DOCUMENT MICROFILMING IDENTIFICATION

G.I.-30 SEPT. 1976

GEOCRES No. 30M13-103

DIST. 6 REGION

W.P. No. 88-78-13(B)

CONT. No.

W. O. No.

STR. SITE No. 37-1341

HWY. No. 407

LOCATION RAINBOW CREEK CULVERT (RE-ALIGNMENT)

No. of Pages -

OVERSIZE DRAWINGS TO BE INCLUDED WITH THIS REPORT.

REMARKS:

FILE COPY
1 of 2

Ministry
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Ontario

FOUNDATION DESIGN SECTION

foundation investigation and design report

ENGINEERING MATERIALS OFFICE
FOUNDATION DESIGN SECTION

WP 88-78-13 DIST 6

HWY 407 STR SITE 37-1341

Rainbow Creek Culvert
at Highway 407/Kipling Avenue I.C.

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The results of the laboratory testing are plotted on the Record of Borehole sheets and are also summarized in Figures 1 through 4.

SUBSURFACE CONDITIONS

General

The subsurface conditions across the site are variable. However, in general, boreholes advanced for the Rainbow Creek culvert reveal a surficial deposit of peat to organic silt ranging from 1.1 m to 1.8 m thick. The organic material is underlain by a gravelly sand deposit extending for a thickness of 1.8 m to 2.3 m. The gravelly sand material typically overlies a clayey silt to silt deposit ranging from 2.1 m to greater than 7.9 m thick. The clayey silt to silt deposit was generally found to be underlain by a silty sand deposit that exceeds 3.8 m in thickness.

The subsurface conditions across the valley floor are composed of a combination of water-laid and glacial deposits. Although no artesian conditions were encountered, previous investigations conducted in the area reveal that the cohesive clayey silt to silt deposit often confines water-bearing silty sand strata. When the non-cohesive strata are exposed artesian pressures may be encountered.

Along the length of the proposed culvert, the groundwater level varied from 1.2 m to 2.0 m below ground surface.

The boundaries of the different strata, together with the field and laboratory test results, appear on the Record of Borehole sheets appended to this Report. Refer to these sheets for the locations and elevations of the boreholes (BH 1, 2, 3, 3A, 4, 4A, 5, 5A, 6 and 7). A stratigraphical profile of the subsurface conditions are shown on Dwg. No. 887813-A. Detailed descriptions of the different strata are provided below.

Peat to Organic Silt

A surficial deposit varying in composition from peat to organic silt was encountered in all but BH's 1, 2 and 3, advanced at the northerly end of the site. At the borehole locations, it extends from ground surface to depths ranging from 1.1 m to 1.8 m. This cohesive stratum is largely fibrous containing some sand as well as fragments of wood and gravel.

The 'N' values obtained from field testing range from 2 to 6 indicating a consistency that varies from very soft to firm. The material exhibits slight to low plasticity. The following physical properties were obtained from a single Atterberg Limits test:

Natural Moisture Content (%)	269.0
Liquid Limit (%)	211.0
Plastic Limit (%)	202.0

Gravelly Sand

A non-cohesive stratum of gravelly sand was encountered at the central and south ends of the site (BH's 3, 3A, 5, 6 and 7). It underlies the organic deposit at all locations except BH 3, where it occurs as the surficial deposit. The stratum was also present as a thin seam of sand and gravel within the clayey silt to silt deposit in BH 4. The thickness of the deposit varies between 0.6 m to 2.3 m across the site, and was typically encountered between El. 136 m and El. 138 m.

Results of the Standard Penetration Test indicate that 'N' values vary from 4 to 44, but range more commonly from 9 to 18. These values reflect a state of compaction ranging from loose to dense, but more typically from loose to compact. The moisture contents obtained from laboratory testing measured from 13% to 38%.

Refer to Figure 1 for a typical grain size distribution envelope for this material.

Clayey Silt to Silt

A clayey silt to silt deposit was encountered in all the boreholes except BH 3A. The cohesive deposit occurs as the surficial deposit in BH's 1 and 2 advanced at the north end of the site, but is generally present directly beneath the gravelly sand stratum. The clayey silt to silt deposit ranges in thickness from 2.1 to 6.1 m where its boundaries were identified. However, the borings were commonly terminated in this deposit. The clayey silt to silt stratum contains varying proportions of sand, trace gravel and occasional sand seams. The deposit is glacial in origin and is typically a glacial till. However, the clayey silt to silt encountered in BH's 5 and 6 contained a very small percentage of sand and its homogeneous nature is indicative of glacio-lacustrine deposition.

'N' values ranging from 7 to in excess of 120 were obtained during field testing reflecting a consistency ranging from firm to hard. More typically, the 'N' values exceed 20 blows per 30 cm indicating a material that is of very stiff to hard consistency. The clayey silt to silt exhibits slight to low plasticity as shown in Figure 2, Plasticity Chart. Laboratory testing yielded the following physical properties:

	Range	Average
Natural Moisture Content (w%)	7.5-22.5	13.5
Liquid Limit (w_L%)	14.5-25.0	19.5
Plastic Limit (wp%)	9.5-19.5	14.0
Unit Weight (kN/m^3)	24.0	

Refer to Figure 3 for the grain size distribution envelope for this material.

Silty Sand

A non-cohesive silty sand deposit was encountered beneath the gravelly sand deposit in BH's 3 and 3A, beneath the clayey silt to silt deposit in BH 5 and interbedded with the clayey silt strata in BH's 2 and 4. Boring was terminated in this deposit at BH's 3A and 5. The thickness of the strata

at the remaining borehole locations varies from 1.9 m to 3.8 m. The silty sand material contains trace gravel and trace clay. This composition makes it sensitive to disturbance under conditions of unbalanced hydrostatic head.

The 'N' values for this material vary from 21 to greater than 120 blows, but are more commonly found to exceed 40 blows. These values reflect a state of compaction ranging from compact to very dense, but more typically from dense to very dense. The moisture contents obtained from laboratory testing measured from 16.5% to 19.0%.

The grain size distribution of the silty sand stratum is sketched in envelope form in Figure 4.

GROUNDWATER CONDITIONS

Groundwater levels were measured in the open boreholes during the investigation. Although no artesian condition was encountered in the boreholes advanced at this site, the presence of this condition in the silty sand stratum is possible since artesian pressures were encountered during previous investigations conducted in the immediate vicinity of the site. In addition, natural springs were observed at two separate locations.

The groundwater elevations recorded at the time of the investigation are tabled below and are plotted on the Record of Borehole sheets and stratigraphical profile.

Borehole	Elevation (m)
1	139.1
2	138.5
3	137.7
3A	Not established
4	139.2
5	Not established
6	137.8
7	137.1

The elevation of the creek, at the time of the investigation was approximately 137.5 m, considerably higher than that observed during the soils investigation conducted during the period from 89 08 22 to 89 09 14 (136.5 m±). The increased water flow resulted from a combination of unseasonably warm winter temperatures and heavy rainfall.

RECOMMENDATIONS

It is proposed to divert Rainbow Creek east of its present course via twin 6.0 m x 4.0 m concrete box culverts for a distance of 290 m. The proposed invert elevation at the inlet is 137.4 m and 135.95 m at the outlet. The culverts will be overlain with varying amounts of fill ranging from no cover for a section between Kipling Avenue and Highway 407, to a height of approximately 7.4 m at the proposed Highway 407 crossing.

Structure Foundations

The subsurface material across the proposed culvert site was found to be fairly competent for shallow foundations. However, the length of the culverts is extensive and will be founded on subsurface materials of varying compositions and strengths.

The twin box culverts may be founded on spread footings placed 1.0 m below the proposed invert elevations.

The bearing capacities recommended for much of the culvert length, as per the O.H.B.D.C., are as follows:

Factored Bearing Capacity at U.L.S.	450 kPa
Bearing Capacity at S.L.S. Type II	300 kPa

A section of the proposed culverts between Sta. 9+950 and 10+050 was found to be slightly less competent due to the presence of more extensive depths of organic material. As a result, it is recommended that the following design values be applied through this area:

Factored Bearing Capacity at U.L.S.	300 kPa
Bearing Capacity at S.L.S. Type II	200 kPa

From a previous investigation conducted in the vicinity of the culvert site, artesian conditions were encountered at some borehole locations and not at others. Although no artesian conditions were experienced during the

soils investigation for the culvert, the Contractor should be made aware of its potential occurrence. Excavation should proceed with considerable care so as to minimize disturbance of the founding soil in the event that artesian pressures are experienced. It is recommended that no excavation should extend more then 0.5 m below the culvert invert.

The culvert footings should be constructed in the 'dry'. Since the excavation for the culverts will progress 1.0 m to 2.0 m below the prevailing groundwater level, a dewatering scheme will be required. The silty sand deposit, which occurs at random elevations across the site, is susceptible to conditions of unbalanced hydrostatic head. The presence of the silty sand deposit is fairly irregular and its precise location can be determined only during construction of the excavation.

While the details of the dewatering scheme are the responsibility of the Contractor, one possible method of unwatering would be to construct an oversize excavation with perimeter ditches or drains, combined with a pump at the downstream end. A non-standard special provision will be required in the contract documents for this item.

The slopes of the temporary excavation should be maintained at 1.5H:1V or flatter. It is recommended that excavation begin at the downstream end and proceed in a upstream direction to facilitate drainage. It is suggested that a pilot trench approximately 0.5 m deep, be incorporated in the excavation to prevent ponding of water in the excavation. The pilot trench may be dug along the centreline of the excavation or incorporated into the perimeter ditches and backfilled with compacted free-draining granular material. Provision should be made to allow water in the trench to drain by connecting it to the dewatering system. In addition, the excavation base should be covered with a 300 mm thick pad of granular material within 6 to 8 hours of exposure. The working pad should consist of a compacted free-draining granular material such as Granular 'A' or crushed stone.

Backfill

Backfill to the culvert should be placed in accordance with OPSD 803.03. Backfill should consist of Granular 'A' or Granular 'B'. The following properties may be assumed for design purposes:

	ϕ	γ
Granular 'A'	35°	22.8 kN/m^3
Granular 'B'	30°	21.2 kN/m^3

Native material may be used as backfill and fill material beyond the limits specified in the OPSD, provided that it complies with MTO standards.

The backfill should be placed simultaneously on both sides of the culvert such that the maximum difference in backfill heights does not exceed 300 mm. In addition, the backfill should be placed in lifts not exceeding 300 mm in thickness.

Slope Stability

To achieve the profile grade of Highway 407, fill heights of up to 7.4 m± are required in the vicinity of the culvert. Prior to placement of any fill, all surficial organic material should be removed under the plan limits of embankments. The initial subexcavation should not exceed the depth required for installation of the culvert because of the concerns with artesian conditions. The exposed excavation base should be proof rolled prior to placement of fill material and any soft pockets removed to a maximum depth of 0.5 m below the culvert invert. The subexcavated material should be replaced with compacted granular backfill.

Because the subsurface conditions at this site are similar to those encountered during the investigation for the Kipling Avenue Overpass, the results of the Total Stress Analysis performed at the latter site were applied at the culvert site. No slope stability problems are anticipated

provided that 2H:1V slopes are maintained and that a berm, placed at approximately mid-height, be incorporated where fill heights equal or exceed 6.0 m. The berm width increases with the height of fill as charted in Figure 5. The berms may run out as quickly as is feasible in the area beyond which they are required for stability.

To protect the fill embankments from erosion, the slopes should be treated with a 600 mm granular blanket to the potential high water level approximate El. 143.6 m (as per Marshall Macklin Monaghan memo to Central Region Planning and Design dated 89 11 13). The granular blanket is not required if the embankment fill is composed of granular material. In addition, topsoil should be placed and slope vegetation established as soon as possible after placement of the fill in order to control surficial erosion.

Refer to Figure 6 for a typical section of the slope geometry and treatment.

Settlement

Because of the varying subsurface conditions and the variable loads imposed on the culverts it is anticipated that there will be some minor differential settlement occurring within the subsoil. It is expected that the greatest settlement will occur beneath the Highway 407 crossing where the highest fill will be placed. To compensate for anticipated differential settlements, consideration should be given to incorporating articulated joints at reasonable intervals along the entire length of the culverts, perhaps every 30 m±.

Culvert Treatment

A seal of cohesive material with a minimum thickness of 600 mm is recommended at the culvert inlet. The seal should comply with the requirements outlined in Form 1205 'Material Specification for Clay Seal'. It should extend over the backfill to the culvert from the projected high water level down to the creek bed and 6.0 m along the creek bed.

