DOCUMENT MICROFILMING IDENTIFICATION

G.I.-30 SEPT. 1976

GEOCRES No. 31D-324

DIST. 7 REGION

W.P. No. 74-70-11

CONT. No. 91-93

W. O. No.

STR. SITE No. 21-440

HWY. No. 11 S

LOCATION Hwy 115 & Victoria/Durham Boundary Rd.

No. OF PAGES -

OVERSIZE DRAWINGS TO BE INCLUDED WITH THIS REPORT.

REMARKS:

FOUNDATION INVESTIGATION REPORT

CONTRACT NO. 91-93

Ontario

Ministry of
Transportation

INDEX

Note: For purposes of the contract, this report supersedes all other Foundation Reports prepared by, or for the Ministry in connection with the above mentioned project.

EXPLANATION OF TERMS USED IN REPORT

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

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

SOILS ARE DESCRIBED BY THEIR COMPOSITION AND CONSISTENCY OR DENSENESS.

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

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

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

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

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

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

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

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

JOINTING AND BEDDING:

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

ABBREVIATIONS AND SYMBOLS

FIELD SAMPLING

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

STRESS AND STRAIN

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

MECHANICAL PROPERTIES OF SOIL

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

FOUNDATION INVESTIGATION REPORT

For

Boundary Road Hwy. 115 Interchange

W.P. 74-70-11, Site No. 21-440

District 7, Port Hope

INTRODUCTION

This report contains the results of a foundation investigation at the above mentioned site carried out during the period 89 03 08 to 89 03 13. The investigation was conducted at the request of the Central Region Structural Section. The fieldwork consisted of five sampled boreholes and four dynamic cone penetration tests. The borings were advanced using a Muskeg vehicle mounted auger machine equipped with hollow stem augers. Sampling was done to a maximum depth of 15.7 m and the dynamic cone tests to a maximum depth of 6 m.

SITE DESCRIPTION

The site is located on Hwy. 115 2.3 km north of the junction of Hwy. 115 & Hwy. 35. The terrain is hilly with mixed hardwood forest cover. Immediately east and west of the site aggregate pits are or have been mined.

According to Chapman & Putnam (1984), the area is in the Oak Ridges Moraine. It is typically composed of sandy loam, sand or gravelly sand.

SUBSURFACE CONDITIONS

The subsoil consists of glacial and glacio-lacustrine deposits. A surficial layer of fine sand overlies sand and gravel which is in turn underlain by fine sand.

The boundaries of the different deposits together with the field and lab test results are shown on the Record of Borehole sheets No's 1 to 5 contained in the appendix of this report. The stratigraphical sections are shown on Drawing No. 747011-A.* This drawing also shows the locations and elevations of the borings. A description of the different strata encountered is given below:

* DWG NO 2 OF THE CONTRACT DWG'S

Fine Sand, trace of Silt

The surficial soil consists of very loose to very dense fine sand. The bottom of this layer is relatively flat ranging between El. 350.3 to El. 349.1. The thickness of this layer ranges from 1.8 to 8.8 m. The irregularity is due to the hilly surface topography. There are some gravel layers between the ground surface and El. 354 m. Occasional layers of silty sand exist at lower depths. West of Hwy. 115 along the top of the existing cut slope there is 1.2 m of silty sand overlying fine sand. Measured in situ and laboratory properties are as follows:

	Range	Mean	Median
Moisture Content (w) %	2.5-8	4	4
SPT Blows 'N'	1-69	19	19

The average SPT 'N' value is 19 however the range is quite large with the 'N' values increasing with depth. The low 'N' values near the surface are not representative of the general condition of this deposit and can be attributed to the lack of overburden pressure. The density of this deposit increases with depth.

The moisture content also varies with depth in this deposit. The moisture content of this deposit is slightly higher near the surface due to the affects of surface infiltration and organics. This deposit is however dry and would require the addition of water to assist in compaction.

The grain size distribution is uniform within this deposit as shown in the narrow grain size envelope on Figure 1.

Sand and Gravel, occasional Cobbles

This deposit is a heterogeneous mixture of sand and gravel with traces of silt and random layers of silty sand in some boreholes. The thickness is in the order of 4 to 4.5 m. The lower boundary of this layer slopes downward slightly from the north abutment at El. 345.1 m to lower than El. 344.3 m at the south approach.

The in situ and laboratory properties are as follows:

	Range	Mean	Median
Moisture Content (w) %	1.5-3.5	2-5	2-5
SPT Blows 'N'	44-180	56	81

Based on blow counts ranging from 44 to 180 blows, the material can be described as dense to very dense. The blow counts varied randomly with an average blow count of 51 indicating that most of this deposit is very dense.

While the blow counts have a large range the moisture content is relatively uniform ranging from 1.5 to 3.5%. Very little moisture penetrates from the surface to this deposit.

Analysis of the grain size distribution envelope for this deposit (Figure 2) shows a wide distribution of grain sizes up to cobble size particles. The cobbles are dispersed randomly throughout the deposit.

Fine Sand, trace of Silt

Below the sand and gravel the boreholes were terminated in a fine sand layer. It contains occasional silty sand layers and in general silt content increases with depth. A moist sandy silt layer was found at the bottom of BH #3. The laboratory and in situ properties are as follows:

	Range	Mean	Median
Moisture Content (w) %	3.5-4	3.75	-
SPT Blows 'N'	25-62	48	47

The 'N' values indicate that this layer ranges from compact to very dense. The blow counts vary randomly with an average 'N' value of 48 blows. The deposit is therefore basically dense.

This deposit is dry with practically no variance in moisture content.

The grain size distribution (Figure 3) indicates a poorly graded medium to fine sand with traces of silt.

Groundwater

All the boreholes were dry. According to Chapman and Putnam (1984) the water drains vertically through the sand and gravel, moving laterally only when it reaches less pervious beds. However, lateral drainage was not encountered in any of the boreholes.

MISCELLANEOUS

The field work for this project was supervised by Mr. F. Pinder, Engineer Trainee. The equipment used was owned and operated by Master Soil Investigations Ltd. This report was prepared by Mr. S. Holmes, Foundation Engineer, and reviewed by Mr. M. Devata, Cheif Foundation Engineer.

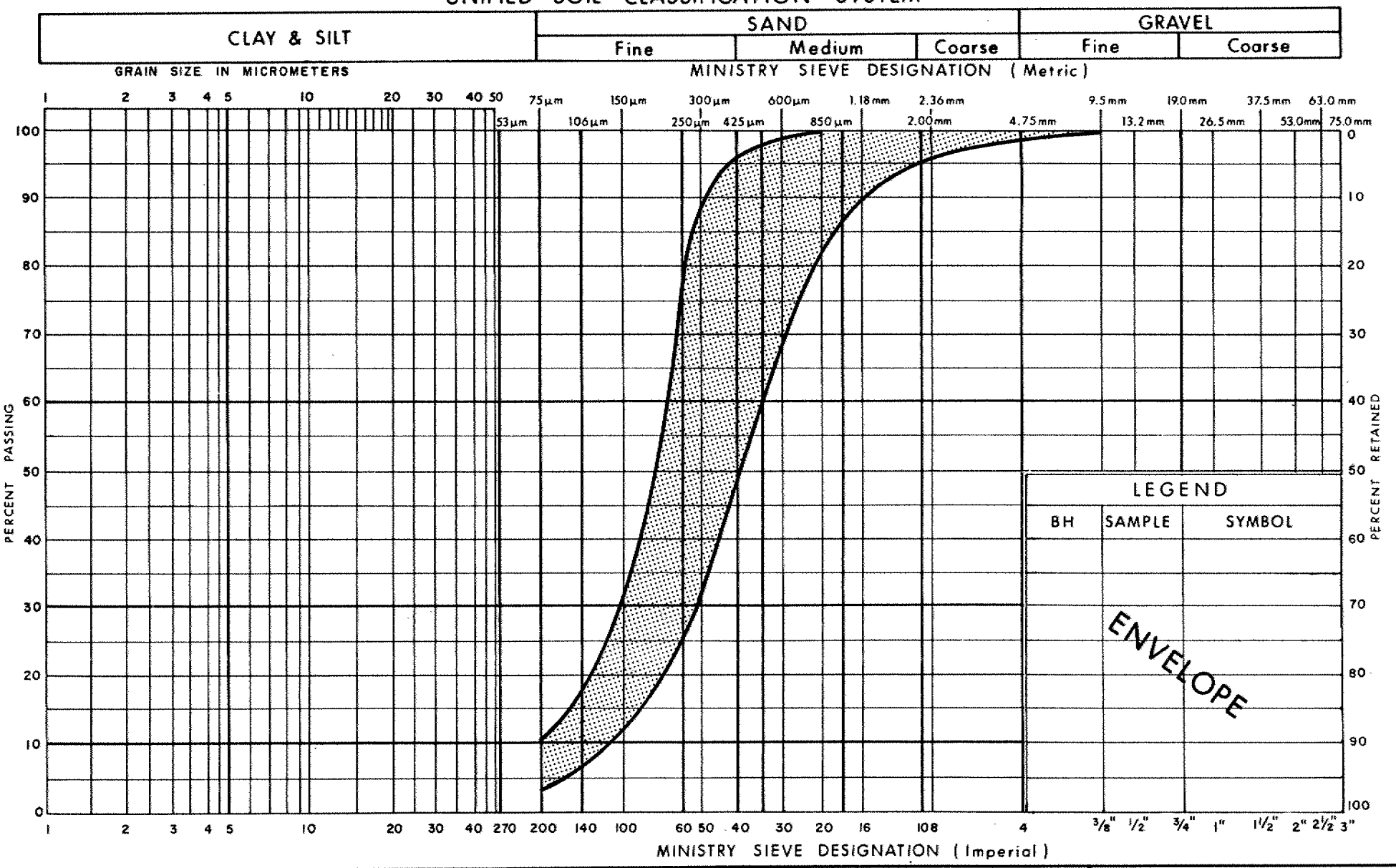
Dr. B. Iyer, P. Eng.
Sr. Foundation Engineer

