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FOUNDATION INVESTIGATION REPORT

CONTRACT NO. 94-84



Ministry of
Transportation

Ontario

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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 projects.

EXPLANATION OF TERMS USED IN REPORT

2

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

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

SOILS ARE DESCRIBED BY THEIR COMPOSITION AND CONSISTENCY OR DENSENESS.

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

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

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

N (BLOWS/0.3m)	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

SS	SPLIT SPOON	TP	THINWALL PISTON
WS	WASH SAMPLE	OS	OSTERBERG SAMPLE
ST	SLOTTED TUBE SAMPLE	RC	ROCK CORE
BS	BLOCK SAMPLE	PH	TW ADVANCED HYDRAULICALLY
CS	CHUNK SAMPLE	PM	TW ADVANCED MANUALLY
TW	THINWALL OPEN	FS	FOIL SAMPLE

STRESS AND STRAIN

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

MECHANICAL PROPERTIES OF SOIL

m_v	kPa ⁻¹	COEFFICIENT OF VOLUME CHANGE
C_c	1	COMPRESSION INDEX
C_s	1	SWELLING INDEX
C_α	1	RATE OF SECONDARY CONSOLIDATION
c_v	m ² /s	COEFFICIENT OF CONSOLIDATION
H	m	DRAINAGE PATH
T_v	1	TIME FACTOR
U	%	DEGREE OF CONSOLIDATION
σ'_{v0}	kPa	EFFECTIVE OVERBURDEN PRESSURE
σ'_p	kPa	PRECONSOLIDATION PRESSURE
τ_f	kPa	SHEAR STRENGTH
c'	kPa	EFFECTIVE COHESION INTERCEPT
ϕ'	-°	EFFECTIVE ANGLE OF INTERNAL FRICTION
c_u	kPa	APPARENT COHESION INTERCEPT
ϕ_u	-°	APPARENT ANGLE OF INTERNAL FRICTION
τ_R	kPa	RESIDUAL SHEAR STRENGTH
τ_r	kPa	REMOULDED SHEAR STRENGTH
S_t	1	SENSITIVITY = $\frac{c_u}{\tau_r}$

PHYSICAL PROPERTIES OF SOIL

ρ_s	kg/m ³	DENSITY OF SOLID PARTICLES	e	1, %	VOID RATIO	e_{min}	1, %	VOID RATIO IN DENSEST STATE
γ_s	kN/m ³	UNIT WEIGHT OF SOLID PARTICLES	n	1, %	POROSITY	I_D	1	DENSITY INDEX = $\frac{e_{max} - e}{e_{max} - e_{min}}$
ρ_w	kg/m ³	DENSITY OF WATER	w	1, %	WATER CONTENT	D	mm	GRAIN DIAMETER
γ_w	kN/m ³	UNIT WEIGHT OF WATER	S_r	%	DEGREE OF SATURATION	D_n	mm	n PERCENT - DIAMETER
P	kg/m ³	DENSITY OF SOIL	w_L	%	LIQUID LIMIT	C_u	1	UNIFORMITY COEFFICIENT
γ	kN/m ³	UNIT WEIGHT OF SOIL	w_p	%	PLASTIC LIMIT	h	m	HYDRAULIC HEAD OR POTENTIAL
ρ_d	kg/m ³	DENSITY OF DRY SOIL	w_s	%	SHRINKAGE LIMIT	q	m ³ /s	RATE OF DISCHARGE
γ_d	kN/m ³	UNIT WEIGHT OF DRY SOIL	I_p	%	PLASTICITY INDEX = $w_L - w_p$	v	m/s	DISCHARGE VELOCITY
ρ_{sat}	kg/m ³	DENSITY OF SATURATED SOIL	I_L	1	LIQUIDITY INDEX = $\frac{w - w_p}{I_p}$	i	1	HYDRAULIC GRADIENT
γ_{sat}	kN/m ³	UNIT WEIGHT OF SATURATED SOIL	I_C	1	CONSISTENCY INDEX = $\frac{w_L - w}{I_p}$	k	m/s	HYDRAULIC CONDUCTIVITY
ρ'	kg/m ³	DENSITY OF SUBMERGED SOIL	e_{max}	1, %	VOID RATIO IN LOOSEST STATE	j	kN/m ³	SEEPAGE FORCE
γ'	kN/m ³	UNIT WEIGHT OF SUBMERGED SOIL						

FOUNDATION INVESTIGATION REPORT

For

Culvert Replacement

W.P. 331- 89-00

Queen Elizabeth Way

Fifty Road to Casablanca Boulevard

Stoney Creek and Grimsby

1.0 INTRODUCTION

This report presents the results of a foundation investigation carried out at 18 proposed culvert replacement sites in the City of Stoney Creek and Town of Grimsby, Ontario. The investigation was carried out in accordance with our proposal dated 94/08/06. Authorization to carry out the work was provided by the Foundation Design Section, Ministry of Transportation, Ontario (MTO).

This report contains factual information pertaining to the subsurface condition.

2.0 SITE DESCRIPTION AND GEOLOGY

Eighteen (18) culvert replacement sites are located along the Queen Elizabeth Way (QEW) from Fifty Road in Stoney Creek to approximately 1 km east of Casablanca Boulevard in Grimsby. The terrain surrounding the sites is generally flat and consists of mixed residential, agricultural and industrial land uses. The existing ground surface generally slopes downward gently from south to north, towards Lake Ontario.

At the time of the investigation, the QEW is a four-lane divided highway with gravel shoulders. A North Service Road and South Service Road is located parallel to the QEW on the north and south sides, respectively. Both the North and South Service Roads are two-lane paved roads with gravel shoulders.

Drainage of the existing QEW is provided by highway ditches located on both the north and south sides and in between the QEW and the two service roads. The culverts investigated during this study facilitate drainage of these ditches beneath the QEW towards the north into Lake Ontario. At each culvert location beneath the QEW, there is an additional two separate culverts constructed beneath the North Service Road and the South Service Road.

The existing culverts beneath the QEW and the existing culverts beneath the two service roads consist of either a concrete box culvert or a Corrugated Steel Pipe (CSP) culvert).

Physiographically, the sites lie in the area known as the Halton Till Plain, which consists of glacial till with clayey silt to silty clay size particles and little to no cobbles and boulders. Bedrock underlying the overburden consists of Ordovician shale of the Queenston Formation throughout the study area.

3.0 PROCEDURE

3.1 Field Investigation

Prior to the onset of the drilling investigation, the necessary utility check clearances were obtained by our site personnel. Traffic control for this project was provided by Barricade Traffic Services Inc., who were coordinated by MTO.

The field work for this investigation was carried out between August 16 and 25, 1994. Three (3) boreholes were put down at each of the culvert locations. The test locations are indicated on Drawings 3318900-A to 3318900-D (Refer to Sheets 91A to D in the Contract Drawings). One dynamic cone penetration test was also conducted at each culvert location.

All boreholes were put down using either a track-mounted or truck-mounted power auger drill suitable equipped for soil and bedrock sampling. Continuous flight solid stem augers and NQ-sized rock coring techniques (where required) were employed during the course of the investigation to advance the boreholes.

The overburden soils encountered were sampled by means of a split spoon sampler during the performance of Standard Penetration Tests (SPT) (ASTM D 1586). Where soft to firm cohesive soils were encountered, field vane tests were conducted at selected locations. Sampling was generally conducted on a near continuous basis (intervals of 0.76 m) at the top 4.6 m of the borehole. Below this depth, sampling was conducted in intervals of about 1.5 m.

Water levels, where observed, were obtained in the open boreholes upon completion of the drilling. All boreholes were backfilled with auger cuttings and sealed with a minimum 500 mm thick bentonite layer at the ground surface. Boreholes put down at the median where the surface consists of asphaltic concrete were surfaced with a minimum of 50 mm of cold mix asphalt.

3.2 Survey

The borehole and cone penetration test locations and ground surface elevations were surveyed by Jacques Whitford Environment Limited (JWEL) personnel after completion of the field work. The elevations were referenced to the existing culvert invert elevations shown on the site plans, provided by MTO. The elevations are assumed to be referenced to the Geodetic datum.

3.3 Laboratory Testing

To identify the properties of the samples collected during the field investigation, the following laboratory tests were carried out on selected samples:

- Detailed visual classification,
- Natural moisture content,
- Sieve and hydrometer analyses,
- Atterberg Limits determination,
- Natural unit weight determination

4.0 RESULTS OF THE INVESTIGATION

The subsurface conditions observed in the boreholes are presented in detail on the Record of Boreholes provided in Appendix .

A brief discussion of the observed subsurface conditions is provided below. Specific details of the subsurface materials at a particular culvert location should be obtained from the Record of Boreholes.

4.1 W.P. 331-89-00

4.1.1 Topsoil

Topsoil was encountered at the ground surface in most boreholes except the boreholes located in the median of the QEW. The thickness of the topsoil ranges from 50 mm to 600 mm.

4.1.2 Asphaltic Concrete

Asphaltic concrete was encountered at the ground surface in Boreholes 135-41-2, 136-04-2, 136-14-2 and 136-15-2 (QEW median locations). The thickness of the asphaltic concrete ranged from 50 mm to 100 mm at the time of the investigation with an average thickness of about 75 mm.

4.1.3 Sand, Silt and Gravel (Fill) / Silt (Fill)

A loose to compact mixture of sand, silt and gravel (fill) layer was encountered at the ground surface or underlying the asphaltic concrete in all QEW median boreholes. The thickness of the fill layer ranged from 0.5 m to 2.6 m. The SPT conducted in this fill layer yielded N values ranging from 6 to 20. In general, this material was observed to be compact. Based on visual identification and laboratory tests, this fill can be classified as inorganic and cohesionless.

A compact silt (fill) with varying amounts of sand, clay and gravel was encountered underlying the sand, silt and gravel (fill) mentioned above, in Boreholes 135-40-2, 136-01-2, 136-05-2, 136-07-2, and 136-12-2. The thickness of the fill layer ranged from 0.9 m to 1.5 m. The SPT conducted in this fill layer yielded N values ranging from 9 to 25. The visual observations and laboratory test results indicate that this material is cohesionless.

The results of laboratory testing carried out on selected samples of both fill material types are provided on the Record of Boreholes, on Figures 5 and 7 in Appendix and are summarized below:

Property	Range	# Tests	Average
Moisture Content (%)	4-18	16	10
Grain Size			
% Gravel	0-42	4	18
% Sand	4-45	4	28
% Silt	13-76	4	43
% Clay	0-20	4	11
Liquid Limit (%)	24-39	3	30
Plastic Limit (%)	16-22	3	18
Plasticity Index (%)	7-17	3	12

4.1.4 Heterogeneous Mixture of Silt and Clay, some Sand, trace Gravel (Glacial Till)

A heterogeneous mixture of silt and clay, some sand, trace gravel (glacial till) was encountered in all boreholes except Boreholes 136-10-2, 136-11-2, 136-12-1 and 136-12-2. The glacial till was observed at the ground surface or it was underlying the fill or topsoil. Where present, the glacial till surface was encountered at elevations ranging from El. 79.3 m to El. 84.3 m (depths of 0 m to 2.6 m).

The SPT conducted in the glacial till layer yielded N values ranging from 4 to over 100. All boreholes were terminated within the glacial till deposit with the exception of Boreholes 135-41-3, 136-08-3 to 136-13-3, and 136-16-1 to 136-16-3, which encountered shale bedrock.

The results of laboratory testing on selected SPT samples of this till material are provided on the Record of Boreholes, on Figures 1 to 4 and 8 in Appendix 1, and are summarized below:

Property	Range	# Test	Average
Moisture Content (%)	4-37	184	14
Grain size			
% Gravel	0-9	32	2
% Sand	10-56	32	18
% Silt and Clay	39-90	32	80
% Silt	34-73	32	55
% Clay	5-41	32	25
Liquid Limit (%)	23-39	31	32
Plastic Limit (%)	10-20	31	16
Plasticity Index (%)	10-22	31	16

Based on the above testing and visual identification, this till material can generally be classified as an inorganic, cohesive silt and clay of low to medium plasticity. Seams of cohesionless materials, generally consisting of sands and gravels, are noted at random depths and locations throughout the deposit. Grain size analysis of glacial till samples is limited to the maximum size of the SPT sampling methods that were employed (38 mm). Cobbles and/or boulders can be encountered in a glacial till deposit. Large cobbles or boulders were not detected in any of the boreholes put down as part of this investigation.

Vane shear testing was not possible due to the stiffness of this material. Based on laboratory observations and SPT correlations, the till is typically in the very stiff to hard range.

4.1.5 Bedrock

Bedrock was encountered underlying the glacial till in Boreholes 135-41-3, 136-08-3 to 136-13-3, and 136-16-1 to 136-16-3, and sampled by coring in NQ-size in Boreholes 136-10-1 and 136-11-1. In the other boreholes, the bedrock could be penetrated by solid stem augers. The bedrock surface at these locations was encountered between El. 75.0 m and El. 83.4 m (depths of 0.2 m to 6.1 m). The bedrock is a reddish brown to grey, weathered to unweathered shale of the Queenston Formation. The bedrock is of poor to good quality (RQD of the unweathered shale ranging from 65% to 88%). Core recoveries varied between 97% and 100%. The average RQD over 5.8 m of rock cored was 74%, indicating an overall rock mass quality of fair.

4.1.6 Groundwater

Groundwater was encountered in Boreholes 135-40-3, 136-02-3, 136-04-2, 136-05-3, 136-06-3, 136-11-3, 136-12-2, 136-13-3, 136-16-2 and 136-16-3 as noted on the Borehole Records. Groundwater levels at these locations ranged between El. 75.1 m and El. 81.3 m, or from 1.9 m to 7.7 m below ground surface immediately prior to backfilling. Groundwater was not encountered in other boreholes. Artesian conditions were not encountered in any of the boreholes.

The groundwater levels noted on the Borehole Records were recorded immediately after drilling. Due to the relatively low permeability of the overburden soils, these groundwater levels may not represent the static water levels which would approximately correspond to an adjacent creek level draining into Lake Ontario. Groundwater levels are subject to seasonal fluctuations.

5.0 MISCELLANEOUS

The field work for this investigation was carried out under the supervision of R. Rintjema, P. Eng., N. Lobo and C. Reynolds. Drilling equipment was provided by Master Soil Investigation Ltd. and Eastern Soil Investigation Ltd.

The report was prepared by C. Kwok and T. Olson, Project Engineer, and approved G. Kack, Project Manager.

Note: The preceding report is a copy of the factual information from the Foundation Investigation and Design Report prepared by Jacques Whitford Environment Ltd. (consulting geotechnical engineers for this project), under the technical supervision of the MTO Foundation Design Section.

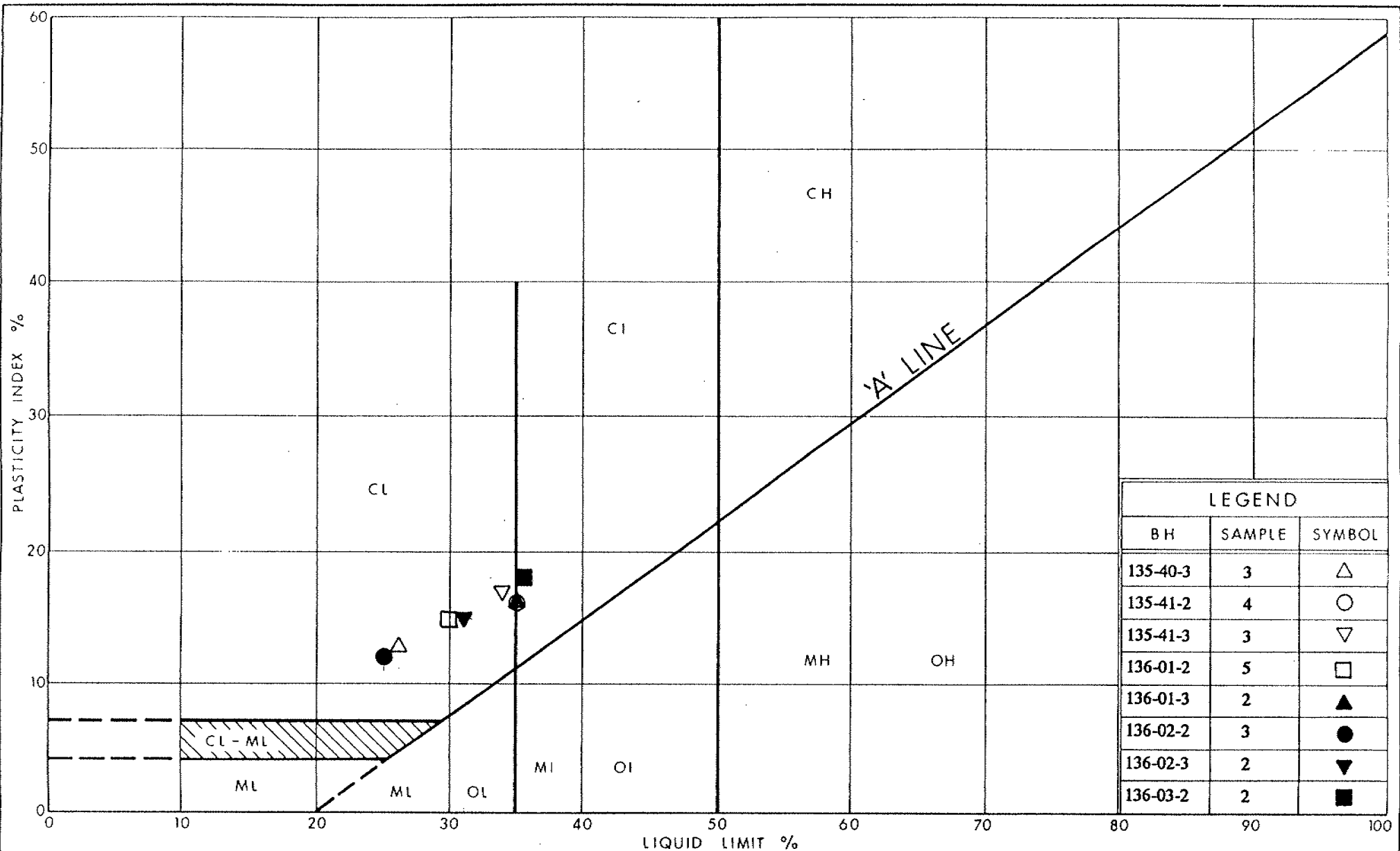


D. Dundas

D. Dundas, P. Eng.

Sr. Foundation Engineer

APPENDIX



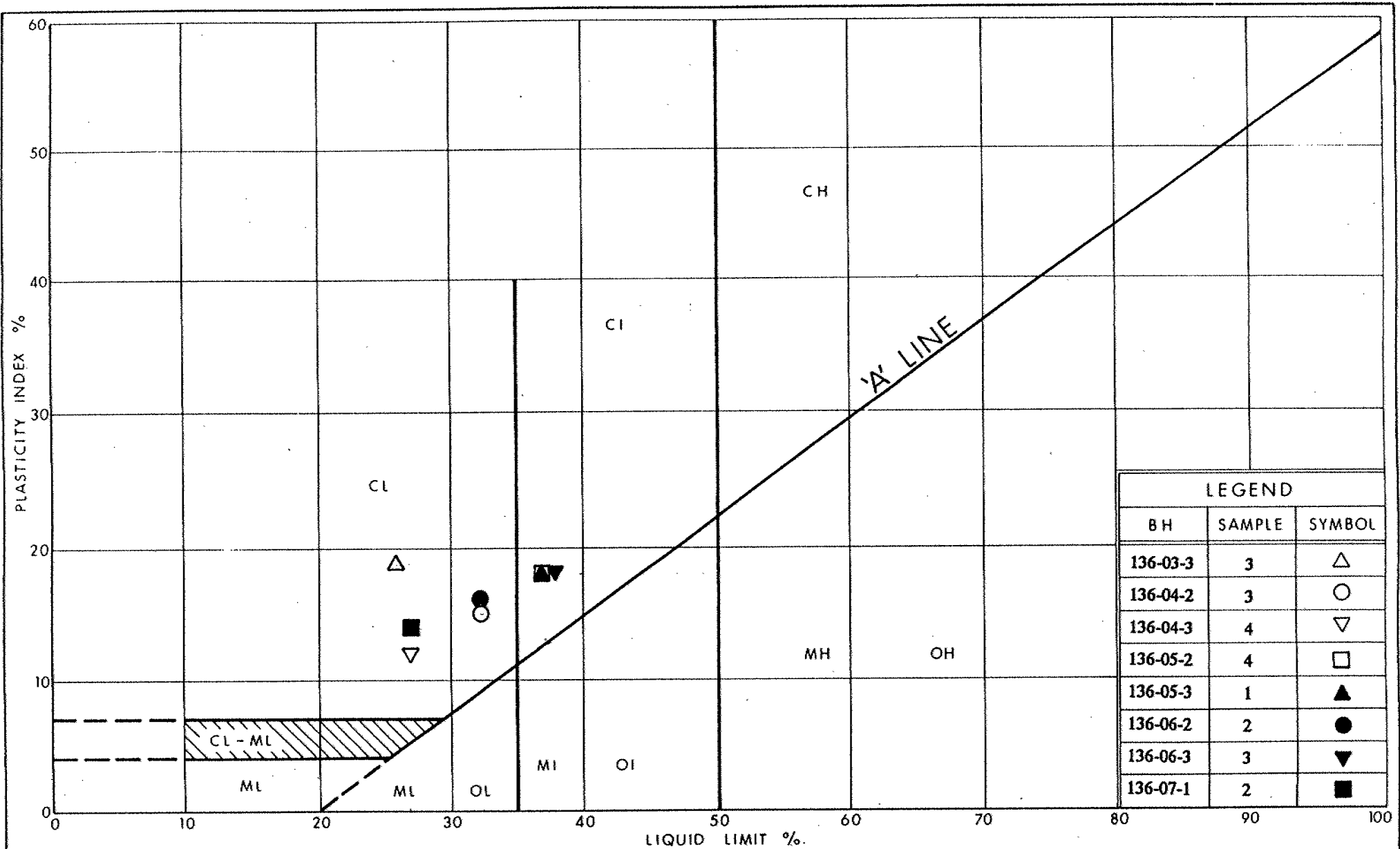
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PLASTICITY CHART
HET MIXTURE OF SILT & CLAY, SOME SAND,
TRACE GRAVEL (Glacial Till)

FIG No 1

W P 331-89-00

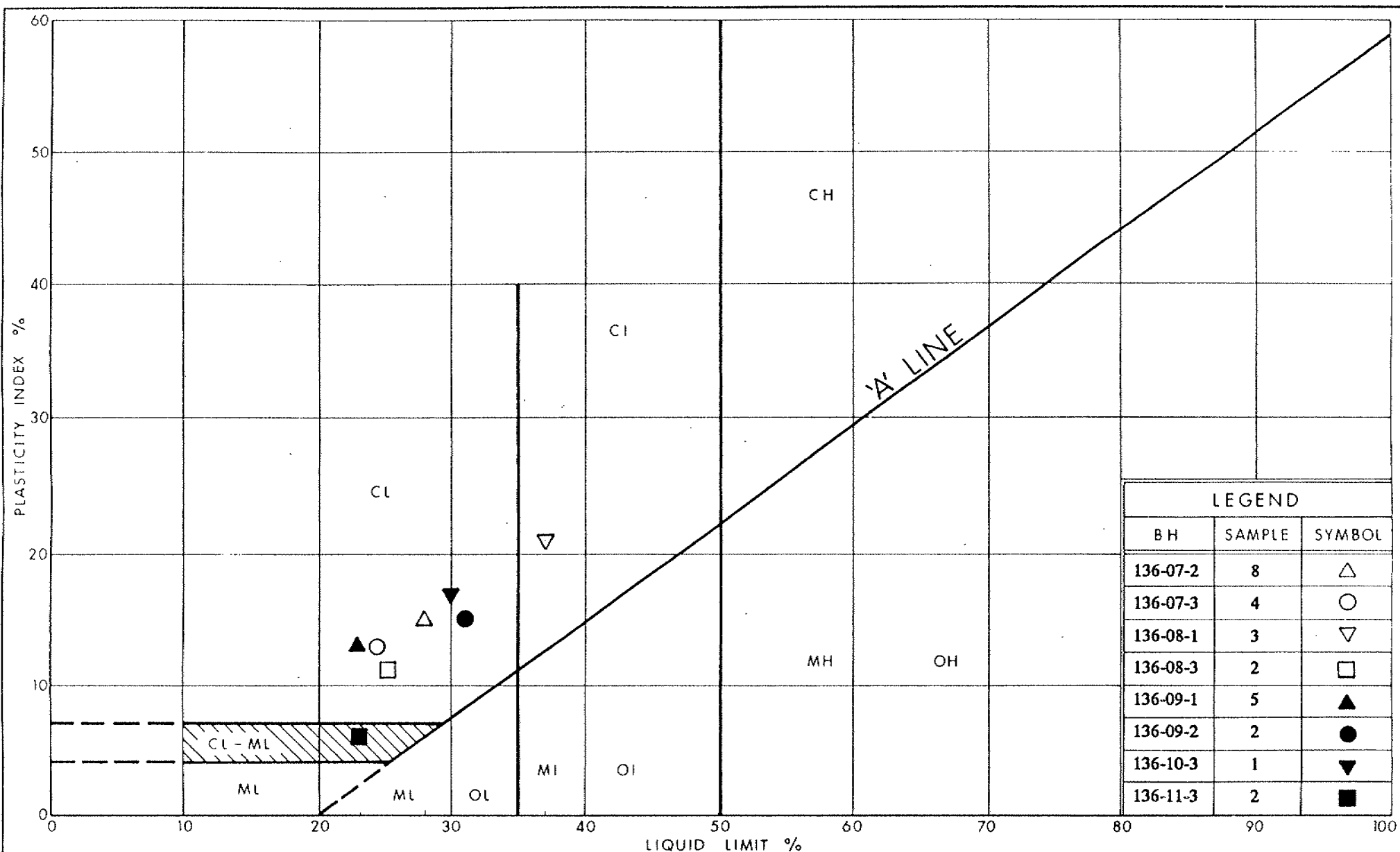


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PLASTICITY CHART
HET MIXTURE OF SILT & CLAY, SOME SAND,
TRACE GRAVEL (Glacial Till)

FIG No 2

W P 331-89-00



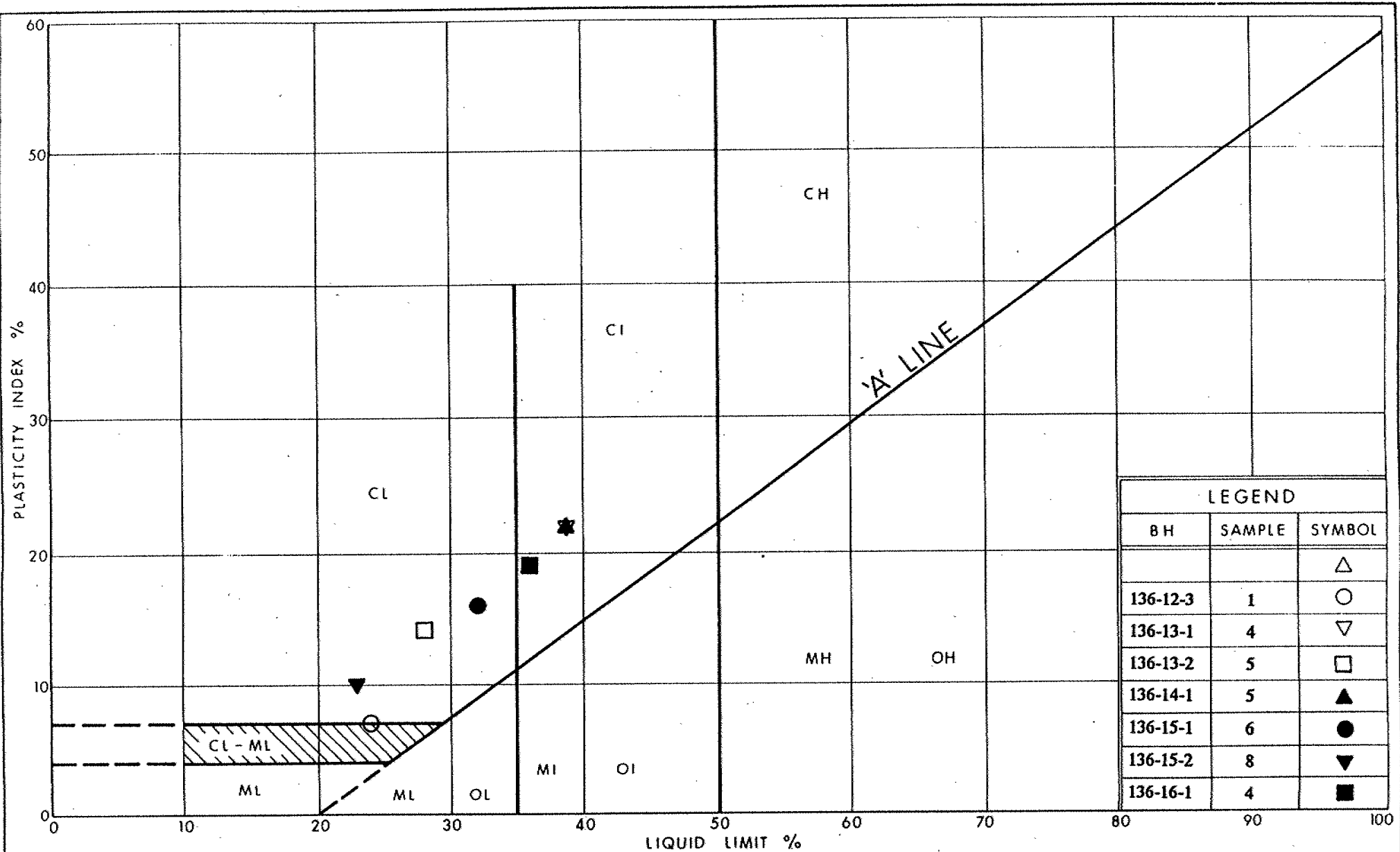
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Ontario

PLASTICITY CHART
HET MIXTURE OF SILT & CLAY, SOME SAND,
TRACE GRAVEL (Glacial Till)

FIG No 3

W P 331-89-00

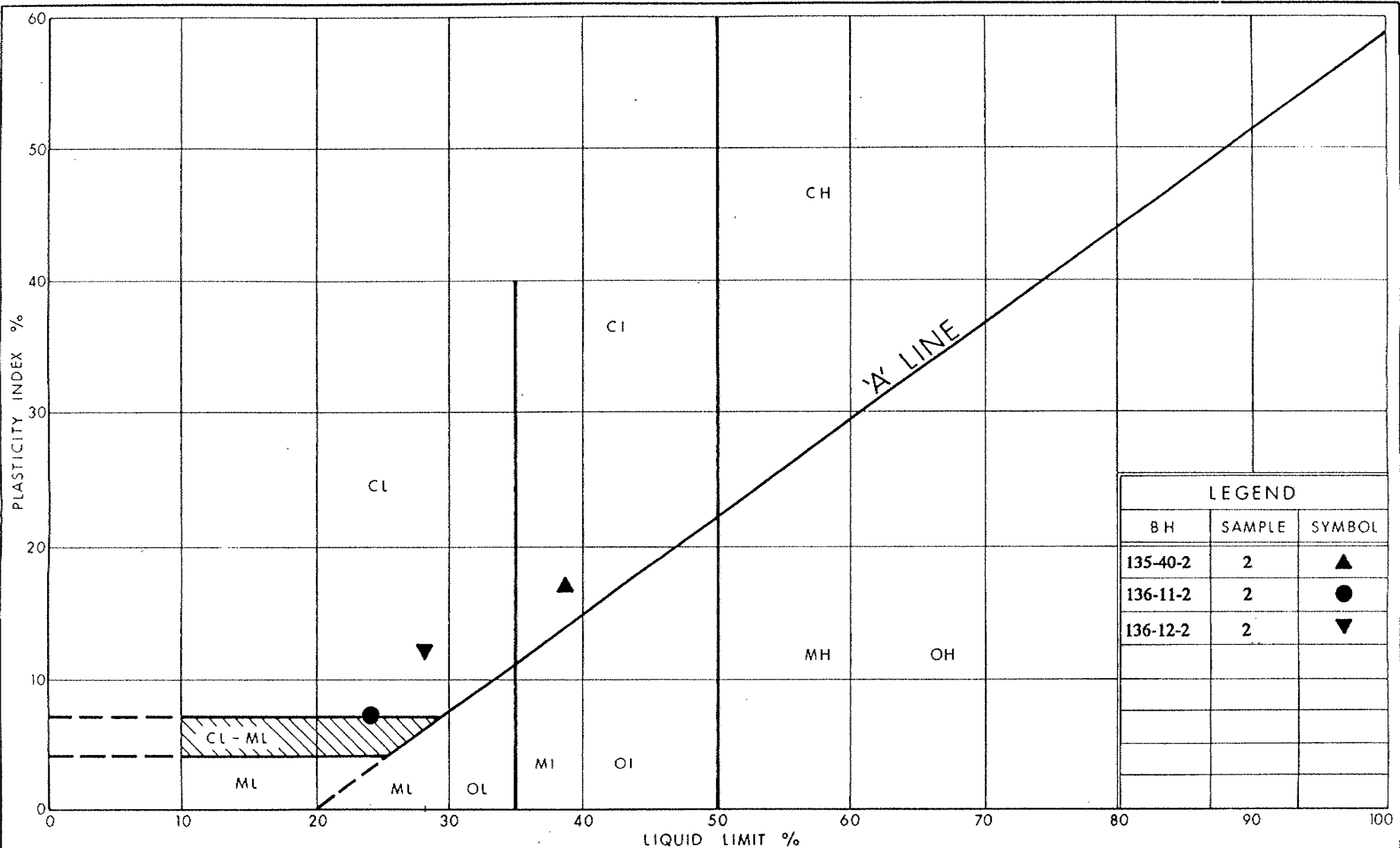


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PLASTICITY CHART
HET MIXTURE OF SILT & CLAY, SOME SAND,
TRACE GRAVEL (Glacial Till)

