the Atterberg Limit Tests are shown on Figure 2.

The natural moisture content of this clay deposit varies from 10.5% to 24% with an average value of 15.4%. The Standard Penetration Test results vary from 19 blows/30 cm to 41 blows/30 cm with an average value of 30 blows/30 cm. This layer was observed to be in very stiff to hard consistency, however, the upper 0.8 m was observed to be firm.

Heterogeneous Mixture of Gravel, Sand, Silt & Clay (Glacial Till)

The clayey silt layer is underlain by a cohesive glacial till deposit. The Grain Size Distribution Test results are shown on Figure 3 in an envelope form. These results indicate 15% to 25% clay, 41% to 47% silt, 18% to 34% sand and 8% to 14% gravel. The Standard Penetration Test results of this deposit vary from 53 blows/30 cm to over 100 blows/30 cm indicating hard consistency. This deposit extends to the depth probed (i.e. elevation 334.8), however the full extent of this glacial deposit was not proven.

Groundwater Conditions

The stabilized ground water level was observed at or near the drainage channel water level (El. 345.0 m). Seasonal fluctuation of the ground water level may be expected. The ground water elevation at each borehole location is as follows:

Borehole No.	Elevation
1	345.05
2	345.05

DISCUSSION AND RECOMMENDATIONS

It is proposed to replace the existing structure with a (open type or box) concrete culvert of 5.0 m span. The proposed road profile grade is set at El. 349.0 m which is same as the existing grade. The invert level of the existing culvert is around El. 344.7 m. However, the proposed invert or floor level of the culvert is not available.

Structure Foundation

Considering the subsoil conditions at this site, if the foundation for the culvert is constructed at a level not higher than El. 344.5 m, an allowable bearing pressure of 300 kPa may be assumed for the design.

For the purpose of the O.H.B.D.C., the following bearing capacity values are recommended:

Factored Bearing Capacity at U.L.S.	600 kPa
Bearing Capacity at S.L.S. Type II	300 kPa

The granular backfill requirements should be as outlined on current MTO Standards. The Granular "A" or "B" backfill should be in accordance with the Current MTO Standards. The following parameters are recommended for the granular backfill.

	Granular "A"	Granular "B"
Angle of Internal Friction	$\phi = 35°$	$\phi = 30°$
Unit Weight (kN/m^3)	$\gamma = 22.8$	$\gamma = 21.2$

The earth pressure should be computed as per Section 6.1.2.2. of the O.H.B.D.C. assuming "at rest" condition.

Other Considerations

The backfill operations should be carried out simultaneously on both sides of the proposed culvert. Compaction of the backfill should adhere to the Ministry Directive B-131.

The concrete for the culvert foundation should be placed in the dry base condition. During construction, if the bottom slab or foundation of the culvert is located below the ground water level, a dewatering scheme will be required. Steps should be taken to prevent any surface water flow in to the excavations. The base of the excavation at the foundation level should be covered with a 150 mm thick lean concrete pad within 8 hours of exposure.

Since no boring was carried out in the drain bed, any silt or spongy areas observed in the channel bed should be removed and backfilled with well compacted granular material.

The frost protection requirements in this area is in the order of 1.5 m of earth cover.