M. Devata, P. Eng.
Chief Foundation Engineer

APPENDIX

78 12 M

UNIFIED SOIL CLASSIFICATION SYSTEM



Ministry of Transportation
Ontario

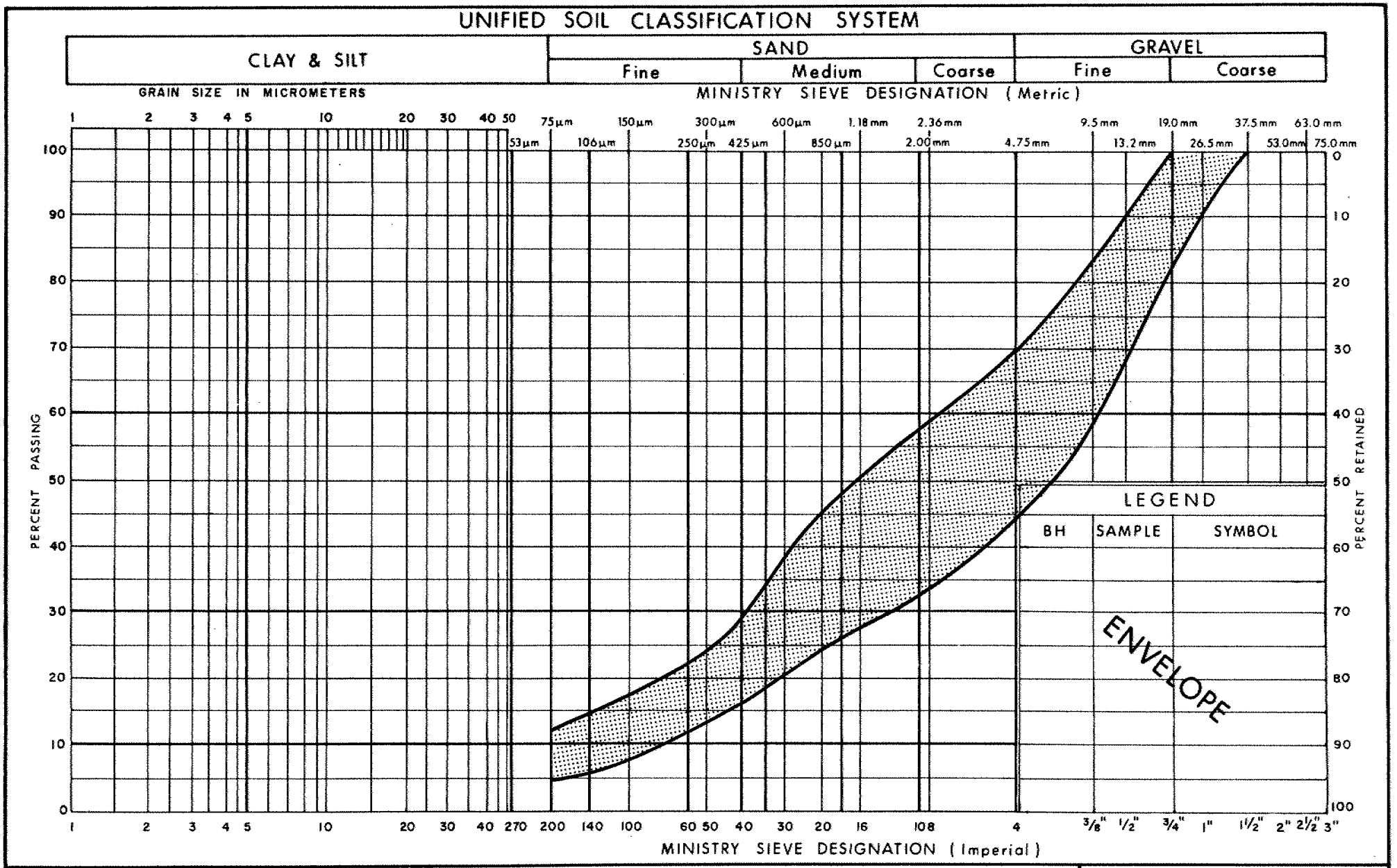
GRAIN SIZE DISTRIBUTION

FINE SAND, TRACE OF SILT

FIG No 1

W P 74-70-11

∞



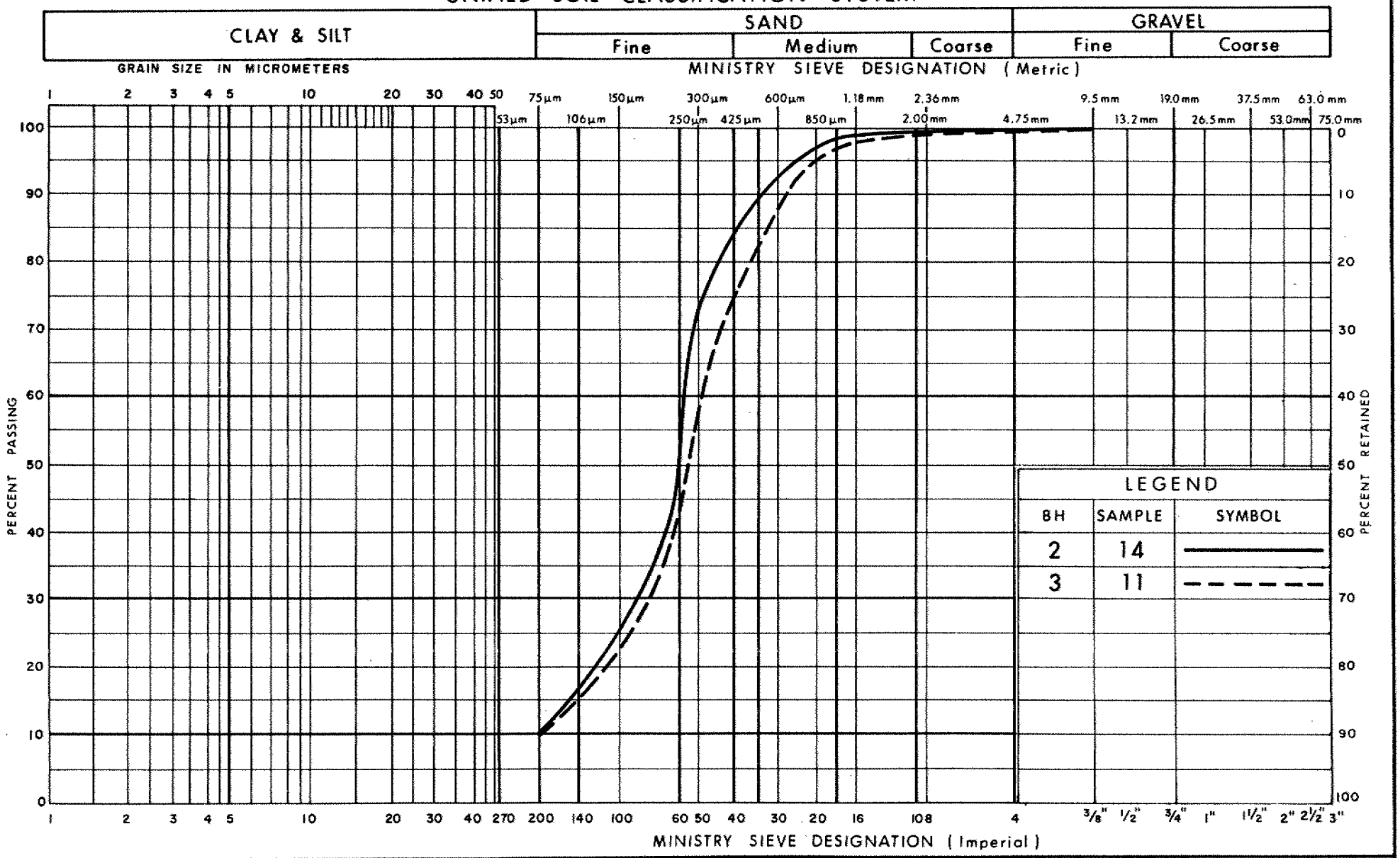
Ministry of Transportation
Ontario

GRAIN SIZE DISTRIBUTION
SAND & GRAVEL

FIG No 2
W P 74-70-11

6

UNIFIED SOIL CLASSIFICATION SYSTEM



Ministry of Transportation
Ontario

GRAIN SIZE DISTRIBUTION

FINE SAND, TRACE OF SILT

FIG No 3

W P 74-70-11

10

Ministry of Transportation Ontario

RECORD OF BOREHOLE No 1 METRIC

W P 74-70-11 LOCATION Co-ords: N 4 882 292.9; E 376 605.8 ORIGINATED BY FP

DIST 7 HWY 115 BOREHOLE TYPE Hollow Stem Augers COMPILED BY FP

DATUM Geodetic DATE 89 03 08 CHECKED BY DD

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 kPa ○ 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 γ	REMARKS & GRAIN SIZE DISTRIBUTION (%) GR SA SI CL
356.9	Ground Surface										
0.0	Occ. Gravel Layers		1	SS	20	*	356				
			2	SS	13						
	Fine Sand Trace of Silt Loose to Very Dense		3	SS	15		354		○		0 92 (8)
			4	SS	16						
			5	SS	16						
	Occ. Silty Sand Layers		6	SS	15		352				
			7	SS	21						
349.2			8	SS	8		350				
7.7			9	SS	44						
	Sand and Gravel Occ. Cobbles Dense to Very Dense		10	SS	67		348				
			11	SS	56		346				
344.3			12	SS	75						
12.6	End of Borehole *Borehole Dry										

OFFICE REPORT ON SOIL EXPLORATION

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

15 20/10 5 (%) STRAIN AT FAILURE

Ministry of Transportation Ontario

RECORD OF BOREHOLE No 2 METRIC

W P 74-70-11 LOCATION Co-ords: N 4 882 302.1; E 376 580.9 ORIGINATED BY FP

DIST 7 HWY 115 BOREHOLE TYPE Hollow Stem Augers & Dynamic Cone Penetration COMPILED BY FP

DATUM Geodetic DATE 89 03 08 CHECKED BY DD

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: ○ 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
358.7	Ground Surface										
0.0						*	358	Augered			
			1	SS	1				○		1 90 (9)
			2	SS	11						
	Occ. Gravel Layers		3	SS	69		356		○		12 82 (6)
			4	SS	36						
	Fine Sand		5	SS	24		354				
	Trace of Silt		6	SS	18				○		0 97 (3)
	Very Loose to		7	SS	21						
	Very Dense		8	SS	19		352				
			9	SS	11				○		0 96 (4)
349.9											
8.8			10	SS	94		350				
	Sand and Gravel		11	SS	60	10 cm	348		○		45 49 (6)
	Occ. Cobbles										
	Very Dense		12	SS	77						
344.9							346				
13.8	Fine Sand		13	SS	60						
	Trace of Silt						344				
	Very Dense										
343.0			14	SS	60				○		0 90 (10)
15.7	End of Borehole										

*Borehole Dry

OFFICE REPORT ON SOIL EXPLORATION

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

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

Ministry of Transportation Ontario

RECORD OF BOREHOLE No 3 METRIC

W P 74-70-11 LOCATION Co-ords: N 4 882 290.6; E 376 537.9 ORIGINATED BY FP

DIST 7 HWY 115 BOREHOLE TYPE Hollow Stem Augers & Dynamic Cone Penetration COMPILED BY FP