FIG No **4**

W P **331-89-00**



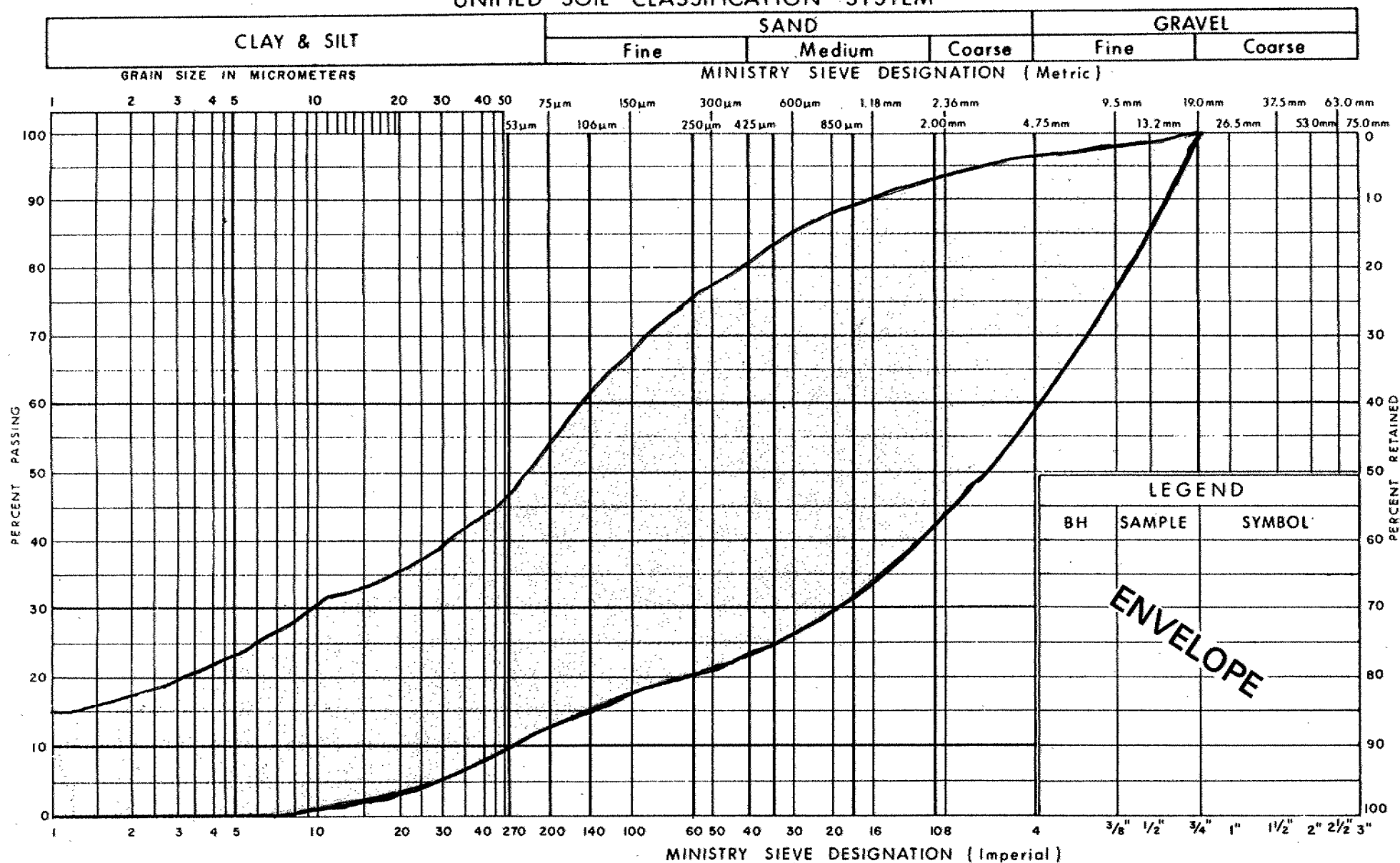
Ministry of
Transportation

PLASTICITY CHART MIXTURE OF SILT, CLAY, SAND & GRAVEL (FILL)

FIG No 5

W P 331-89-00

UNIFIED SOIL CLASSIFICATION SYSTEM

Ministry of
Transportation

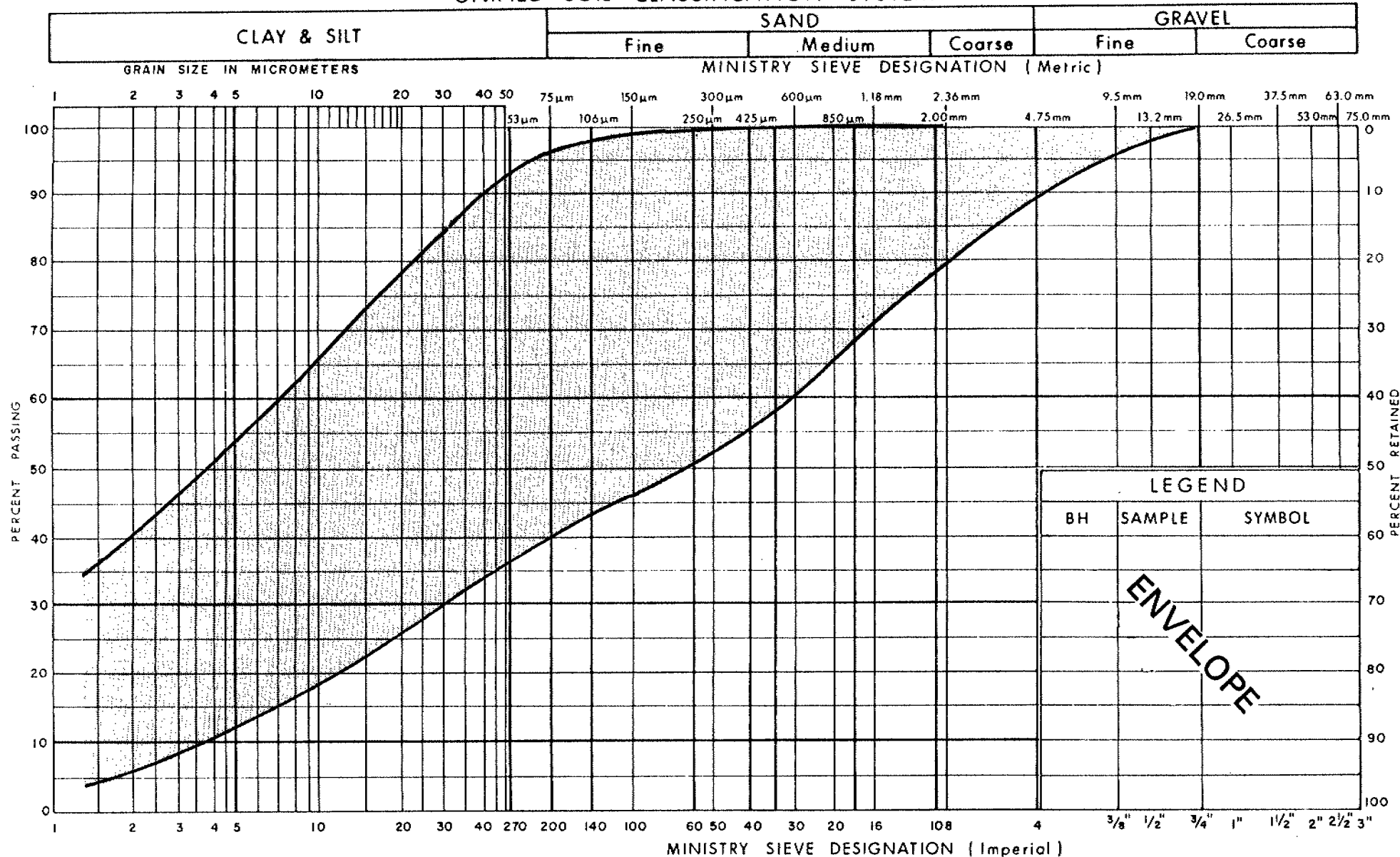
GRAIN SIZE DISTRIBUTION

FILL

FIG No 7

W P 331-89-00

UNIFIED SOIL CLASSIFICATION SYSTEM



Ministry of
Transportation

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

FIG No 8

W P 331-89-00

RECORD OF BOREHOLE No 135-40-1

1 OF 1

METRIC

W.P. 331-89-00 LOCATION WC 135-40; Sta. 31+688, O-S 25m Lt. ORIGINATED BY IK
DIST 4 HWY QEW BOREHOLE TYPE Solid Stem COMPILED BY IK
DATUM SEE TEXT DATE 94.08.24 & 94.08.24 CHECKED BY TO

SOIL PROFILE		SAMPLES			GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT					UNIT WEIGHT γ kN/m ³	REMARKS & GRAIN SIZE DISTRIBUTION (%)
ELEV DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE	"N" VALUES		20	40	60	80	100		
81.8	Ground Surface												
0.0	Topsoil		1	SS	12								
81.4													
0.5	Het. mixture of Silt and Clay, some sand, trace gravel (Glacial Till) Very Stiff to Hard Brown Grey		2	SS	37	81							
			3	SS	21	80						24.2	
			4	SS	10	79							
			5	SS	13	78							
			6	SS	22	77							
						76							
75.1			7	SS	35								
6.7	END OF BOREHOLE Borehole dry upon completion												

RECORD OF BOREHOLE No 135-40-2

1 OF 1

METRIC

W.P. 331-89-00 LOCATION WC 135-40; Sta. 31+688, O-S 4m Rt. ORIGINATED BY IK
DIST 4 HWY OEW BOREHOLE TYPE Solid Stem, Cone Test COMPILED BY IK
DATUM SEE TEXT DATE 94.08.10 & 94.08.10 CHECKED BY TO

SOIL PROFILE			SAMPLES			GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT		PLASTIC LIMIT W _P	NATURAL MOISTURE CONTENT W	LIQUID LIMIT W _L	UNIT WEIGHT γ kN/m ³	REMARKS & GRAIN SIZE DISTRIBUTION (%) GR SA SI CL		
ELEV DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE	"N" VALUES			20	40						60	80
83.5	Ground Surface															
0.0	Mixture of Sand, Silt and Clay, trace gravel. (Fill) Stiff		1	AS												
			2	SS	12											
82.0																
1.5	Het. mixture of Silt and Clay, some sand, trace gravel (Glacial Till) Very Stiff to Hard Brown Brown Grey		3	SS	21											
			4	SS	30											
			5	SS	26											
			6	SS	29											
			7	SS	34											
			8	SS	37											
			9	SS	49											
75.3																
8.2	END OF BOREHOLE Borehole dry upon completion															

RECORD OF BOREHOLE No 135-40-3

1 OF 1

METRIC

W.P. 331-89-00 LOCATION WC 135-40; Sta. 31+688, O-S 28m Rt. ORIGINATED BY IK
DIST 4 HWY QEW BOREHOLE TYPE Solid Stem COMPILED BY IK
DATUM SEE TEXT DATE 94.08.11 & 94.08.11 CHECKED BY TO

SOIL PROFILE		SAMPLES			GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT					UNIT WEIGHT γ kN/m ³	REMARKS & GRAIN SIZE DISTRIBUTION (%)
ELEV DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE			20	40	60	80	100		
82.0	Ground Surface					82							
0.0	Het. mixture of Silt and Clay, some sand, trace gravel (Glacial Till) Very Stiff to Hard Brown Grey		1	SS	18								
			2	SS	29	81							
			3	SS	19	80							
			4	SS	20								
			5	SS	21	79							
			6	SS	24	78							
			7	SS	34	77							
			8	SS	30	76							
75.3	END OF BOREHOLE												
6.7													

RECORD OF BOREHOLE No 135-41-1

1 OF 1

METRIC

W.P. 331-89-00

LOCATION WC 135-41; Sta. 32+102, O-S 30m Lt.

ORIGINATED BY JK

DIST 4

HWY QEW

BOREHOLE TYPE Solid Stem

COMPILED BY IK

DATUM SEE TEXT

DATE 94.08.23 & 94.08.23

CHECKED BY _____ TO _____

[illegible]

*³, ×³: Numbers refer to Sensitivity

RECORD OF BOREHOLE No 135-41-2

1 OF 1

METRIC

W.P. 331-89-00 LOCATION WC 135-41; Sta. 32+102, O-S 3m Rt. ORIGINATED BY IK
DIST 4 HWY QEW BOREHOLE TYPE Solid Stem, Cone Test COMPILED BY IK
DATUM SEE TEXT DATE 94.08.10 & 94.08.10 CHECKED BY TO

SOIL PROFILE		SAMPLES			GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT		PLASTIC LIMIT W _P	NATURAL MOISTURE CONTENT W	LIQUID LIMIT W _L	UNIT WEIGHT γ	REMARKS & GRAIN SIZE DISTRIBUTION (%)
ELEV DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE	"N" VALUES		20 40 60 80 100	20 40 60 80 100					
82.1	Ground Surface												
82.0	75mm ASPHALT												
0.1	Mixture of Sand, Silt and Gravel. (Fill)		1	AS									
81.2													
0.9	Het. mixture of Silt and Clay, some sand, trace gravel		2	SS	6								
	(Glacial Till)		3	SS	29								
	Very Stiff to Hard		4	SS	25								
			5	SS	25								
			6	SS	18								
			7	SS	24								
	Brown Grey		8	SS	33								
			9	SS	25								
74.6													
7.6	END OF BOREHOLE												
	Borehole dry upon completion												

RECORD OF BOREHOLE No 135-41-3

1 OF 1

METRIC

W.P. 331-89-00 LOCATION WC 135-41; Sta. 32+102, O-S 36m Rt. ORIGINATED BY IK
DIST 4 HWY QEW BOREHOLE TYPE Solid Stem COMPILED BY IK
DATUM SEE TEXT DATE 94.08.11 & 94.08.11 CHECKED BY TO

SOIL PROFILE			SAMPLES			GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT					UNIT WEIGHT γ kN/m ³	REMARKS & GRAIN SIZE DISTRIBUTION (%) GR SA SI CL
ELEV DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE	"N" VALUES			20	40	60	80	100		
80.5	Ground Surface													
80.4	50mm Topsoil		1	SS	8									
0.1	Het. mixture of Silt and Clay, some sand, trace gravel (Glacial Till) Very Stiff to Hard		2	SS	27									
			3	SS	33									
			4	SS	24									
			5	SS	27									
			6	SS	32									
75.0														
5.6	Shale Bedrock Poor to Fair		7	SS	50	100mm								
73.8														
6.7	END OF BOREHOLE Borehole dry upon completion													

RECORD OF BOREHOLE No 136-01-1

1 OF 1

METRIC

W.P. 331-89-00 LOCATION WC 136-01; Sta. 10+419, O-S 23m Lt. ORIGINATED BY IK
DIST 4 HWY QEW BOREHOLE TYPE Solid Stem COMPILED BY IK
DATUM SEE TEXT DATE 94.08.23 & 94.08.23 CHECKED BY TO

SOIL PROFILE			SAMPLES			GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT					UNIT WEIGHT γ kN/m ³	REMARKS & GRAIN SIZE DISTRIBUTION (%) GR SA SI CL
ELEV DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE	"N" VALUES			20 40 60 80 100	20 40 60 80 100	20 40 60 80 100	20 40 60 80 100	20 40 60 80 100		
80.2	Ground Surface													
79.9	Topsoil		1	SS	13		80							
0.3	Het. mixture of Silt and Clay, some sand, trace gravel (Glacial Till) Very Stiff to Hard Brown Grey -grey shale seam (75mm)		2	SS	26		79						20.7	
			3	SS	35		78							
			4	SS	63		77							
			5	SS	68	283mm	76							
			6	SS	26		75							
			7	SS	29		74							
73.5	END OF BOREHOLE													
6.7	Borehole dry upon completion													

RECORD OF BOREHOLE No 136-01-2

1 OF 1

METRIC

W.P. 331-89-00 LOCATION WC 136-01; Sta. 10+419, O-S 4m Rt. ORIGINATED BY IK
DIST 4 HWY QEW BOREHOLE TYPE Solid Stem, Cone Test COMPILED BY IK
DATUM SEE TEXT DATE 94.08.11 & 94.08.11 CHECKED BY TO

SOIL PROFILE			SAMPLES			GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT				UNIT WEIGHT γ kN/m ³	REMARKS & GRAIN SIZE DISTRIBUTION (%) GR SA SI CL
ELEV DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE	"N" VALUES			20	40	60	80		
82.0	Ground Surface												
81.7	Mixture of Sand, Silt and Gravel (Fill)		1	SS	8								
80.3	Mixture of Silt and Sand, trace clay (Fill), loose		2	SS	9								
1.7	Het. mixture of Silt and Clay, some sand, trace gravel (Glacial Till) Very Stiff to Hard Brown Grey		3	SS	33								
			4	SS	45								
			5	SS	59								
			6	SS	69								
			7	SS	35								
			8	SS	49								
			9	SS	36								
73.8	END OF BOREHOLE												
8.2	Borehole dry upon completion												

RECORD OF BOREHOLE No 136-01-3

1 OF 1

METRIC

W.P. 331-89-00 LOCATION WC 136-01; Sta. 10+419, O-S 22m Rt. ORIGINATED BY IK
DIST 4 HWY QEW BOREHOLE TYPE Solid Stem COMPILED BY IK
DATUM SEE TEXT DATE 94.08.11 & 94.08.11 CHECKED BY TO

SOIL PROFILE		SAMPLES			GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT					UNIT WEIGHT γ _s kN/m ³	REMARKS & GRAIN SIZE DISTRIBUTION (%)
ELEV DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE			20	40	60	80	100		
79.9	Ground Surface												
79.8	75mm Topsoil		1	SS	9								
0.1	Het. mixture of Silt and Clay, some sand, trace gravel		2	SS	4	79							
	(Glacial Till)		3	SS	26	78							
	Very Stiff to Hard		4	SS	77	77							
	Brown Grey		5	SS	45	76							
			6	SS	54	75							
						74							
73.2			7	SS	31								
6.7	END OF BOREHOLE												
	Borehole dry upon completion												

×³ . ×³: Numbers refer to Sensitivity 20 15 10 (%) STRAIN AT FAILURE

RECORD OF BOREHOLE No 136-02-1

1 OF 1

METRIC

W.P. 331-89-00 LOCATION WC 136-02; Sta. 10+622, O-S 23m Lt. ORIGINATED BY IK
DIST 4 HWY QEW BOREHOLE TYPE Solid Stem COMPILED BY IK
DATUM SEE TEXT DATE 94.08.23 & 94.08.23 CHECKED BY TO

SOIL PROFILE		SAMPLES			GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT					UNIT WEIGHT γ kN/m ³	REMARKS & GRAIN SIZE DISTRIBUTION (%)
ELEV DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE	"N" VALUES		20	40	60	80	100		
81.3	Ground Surface												
80.8	Topsoil		1	SS	14	81							
0.3	Het. mixture of Silt and Clay, some sand, trace gravel (Glacial Till) Very Stiff to Hard Brown Grey		2	SS	27	80							
			3	SS	24	79							
			4	SS	38	78							
			5	SS	36	77							
			6	SS	26	76							
			7	SS	22	75							
74.6	END OF BOREHOLE												
6.7	Borehole dry upon completion												

RECORD OF BOREHOLE No 136-02-2

1 OF 1

METRIC

W.P. 331-89-00 LOCATION WC 136-02; Sta. 10+822, O-S 3m Rt. ORIGINATED BY JK
DIST 4 HWY QEW BOREHOLE TYPE Solid Stem, Cone Test COMPILED BY JK
DATUM SEE TEXT DATE 94.08.11 & 94.08.11 CHECKED BY TO

SOIL PROFILE			SAMPLES			GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT					UNIT WEIGHT & kN/m ³	REMARKS & GRAIN SIZE DISTRIBUTION (%)
ELEV DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE	"N" VALUES			20	40	60	80	100		
82.2	Ground Surface													
0.0	Mixture of Sand, Silt and Gravel (Fill), compact		1	SS	7		82							
81.6														
0.6	Het. mixture of Silt and Clay, some sand, trace gravel (Glacial Till) Very Stiff to Hard		2	SS	8		81							
			3	SS	32		80							
			4	SS	34		79							
			5	SS	31		78							
			6	SS	43		77							
			7	SS	42		76							
			8	SS	30		75							
74.6			9	SS	30									
7.6	END OF BOREHOLE Borehole dry upon completion													

x³, x²: Numbers refer to
Sensitivity

20
15
10

(%) STRAIN AT FAILURE

RECORD OF BOREHOLE No 136-02-3

1 OF 1

METRIC

W.P. 331-89-00 LOCATION WC 136-02; Sta. 10+622, O-S 23m Rt. ORIGINATED BY IK
DIST 4 HWY QEW BOREHOLE TYPE Solid Stem COMPILED BY IK
DATUM SEE TEXT DATE 94.08.11 & 94.08.11 CHECKED BY TO

SOIL PROFILE			SAMPLES			GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT		PLASTIC LIMIT W _P	NATURAL MOISTURE CONTENT W	LIQUID LIMIT W _L	UNIT WEIGHT γ kN/m ³	REMARKS & GRAIN SIZE DISTRIBUTION (%) GR SA SI CL
ELEV DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE	*N* VALUES			SHEAR STRENGTH kPa	WATER CONTENT (%)					
81.5	Ground Surface													
0.0	Topsoil		1	SS	7									
81.1														
0.4	Het. mixture of Silt and Clay, some sand, trace gravel (Glacial Till) Very Stiff to Hard Brown Grey		2	SS	30									0 17 54 29
			3	SS	35									
			4	SS	45									
			5	SS	38									
			6	SS	38									
74.8			7	SS	27									
6.7	END OF BOREHOLE													

RECORD OF BOREHOLE No 136-03-1

1 OF 1

METRIC

W.P. 331-88-00 LOCATION WC 136-03; Sta. 10+825, O-S 22m Lt. ORIGINATED BY IK
DIST 4 HWY QEW BOREHOLE TYPE Solid Stem COMPILED BY IK
DATUM SEE TEXT DATE 94.08.23 & 94.08.23 CHECKED BY TO

SOIL PROFILE			SAMPLES			GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT					UNIT WEIGHT γ kN/m ³	REMARKS & GRAIN SIZE DISTRIBUTION (%) GR SA SI CL
ELEV DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE	"N" VALUES			20 40 60 80 100	20 40 60 80 100	20 40 60 80 100	20 40 60 80 100	20 40 60 80 100		
81.8	Ground Surface													
81.8	Topsoil		1	SS	2									
0.3	Het. mixture of Silt and Clay, some sand, trace gravel (Glacial Till) Very Stiff to Hard Brown Grey		2	SS	13		81						22.2	
			3	SS	34		80							
			4	SS	26		79							
			5	SS	26		78							
			6	SS	28		77							
							76							
75.1			7	SS	30									
6.7	END OF BOREHOLE Borehole dry upon completion													

\times^3, \times^3 : Numbers refer to Sensitivity $\frac{20}{15 \times 6}$ (%) STRAIN AT FAILURE

RECORD OF BOREHOLE No 136-03-2

1 OF 1

METRIC

W.P. 331-89-00 LOCATION WC 136-03; Sta. 10+825, O-S 3m Rt. ORIGINATED BY IK
DIST 4 HWY QEW BOREHOLE TYPE Solid Stem, Cone Test COMPILED BY IK
DATUM SEE TEXT DATE 94.08.11 & 94.08.11 CHECKED BY TO

SOIL PROFILE			SAMPLES			GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT		UNIT WEIGHT γ kN/m ³	REMARKS & GRAIN SIZE DISTRIBUTION (%)
ELEV DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE	"N" VALUES			20 40 60 80 100	20 40 60 80 100		
82.3	Ground Surface										
0.0	Mixture of Sand, Silt and Gravel. (Fill), compact		1	AS							
81.5											
0.8	Het. mixture of Silt and Clay, some sand, trace gravel (Glacial Till) Very Stiff to Hard Brown Grey -100mm sand seam		2	SS	15						
			3	SS	36						
			4	SS	45						
			5	SS	55						
			6	SS	36						
			7	SS	30						
			8	SS	28						
			9	SS	33						
74.1											
8.2	END OF BOREHOLE Borehole dry upon completion										

RECORD OF BOREHOLE No 136-03-3

1 OF 1

METRIC

W.P. 331-89-00 LOCATION WC 136-03; Sta. 10+825, O-S 22m Rt. ORIGINATED BY IK
DIST 4 HWY QEW BOREHOLE TYPE Solid Stem COMPILED BY IK
DATUM SEE TEXT DATE 94.08.11 & 94.08.11 CHECKED BY TO

SOIL PROFILE			SAMPLES			GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT					UNIT WEIGHT γ kN/m ³	REMARKS & GRAIN SIZE DISTRIBUTION (%)
ELEV DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE	"N" VALUES			20 40 60 80 100	20 40 60 80 100	20 40 60 80 100	20 40 60 80 100	20 40 60 80 100		
81.6	Ground Surface													
81.6	Topsoil		1	SS	14		81							
0.1	Het. mixture of Silt and Clay, some sand, trace gravel (Glacial Till) Very Stiff to Hard		2	SS	36		80						21.0	0 15 55 30
			3	SS	45		79							
			4	SS	50		78							
			5	SS	31		77							
			6	SS	29		76							
			7	SS	27		75							
74.9	END OF BOREHOLE													
6.7	Borehole dry upon completion													

RECORD OF BOREHOLE No 136-04-1

1 OF 1

METRIC

W.P. 331-89-00

LOCATION WC 136-04; Sta. 11+101, O-S 23m Lt.

ORIGINATED BY IK

DIST 4 HWY QEW

BOREHOLE TYPE Solid Stem

COMPILED BY IK

DATUM SEE TEXT

DATE 94.08.23 & 94.08.23

CHECKED BY TO

SOIL PROFILE			SAMPLES			GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT					UNIT WEIGHT γ kN/m ³	REMARKS & GRAIN SIZE DISTRIBUTION (%)
ELEV DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE	"N" VALUES			20	40	60	80	100		
81.6	Ground Surface													
81.3	Topsoil		1	SS	5									
0.3	Het. mixture of Silt and Clay, some sand, trace gravel (Glacial Till) Very Stiff to Hard Brown Grey		2	SS	26									
			3	SS	49									
			4	SS	41									
			5	SS	28									
			6	SS	43									
			7	SS	20									
74.9	END OF BOREHOLE												22.8	
6.7	Borehole dry upon completion													

RECORD OF BOREHOLE No 136-04-2

1 OF 1

METRIC

W.P. 331-89-00 LOCATION WC 136-04; Sta. 11+101, O-S 3m Rt. ORIGINATED BY IK
DIST 4 HWY QEW BOREHOLE TYPE Solid Stem, Cone Test COMPILED BY IK
DATUM SEE TEXT DATE 94.08.11 & 94.08.11 CHECKED BY TO

SOIL PROFILE			SAMPLES			GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT		PLASTIC LIMIT w _p	NATURAL MOISTURE CONTENT w	LIQUID LIMIT w _L	UNIT WEIGHT γ kN/m ³	REMARKS & GRAIN SIZE DISTRIBUTION (%) GR SA SI CL
ELEV DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE	*N* VALUES			SHEAR STRENGTH kPa	WATER CONTENT (%)					
82.7	Ground Surface													
82.8	75mm ASPHALT													
0.1	Brown Sand and Gravel (Fill)		1	SS	7									
82.2	Het. mixture of Silt and Clay, some sand, trace gravel		2	SS	7									
0.5	(Glacial Till)		3	SS	22									
	Very Stiff to Hard		4	SS	32									
	Brown Grey		5	SS	28									
			6	SS	50									
			7	SS	48									
			8	SS	34									
75.1			9	SS	36									
7.6	END OF BOREHOLE													

RECORD OF BOREHOLE No 136-04-3

1 OF 1

METRIC

W.P. 331-89-00 LOCATION WC 136-04; Sta. 11+101, O-S 23m Rt. ORIGINATED BY IK
DIST 4 HWY QEW BOREHOLE TYPE Solid Stem COMPILED BY IK
DATUM SEE TEXT DATE 94.08.12 & 94.08.12 CHECKED BY TO

SOIL PROFILE			SAMPLES			GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT				UNIT WEIGHT γ kN/m ³	REMARKS & GRAIN SIZE DISTRIBUTION (%)
ELEV DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE	"N" VALUES			20 40 60 80 100	20 40 60 80 100	PLASTIC LIMIT	NATURAL MOISTURE CONTENT	LIQUID LIMIT	
81.5	Ground Surface												
81.2	Topsoil		1	SS	34		81						
0.3	Het. mixture of Silt and Clay, some sand, trace gravel (Glacial Till) Very Stiff to Hard - medium to coarse gravel Brown Grey		2	SS	26		80						
			3	SS	38		79						
			4	SS	74	225mm	78						
			5	SS	44		77						
			6	SS	42		76						
75.0			7	SS	80	275mm	75						
6.5	END OF BOREHOLE Borehole dry upon completion												

\times^3, \times^3 : Numbers refer to Sensitivity 20 15 10 5 10 (%) STRAIN AT FAILURE

RECORD OF BOREHOLE No 136-05-1

1 OF 1

METRIC

W.P. 331-89-00 LOCATION WC 136-05; Sta. 11+262, O-S 22m Lt. ORIGINATED BY IK
DIST 4 HWY QEW BOREHOLE TYPE Solid Stem COMPILED BY IK
DATUM SEE TEXT DATE 94.08.23 & 94.08.23 CHECKED BY TO

SOIL PROFILE			SAMPLES			GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT					UNIT WEIGHT γ kN/m ³	REMARKS & GRAIN SIZE DISTRIBUTION (%)
ELEV DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE	"N" VALUES			20	40	60	80	100		
81.7	Ground Surface													
81.2	Topsoil		1	SS	11									
0.3	Het. mixture of Silt and Clay, some sand, trace gravel (Glacial Till) Very Stiff to Hard Brown Grey		2	SS	47		81							
			3	SS	60		80							
			4	SS	47		79							
			5	SS	39		78							
			6	SS	24		77							
							76							
76.0			7	SS	33		75							
6.7	END OF BOREHOLE Borehole dry upon completion													

RECORD OF BOREHOLE No 136-05-2

1 OF 1

METRIC

W.P. 331-89-00 LOCATION WC 136-05; Sta. 11+262, O-S 3m Rt. ORIGINATED BY IK
DIST 4 HWY QEW BOREHOLE TYPE Solid Stem, Cone Test COMPILED BY IK
DATUM SEE TEXT DATE 94.08.11 & 94.08.12 CHECKED BY TO

SOIL PROFILE			SAMPLES			GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT		PLASTIC LIMIT W _p	NATURAL MOISTURE CONTENT W	LIQUID LIMIT W _L	UNIT WEIGHT γ kN/m ³	REMARKS & GRAIN SIZE DISTRIBUTION (%)
ELEV DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE	"N" VALUES			20 40 60 80 100	20 40 60 80 100					
82.9	Ground Surface													
82.9	Brown Sand (Fill)		1	SS	23									
0.3	Brown Silt (Fill), some sand, trace clay and gravel		2	SS	14									
	Compact													
81.1	Het. mixture of Silt and Clay, some sand, trace gravel		3	SS	34									
1.8	(Glacial Till)		4	SS	32									
	Very Stiff to Hard		5	SS	28									
			6	SS	52									
			7	SS	37									
			8	SS	28									
			9	SS	42									
74.7	END OF BOREHOLE													
8.2	Borehole dry upon completion													

RECORD OF BOREHOLE No 136-05-3

1 OF 1

METRIC

W.P. 331-89-00 LOCATION WC 136-05; Sta. 11+262, O-S 22m Rt. ORIGINATED BY IK
DIST 4 HWY QEW BOREHOLE TYPE Solid Stem COMPILED BY IK
DATUM SEE TEXT DATE 94.08.12 & 94.08.12 CHECKED BY TO

SOIL PROFILE			SAMPLES			GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT			UNIT WEIGHT γ kN/m ³	REMARKS & GRAIN SIZE DISTRIBUTION (%) GR SA SI CL		
ELEV DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE	"N" VALUES			SHEAR STRENGTH kPa						
								20 40 60 80 100						
								20 40 60 80 100						
			○ UNCONFINED × FIELD VANE			PLASTIC LIMIT NATURAL MOISTURE CONTENT LIQUID LIMIT								
			● QUICK TRIAXIAL × LAB VANE			WATER CONTENT (%)								
						20 40 60 80 100			w _p w w _L					
									10 20 30					
82.2	Ground Surface													
82.1	75mm Topsoil		1	SS	12		82						0 15 59 26	
0.1	Het. mixture of Silt and Clay, some sand, trace gravel (Glacial Till) Very Stiff to Hard - seams of silty sand Brown Grey		2	SS	25		81							
			3	SS	34		80							
			4	SS	60		79							
			5	SS	46		78							
			6	SS	32		77							
							76							
			7	SS	32									
75.5														
6.7	END OF BOREHOLE													

RECORD OF BOREHOLE No 136-06-1

1 OF 1

METRIC

W.P. 331-89-00 LOCATION WC 136-06; Sta. 11+446, O-S 23m Lt. ORIGINATED BY IK
DIST 4 HWY QEW BOREHOLE TYPE Solid Stem COMPILED BY IK
DATUM SEE TEXT DATE 94.08.23 & 94.08.23 CHECKED BY TO

SOIL PROFILE			SAMPLES			GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT					UNIT WEIGHT γ _s kN/m ³	REMARKS & GRAIN SIZE DISTRIBUTION (%)
ELEV DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE	"N" VALUES			20 40 60 80 100	20 40 60 80 100	20 40 60 80 100	20 40 60 80 100	20 40 60 80 100		
81.8	Ground Surface													
81.8	Topsoil		1	SS	8									
0.3	Het. mixture of Silt and Clay, some sand, trace gravel (Glacial Till) Very Stiff to Hard Brown Grey		2	SS	35		81						22.0	
			3	SS	34		80							
			4	SS	54		79							
			5	SS	47		78							
			6	SS	32		77							
							76							
75.1			7	SS	31									
6.7	END OF BOREHOLE Borehole dry upon completion													

RECORD OF BOREHOLE No 136-06-2

1 OF 1

METRIC

W.P. 331-89-00 LOCATION WC 136-06: Sta. 11+448, O-S 3.0m Rt. ORIGINATED BY IK
DIST 4 HWY QEW BOREHOLE TYPE Solid Stem, Cone Test COMPILED BY IK
DATUM SEE TEXT DATE 94.08.11 & 94.08.11 CHECKED BY TO

SOIL PROFILE			SAMPLES			GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT		PLASTIC LIMIT w _p	NATURAL MOISTURE CONTENT w	LIQUID LIMIT w _L	UNIT WEIGHT γ	REMARKS & GRAIN SIZE DISTRIBUTION (%)
ELEV DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE	"N" VALUES			SHEAR STRENGTH kPa	WATER CONTENT (%)					
82.9	Ground Surface													
0.0	Mixture of Sand, Silt and Gravel (Fill), compact		1	SS	11									
82.3	Het. mixture of Silt and Clay, some sand, trace gravel (Glacial Till) Very Stiff to Hard		2	SS	10									
			3	SS	20									
			4	SS	28									
			5	SS	27									
			6	SS	40									
			7	SS	45									
			8	SS	38									
			9	SS	31									
75.3														
7.6	END OF BOREHOLE Borehole dry upon completion													

RECORD OF BOREHOLE No 136-06-3

1 OF 1

METRIC

W.P. 331-89-00 LOCATION WC 136-06; Sta. 11+446, O-S 23m Rt. ORIGINATED BY JK
DIST 4 HWY QEW BOREHOLE TYPE Solid Stem COMPILED BY JK
DATUM SEE TEXT DATE 94.08.12 & 94.08.12 CHECKED BY TO

SOIL PROFILE			SAMPLES			GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT					UNIT WEIGHT γ kN/m ³	REMARKS & GRAIN SIZE DISTRIBUTION (%)
ELEV DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE	"N" VALUES			20	40	60	80	100		
82.1	Ground Surface						82							
82.0	Topsoil		1	SS	2		81							
0.1	Het. mixture of Silt and Clay, some sand, trace gravel (Glacial Till) Very Stiff to Hard		2	SS	25		80							
			3	SS	31		79							
			4	SS	70	290mm	78							
			5	SS	35		77							
			6	SS	50	125mm	76							
75.4			7	SS	28									
6.7	END OF BOREHOLE													

RECORD OF BOREHOLE No 136-07-1

1 OF 1

METRIC

W.P. 331-89-00 LOCATION WC 136-07; Sta. 11+656, O-S 22m Lt. ORIGINATED BY IK
DIST 4 HWY QEW BOREHOLE TYPE Solid Stem COMPILED BY IK
DATUM SEE TEXT DATE 94.08.17 & 94.08.17 CHECKED BY TO