Transversely, the seal should extend 6.0 m on either side of the culvert. The clay seal is placed to ensure that water flow is channelled through the culvert and does not seep through the backfill. The granular blanket recommended for slope treatment should be placed as required over the clay seal. The blanket should in turn, be overlain by a 600 mm thickness of rock protection to control surficial erosion.

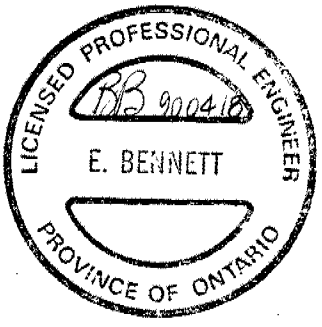
The culvert outlet should be treated with a 600 mm granular blanket overlain by rock protection as per OPSD 810.01 Type A. The treatment should extend for 10 m along the proposed excavated channel, across the channel bed and up to the proposed high water level.

Rainbow Creek Trunk Sewer

The existing Rainbow Creek trunk sewer that crosses the proposed culverts at the outlet is constructed of asbestos concrete and is therefore sensitive to heavy loads. It is recommended that no heavy equipment be operated within 3.0 m of the existing sewer pipe to minimize disturbance. Machine excavation should not be proceed within 1.0 m of the existing pipe. In addition, provision should be made to ensure that there is adequate frost protection for the sewer. The existing drawings indicate that only 1.06 m of earth would cover the sewer following excavation of the channel outlet.

MISCELLANEOUS

The fieldwork for this investigation was carried out by C. Curtis, Engineering Trainee. The drilling equipment was owned and operated by Master Soil Investigations Ltd. of Toronto. The report was prepared by Ms. B. Bennett, Foundation Engineer, under the general supervision of D. Dundas, Senior Foundation Engineer. The report was reviewed by Mr. D. Dundas and approved by Mr. M. Devata, Chief Foundation Engineer.



B Bennett

B. Bennett, P.Eng.
Foundation Engineer

M. Devata

M.S. Devata, P.Eng.
Chief Foundation Engineer

APPENDIX

EXPLANATION OF TERMS USED IN REPORT

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

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

SOILS ARE DESCRIBED BY THEIR COMPOSITION AND CONSISTENCY OR DENSENESS.

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

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

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

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

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

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

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

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

JOINTING AND BEDDING:

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

ABBREVIATIONS AND SYMBOLS

FIELD SAMPLING

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

STRESS AND STRAIN

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

MECHANICAL PROPERTIES OF SOIL

m_v	kPa^{-1}	COEFFICIENT OF VOLUME CHANGE
C_c	1	COMPRESSION INDEX
C_s	1	SWELLING INDEX
C_α	1	RATE OF SECONDARY CONSOLIDATION
c_v	m^2/s	COEFFICIENT OF CONSOLIDATION
H	m	DRAINAGE PATH
T_v	1	TIME FACTOR
U	%	DEGREE OF CONSOLIDATION
σ'_{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. 88-78-13 LOCATION N 4 847 177, E 297 195 ORIGINATED BY CC

DIST 6 HWY 407 BOREHOLE TYPE HS Auger COMPILED BY BB

DATUM Geodetic DATE 90-01-26 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 (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/m³	REMARKS & GRAIN SIZE DISTRIBUTION (%) GR SA SI CL
140.9	GROUND SURFACE										
0.0											
			1	SS	7		140				
			2	SS	75	▼					
	Trace Organics										
			3	SS	38						5 58 26 11
							138				
	CLAYEY SILT to SILT		4	SS	97				o	24.0	5 32 (63)
	Some/With Sand Trace Gravel										
	Occasional silty sand seams		5	SS	110	/23cm					
	Firm to Hard										
			6	SS	89		136				
			7	SS	89						8 62 (30)
			8	SS	101	/28cm					
							134				
133.0			9	SS	101	/26cm					
7.9	End of Borehole										

+3, ×5 : Numbers refer to Sensitivity

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

RECORD OF BOREHOLE No 2 1 OF 1 METRIC

W.P. 88-78-13 LOCATION N 4 847 144, E 297 230 ORIGINATED BY CC

DIST 6 HWY 407 BOREHOLE TYPE Cone Test, HS Auger COMPILED BY BB

DATUM Geodetic DATE 90-01-26 CHECKED BY DD

ELEV / DEPTH	DESCRIPTION	STRAT PLOT	SAMPLES NUMBER	SAMPLES TYPE	SAMPLES 'N' VALUES	GROUND WATER CONDITIONS	REMARKS & GRAIN SIZE DISTRIBUTION (%) GR SA SI CL
140.5	GROUND SURFACE						
0.0	CLAYEY SILT to SILT Some/With Sand Trace Gravel Trace Organics Occasional silty sand seams Stiff		1	SS	10		
			2	SS	14	▼	
138.4							
2.1	SILTY SAND Trace Gravel Trace Clay Dense to Very Dense		3	SS	32		
			4	SS	75		1 50 45 4
			5	SS	99		
			6	SS	109		
			7	SS	71		
134.6							
5.9	CLAYEY SILT to SILT Some/With Sand Trace Gravel Hard		8	SS	104	/26cm	4 36 (60)
132.7			9	SS	106	/23cm	
7.8	End of Borehole						

ELEVATION SCALE: 140, 138, 136, 134

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

120/28cm

PLASTIC LIMIT w_P NATURAL MOISTURE CONTENT w LIQUID LIMIT w_L

WATER CONTENT (%): 10 20 30

UNIT WEIGHT γ kN/m³

+³, ×⁵: Numbers refer to Sensitivity

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

RECORD OF BOREHOLE No 3 — 1 OF 1 — METRIC

W.P. 88-78-13 LOCATION N 4 847 112, E 297 268 ORIGINATED BY CC
DIST 6 HWY 407 BOREHOLE TYPE Cone Test, HS Auger COMPILED BY BB
DATUM Geodetic DATE 90-01-29 CHECKED BY DD

ELEV / DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE	'N' VALUES	GROUND WATER CONDITIONS	REMARKS & GRAIN SIZE DISTRIBUTION (%) GR SA SI CL
139.2	GROUND SURFACE						
0.0	GRAVELLY SAND Some Silt Trace Clay Compact		1	SS	16		
137.4			2	SS	10		
1.8	SILTY SAND Trace Gravel Trace Clay Dense to Very Dense		3	SS	53		1 73 24 2
135.5			4	SS	85		
3.7	CLAYEY SILT to SILT Some/With Sand Trace Gravel Hard		5	SS	102 /23cm		6 39 (55)
			6	SS	104 /23cm		
			7	SS	105 /31cm		
			8	SS	106 /26cm		
131.1			9	SS	108 /28cm		
8.1	End of Borehole						

ELEVATION SCALE: 138, 136, 134, 132

DYNAMIC CONE PENETRATION RESISTANCE PLOT: 20 40 60 80 100
120/23cm

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

+^{3}, ×^{5} : Numbers refer to Sensitivity

20
15 ◇ 5 (%) STRAIN AT FAILURE
10

RECORD OF BOREHOLE No 3A 1 OF 1 METRIC

W.P. 88-78-13 LOCATION N 4 847 130.0, E 297 271.1 ORIGINATED BY CC, BB

DIST 6 HWY 407 BOREHOLE TYPE Cone Test, HS Auger COMPILED BY CC

DATUM Geodetic DATE 90-01-30 CHECKED BY DD

SOIL PROFILE			SAMPLES			GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT / SHEAR STRENGTH kPa	PLASTIC LIMIT w_P / NATURAL MOISTURE CONTENT w / LIQUID LIMIT w_L	UNIT WEIGHT	REMARKS & GRAIN SIZE DISTRIBUTION (%)
ELEV / DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE	'N' VALUES			20 40 60 80 100	WATER CONTENT (%) 10 20 30	γ kN/m^3	GR SA SI CL
140.0 / 0.0	GROUND SURFACE										
	PEAT to ORGANIC SILT Some Sand Black Fibrous Soft to Stiff		1	SS	3						
138.2			2	SS	10						
1.8 / 137.6	GRAVELLY SAND Some Sand Trace Clay Compact						138				
2.4	Some Gravel		3	SS	21				o		11 80 (9)
			4	SS	54				o		0 89 6 5
	SILTY SAND Trace Gravel Trace Clay Dense to Very Dense		5	SS	101	/26cm	136				
			6	SS	105			125			
			7	SS	37				o		0 83 13 4
							134				
			8	SS	65						
132.1			9	SS	102	/28cm					
7.9	End of Borehole										

* Water Level Not Established

+3, x5 : Numbers refer to Sensitivity

20
15 ◇ 5 (%) STRAIN AT FAILURE
10

RECORD OF BOREHOLE No 4 1 OF 1 METRIC

W.P. 88-78-13 LOCATION N 4 847 101.0, E 297 321.5 ORIGINATED BY CC

DIST 6 HWY 407 BOREHOLE TYPE Cone Test, HS Auger COMPILED BY CC,BB

DATUM Geodetic DATE 90-01-30/31 CHECKED BY DD

SOIL PROFILE ELEV/DEPTH	DESCRIPTION	STRAT PLOT	SAMPLES NUMBER	TYPE	'N' VALUES	GROUND WATER CONDITIONS	ELEVATION SCALE
140.4	GROUND SURFACE						
0.0	PEAT to ORGANIC SILT Some Sand Black Fibrous						
139.3	Soft to Firm		1	SS	5	▼	
1.1	Sand and Gravel		2	SS	15		
	CLAYEY SILT to SILT Some/With Sand Trace Gravel		3	SS	49		
	Occasional silty sand seams						
136.7	Stiff to Hard		4	SS	52		
3.7	SILTY SAND Trace Gravel Trace Clay		5	SS	48		
	Dense to Very Dense		6	SS	62		
			7	SS	49		
133.5			8	SS	43		
6.9	CLAYEY SILT to SILT Some/With Sand Trace Gravel						
132.3	Hard		9	SS	98		
8.1	End of Borehole						

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

ELEVATION SCALE: 140, 138, 136, 134

120/25cm

UNIT WEIGHT γ kN/m³

REMARKS & GRAIN SIZE DISTRIBUTION (%)	GR	SA	SI	CL
	20	48	25	7
	0	85	13	2

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

20
15 ◇ 5 (%) STRAIN AT FAILURE
10

RECORD OF BOREHOLE No 4A 1 OF 1 METRIC

W.P. 88-78-13 LOCATION N 4 847 084.0, E 297 335.5 ORIGINATED BY BB, CC

DIST 6 HWY 407 BOREHOLE TYPE Cone Test, Vane Test COMPILED BY CC

DATUM Geodetic DATE 90-02-01 CHECKED BY DD

SOIL PROFILE			SAMPLES			GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT / SHEAR STRENGTH kPa	WATER CONTENT (%)	UNIT WEIGHT	REMARKS & GRAIN SIZE DISTRIBUTION (%)
ELEV / DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE	'N' VALUES			20 40 60 80 100	PLASTIC LIMIT w_P — NATURAL MOISTURE CONTENT w — LIQUID LIMIT w_L	γ kN/m³	GR SA SI CL
139.4 GROUND SURFACE								o UNCONFINED + FIELD VANE; • QUICK TRIAXIAL × LAB VANE	10 20 30		
0.0	Probable PEAT to ORGANIC SILT Some Sand Black Fibrous					*		+3			
137.9							138				
1.5	Probable GRAVELLY SAND Some Silt Trace Clay										
136.7											
2.7	Probable CLAYEY SILT to SILT Some Sand Trace Gravel						136				
135.4											
4.0	End of Cone Test										

* Water Level Not Established

+3, ×5 : Numbers refer to Sensitivity

20
15 ◇ 5 (%) STRAIN AT FAILURE
10

RECORD OF BOREHOLE No 5 1 OF 1 METRIC

W.P. 88-78-13 LOCATION N 4 847 063.0, E 297 368.7 ORIGINATED BY CC

DIST 6 HWY 407 BOREHOLE TYPE Cone Test, HS Auger COMPILED BY CC,BB

DATUM Geodetic DATE 90-01-31/90-02-01 CHECKED BY DD

ELEV / DEPTH	DESCRIPTION	STRAT PLOT	SAMPLES NUMBER	SAMPLES TYPE	SAMPLES 'N' VALUES	GROUND WATER CONDITIONS	ELEVATION SCALE
139.5	GROUND SURFACE						
0.0	PEAT TO ORGANIC SILT Some Sand Block Fibrous Very Soft		1	SS	2	*	
137.7			2	SS	2		138
1.8	GRAVELLY SAND Some Silt Trace Clay Very Loose to Compact		3	SS	4		
135.7			4	SS	18		136
3.8	CLAYEY SILT to SILT Trace Sand Very Stiff		5	SS	26		
			6	SS	25		
			7	SS	24		134
			8	SS	22		
			9	SS	18		132
			10	SS	27		
129.6							130
9.9	SILTY SAND Trace Gravel Trace Clay						
128.4	Very Dense		11	SS	64		
11.1	End of Borehole						