DATUM Geodetic DATE 89 03 09 CHECKED BY DD

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 kPo (○ 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 γ	REMARKS & GRAIN SIZE DISTRIBUTION (%) GR SA SI CL
353.8	Ground Surface										
0.0	Fine Sand Trace of Silt Compact		1	SS	19	*		Augered	○		0 94 (6)
			2	SS	19		352				
			3	SS	24				○		0 95 (5)
350.0	Occ. Silty Sand Layers		4	SS	24						
3.8	Occ. Silty Sand Layers		5	SS	33		350				
			6	SS	52				○		34 55 (11)
			7	SS	111		348				
	Sand and Gravel Occ. Cobbles Dense to Very Dense		8	SS	60 / 15 cm						
			9	SS	81		346		○		39 52 (9)
344.7											
9.1	Fine Sand Trace of Silt Dense to Very Dense		10	SS	54		344				
	Silty Sand Layers		11	SS	47				○		0 90 (10)
341.1	Sandy Silt		12	SS	54		342		○		0 20 (80)
12.7	End of Borehole										

*Borehole Dry

OFFICE REPORT ON SOIL EXPLORATION

+3, x5 : Numbers refer to Sensitivity

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

RECORD OF BOREHOLE No 4 METRIC

W P 74-70-11 LOCATION Co-ords: N 4·882 307.1; E 376 514.1 ORIGINATED BY FP

DIST 7 HWY 115 BOREHOLE TYPE Hollow Stem Augers & Dynamic Cone Penetration COMPILED BY FP

DATUM Geodetic DATE 89 03 09 CHECKED BY DD

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 kPa (○ 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
355.8	Ground Surface										
0.0	Silty Sand Occ. Gravel Layers		1	SS	5	*		Augered	○		12 68 (20)
	Fine Sand Trace of Silt Loose to Dense		2	SS	13		354				
			3	SS	16				○		3 94 (3)
	Occ. Silty Sand Layers		4	SS	24		352				
			5	SS	18						
			6	SS	15						
			7	SS	39		350		○		0 95 (5)
349.1			8	SS	38						
6.7	Sand and Gravel Occ. Cobbles Very Dense		9	SS	60	10 cm	348				
			10	SS	115		346		○		32 60 (8)
345.1											
10.7	Fine Sand Trace of Silt Dense to Very Dense		11	SS	62		344				
			12	SS	49						
341.6			13	SS	44		342				
14.2	End of Borehole *Borehole Dry										

OFFICE REPORT ON SOIL EXPLORATION

+3, ×5 : Numbers refer to Sensitivity

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

Ministry of Transportation Ontario

RECORD OF BOREHOLE No 5 METRIC

W P 74-70-11 LOCATION Co-ords: N 4 882 302.3; E 376 479.7 ORIGINATED BY FP

DIST 7 HWY 115 BOREHOLE TYPE Hollow Stem Augers & Dynamic Cone Penetration COMPILED BY FP

DATUM Geodetic DATE 89 03 13 CHECKED BY DD

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 (○ 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
352.1	Ground Surface										
0.0	Fine Sand Trace of Silt Very Loose		1	SS	4	*	352	Augered	○		30 63 (7)
350.3			2	SS	29						
1.8	Sand and Gravel Occ. Cobbles Very Dense		3	SS	56		350		○		56 39 (5)
			4	SS	58						
	Occ. Silty Sand Layers		5	SS	102		348				
			6	SS	82						
			7	SS	55		346				
344.8			8	SS	62						
7.3	Fine Sand Trace of Silt Compact to Dense		9	SS	43		344				
			10	SS	32						
			11	SS	25		342				
	Silty Sand Layers										
339.5			12	SS	46		340				
12.6	End of Borehole										

*Borehole Dry

OFFICE REPORT ON SOIL EXPLORATION

+3, ×5 : Numbers refer to Sensitivity

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

ENGINEERING MATERIALS OFFICE
FOUNDATION DESIGN SECTION

CONT 91-93

WP 74-70-11 DIST 7

HWY 115 STR SITE 21-440

Boundary Road Hwy. 115 Interchange

DISTRIBUTION

G.C.E. Burkhardt (3)
G. Cautillo
J. Smrcka (2)
A. Wittenberg
K. Bassi
D. Aspinwall
T. Yakutchik
G. Szekreny
B. Steeves (Cover Only)
M. MacLean (Cover Only)
File

GEOCRES 31D-324 DATE JUN 14 1989

FOUNDATION INVESTIGATION REPORT

For

Boundary Road Hwy. 115 Interchange

W.P. 74-70-11, Site No. 21-440

District 7, Port Hope

INTRODUCTION

This report contains the results of a foundation investigation at the above mentioned site carried out during the period 89 03 08 to 89 03 13. The investigation was conducted at the request of the Central Region Structural Section. The fieldwork consisted of five sampled boreholes and four dynamic cone penetration tests. The borings were advanced using a Muskeg vehicle mounted auger machine equipped with hollow stem augers. Sampling was done to a maximum depth of 15.7 m and the dynamic cone tests to a maximum depth of 6 m.

SITE DESCRIPTION

The site is located on Hwy. 115 2.3 km north of the junction of Hwy. 115 & Hwy. 35. The terrain is hilly with mixed hardwood forest cover. Immediately east and west of the site aggregate pits are or have been mined.

According to Chapman & Putnam (1984), the area is in the Oak Ridges Moraine. It is typically composed of sandy loam, sand or gravelly sand.

SUBSURFACE CONDITIONS

The subsoil consists of glacial and glacio-lacustrine deposits. A surficial layer of fine sand overlies sand and gravel which is in turn underlain by fine sand.

The boundaries of the different deposits together with the field and lab test results are shown on the Record of Borehole sheets No's 1 to 5 contained in the appendix of this report. The stratigraphical sections are shown on Drawing No. 747011-A. This drawing also shows the locations and elevations of the borings. A description of the different strata encountered is given below:

Fine Sand, trace of Silt

The surficial soil consists of very loose to very dense fine sand. The bottom of this layer is relatively flat ranging between El. 350.3 to El. 349.1. The thickness of this layer ranges from 1.8 to 8.8 m. The irregularity is due to the hilly surface topography. There are some gravel layers between the ground surface and El. 354 m. Occasional layers of silty sand exist at lower depths. West of Hwy. 115 along the top of the existing cut slope there is 1.2 m of silty sand overlying fine sand. Measured in situ and laboratory properties are as follows:

	Range	Mean	Median
Moisture Content (w) %	2.5-8	4	4
SPT Blows 'N'	1-69	19	19

The average SPT 'N' value is 19 however the range is quite large with the 'N' values increasing with depth. The low 'N' values near the surface are not representative of the general condition of this deposit and can be attributed to the lack of overburden pressure. The density of this deposit increases with depth.

The moisture content also varies with depth in this deposit. The moisture content of this deposit is slightly higher near the surface due to the affects of surface infiltration and organics. This deposit is however dry and would require the addition of water to assist in compaction.

The grain size distribution is uniform within this deposit as shown in the narrow grain size envelope on Figure 1.

Sand and Gravel, occasional Cobbles

This deposit is a heterogeneous mixture of sand and gravel with traces of silt and random layers of silty sand in some boreholes. The thickness is in the order of 4 to 4.5 m. The lower boundary of this layer slopes downward slightly from the north abutment at El. 345.1 m to lower than El. 344.3 m at the south approach.

The in situ and laboratory properties are as follows:

	Range	Mean	Median
Moisture Content (w) %	1.5-3.5	2-5	2-5
SPT Blows 'N'	44-180	56	81

Based on blow counts ranging from 44 to 180 blows, the material can be described as dense to very dense. The blow counts varied randomly with an average blow count of 51 indicating that most of this deposit is very dense.

While the blow counts have a large range the moisture content is relatively uniform ranging from 1.5 to 3.5%. Very little moisture penetrates from the surface to this deposit.

Analysis of the grain size distribution envelope for this deposit (Figure 2) shows a wide distribution of grain sizes up to cobble size particles. The cobbles are dispersed randomly throughout the deposit.

Fine Sand, trace of Silt

Below the sand and gravel the boreholes were terminated in a fine sand layer. It contains occasional silty sand layers and in general silt content increases with depth. A moist sandy silt layer was found at the bottom of BH #3. The laboratory and in situ properties are as follows:

	Range	Mean	Median
Moisture Content (w) %	3.5-4	3.75	-
SPT Blows 'N'	25-62	48	47

The 'N' values indicate that this layer ranges from compact to very dense. The blow counts vary randomly with an average 'N' value of 48 blows. The deposit is therefore basically dense.

This deposit is dry with practically no variance in moisture content.

The grain size distribution (Figure 3) indicates a poorly graded medium to fine sand with traces of silt.

Groundwater

All the boreholes were dry. According to Chapman and Putnam (1984) the water drains vertically through the sand and gravel, moving laterally only when it reaches less pervious beds. However, lateral drainage was not encountered in any of the boreholes.

DISCUSSION AND RECOMMENDATIONS

It is proposed to construct a two lane, two span structure over Hwy. 115 at Boundary Road. The span lengths will be 33.5 m each. The south approach will consist of up to 4.5 m of fill and the north approach of up to 9.0 m of fill. In view of the encountered subsoil conditions the following recommendations are being made:

Abutment Foundations

Foundations for the abutments can be founded on spread footings placed 2.5 m below the existing ground surface. The base of the excavation should be well compacted with 100% maximum dry density achieved. Provided that the base of the excavations are well compacted the following O.H.B.D.C. parameters for both abutments may be used for design purposes:

Factored Bearing Capacity at U.L.S. = 900 kPa
Bearing Capacity at S.L.S. Type II = 350 kPa

The grade raise at the north and south abutments is approximately 6.7 and 1.0 m respectively. In order to elevate the founding elevation of the abutment footings and decrease the height of the abutments, spread footings can be perched on a well compacted Granular 'A' core constructed as illustrated in Figure 4. Excavation for the base of the granular core should extend 1.5 m below the top of existing ground. The base of the excavation should then be compacted with 100% maximum dry density achieved before constructing the granular pad.

For spread footings founded on a Granular 'A' core the following O.H.B.D.C. parameters for both abutments may be used for design.

Factored Bearing Capacity of U.L.S. = 900 kPa
Bearing Capacity at S.L.S. Type II = 350 kPa

Pier Foundations

The pier can be founded on a shallow spread footing a minimum depth of 2.0 m below the existing ground surface, provided there is adequate frost protection. The base of excavation should be compacted and 100% maximum dry density achieved. The following O.H.B.D.C. parameters are applicable:

Factored Bearing Capacity at U.L.S. = 900 kPa
Bearing Capacity at S.L.S. Type II = 350 kPa

Approach Embankments (Boundary Road)

The approaches should be built with 2:1 forward and side slopes and should consist of well compacted acceptable embankment material. The maximum unbroken height of fill should be 8 m. A 2 m wide berm is required for fills higher than 8 m. Since the abutments are being placed on an existing slope, the toe of slope for the fill can be assumed to be at a point where the existing slope is steeper that 4:1.

Approach Cuts (Hwy. 115)

The approach slopes on Hwy. 115 should be cut at 2:1.

Settlement

It is anticipated that the settlement of the approach fill at this site will be instantaneous or elastic and therefore insignificant.

Dewatering

Dewatering will not be a problem as the groundwater is below the base of the required elevations.