SOIL PROFILE			SAMPLES			GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT				UNIT WEIGHT γ kN/m ³	REMARKS & GRAIN SIZE DISTRIBUTION (%) GR SA SI CL
ELEV DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE	"N" VALUES			20 40 60 80 100	20 40 60 80 100	20 40 60 80 100	20 40 60 80 100		
82.5	Ground Surface												
82.4	50mm Topsoil		1	SS	3								
0.1	Het. mixture of Silt and Clay, some sand, trace gravel (Glacial Till) Very Stiff to Hard		2	SS	20								
			3	SS	23								
			4	SS	50	100mm							
			5	SS	38								
			6	SS	40								
			7	SS	31								
75.8													
6.7	END OF BOREHOLE Borehole dry upon completion												

RECORD OF BOREHOLE No 136-07-2

1 OF 1

METRIC

W.P. 331-89-00 LOCATION WC 136-07; Sta. 11+656, O-S 3m Rt. ORIGINATED BY JK
DIST 4 HWY QEW BOREHOLE TYPE Solid Stem, Cone Test COMPILED BY JK
DATUM SEE TEXT DATE 94.08.12 & 94.08.12 CHECKED BY TO

SOIL PROFILE			SAMPLES			GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT		PLASTIC LIMIT W _p	NATURAL MOISTURE CONTENT W	LIQUID LIMIT W _L	UNIT WEIGHT γ _s kN/m ³	REMARKS & GRAIN SIZE DISTRIBUTION (%) GR SA SI CL
ELEV DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE	*N* VALUES			SHEAR STRENGTH kPa	WATER CONTENT (%)					
83.1	Ground Surface													
0.0	Mixture of Sand, Silt and Gravel (Fill), compact		1	SS	10									
82.4														
0.7	Brown Silt (Fill), sandy and clayey, trace gravel, compact		2	SS	12									
81.6														
1.6	Het. mixture of silt and clay, some sand, trace gravel (Glacial till) Very stiff to hard Brown Grey		3	SS	27									
			4	SS	34									
			5	SS	63									
			6	SS	55									
			7	SS	48									
			8	SS	46									
			9	SS	68									
74.9														
8.2	END OF BOREHOLE Borehole dry upon completion													

RECORD OF BOREHOLE No 136-07-3

1 OF 1

METRIC

W.P. 331-89-00 LOCATION WC 136-07; Sta. 11+656, O-S 23m Rt. ORIGINATED BY IK
DIST 4 HWY QEW BOREHOLE TYPE Solid Stem COMPILED BY IK
DATUM SEE TEXT DATE 94.08.12 & 94.08.12 CHECKED BY TO

SOIL PROFILE			SAMPLES			GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT		PLASTIC LIMIT W _p	NATURAL MOISTURE CONTENT W	LIQUID LIMIT W _L	UNIT WEIGHT γ kN/m ³	REMARKS & GRAIN SIZE DISTRIBUTION (%)
ELEV DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE	"N" VALUES			SHEAR STRENGTH kPa						
82.4	Ground Surface													
82.3	Topsoil		1	SS	6		82							
0.1	Het. mixture of Silt and Clay, some sand, trace gravel		2	SS	21		81						23.0	
	(Glacial Till)		3	SS	52		80							
	Very Stiff to Hard		4	SS	31		79							
	Brown Grey		5	SS	31		78							
			6	SS	38		77							
			7	SS	28		76							
75.7	END OF BOREHOLE													
6.7	Borehole dry upon completion													

RECORD OF BOREHOLE No 136-08-1

1 OF 1

METRIC

W.P. 331-89-00 LOCATION WC 136-08; Sta. 11+853, O-S 23m Lt. ORIGINATED BY IK
DIST HWY QEW BOREHOLE TYPE Solid Stem COMPILED BY IK
DATUM SEE TEXT DATE 94.08.17 & 94.08.17 CHECKED BY TO

SOIL PROFILE			SAMPLES			GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT		PLASTIC LIMIT W _P	NATURAL MOISTURE CONTENT W	LIQUID LIMIT W _L	UNIT WEIGHT γ kN/m ³	REMARKS & GRAIN SIZE DISTRIBUTION (%) GR SA SI CL
ELEV DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE	"N" VALUES			20 40 60 80 100	20 40 60 80 100					
82.9	Ground Surface													
0.0	Topsoil		1	SS	3									
82.3														
0.6	Het. mixture of Silt and Clay, some sand, trace gravel (Glacial Till) Very Stiff to Hard Brown Grey		2	SS	26		82							
			3	SS	35		81							1 15 55 29
			4	SS	42		80							
			5	SS	57		79							
			6	SS	71		78							
							77							
76.2			7	SS	46									
6.7	END OF BOREHOLE Borehole dry upon completion													

RECORD OF BOREHOLE No 136-08-2

1 OF 1

METRIC

W.P. 331-89-00 LOCATION WC 136-08; Sta. 11+853, O-S 3m Rt. ORIGINATED BY IK
DIST HWY QEW BOREHOLE TYPE Solid Stem, Cone Test COMPILED BY IK
DATUM SEE TEXT DATE 94.08.12 & 94.08.12 CHECKED BY TO


SOIL PROFILE		SAMPLES			GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT		PLASTIC LIMIT w _p	NATURAL MOISTURE CONTENT w	LIQUID LIMIT w _L	UNIT WEIGHT γ kN/m ³	REMARKS & GRAIN SIZE DISTRIBUTION (%) GR SA SI CL
ELEV DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE			"N" VALUES	SHEAR STRENGTH kPa					
						20 40 60 80 100	20 40 60 80 100						
83.4	Ground Surface												
0.0	Mixture of Sand, Silt and Gravel (Fill), loose		1	SS	8								
82.5													
0.9	Het. mixture of Silt and Clay, some sand, trace gravel (Glacial Till) Very Stiff to Hard		2	SS	5								
			3	SS	34								
			4	SS	48								
			5	SS	60								
			6	SS	36								
			7	SS	44								
			8	SS	30								
			9	SS	65								
75.8													
7.6	END OF BOREHOLE Borehole dry upon completion												

RECORD OF BOREHOLE No 136-08-3

1 OF 1

METRIC

W.P. 331-89-00 LOCATION WC 136-08; Sta. 11+853, O-S 23m Rt. ORIGINATED BY IK
DIST HWY QEW BOREHOLE TYPE Solid Stem COMPILED BY IK
DATUM SEE TEXT DATE 94.08.12 & 94.08.12 CHECKED BY TO

SOIL PROFILE			SAMPLES			GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT		PLASTIC LIMIT	NATURAL MOISTURE CONTENT	LIQUID LIMIT	UNIT WEIGHT γ kN/m ³	REMARKS & GRAIN SIZE DISTRIBUTION (%)	
ELEV DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE	"N" VALUES			SHEAR STRENGTH kPa							WATER CONTENT (%)
82.5	Ground Surface							20 40 60 80 100		W _p	W	W _L		GR SA SI CL	
82.2	Topsoil		1	SS	25			20 40 60 80 100							
0.3	Het. mixture of Silt and Clay, some sand, trace gravel (Glacial Till) Very Stiff to Hard		2	SS	44									9 22 54 15	
			3	SS	67	125mm									
			4	SS	72										
			5	SS	47										
			6	SS	50	125mm									
			7	SS	50	75mm									
77.0															
5.5	Shale, Bedrock														
76.3	Poor to Fair														
6.2	END OF BOREHOLE														
	Borehole dry upon completion														

RECORD OF BOREHOLE No 136-09-1

1 OF 1

METRIC

W.P. 331-89-00 LOCATION WC 136-09: Sta. 12+059, O-S 34m Lt. ORIGINATED BY IK
DIST 4 HWY QEW BOREHOLE TYPE Solid Stem COMPILED BY IK
DATUM SEE TEXT DATE 94.08.17 & 94.08.17 CHECKED BY TO

SOIL PROFILE			SAMPLES			GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT				PLASTIC LIMIT W _p	NATURAL MOISTURE CONTENT W	LIQUID LIMIT W _L	UNIT WEIGHT γ kN/m ³	REMARKS & GRAIN SIZE DISTRIBUTION (%) GR SA SI CL
ELEV DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE	"N" VALUES			20	40	60	80					
82.8	Ground Surface															
82.8	Topsoil		1	SS	8											
82.8	Het. mixture of Silt and Clay, some sand, trace gravel		2	SS	54											
	(Glacial Till)															
	Very Stiff to Hard		3	SS	36											
	Brown		4	SS	66											
			5	SS	44											
			6	SS	51											
77.6																
5.3	Shale															
	Bedrock															
	Poor to Fair															
76.6			7	SS	50	75mm										
6.2	END OF BOREHOLE															
	Borehole dry upon completion															

RECORD OF BOREHOLE No 136-09-2

1 OF 1

METRIC

W.P. 331-89-00 LOCATION WC 136-09; Sta. 12+059, O-S 3m Rt. ORIGINATED BY IK
DIST HWY QEW BOREHOLE TYPE Solid Stem, Cone Test COMPILED BY IK
DATUM SEE TEXT DATE 94.08.12 & 94.08.12 CHECKED BY TO

SOIL PROFILE			SAMPLES			GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT		PLASTIC LIMIT WP	NATURAL MOISTURE CONTENT W	LIQUID LIMIT WL	UNIT WEIGHT γ kN/m ³	REMARKS & GRAIN SIZE DISTRIBUTION (%) GR SA SI C
ELEV DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE	"N" VALUES			SHEAR STRENGTH kPa						
								○ UNCONFINED ✕ FIELD VANE						
								● QUICK TRIAXIAL ✕ LAB VANE						
									20 40 60 80 100					
									20 40 60 80 100					
83.7	Ground Surface													
0.0	Mixture of Sand, Silt and Gravel (Fill), compact.		1	SS	14									
82.8														
0.9	Het. mixture of Silt and Clay, some sand, trace gravel (Glacial Till)		2	SS	13									0 11 56 33
			3	SS	29									
	Very Stiff to Hard													
			4	SS	35									
	Brown													
			5	SS	95									
			6	SS	70									
78.6			7	SS	91									
5.2	Shale													
	Bedrock													
	Poor to Fair		8	SS	100	75mm								
			9	SS	100	63mm								
76.4														
7.3	END OF BOREHOLE													
	Borehole dry upon completion													

RECORD OF BOREHOLE No 136-09-3

1 OF 1

METRIC

W.P. 331-89-00 LOCATION WC 136-09; Sta. 12+059, O-S 24m Rt. ORIGINATED BY IK
DIST HWY QEW BOREHOLE TYPE Solid Stem COMPILED BY IK
DATUM SEE TEXT DATE 94.08.15 & 94.08.15 CHECKED BY TO

SOIL PROFILE			SAMPLES			GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT				UNIT WEIGHT γ kN/m ³	REMARKS & GRAIN SIZE DISTRIBUTION (%)
ELEV DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE	"N" VALUES			20 40 60 80 100	20 40 60 80 100	20 40 60 80 100	20 40 60 80 100		
83.3	Ground Surface												
0.0	Topsoil		1	SS	6		83						
82.6													
0.8	Het. mixture of Silt and Clay, some sand, trace gravel		2	SS	27		82						
	(Glacial Till)		3	SS	50								
	Very Stiff to Hard		4	SS	74		81						
80.3	Brown												
3.1	Shale		5	SS	50	125mm	80						
	Bedrock		6	SS	50	100mm	79						
	Poor to Fair						78						
							77						
76.6			7	SS	50	25mm							
6.7	END OF BOREHOLE												
	Borehole dry upon completion												

\times^3, \times^3 : Numbers refer to Sensitivity 20 15 10 (% STRAIN AT FAILURE

RECORD OF BOREHOLE No 136-10-1

1 OF 1

METRIC

W.P. 331-89-00 LOCATION WC 136-10; Sta. 12+347, O-S 24m Lt. ORIGINATED BY JK
DIST 4 HWY QEW BOREHOLE TYPE Solid Stem, N-Casing, Rock Coring COMPILED BY JK
DATUM SEE TEXT DATE 94.08.18 & 94.08.18 CHECKED BY TO

SOIL PROFILE			SAMPLES			GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT					UNIT WEIGHT γ kN/m ³	REMARKS & GRAIN SIZE DISTRIBUTION (%)
ELEV DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE	*N* VALUES			20	40	60	80	100		
83.5	Ground Surface													
83.4	Topsoil		1	SS	4		83							
0.1	Het. mixture of silt and clay, some sand, trace gravel (Glacial Till), Very Stiff to Hard, brown		2	SS	80		82							
82.1	Shale		3	SS	50	150mm	81							
1.5	Bedrock		4	SS	50	150mm	80							
	Poor to Fair		5	NQ RC	REC 97%		79							RQD = 65%
			6	NQ RC	REC 100%		78							RQD = 73%
77.4	END OF BOREHOLE													
6.1														

RECORD OF BOREHOLE No 136-10-2

1 OF 1

METRIC

W.P. 331-89-00 LOCATION WC 136-10; Sta. 12+347, O-S 3m Rt. ORIGINATED BY IK
DIST 4 HWY QEW BOREHOLE TYPE Solid Stem, Cone Test COMPILED BY IK
DATUM SEE TEXT DATE 94.08.16 & 94.08.16 CHECKED BY TO

SOIL PROFILE			SAMPLES			GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT		PLASTIC LIMIT w _p	NATURAL MOISTURE CONTENT w	LIQUID LIMIT w _L	UNIT WEIGHT γ	REMARKS & GRAIN SIZE DISTRIBUTION (%)
ELEV DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE	"N" VALUES			20	40					
84.4	Ground Surface		1	SS	9		84							
0.0	Mixture of Sand, Silt and Gravel (Fill) Compact		2	SS	20		83							
83.4			3	SS	100	250mm	82							
1.1	Shale		4	SS	60	125mm	81							
	Bedrock		5	SS	50	25mm	80							
	Poor to Fair		6	SS	60	50mm	79							
			7	SS	60	63mm	78							
			8	SS	65	25mm	77							
76.8			9	SS	70	25mm								
7.7	END OF BOREHOLE													
	Borehole dry upon completion													

RECORD OF BOREHOLE No 136-10-3

1 OF 1

METRIC

W.P. 331-89-00 LOCATION WC 136-10; Sta. 12+347, O-S 30m Rt. ORIGINATED BY IK
DIST 4 HWY QEW BOREHOLE TYPE Solid Stem COMPILED BY IK
DATUM SEE TEXT DATE 94.08.15 & 94.08.15 CHECKED BY TO

SOIL PROFILE		SAMPLES			GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT					UNIT WEIGHT γ kN/m ³	REMARKS & GRAIN SIZE DISTRIBUTION (%)
ELEV DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE	"N" VALUES		20	40	60	80	100		
83.0	Ground Surface												
0.0	Het. mixture of Silt and Clay,		1	SS	9								0 23 73 5
82.6	some sand, trace gravel		2	SS	50								
0.5	(Glacial Till), very stiff to hard,												
	brown												
	Shale		3	SS	50	50mm							
	Bedrock					100mm							
	Poor to Fair		4	SS	50	125mm							
			5	SS	50	25mm							
			6	SS	50	25mm							
			7	SS	50	125							
76.3	END OF BOREHOLE												
6.7	Borehole dry upon completion												

*³, X³: Numbers refer to Sensitivity 20 15 10 (%) STRAIN AT FAILURE

RECORD OF BOREHOLE No 136-11-1

1 OF 1

METRIC

W.P. 331-89-00 LOCATION WC 136-11; Sta. 12+675, O-S 25m Lt. ORIGINATED BY IK
DIST 4 HWY QEW BOREHOLE TYPE Solid Stem, N-Casing, Rock Coring COMPILED BY IK
DATUM SEE TEXT DATE 94.08.17 & 94.08.18 CHECKED BY TO

SOIL PROFILE		SAMPLES			GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT					PLASTIC LIMIT WP	NATURAL MOISTURE CONTENT W	LIQUID LIMIT WL	UNIT WEIGHT γ kN/m ³	REMARKS & GRAIN SIZE DISTRIBUTION (%) GR SA SI CL
ELEV DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE			"N" VALUES	SHEAR STRENGTH kPa								
						20	40	60	80	100	WATER CONTENT (%)					
						○ UNCONFINED × FIELD VANE ● QUICK TRIAXIAL × LAB VANE										
						20	40	60	80	100	10	20	30			
83.3	Ground Surface															
83.0	Topsoil		1	SS	5											
81.8	Het. mixture of Silt and Clay, some sand, trace gravel (Glacial Till), very stiff to hard, brown		2	SS	22											
81.5	Shale		3	SS	50	100mm										
	Bedrock		4	SS	50	750mm										
	Fair to Good															
			5	NQ RC	REC 97%											RQD = 88%
			6	NQ RC	REC 100%											RQD = 70%
77.1																
6.2	END OF BOREHOLE															

RECORD OF BOREHOLE No 136-11-2

1 OF 1

METRIC

W.P. 331-89-00 LOCATION WC 136-11; Ste. 12+675, O-S 3m Rt. ORIGINATED BY IK
DIST HWY QEW BOREHOLE TYPE Solid Stem, Cone Test COMPILED BY IK
DATUM SEE TEXT DATE 94.08.16 & 94.08.16 CHECKED BY TO

SOIL PROFILE		SAMPLES			GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT		PLASTIC LIMIT W _p	NATURAL MOISTURE CONTENT W	LIQUID LIMIT W _L	UNIT WEIGHT γ kN/m ³	REMARKS & GRAIN SIZE DISTRIBUTION (%) GR SA SI CL
ELEV DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE			"N" VALUES	SHEAR STRENGTH kPa					
84.8	Ground Surface												
0.0	Mixture of Sand, Silt and Gravel (Fill), trace clay, compact		1	SS	10								
			2	SS	10								
82.8			3	SS	15								
2.0	Shale		4	SS	60	125mm							
	Bedrock												
	Poor to Fair		5	SS	60	50mm							
			6	SS	60	63mm							
			7	SS	60	63mm							
			8	SS	60	60mm							
77.1			9	SS	60	50mm							
7.7	END OF BOREHOLE												
	Borehole dry upon completion												

RECORD OF BOREHOLE No 136-11-3

1 OF 1

METRIC

W.P. 331-89-00 LOCATION WC 136-11; Sta. 12+676, O-S 32m Rt. ORIGINATED BY IK
DIST 4 HWY QEW BOREHOLE TYPE Solid Stem COMPILED BY IK
DATUM SEE TEXT DATE 94.08.15 & 94.08.15 CHECKED BY TO

SOIL PROFILE		SAMPLES			GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT					UNIT WEIGHT γ kN/m ³	REMARKS & GRAIN SIZE DISTRIBUTION (%)
ELEV DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE	"N" VALUES		20	40	60	80	100		
84.5	Ground Surface												
84.3	Topsoil		1	SS	7								
0.2	Het. mixture of Silt and Clay, some sand, trace gravel (Glacial Till), very stiff to hard		2	SS	50	75mm							
83.0	Shale		3	SS	50	75mm							
1.6	Bedrock		4	SS	50	25mm							
	Poor to Fair		5	SS	50	25mm							
			6	SS	50	25mm							
			7	SS	50	100mm							
77.8	END OF BOREHOLE												
6.7													

RECORD OF BOREHOLE No 136-12-1

1 OF 1

METRIC

W.P. 331-89-00 LOCATION WC 136-12; Sta. 12+885, O-S 36m Lt. ORIGINATED BY JK
DIST HWY QEW BOREHOLE TYPE Solid Stem COMPILED BY JK
DATUM SEE TEXT DATE 94.08.17 & 94.08.17 CHECKED BY TO

SOIL PROFILE		SAMPLES			GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT					UNIT WEIGHT γ kN/m ³	REMARKS & GRAIN SIZE DISTRIBUTION (%) GR SA SI CL
ELEV DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE	"N" VALUES		20	40	60	80	100		
83.0	Ground Surface												
82.8	Topsoil		1	SS	37								
0.2	Shale		2	SS	50	100mm							
	Bedrock		3	SS	50	100mm							
	Poor to Fair		4	SS	50	100mm							
			5	SS	50	40mm							
			6	SS	50	40mm							
76.8			7	SS	50	125m							
6.2	END OF BOREHOLE												
	Borehole dry upon completion												

RECORD OF BOREHOLE No 136-12-2

1 OF 1

METRIC

W.P. 331-89-00 LOCATION WC 136-12; Sta. 12+885, O-S 3m Rt. ORIGINATED BY JK
DIST 4 HWY QEW BOREHOLE TYPE Solid Stem, Cone Test COMPILED BY JK
DATUM SEE TEXT DATE 94.08.17 & 94.08.17 CHECKED BY TO

SOIL PROFILE			SAMPLES			GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT		PLASTIC LIMIT W _P	NATURAL MOISTURE CONTENT W	LIQUID LIMIT W _L	UNIT WEIGHT & kN/m ³	REMARKS & GRAIN SIZE DISTRIBUTION (%)
ELEV DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE	"N" VALUES			SHEAR STRENGTH kPa	WATER CONTENT (%)					
84.5	Ground Surface													
0.0	Mixture of Sand, Silt and Gravel (Fill), compact		1	SS	20									
83.7														
0.8	Clayey Silt (Fill), trace sand, very stiff, brown		2	SS	25									
82.9														
1.7	Shale		3	SS	35									
	Bedrock		4	SS	70	100mm								
	Poor to Fair		5	SS	80	25mm								
			6	SS	70	125mm								
			7	SS	60	100mm								
			8	SS	60	50mm								
76.8			9	SS	60	50mm								
7.7	END OF BOREHOLE													

RECORD OF BOREHOLE No 136-12-3

1 OF 1

METRIC

W.P. 331-89-00 LOCATION WC 136-12; Sta. 12+885, O-S 26m Rt. ORIGINATED BY IK
DIST HWY QEW BOREHOLE TYPE Solid Stem COMPILED BY IK
DATUM SEE TEXT DATE 94.08.15 & 94.08.15 CHECKED BY TO

SOIL PROFILE			SAMPLES			GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT					PLASTIC LIMIT W _P	NATURAL MOISTURE CONTENT W	LIQUID LIMIT W _L	UNIT WEIGHT γ kN/m ³	REMARKS & GRAIN SIZE DISTRIBUTION (%)
ELEV DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE	"N" VALUES			20	40	60	80	100					
83.7	Ground Surface		1	SS	12												
0.0	Het. mixture of Silt and Clay, some sand, trace gravel (Glacial Till) Very Stiff to Hard		2	SS	76												
82.2																	
1.5	Shale		3	SS	50	75mm											
	Bedrock																
	Poor to Fair		4	SS	50	10mm											
			5	SS	50	10mm											
			6	SS	50	10mm											
77.5																	
6.3	END OF BOREHOLE																
	Borehole dry upon completion																

RECORD OF BOREHOLE No 136-13-1

1 OF 1

METRIC

W.P. 331-89-00 LOCATION WC 136-13; Sta. 13+085, O-S 32m Lt. ORIGINATED BY IK
DIST 4 HWY QEW BOREHOLE TYPE Solid Stem COMPILED BY IK
DATUM SEE TEXT DATE 94.08.17 & 94.08.17 CHECKED BY TO

SOIL PROFILE			SAMPLES			GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT					UNIT WEIGHT γ kN/m ³	REMARKS & GRAIN SIZE DISTRIBUTION (%)
ELEV DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE	"N" VALUES			20	40	60	80	100		
82.5	Ground Surface													
82.2	Topsoil		1	SS	6		82							
0.3	Het. mixture of Silt and Clay, some sand, trace gravel (Glacial Till) Very Stiff to Hard Brown		2	SS	20		81							
			3	SS	13		80							
			4	SS	15		79							
			5	SS	32		78							
78.3			6	SS	33		77							
4.3	Shale Bedrock Poor to Fair													
76.3			7	SS	50	100mm								
6.2	END OF BOREHOLE Borehole dry upon completion													

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

RECORD OF BOREHOLE No 136-13-2

1 OF 1

METRIC

W.P. 331-89-00 LOCATION WC 136-13; Sta. 13+085, O-S 3m Lt. ORIGINATED BY JK
DIST HWY OEW BOREHOLE TYPE Solid Stem, Cone Test COMPILED BY JK
DATUM SEE TEXT DATE 94.08.12 & 94.08.12 CHECKED BY TO

SOIL PROFILE			SAMPLES			GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT		PLASTIC LIMIT W _P	NATURAL MOISTURE CONTENT W	LIQUID LIMIT W _L	UNIT WEIGHT γ kN/m ³	REMARKS & GRAIN SIZE DISTRIBUTION (%) GR SA SI CL
ELEV DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE	"N" VALUES			20 40 60 80 100	20 40 60 80 100					
83.7	Ground Surface													
0.0	Silty Sand (Fill), some gravel, compact Brown		1	SS	9									
82.6			2	SS	13									
1.1	Het. mixture of Silt and Clay, some sand, trace gravel (Glacial Till) Very Stiff to Hard		3	SS	17									
			4	SS	20									
			5	SS	25									
			6	SS	39									
79.0			7	SS	70	38mm								
4.7	Shale Bedrock Poor to Fair		8	SS	100	75mm								
			9	SS	100	75mm								
76.2														
7.6	END OF BOREHOLE Borehole dry upon completion													

RECORD OF BOREHOLE No 136-13-3

1 OF 1

METRIC

W.P. 331-89-00 LOCATION WC 136-13; Ste. 13+085, O-S 47m Rt. ORIGINATED BY IK
 DIST HWY QEW BOREHOLE TYPE Solid Stem COMPILED BY IK
 DATUM SEE TEXT DATE 94.08.15 & 94.08.15 CHECKED BY TO

SOIL PROFILE		SAMPLES			GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT					UNIT WEIGHT γ kN/m ³	REMARKS & GRAIN SIZE DISTRIBUTION (%)
ELEV DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE	"N" VALUES		20	40	60	80	100		
82.8	Ground Surface												
0.0	Het. mixture of Silt and Clay, some sand, trace gravel (Glacial Till) Very Stiff to Hard Brown Grey		1	SS	4								
			2	SS	4								
			3	SS	18								
			4	SS	50								
79.6			5	SS	50	50mm							
3.3	Shale		6	SS	50	135mm							
	Bedrock												
	Poor to Fair												
76.2			7	SS	50	75mm							
6.7	END OF BOREHOLE												

RECORD OF BOREHOLE No 136-14-1

1 OF 1

METRIC

W.P. 331-89-00 LOCATION WC 136-14; Sta. 13+278, O-S 30m Lt. ORIGINATED BY IK
DIST HWY QEW BOREHOLE TYPE Solid Stem COMPILED BY IK
DATUM SEE TEXT DATE 94.08.16 & 94.08.16 CHECKED BY TO

SOIL PROFILE			SAMPLES			GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT			UNIT WEIGHT γ kN/m ³	REMARKS & GRAIN SIZE DISTRIBUTION (%) GR SA SI CL			
ELEV DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE	"N" VALUES			SHEAR STRENGTH kPa					WATER CONTENT (%)		
								20 40 60 80 100							
82.6	Ground Surface														
82.6	Topsoil		1	SS	4										
0.1	Het. mixture of Silt and Clay, some sand, trace gravel		2	SS	26										
	(Glacial Till)		3	SS	37										
	Very Stiff to Hard		4	SS	13										
	Brown		5	SS	12										
			6	SS	12										
			7	SS	38										
75.9															
6.7	END OF BOREHOLE														
	Borehole dry upon completion														

RECORD OF BOREHOLE No 136-14-2

1 OF 1

METRIC

W.P. 331-89-00 LOCATION WC 136-14; Sta. 13+278, O-S 3m Lt. ORIGINATED BY IK
DIST HWY QEW BOREHOLE TYPE Solid Stem, Cone Test COMPILED BY IK
DATUM SEE TEXT DATE 94.08.13 & 94.08.13 CHECKED BY TO

SOIL PROFILE		SAMPLES			GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT		PLASTIC LIMIT w _p	NATURAL MOISTURE CONTENT w	LIQUID LIMIT w _L	UNIT WEIGHT γ kN/m ³	REMARKS & GRAIN SIZE DISTRIBUTION (%) GR SA SI CL
ELEV DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE			"N" VALUES	SHEAR STRENGTH kPa					
83.7	Ground Surface												
83.6	100mm Asphalt												
0.1	Mixture of Sand, Silt and Gravel (Fill), loose, brown		1	SS	9								
82.6			2	SS	8								
1.1	Het. mixture of Silt and Clay, some sand, trace gravel (Glacial Till) Very Stiff to Hard Brown		3	SS	19								
			4	SS	29								
			5	SS	18								
			6	SS	8								
			7	SS	7								
			8	SS	130								
			9	SS	37								
76.1													
7.6	END OF BOREHOLE Borehole dry upon completion												

RECORD OF BOREHOLE No 136-14-3

1 OF 1

METRIC

W.P. 331-89-00

LOCATION WC 136-14; Sta. 13+278, O-S 34m Rt.

ORIGINATED BY IK

DIST 4

HWY QEWBOREHOLE TYPE Solid Stem

COMPILED BY IK

DATUM SEE TEXT

DATE 94.08.15 & 94.08.15

CHECKED BY _____ TO _____

[illegible]

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

RECORD OF BOREHOLE No 136-15-1

1 OF 1

METRIC

W.P. 331-89-00 LOCATION WC 136-15: Sta. 13+499, O-S 23m Lt. ORIGINATED BY IK
DIST HWY QEW BOREHOLE TYPE Solid Stem COMPILED BY IK
DATUM SEE TEXT DATE 94.08.16 & 94.08.16 CHECKED BY TO

SOIL PROFILE			SAMPLES			GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT			UNIT WEIGHT γ kN/m ³	REMARKS & GRAIN SIZE DISTRIBUTION (%)
ELEV DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE	"N" VALUES			SHEAR STRENGTH kPa				
82.6	Ground Surface							20 40 60 80 100				
82.6	Topsoil		1	SS	9		82					
0.1	Het. mixture of Silt and Clay, some sand, trace gravel		2	SS	32		81					
	(Glacial Till)		3	SS	28		80					
	Very Stiff to Hard		4	SS	17		79					
	Brown Grey		5	SS	11		78					
			6	SS	11		77					
			7	SS	41		76					
75.9	END OF BOREHOLE											
6.7	Borehole dry upon completion											

RECORD OF BOREHOLE No 136-15-2

1 OF 1

METRIC

W.P. 331-89-00 LOCATION WC 136-15; Sta. 13+499, O-S 3m Lt. ORIGINATED BY IK
DIST 4 HWY QEW BOREHOLE TYPE Solid Stem, Cone Test COMPILED BY IK
DATUM SEE TEXT DATE 94.08.12 & 94.08.12 CHECKED BY TO

SOIL PROFILE			SAMPLES			GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT				UNIT WEIGHT γ kN/m ³	REMARKS & GRAIN SIZE DISTRIBUTION (%)
ELEV DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE	"N" VALUES			20	40	60	80	100	
83.6	Ground Surface												
83.5	50mm Asphalt												
83.2	Mixture of Sand and Gravel (Fill), trace silt, compact		1	SS	13								
83.2	Het. mixture of Silt and Clay, some sand, trace gravel		2	SS	6								
0.5	(Glacial Till)		3	SS	21								
	Very Stiff to Hard		4	SS	31								
	Brown Grey		5	SS	22								
			6	SS	15								
			7	SS	9								
			8	SS	27								
			9	SS	29								
76.0	END OF BOREHOLE												
7.6	Borehole dry upon completion												

RECORD OF BOREHOLE No 136-15-3

1 OF 1

METRIC

W.P. 331-89-00 LOCATION WC 136-15; Sta. 13+499, O-S 21m Rt. ORIGINATED BY IK
DIST HWY QEW BOREHOLE TYPE Solid Stem COMPILED BY IK
DATUM SEE TEXT DATE 94.08.15 & 94.08.15 CHECKED BY TO

SOIL PROFILE			SAMPLES			GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT		PLASTIC LIMIT	NATURAL MOISTURE CONTENT	LIQUID LIMIT	UNIT WEIGHT γ kN/m ³	REMARKS & GRAIN SIZE DISTRIBUTION (%) GR SA SI CL
ELEV DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE	"N" VALUES			SHEAR STRENGTH kPa	WATER CONTENT (%)					
82.5	Ground Surface													
82.4	Topsoil		1	SS	7									
0.1	Het. mixture of Silt and Clay, some sand, trace gravel (Glacial Till) Very Stiff to Hard Brown Grey		2	SS	35									
			3	SS	28									
			4	SS	24									
			5	SS	14									
			6	SS	23									
			7	SS	46									
75.8	END OF BOREHOLE													
6.7	Borehole dry upon completion													

RECORD OF BOREHOLE No 136-16-1

1 OF 1

METRIC

W.P. 331-89-00 LOCATION WC 136-16; Sta. 13+817, O-S 27m Lt. ORIGINATED BY IK
DIST HWY QEW BOREHOLE TYPE Solid Stem COMPILED BY IK
DATUM SEE TEXT DATE 94.08.16 & 94.08.18 CHECKED BY TO

SOIL PROFILE			SAMPLES			GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT			UNIT WEIGHT γ kN/m ³	REMARKS & GRAIN SIZE DISTRIBUTION (%)
ELEV DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE	"N" VALUES			SHEAR STRENGTH kPa				
83.4	Ground Surface						20 40 60 80 100	PLASTIC LIMIT NATURAL MOISTURE CONTENT LIQUID LIMIT WP W WL				
82.8	Topsoil		1	SS	7		20 40 60 80 100	O UNCONFINED X FIELD VANE ● QUICK TRIAXIAL X LAB VANE				
0.2	Mixture of Sand, Silt and Gravel (Fill), loose		2	SS	6			WATER CONTENT (%)				
82.0												
1.4	Het. mixture of Silt and Clay, some sand, trace gravel (Glacial Till) Very Stiff to Hard Grey		3	SS	28							
			4	SS	37							
			5	SS	58							
79.2			6	SS	55							
4.2	Shale											
	Bedrock											
	Poor to Fair											
77.2			7	SS	50	150mm						
6.3	END OF BOREHOLE											

RECORD OF BOREHOLE No 136-16-2

1 OF 1

METRIC

W.P. 331-89-00 LOCATION WC 136-16; Sta. 13+817, O-S 3m Lt. ORIGINATED BY IK
 DIST HWY QEW BOREHOLE TYPE Solid Stem, Cone Test COMPILED BY IK
 DATUM SEE TEXT DATE 94.08.12 & 94.08.12 CHECKED BY TO