MISCELLANEOUS

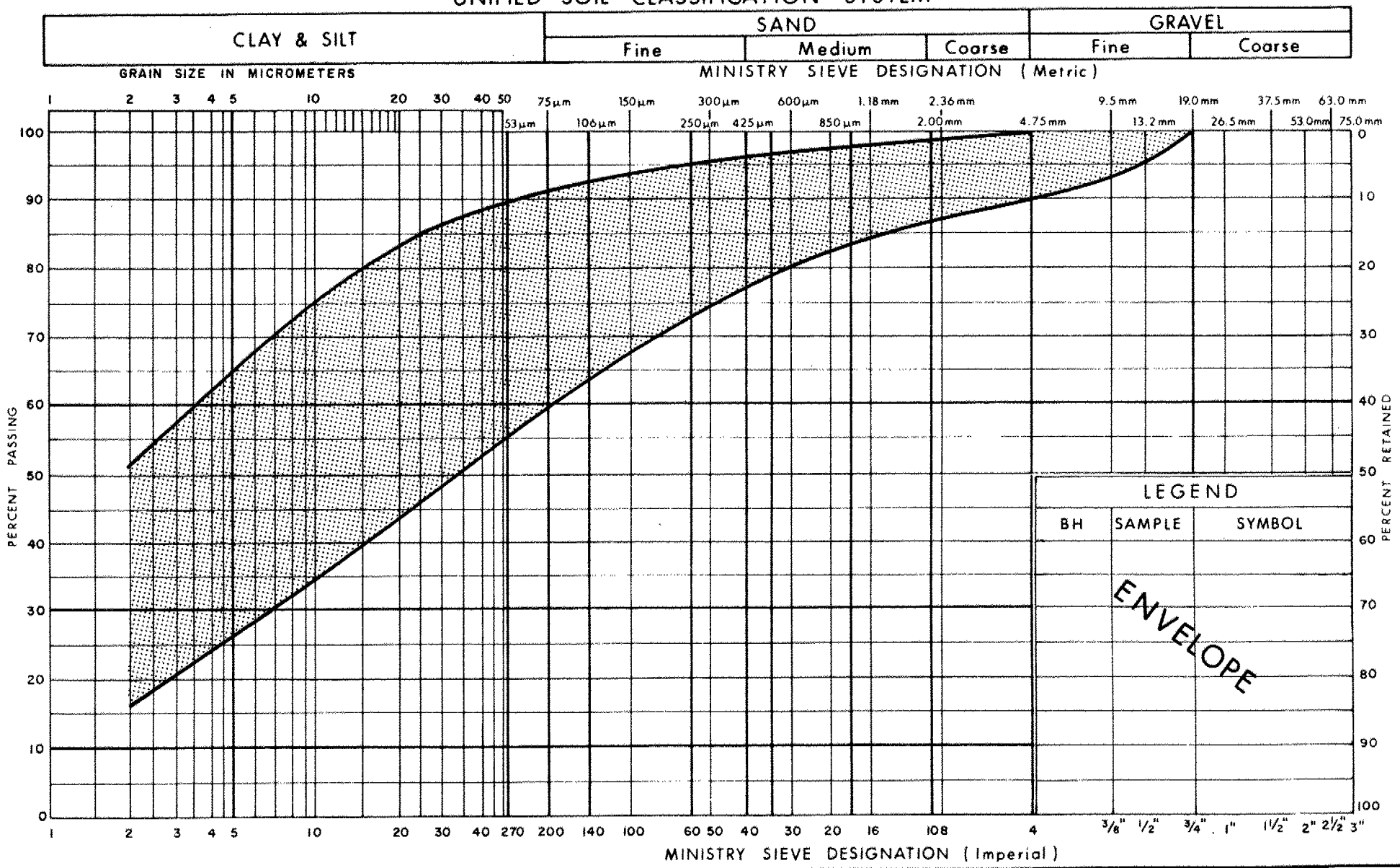
The field work for this investigation was carried out under the supervision of Mr. R. Cheung. The equipment was owned and operated by London Soil Test. This report was prepared by Mr. M. Vasavithasan, reviewed by Mr. P. Payer, Senior Foundation Engineer and approved by Mr. M. Devata, Chief Foundation Engineer.