Other Considerations

Earth pressures should be computed as per subsection 6.6.1.2.1 of the code. The active condition will apply.

The Granular 'A' or 'B' backfill should be in accordance with Special Provision No. 109F03 (Latest Revision). The following parameters are recommended for the granular backfill.

		Granular 'A'	Granular 'B'
Angle of Internal Friction ϕ	=	35°	30°
Unit Weight (kN/m^3) γ	=	22.8	21.2

The spread footings should have a minimum of 1.5 m earth cover for frost protection.

For sliding resistance, an unfactored friction angle of 30° can be assumed to apply between footings and native overburden or granular pads and native overburden. An unfactored friction angle of 35° can be assumed between the base of footings and compacted Granular 'A' pads.

MISCELLANEOUS

The field work for this project was supervised by Mr. F. Pinder, Engineer Trainee. The equipment used was owned and operated by Master Soil Investigations Ltd. This report was prepared by Mr. S. Holmes, Foundation Engineer, and reviewed by Mr. M. Devata, Cheif Foundation Engineer.

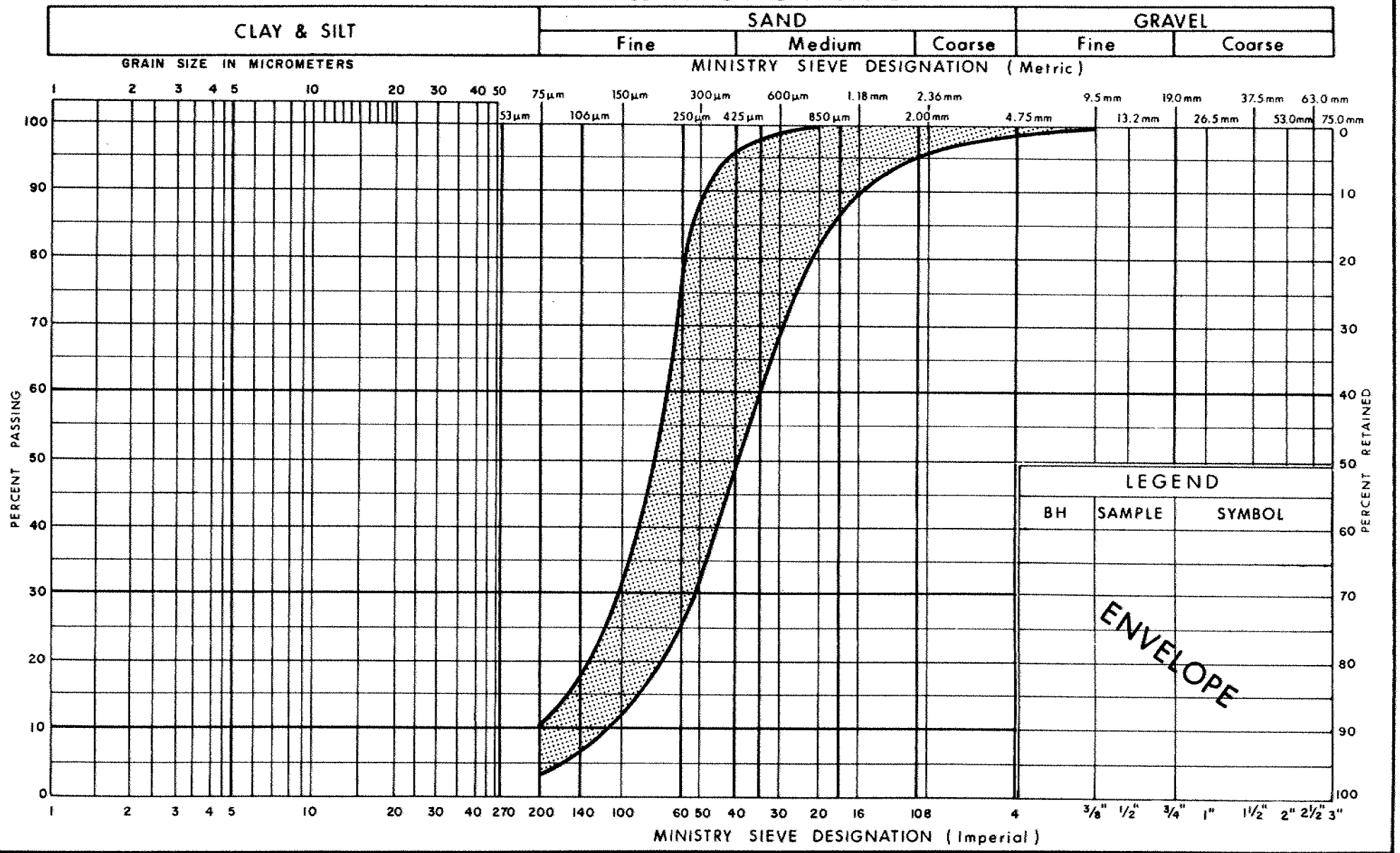
S. Holmes, P.Eng.
Foundation Engineer

M. Devata, P.Eng.
Chief Foundation Engineer

APPENDIX

78 12 M

UNIFIED SOIL CLASSIFICATION SYSTEM



Ministry of Transportation
Ontario

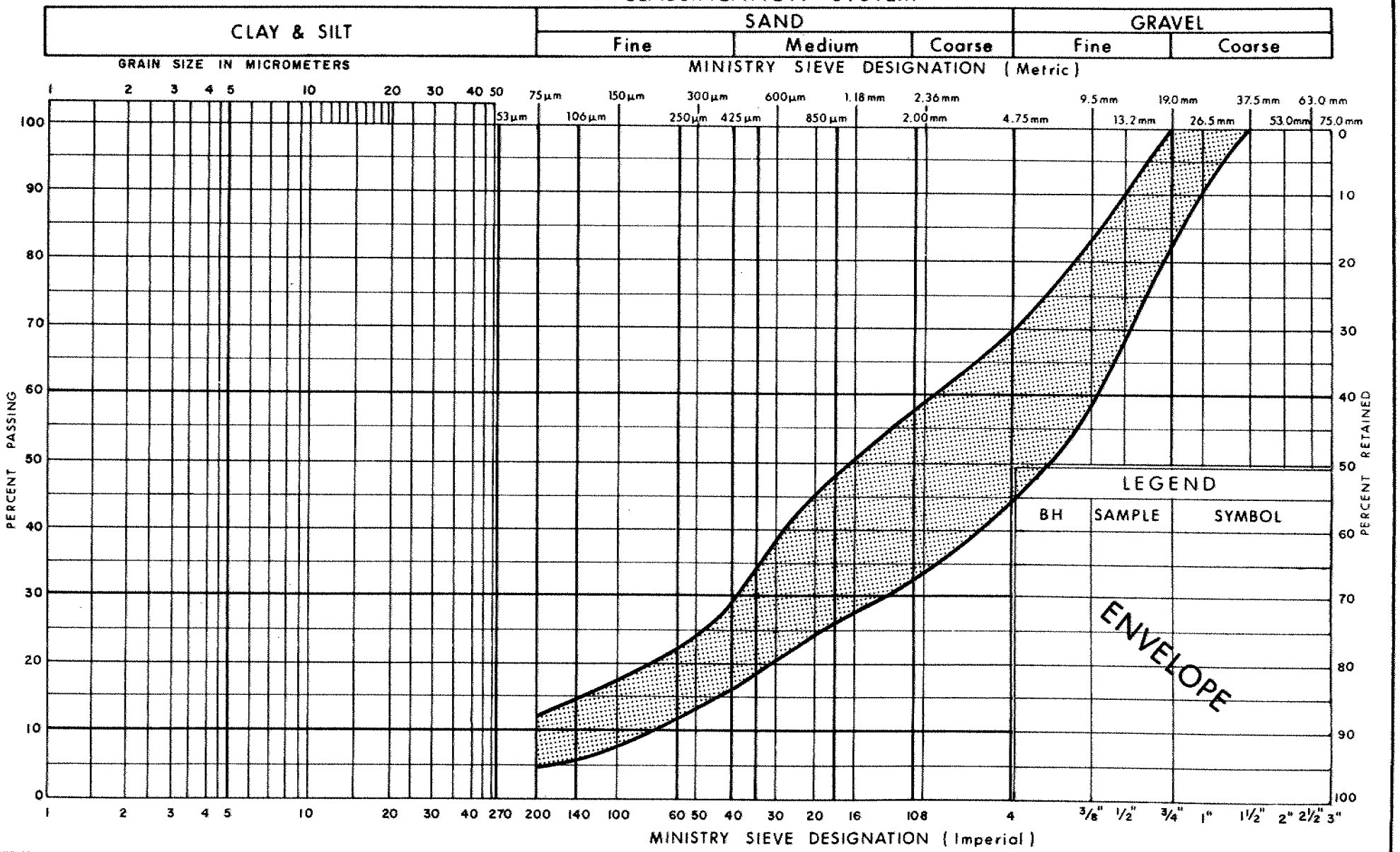
GRAIN SIZE DISTRIBUTION

FINE SAND, TRACE OF SILT

FIG No 1

W P 74-70-11

UNIFIED SOIL CLASSIFICATION SYSTEM

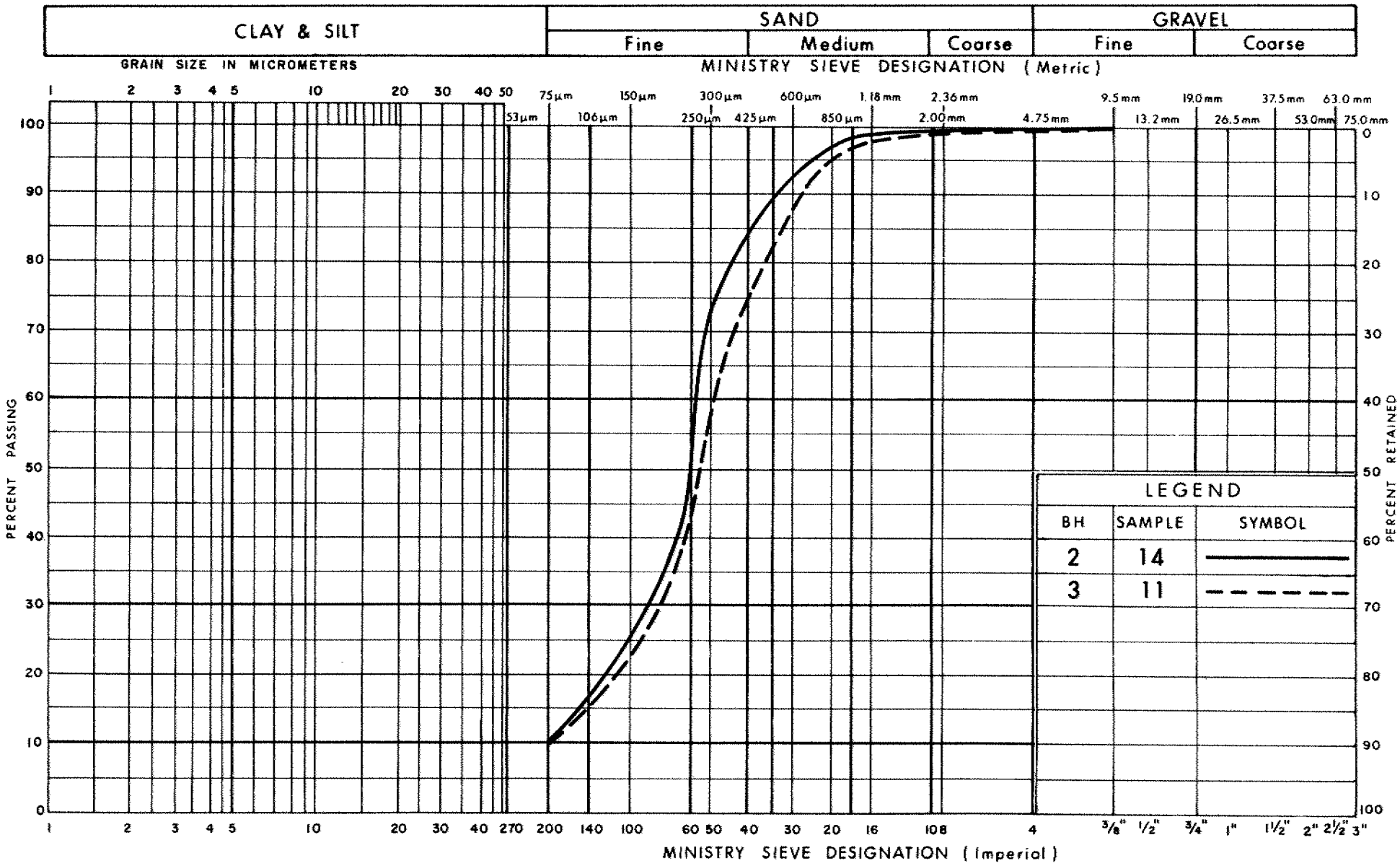


Ministry of Transportation
Ontario

GRAIN SIZE DISTRIBUTION
SAND & GRAVEL

FIG No 2
W P 74-70-11

UNIFIED SOIL CLASSIFICATION SYSTEM



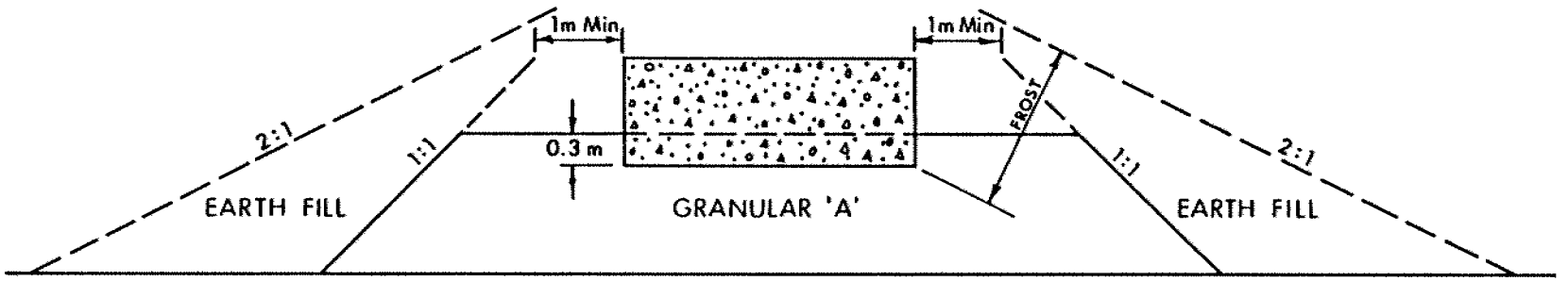
Ministry of Transportation
Ontario

GRAIN SIZE DISTRIBUTION

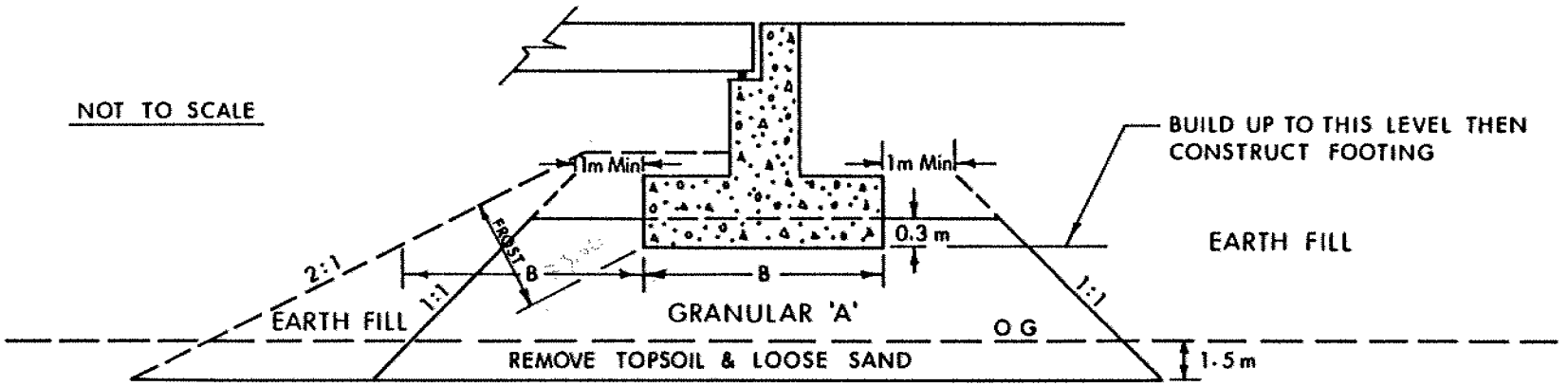
FINE SAND, TRACE OF SILT

FIG No 3

W P 74-70-11



X SECTION



LONGITUDINAL SECTION

NOTES:

1 - REMOVE TOPSOIL &/ LOOSE SUBSOIL UNDER AREA OF COMPACTED GRANULAR 'A' & EARTH FILL.

2 - PLACE GRANULAR 'A' & EARTH FILL TO BOTTOM OF FOOTING LEVEL, COMPACTED ACCORDING TO CURRENT M TO STANDARDS.

3 - CONSTRUCT CONCRETE FOOTING.

4 - PLACE REMAINDER OF GRANULAR 'A' & EARTH FILL AS REQUIRED.

Ministry of Transportation Ontario	ABUTMENT ON COMPACTED FILL SHOWING GRANULAR 'A' CORE	FIG No 4 W P 74-70-11

EXPLANATION OF TERMS USED IN REPORT

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

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

SOILS ARE DESCRIBED BY THEIR COMPOSITION AND CONSISTENCY OR DENSENESS.

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

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

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

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

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

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

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

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