SOIL PROFILE			SAMPLES			GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT			UNIT WEIGHT γ _s kN/m ³	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	
84.7	Ground Surface											
0.0	Mixture of Sand, Silt and Gravel (Fill)		1	SS	19		84					
	Loose to Compact		2	SS	10							
			3	SS	6		83					
82.2			4	SS	15		82					
2.6	Het. mixture of Silt and Clay, some sand, trace gravel		5	SS	50							
	(Glacial Till)		6	SS	60	125mm	81					
	Very Stiff to Hard		7	SS	60	125mm	80					
	Grey						79					
78.7			8	SS	80	10mm	78					
6.1	Shale											
	Bedrock		9	SS	80	25mm	77					
	Poor to Fair											
76.5												
8.2	END OF BOREHOLE											

x³, x³: Numbers refer to Sensitivity 20 15 10 (%) STRAIN AT FAILURE

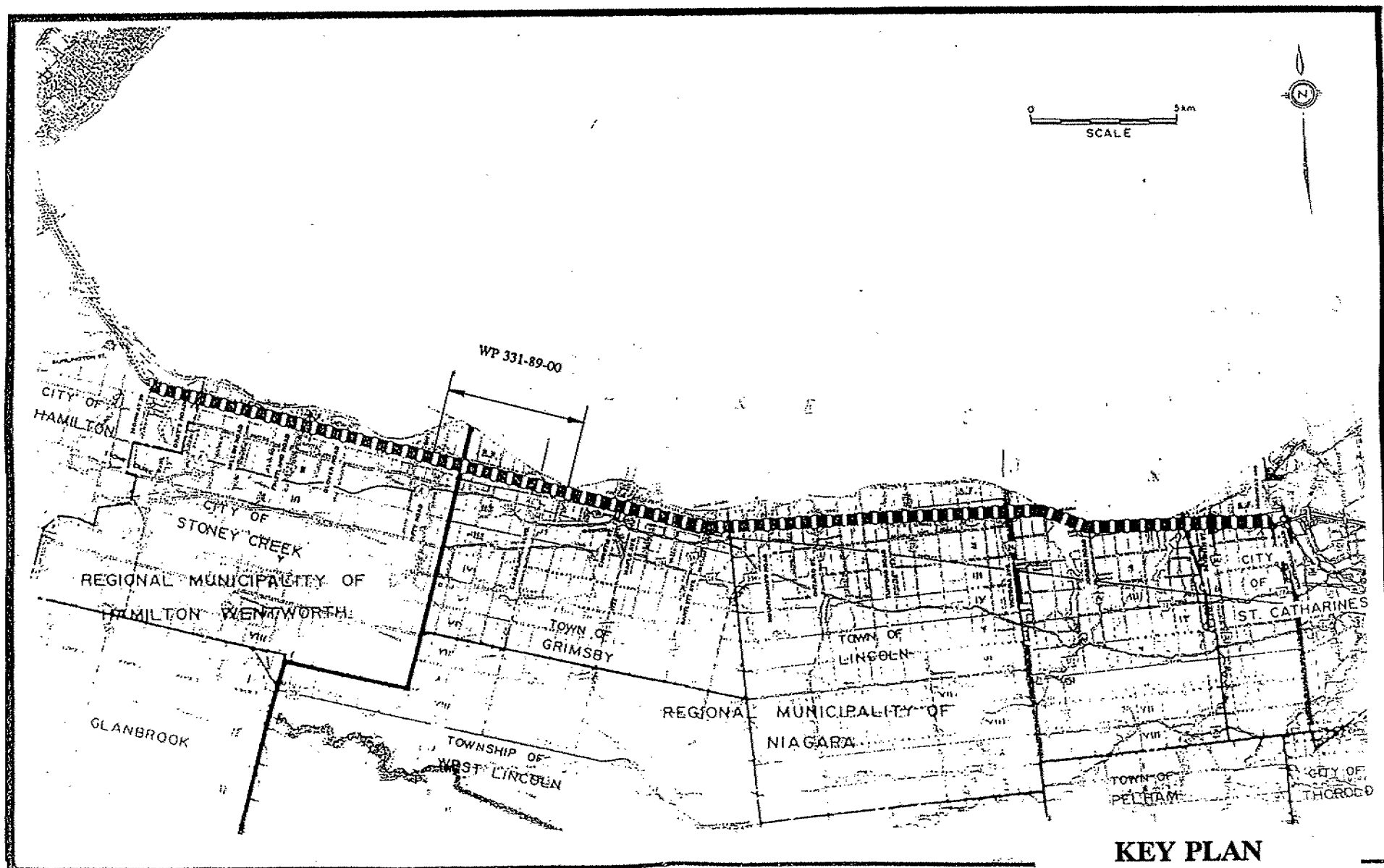
RECORD OF BOREHOLE No 136-16-3

1 OF 1

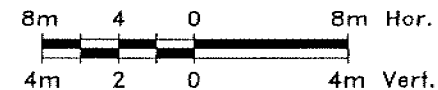
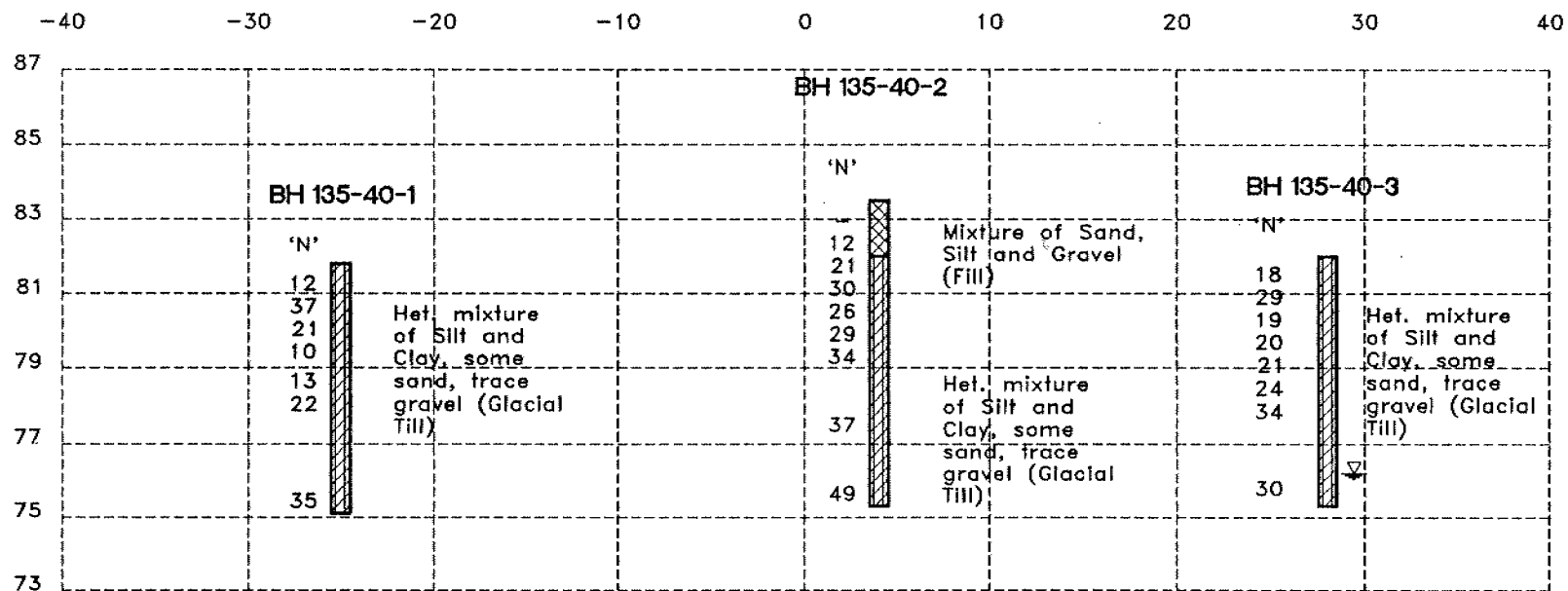
METRIC

W.P. 331-89-00 LOCATION WC 136-16; Sta. 13+817, O-S 29m Rt. ORIGINATED BY IK
DIST HWY GEW BOREHOLE TYPE Solid Stem COMPILED BY IK
DATUM SEE TEXT DATE 94.08.16 & 94.08.16 CHECKED BY TO

SOIL PROFILE			SAMPLES			GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT			UNIT WEIGHT kN/m ³	REMARKS & GRAIN SIZE DISTRIBUTION (%) GR SA SI CL		
ELEV DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE	"N" VALUES			SHEAR STRENGTH kPa					WATER CONTENT (%)	
83.2	Ground Surface							20 40 60 80 100		PLASTIC LIMIT w _p	NATURAL MOISTURE CONTENT w	LIQUID LIMIT w _L		
83.9	Topsoil		1	SS	8		83							
0.1	Silty Sand (Fill), some gravel Loose Brown		2	SS	7		82							
81.7							81							
1.5	Het. mixture of Silt and Clay, some sand, trace gravel (Glacial Till) Very Stiff to Hard Brown		3	SS	22		80							
			4	SS	60		79							
79.9			5	SS	100		78							
3.3	Shale		6	SS	100									
	Bedrock													
	Poor to Fair													
77.1			7	SS	50									
6.2	END OF BOREHOLE													



**KEY PLAN
FIGURE 1**



WC 135-40 - ξ PROFILE STATION 31+688

Job No.:
WP 331-89-00

Dwg. No.:
3318900-E

Date:
94/09/06

Dwn. by:
TA

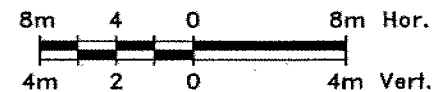
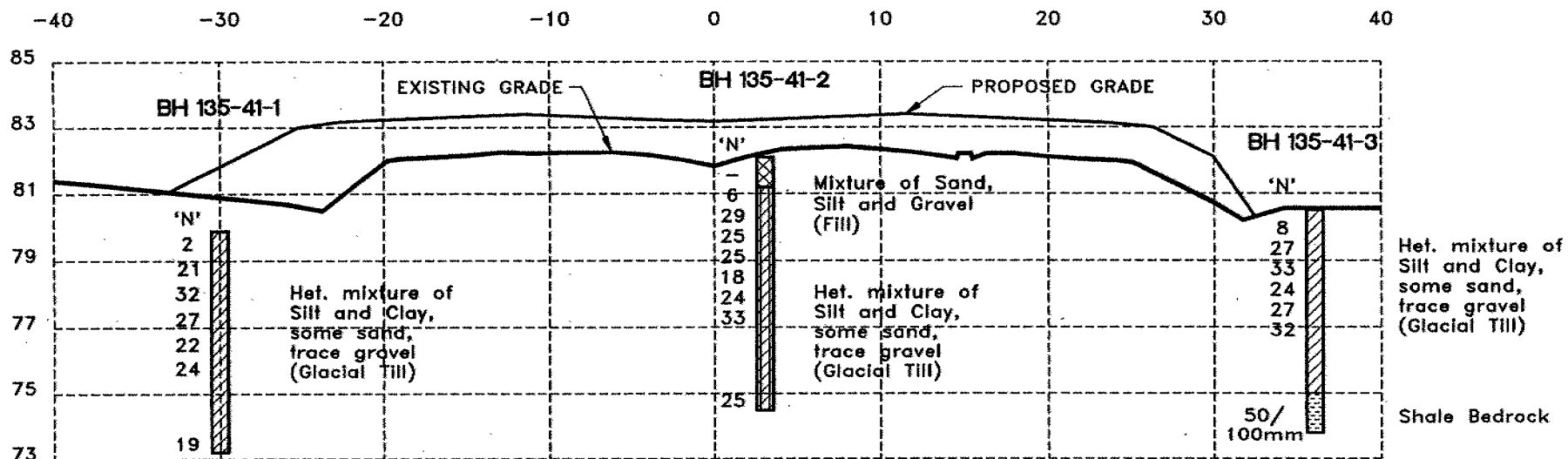
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TO



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3318900-E



WC 135-41 - C PROFILE STATION 32+102

Job No.:
WP 331-89-00

Dwg. No.:
3318900-F

Date:
94/09/06

Dwn. by:
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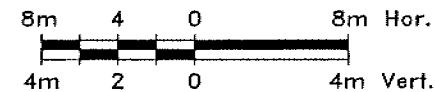
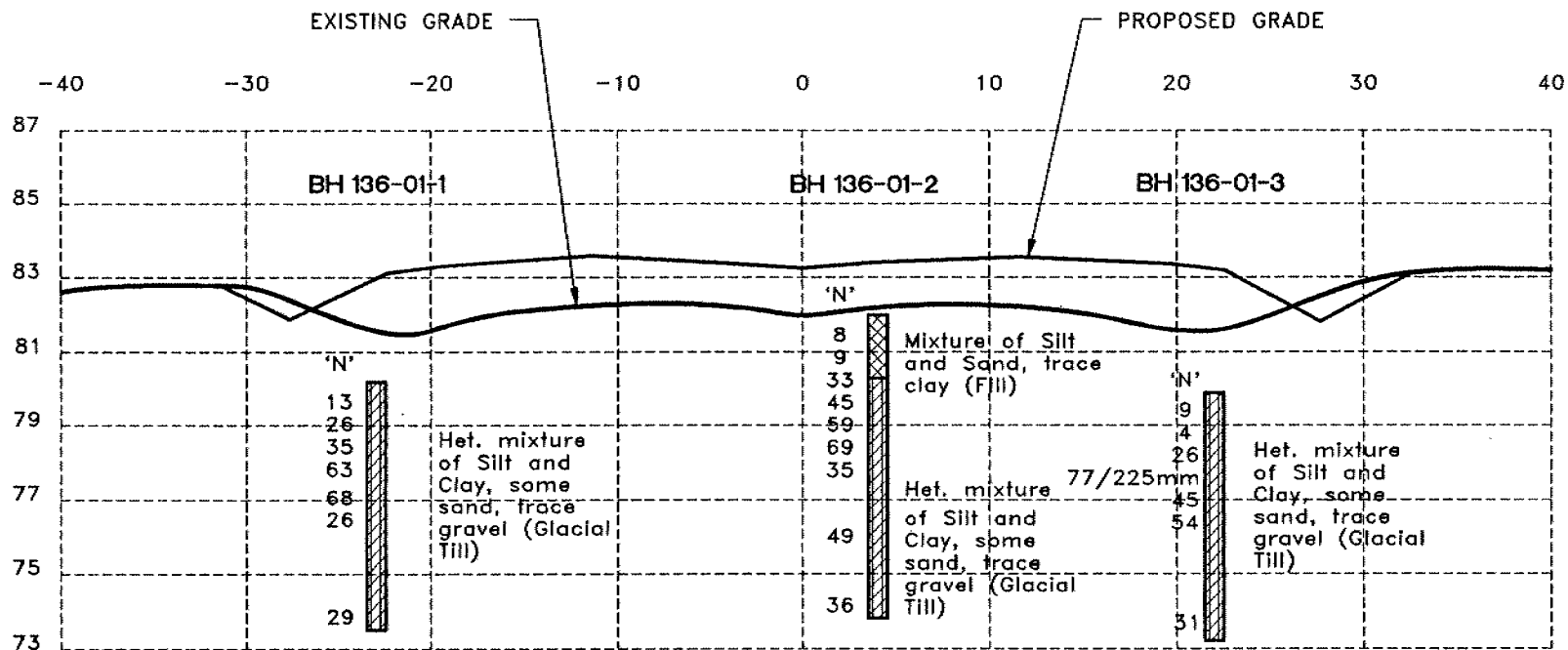
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TO



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Whitford

75

3318900-F



WC 136-01 - ζ PROFILE STATION 10+419

Job No.:
WP 331-89-00

Dwg. No.:
3318900-G

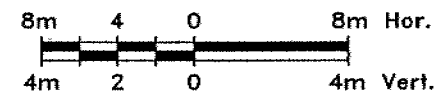
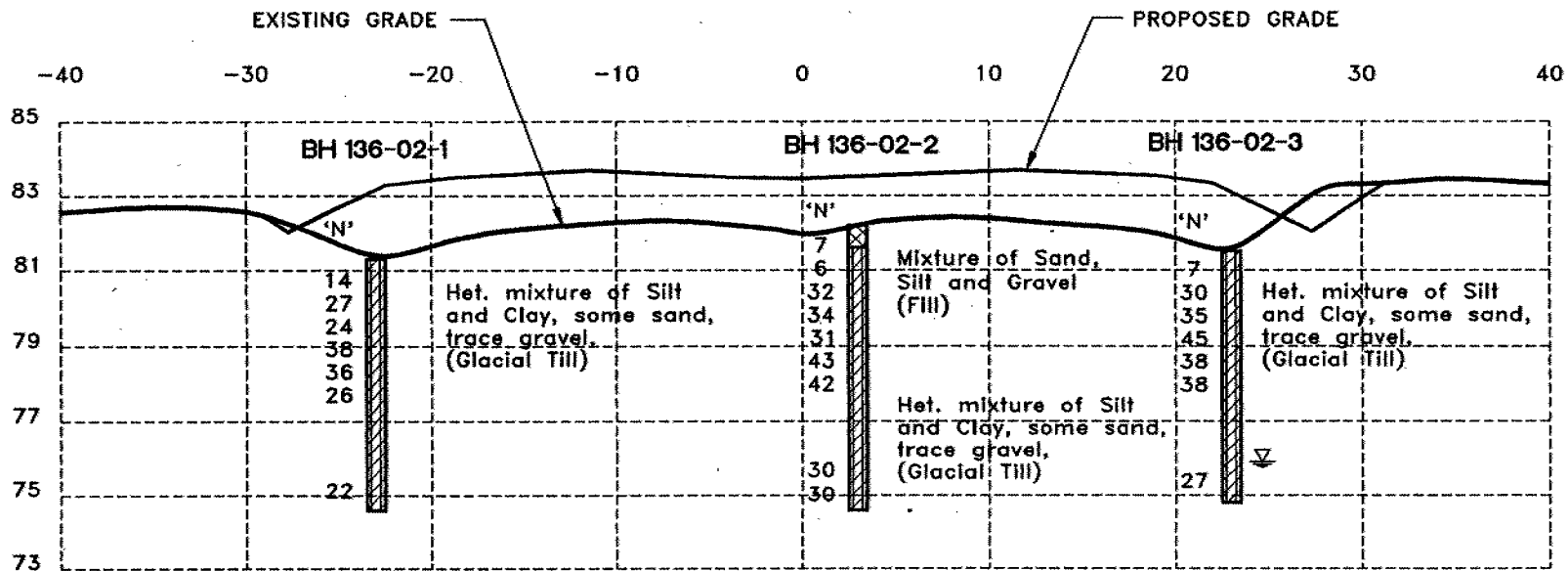
Date:
94/09/06

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TA

Appd.:
TO



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WC 136-02 - C PROFILE STATION 10+622

Job No.:
WP 331-89-00

Dwg. No.:
3318900-H

Date:
94/09/06

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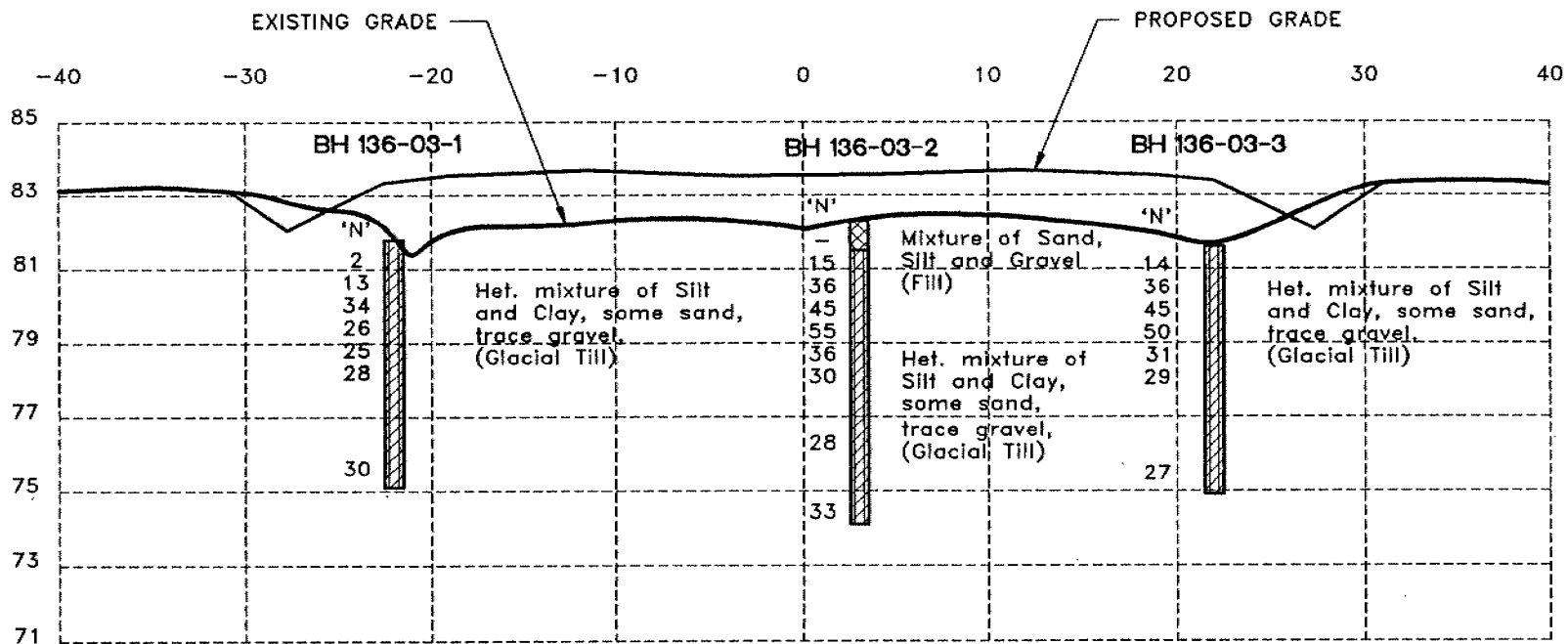
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77

3318900-H



WC 136-03 - C PROFILE STATION 10+825

Job No.:
WP 331-89-00

Dwg. No.:
3318900-1

Date:
94/09/06

Dwn. by:
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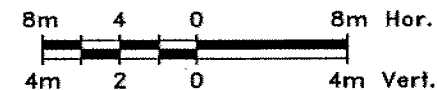
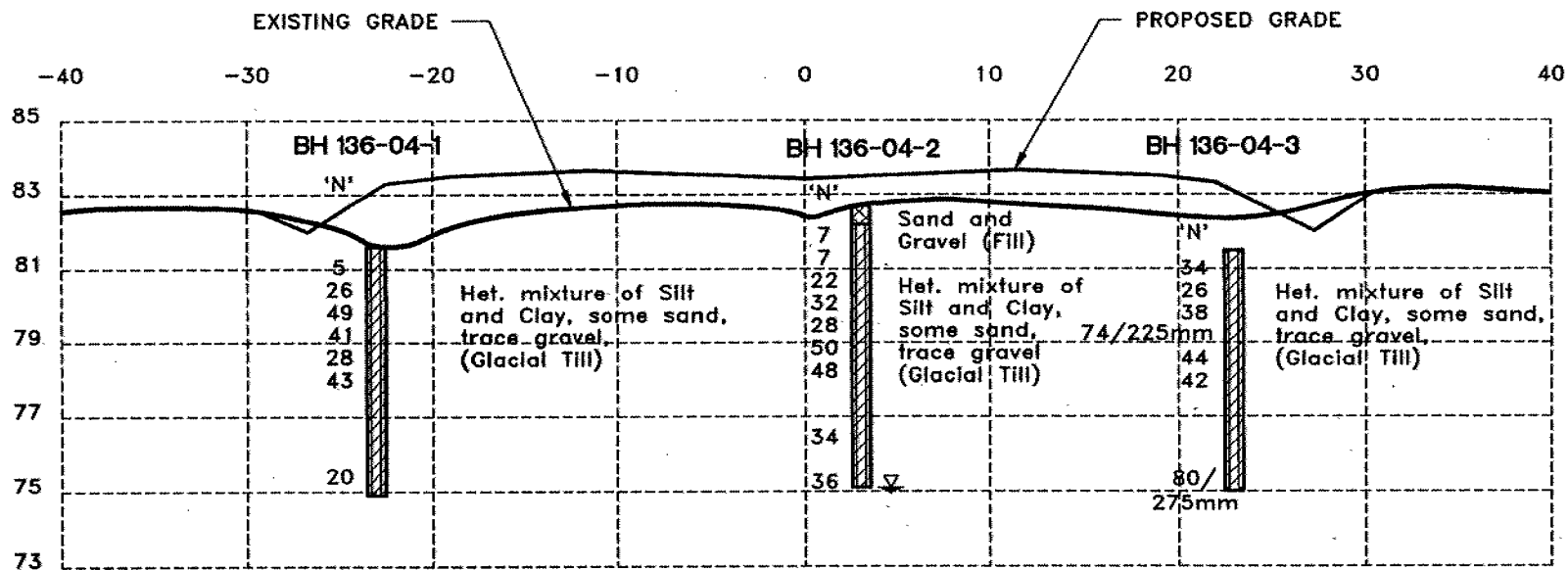
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Whitford

78

3318900-1



WC 136-04 - C PROFILE STATION 11+101

Job No.:
WP 331-89-00

Dwg. No.:
3318900-J

Date:
94/09/06

Dwn. by:
TA

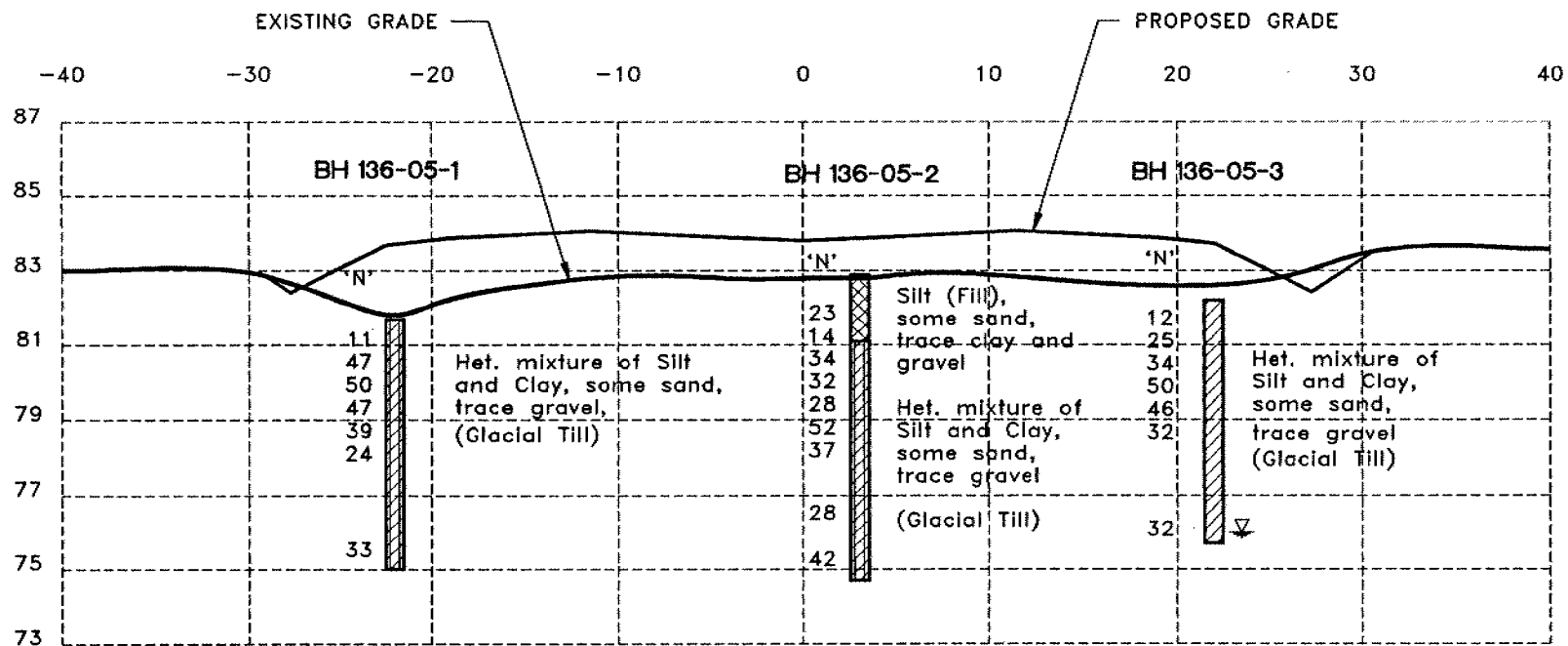
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3318900-J



WC 136-05 - ζ PROFILE STATION 11+262

Job No.:
WP 331-89-00

Dwg. No.:
3318900-K

Date:
94/09/06

Dwn. by:
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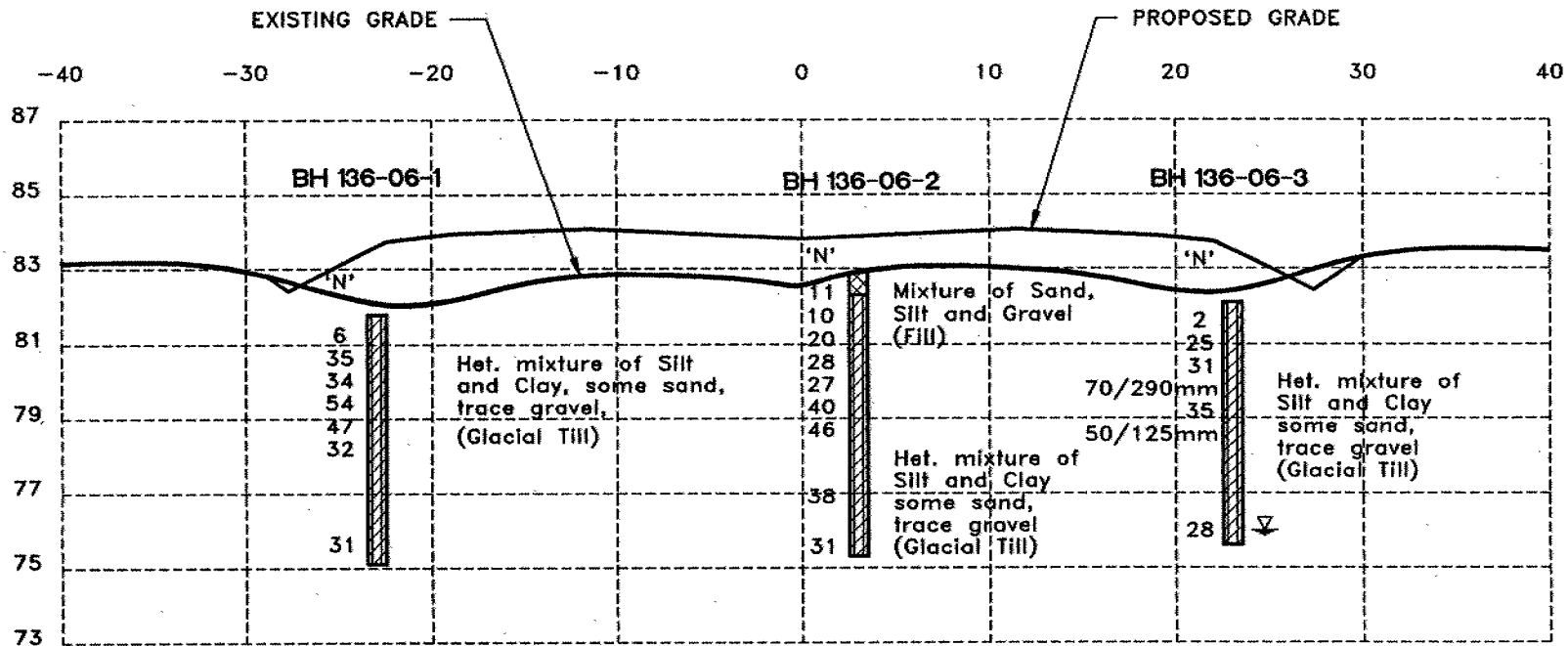
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3318900-K



WC 136-06 - C PROFILE STATION 11+446

Job No.:
WP 331-89-00

Dwg. No.:
3318900-L

Date:
94/09/06

Dwn. by:
TA

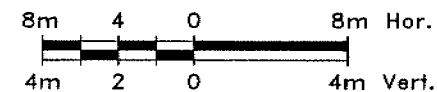
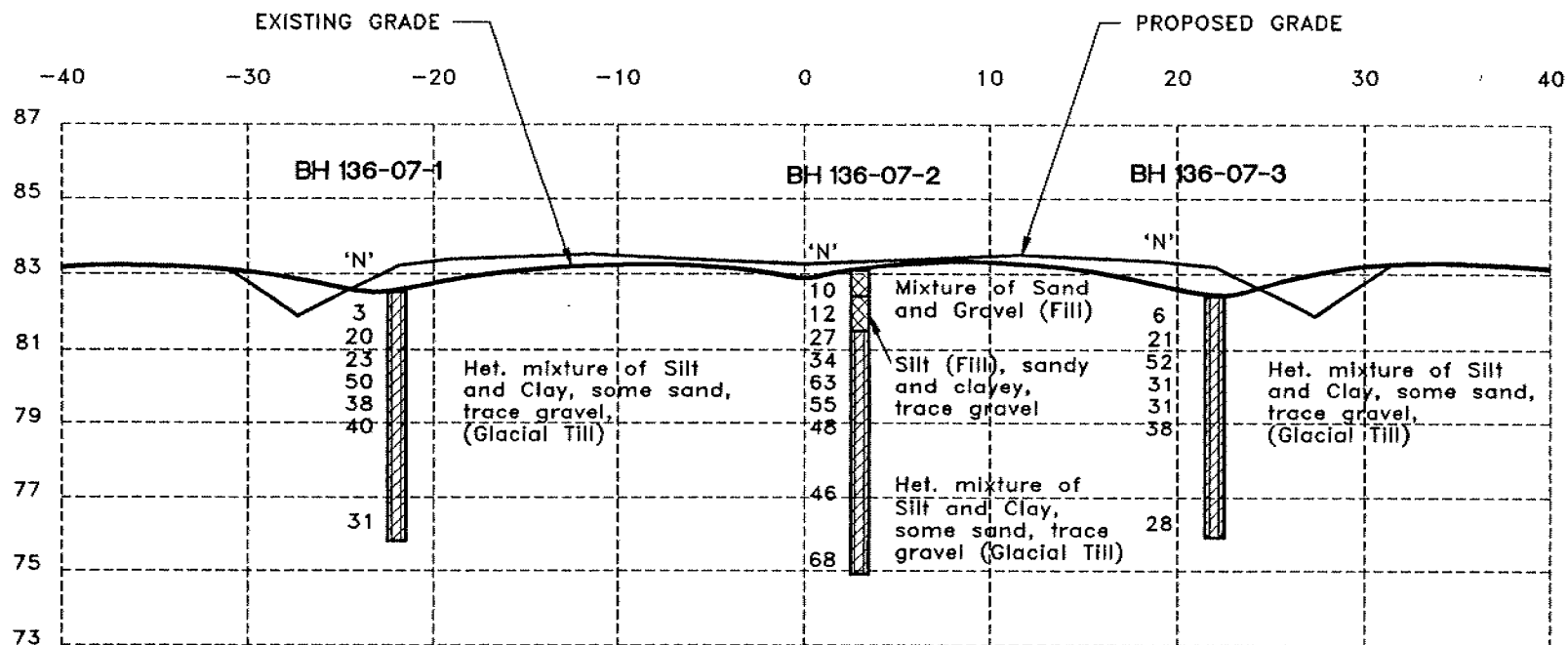
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Whitford