M. Vasavithasan, P.Eng.
Foundation Engineer

M. Devata, P.Eng.
Chief Foundation Engineer

APPENDIX

UNIFIED SOIL CLASSIFICATION SYSTEM



Ministry of Transportation
Ontario

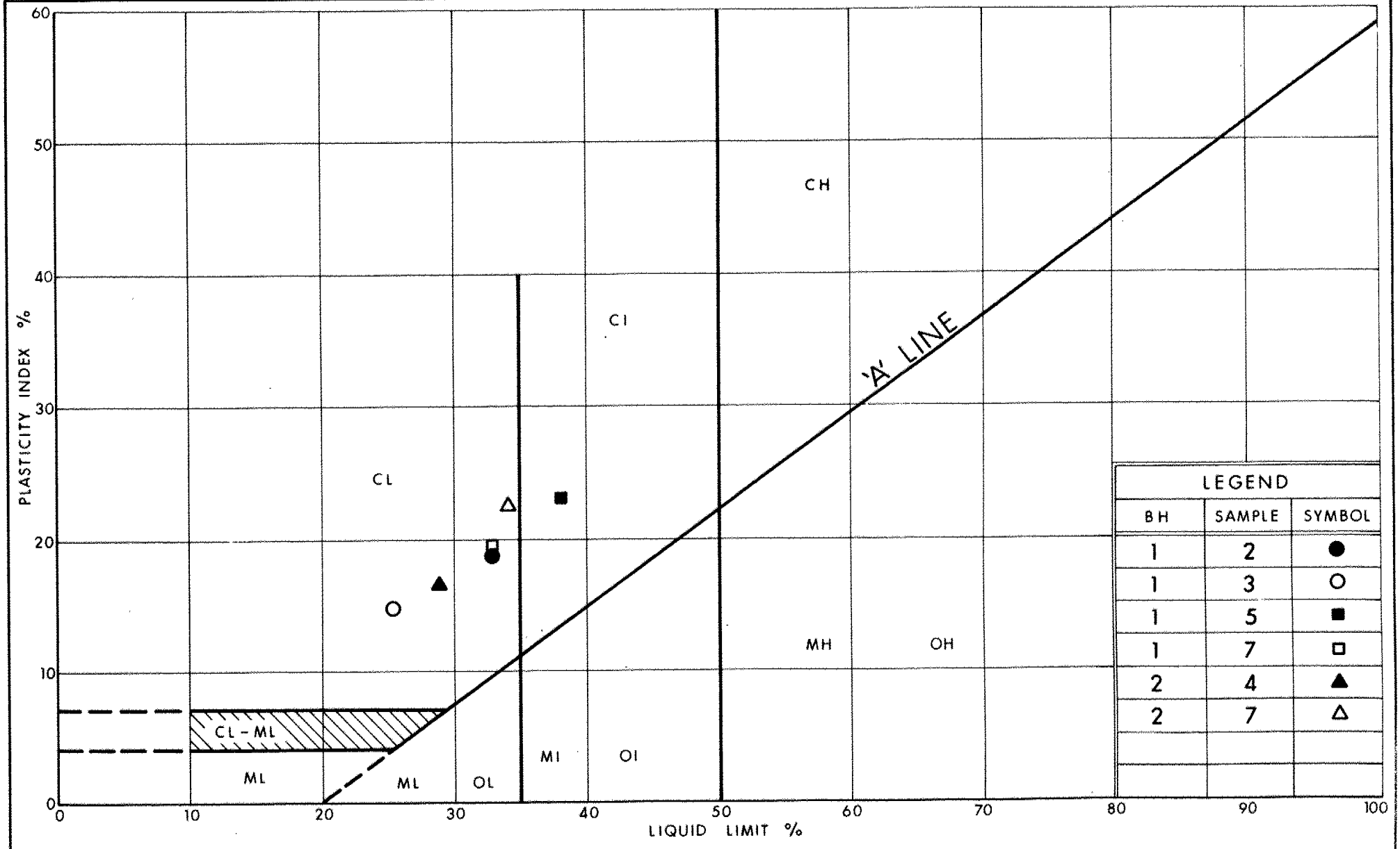
GRAIN SIZE DISTRIBUTION

CLAYEY SILT, SOME SAND, TRACE OF GRAVEL

FIG No 1

WP 259-88-01

Oct 75, FF-S-21



Ministry of Transportation
Ontario

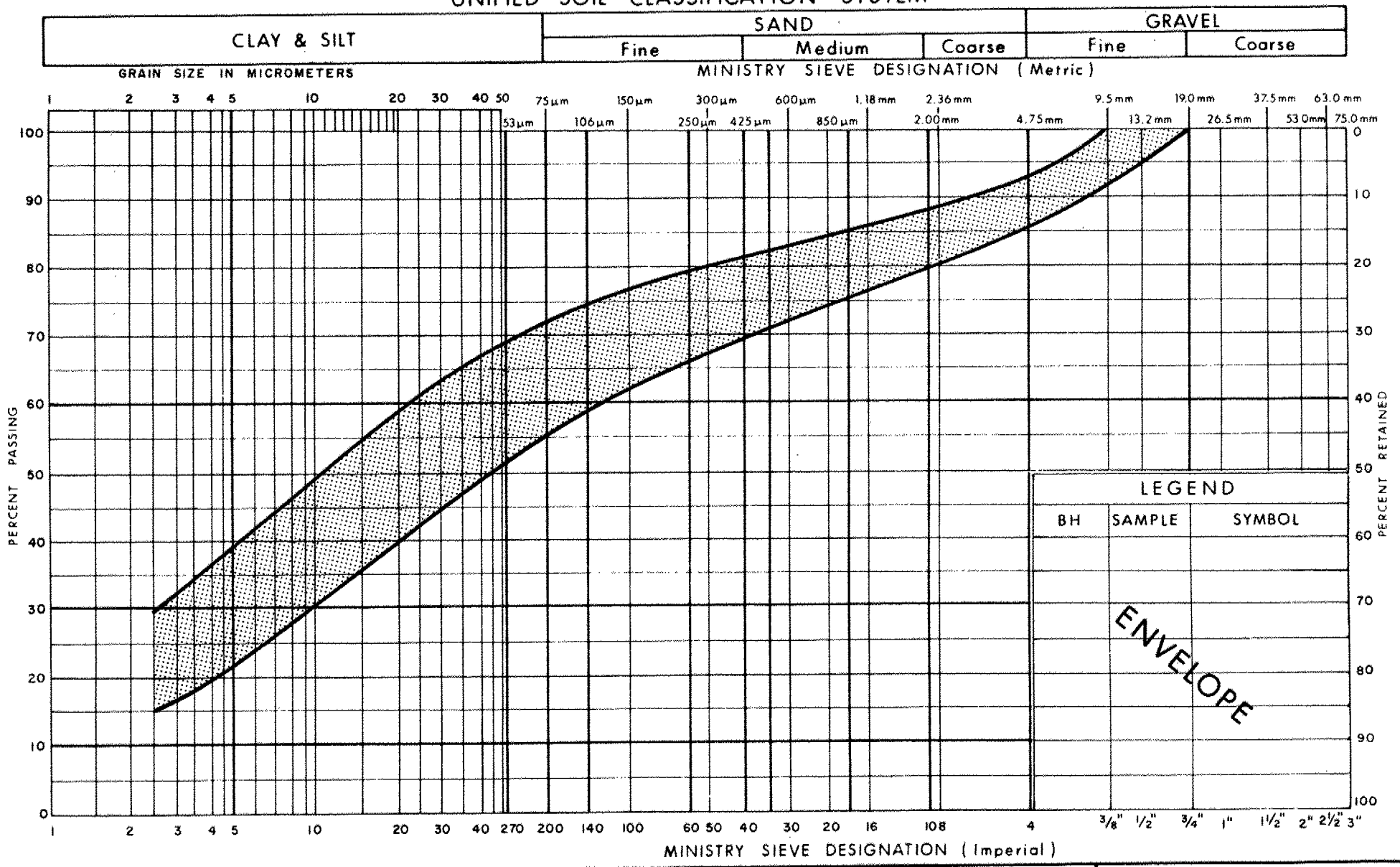
PLASTICITY CHART

CLAYEY SILT, SOME SAND, TRACE OF GRAVEL

FIG No 2

W P 259-88-01

UNIFIED SOIL CLASSIFICATION SYSTEM



Ministry of Transportation
Ontario

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

FIG No 3
W P 259-88-01

EXPLANATION OF TERMS USED IN REPORT

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

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

SOILS ARE DESCRIBED BY THEIR COMPOSITION AND CONSISTENCY OR DENSENESS

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

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

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

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

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

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

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

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

JOINTING AND BEDDING:

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

ABBREVIATIONS AND SYMBOLS

FIELD SAMPLING

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

STRESS AND STRAIN

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

MECHANICAL PROPERTIES OF SOIL

m_v	kPa^{-1}	COEFFICIENT OF VOLUME CHANGE
C_c	1	COMPRESSION INDEX
C_s	1	SWELLING INDEX
C_α	1	RATE OF SECONDARY CONSOLIDATION
c_v	m^2/s	COEFFICIENT OF CONSOLIDATION
H	m	DRAINAGE PATH
T_v	1	TIME FACTOR
U	%	DEGREE OF CONSOLIDATION
σ'_{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_t	1	SENSITIVITY = $\frac{c_u}{\tau_r}$

PHYSICAL PROPERTIES OF SOIL

ρ_s	kg/m^3	DENSITY OF SOLID PARTICLES
γ_s	kN/m^3	UNIT WEIGHT OF SOLID PARTICLES
ρ_w	kg/m^3	DENSITY OF WATER
γ_w	kN/m^3	UNIT WEIGHT OF WATER
ρ	kg/m^3	DENSITY OF SOIL
γ	kN/m^3	UNIT WEIGHT OF SOIL
ρ_d	kg/m^3	DENSITY OF DRY SOIL
γ_d	kN/m^3	UNIT WEIGHT OF DRY SOIL
ρ_{sat}	kg/m^3	DENSITY OF SATURATED SOIL
γ_{sat}	kN/m^3	UNIT WEIGHT OF SATURATED SOIL
ρ'	kg/m^3	DENSITY OF SUBMERGED SOIL
γ'	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

RECORD OF BOREHOLE No 1 — 1 OF 1 — METRIC

W.P 259 - 88 - 01 | LOCATION STA. 23 + 898.9; O/S 5.8m LT. CL. HWY. 8 | ORIGINATED BY R. C

DIST 3 | HWY 8 | BOREHOLE TYPE CONTINUOUS FLIGHT SOLID STEM AUGER & CONE TEST | COMPILED BY M. V

DATUM GEODETIC | DATE 90 03 05 | CHECKED BY P. P

ELEV / DEPTH	DESCRIPTION	NUMBER	TYPE	'N' VALUES	GROUND WATER CONDITIONS	ELEVATION SCALE	UNIT WEIGHT kN/m³	REMARKS & GRAIN SIZE DISTRIBUTION (%) GR SA SI CL
348.8	Highway #8 Shoulder							
0.0	Sand, With/Some Gravel and Cobbles, Trace of Silt, Compact to Loose (Fill)							
347.5								
1.3	Silt, Some Sand and Clay, Trace of Gravel, Dense to Compact (Fill)	1	SS	53				
345.9								
2.9	Firm	2	SS	7	▼			1 20 50 29
	Clayey Silt, Some Sand, Trace of Gravel, Very Stiff to Hard	3	SS	41				2 12 51 35
		4	SS	29				
		5	SS	19				7 6 37 50
		6	SS	29				
		7	SS	25				3 10 38 49
340.1		8	SS	68				
8.7	Heterogeneous Mixture of Gravel, Sand, Silt And Clay, Very Dense (Glacial Till)	9	SS	53				10 18 47 25
		10	SS	60 /8cm				
		11	SS	62 /8cm				
334.8			SS	61 /13cm				
14.0	End of Borehole							