JOINTING AND BEDDING:

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

ABBREVIATIONS AND SYMBOLS

FIELD SAMPLING

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

STRESS AND STRAIN

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

MECHANICAL PROPERTIES OF SOIL

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

Ministry of Transportation
Ontario

RECORD OF BOREHOLE No 1 METRIC

W P 74-70-11 LOCATION Co-ords: N 4 882 292.9; E 376 605.8 ORIGINATED BY FP
DIST 7 HWY 115 BOREHOLE TYPE Hollow Stem Augers COMPILED BY FP
DATUM Geodetic DATE 89 03 08 CHECKED BY DD

SOIL PROFILE			SAMPLES			GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT / SHEAR STRENGTH kPa	PLASTIC LIMIT Wp / NATURAL MOISTURE CONTENT W / LIQUID LIMIT W_L / WATER CONTENT (%)	UNIT WEIGHT γ	REMARKS & GRAIN SIZE DISTRIBUTION (%)
ELEV / DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE	'N' VALUES						GR SA SI CL
356.9	Ground Surface										
0.0	Occ. Gravel Layers		1	SS	20	*	356				
			2	SS	13						
	Fine Sand Trace of Silt Loose to Very Dense		3	SS	15		354		o		0 92 (8)
			4	SS	16						
			5	SS	16						
	Occ. Silty Sand Layers		6	SS	15		352				
			7	SS	21						
349.2			8	SS	8		350				
7.7			9	SS	44						
	Sand and Gravel Occ. Cobbles Dense to Very Dense		10	SS	67		348				
			11	SS	56		346				
344.3			12	SS	75						
12.6	End of Borehole *Borehole Dry										

OFFICE REPORT ON SOIL EXPLORATION

+3, ×5 : Numbers refer to Sensitivity

15 20/10 5 (%) STRAIN AT FAILURE

Ministry of Transportation
Ontario

RECORD OF BOREHOLE No 2 METRIC

W P 74-70-11 LOCATION Co-ords: N 4 882 302.1; E 376 580.9 ORIGINATED BY FP
DIST 7 HWY 115 BOREHOLE TYPE Hollow Stem Augers & Dynamic Cone Penetration COMPILED BY FP
DATUM Geodetic DATE 89 03 08 CHECKED BY DD

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 (○ 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
358.7	Ground Surface										
0.0						*	358	Augered			
			1	SS	1				○		1 90 (9)
			2	SS	11						
	Occ. Gravel Layers		3	SS	69		356		○		12 82 (6)
			4	SS	36						
	Fine Sand		5	SS	24		354				
	Trace of Silt										
	Very Loose to		6	SS	18				○		0 97 (3)
	Very Dense		7	SS	21						
			8	SS	19		352				
			9	SS	11				○		0 96 (4)
349.9											
8.8			10	SS	94		350				
	Sand and Gravel		11	SS	60 / 10 cm		348		○		45 49 (6)
	Occ. Cobbles										
	Very Dense		12	SS	77		346				
344.9											
13.8	Fine Sand		13	SS	60						
	Trace of Silt						344				
	Very Dense										
343.0			14	SS	60				○		0 90 (10)
15.7	End of Borehole										
	*Borehole Dry										

OFFICE REPORT ON SOIL EXPLORATION

+3, ×5 : Numbers refer to Sensitivity

15 20/10 5 (%) STRAIN AT FAILURE

Ministry of Transportation Ontario

RECORD OF BOREHOLE No 3 METRIC

W P 74-70-11 LOCATION Co-ords: N 4 882 290.6; E 376 537.9 ORIGINATED BY FP

DIST 7 HWY 115 BOREHOLE TYPE Hollow Stem Augers & Dynamic Cone Penetration COMPILED BY FP