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3318900-L



WC 136-07 - C PROFILE STATION 11+656

Job No.:
WP 331-89-00

Dwg. No.:
3318900-M

Date:
94/09/06

Dwn. by:
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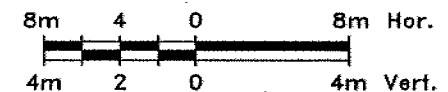
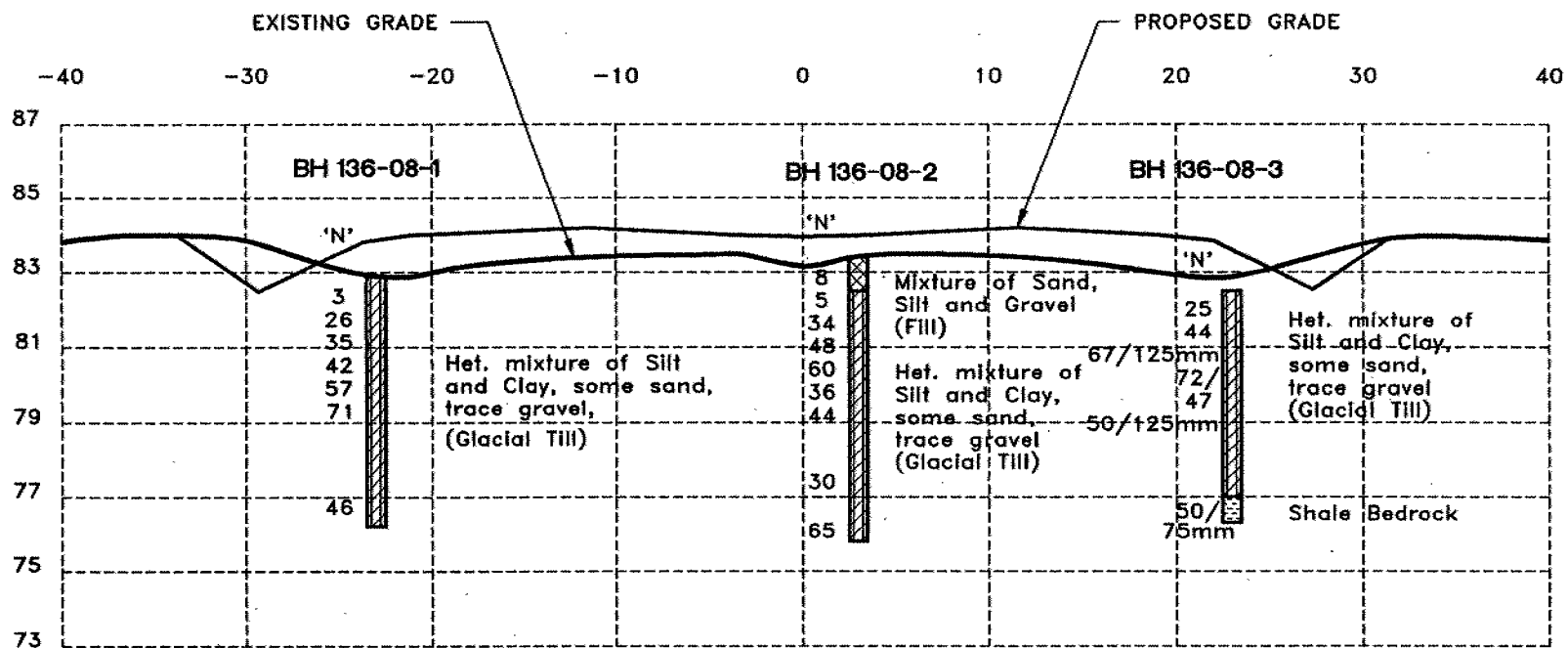
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202

3318900-M



WC 136-08 - C PROFILE STATION 11+853

Job No.:
WP 331-89-00

Dwg. No.:
3318900-N

Date:
94/09/06

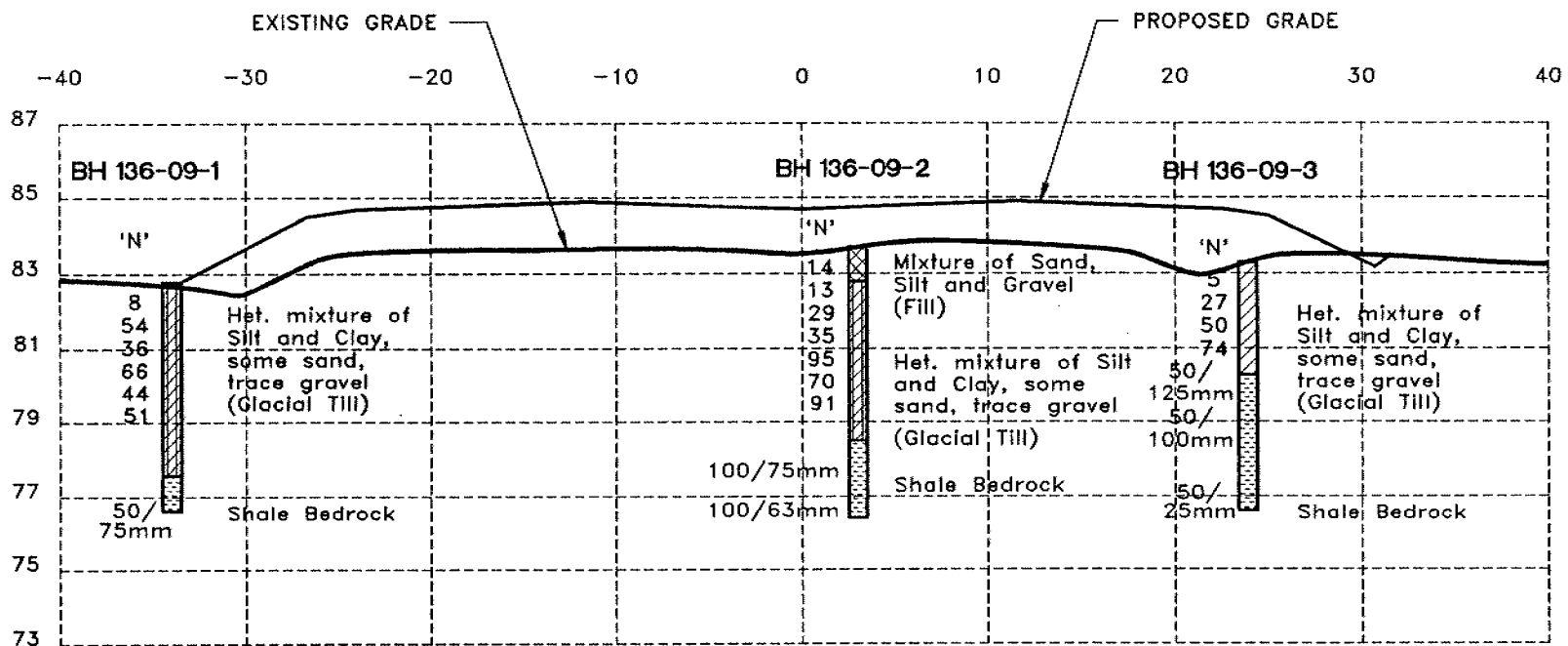
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Appd.:
TO



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3318900-N



WC 136-09 - C PROFILE STATION 12+059

Job No.:

WP 331-89-00

Dwg. No.:

3318900-0

Date:

94/09/06

Dwn. by:

TA

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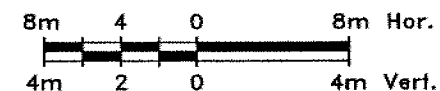
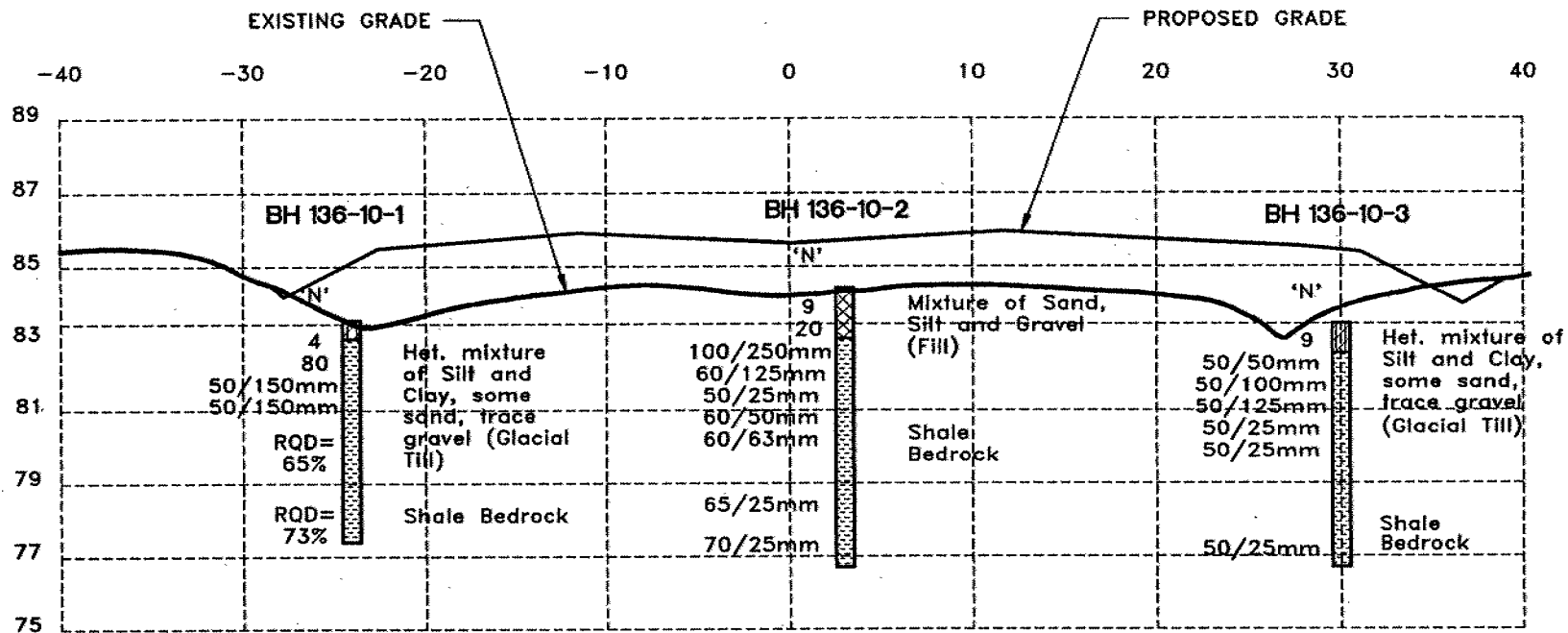
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84

3318900



WC 136-10 - C PROFILE STATION 12+347

Job No.:
WP 331-89-00

Dwg. No.:
3318900-P

Date:
94/09/06

Dwn. by:
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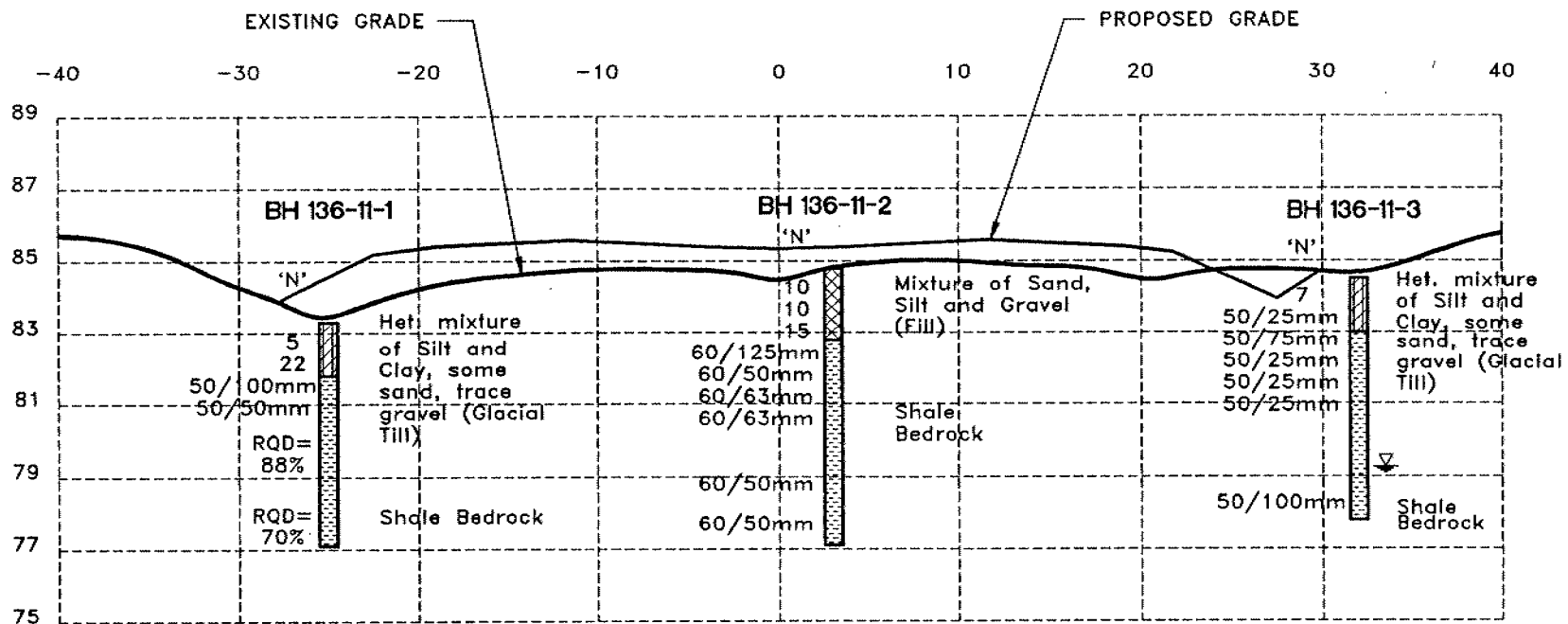
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Whitford

85

3318900-P



WC 136-11 - C PROFILE STATION 12+675

Job No.:
WP 331-89-00

Dwg. No.:
3318900-0

Date:
94/09/06

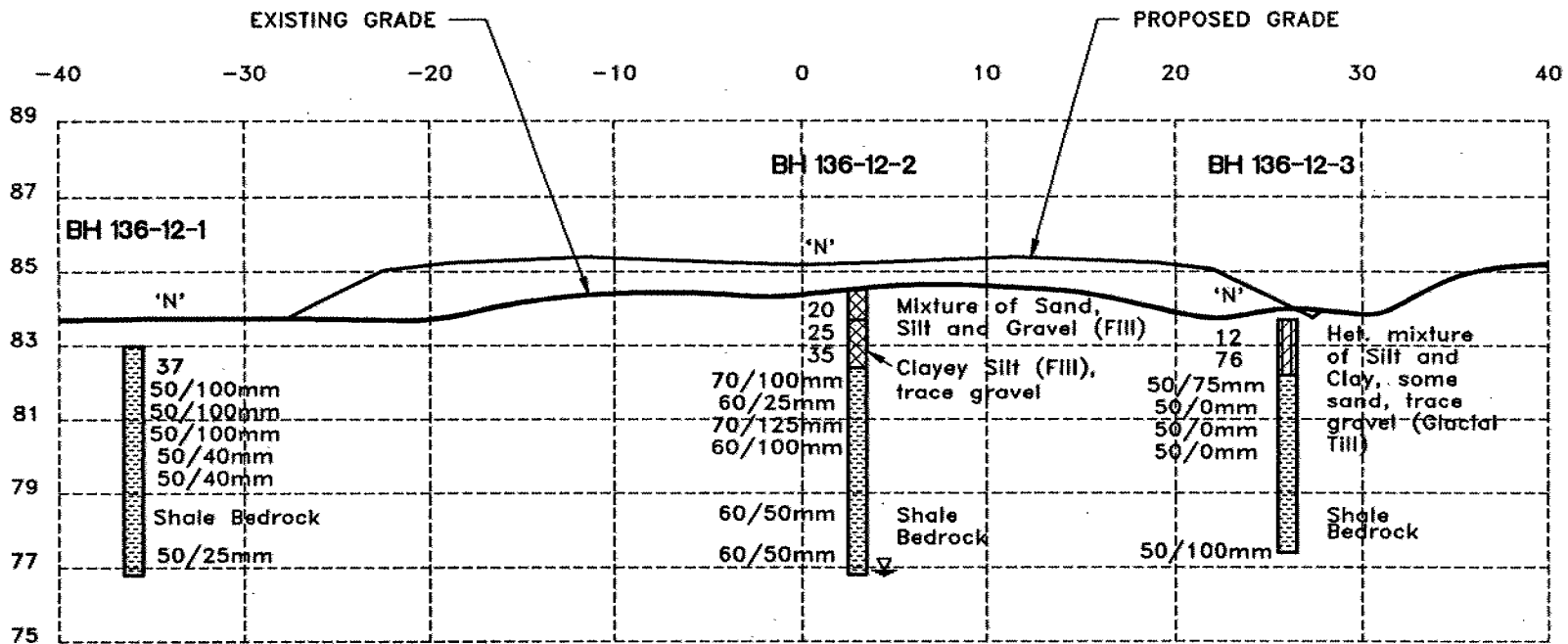
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Appd.:
TO



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Whitford

33189000



WC 136-12 - C PROFILE STATION 12+885

Job No.:
WP 331-89-00

Dwg. No.:
3318900-R

Date:
94/09/06

Dwn. by:
TA

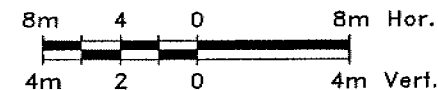
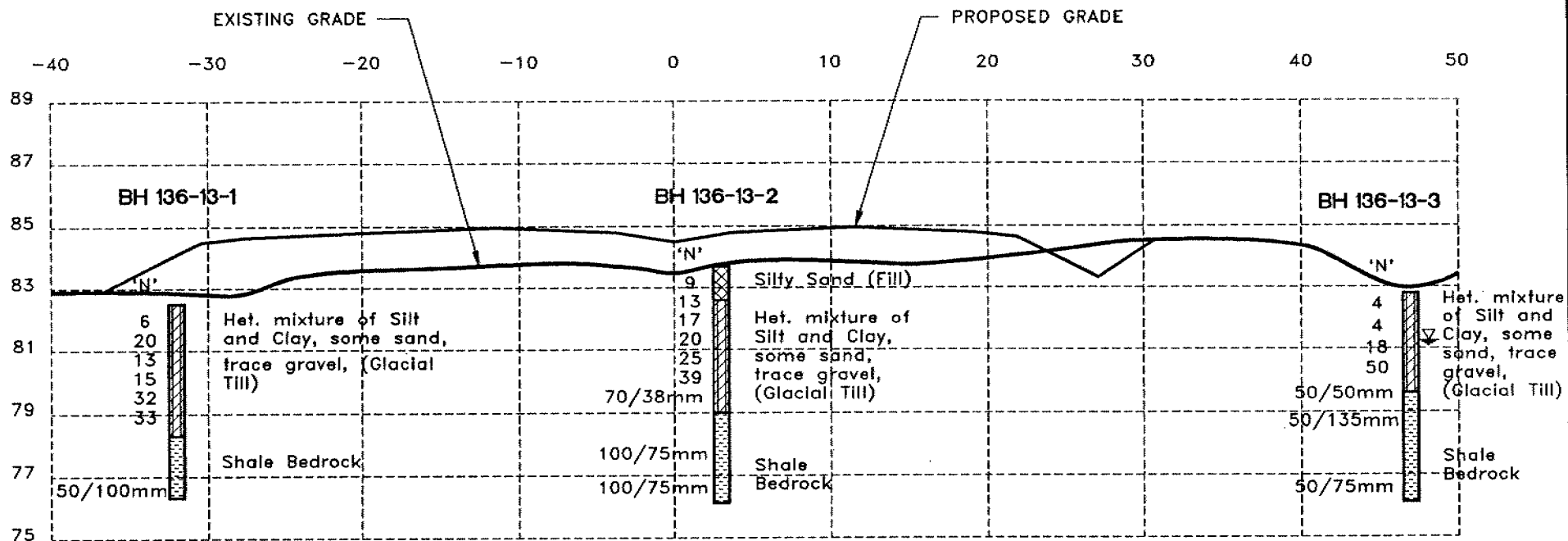
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Whitford

87

3318900-R



WC 136-13 - ζ PROFILE STATION 13+085

Job No.:
WP 331-89-00

Dwg. No.:
3318900-S

Date:
94/09/06

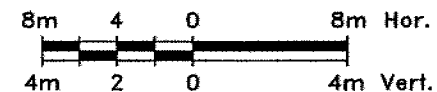
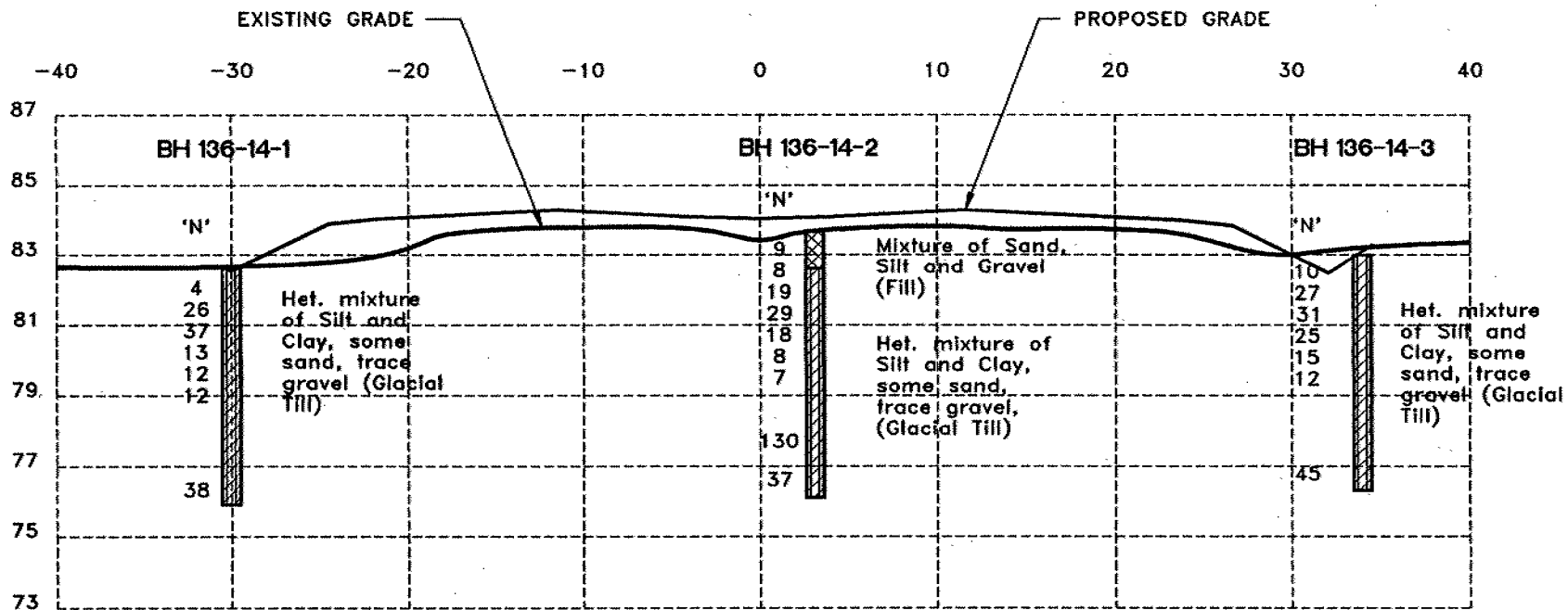
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Appd.:
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Jacques Whitford

3318900-S



WC 136-14 - C PROFILE STATION 13+278

Job No.:
WP 331-89-00

Dwg. No.:
3318900-T

Date:
94/09/06

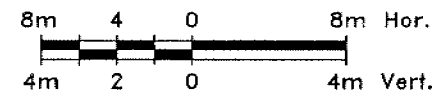
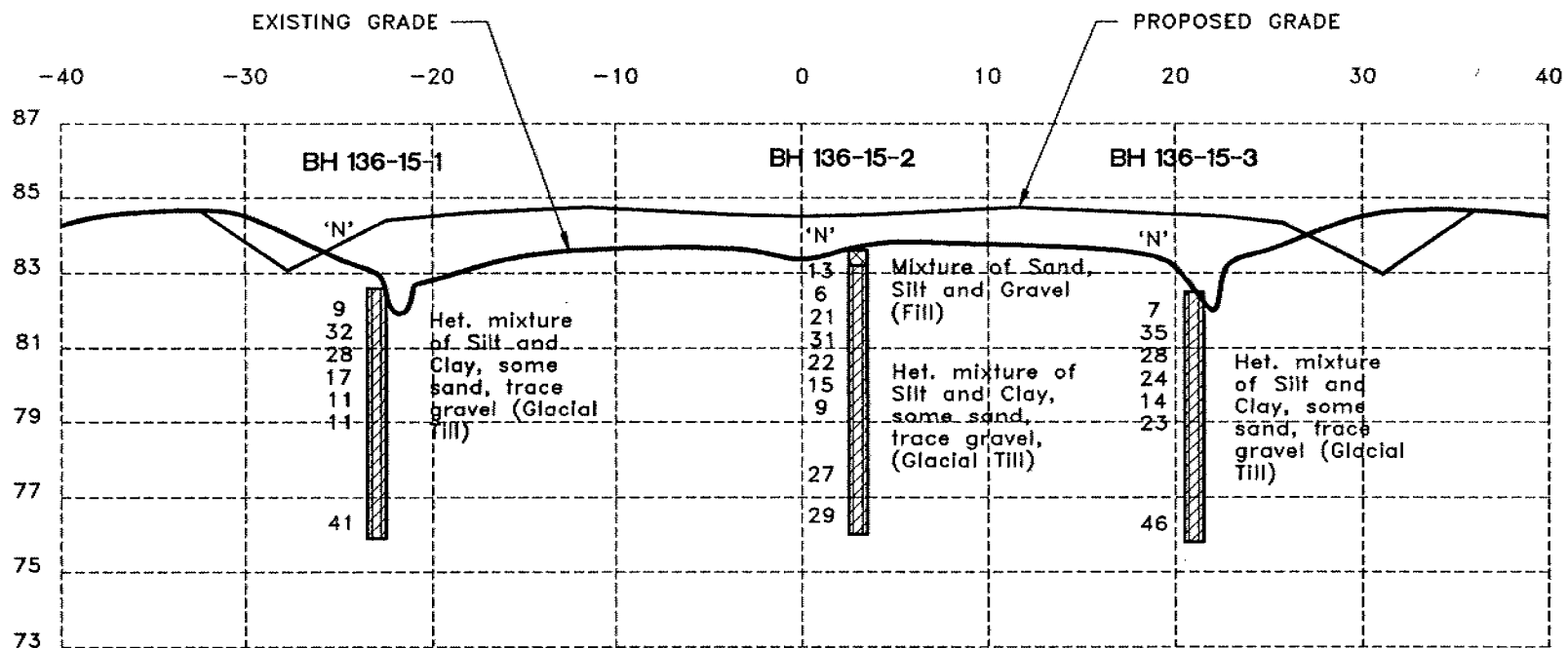
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Appd.:
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3318900-T



WC 136-15 - C PROFILE STATION 13+499

Job No.:
WP 331-89-00

Dwg. No.:
3318900-U

Date:
94/09/06

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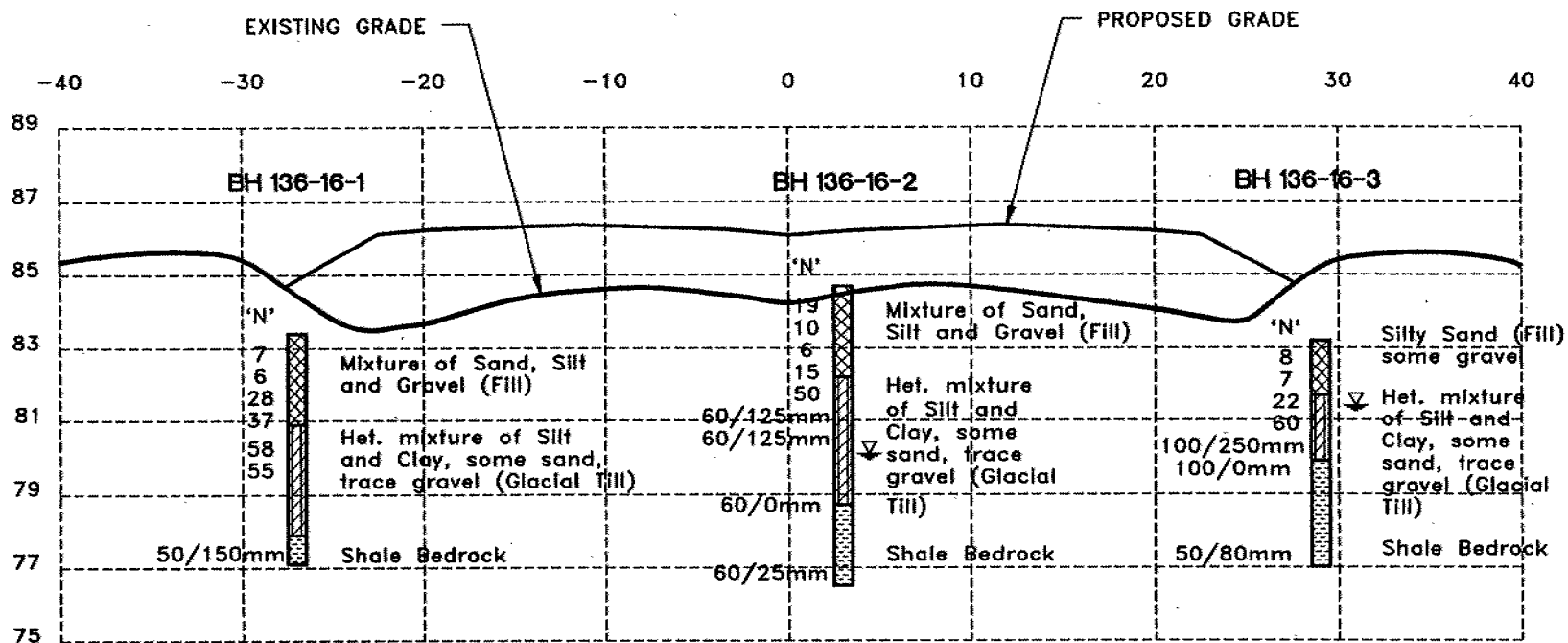
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Whitford

06

3318900-U



WC 136-16 - E PROFILE STATION 13+817

Job No.:
WP 331-89-00

Dwg. No.:
3318900-V

Date:
94/09/06

Dwn. by:
TA

Appd.:
TO



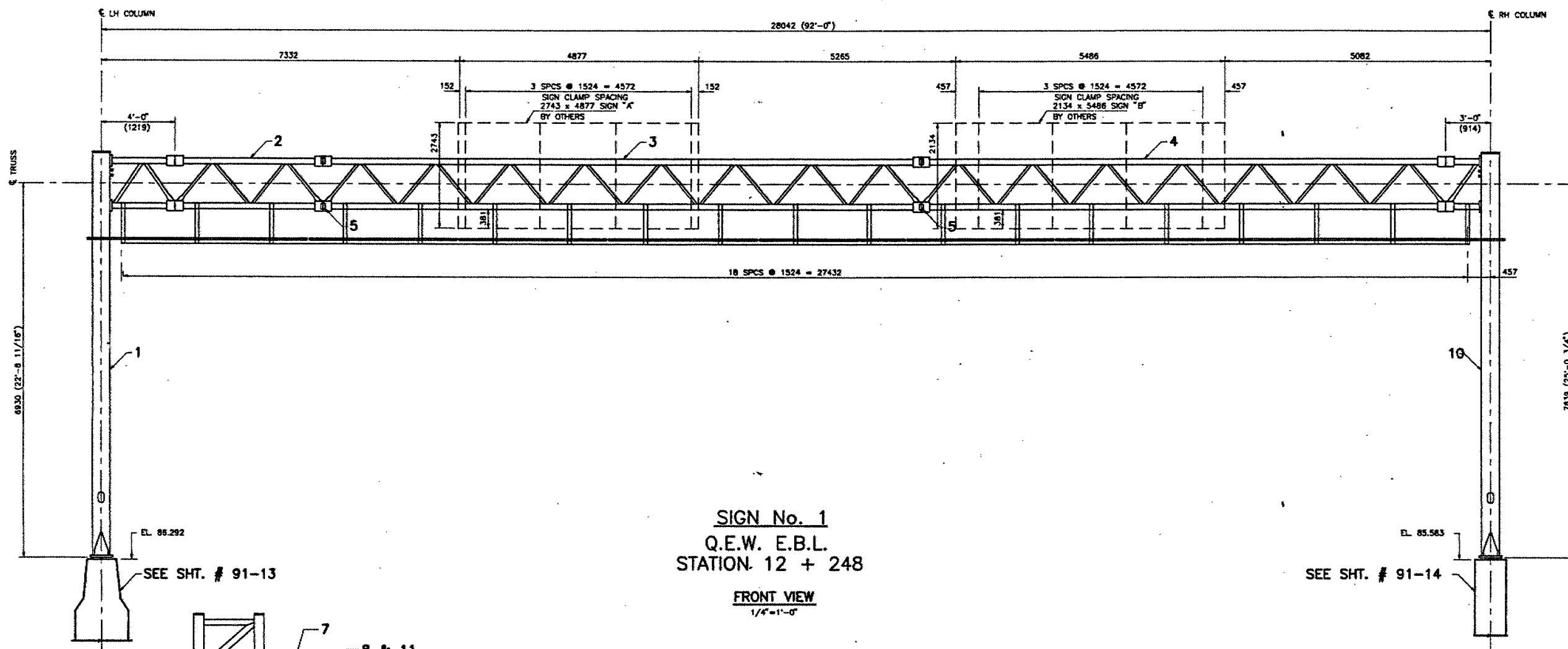
Jacques
Whitford

DIST. No.
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WP. No. 331-89-00

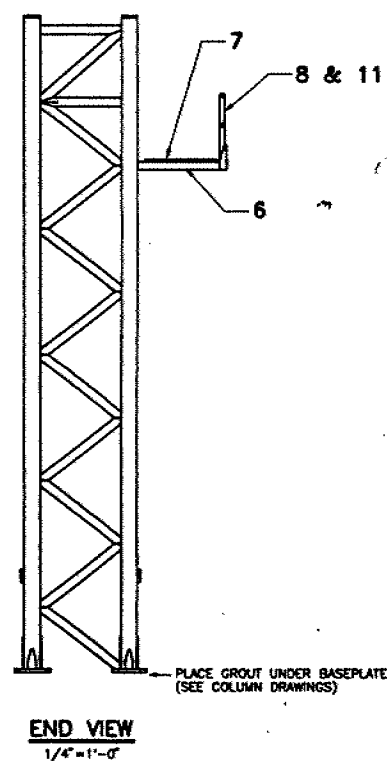
ALUMINUM TRUSS SIGN SUPPORT
HWY. Q.E.W. E.B.L.
STA. 12 + 248
92' GENERAL ARRANGEMENT

SHEET
91-1

SIGN No. 1



SIGN No. 1
Q.E.W. E.B.L.
STATION 12 + 248
FRONT VIEW
1/4"=1'-0"



END VIEW
1/4"=1'-0"