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

w=269, w_P=202, w_L=211

120/25cm

UNIT WEIGHT γ kN/m³

REMARKS & GRAIN SIZE DISTRIBUTION (%)

	GR	SA	SI	CL
o	0	56	40	4
	0	3		(97)
	0	1		(99)

* Water Level not Established

+3, ×5 : Numbers refer to Sensitivity

20
15 ◇ 5 (%) STRAIN AT FAILURE
10

RECORD OF BOREHOLE No 5A 1 OF 1 METRIC

W.P. 88-78-13 LOCATION N 4 847 046.2, E 297 412.8 ORIGINATED BY CC

DIST 6 HWY 407 BOREHOLE TYPE Cone Test COMPILED BY CC

DATUM Geodetic DATE 90-02-01 CHECKED BY DD

SOIL PROFILE			SAMPLES			GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT / SHEAR STRENGTH kPa	PLASTIC LIMIT w_P / NATURAL MOISTURE CONTENT w / LIQUID LIMIT w_L	UNIT WEIGHT	REMARKS & GRAIN SIZE DISTRIBUTION (%)
ELEV / DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE	'N' VALUES			20 40 60 80 100	WATER CONTENT (%) 10 20 30	γ kN/m^3	GR SA SI CL
138.9 GROUND SURFACE								o UNCONFINED + FIELD VANE; • QUICK TRIAXIAL × LAB VANE; 20 40 60 80 100			
0.0	Probable PEAT to ORGANIC SILT Some Sand Block Fibrous					*	138				
136.8											
2.1	Probable GRAVELLY SAND Some Silt Trace Clay						136				
135.2											
3.7	Probable CLAYEY SILT to SILT Some Sand Trace Gravel										
134.6											
4.3	End of Cone Test										

* Water Level Not Established

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

20
15 ◇ 5 (%) STRAIN AT FAILURE
10

RECORD OF BOREHOLE No 6 1 OF 1 METRIC

W.P. 88-78-13 LOCATION N 4 847 019.5, E 297 463.7 ORIGINATED BY CC

DIST 6 HWY 407 BOREHOLE TYPE Cone Test, HS Auger COMPILED BY CC,BB

DATUM Geodetic DATE 90-01-31 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 / SHEAR STRENGTH kPa (o UNCONFINED, • QUICK TRIAXIAL, + FIELD VANE, × LAB VANE)	PLASTIC LIMIT w_P / NATURAL MOISTURE CONTENT w / LIQUID LIMIT w_L / WATER CONTENT (%)	UNIT WEIGHT γ kN/m³	REMARKS & GRAIN SIZE DISTRIBUTION (%) GR SA SI CL
139.0	GROUND SURFACE							20 40 60 80 100	10 20 30		
0.0	PEAT to ORGANIC SILT Some Sand Black Fibrous										
137.6	Firm		1	SS	6	▼	138				
1.4	GRAVELLY SAND Some Silt Trace Clay		2	SS	5						
	Loose		3	SS	9				o		31 58 10 1
135.8							136				
3.2	Trace Gravel Some Sand		4	SS	31				d		7 15 70 8
			5	SS	43						
	CLAYEY SILT to SILT Trace Sand Hard		6	SS	55		134				
			7	SS	43				b		0 1 (99)
			8	SS	55						
							132				
130.9			9	SS	52						
8.1	End of Borehole										

+3, ×3 ; Numbers refer to Sensitivity

20
15 ◇ 5 (%) STRAIN AT FAILURE
10

RECORD OF BOREHOLE No 7 1 OF 1 METRIC

W.P. 88-78-13 (88-78-02) LOCATION N 4 847 032, E 297 422 ORIGINATED BY DC

DIST 6 HWY 407 BOREHOLE TYPE Cone Test, HS Auger COMPILED BY BB

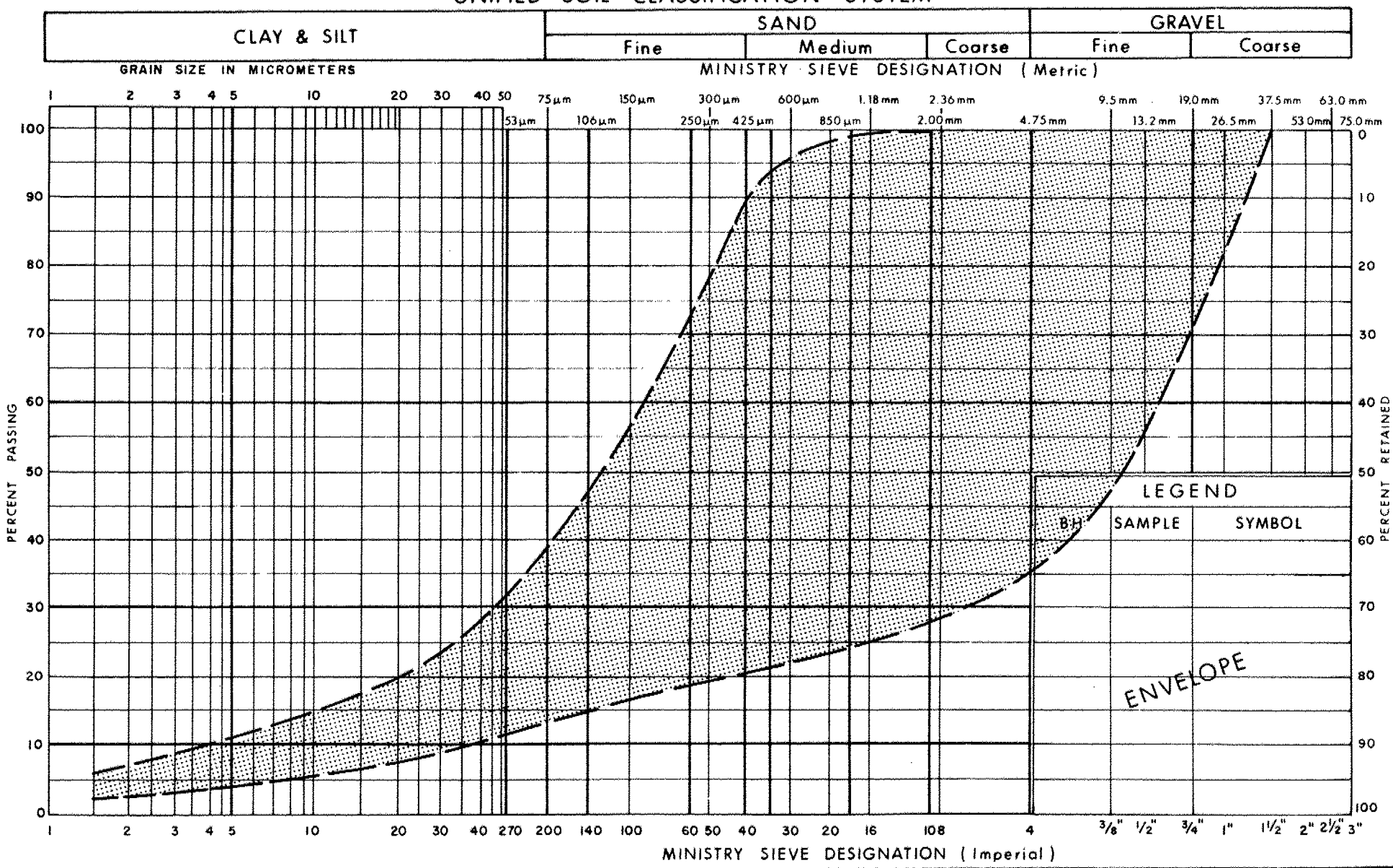
DATUM Geodetic DATE 89-09-12 CHECKED BY DD

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 (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
138.9	GROUND SURFACE										
0.0	PEAT to ORGANIC SILT Some Sand Black Fibrous Firm		1	SS	3		138				0 40 59 1
137.5											
1.4	GRAVELLY SAND Some Silt Trace Clay Compact		2	SS	11	▼			o		16 47 32 5
			3	SS	23						
135.2			4	SS	44		136				
3.7	CLAYEY SILT to SILT Some Sand Trace Gravel Hard		5	SS	70			140 25cm			
			6	SS	61		134				
132.3			7	SS	63						
6.6	End of Borehole										

+3, ×5 : Numbers refer to Sensitivity

20
15 ◇ 5 (%) STRAIN AT FAILURE
10

UNIFIED SOIL CLASSIFICATION SYSTEM



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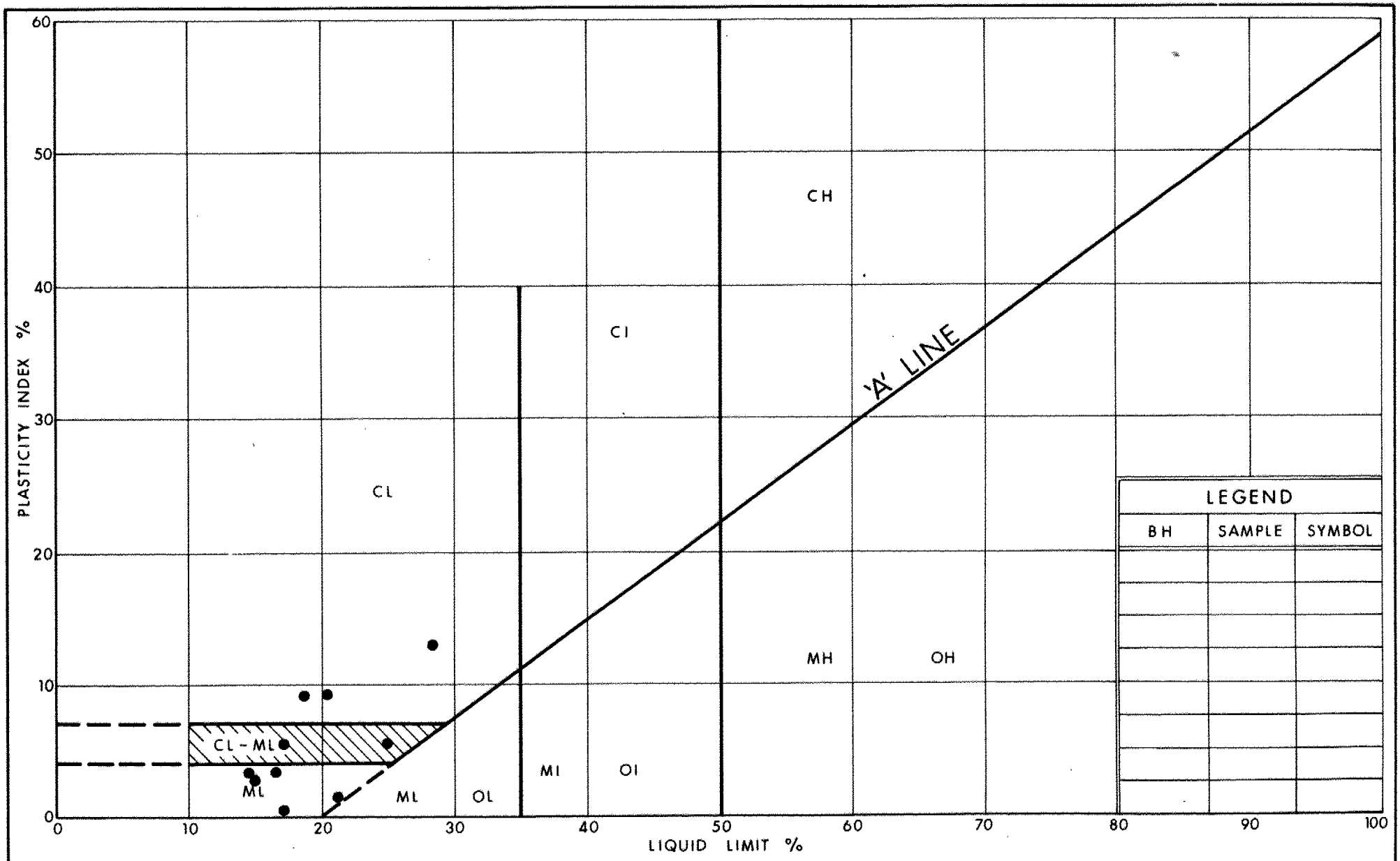
Ontario