DATUM Geodetic DATE 89 03 09 CHECKED BY DD

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 (○ 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
353.8	Ground Surface										
0.0	Fine Sand Trace of Silt Compact		1	SS	19	*		Augered	○		0 94 (6)
			2	SS	19		352				
			3	SS	24				○		0 95 (5)
350.0	Occ. Silty Sand Layers		4	SS	24						
3.8	Occ. Silty Sand Layers		5	SS	33		350				
			6	SS	52				○		34 55 (11)
			7	SS	111		348				
	Sand and Gravel Occ. Cobbles Dense to Very Dense		8	SS	60 / 15 cm						
			9	SS	81		346		○		39 52 (9)
344.7											
9.1	Fine Sand Trace of Silt Dense to Very Dense		10	SS	54		344				
	Silty Sand Layers		11	SS	47				○		0 90 (10)
							342				
341.1	Sandy Silt		12	SS	54				○		0 20 (80)
12.7	End of Borehole										

*Borehole Dry

OFFICE REPORT ON SOIL EXPLORATION

+3, ×5 : Numbers refer to Sensitivity

15 20 10 5 (%) STRAIN AT FAILURE

Ministry of Transportation Ontario

RECORD OF BOREHOLE No 4 METRIC

W P 74-70-11 LOCATION Co-ords: N 4 882 307.1; E 376 514.1 ORIGINATED BY FP

DIST 7 HWY 115 BOREHOLE TYPE Hollow Stem Augers & Dynamic Cone Penetration COMPILED BY FP

DATUM Geodetic DATE 89 03 09 CHECKED BY DD

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 (○ 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
355.8	Ground Surface										
0.0	Silty Sand Occ. Gravel Layers		1	SS	5	*		Augered	○		12 68 (20)
	Fine Sand Trace of Silt Loose to Dense		2	SS	13		354				
			3	SS	16				○		3 94 (3)
	Occ. Silty Sand Layers		4	SS	24						
			5	SS	18		352				
			6	SS	15						
			7	SS	39				○		0 95 (5)
349.1			8	SS	38		350				
6.7	Sand and Gravel Occ. Cobbles Very Dense		9	SS	60 / 10 cm		348				
			10	SS	115				○		32 60 (8)
345.1							346				
10.7	Fine Sand Trace of Silt Dense to Very Dense		11	SS	62						
			12	SS	49		344				
341.6			13	SS	44		342				
14.2	End of Borehole *Borehole Dry										

OFFICE REPORT ON SOIL EXPLORATION

+3, ×5 : Numbers refer to Sensitivity

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

Ministry of Transportation
Ontario

RECORD OF BOREHOLE No 5 METRIC

W P 74-70-11 LOCATION Co-ords: N 4 882 302.3; E 376 479.7 ORIGINATED BY FP
DIST 7 HWY 115 BOREHOLE TYPE Hollow Stem Augers & Dynamic Cone Penetration COMPILED BY FP
DATUM Geodetic DATE 89 03 13 CHECKED BY DD

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 kPo: ○ 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
352.1	Ground Surface						352				
0.0	Fine Sand Trace of Silt Very Loose		1	SS	4	*		Augered	○		30 63 (7)
350.3			2	SS	29		350				
1.8	Sand and Gravel Occ. Cobbles Very Dense		3	SS	56				○		56 39 (5)
			4	SS	58						
	Occ. Silty Sand Layers		5	SS	102		348				
			6	SS	82						
			7	SS	55						
344.8			8	SS	62		346				
7.3	Fine Sand Trace of Silt Compact to Dense		9	SS	43		344				
			10	SS	32						
			11	SS	25		342				
	Silty Sand Layers										
339.5			12	SS	46		340				
12.6	End of Borehole *Borehole Dry										

OFFICE REPORT ON SOIL EXPLORATION

+3, ×5 : Numbers refer to Sensitivity

20
15 ⊹ 5 (%) STRAIN AT FAILURE
10

MINISTRY OF TRANSPORTATION, ONTARIO PH-D-207 88.10

METRIC

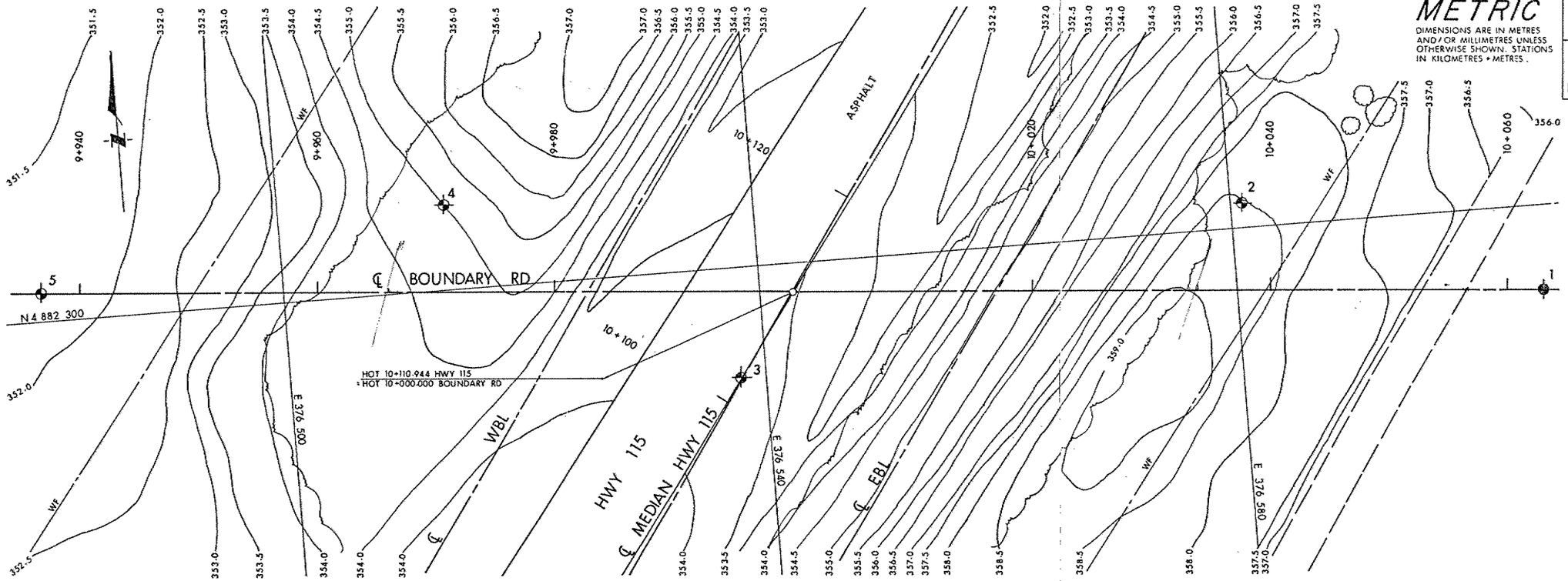
DIMENSIONS ARE IN METRES AND/OR MILLIMETRES UNLESS OTHERWISE SHOWN. STATIONS IN KILOMETRES + METRES.

CONT No
WP No 74-70-11

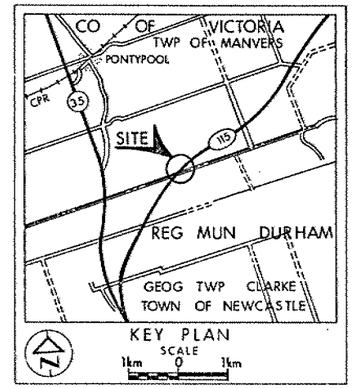
BOUNDARY RD UNDERPASS

BORE HOLE LOCATIONS & SOIL STRATA

SHEET

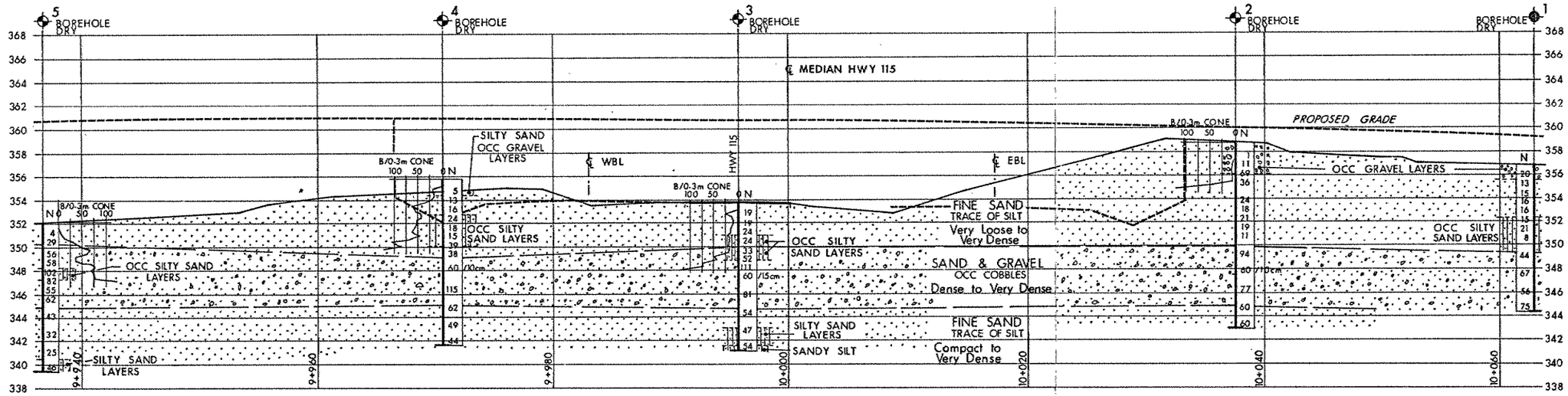


PLAN
SCALE
4m 2 0 4m



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 89 03



℄ PROFILE BOUNDARY RD
SCALE
4m 2 0 4m

No	ELEVATION	CO-ORDINATES NORTH	EAST
1	356·9	4 882 292·9	376 605·8
2	358·7	4 882 302·1	376 580·9
3	353·8	4 882 290·6	376 537·9
4	355·8	4 882 307·1	376 514·1
5	352·1	4 882 302·3	376 479·7

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 31D-324

REF No E-6061-1, 85 10

HWY No 115			DIST 7
SUBM'D SMH	CHECKED	DATE 89 05 02	SITE 21-440
DRAWN DT	CHECKED	APPROVED	DWG 747011-A

(RETAIN THIS COPY FOR FOLLOW-UP)

7540-1021

SEND TO: Mr. G. Al-Bazi
Head, Design Section
Structural Office

FROM: S. Holmes DEPT. Foundation Design DATE 89-09-29

SUBJECT: WP 74-70-11 Hwy 115 Boundary Rd Underpass

Please find attached a sketch of the footing elevations. It should be noted that the elevation provided for BH 4 was 0.8m higher than what is indicated when the BH is plotted on the contours. This indicates that either the BH was incorrectly surveyed or that the contours are in error. The elevation provided for the west abutment were based on the contours from the B Plan. The grading limit of 1m at the west abutment is as indicated in the report. The pier has the footing founded at 0.5m lower elevation than the elevation required for foundation

REPLY

purposes. At the east abutment the cut requires the footing to be founded at a lower elevation than required for foundation purposes. However, to provide 1.5m of frost cover the footing should be founded at el 354.
other points: WP on drawing is 74-70-04 instead of 74-70-11
The east elevation should read "South elevation