DYNAMIC CONE PENETRATION RESISTANCE PLOT — 20 40 60 80 100

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

PLASTIC LIMIT w_P — NATURAL MOISTURE CONTENT w — LIQUID LIMIT w_L

WATER CONTENT (%) — 10 20 30

AUGER

120/23cm

+³, ×⁵ : Numbers refer to Sensitivity

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

RECORD OF BOREHOLE No 2 1 OF 1 METRIC

W.P 259 - 88 - 01 LOCATION STA. 23 + 921.7; O/S 5.2m RT. CL. HWY. 8 ORIGINATED BY R. C

DIST 3 HWY 8 BOREHOLE TYPE CONTINUOUS FLIGHT SOLID STEM AUGER & CONE TEST COMPILED BY M. V

DATUM GEODETIC DATE 90 03 05 & 6 CHECKED BY P. P

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 kPa (o UNCONFINED, + FIELD VANE, • QUICK TRIAXIAL, × LAB VANE) (20 40 60 80 100)	PLASTIC LIMIT w_P / NATURAL MOISTURE CONTENT w / LIQUID LIMIT w_L — WATER CONTENT (%) (10 20 30)	UNIT WEIGHT γ kN/m^3	REMARKS & GRAIN SIZE DISTRIBUTION (%) GR SA SI CL
348.7	Highway #8 Shoulder										
0.0	Sand, With/Some Gravel, Some/Trace Silt, Compact to Loose (Fill)		1	SS	9		348	AUGER			
346.6							347				
2.1	Organic Silt, Some Sand, Firm		2	SS	8		346		46.5		0 23 63 14
345.3							345				
3.4	Clayey Silt, Some Sand, Trace of Gravel, Very Stiff to Hard		3	SS	39	▼	344				
			4	SS	31		343				1 19 55 25
			5	SS	27		342				
			6	SS	25						
			7	SS	38		341				11 30 34 25
339.7			8	SS	34		340				
9.0	Heterogeneous Mixture of Gravel, Sand, Silt And Clay, Very Dense (Glacial Till)		9	SS	62	/5cm	339				
			10	SS	112	/23cm					8 34 42 16
			11	SS	60	/5cm	338				
							337				
335.5			12	SS	61	/13cm	336				14 30 41 15
13.2	End of Borehole										

+3, ×5 : Numbers refer to Sensitivity

20
15 ◇ 5 (%) STRAIN AT FAILURE
10

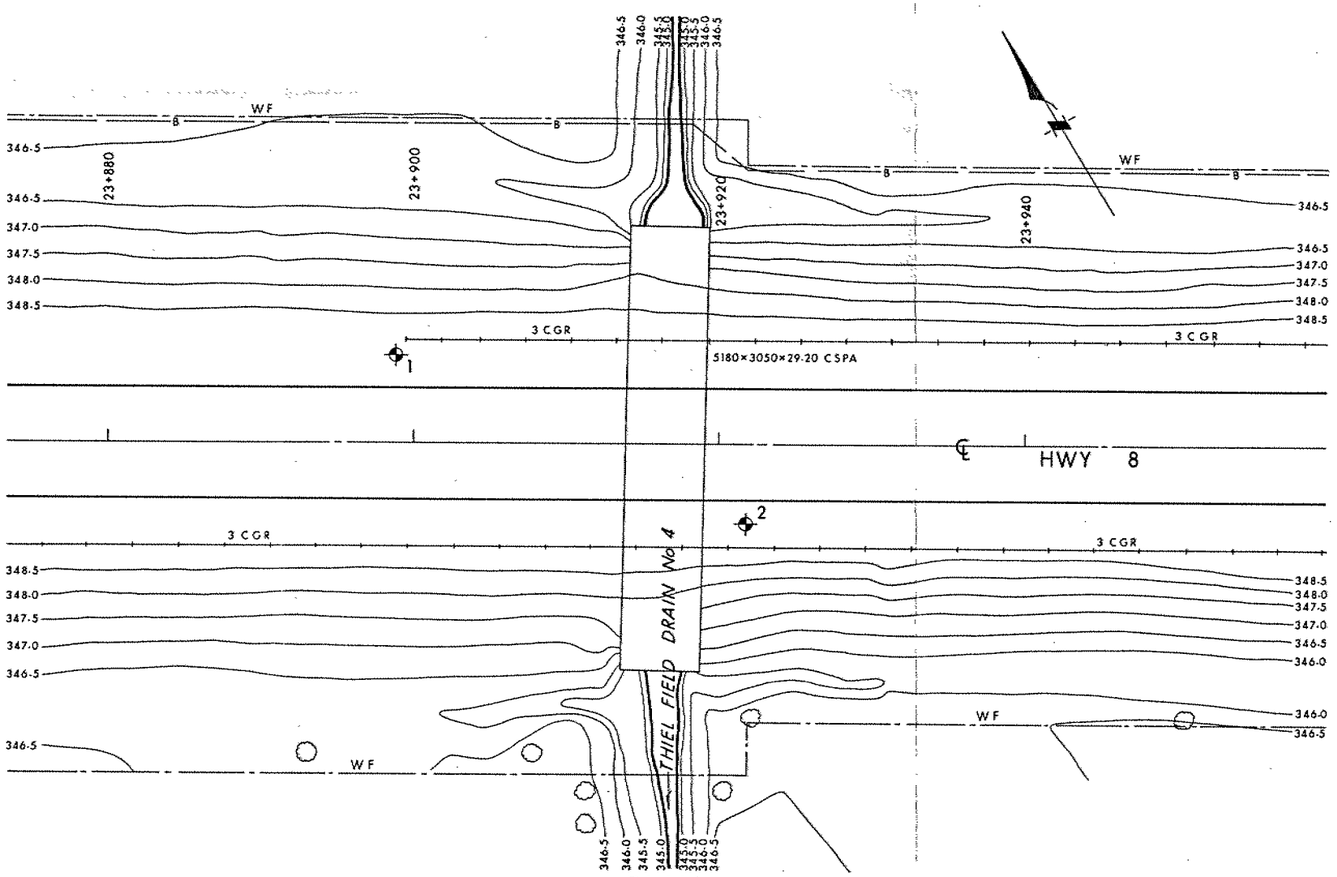
MINISTRY OF TRANSPORTATION, ONTARIO PH-D-207 88 10