LIST OF SUBASSEMBLIES				
FIG.	NAME	QTY.	DRAWING REF.	REMARKS
1	COLUMN	1	91-2-4-1	(MODIFIED) SEE DWG. 2, 3 & 4.
2	10 FT. TRUSS	1	91-3-10-1	
3	40 FT. TRUSS	1	91-3-40-1	
4	35 FT. TRUSS	1	91-3-35-1	
5	SHEAR RING IN CONNECTOR	8	91-4-5-2	
6	WALK ARM	19	LCM 221-045-6A	
7	GRATING	18	LCM 221-045-7A	
8	RAILING	8	BD 221-045-8A	TWO POST
9	SIZE 5 CLAMP	54	BD 221-095-7	FOR WALK ARM 38 FOR SIGN 16
10	COLUMN	1	91-2-3-1	
11	RAILING	1	BD 221-045-10A	THREE POST

STANDARD DRAWING
(MODIFIED) 91-1-95

DRAWING NOT TO BE SCALED
0 1 2 3
3 INCHES ON ORIGINAL PLAN

REVISIONS	DATE	BY	DESCRIPTION

DESIGN	STD	CHK.	CODE	LOAD	DATE	JAN. 1995
DRAWN	B.G.	CHK.	SITE	STRUCT.S	SCHEME	DWG. 1

REGIONAL MUNICIPALITY OF
NIAGARA

TOWN OF GRIMSBY
GEO. TWP. OF N. GRIMSBY

CONT 94-84	SHEET 91-D
WP 331-89-00	

LAKE ONTARIO

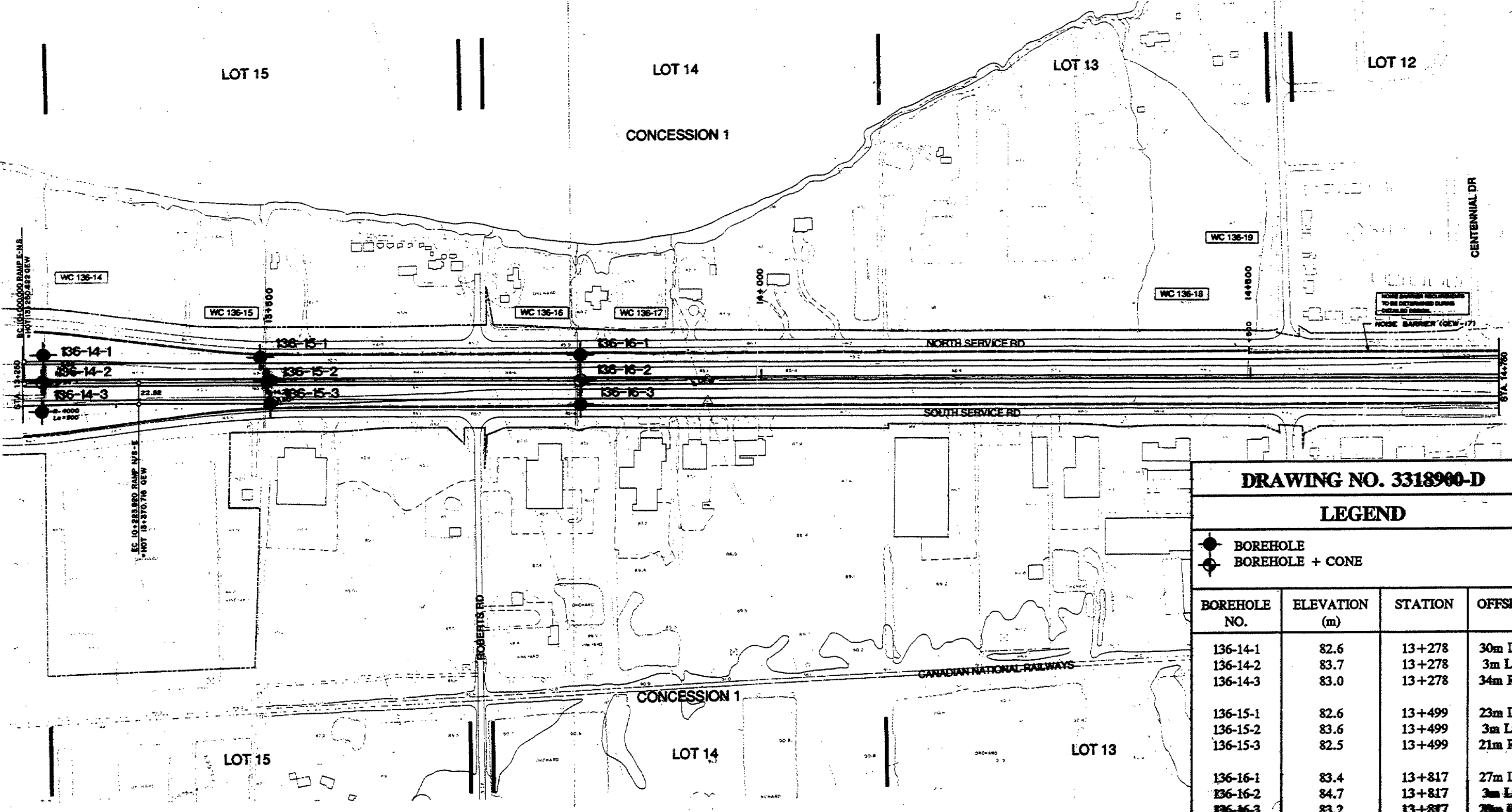
LOT 15

LOT 14

LOT 13

LOT 12

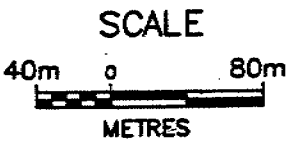
CONCESSION 1



DRAWING NO. 3318900-D

LEGEND

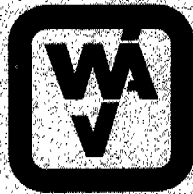
	BOREHOLE		
	BOREHOLE + CONE		
BOREHOLE NO.	ELEVATION (m)	STATION	OFFSET
136-14-1	82.6	13+278	30m Lt.
136-14-2	83.7	13+278	3m Lt.
136-14-3	83.0	13+278	34m Rt.
136-15-1	82.6	13+499	23m Lt.
136-15-2	83.6	13+499	3m Lt.
136-15-3	82.5	13+499	21m Rt.
136-16-1	83.4	13+817	27m Lt.
136-16-2	84.7	13+817	3m Lt.
136-16-3	83.2	13+817	20m Rt.



LEGEND

- FLOODPLAIN LINE
- FILL LINE
- EXISTING PROPERTY
- PROPOSED CAH
- PROPERTY ACQUISITION

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**Jacques Whitford
Environment Limited**

Consulting Engineers
and Scientists



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FOUNDATION INVESTIGATION REPORT

**W.P. 331-89-00 & W.P. 333-89-00
CULVERT REPLACEMENT
QUEEN ELIZABETH WAY
STONEY CREEK, GRIMSBY & ST. CATHERINES**

MINISTRY OF TRANSPORTATION ONTARIO

SUBMITTED BY

JACQUES WHITFORD ENVIRONMENT LIMITED

**85 CITIZEN COURT
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*GEOCRETS No's 30M3 - 203
30M4 - 76*

SEP 16 1994

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Appendix 1

Explanation of Terms Used in Report

Record of Boreholes

Figure 1 - 6 : Plasticity Chart

Figure 7 - 8 : Grain Size Distribution

Appendix 2

Figure 1 Key Plan

Table 1 - Culvert Details

Table 2 - Report of Soil Chemistry Analysis

Drawing No. 3318900- A to D - Borehole Locations

Drawing No. 3338900- A and B - Borehole Locations

Drawing No. 3318900- E to V - Soil Strata Profile

Drawing No. 3338900- C and D - Soil Strata Profile

FOUNDATION INVESTIGATION REPORT

for

Culvert Replacement

**W.P. 331-89-00
Queen Elizabeth Way
Fifty Road to Casablanca Boulevard
Stoney Creek and Grimsby**

and

**W.P. 333-89-00
Queen Elizabeth Way
Jordan Road
St. Catharines**

1.0 INTRODUCTION

This report presents the results of a foundation investigation carried out at twenty (20) proposed culvert replacement sites in the City of Stoney Creek, Town of Grimsby and City of St. Catharines, Ontario. The investigation was carried out in accordance with our proposal dated 94/08/06. Authorization to carry out the work was provided by the Foundation Design Section, Ministry of Transportation, Ontario (MTO).

This report contains factual information together with discussion and recommendations pertaining to the subsurface conditions.

2.0 SITE DESCRIPTION AND GEOLOGY

Eighteen (18) culvert replacement sites are located along the Queen Elizabeth Way (QEW) from Fifty Road in Stoney Creek to approximately 1 km east of Casablanca Boulevard in Grimsby. A key plan illustrating the site location is provided as Figure 1 in Appendix 2. Two (2) culvert replacement sites are located along the QEW at Jordan Road in St. Catharines. The terrain surrounding the sites is generally flat and consists of mixed residential, agricultural and industrial land uses. The existing ground surface generally slopes downward gently from south to north, towards Lake Ontario.

At the time of the investigation, the QEW is a four-lane divided highway with gravel shoulders. A North Service Road and South Service Road is located parallel to the QEW on the north and south sides, respectively. Both the North and South Service Roads are two-lane paved roads with gravel shoulders.

Drainage of the existing QEW is provided by highway ditches located on both the north and south sides and in between the QEW and the two service roads. The 20 culverts investigated during this study facilitate drainage of these ditches beneath the QEW towards the north into Lake Ontario. At each culvert location beneath the QEW, there is an additional two separate culverts constructed beneath the North Service Road and the South Service Road.

The 20 existing culverts beneath the QEW and the 40 existing culverts beneath the two service roads consist of either a concrete box culvert or a Corrugated Steel Pipe (CSP) culvert.

Physiographically, the sites in Stoney Creek and Grimsby lie in the area known as the Halton Till Plain, which consists of glacial till with clayey silt to silty clay size particles and little to no cobbles and boulders. The sites in St. Catharines lie in the glacial Lake Iroquois stratified sands and silts. Bedrock underlying the overburden consists of Ordovician shale of the Queenston Formation throughout the study area.

3.0 PROCEDURE

3.1 Field Investigation

Prior to the onset of the drilling investigation, the necessary utility check clearances were obtained by our site personnel. Traffic control for this project was provided by Barricade Traffic Services Inc., who were coordinated by MTO.

The field work for this investigation was carried out between August 16 and 25, 1994. Three (3) boreholes were put down at each of the twenty (20) culvert locations. The test locations are indicated on Drawings 3318900-A to 3318900-D and 3338900-A and 3338900-B provided in Appendix 2. One dynamic cone penetration test was also conducted at each culvert location. Bedrock was proven by coring in NQ-size at two culvert locations (WC136-10 and WC136-11).

All boreholes were put down using either a track-mounted or truck-mounted power auger drill suitably equipped for soil and bedrock sampling. Continuous flight solid stem augers and NQ-sized rock coring techniques (where required) were employed during the course of the investigation to advance the boreholes. The boreholes were put down to depths of about 4 m to 5 m below the existing culvert founding levels, to total depths ranging from 6.1 m to 12.8 m.

The overburden soils encountered were sampled by means of a split spoon sampler during the performance of Standard Penetration Tests (SPT) (ASTM D1586). Where soft to firm cohesive soils were encountered, field vane tests were conducted at selected locations. Sampling was generally conducted on a near continuous basis (intervals of 0.76 m) at the top 4.6 m of the borehole. Below this depth, sampling was conducted in intervals of about 1.5 m.

All soil samples recovered together with bedrock core samples were stored in moisture-proof bags or core boxes, and were returned to our Markham laboratory for detailed classification and testing.

Water levels, where observed, were obtained in the open boreholes upon completion of the drilling. All boreholes were backfilled with auger cuttings and sealed with a minimum 500 mm thick bentonite layer at the ground surface. Boreholes put down at the median where the surface consists of asphaltic concrete were surfaced with a minimum of 50 mm of cold mix asphalt.

3.2 Survey

The borehole and cone penetration test locations and ground surface elevations were surveyed by Jacques Whitford Environment Limited (JWEL) personnel after completion of the field work. The elevations were referenced to existing culvert invert elevations shown on the site plans, provided by MTO. These elevations are assumed to be referenced to the Geodetic datum. The borehole and elevation data is summarized on Drawings 3318900-A to 3318900-D, and 3338900-A and 3338900-B in Appendix 2.

3.3 Laboratory Testing

To identify the properties of the samples collected during the field investigation, the following laboratory tests were carried out on selected samples:

- Detailed visual classification,
- Natural moisture content,
- Sieve and hydrometer analyses,
- Atterberg Limits determination,
- Natural unit weight determination.

4.0 RESULTS OF THE INVESTIGATION

The subsurface conditions observed in the boreholes are presented in detail on the Record of Boreholes provided in Appendix 1. An Explanation of Terms Used in Report is also provided in Appendix 1. Cross sections showing the soil profiles at each culvert location are provided in Appendix 2. The laboratory test results are summarized in the Record of Boreholes and also on Figures 1 to 8 in Appendix 1.

A brief discussion of the observed subsurface conditions is provided below. For the purpose of presentation, this discussion is broken down into two sections. Specific details of the subsurface materials at a particular culvert location should be obtained from the Record of Boreholes.

4.1 W.P. 331-89-00

4.1.1 Topsoil

Topsoil was encountered at the ground surface in most boreholes except the boreholes located in the median of the QEW. The thickness of the topsoil ranges from 50 mm to 600 mm.

4.1.2 Asphaltic Concrete

Asphaltic concrete was encountered at the ground surface in Boreholes 135-41-2, 136-04-2, 136-14-2 and 136-15-2 (QEW median locations). The thickness of the asphaltic concrete ranged from 50 mm to 100 mm at the time of the investigation with an average thickness of about 75 mm.

4.1.3 Sand, Silt and Gravel (Fill) / Silt (Fill)

A loose to compact mixture of sand, silt and gravel (fill) layer was encountered at the ground surface or underlying the asphaltic concrete in all QEW median boreholes. The thickness of the fill layer ranged from 0.5 m to 2.6 m. The SPT conducted in this fill layer yielded N values ranging from 6 to 20. In general, this material was observed to be compact. Based on visual identification and laboratory tests, this fill can be classified as inorganic and cohesionless.

A compact silt (fill) with varying amounts of sand, clay and gravel was encountered underlying the sand, silt and gravel (fill) mentioned above, in Boreholes 135-40-2, 136-01-2, 136-05-2, 136-07-2, and 136-12-2. The thickness of the fill layer ranged from 0.9 m to 1.5 m. The SPT conducted in this fill layer yielded N values ranging from 9 to 25. The visual observations and laboratory test results indicate that this material is cohesionless.

The results of laboratory testing carried out on selected samples of both fill material types are provided on the Record of Boreholes, on Figures 5 and 7 in Appendix 1, and are summarized below:

Property	Range	# Tests	Average
Moisture Content (%)	4-18	16	10
Grain Size			
% Gravel	0-42	4	18
% Sand	4-45	4	28
% Silt	13-76	4	43
% Clay	0-20	4	11
Liquid Limit (%)	24-39	3	30
Plastic Limit (%)	16-22	3	18
Plasticity Index (%)	7-17	3	12

4.1.4 Heterogeneous Mixture of Silt and Clay, some Sand, trace Gravel (Glacial Till)

A heterogeneous mixture of silt and clay, some sand, trace gravel (glacial till) was encountered in all boreholes except Boreholes 136-10-2, 136-11-2, 136-12-1 and 136-12-2. The glacial till was observed at the ground surface or it was underlying the fill or topsoil. Where present, the glacial till surface was encountered at elevations ranging from El. 79.3 m to El. 84.3 m (depths of 0 m to 2.6 m).

The SPT conducted in the glacial till layer yielded N values ranging from 4 to over 100. All boreholes were terminated within the glacial till deposit with the exception of Boreholes 135-41-3, 136-08-3 to 136-13-3, and 136-16-1 to 136-16-3, which encountered shale bedrock.

The results of laboratory testing on selected SPT samples of this till material are provided on the Record of Boreholes, on Figures 1 to 4 and 8 in Appendix 1, and are summarized below:

Property	Range	# Test	Average
Moisture Content (%)	4-37	184	14
Grain size			
% Gravel	0-9	32	2
% Sand	10-56	32	18
% Silt and Clay	39-90	32	80
% Silt	34-73	32	55
% Clay	5-41	32	25
Liquid Limit (%)	23-39	31	32
Plastic Limit (%)	10-20	31	16
Plasticity Index (%)	10-22	31	16

Based on the above testing and visual identification, this till material can generally be classified as an inorganic, cohesive silt and clay of low to medium plasticity. Seams of cohesionless materials, generally consisting of sands and gravels, are noted at random depths and locations throughout the deposit. Grain size analysis of glacial till samples is limited to the maximum size of the SPT sampling methods that were employed (38 mm). Cobbles and/or boulders can be encountered in a glacial till deposit. Large cobbles or boulders were not detected in any of the boreholes put down as part of this investigation.

Vane shear testing was not possible due to the stiffness of this material. Based on laboratory observations and SPT correlations, the till is typically in the very stiff to hard range.

4.1.5 Bedrock

Bedrock was encountered underlying the glacial till in Boreholes 135-41-3, 136-08-3 to 136-13-3, and 136-16-1 to 136-16-3, and sampled by coring in NQ-size in Boreholes 136-10-1 and 136-11-1. In the other boreholes, the bedrock could be penetrated by solid stem augers. The bedrock surface at these locations was encountered between El. 75.0 m and El. 83.4 m (depths of 0.2 m to 6.1 m). The bedrock is a reddish brown to grey, weathered to unweathered shale of the Queenston Formation. The bedrock is of poor to good quality (RQD of the unweathered shale ranging from 65% to 88%). Core recoveries varied between 97% and 100%. The average RQD over 5.8 m of rock cored was 74%, indicating an overall rock mass quality of fair.

4.1.6 Groundwater

Groundwater was encountered in Boreholes 135-40-3, 136-02-3, 136-04-2, 136-05-3, 136-06-3, 136-11-3, 136-12-2, 136-13-3, 136-16-2 and 136-16-3 as noted on the Borehole Records. Groundwater levels at these locations ranged between El. 75.1 m and El. 81.3 m, or from 1.9 m to 7.7 m below ground surface immediately prior to backfilling. Groundwater was not encountered in other boreholes. Artesian conditions were not encountered in any of the boreholes.

The groundwater levels noted on the Borehole Records were recorded immediately after drilling. Due to the relatively low permeability of the overburden soils, these groundwater levels may not represent the static water levels which would approximately correspond to an adjacent creek level draining into Lake Ontario. Groundwater levels are subject to seasonal fluctuations.

4.2 W.P. 333-89-00

4.2.1 Topsoil

Topsoil was encountered at the ground surface in all boreholes except the boreholes located in the median of the QEW. The thickness of the topsoil ranges from 100 mm to 300 mm.

4.2.2 Fill

A mixture of sand, silt and gravel (fill) layer was encountered at the ground surface in Boreholes 138-06-2 and 138-07-2. The thickness of the fill layer ranged from 0.2 m to 0.3 m. Based on visual identification and laboratory tests, this fill can be classified as inorganic and cohesionless.

A silt (fill) with some sand and clay was observed in Boreholes 138-06-01, 139-06-02, and 138-07-02. The thickness of the fill layer ranged from 3.0 m to 3.4 m. The SPT conducted in this fill layer yielded N values ranging from 7 to 30, indicating a relative density of loose to compact. Laboratory analysis carried out on a sample of the fill indicated a grain size distribution of 0% gravel, 10% sand, 76% silt and 14% clay. The moisture content of the fill ranged from 12% to 20% with an average of about 15%. Based on visual observation and laboratory tests, this material can be classified as inorganic and cohesionless.

4.2.3 Silt

A silt with some sand and clay was encountered underlying the fill or topsoil in all boreholes except Boreholes 138-07-2 and 138-07-3. Where present, the silt surface was encountered at elevations ranging from El. 82.3 m to El. 85.5 m (depths of 0.3 m to 3.0 m).

The SPT conducted in the silt layer yielded N values ranging from 3 to 26, indicating a relative density of loose to compact. Laboratory analyses carried out on a representative sample of the silt indicated a grain size distribution of 0% gravel, 18% sand, 71% silt and 11% clay. The moisture content of the silt ranged from 13% to 19%, with an average of about 17%. This material is classified as cohesionless. Non-cohesive deposits such as this silt material are susceptible to base disturbance or boiling if an unbalanced piezometric head is introduced during construction.

4.2.4 Silt and Clay

A lacustrine deposit of silt and clay with some sand was encountered underlying the fill or silt in the boreholes. The silty clay surface was encountered at elevations ranging from El. 79.2 m to El. 84.0 m.

Field vane tests indicated shear strengths exceeding 120 kPa. Based on laboratory observations and SPT correlations, the silt and clay has a general consistency in the stiff to very stiff range.

Laboratory analyses carried out on a representative sample of the silt and clay indicated a grain size distribution of 0% gravel, 34% sand, 53% silt and 13% clay. The moisture content of the silt and clay ranged from 12% to 28%, with an average of about 17%.

Based on the above testing and visual identification, this silt and clay material can generally be classified as inorganic, cohesive and of low plasticity.

4.2.5 Groundwater

Groundwater was encountered in all boreholes except Borehole 138-07-2, as noted in the Borehole Records, which caved in at 4.9 m. Groundwater levels at these locations ranged between El. 77.7 m and El. 81.5 m, or from 4.6 m to 9.2 m below ground surface prior to backfilling. Artesian conditions were not encountered in any of the boreholes.

The groundwater levels noted on the Borehole Records were recorded immediately after drilling. Due to the relatively low permeability of the overburden soils, these groundwater levels may not represent the static water levels which would approximately correspond to an adjacent creek level draining into Lake Ontario. Groundwater levels are subject to seasonal fluctuations.

5.0 DISCUSSION AND RECOMMENDATIONS

5.1 Proposed Development

It is understood that it is proposed to replace the existing culverts under the QEW with concrete culverts at the twenty sites investigated. Concrete box culverts are the anticipated culvert type. Open footing concrete culverts could also possibly be considered. The new concrete culvert at each site is proposed to be extended to connect to the existing culverts beneath the North Service Road and the South Service Road. The culvert extension is to allow reconstruction and widening of the QEW. It is understood that the finished road grades at the culvert locations are to be raised 1.5 m or less.

5.2 Geotechnical Assessment

The subsurface profiles at the culvert sites below the culvert inverts can be generalized as follows:

W.P. 331-89-00	Very stiff to hard glacial till underlain by shale bedrock
W.P. 333-89-00	Loose to compact silt underlain by stiff to very stiff silt and clay

The proposed culverts at all culvert site locations may be placed at the founding level of the existing culverts. Settlement of the supporting soil beneath the culvert due to the anticipated culvert loading and adjacent fill placement is expected to be less than 25 mm.

It is expected that shoring will be required during construction of the culverts to minimize excavation and to facilitate traffic flow on the QEW.

This report contains our detailed recommendations for the proposed culvert structures at the culvert sites in W.P. 331-89-00 and 333-89-00 in the following areas:

- 1) Structure Foundations
- 2) Culvert Backfill
- 3) Temporary Shoring
- 4) Construction Considerations

5.3 Structure Foundations

5.3.1 Construction Method

It is anticipated that construction of the proposed concrete culverts beneath QEW will use conventional excavation and temporary shoring techniques. Dewatering and/or temporary shoring may be required during excavation if open-footing culverts placed on native undisturbed soils are proposed. Bearing capacities and sliding resistances of the native soils are provided in Section 5.3.2.

If concrete box culverts are used, consideration could be given to sub-excavating the native soil for a depth of 500 mm beneath the culvert invert and replacing this sub-excavation with OPSS Granular A that is end dumped from the top of the excavation and not compacted. The use of this construction method could minimize the dewatering requirements thereby simplifying construction and reducing the overall project costs.

5.3.2 Native Soil Support

W.P. 331-89-00

Concrete culvert structures may be founded directly on the very stiff to hard silt and clay glacial till, or on the shale bedrock, depending on the elevations of the bedrock surface relative to the proposed invert elevations. The approximate elevation of the culvert invert is summarized for each culvert on Table 1 provided in Appendix 2. The following design values are recommended for structure foundation design:

<u>Founding Stratum</u>	<u>Bearing Capacity at S.L.S.</u>	<u>Factored Bearing Capacity at U.L.S.</u>
Glacial Till	250 kPa	450 kPa
Shale Bedrock	300 kPa	550 kPa

Sliding resistance between the concrete and the foundation bearing surface should be calculated in accordance with Section 6-8.4.3 of the O.H.B.D.C. assuming the following unfactored coefficients of friction.

Concrete - Glacial Till	0.58
Concrete - Shale Bedrock	0.53

W.P. 333-89-00

Concrete culvert structures may be founded within the native undisturbed silt or silt and clay depending on the proposed culvert inverts (see Table 1 in Appendix 2). The following design values are recommended for structure foundation design:

<u>Founding Stratum</u>	<u>Bearing Capacity at S.L.S.</u>	<u>Factored Bearing Capacity at U.L.S.</u>
Silt	175 kPa	275 kPa
Silt and Clay	150 kPa	250 kPa

Sliding resistance between the concrete and the foundation bearing surface should be calculated in accordance with Section 6-8.4.3 of the O.H.B.D.C. assuming the following unfactored coefficients of friction.

Concrete - Silt	0.53
Concrete - Silt and Clay	0.50

5.3.3 All Culvert Sites

The following is applicable to all culvert sites in W.P. 331-89-00 and W.P. 333-89-00.

The above recommended U.L.S. capacities are applicable to footing widths (B) from 2.5 m to 6 m.

The underside of all footings should be provided with a minimum 1.2 m of earth cover for frost protection if open footing culverts are proposed. This earth cover has been taken into account for the bearing capacity recommendations provided above.

Settlement of the foundation soil as a result of the applied footing pressure is anticipated to be less than 25 mm, provided that the bearing surface is not disturbed by construction or related activities. All foundation bearing materials, including the glacial till, shale bedrock, silt and silt and clay are susceptible to wet weather conditions or construction activities. To prevent disturbance of the bearing surface, it is recommended that a 150 mm layer of lean concrete working slab be placed to protect the footing bearing surface within 4 hours of exposure.

5.4 Culvert Backfill

The following is applicable to all culvert sites in W.P. 331-89-00 and W.P. 333-89-00.

To prevent hydrostatic pressure buildup, backfill against the culvert walls should consist of free draining materials such as OPSS Granular A or Granular B. Backfill requirements for culverts should be in accordance with OPSD 803 series.

Computation of earth pressures should be in accordance with Section 6-7 of the O.H.B.D.C.. The active earth pressure should be used if the structure is unyielding. For rigidly tied structures, the at-rest earth pressure should be used for design, unless enough deflection (approximately 0.05% of the wall height) is allowed to establish active conditions.

For a horizontal backfill the following soil parameters are recommended for design:

	<u>Granular A</u>	<u>Granular B</u>
Unit Weight (kN/m^3)	22.8	21.2
Effective Friction Angle, ϕ	35°	30°
Coefficient of Active Earth Pressure, K_a	0.27	0.33
Coefficient of Earth Pressure at Rest, K_o	0.43	0.50

For W.P. 331-89-00, consideration can be given to using the excavated glacial till and shale bedrock as backfill above the water line. An effective friction angle of 28 degrees and a unit weight of 20.8 kN/m^3 could be used for these materials.

The backfill should be constructed in 300 mm lifts on alternating sides of the culvert so that the maximum differential backfill height does not exceed 300 mm.

Compaction of the granular backfill located within a 1H:2V projection from the culvert invert should be carried out using hand-operated equipment to prevent overstressing the culvert walls.

5.5 Temporary Shoring

5.5.1 Lateral Earth Pressures

Temporary shoring will likely be required near the QEW median during construction to maintain traffic flow. The following lateral earth parameters for the native soils encountered at the sites are recommended for shoring design. The parameters are based on a horizontal surface behind the shoring.

	Silt and Clay Glacial Till (W.P. 331-89-00)	Silt Fill / Silt / Silt and Clay (W.P. 333-89-00)
Unit Weight (kN/m^3)	21.0	19.0
Effective Cohesion, c' (kPa)	0	0
Effective Friction Angle, ϕ	29°	28°
Coefficient of Active Earth Pressure, K_a	0.33	0.36
Coefficient of Earth Pressure at Rest, K_0	0.50	0.53

Earth pressure distribution behind a temporary shoring system is dependent on the type of shoring system. The following earth pressure distributions are recommended for calculations of commonly used temporary shoring systems:

- For a flexible cantilevered and tied back shoring system such as the anticipated system described above, it is recommended that a triangular pressure distribution based on Rankine coefficients of active and passive pressures be used for calculations.
- For strutted flexible walls, it is recommended that a rectangular earth pressure distribution of $0.65K_a\gamma H$ be used for calculations.
 - where K_a = Coefficient of active earth pressure
 - γ = Unit weight of soil behind shoring system
 - H = Height of shoring system

Based on the excavation depths and the soil conditions encountered, it is anticipated that conventional soldier piles with timber lagging system, supplemented by soil/rock anchors if required, will be the most likely shoring alternative.

5.5.2 Soil and Rock Anchors

5.5.2.1 W.P. 331-89-00

The following allowable bond stresses are recommended for tieback anchor design calculations for culvert sites in W.P. 331-89-00 (WC135-40, 135-41, 136-01 to 136-16 inclusive).

<u>Material</u>	<u>Allowable Bond Stress</u>
Silt and Clay Glacial Till	30 kPa
Shale Bedrock	200 kPa

Soil and rock anchors should be designed in accordance with current MTO standards. Refer to the Foundation Design Unit of the Pavements and Foundation Section for the appropriate Non Standard Special Provision for design purposes.

5.5.2.2 W.P. 333-89-00

At culvert sites WC138-06 and 138-07 (W.P. 333-89-00), the subsurface profile consists of silt underlain by silt and clay. Anchors installed in these materials are not recommended. Anchors could either be extended to bedrock or not used.

5.6 Construction Considerations

5.6.1 Open Cut Excavations

5.6.1.1 W.P. 331-89-00

Temporary unshored excavations in the silt and clay glacial till may be undertaken using vertical side slopes up to a height of 1.2 m from the excavation bottom. The portion of the excavation higher than 1.2 m from the bottom should be undertaken using side slopes no steeper than 1H:1V up to a maximum total height of 7.0 m. Vertical side slopes may be utilized for temporary excavations within the shale bedrock.

5.6.1.2 W.P. 333-89-00

Temporary unshored excavations in the silt fill and the underlying native silt and silt and clay should be undertaken using side slopes no steeper than 1H:1V, up to a total height of 7.0 m, from the bottom of the excavation. In cohesionless deposits (silt fill and silt) where seepage is encountered, flatter side slopes may be required, or alternatively a shoring system may be utilized.

5.6.2 Dewatering

It is the responsibility of the contractor to lower the groundwater below the excavation base, and to construct the structure foundations in the dry conditions without disturbing the underlying foundation soils.

Based on the soil types and the groundwater conditions encountered during the investigation, the following dewatering methods may be considered.

- For unshored excavations, perimeter ditches within a gravity system in conjunction with a sump pump discharge system to drain accumulated water may be utilized.
- Dewatering may be achieved by pumping from inside a shored excavation.

Other dewatering alternatives may also be considered. The more economical and practically feasible dewatering alternative should be selected. As discussed in Section 5.3.1, consideration could be given to using precast concrete sections placed on Granular A to minimize the amount of dewatering required. Groundwater levels and the amount of inflow should be expected to fluctuate seasonally.

5.7 Soil Chemistry

Representative soil samples were submitted to Environment Protection Laboratories Inc. of Mississauga for pH, sulphate and chloride testing to assess the potential of sulphate attack on concrete and potential attack on exposed steel.

The results of the testing are summarized on Table 2 provided in Appendix 2.

6.0 MISCELLANEOUS

The field work for this investigation was carried out under the supervision of R. Rintjema, P.Eng., N. Lobo and C. Reynolds. Drilling equipment was provided by Master Soil Investigations Ltd. and Eastern Soil Investigation Ltd.

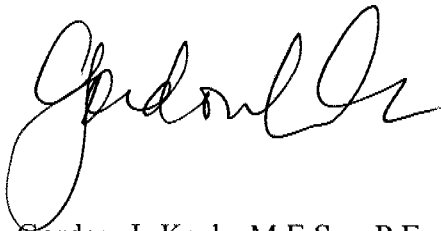
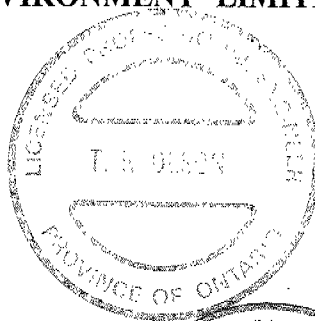
This report was prepared by C. Kwok and T. Olson, Project Engineer, and approved by G. Kack, Project Manager.