REPLY FROM

REPLY DATE

METRIC

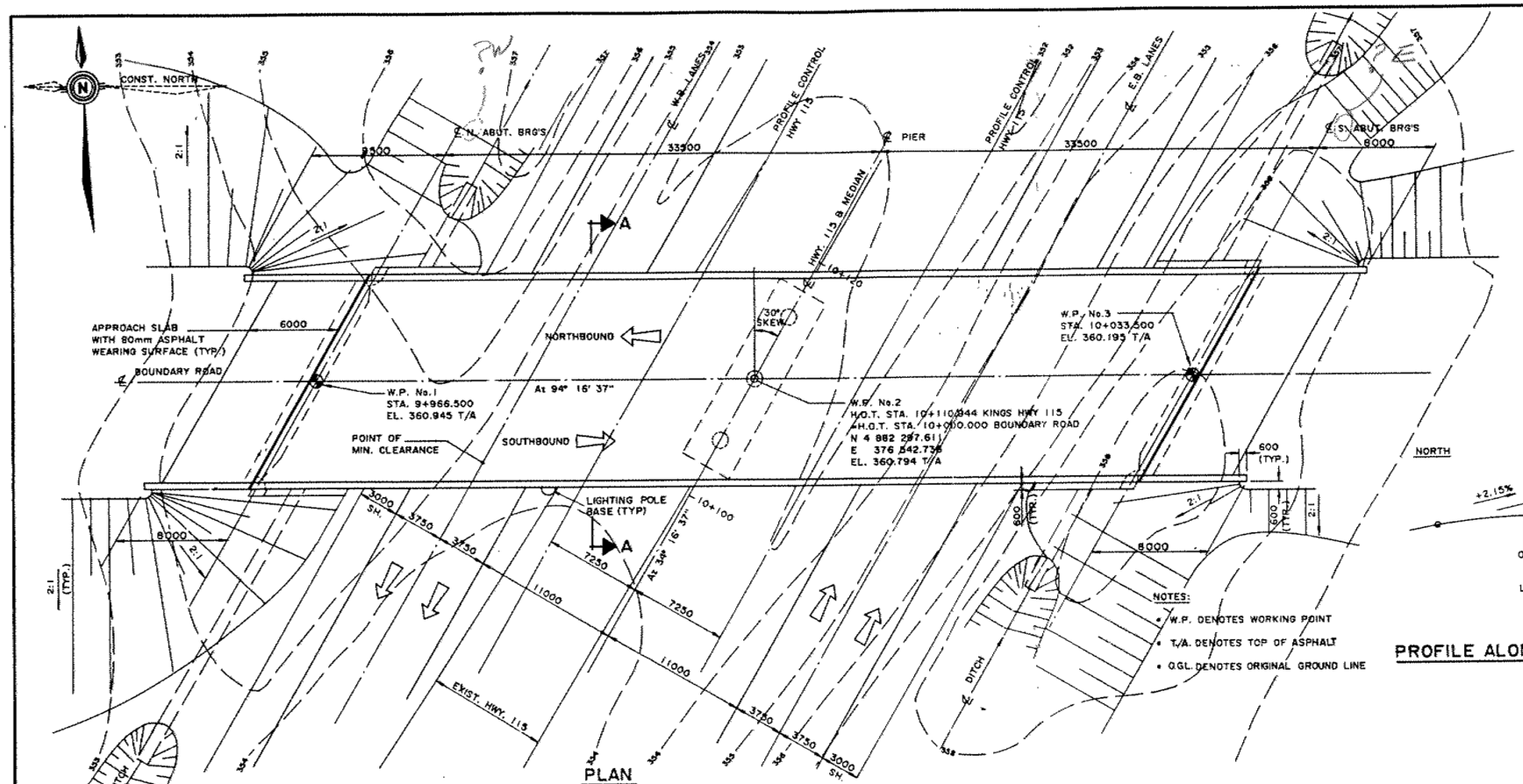
DIMENSIONS ARE IN METRES AND/OR MILLIMETRES UNLESS OTHERWISE SHOWN

DISTRICT No. 7
CONT No
WP No 74-70-11

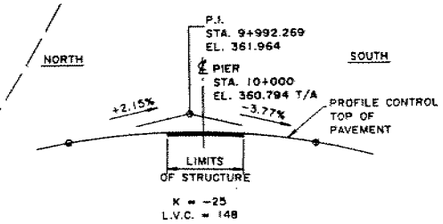
SHEET

VICTORIA/DURHAM
BOUNDARY ROAD
UNDERPASS
GENERAL ARRANGEMENT

totten sims hubicki associates
ENGINEERS ARCHITECTS AND PLANNERS



PLAN
SCALE 1:200



PROFILE ALONG ℄ BOUNDARY ROAD
N.T.S.

GENERAL NOTES

CLASS OF CONCRETE

• DECK AND PIER COLUMNS	35MPa
• REMAINDER	30MPa

REINFORCING STEEL

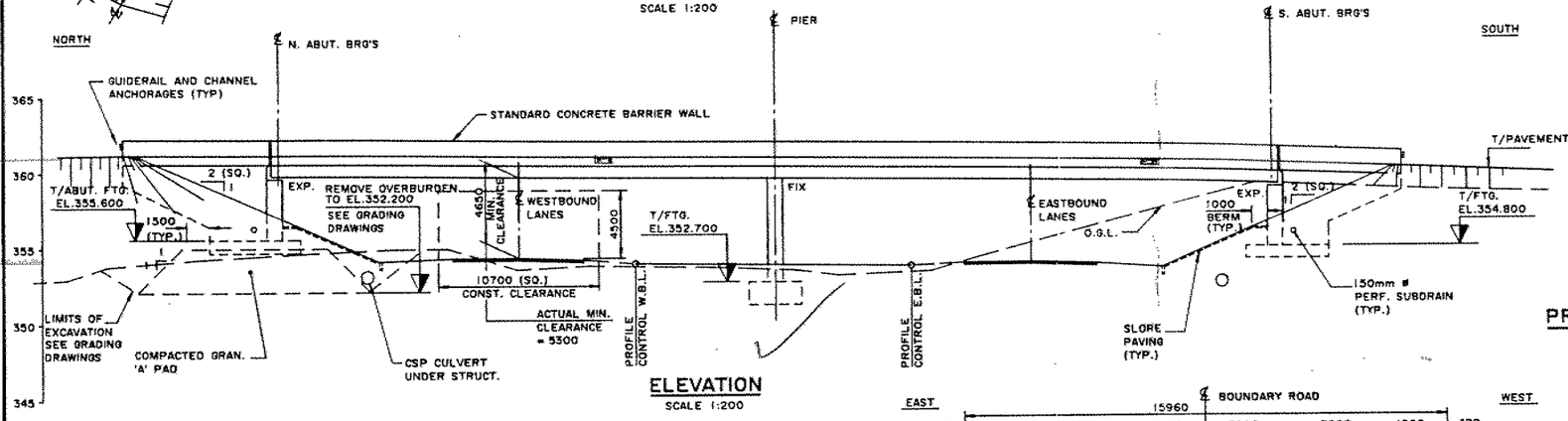
• REINFORCING STEEL SHALL BE GRADE 400 UNLESS OTHERWISE SPECIFIED. BAR MARKS WITH SUFFIX "C" DENOTE COATED BARS.

CLEAR COVER TO REINFORCING STEEL

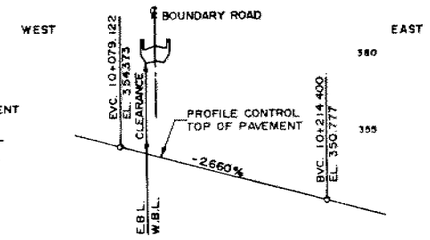
• FOOTINGS		100 ±25mm
• ABUTMENTS, WINGWALLS	FRONT FACE	80 ±20mm
	BACK FACE	70 ±20mm
• PIER COLUMNS		80 ±20mm
• DECK	TOP	70 ±20mm
	BOTTOM	50 ±10mm
• REMAINDER UNLESS OTHERWISE NOTED		70 ±20mm

BEARING SEAT ELEVATIONS

• IF THE ACTUAL BEARING HEIGHTS ARE DIFFERENT FROM THE ASSUMED HEIGHTS GIVEN WITH THE BEARING DESIGN DATA, THE CONTRACTOR SHALL ADJUST THE BEARING SEAT ELEVATIONS AND THE REINFORCING STEEL TO SUIT THE ACTUAL HEIGHTS.

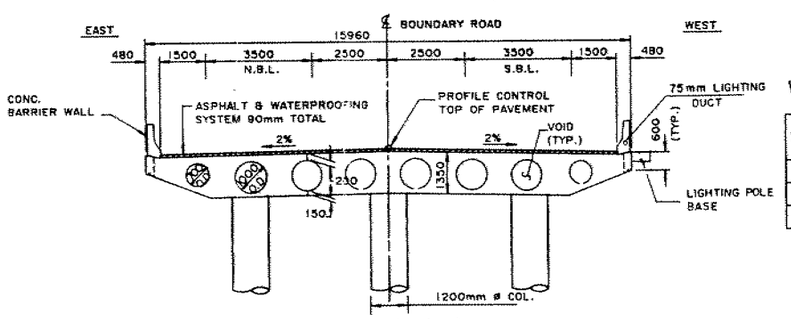


ELEVATION
SCALE 1:200



PROFILE ALONG E.B.L. & W.B.L. HWY. 115
N.T.S.

LIST OF DRAWINGS



SECTION A-A
SCALE 1:100

WORKING POINTS DATA

WP	CO-ORDINATES	
	NORTH	EAST
1	4 882 300.109	376 509.329
2	4 882 297.611	376 542.736
3	4 882 295.113	376 576.143

APPLICABLE STANDARD DRAWINGS

OD-3502	MINIMUM GRANULAR BACKFILL REQUIREMENTS
OD-3503	MINIMUM GRANULAR BACKFILL REQUIREMENTS
OD-4602	FALSEWORK CLEARANCES

REGISTERED PROFESSIONAL ENGINEER — L. L. ALEONG — PROVINCE OF ONTARIO

REGISTERED PROFESSIONAL ENGINEER — G. O. LODIN — PROVINCE OF ONTARIO

MTC B.M. 748537
EL. 355.815
TABLET SET IN STEEL ROD WITH BRASS CAP 21cm N OF S R/W FENCE 11.1m S OF N POLE AND IS MARKED BY A MARKER POST SET 43m N OF BM 32.5 RT 10+076.1 ROUTE 114.