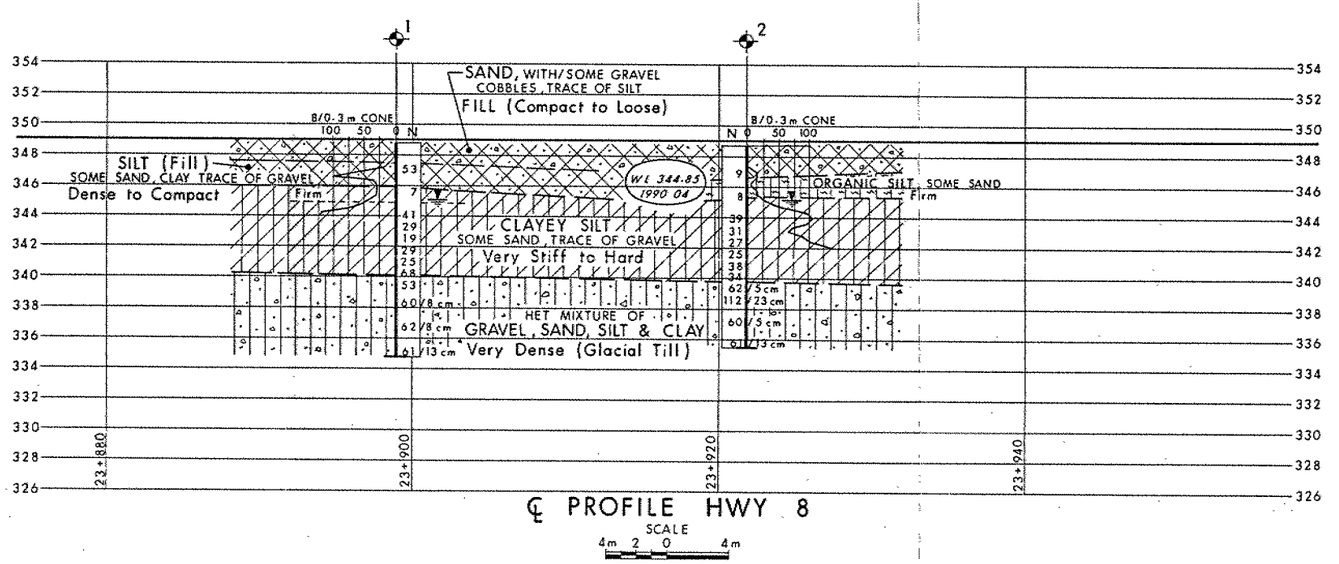
METRIC
DIMENSIONS ARE IN METRES AND/OR MILLIMETRES UNLESS OTHERWISE SHOWN. STATIONS IN KILOMETRES + METRES.