GRAIN SIZE DISTRIBUTION
GRAVELLY SAND
SOME SILT , TRACE CLAY

FIG No 1
W P 88-78-13

Oct 75, FF-S-21



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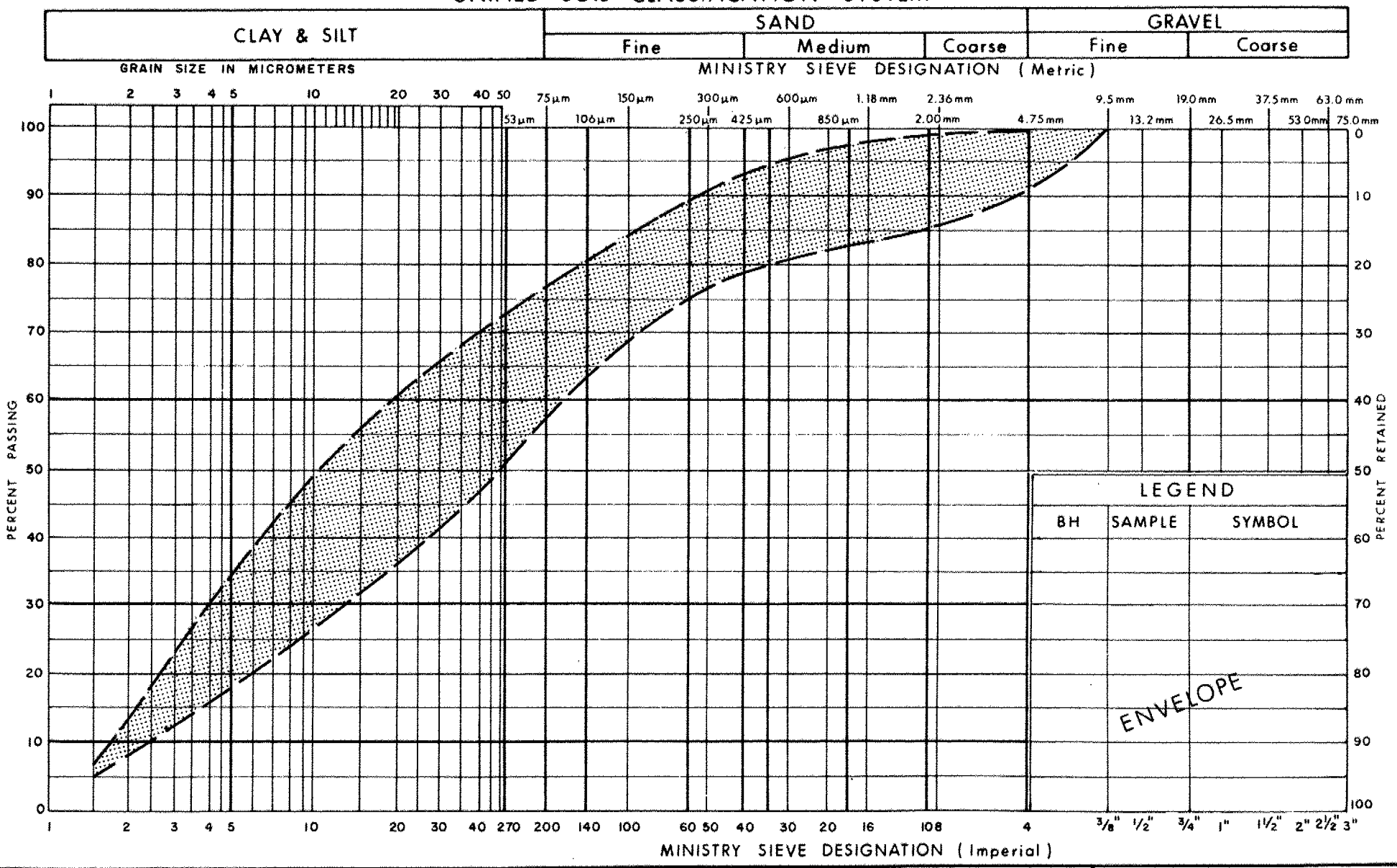
Ontario

PLASTICITY CHART
CLAYEY SILT TO SILT
SOME/WITH SAND, TRACE GRAVEL

FIG No 2
W P 88-78-13

78 12 M

UNIFIED SOIL CLASSIFICATION SYSTEM



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Ontario

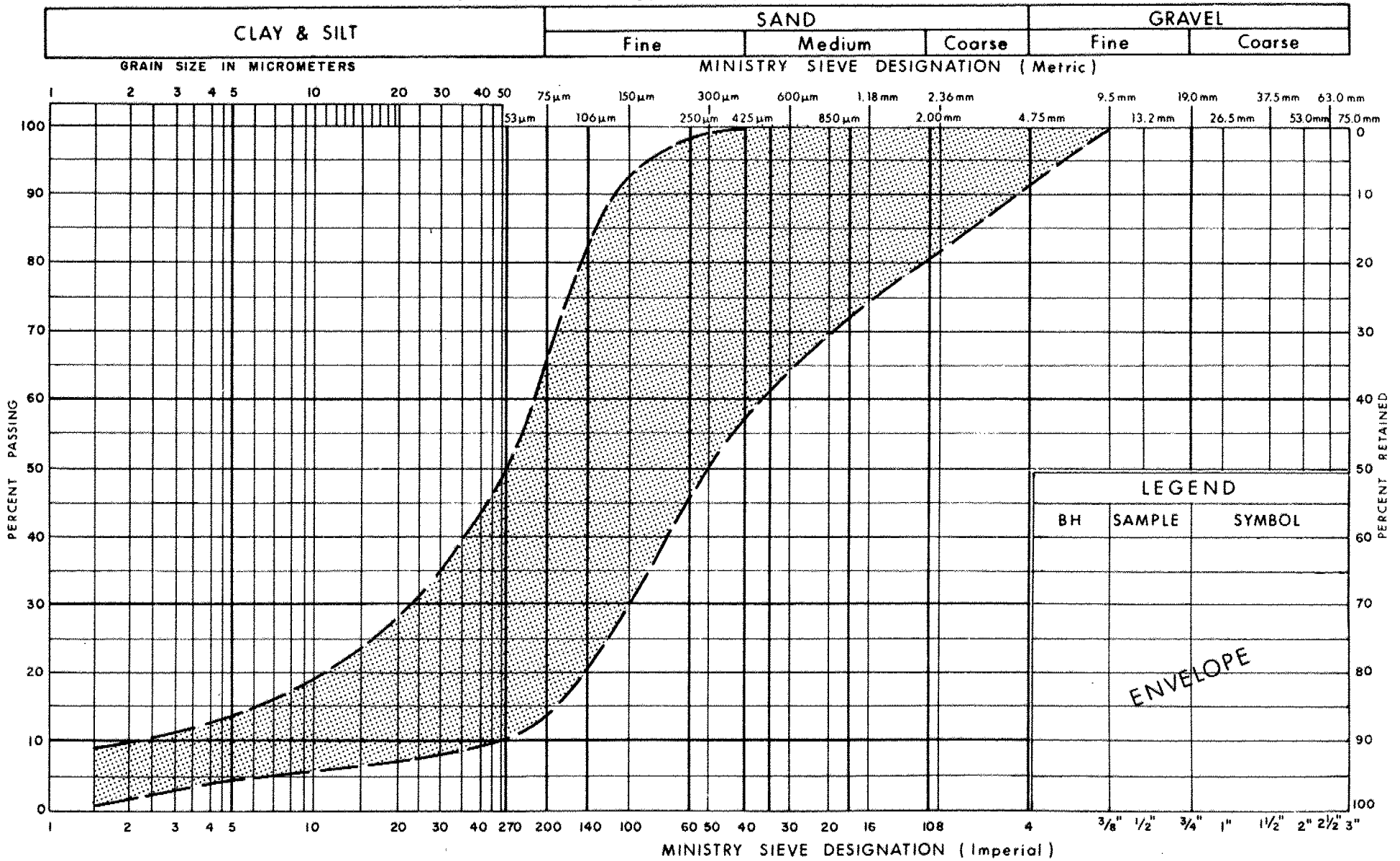
GRAIN SIZE DISTRIBUTION
CLAYEY SILT TO SILT
SOME/WITH SAND, TRACE GRAVEL

FIG No 3

W P 88-78-13

78 12 M

UNIFIED SOIL CLASSIFICATION SYSTEM



Ministry of Transportation
Ontario

GRAIN SIZE DISTRIBUTION
SILTY SAND
TRACE GRAVEL, TRACE CLAY

FIG No 4
W P 88-78-13

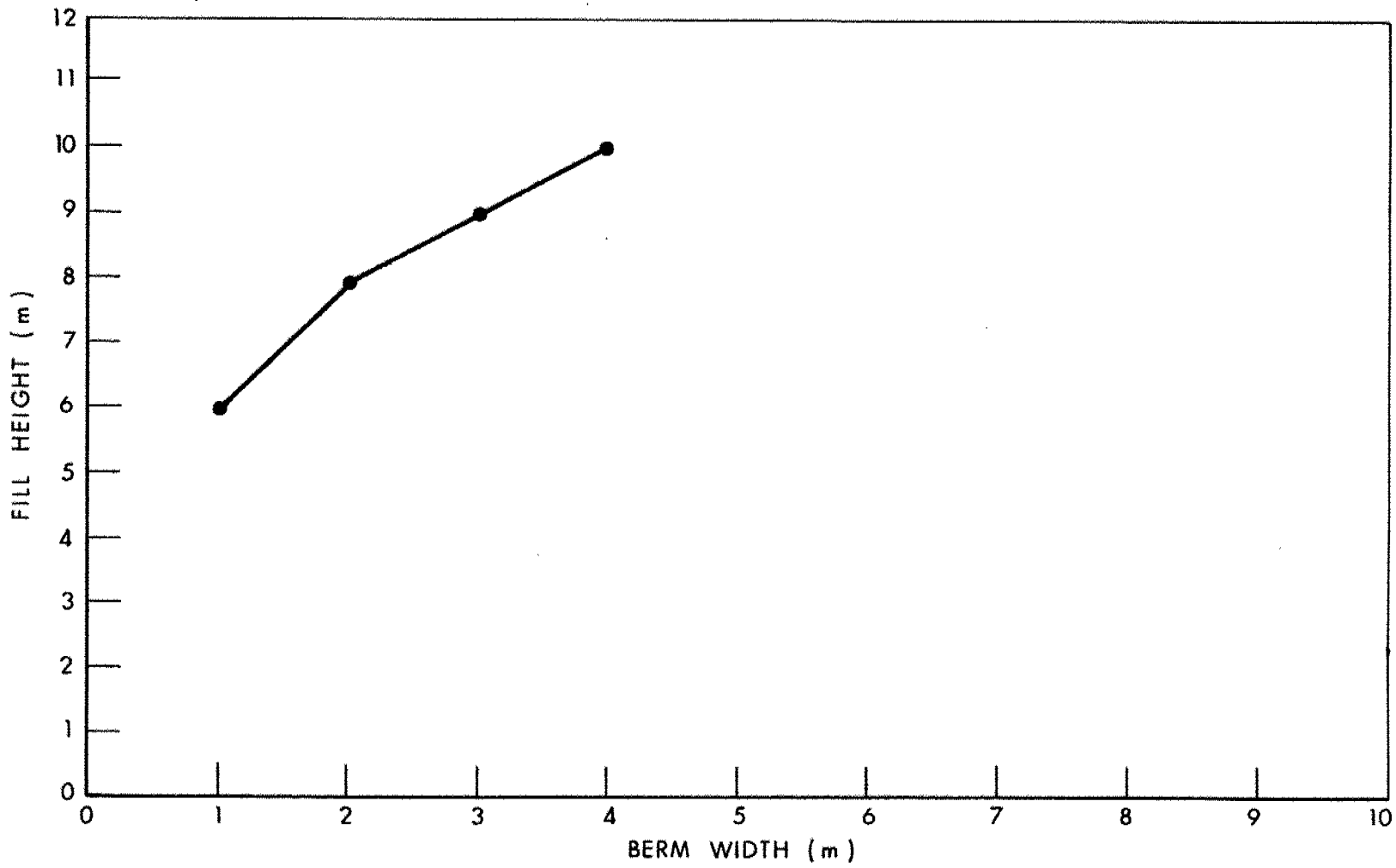
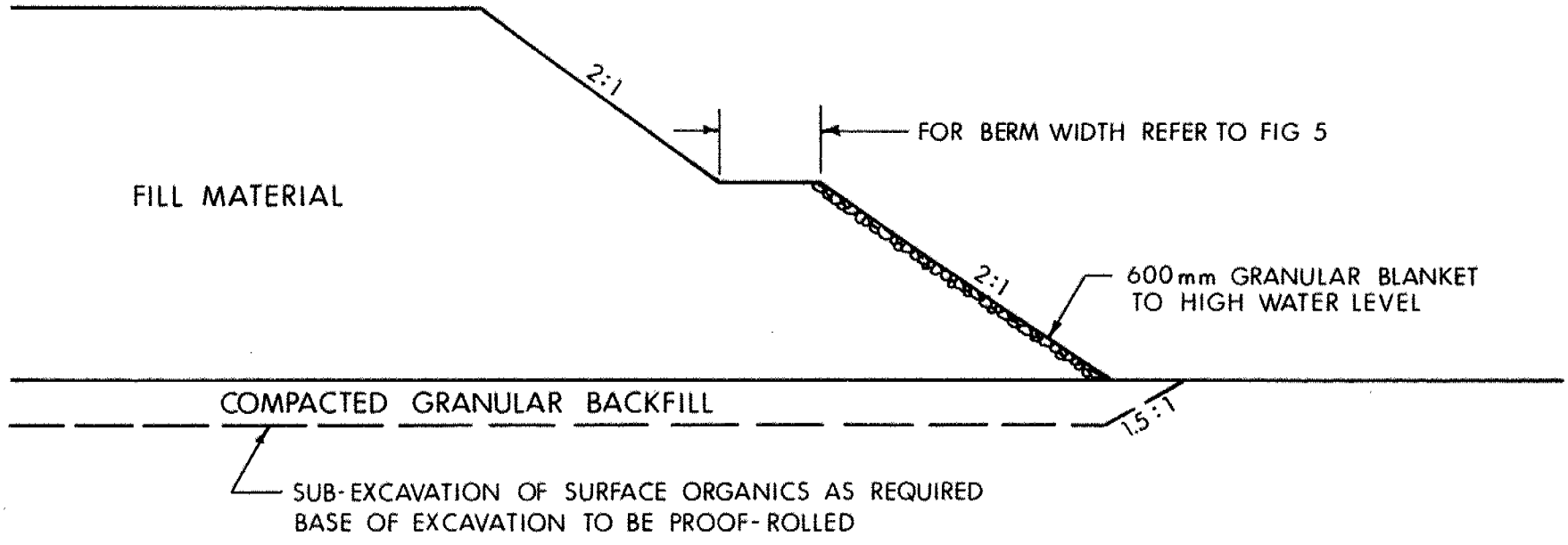