DRAWING NOT TO BE SCALED
100 mm ON ORIGINAL DRAWING

REVISIONS	DATE	BY	DESCRIPTION

DESIGN G.O.L.	CHK W.L.	CODE OHBDC B3	LOAD CLASS 'A'	DATE JUNE, 1990	
DRAWN P.S.H.	CHK G.L.A.	SITE 21-440	STRUCT	SCHEME	DWG 1

18239C

CONSTRUCTION NORTH

METRIC

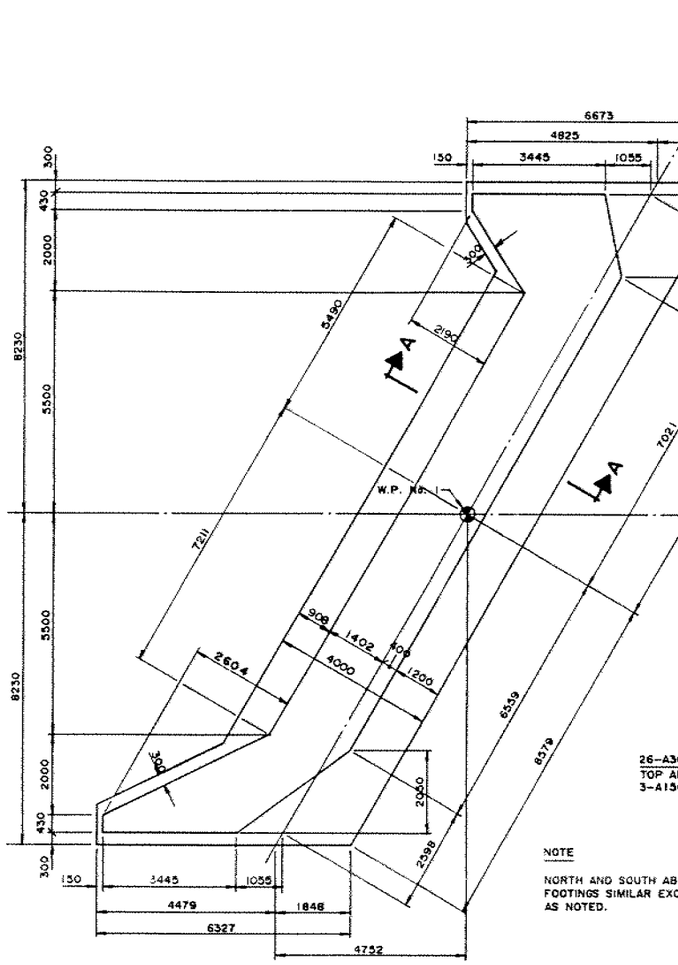
DIMENSIONS ARE IN METRES AND/OR MILLIMETRES UNLESS OTHERWISE SHOWN

DISTRICT No. 7
CONT No
WP No 74-70-11

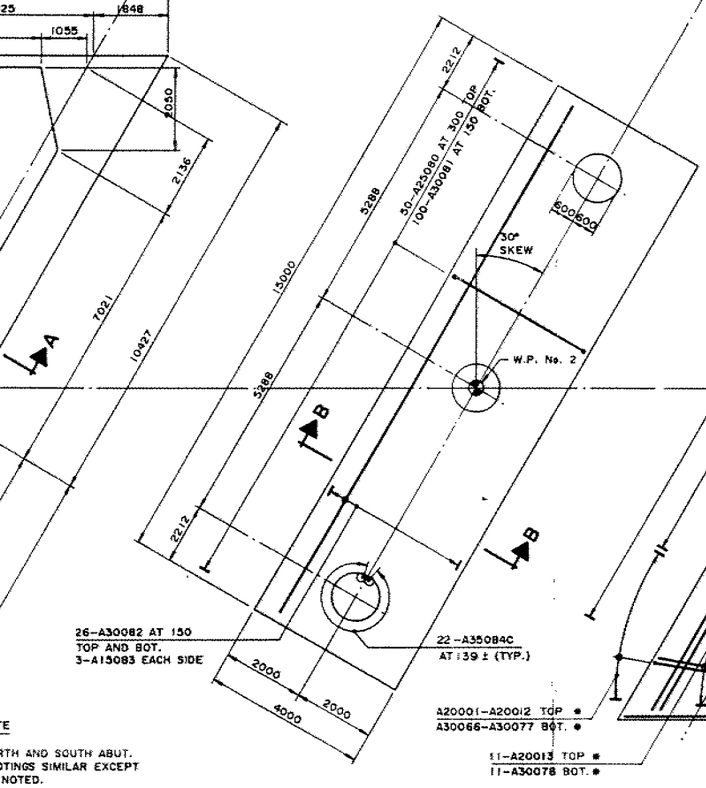
VICTORIA/DURHAM
BOUNDARY ROAD
UNDERPASS
FOOTINGS

SHEET

totten sims hubicki associates
ENGINEERS ARCHITECTS AND PLANNERS



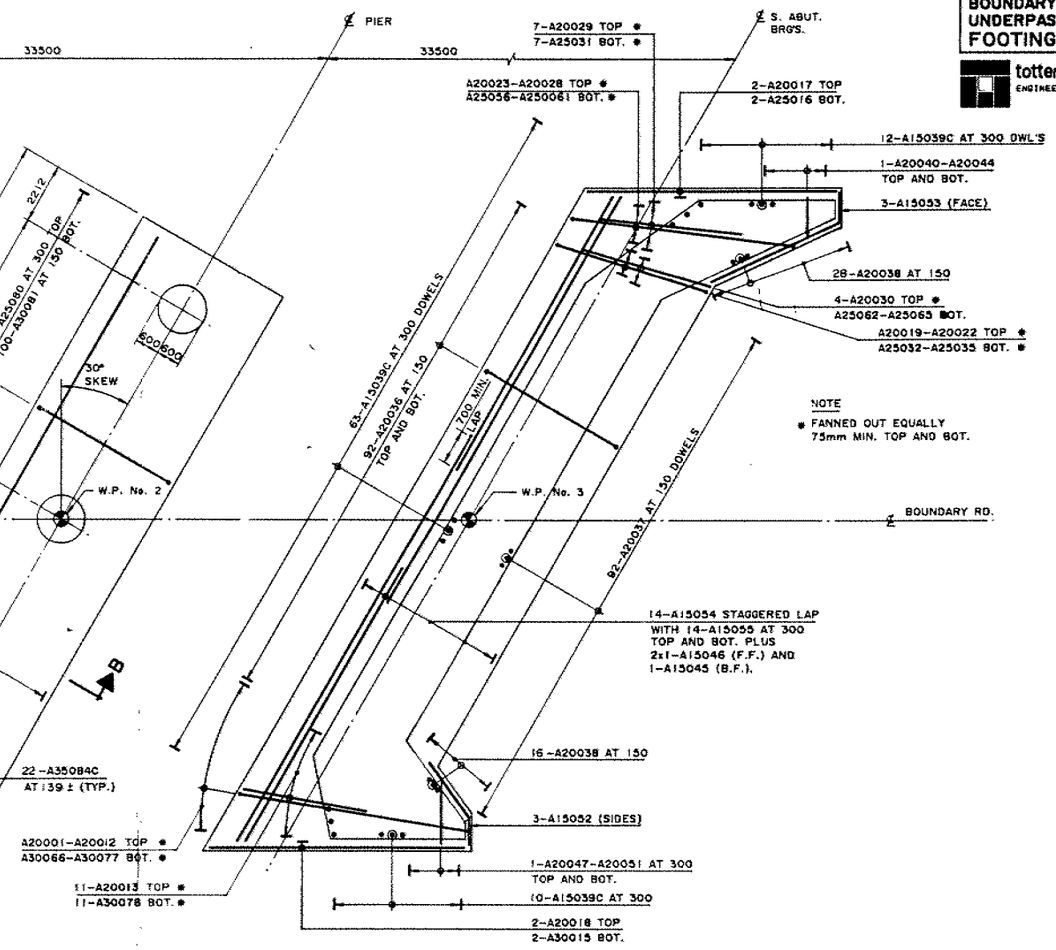
DIMENSIONS



NOTE

NORTH AND SOUTH ABUT. FOOTINGS SIMILAR EXCEPT AS NOTED.

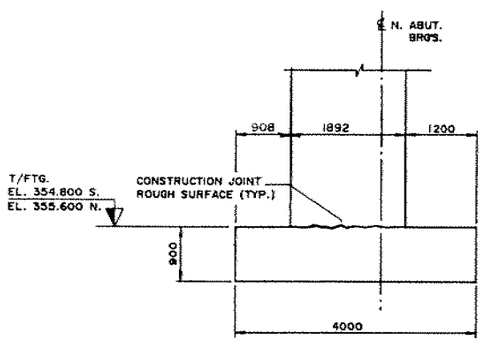
DIMENSIONS AND REINFORCEMENT



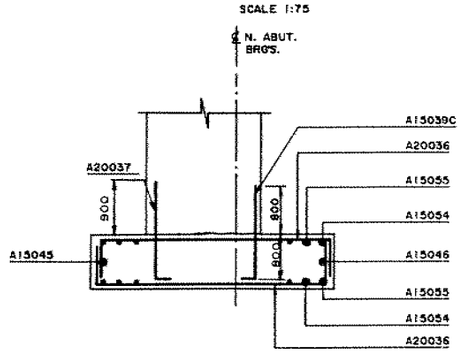
NOTE
* FANNED OUT EQUALLY 75mm MIN. TOP AND BOT.

REINFORCEMENT

PLAN
SCALE 1:75

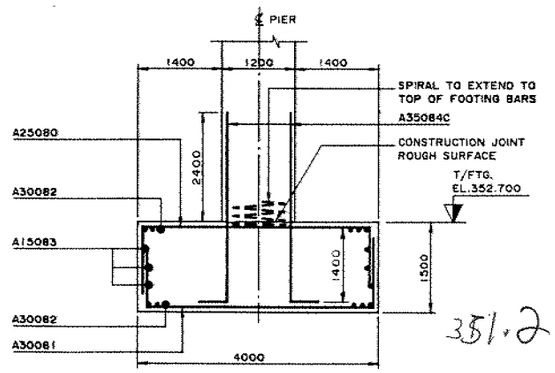


DIMENSIONS



REINFORCEMENT

SECTION A-A
SCALE 1:50



DIMENSIONS AND REINFORCEMENT

SECTION B-B
SCALE 1:50

NOTE

SIDES AND BOTTOM OF SOUTH ABUT. AND PIER FOOTINGS TO BE CAST AGAINST UNDISTURBED SOIL.

351.2

DRAWING NOT TO BE SCALED
100 mm ON ORIGINAL DRAWING

REGISTERED PROFESSIONAL ENGINEER G. L. ALEONG PROVINCE OF ONTARIO

REGISTERED PROFESSIONAL ENGINEER G. O. LODIN PROVINCE OF ONTARIO

REVISIONS		
DATE	BY	DESCRIPTION

DESIGN G.O.L.	CHK W.L.	CODE OHBDC S3	LOAD CLASS 'A'	DATE JUNE, 1990	
DRAWN C.O.T.	CHK G.L.A.	SITE 21-440	STRUCT	SCHEME	DWG 3

TD2446F