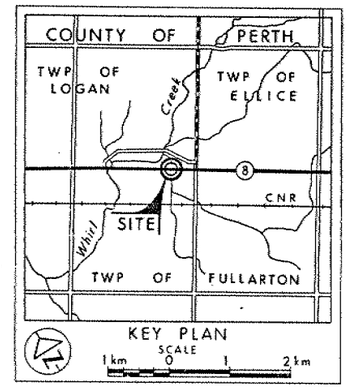
CONT No
WP No 259-88-01

THIEL FIELD DRAIN No 4
CULVERT REPLACEMENT
BORE HOLE LOCATIONS & SOIL STRATA

SHEET







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 1990 03

No	ELEVATION	STATION	OFFSET
1	348.8	23+898.9	5.8m Lt
2	348.7	23+921.7	5.2m Rt

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

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

REV	DATE	BY	DESCRIPTION

Geocres No 40P6-17

REF No E-168-8-1 ; 1990 04

HWY No 8			DIST 3
SJBM'D MV	CHECKED MV	DATE 1990 05 14	SITE 25-352
DRAWN CP	CHECKED	APPROVED	DWG 2598801-A

memorandum

Ontario

To: A. Ho
Head, Structural Section
Southwestern Region

Date: 1990 03 27

From: Foundation Design Office
Room 315, Central Bldg.

Re: W.P. 259-88-01, Hwy. 8
District 3, Site 25-352

The field work for this project was carried out on 90 03 05 & 06. In the absence of the E-plan, a preliminary recommendation is submitted. The final foundation investigation report will be submitted after the issue of the E-plan. Your office should allow at least four weeks after the issue of the E-plan for the report.

The field work consisted of two sampled boreholes and Dynamic Cone Penetration test adjacent to these holes.

The existing culvert is about 29 m long structural steel pipe-arch of 5.1 m span and 3.1 m rise. The culvert is temporarily supported at the crown to avoid further distress.

It is proposed to replace the existing structure with a (open type or box) concrete culvert of 5.0 m span.

The road embankment fill is underlain by about 0.9 m thick firm clayey silt and organic silt. This is underlain by very stiff to hard/compact to dense clayey silt to silt which overlies sand and silt with varying proportions of gravel and clay sized particles (glacial till).

The stabilized ground water level was observed at or near the creek water level (EL: 345.0). Seasonal fluctuation of the ground water level may be expected.

The proposed invert or floor level of the culvert is not available. However, if the floor of the culvert is constructed about 4.0 m (El: 345.0±) below the existing road level, an allowable bearing pressure of 350 kPa may be assummed for the design.

For the purposes of the O.H.B.D.C., the following bearing capacity values are recommended:

Factored Capacity at U.L.S. = 800 kPa
Bearing Capacity at S.L.S. Type II = 350 kPa

The granular backfill requirements should be as outlined on current MTO Standards. The granular "A" or "B" backfill should be in accordance with the Special Provision No. 109F03. The following parameters are recommended for the granular backfill.

..../2

	Granular "A"	Granular "B"
Angle of Internal Friction	$\emptyset$ = 35°	$\emptyset$ = 30°
Unit Weight (kN/m^3)	γ = 22.8	γ = 21.2

The earth pressure should be computed as per 6.1.2.2 of the code assuming "at rest" condition.

The backfill operations should be carried out simultaneously on both sides of the proposed culvert. Compaction of the backfill should adhere to the Ministry Directive B-131.

The frost protection requirements in this area is in the order of 1.5 m of earth cover.

M. Vasavithasan, P. Eng.
Foundation Engineer

for

P. Payer, P. Eng.
Sr. Foundation Engineer

PP/MV/jb