FIG 5- FILL HEIGHT versus BERM WIDTH

WP 88-78-13



NTS

FIG 6 - SLOPE GEOMETRY AND TREATMENT

WP 88-78-13

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

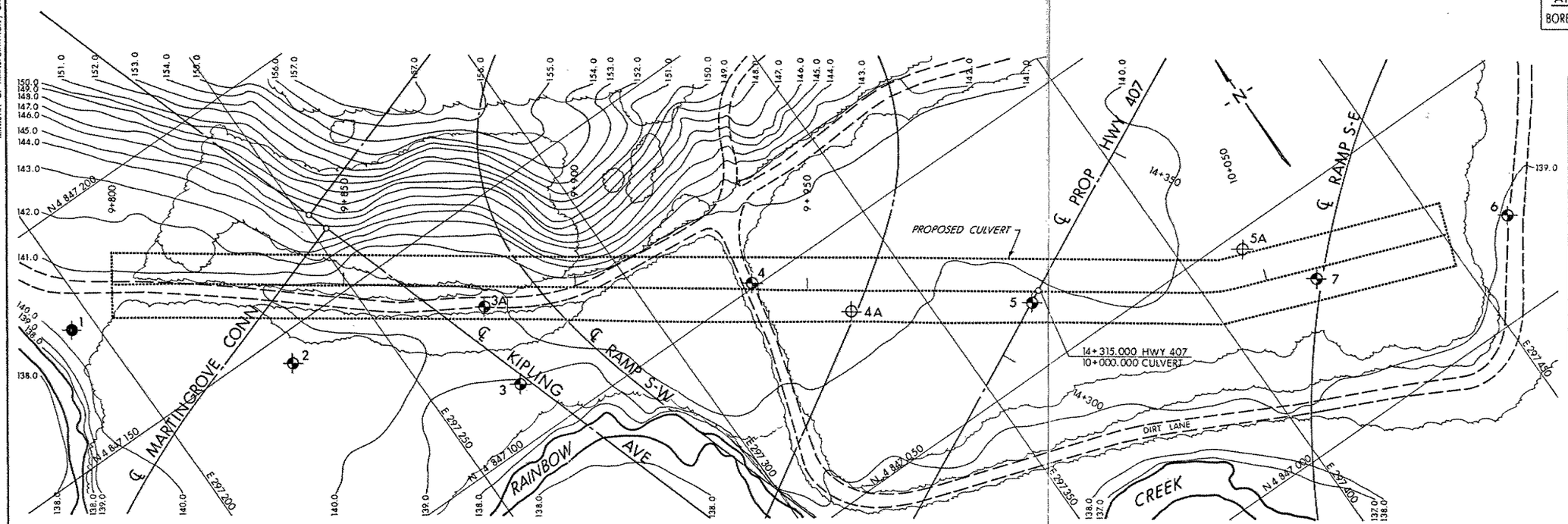
METRIC
DIMENSIONS ARE IN METRES AND/OR MILLIMETRES UNLESS OTHERWISE SHOWN. STATIONS IN KILOMETRES + METRES.

CONT No
WP No **88-78-13**

RAINBOW CREEK CULVERT AT HWY 407 / KIPLING AVE IC

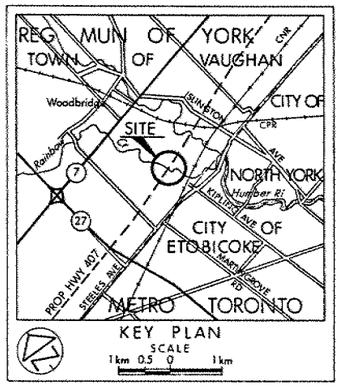
BORE HOLE LOCATIONS & SOIL STRATA

SHEET



PLAN

SCALE
10m 5 0 10m

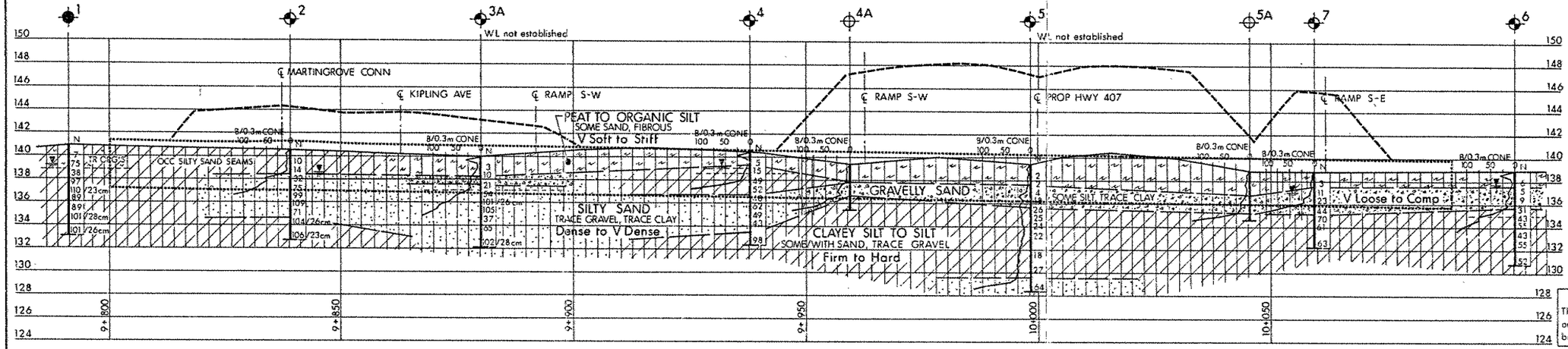


KEY PLAN
SCALE
1km 0.5 0 1km

LEGEND

- Bore Hole
- Dynamic Cone Penetration Test (Cone)
- Bore Hole & Cone
- N Blows/0.3m (Std Pen Test, 475 J/blow)
- CONE Blows/0.3m (60° Cone, 475 J/blow)
- W L at time of investigation 8909&9001

NOTE: SUBSOIL INFORMATION FOR BH 3 REFER TO RECORD OF BOREHOLE



℄ PROFILE ALONG CULVERT

SCALE
10m 5 0 10m Hor
4m 2 0 4 m Vert

No	ELEVATION	CO-ORDINATES NORTH	EAST
1	140.9	4 847 177.0	297 195.0
2	140.5	4 847 144.0	297 230.0
3	139.2	4 847 112.0	297 268.0
3A	140.0	4 847 130.0	297 271.1
4	140.0	4 847 101.0	297 321.5
4A	139.4	4 847 084.0	297 335.5
5	139.5	4 847 063.0	297 368.7
5A	138.9	4 847 046.2	297 412.8
6	139.0	4 847 019.5	297 463.7
7	138.9	4 847 032.0	297 422.0

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

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

REV	DATE	BY	DESCRIPTION

Geocres No 30M13-103

HWY No 407			DIST 6
SUBM'D BB	CHECKED	DATE	SITE 37-1341
DRAWN SO	CHECKED	APPROVED	DWG 887813-A

REF NO E-73-407-5 89 04

MINUTES OF MEETING

DATE: 90 01 15

LOCATION: M.T.O, Atrium Tower, 4th Floor

ATTENDEES: L. Markovic - M.T.O
D. Solomon - M.T.O
R. Kivi - M.M.M.

RE: Highway 407/Kipling Avenue
W.P. 99-78-02 - Rainbow Creek

R. Kivi presented the Rainbow Creek culvert according to the alignment proposed by Structural Section. He expressed concern over the crossing of Rainbow Creek culvert under Kipling Avenue due to insufficient cover under Kipling Avenue. The proposed profile of Rainbow Creek culvert is constrained by the upstream creek profile and the existing storm sewer elevation crossing downstream. In addition, some difficulty was noted in grading the Kipling S-W ramp (inside the loop) due to shallow profile of the proposed culvert. R. Kivi is to propose a new location of Rainbow Creek culvert in order to increase the cover under Kipling Avenue at Rainbow Creek crossing.

Comments and review of urban versus rural cross-section of Rainbow Creek is to be done by M.M.M. R. Kivi is to provide Structural Section and Planning & Design Section with these items:

1)	E-plan for Kipling Avenue/CNR by	90 01 16
2)	Hydrology Report by	90 01 19
3)	Co-ordinates, clearances, and locations for structures of CNR, Hwy. 407 (EBL & WBL) by	90 01 16
4)	An updated schedule printout.	
5)	E-plans for Rainbow Creek Tributary by	90 01 19
6)	Highmast pole locations, station and elevations by	90 01 30

Minutes prepared by
Dan Solomon
Senior Project Manager

cc: L. Markovic
J. Klowak
V. Boehnke
R. Kivi - M.M.M.
D. Dundas - M.T.O., Foundation

* Rec'd E-Plan of proposed alignment 01-29

memorandum

Ontario

To: V. Boehnke
Head, Structural Section
4th Floor, Atrium Tower

Date: 1990 02 14

Attn: S. Markovic
Sr. Structural Engineer

From: Foundation Design Section
Room 315, Central Building

Re: Revised Culvert Alignment
W.P. 88-78-13, Rainbow Creek Culvert
Highway 407/Kipling Avenue Interchange
District 6, Toronto

During the soils investigation for the Rainbow Creek Culvert, we received the E-plan for the culvert along a revised alignment. To accomodate the new alignment in our investigation, it was necessary to measure off new borehole locations using fairly crude means. A survey request was issued upon completion of the investigation to determine more precisely the location of the boreholes with respect to the revised culvert alignment. We were informed, by Surveys and Plans, that they would be unable to comply with the request until the end of February, at the earliest. As a result, the Foundation Design Report due date will be delayed by one month, following the arrival of the survey results.

In the meantime, if you would be interested in our preliminary comments for the Rainbow Creek culvert, perhaps a meeting could be arranged to discuss the foundation considerations at this site.

B Bennett

B. Bennett, P. Eng.
Foundation Engineer

BB/jb

DOCUMENT MICROFILMING IDENTIFICATION

G.I.-30 SEPT. 1976

GEOCRES No. 30M13 - 103

DIST. 6 REGION

W.P. No. 88-78-13(C)

CONT. No.