Respectfully submitted,

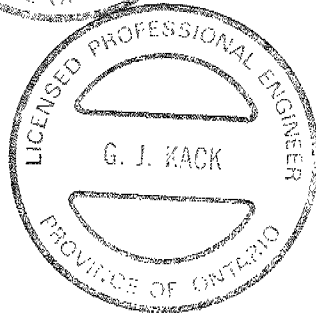
JACQUES WHITFORD ENVIRONMENT LIMITED



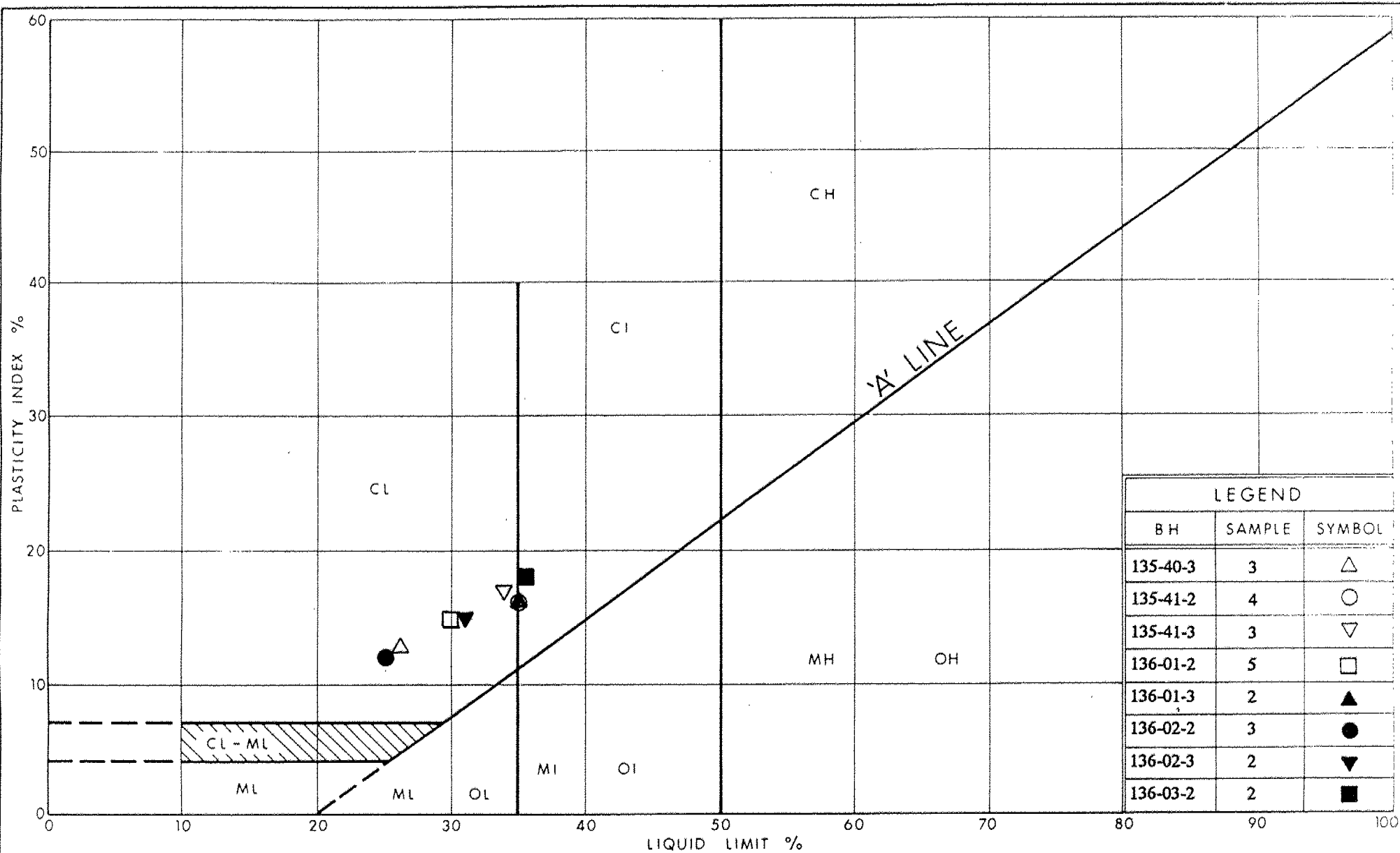
Timothy K. Olson, P.Eng.
Project Engineer



Gordon J. Kack, M.E.Sc., P.Eng.
Project Manager



APPENDIX 1

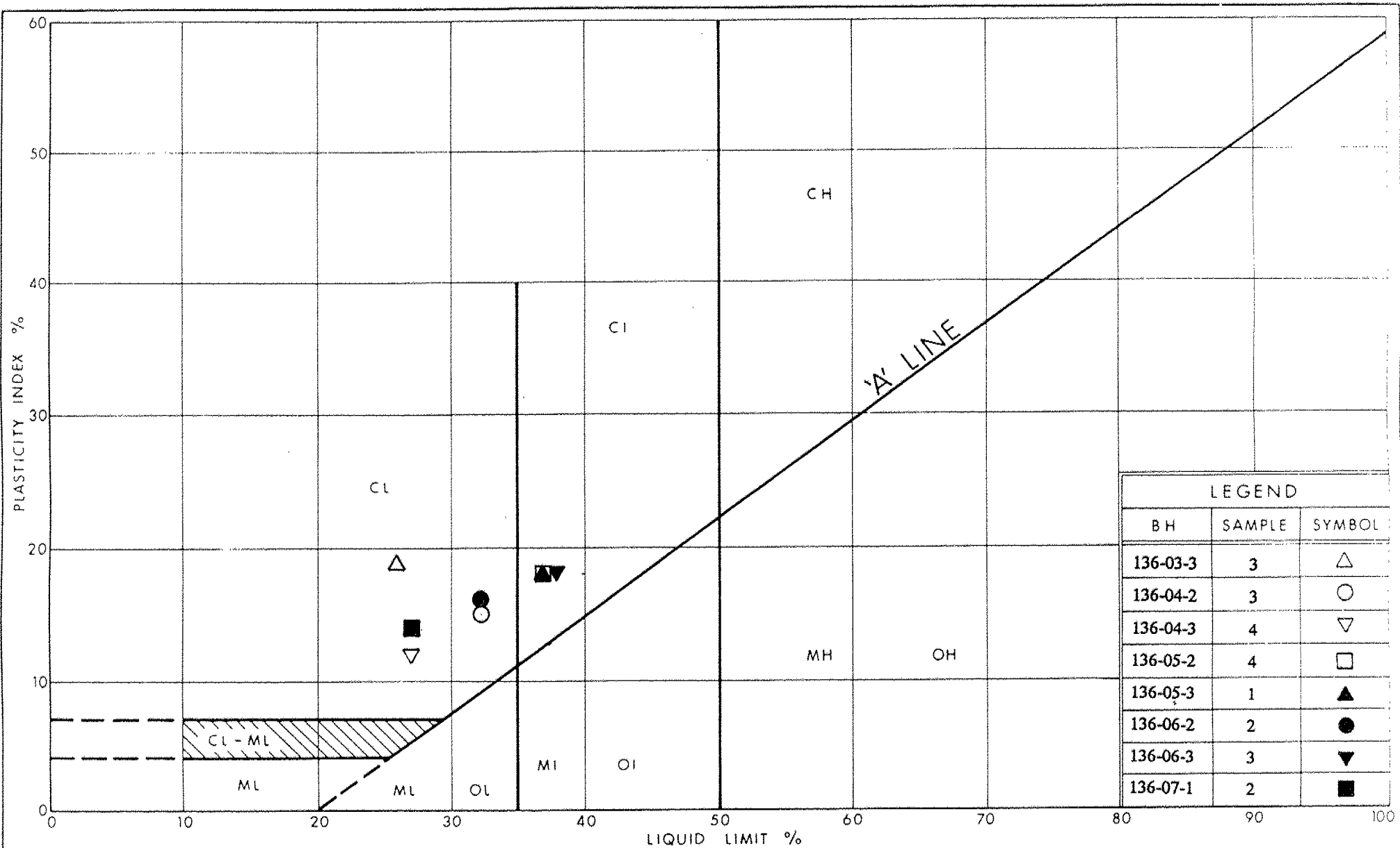


Ministry of
Transportation

PLASTICITY CHART
HET MIXTURE OF SILT & CLAY, SOME SAND,
TRACE GRAVEL (Glacial Till)

FIG No 1

W P 331-89-00

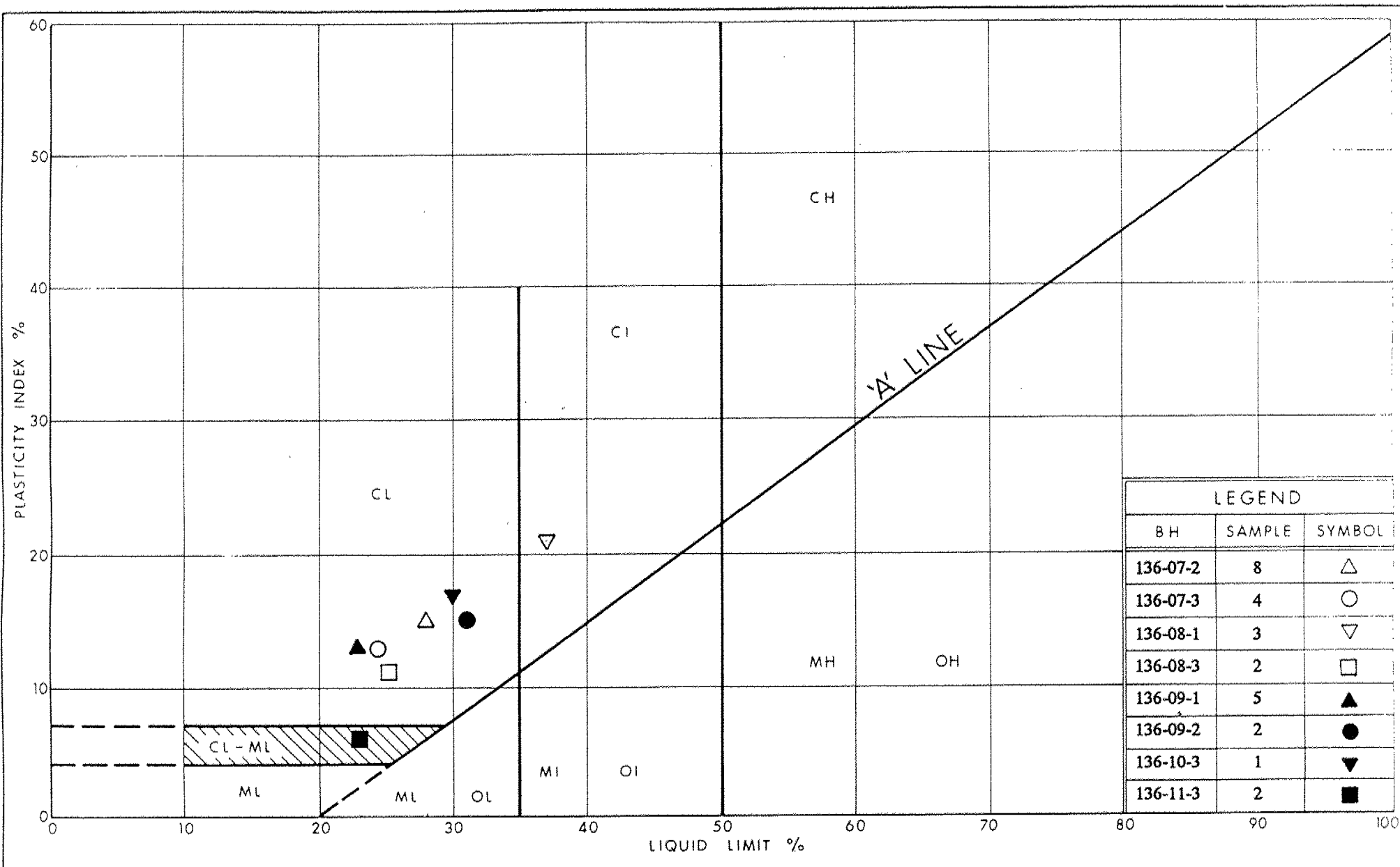


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Ontario

PLASTICITY CHART
HET MIXTURE OF SILT & CLAY, SOME SAND,
TRACE GRAVEL (Glacial Till)

FIG No 2

W P 331-89-00

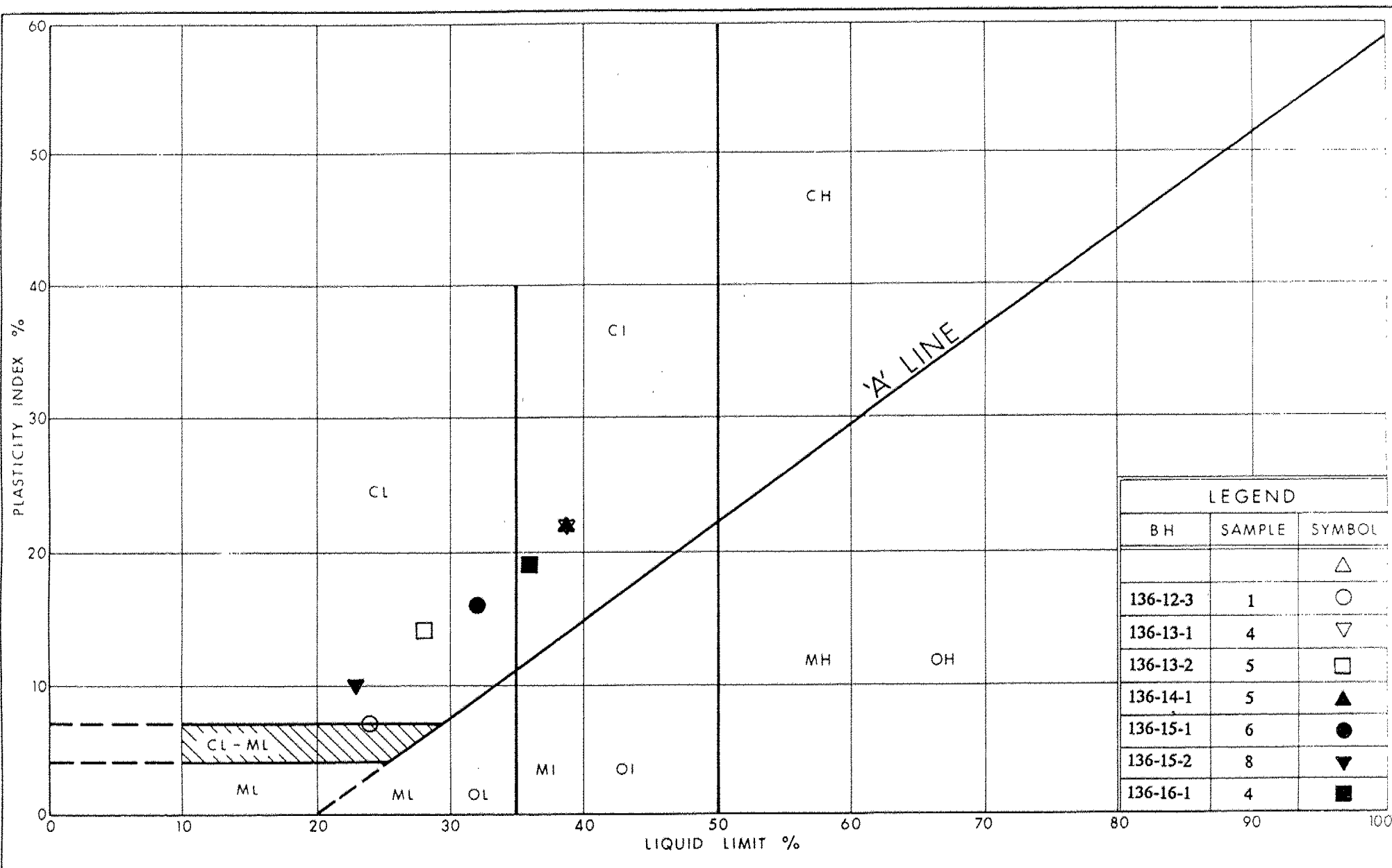


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Ontario

PLASTICITY CHART
HET MIXTURE OF SILT & CLAY, SOME SAND,
TRACE GRAVEL (Glacial Till)

FIG No 3

W P 331-89-00



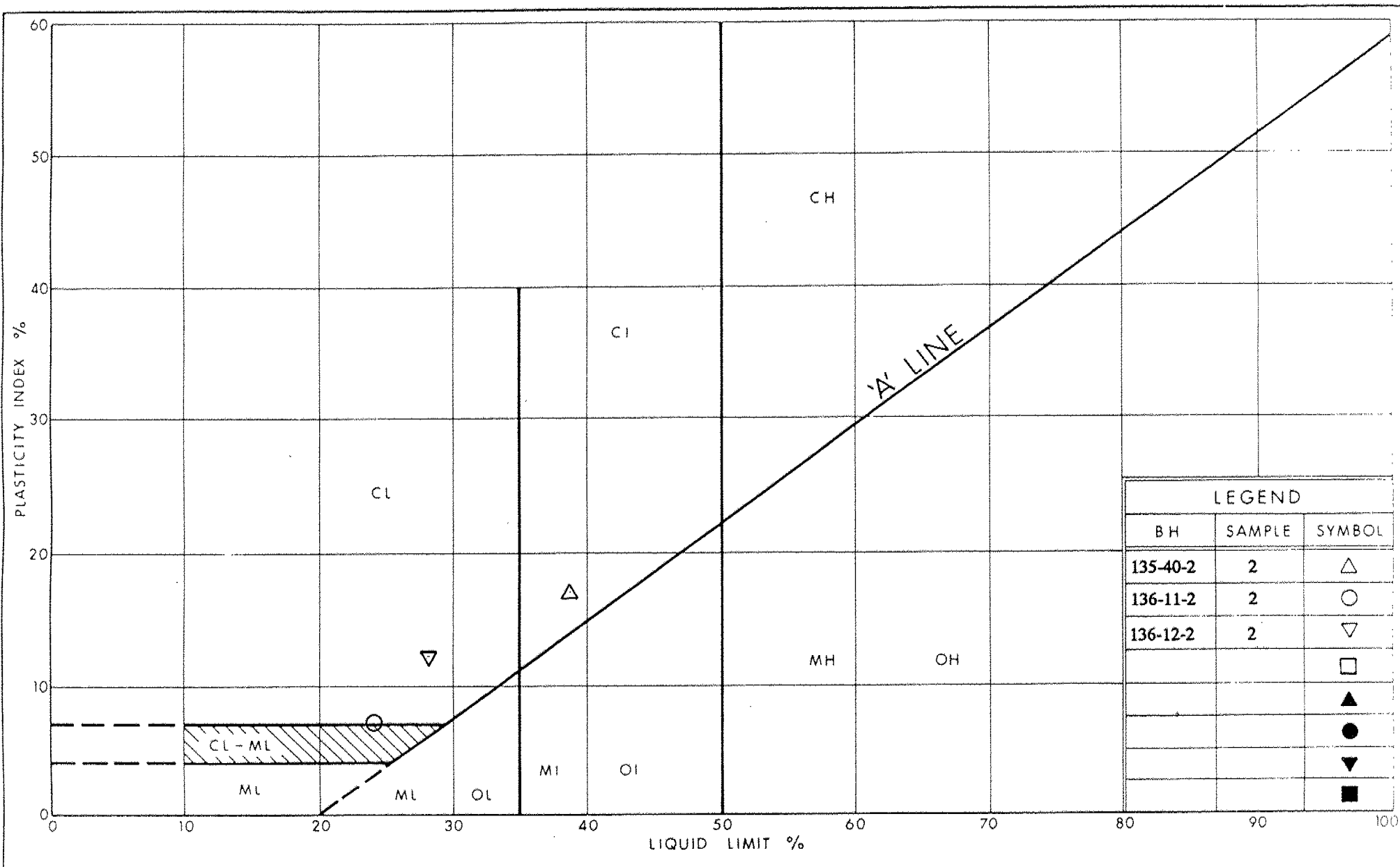
Ministry of
Transportation

Ontario

PLASTICITY CHART
HET MIXTURE OF SILT & CLAY, SOME SAND,
TRACE GRAVEL (Glacial Till)

FIG No 4

W P 331-89-00

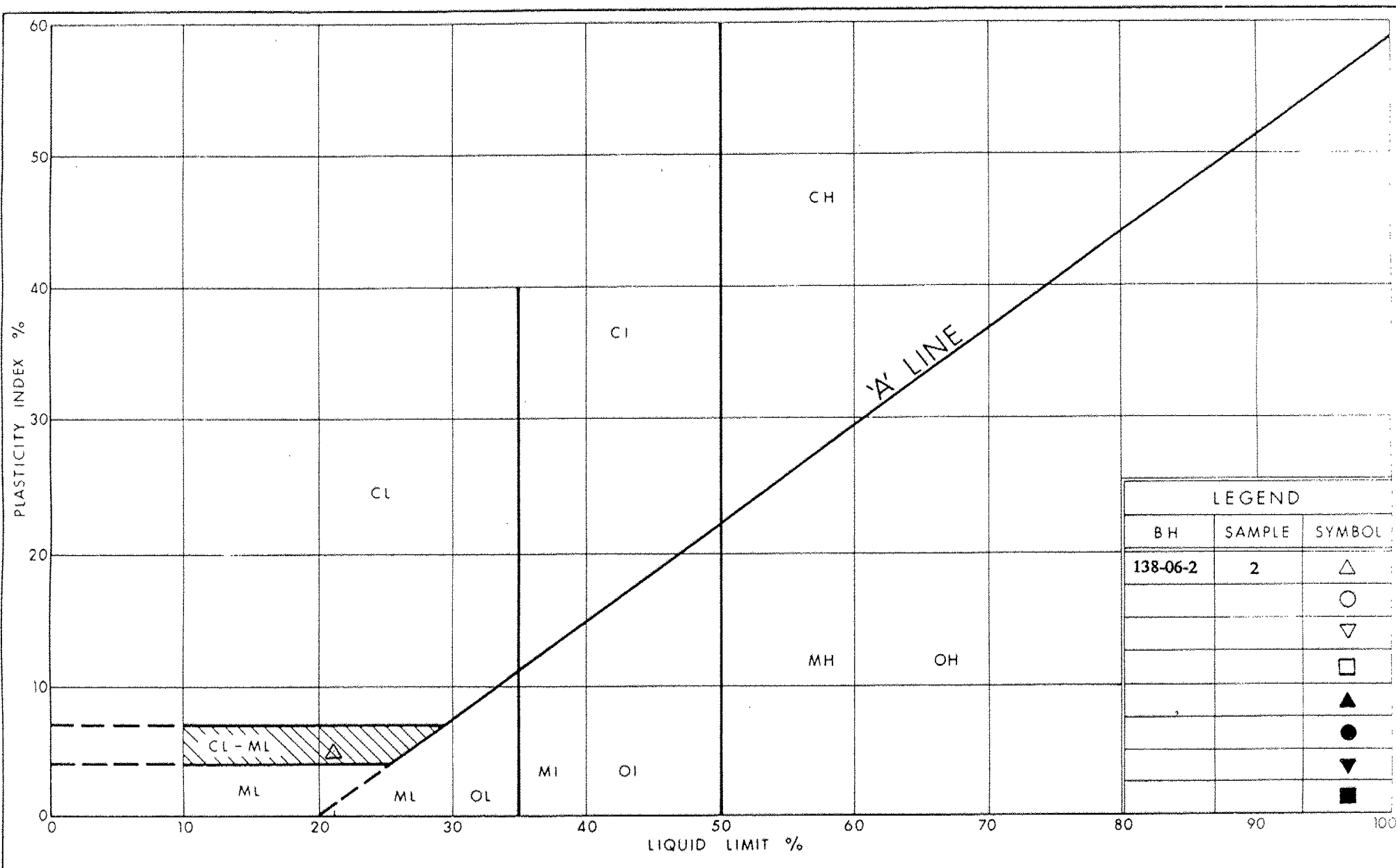


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PLASTICITY CHART
MIXTURE OF SILT, CLAY, SAND & GRAVEL (FILL)

FIG No 5

W P 331-89-00



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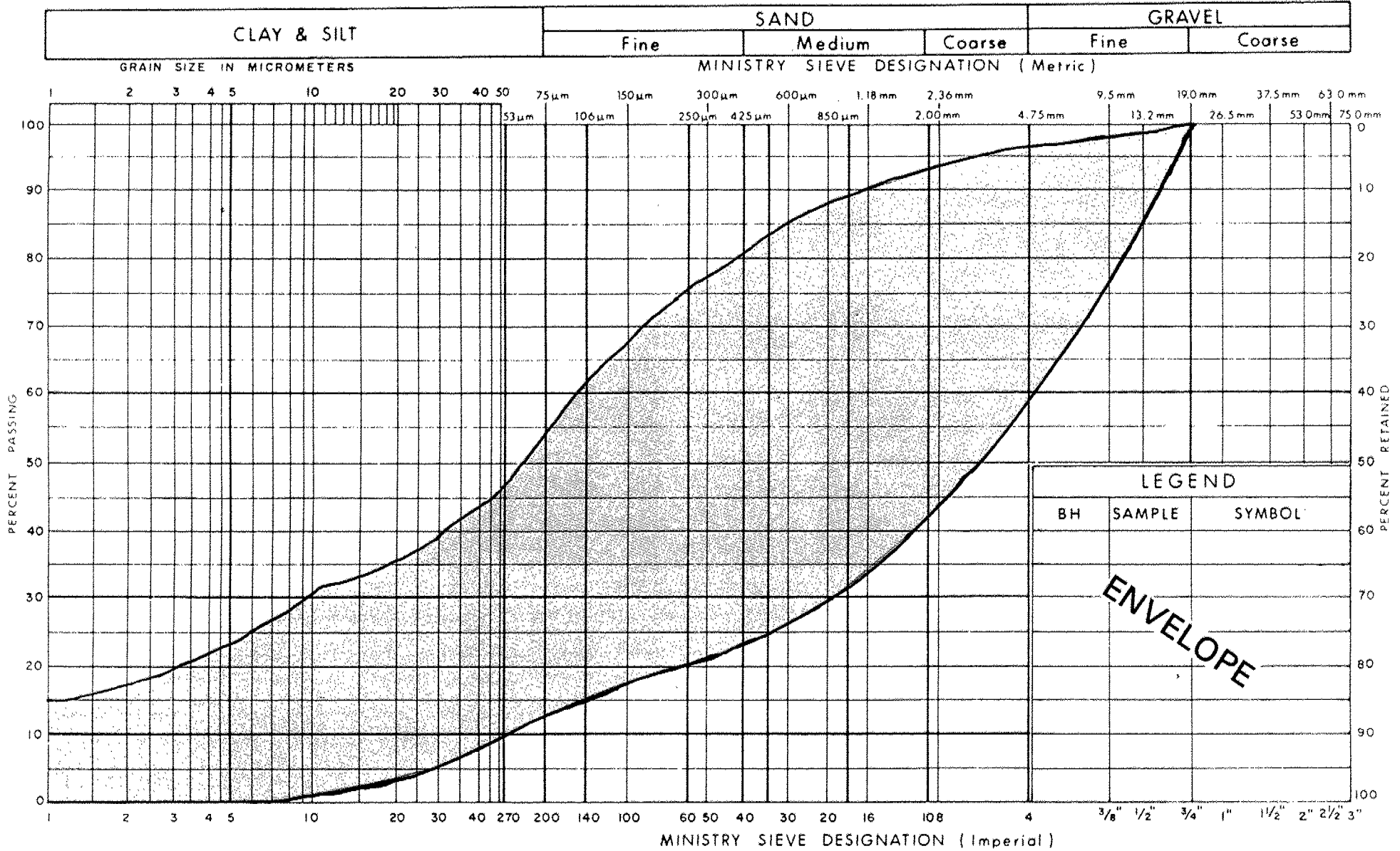
Ontario

PLASTICITY CHART SILT (FILL), SOME SAND & CLAY

FIG No 6

W P 333-89-00

UNIFIED SOIL CLASSIFICATION SYSTEM

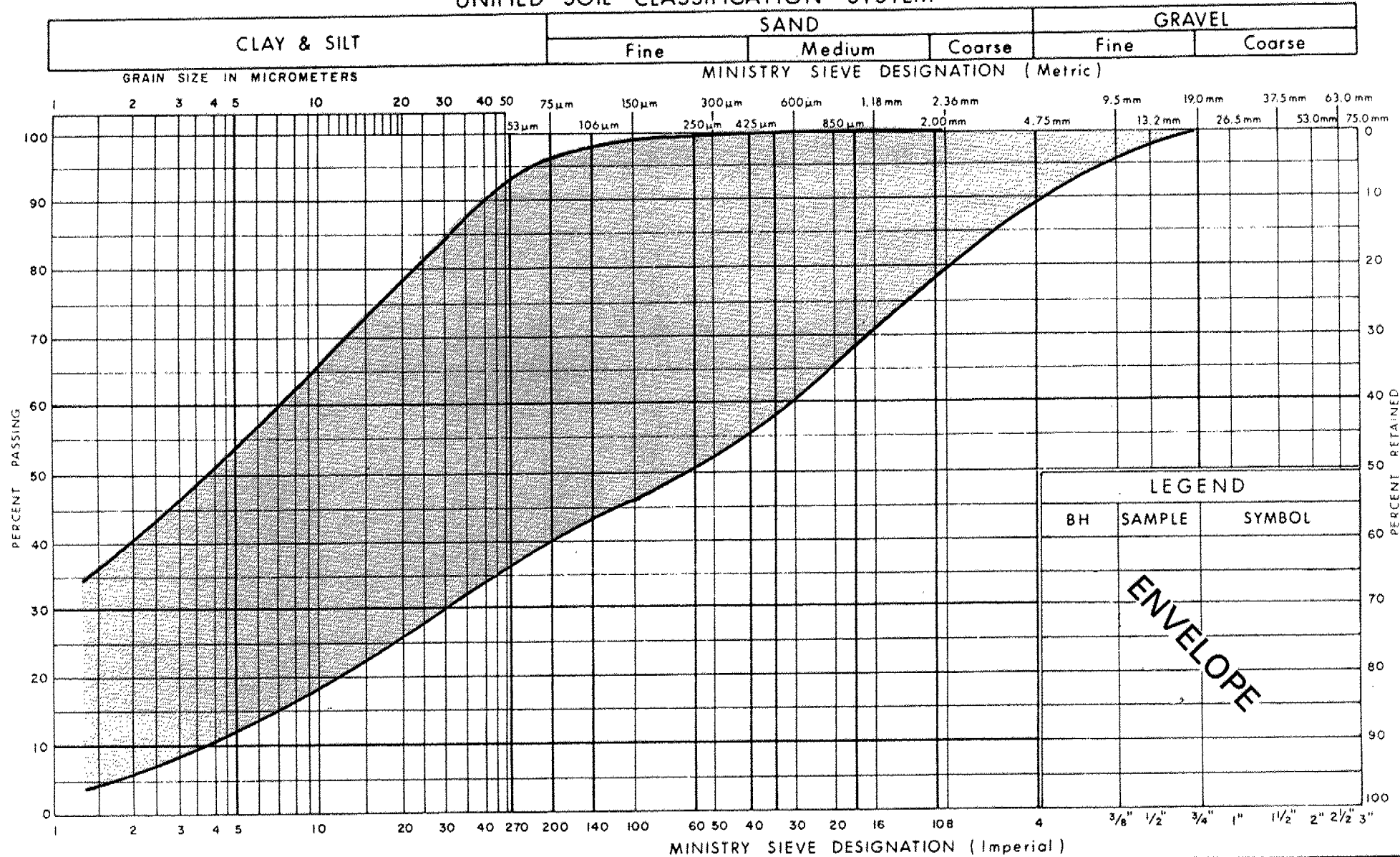


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GRAIN SIZE DISTRIBUTION
FILL

FIG No 7
W P 331-89-00

UNIFIED SOIL CLASSIFICATION SYSTEM



Ministry of
Transportation

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

FIG No 8

W P 331-89-00

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 31mm 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 (31mm 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

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 = $\frac{c_u}{\tau_r}$

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

PHYSICAL PROPERTIES OF SOIL

ρ_s	kg/m^3	DENSITY OF SOLID PARTICLES	e	1, %	VOID RATIO	e_{min}	1, %	VOID RATIO IN DENSEST STATE
γ_s	kN/m^3	UNIT WEIGHT OF SOLID PARTICLES	n	1, %	POROSITY	I_D	1	DENSITY INDEX = $\frac{e_{max} - e}{e_{max} - e_{min}}$
ρ_w	kg/m^3	DENSITY OF WATER	w	1, %	WATER CONTENT	D	mm	GRAIN DIAMETER
γ_w	kN/m^3	UNIT WEIGHT OF WATER	S_r	%	DEGREE OF SATURATION	D_n	mm	n PERCENT - DIAMETER
ρ	kg/m^3	DENSITY OF SOIL	w_L	%	LIQUID LIMIT	C_u	1	UNIFORMITY COEFFICIENT
γ	kN/m^3	UNIT WEIGHT OF SOIL	w_p	%	PLASTIC LIMIT	h	m	HYDRAULIC HEAD OR POTENTIAL
ρ_d	kg/m^3	DENSITY OF DRY SOIL	w_s	%	SHRINKAGE LIMIT	q	m^3/s	RATE OF DISCHARGE
γ_d	kN/m^3	UNIT WEIGHT OF DRY SOIL	I_p	%	PLASTICITY INDEX = $w_L - w_p$	v	m/s	DISCHARGE VELOCITY
ρ_{sat}	kg/m^3	DENSITY OF SATURATED SOIL	I_L	1	LIQUIDITY INDEX = $\frac{w - w_p}{I_p}$	i	1	HYDRAULIC GRADIENT
γ_{sat}	kN/m^3	UNIT WEIGHT OF SATURATED SOIL	I_C	1	CONSISTENCY INDEX = $\frac{w_L - w}{I_p}$	k	m/s	HYDRAULIC CONDUCTIVITY
ρ'	kg/m^3	DENSITY OF SUBMERGED SOIL	e_{max}	1, %	VOID RATIO IN LOOSEST STATE	j	kN/m^2	SEEPAGE FORCE
γ'	kN/m^3	UNIT WEIGHT OF SUBMERGED SOIL						

RECORD OF BOREHOLE No 135-40-1

1 OF 1

METRIC

W.P. 331-89-00 LOCATION WC 135-40; Sta. 31 + 688, O-S 25m Lt. ORIGINATED BY IK
 DIST 4 HWY QEW BOREHOLE TYPE Solid Stem COMPILED BY IK
 DATUM SEE TEXT DATE 94.08.24 & 94.08.24 CHECKED BY TO

SOIL PROFILE			SAMPLES			GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT					UNIT WEIGHT γ kN/m ³	REMARKS & GRAIN SIZE DISTRIBUTION (%)
ELEV DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE	"N" VALUES			SHEAR STRENGTH kPa						
81.8	Ground Surface							20 40 60 80 100						
0.0	Topsoil		1	SS	12			20 40 60 80 100						
81.4								20 40 60 80 100						
0.5	Het. mixture of Silt and Clay, some sand, trace gravel (Glacial Till) Very Stiff to Hard Brown Grey		2	SS	37		81	20 40 60 80 100					24.2	
			3	SS	21		80	20 40 60 80 100						
			4	SS	10		79	20 40 60 80 100						
			5	SS	13		78	20 40 60 80 100						
			6	SS	22		77	20 40 60 80 100						
							76	20 40 60 80 100						
75.1			7	SS	35			20 40 60 80 100						
6.7	END OF BOREHOLE Borehole dry upon completion							20 40 60 80 100						

RECORD OF BOREHOLE No 135-40-2

1 OF 1

METRIC

W.P. 331-89-00 LOCATION WC 135-40; Sta. 31+688, O-S 4m Rt. ORIGINATED BY IK
DIST 4 HWY QEW BOREHOLE TYPE Solid Stem, Cone Test COMPILED BY IK
DATUM SEE TEXT DATE 94.08.10 & 94.08.10 CHECKED BY TO

SOIL PROFILE			SAMPLES			GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT		PLASTIC LIMIT w _p	NATURAL MOISTURE CONTENT w	LIQUID LIMIT w _L	UNIT WEIGHT γ	REMARKS & GRAIN SIZE DISTRIBUTION (%)
ELEV DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE	"N" VALUES			SHEAR STRENGTH kPa	WATER CONTENT (%)					
83.5	Ground Surface							20 40 60 80 100	20 40 60 80 100					
0.0	Mixture of Sand, Silt and Clay, trace gravel. (Fill) Stiff		1	AS			83							
82.0			2	SS	12		82							4 37 42 17
1.5	Het. mixture of Silt and Clay, some sand, trace gravel (Glacial Till) Very Stiff to Hard Brown Brown Grey		3	SS	21		81							
			4	SS	30		80							
			5	SS	26		79							
			6	SS	29		78							
			7	SS	34		77							
			8	SS	37		76							
75.3			9	SS	49									
8.2	END OF BOREHOLE Borehole dry upon completion													

x³, x³; Numbers refer to Sensitivity 20 15 10 (% STRAIN AT FAILURE

RECORD OF BOREHOLE No 135-40-3

1 OF 1

METRIC

W.P. 331-89-00 LOCATION WC 135-40; Sta. 31+688, O-S 28m Rt. ORIGINATED BY IK
DIST 4 HWY QEW BOREHOLE TYPE Solid Stem COMPILED BY IK
DATUM SEE TEXT DATE 94.08.11 & 94.08.11 CHECKED BY TO

SOIL PROFILE			SAMPLES			GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT					UNIT WEIGHT γ kN/m ³	REMARKS & GRAIN SIZE DISTRIBUTION (%)
ELEV DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE	"N" VALUES			20	40	60	80	100		
82.0	Ground Surface						82							
0.0	Het. mixture of Silt and Clay, some sand, trace gravel (Glacial Till) Very Stiff to Hard		1	SS	18		81							
			2	SS	29		80							
			3	SS	19		79							
			4	SS	20		78							
			5	SS	21		77							
			6	SS	24		76							
			7	SS	34									
			8	SS	30									
75.3														
6.7	END OF BOREHOLE													