W. O. No.

STR. SITE No. 37-1341

HWY. No. 407

LOCATION RAINBOW CREEK CULVERT No 2 AT Hwy 407/ KIPLING AVE INTERCHANGE

OVERSIZE DRAWINGS TO BE INCLUDED WITH THIS REPORT.

REMARKS:

FILE COPY
2 of 2

Ministry
of
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Ontario

FOUNDATION DESIGN SECTION

foundation investigation and design report

ENGINEERING MATERIALS OFFICE
FOUNDATION DESIGN SECTION

WP 88-78-13 (C) DIST 6

HWY 407 STR SITE 37-1341

Rainbow Creek Culvert No. 2 at
Highway 407/Kipling Avenue Interchange

DISTRIBUTION

V.F. Boehnke (3)
G. Cautillo
J. Cullen (2)
A. Wittenberg
K.G. Bassi
S.J. Dunham
E.A. Joseph
I. Harrod (Cover Only)
I. Bullen (Cover Only)
File ✓

GEOCRES 30M13-103 DATE APR 0 2 1991

SUPPLEMENTARY FOUNDATION INVESTIGATION REPORT
For
Rainbow Creek Culvert No. 2 at
Highway 407/Kipling Avenue Interchange
W.P. 88-78-13, Site No. 37-1341
District 6, Toronto

INTRODUCTION

This report summarizes the results of a foundation investigation carried out for the Rainbow Creek Culvert No. 2 proposed at Highway 407 and Kipling Avenue Interchange. This culvert is required under the revised configuration of the entire drainage system for the interchange, to convey the flow from the new division channel to Rainbow Creek Culvert. The culvert runs roughly parallel to Highway 407 and intersects Rainbow Creek Culvert at Sta. 9+930. This report should be read in conjunction with the previous investigation for Rainbow Creek Culvert in Foundation Investigation Report W.P. 88-78-13 dated May 16, 1990.

SITE DESCRIPTION

The site is located at approximately 700 m north of the interchange of Kipling and Steeles Avenue in the Township of Vaughan, District of Toronto. The proposed culvert location is situated in the flood plain of the Rainbow Creek. The creek is about 5 m wide where the proposed culvert crosses it. The area is generally densely vegetated with trees and bushes. The creek bed is composed of gravel and sand with numerous cobbles. The creek was generally running full across its width during the time of the investigation.

Physiographically, the site is within the South Slope Region (Chapman and Putnam, 1984) and mainly consists of glacial deposits.

INVESTIGATION PROCEDURES

The field investigation for this project was conducted on 90 12 14 and 90 12 17 and comprised four (4) boreholes drilled to depths of 4.9 m to 8 m (elevations 129.8 m to 134.3 m). The boreholes were advanced using a continuous flight track mounted drilling machine equipped with hollow stem augers. Soil samples were taken generally at regular intervals in conjunction with Standard

The elevations and co-ordinates of the boreholes were determined from the site plan (Plan No. E-73-407-5) provided by MTO Central Region Structural Section.

The following laboratory tests were carried out on representative samples to identify and determine the physical properties of the overburden.

- Natural Moisture Content Determinations
- Grain Size Distribution Analysis
- Atterberg Limits Determinations
- Bulk Unit Weight Determinations

The results of the laboratory testing are plotted on the Record of Borehole sheets.

SUBSURFACE CONDITIONS

The Record of Borehole sheets in the Appendix illustrate the subsurface conditions at the borehole (BH 101 to BH 104) locations. The locations and elevations of the boreholes, along with stratigraphical profiles based on the borehole data are shown on Drawing No. 887813-A.

The subsurface conditions along the culvert alignment are quite variable. In general, the subsurface stratigraphy comprises a surficial layer of topsoil, overlying gravelly sand or silty sand and clayey silt till. Where a non-cohesive stratum was exposed at depth below the clayey silt material as in BH 102, artesian pressure was encountered.

Topsoil

A layer of topsoil was encountered in all boreholes to about 0.8 m depth. Except BH 101, the material has been described as clayey silt with some organics and roothair. In BH 101, the material was a silty sand with organics and some roothair.

Clayey Silt

A 0.1 m layer of clayey silt was contacted in BH 101 below the topsoil. This cohesive layer has been described as clayey silt with trace of sand and gravel and occasional roothair. The consistency of the material is stiff.

Gravelly Sand/Sand and Gravel

A non-cohesive stratum of gravelly sand or sand and gravel is encountered in BH's 102 and 104 below the topsoil. The thickness of the deposit varies between 0.7 m to 1.5 m and was typically contacted between elevations 136 m and 137 m.

Results of the Standard Penetration Test indicate that the denseness of the material is compact. The following physical properties were obtained from a single set of laboratory tests.

Natural Moisture Content (%)		8.0
Grain Size Distribution (%)	- Gravel	23
	- Sand	56
	- Silt	19
	- Clay	2

Silty Sand/Sand and Silt

A non-cohesive silty sand deposit was encountered beneath the topsoil layer in BH 103 and the clayey silt stratum in BH 101. In BH 101, the material has been described as silty sand with trace of clay and gravel and the denseness of the material according to Standard Penetration 'N' values ranges from dense to very dense. The thickness of the layer is about 3 m, and it lies between elevations 136 and 139 m approximately.

In BH 103 between elevations 136.3 m and 138.5 m, the material has been described as silty sand, trace of clay and gravel, and with organics, roothairs and pieces of decayed wood. 'N' values ranging from 6 to 10 were obtained during field testing indicating denseness of loose to compact. Underlying this layer of organic bearing silty sand is a major deposit of sand and silt. This

stratum was not penetrated at the termination of borehole at elevation 132.7 m. The material has been described as sand and silt with some gravel. Results of Standard Penetration Test indicate that the material is in a loose state.

		Range
Natural Moisture Content (%)		11-22
Grain Size Distribution (%)	- Gravel	0-19
	- Sand	39-72
	- Silt	27-36
	- Clay	1-11

Clayey Silt to Silt (Glacial Till)

A clayey silt to silt deposit was contacted in all boreholes except BH 103, underlying the above-noted non-cohesive strata from elevation 136 m approximately. The thickness of the layer is 6.1 m in BH 102 (elevation 130.2 m) and it is not penetrated in BHs 101 and 104 at the termination of the boreholes at elevations 134.3 m and 133.2 m respectively. The material has generally been described as clayey silt to silt with some sand and trace of gravel. 'N' values obtained indicate that the consistency of the material is very hard. The following physical properties were obtained from laboratory testing on representative samples.

		Range
Natural Moisture Content (%)		6.5-8.5
Bulk Unit Weight (kN/m^3)		23.2-25.0
Grain Size Distribution (%)	- Gravel	1-14
	- Sand	28-43
	- Silt	32-58
	- Clay	10-15
Liquid Limit (%)		14-19.5
Plastic Limit (%)		12-13.5

Sand

This non-cohesive stratum was contacted in BH 102 beneath the glacial till deposit. The material has been described as sand with trace of gravel and the denseness is very dense.

GROUNDWATER

Groundwater levels were measured in the open boreholes upon completion of augering and the results were shown in the Record of Borehole sheets. Artesian condition was encountered in BH 102 at the end of the borehole. Artesian pressure was built up when the cohesive till stratum was penetrated at elevation 130.2 m into a cohesionless sand stratum. The stabilized water level measured in a piezometer installed was found to be at about 2 m above grade, at elevation 139.8 m.

Groundwater levels measured in the open boreholes were at elevations 138.9 m and 136.6 m in BH's 101 and 103 respectively. No free water was detected in BH 104 upon completion of the borehole. During the time of the investigation, the creek water level was approximately elevation 136.5 m. Seasonal variations are expected.

DISCUSSION AND RECOMMENDATIONS

It is proposed to construct culvert No. 2 to convey the flow from a diversion channel into the Rainbow Creek Culvert. The length of the culvert is about 45 m. The proposed invert elevation at the inlet is 137.6 m and 137.4 m at the outlet. The culvert will be an approximate 4 m x 7 m concrete box and situated about 1 m below the proposed Kipling Avenue extension.

Structural Foundations

The subsurface material beneath the surficial topsoil or organic material is generally competent to support the culvert foundation. It is recommended to subexcavate down to the competent stratum and backfill the excavation with compacted Granular 'A' material. Based on the investigation results, the recommended excavation level is 136 m at the inlet and 137 m at the outlet. Intermediate levels can be interpolated between these points.

In view of the artesian conditions encountered in this area during this and previous investigations, excavation should be carried out with extreme care not to initiate any disturbance of the founding subsoil due to artesian pressures. Should excavation be required below elevation 134.5 m to remove the organic material, this office should be notified to review the situation.

The bearing capacities recommended for the culvert and the head walls as per the O.H.B.D.C. are as follows.

Factored Bearing Capacity at U.L.S. = 300 kPa
Bearing Capacity at S.L.S. Type II = 200 kPa

Based on the investigation results, excavation for the culverts will be carried down to 0.5 m to 2.0 m below the prevailing groundwater table. The non-cohesive stratum anticipated at the bottom of the excavation is susceptible to conditions of unbalanced hydrostatic head. A dewatering system is therefore required to allow backfilling and placement of concrete footings be carried out in the 'dry'.

The creek has to be diverted prior to construction. In addition, a dewatering scheme will be required since the excavation for the culvert base will be situated below water level generally in granular subsoil. Dewatering can be achieved by carrying out oversized excavation with perimeter drains as shown in Figure 1.

The depth of the excavation will be up to about 4 m. Temporary slopes should be maintained at 1H:1V or flatter. It is recommended that excavation proceeds from the downstream end to facilitate drainage.

The minimum earth cover required for frost protection is 1.2 m, unless if the structure is designed to withstand frost pressures.

Backfill

Backfill to the culvert may consist of Granular 'A' or 'B'. Reference is made to OPSD 803 standards for details. Only free draining granular material should be used below the groundwater.

Slope Stability

Only minor fill slopes (2 m to 5 m) will be required around the culvert location to maintain the proposed grades of the Kipling Avenue extension. Slopes formed to 2H:1V gradient are recommended. Finished slopes should be turfed to minimize erosion and direct infiltration.

Culvert Treatment

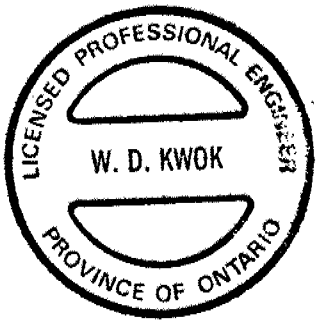
For granular backfill, a seal of cohesive material (CI-CH Clay) with a minimum thickness of 600 mm should be constructed at the culvert inlet. The intent of the clay seal is to protect the granular backfill. The seal should extend a minimum of 1 m on each side of the granular backfill at culvert inlet, and from the high water level down to 1 m below the base of the culvert or 2 m along the creek bottom as a cutoff. The culvert inlet should be protected with 600 mm of

rock protection extending a minimum of 1 m beyond the clay seal. The diversion channel leading to the culvert inlet should also be protected with 600 mm rock protection up to high water mark against channel erosion.

The culvert outlet will be structurally connected directly to the Rainbow Creek Culvert and no treatment is required from a geotechnical point of view.

MISCELLANEOUS

The fieldwork for this investigation was carried out by D. Kwok, Project Foundation Engineer. The drilling equipment was owned and operated by Master Soil Investigation Ltd. The report was prepared by D. Kwok under the general supervision of Mr. D. Dundas, Senior Foundation Engineer. The report was reviewed and approved by Mr. M. Devata, Chief Foundation Engineer.



D. Kwok, P.Eng.
Project Foundation Engineer

M.S. Devata, P.Eng.
Chief Foundation Engineer

APPENDIX

EXPLANATION OF TERMS USED IN REPORT

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

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

SOILS ARE DESCRIBED BY THEIR COMPOSITION AND CONSISTENCY OR DENSENESS.

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

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

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

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

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

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

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

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

JOINTING AND BEDDING:

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

ABBREVIATIONS AND SYMBOLS

FIELD SAMPLING

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

STRESS AND STRAIN

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

MECHANICAL PROPERTIES OF SOIL

m_v	kPa^{-1}	COEFFICIENT OF VOLUME CHANGE
C_c	1	COMPRESSION INDEX
C_s	1	SWELLING INDEX
C_α	1	RATE OF SECONDARY CONSOLIDATION
c_v	m^2/s	COEFFICIENT OF CONSOLIDATION
H	m	DRAINAGE PATH
T_v	1	TIME FACTOR
U	%	DEGREE OF CONSOLIDATION
σ'_{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 101 1 OF 1 METRIC

W.P. 88-78-13 LOCATION N 4 847100 E 297300 ORIGINATED BY DK

DIST 6 HWY 407 BOREHOLE TYPE Hollow Stem Auger COMPILED BY DK

DATUM Geodetic DATE 1990 12 17 CHECKED BY DD

SOIL PROFILE			SAMPLES			GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT (20 40 60 80 100) / SHEAR STRENGTH kPa (○ UNCONFINED, + FIELD VANE, ● QUICK TRIAXIAL, × LAB VANE) (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/m³	REMARKS & GRAIN SIZE DISTRIBUTION (%) GR SA SI CL
ELEV / DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE	'N' VALUES						
140.4 GROUND SURFACE											
0.0 / 139.6	Silty Sand with organics and some roothair, Black (Topsoil)						140				
0.8 / 138.9	Clayey Silt, trace of Sand and Gravel, occasional roothair, Grey, Stiff		1	SS	10	▼*	139				
1.5 / 135.8	Silty Sand, trace of Clay and Gravel, Grey, Dense to Very Dense		2	SS	36		138		o		0 72 27 1
			3	SS	35		137				
			4	SS	70 /29cm		136		o ⊢		
4.6 / 134.3	Clayey Silt, trace of Gravel, some wet sand seams, Grey, Hard (Glacial Till)		5	SS	75 /28cm		135				7 36 47 10
6.1	End of Borehole		**								

** At 6.1m depth, 900mm of sand blow-in, no sample taken.

+3, ×5 : Numbers refer to Sensitivity

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

RECORD OF BOREHOLE No 102 1 OF 1 METRIC

W.P. 88-78-13 LOCATION N 4 847086 E 297277 ORIGINATED BY DK

DIST 6 HWY 407 BOREHOLE TYPE Hollow Stem Auger COMPILED BY DK

DATUM Geodetic DATE 1990.12.14 CHECKED BY DD

ELEV / DEPTH	DESCRIPTION	STRAT PLOT	SAMPLES NUMBER	SAMPLES TYPE	'N' VALUES	GROUND WATER CONDITIONS	ELEVATION SCALE	UNIT WEIGHT γ kN/m³	REMARKS & GRAIN SIZE DISTRIBUTION (%) GR SA SI CL
137.8	GROUND SURFACE								
0.0 137.0	Clayey Silt, some organics and roothair, Brown (Topsoil)								
0.8 136.3	Sand and Gravel Brown, Compact		1	SS	15		137		
1.5	Clayey Silt to Silt, some Sand, trace of Gravel Grey, Hard (Glacial Till)		2	SS	75/25cm		136	25.0	1 28 57 14
			3	SS	54/13cm		135		
			4	SS	87/23cm		134		6 32 47 15
			5	SS	53/13cm		133		
			6	SS	80/25cm		132		
130.2							131		
7.6 129.8	Sand, trace of Gravel Grey, Very Dense		7	SS	78/25cm	P1	130		
8.0	End of Borehole Encountered artesian condition at the end of borehole Artesian Head to El 139.8m								

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

1990 12 14
* GROUND WATER CONDITIONS

PIEZO. NO.	GROUND WATER ELEVATION (Metres)
1	139.8

+³, ×⁵ : Numbers refer to Sensitivity

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

RECORD OF BOREHOLE No 103 1 OF 1 METRIC

W.P. 88-78-13 LOCATION N 4 847082 E 297258 ORIGINATED BY DK

DIST 6 HWY 407 BOREHOLE TYPE Hollow Stem Auger, Cone COMPILED BY DK

DATUM Geodetic DATE 1990 12 17 CHECKED BY DD

ELEV / DEPTH	DESCRIPTION	STRAT PLOT	SAMPLES NUMBER	SAMPLES TYPE	SAMPLES 'N' VALUES	GROUND WATER CONDITIONS	ELEVATION SCALE	UNIT WEIGHT kN/m³	REMARKS & GRAIN SIZE DISTRIBUTION (%) GR SA SI CL
139.3	GROUND SURFACE								
0.0 / 138.5	Clayey Silt, trace of Sand occasional roothair and organics (Topsoil)								
0.8 / 136.3	Silty Sand, trace of Clay and Gravel, occasional roothair trace of organics — Brown — Grey — Compact to Loose — occasional stained joints and wet seams — with pieces of black decayed wood		1	SS	10				
			2	SS	10				4 49 36 11
			3	SS	6	▼*			
3.0 / 132.7	Sand and Silt some Gravel Grey, Loose		4	SS	8				19 39 34 8
			5	SS	6				
			6	SS	9				
6.6	End of Borehole								

DYNAMIC CONE PENETRATION RESISTANCE PLOT 20 40 60 80 100

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

ELEVATION SCALE: 139, 138, 137, 136, 135, 134, 133

PLASTIC LIMIT w_P NATURAL MOISTURE CONTENT w LIQUID LIMIT w_L
WATER CONTENT (%) 10 20 30

* upon completion of augering, 900mm of sand blow-in; water level at 2.7m depth

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

$15 \overset{20}{\underset{10}{\diamond}} 5$ (%) STRAIN AT FAILURE

RECORD OF BOREHOLE No 104 1 OF 1 METRIC

W.P. 88-78-13 LOCATION N 4 847088 E 297270 ORIGINATED BY DK

DIST 6 HWY 407 BOREHOLE TYPE Hollow Stem Auger COMPILED BY DK

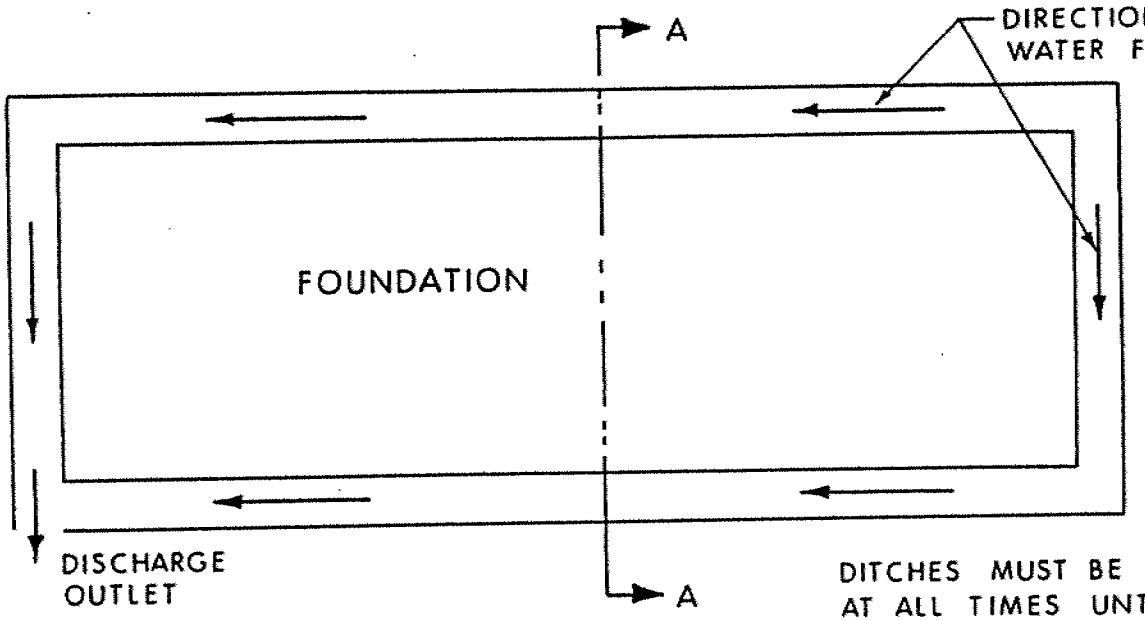
DATUM Geodetic DATE 1990 12 17 CHECKED BY DD

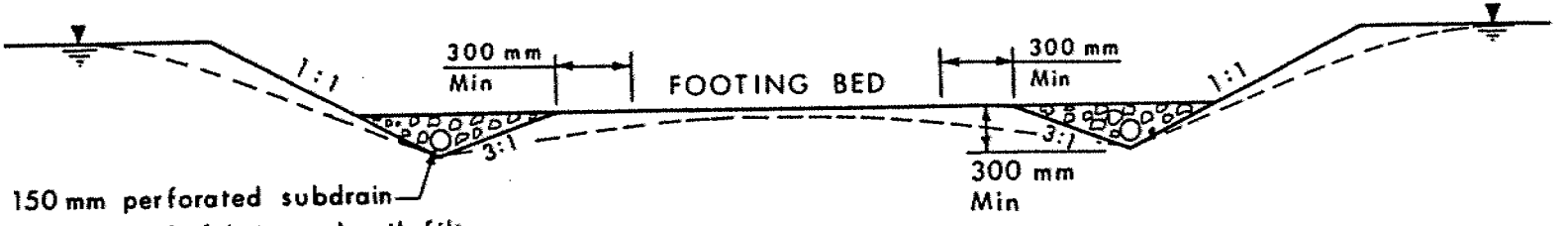
SOIL PROFILE			SAMPLES			GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT (20 40 60 80 100) / SHEAR STRENGTH kPa (o UNCONFINED, + FIELD VANE, • QUICK TRIAXIAL, x LAB VANE) (20 40 60 80 100)	PLASTIC LIMIT w_P / NATURAL MOISTURE CONTENT w / LIQUID LIMIT w_L — WATER CONTENT (%) (10 20 30)	UNIT WEIGHT γ kN/m³	REMARKS & GRAIN SIZE DISTRIBUTION (%) GR SA SI CL
ELEV / DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE	'N' VALUES						
138.1	GROUND SURFACE										
0.0 / 137.3	Clayey Silt, some roothairs and organics, Brown (Topsoil)					*					
0.8	Gravelly Sand, some Silt		1	SS	22		137		o		23 56 19 2
	Brown, Compact		2	SS	20						
135.8							136				
2.3	Clayey Silt, occasional wet sand seams		3	SS	67	/29cm			o H	23.2	14 43 32 11
	trace of Sand and Gravel		4	SS	41		135				
	Grey, Hard (Glacial Till)						134				
133.2			5	SS	72	/28cm					
4.9	End of Borehole										

* upon completion of augering, no free water

+3, x5 : Numbers refer to Sensitivity

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





SECTION A-A
(NTS)

DEWATERING SCHEME - PERIMETER DITCHES

WP 88-78-13
FIG 1

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

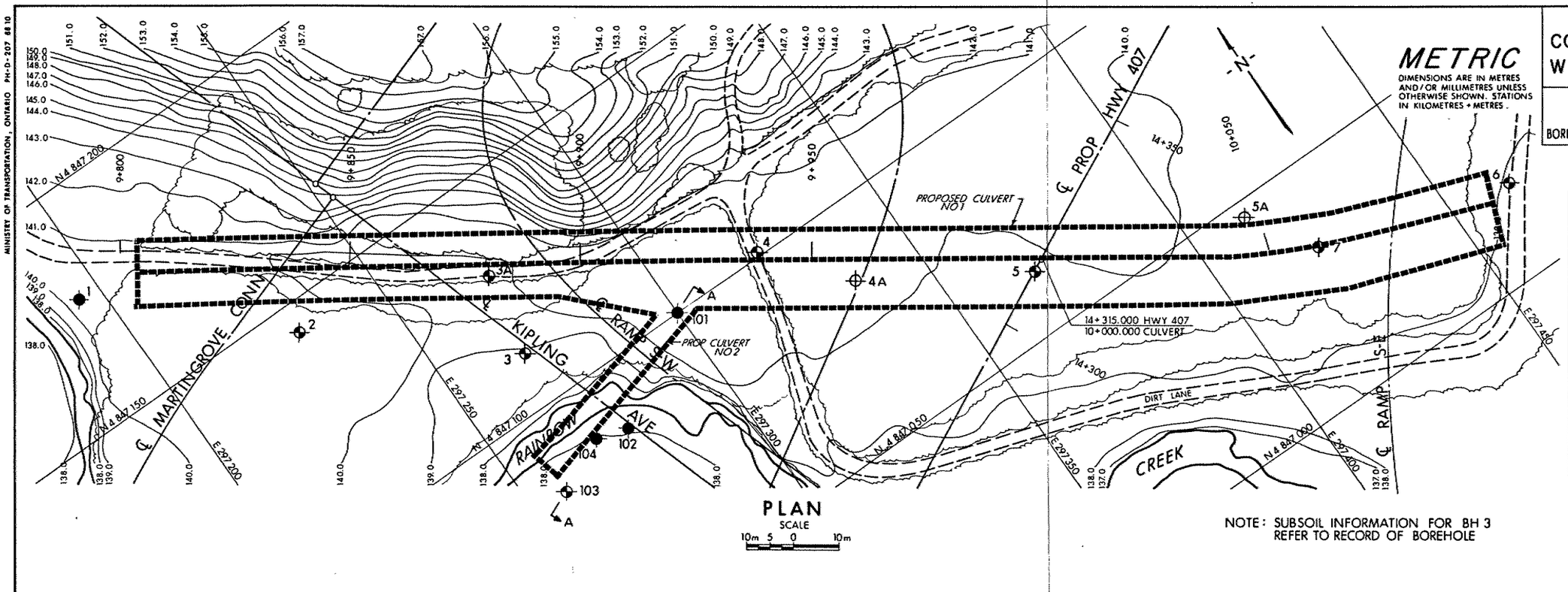
CONT No
WP No 88-78-13

SHEET

RAINBOW CREEK
CULVERT NO 1 & 2
BORE HOLE LOCATIONS & SOIL STRATA

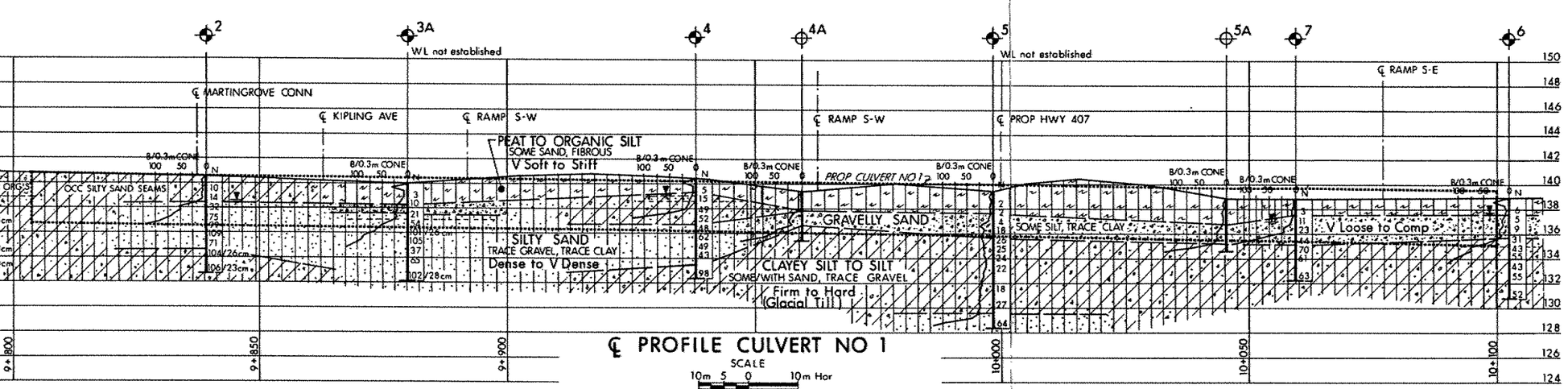
METRIC

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

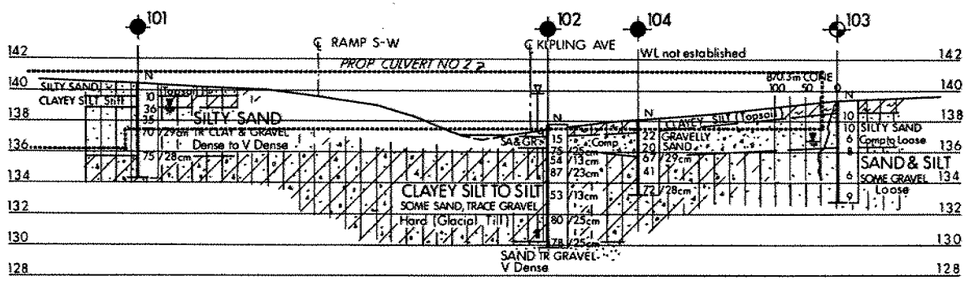


PLAN
SCALE
10m 5 0 10m

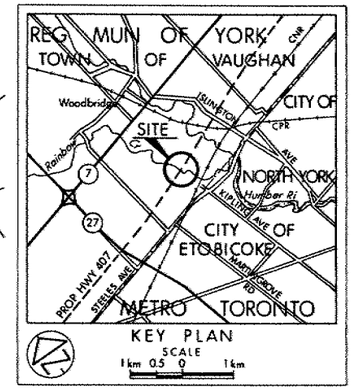
NOTE: SUBSOIL INFORMATION FOR BH 3 REFER TO RECORD OF BOREHOLE



℄ PROFILE CULVERT NO 1
SCALE
10m 5 0 10m Hor
4m 2 0 4m Vert



SECTION A-A
SCALE
4m 2 0 4m



KEY PLAN
SCALE
1km 0.5 0 1km

LEGEND

- Bore Hole
- Dynamic Cone Penetration Test (Cone)
- Bore Hole & Cone
- N Blows/0.3m (Std Pen Test, 475 J/blow)
- CONE Blows/0.3m (60° Cone, 475 J/blow)
- W L at time of investigation 89 09, 90 01 & 90 12
- Artesian Head
- Piezometer

No	ELEVATION	CO-ORDINATES NORTH	EAST
1	140.9	4 847 177.0	297 195.0
2	140.5	4 847 144.0	297 230.0
3	139.2	4 847 112.0	297 268.0
3A	140.0	4 847 130.0	297 271.1
4	140.0	4 847 101.0	297 321.5
4A	139.4	4 847 084.0	297 335.5
5	139.5	4 847 063.0	297 368.7
5A	138.9	4 847 046.2	297 412.8
6	139.0	4 847 019.5	297 463.7
7	138.9	4 847 032.0	297 422.0
101	140.4	4 847 100.0	297 300.0
102	137.8	4 847 086.0	297 277.0
103	139.3	4 847 082.0	297 258.0
104	138.1	4 847 088.0	297 270.0

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

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

REV	DATE	BY	DESCRIPTION
	91 03 15	SO	BH'S 101, 102, 103, 104 & SECTION A-A ADDED

Geocres No 30M13-103

HWY No 407			DIST 6
SUBM'D BB	CHECKED BB	DATE 1990 05 11	SITE 37-1341
DRAWN SO	CHECKED	APPROVED	DWG 887813-A

REF NO E-73-407-5 89 04

MEMORANDUM

To : Mr. V.F.Boehnke
Head, Structural Section

Date : 91 03 18

Attn : S. Markovic

From : Foundation Design Section
Room 315, Central Building

Re : W.P.88-78-13 Highway 407/ Rainbow Creek Structure

We refer to your memorandum dated 90 12 05 and the minutes of progress meeting #2 attached therin.

Regarding question 2(a) of the meeting minutes, our recommendation is to design the joints to take the maximum settlement under the worst condition. The maximum differential settlement will take place at the location where the allowable bearing capacity of the founding subsoil changes.

D. Kwok, P.Eng.
Project Foundation Engineer

for

D. Dundas, P.Eng.
Senior Foundation Engineer

Cumming Cockburn Limited
Consulting Engineers and Planners

MINUTES OF MEETING

DATE: November 2, 1990

TIME: 9:30 A.M.

LOCATION: Atrium Building, Ministry of Transportation

SUBJECT: Rainbow Creek Culvert

PRESENT:

S. Markovic	Ministry of Transportation (MTO)
D. Fulford	Cumming Cockburn Limited (CCL)
J. Juffs	"

	ITEM	ACTION BY:
1.	Can excavated material from culvert be used as fill in existing rainbow creek? Would granular layer be required to relieve groundwater pressure during fill placement?	(1) Yes material from culvert can be used to fill channel except under proposed roads where free-draining granular material should be placed below water table and the remainder of the fill should be to MTO standards.
2.	What are backfill limits after culvert completion? • Temporary grade with temporary drainage plan by CCL vs. road subgrade.	
3.	Need elevation of Martin Grove connection for final upstream wingwall elevations.	
4.	Downstream geometry not yet finalized by grading consultant.	None
5.	Location of culvert and Kipling Avenue relative to contours is presently based on tracing in Preliminary Design Report E.73-407-5. Is this precise enough for culvert general arrangement drawing?	

145 Sparks Avenue, Willowdale, Ontario M2H 2S5 Telephone (416) 497-2929/Fax (416) 497-0298
Hull, Ottawa, Brockville, Kingston, Toronto, Waterloo, London

6. Grid system to appear on general arrangement. CCL

7. Should northing and easting be shown?

8. SLS applied load exceeds 200 KPa (230 KPa actual) allowable bearing. This is less than the load on soils to each side of culvert. Is it acceptable to exceed 200 KPa?

9. What is anticipated settlement at culvert? Since the culvert will be constructed in advance of preloading, we require settlement to detail articulated joints.

10. Will there be any stormwater leads into the culvert?

11. CCL propose relief drain holes in top slab.

12. What is minimum net area required for each culvert barrel? ie. Are present fillets and haunches too large?

13. CCL have proposed the following sequence of construction.

- Diversion scheme - construction sequence
  - culvert I - temp flow in original creek
  - divert to east barrel of culvert I
  - fill channel u/s of culvert II
  - construct culvert II
  - fill remaining channel
  - u/s bank stabilization
  - fill u/s east meander
  - d/s bank stabilization
  - open west barrel
  - complete Rainbow tributary diversion
  - fill tributary

How long is the construction scheduled for? Where does culvert fit into the overall Kipling Avenue interchange construction?

(8) Loads as high as 250 kPa at SLS are acceptable provided that the structure can tolerate increased differential settlement.

(9) Differential settlement of the culvert are expect to be less than 75 mm. However, if possible we recommend that the culvert should be designed to withstand 100 mm.

14. Will there be a crossfall or a low flow channel in centre of each culvert barrel?

15. What are contract limits for culvert contract documents and drawings?

16. Does culvert contract require extra earth to fill the Rainbow Creek channel?

17. What are eligible fill storage sites?

18. Will site be pregraded to eliminate hill at 9950? or will culvert contractor be first on site?

19. Will epoxy steel be required on wingwalls adjacent Martin Grove connection?

20. All cross-sections will be consistent for each opening size, but rebar may vary to suit reduced loading conditions.

21. Should air vents be added at the transition structure?

Prepared By:

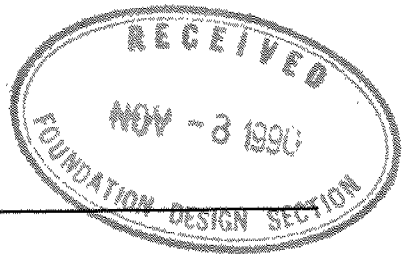
CUMMING COCKBURN LIMITED

J. F. Juffs, P. Eng.

JFJ:rg

MINISTRY OF TRANSPORTATION

MEMORANDUM



TO: Mr. M. Devata,
Chief Foundation Engineer,
Foundation Design Section,
3rd Floor, Central Building

Attn: Mr. D. Dundas,
Senior Foundation Engineer

DATE: November 8, 1990

FROM: Structural Section
4th Floor,
Atrium Tower

RE: W.P. 88-78-13, Highway 407/Rainbow Creek Structure Foundation Investigation and Design Report.

As discussed with D. Dundas (90/10/12), the structural configuration of the Highway 407/Rainbow Creek structure has been modified.

This memo is a request to update the Foundation Investigation and Design Report to reflect the revised configuration.

The revisions are a result of the re-configuration of the entire drainage strategy for the interchange (as described in the Structural Design Report), and consist of:

i) Addition of "Culvert #2" to convey the flow from the new diversion channel;

ii) A minor change in the main structure alignment in the vicinity of the outlet.

The above are shown in the attached preliminary Plan E-73-407-5 (prepared by Marshall Macklin Monaghan Consultants, issued July 23, 1990) and the sketch dated 90/09/26. Please note that the opening sizes shown are still under investigation; as soon as the final plan is submitted, it will be forwarded to your section.

In the meantime, we have instructed the detailed design consultant to proceed using recommendations from the original Foundation Design Report with some exceptions, as defined in the Structural Design Report. Should your findings be different from the information on which we are basing the final design, please advise the undersigned at 235-5506 as soon as possible.

Due to the constrained schedule of the Highway 407/Kipling Avenue project, we are expecting your preliminary recommendations based on available information by December 8, 1990 to be confirmed by your Foundation Report by February 21, 1990.

S. Markovic,
Senior Structural Engineer,
For: V.F. Boehnke,
Head, Structural Section

SM/ld