RECORD OF BOREHOLE No 135-41-1

1 OF 1

METRIC

W.P. 331-89-00 LOCATION WC 135-41; Sta. 32+102, O-S 30m Lt. ORIGINATED BY IK
DIST 4 HWY QEW BOREHOLE TYPE Solid Stem COMPILED BY IK
DATUM SEE TEXT DATE 94.08.23 & 94.08.23 CHECKED BY TO

SOIL PROFILE			SAMPLES			GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT					UNIT WEIGHT γ kN/m ³	REMARKS & GRAIN SIZE DISTRIBUTION (%) GR SA SI CL
ELEV DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE	"N" VALUES			SHEAR STRENGTH kPa						
79.9	Ground Surface							20 40 60 80 100						
0.0	Topsoil		1	SS	2									
79.3														
0.6	Het. mixture of Silt and Clay, some sand, trace gravel (Glacial Till) Very Stiff to Hard Brown Grey		2	SS	21		79							
			3	SS	32		78							
			4	SS	27		77							
			5	SS	22		76							
			6	SS	24		75							
							74							
73.2			7	SS	19									
6.7	END OF BOREHOLE Borehole dry upon completion													

\times^3, \times^3 ; Numbers refer to Sensitivity 20 15 10 (%) STRAIN AT FAILURE

RECORD OF BOREHOLE No 135-41-2

1 OF 1

METRIC

W.P. 331-89-00 LOCATION WC 135-41; Sta. 32+102, O-S 3m Rt. ORIGINATED BY IK
DIST 4 HWY QEW BOREHOLE TYPE Solid Stem, Cone Test COMPILED BY IK
DATUM SEE TEXT DATE 94.08.10 & 94.08.10 CHECKED BY TO

SOIL PROFILE		SAMPLES			GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT		PLASTIC LIMIT W _P	NATURAL MOISTURE CONTENT W	LIQUID LIMIT W _L	UNIT WEIGHT γ kN/m ³	REMARKS & GRAIN SIZE DISTRIBUTION (%) GR SA SI CL
ELEV DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE			"N" VALUES	SHEAR STRENGTH kPa					
82.1	Ground Surface												
82.0	75mm ASPHALT												
0.1	Mixture of Sand, Silt and Gravel. (Fill)		1	AS									
81.2	Het. mixture of Silt and Clay, some sand, trace gravel (Glacial Till) Very Stiff to Hard		2	SS	6								
0.9			3	SS	29								
			4	SS	25								
			5	SS	25								
			6	SS	18								
			7	SS	24								
			8	SS	33								
			9	SS	25								
74.5	END OF BOREHOLE												
7.6	Borehole dry upon completion												

RECORD OF BOREHOLE No 135-41-3

1 OF 1

METRIC

W.P. 331-89-00 LOCATION WC 135-41; Sta. 32+102, O-S 36m Rt. ORIGINATED BY IK
DIST 4 HWY QEW BOREHOLE TYPE Solid Stem COMPILED BY IK
DATUM SEE TEXT DATE 94.08.11 & 94.08.11 CHECKED BY TO

SOIL PROFILE			SAMPLES			GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT					PLASTIC LIMIT W _p	NATURAL MOISTURE CONTENT W	LIQUID LIMIT W _L	UNIT WEIGHT γ kN/m ³	REMARKS & GRAIN SIZE DISTRIBUTION (%) GR SA SI CL
ELEV DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE	"N" VALUES			20	40	60	80	100					
80.5	Ground Surface																
80.4	50mm Topsoil		1	SS	8												
0.1	Het. mixture of Silt and Clay, some sand, trace gravel (Glacial Till) Very Stiff to Hard Brown Grey		2	SS	27												
			3	SS	33												
			4	SS	24												
			5	SS	27												
			6	SS	32												
75.0																	
5.6	Shale Bedrock Poor to Fair		7	SS	50	100mm											
73.8																	
6.7	END OF BOREHOLE Borehole dry upon completion																

RECORD OF BOREHOLE No 136-01-1

1 OF 1

METRIC

W.P. 331-89-00 LOCATION WC 136-01; Sta. 10+419, O-S 23m Lt. ORIGINATED BY IK
 DIST 4 HWY QEW BOREHOLE TYPE Solid Stem COMPILED BY IK
 DATUM SEE TEXT DATE 94.08.23 & 94.08.23 CHECKED BY TO

SOIL PROFILE			SAMPLES			GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT				UNIT WEIGHT γ kN/m ³	REMARKS & GRAIN SIZE DISTRIBUTION (%) GR SA SI CL
ELEV DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE	"N" VALUES			SHEAR STRENGTH kPa					
								20 40 60 80 100		PLASTIC LIMIT NATURAL MOISTURE CONTENT W _p — W — W _L			
							WATER CONTENT (%) 20 40 60 80 100						
80.2	Ground Surface												
79.9	Topsoil		1	SS	13								
0.3	Het. mixture of Silt and Clay, some sand, trace gravel (Glacial Till) Very Stiff to Hard Brown Grey -grey shale seam (75mm)		2	SS	26								
			3	SS	35								
			4	SS	63								
			5	SS	68								
			6	SS	26								
			7	SS	29								
73.5													
6.7	END OF BOREHOLE												
	Borehole dry upon completion												

RECORD OF BOREHOLE No 136-01-2

1 OF 1

METRIC

W.P. 331-89-00 LOCATION WC 136-01; Sta. 10+419, O-S 4m Rt. ORIGINATED BY IK
DIST 4 HWY QEW BOREHOLE TYPE Solid Stem, Cone Test COMPILED BY IK
DATUM SEE TEXT DATE 94.08.11 & 94.08.11 CHECKED BY TO

SOIL PROFILE			SAMPLES			GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT			PLASTIC LIMIT W _p	NATURAL MOISTURE CONTENT W	LIQUID LIMIT W _L	UNIT WEIGHT γ kN/m ³	REMARKS & GRAIN SIZE DISTRIBUTION (%) GR SA SI CL			
ELEV DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE	*N* VALUES			SHEAR STRENGTH kPa								WATER CONTENT (%)		
								○ UNCONFINED	× FIELD VANE	● QUICK TRIAXIAL						× LAB VANE	W _p	W
82.0	Ground Surface						20	40	60	80	100	10	20	30				
0.0 81.7	Mixture of Sand, Silt and Gravel (Fill)		1	SS	8													
0.3	Mixture of Silt and Sand, trace clay (Fill), loose		2	SS	9													
80.3	Het. mixture of Silt and Clay, some sand, trace gravel		3	SS	33													
1.7	(Glacial Till)		4	SS	45													
	Very Stiff to Hard		5	SS	59													
			6	SS	69													
			7	SS	35													
			8	SS	49													
			9	SS	36													
73.8																		
8.2	END OF BOREHOLE																	
	Borehole dry upon completion																	

Numbers refer to
Sensitivity

20
15
10
(%) STRAIN AT FAILURE

RECORD OF BOREHOLE No 136-02-1

1 OF 1

METRIC

W.P. 331-89-00 LOCATION WC 136-02; Sta. 10+622, O-S 23m Lt. ORIGINATED BY IK
 DIST 4 HWY QEW BOREHOLE TYPE Solid Stem COMPILED BY IK
 DATUM SEE TEXT DATE 94.08.23 & 94.08.23 CHECKED BY TO

SOIL PROFILE			SAMPLES			GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT		PLASTIC LIMIT W _P	NATURAL MOISTURE CONTENT W	LIQUID LIMIT W _L	UNIT WEIGHT γ kN/m ³	REMARKS & GRAIN SIZE DISTRIBUTION (%) GR SA SI CL
ELEV DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE	*N° VALUES			20	40					
81.3	Ground Surface													
81.0	Topsoil		1	SS	14									
0.3	Het. mixture of Silt and Clay, some sand, trace gravel (Glacial Till) Very Stiff to Hard Brown Grey		2	SS	27									
			3	SS	24									
			4	SS	38									
			5	SS	36									
			6	SS	26									
			7	SS	22									
74.6	END OF BOREHOLE													
6.7	Borehole dry upon completion													

RECORD OF BOREHOLE No 136-02-2

1 OF 1

METRIC

W.P. 331-89-00 LOCATION WC 136-02; Sta. 10+622, O-S 3m Rt. ORIGINATED BY IK
DIST 4 HWY QEW BOREHOLE TYPE Solid Stem, Cone Test COMPILED BY IK
DATUM SEE TEXT DATE 94.08.11 & 94.08.11 CHECKED BY TO

SOIL PROFILE			SAMPLES			GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT		NATURAL MOISTURE CONTENT		UNIT WEIGHT γ kN/m ³	REMARKS & GRAIN SIZE DISTRIBUTION (%) GR SA SI CL
ELEV DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE	"N" VALUES			20 40 60 80 100	20 40 60 80 100	WP W WL	10 20 30		
82.2	Ground Surface												
0.0	Mixture of Sand, Silt and Gravel (Fill), compact		1	SS	7								
81.6													
0.6	Het. mixture of Silt and Clay, some sand, trace gravel (Glacial Till) Very Stiff to Hard		2	SS	6								
			3	SS	32								
			4	SS	34								
			5	SS	31								
			6	SS	43								
			7	SS	42								
			8	SS	30								
			9	SS	30								
74.5													
7.6	END OF BOREHOLE Borehole dry upon completion												

METRIC

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

RECORD OF BOREHOLE No 136-03-1

1 OF 1

METRIC

W.P. 331-89-00 LOCATION WC 136-03; Sta. 10+825, O-S 22m Lt. ORIGINATED BY IK
 DIST 4 HWY QEW BOREHOLE TYPE Solid Stem COMPILED BY IK
 DATUM SEE TEXT DATE 94.08.23 & 94.08.23 CHECKED BY TO

SOIL PROFILE			SAMPLES			GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT			UNIT WEIGHT & GRAIN SIZE DISTRIBUTION (%)	REMARKS
ELEV DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE	"N" VALUES			SHEAR STRENGTH kPa				
81.8	Ground Surface							20 40 60 80 100				
81.8	Topsoil		1	SS	2			○ UNCONFINED × FIELD VANE ● QUICK TRIAXIAL × LAB VANE				
0.3	Het. mixture of Silt and Clay, some sand, trace gravel		2	SS	13		81	20 40 60 80 100			22.2	
	(Glacial Till)		3	SS	34		80	20 40 60 80 100				
	Very Stiff to Hard		4	SS	26		79	20 40 60 80 100				
			5	SS	25		78	20 40 60 80 100				
			6	SS	28		77	20 40 60 80 100				
			7	SS	30		76	20 40 60 80 100				
76.1								20 40 60 80 100				
6.7	END OF BOREHOLE							20 40 60 80 100				
	Borehole dry upon completion							20 40 60 80 100				

RECORD OF BOREHOLE No 136-03-2

1 OF 1

METRIC

W.P. 331-89-00 LOCATION WC 136-03; Sta. 10+825, O-S 3m Rt. ORIGINATED BY IK
 DIST 4 HWY QEW BOREHOLE TYPE Solid Stem, Cone Test COMPILED BY IK
 DATUM SEE TEXT DATE 94.08.11 & 94.08.11 CHECKED BY TO

SOIL PROFILE			SAMPLES			GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT		PLASTIC LIMIT W _p	NATURAL MOISTURE CONTENT W	LIQUID LIMIT W _L	UNIT WEIGHT γ kN/m ³	REMARKS & GRAIN SIZE DISTRIBUTION (%)
ELEV DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE	"N" VALUES			SHEAR STRENGTH kPa	WATER CONTENT (%)					
82.3	Ground Surface													
0.0	Mixture of Sand, Silt and Gravel. (Fill), compact		1	AS										
81.5														
0.8	Het. mixture of Silt and Clay, some sand, trace gravel (Glacial Till) Very Stiff to Hard		2	SS	15									
			3	SS	36									
			4	SS	45									
			5	SS	55									
			6	SS	36									
			7	SS	30									
			8	SS	28									
			9	SS	33									
74.1														
8.2	END OF BOREHOLE Borehole dry upon completion													

RECORD OF BOREHOLE No 136-03-3

1 OF 1

METRIC

W.P. 331-89-00 LOCATION WC 136-03; Sta. 10+825, O-S 22m Rt. ORIGINATED BY IK
DIST 4 HWY QEW BOREHOLE TYPE Solid Stem COMPILED BY IK
DATUM SEE TEXT DATE 94.08.11 & 94.08.11 CHECKED BY TO

SOIL PROFILE			SAMPLES			GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT		PLASTIC LIMIT W _p	NATURAL MOISTURE CONTENT W	LIQUID LIMIT W _L	UNIT WEIGHT γ kN/m ³	REMARKS & GRAIN SIZE DISTRIBUTION (%) GR SA SI CL
ELEV DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE	"N" VALUES			20 40 60 80 100	20 40 60 80 100					
81.6	Ground Surface													
81.6 0.1	Topsoil		1	SS	14									
	Het. mixture of Silt and Clay, some sand, trace gravel		2	SS	36								21.0	0 15 55 30
	(Glacial Till)		3	SS	45									
	Very Stiff to Hard		4	SS	50									
			5	SS	31									
	Brown Grey		6	SS	29									
			7	SS	27									
74.9	END OF BOREHOLE													
8.7	Borehole dry upon completion													

METRIC

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

RECORD OF BOREHOLE No 136-04-2

1 OF 1

METRIC

W.P. 331-89-00 LOCATION WC 136-04; Sta. 11+101, O-S 3m Rt. ORIGINATED BY IK
DIST 4 HWY QEW BOREHOLE TYPE Solid Stem, Cone Test COMPILED BY IK
DATUM SEE TEXT DATE 94.08.11 & 94.08.11 CHECKED BY TO

SOIL PROFILE			SAMPLES			GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT		PLASTIC LIMIT W _p	NATURAL MOISTURE CONTENT W	LIQUID LIMIT W _L	UNIT WEIGHT γ kN/m ³	REMARKS & GRAIN SIZE DISTRIBUTION (%) GR SA SI CL
ELEV DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE	"N" VALUES			SHEAR STRENGTH kPa						
82.7	Ground Surface													
82.8	75mm ASPHALT													
0.1	Brown Sand and Gravel (Fill)		1	SS	7									
82.2	Het. mixture of Silt and Clay, some sand, trace gravel		2	SS	7									
0.5	(Glacial Till)		3	SS	22									
	Very Stiff to Hard		4	SS	32									
	Brown Grey		5	SS	28									
			6	SS	50									
			7	SS	48									
			8	SS	34									
75.1			9	SS	36									
7.8	END OF BOREHOLE													

RECORD OF BOREHOLE No 136-04-3

1 OF 1

METRIC

W.P. 331-89-00 LOCATION WC 136-04; Sta. 11+101, O-S 23m Rt. ORIGINATED BY IK
DIST 4 HWY QEW BOREHOLE TYPE Solid Stem COMPILED BY IK
DATUM SFE TEXT DATE 94.08.12 & 94.08.12 CHECKED BY TO

SOIL PROFILE			SAMPLES			GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT		PLASTIC LIMIT W _p	NATURAL MOISTURE CONTENT W	LIQUID LIMIT W _L	UNIT WEIGHT γ	REMARKS & GRAIN SIZE DISTRIBUTION (%)
ELEV DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE	*N* VALUES			SHEAR STRENGTH kPa	WATER CONTENT (%)					
81.5	Ground Surface													
81.2	Topsoil		1	SS	34									
0.3	Het. mixture of Silt and Clay, some sand, trace gravel (Glacial Till) Very Stiff to Hard - medium to coarse gravel Brown Grey		2	SS	26									
			3	SS	38									
			4	SS	74	225mm								
			5	SS	44									
			6	SS	42									
75.0			7	SS	80	275mm								
6.5	END OF BOREHOLE Borehole dry upon completion													

×³, ×³: Numbers refer to
Sensitivity

20
15
10

(%) STRAIN AT FAILURE

RECORD OF BOREHOLE No 136-05-1

1 OF 1

METRIC

W.P. 331-89-00 LOCATION WC 136-05; Sta. 11+262, O-S 22m Lt. ORIGINATED BY IK
 DIST 4 HWY QEW BOREHOLE TYPE Solid Stem COMPILED BY IK
 DATUM SEE TEXT DATE 94.08.23 & 94.08.23 CHECKED BY TO

SOIL PROFILE			SAMPLES			GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT					UNIT WEIGHT γ kN/m ³	REMARKS & GRAIN SIZE DISTRIBUTION (%)
ELEV DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE	"N" VALUES			SHEAR STRENGTH kPa						
								20 40 60 80 100						
								PLASTIC LIMIT NATURAL MOISTURE CONTENT LIQUID LIMIT w _p ——— w ——— w _L						
								○ UNCONFINED × FIELD VANE ● QUICK TRIAXIAL × LAB VANE						
								20 40 60 80 100						
81.7	Ground Surface													
81.7	Topsoil		1	SS	11									
0.3	Het. mixture of Silt and Clay, some sand, trace gravel		2	SS	47		81							
	(Glacial Till)		3	SS	50		80							
	Very Stiff to Hard		4	SS	47		79							
			5	SS	39		78							
	Brown Grey		6	SS	24		77							
							76							
75.0			7	SS	33		75							
6.7	END OF BOREHOLE													
	Borehole dry upon completion													

RECORD OF BOREHOLE No 136-05-2

1 OF 1

METRIC

W.P. 331-89-00 LOCATION WC 136-05; Sta. 11+262, O-S 3m Rt. ORIGINATED BY IK
 DIST 4 HWY QEW BOREHOLE TYPE Solid Stem, Cone Test COMPILED BY IK
 DATUM SEE TEXT DATE 94.08.11 & 94.08.12 CHECKED BY TO

SOIL PROFILE			SAMPLES			GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT		PLASTIC LIMIT W _p	NATURAL MOISTURE CONTENT W	LIQUID LIMIT W _L	UNIT WEIGHT γ	REMARKS & GRAIN SIZE DISTRIBUTION (%)
ELEV DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE	"N" VALUES			SHEAR STRENGTH kPa	WATER CONTENT (%)					
82.9	Ground Surface													
82.9	Brown Sand (Fill)		1	SS	23									
0.3	Brown Silt (Fill), some sand, trace clay and gravel		2	SS	14									
	Compact													
81.1	Het. mixture of Silt and Clay, some sand, trace gravel		3	SS	34									
1.8	(Glacial Till)		4	SS	32									
	Very Stiff to Hard		5	SS	28									
			6	SS	52									
			7	SS	37									
			8	SS	28									
			9	SS	42									
74.7	END OF BOREHOLE													
8.2	Borehole dry upon completion													

RECORD OF BOREHOLE No 136-05-3

1 OF 1

METRIC

W.P. 331-89-00 LOCATION WC 136-05; Sta. 11+262, O-S 22m Rt. ORIGINATED BY JK
 DIST 4 HWY QEW BOREHOLE TYPE Solid Stem COMPILED BY JK
 DATUM SEE TEXT DATE 94.08.12 & 94.08.12 CHECKED BY TO

SOIL PROFILE			SAMPLES			GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT		PLASTIC LIMIT NATURAL MOISTURE CONTENT LIQUID LIMIT		UNIT WEIGHT γ kN/m ³	REMARKS & GRAIN SIZE DISTRIBUTION (%) GR SA SI CL
ELEV DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE	"N" VALUES			20 40 60 80 100	20 40 60 80 100	W _p W W _L	10 20 30		
82.2	Ground Surface												
82.1	75mm Topsoil		1	SS	12								0 15 59 26
0.1	Het. mixture of Silt and Clay, some sand, trace gravel (Glacial Till) Very Stiff to Hard - seams of silty sand Brown Grey		2	SS	25								
			3	SS	34								
			4	SS	50								
			5	SS	46								
			6	SS	32								
75.5			7	SS	32								
6.7	END OF BOREHOLE												

RECORD OF BOREHOLE No 136-06-1

1 OF 1

METRIC

W.P. 331-89-00 LOCATION WC 136-06; Sta. 11+446, O-S 23m Lt. ORIGINATED BY IK
DIST 4 HWY QEW BOREHOLE TYPE Solid Stem COMPILED BY IK
DATUM SEE TEXT DATE 94.08.23 & 94.08.23 CHECKED BY TO

SOIL PROFILE			SAMPLES			GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT					UNIT WEIGHT γ kN/m ³	REMARKS & GRAIN SIZE DISTRIBUTION (%)		
ELEV DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE	"N" VALUES			SHEAR STRENGTH kPa								
81.8	Ground Surface							20	40	60	80	100				
80.8	Topsoil		1	SS	6			20	40	60	80	100				
0.3	Het. mixture of Silt and Clay, some sand, trace gravel (Glacial Till) Very Stiff to Hard						81							22.0		
			2	SS	35											
			3	SS	34											
			4	SS	54											
			5	SS	47											
			6	SS	32											
			7	SS	31											
75.1																
6.7	END OF BOREHOLE															
	Borehole dry upon completion															

RECORD OF BOREHOLE No 136-06-2

1 OF 1

METRIC

W.P. 331-89-00 LOCATION WC 136-06; Sta. 11+446, O-S 3.0m Rt. ORIGINATED BY IK
DIST 4 HWY QEW BOREHOLE TYPE Solid Stem, Cone Test COMPILED BY IK
DATUM SEE TEXT DATE 94.08.11 & 94.08.11 CHECKED BY TO

SOIL PROFILE			SAMPLES			GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT		PLASTIC LIMIT W _P	NATURAL MOISTURE CONTENT W	LIQUID LIMIT W _L	UNIT WEIGHT γ kN/m ³	REMARKS & GRAIN SIZE DISTRIBUTION (%) GR SA SI CL
ELEV DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE	"N" VALUES			SHEAR STRENGTH kPa	WATER CONTENT (%)					
82.9	Ground Surface													
0.0	Mixture of Sand, Silt and Gravel (Fill), compact		1	SS	11									
82.3														
0.6	Het. mixture of Silt and Clay, some sand, trace gravel (Glacial Till)		2	SS	10									
	Very Stiff to Hard		3	SS	20									
			4	SS	28									
			5	SS	27									
			6	SS	40									
			7	SS	46									
			8	SS	38									
			9	SS	31									
75.3														
7.6	END OF BOREHOLE													
	Borehole dry upon completion													

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

RECORD OF BOREHOLE No 136-06-3

1 OF 1

METRIC

W.P. 331-89-00 LOCATION WC 136-06: Sta. 11+446, O-S 23m Rt. ORIGINATED BY IK
DIST 4 HWY QEW BOREHOLE TYPE Solid Stem COMPILED BY IK
DATUM SEE TEXT DATE 94.08.12 & 94.08.12 CHECKED BY TO

SOIL PROFILE			SAMPLES			GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT		PLASTIC LIMIT NATURAL MOISTURE CONTENT LIQUID LIMIT		UNIT WEIGHT γ kN/m ³	REMARKS & GRAIN SIZE DISTRIBUTION (%)
ELEV DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE	"N" VALUES			SHEAR STRENGTH kPa		WATER CONTENT (%)			
82.1	Ground Surface							20 40 60 80 100		W _p W W _L			
82.0	Topsoil		1	SS	2			20 40 60 80 100					
0.1	Het. mixture of Silt and Clay, some sand, trace gravel		2	SS	25								
	(Glacial Till)		3	SS	31								
	Very Stiff to Hard		4	SS	70	290mm							
			5	SS	35								
			6	SS	50	125mm							
			7	SS	28								
75.4													
6.7	END OF BOREHOLE												

RECORD OF BOREHOLE No 136-07-1

1 OF 1

METRIC

W.P. 331-89-00 LOCATION WC 136-07; Sta. 11+656, O-S 22m Lt. ORIGINATED BY IK
DIST 4 HWY QEW BOREHOLE TYPE Solid Stem COMPILED BY IK
DATUM SEE TEXT DATE 94.08.17 & 94.08.17 CHECKED BY TO

SOIL PROFILE			SAMPLES			GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT		PLASTIC LIMIT W _p	NATURAL MOISTURE CONTENT W	LIQUID LIMIT W _L	UNIT WEIGHT γ	REMARKS & GRAIN SIZE DISTRIBUTION (%)
ELEV DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE	"N" VALUES			SHEAR STRENGTH kPa						
82.5	Ground Surface							20 40 60 80 100						
82.4	50mm Topsoil		1	SS	3		82							
0.1	Het. mixture of Silt and Clay, some sand, trace gravel		2	SS	20		81							0 16 58 26
	(Glacial Till)		3	SS	23		80							
	Very Stiff to Hard		4	SS	50	100mm	79							
			5	SS	38		78							
			6	SS	40		77							
			7	SS	31		76							
75.8	END OF BOREHOLE													
6.7	Borehole dry upon completion													

x³, x³: Numbers refer to Sensitivity 20 15 10 (%) STRAIN AT FAILURE

RECORD OF BOREHOLE No 136-07-2

1 OF 1

METRIC

W.P. 331-89-00 LOCATION WC 136-07, Sta. 11+656, O-S 3m Rt. ORIGINATED BY IK
 DIST 4 HWY QEW BOREHOLE TYPE Solid Stem, Cone Test COMPILED BY IK
 DATUM SEE TEXT DATE 94.08.12 & 94.08.12 CHECKED BY TO

SOIL PROFILE			SAMPLES			GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT			UNIT WEIGHT γ kN/m ³	REMARKS & GRAIN SIZE DISTRIBUTION (%)
ELEV DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE	"N" VALUES			20 40 60 80 100	20 40 60 80 100	10 20 30		
83.1	Ground Surface											
0.0	Mixture of Sand, Silt and Gravel (Fill), compact		1	SS	10		83					
82.4												
0.7	Brown Silt (Fill), sandy and clayey, trace gravel, compact		2	SS	12		82					
81.5												
1.6	Het. mixture of silt and clay, some sand, trace gravel (Glacial till) Very stiff to hard Brown Grey		3	SS	27		81					
			4	SS	34		80					
			5	SS	63		79					
			6	SS	55		78					
			7	SS	48		77					
			8	SS	46		76					
			9	SS	68		75					
74.9												
8.2	END OF BOREHOLE Borehole dry upon completion											

\times^3, \times^3 : Numbers refer to
Sensitivity 20 15 10 (%) STRAIN AT FAILURE

RECORD OF BOREHOLE No 136-07-3

1 OF 1

METRIC

W.P. 331-89-00 LOCATION WC 136-07; Sta. 11+656, O-S 23m Rt. ORIGINATED BY IK
DIST 4 HWY QEW BOREHOLE TYPE Solid Stem COMPILED BY IK
DATUM SEE TEXT DATE 94.08.12 & 94.08.12 CHECKED BY TO

SOIL PROFILE			SAMPLES			GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT				PLASTIC LIMIT NATURAL MOISTURE CONTENT LIQUID LIMIT			UNIT WEIGHT γ kN/m ³	REMARKS & GRAIN SIZE DISTRIBUTION (%) GR SA SI CL
ELEV DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE	"N" VALUES			SHEAR STRENGTH kPa				WATER CONTENT (%)				
							20	40	60	80	100	W _P	W	W _L		
82.4	Ground Surface															
82.8	Topsoil		1	SS	6											
0.1	Het. mixture of Silt and Clay, some sand, trace gravel (Glacial Till) Very Stiff to Hard		2	SS	21											
			3	SS	52											
			4	SS	31											
			5	SS	31											
			6	SS	38											
			7	SS	28											
75.7																
6.7	END OF BOREHOLE Borehole dry upon completion															

RECORD OF BOREHOLE No 136-08-1

1 OF 1

METRIC

W.P. 331-89-00 LOCATION WC 136-08; Sta. 11+853, O-S 23m Lt. ORIGINATED BY IK
 DIST HWY QEW BOREHOLE TYPE Solid Stem COMPILED BY IK
 DATUM SEE TEXT DATE 94.08.17 & 94.08.17 CHECKED BY TO

SOIL PROFILE			SAMPLES			GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT				UNIT WEIGHT γ kN/m ³	REMARKS & GRAIN SIZE DISTRIBUTION (%)
ELEV DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE	"N" VALUES			SHEAR STRENGTH kPa					
82.9	Ground Surface							20 40 60 80 100					
0.0	Topsoil		1	SS	3			20 40 60 80 100					
82.3								20 40 60 80 100					
0.6	Het. mixture of Silt and Clay, some sand, trace gravel (Glacial Till) Very Stiff to Hard		2	SS	26		82						
			3	SS	35		81						1 15 55 29
			4	SS	42		80						
			5	SS	57		79						
			6	SS	71		78						
							77						
76.2			7	SS	46								
6.7	END OF BOREHOLE Borehole dry upon completion												

$\times^3 \cdot \times^3$: Numbers refer to
Sensitivity

20
15
10

(%) STRAIN AT FAILURE

RECORD OF BOREHOLE No 136-08-2

1 OF 1

METRIC

W.P. 331-89-00 LOCATION WC 136-08; Sta. 11+853, O-S 3m Rt. ORIGINATED BY IK
DIST HWY QEW BOREHOLE TYPE Solid Stem, Cone Test COMPILED BY IK
DATUM SEE TEXT DATE 94.08.12 & 94.08.12 CHECKED BY TO

SOIL PROFILE			SAMPLES			GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT		PLASTIC LIMIT W _p	NATURAL MOISTURE CONTENT W	LIQUID LIMIT W _L	UNIT WEIGHT γ kN/m ³	REMARKS & GRAIN SIZE DISTRIBUTION (%) GR SA SI CL
ELEV DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE	"N" VALUES			SHEAR STRENGTH kPa	WATER CONTENT (%)					
83.4	Ground Surface													
0.0	Mixture of Sand, Silt and Gravel (Fill), loose		1	SS	8									
82.5														
0.9	Het. mixture of Silt and Clay, some sand, trace gravel (Glacial Till) Very Stiff to Hard		2	SS	5									
			3	SS	34									
			4	SS	48									
			5	SS	60									
			6	SS	36									
			7	SS	44									
			8	SS	30									
			9	SS	65									
75.8														
7.6	END OF BOREHOLE Borehole dry upon completion													

RECORD OF BOREHOLE No 136-08-3

1 OF 1

METRIC

W.P. 331-89-00 LOCATION WC 136-08; Sta. 11+853, O-S 23m Rt. ORIGINATED BY IK
 DIST HWY QFW BOREHOLE TYPE Solid Stem COMPILED BY IK
 DATUM SEE TEXT DATE 94.08.12 & 94.08.12 CHECKED BY TO

SOIL PROFILE			SAMPLES			GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT		PLASTIC LIMIT W _p	NATURAL MOISTURE CONTENT W	LIQUID LIMIT W _L	UNIT WEIGHT γ	REMARKS & GRAIN SIZE DISTRIBUTION (%)					
ELEV DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE	"N" VALUES			20	40						60	80	100	20	40
82.5	Ground Surface																		
82.2	Topsoil		1	SS	26														
0.3	Het. mixture of Silt and Clay, some sand, trace gravel (Glacial Till) Very Stiff to Hard		2	SS	44														
			3	SS	67	125mm													
			4	SS	72														
			5	SS	47														
			6	SS	50	125mm													
77.0																			
5.5	Shale, Bedrock																		
76.3	Poor to Fair		7	SS	50	75mm													
6.2	END OF BOREHOLE																		
	Borehole dry upon completion																		

RECORD OF BOREHOLE No 136-09-1

1 OF 1

METRIC

W.P. 331-89-00 LOCATION WC 136-09; Sta. 12+059, O-S 34m Lt. ORIGINATED BY IK
DIST 4 HWY QEW BOREHOLE TYPE Solid Stem COMPILED BY IK
DATUM SEE TEXT DATE 94.08.17 & 94.08.17 CHECKED BY TO

SOIL PROFILE			SAMPLES			GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT			UNIT WEIGHT kN/m ³	REMARKS & GRAIN SIZE DISTRIBUTION (%)
ELEV DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE	*N* VALUES			SHEAR STRENGTH kPa ○ UNCONFINED × FIELD VANE ● QUICK TRIAXIAL × LAB VANE				
82.8	Ground Surface											
82.8 0.2	Topsoil		1	SS	8							
	Het. mixture of Silt and Clay, some sand, trace gravel		2	SS	54							
	(Glacial Till)		3	SS	36							
	Very Stiff to Hard		4	SS	66							
	Brown		5	SS	44							
			6	SS	51							
77.6												
5.3	Shale Bedrock											
76.6	Poor to Fair		7	SS	50	75mm						
6.2	END OF BOREHOLE											
	Borehole dry upon completion											

*³ . *³ : Numbers refer to
Sensitivity

20
15
10

(%) STRAIN AT FAILURE

RECORD OF BOREHOLE No 136-09-2

1 OF 1

METRIC

W.P. 331-89-00 LOCATION WC 136-09; Sta. 12+059, O-S 3m Rt. ORIGINATED BY IK
DIST HWY QEW BOREHOLE TYPE Solid Stem, Cone Test COMPILED BY IK
DATUM SEE TEXT DATE 94.08.12 & 94.08.12 CHECKED BY TO

SOIL PROFILE			SAMPLES			GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT	PLASTIC LIMIT w _p	NATURAL MOISTURE CONTENT w	LIQUID LIMIT w _L	UNIT WEIGHT γ kN/m ³	REMARKS & GRAIN SIZE DISTRIBUTION (%) GR SA SI CL
ELEV DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE	*N* VALUES								
83.7	Ground Surface												
0.0	Mixture of Sand, Silt and Gravel (Fill), compact.		1	SS	14								
82.8													
0.9	Het. mixture of Silt and Clay, some sand, trace gravel (Glacial Till) Very Stiff to Hard Brown		2	SS	13								0 11 56 33
			3	SS	29								
			4	SS	35								
			5	SS	95								
			6	SS	70								
78.6			7	SS	91								
5.2	Shale Bedrock Poor to Fair		8	SS	100	75mm							
			9	SS	100	63mm							
76.4													
7.3	END OF BOREHOLE Borehole dry upon completion												




x³, x³: Numbers refer to Sensitivity 20 15 10 (%) STRAIN AT FAILURE

RECORD OF BOREHOLE No 136-09-3

1 OF 1

METRIC

W.P. 331-89-00 LOCATION WC 136-09; Sta. 12+059, O-S 24m Rt. ORIGINATED BY IK
 DIST HWY QEW BOREHOLE TYPE Solid Stem COMPILED BY IK
 DATUM SEE TEXT DATE 94.08.15 & 94.08.15 CHECKED BY TO

SOIL PROFILE			SAMPLES			GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT			UNIT WEIGHT γ kN/m ³	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		
83.3	Ground Surface											
0.0	Topsoil		1	SS	5		83					
82.6												
0.8	Het. mixture of Silt and Clay, some sand, trace gravel		2	SS	27		82					
	(Glacial Till)		3	SS	50							
	Very Stiff to Hard						81					
	Brown		4	SS	74							
80.3												
3.1	Shale		5	SS	50	125mm	80					
	Bedrock		6	SS	50	100mm	79					
	Poor to Fair						78					
							77					
76.6			7	SS	50	25mm						
6.7	END OF BOREHOLE											
	Borehole dry upon completion											

RECORD OF BOREHOLE No 136-10-1

1 OF 1

METRIC

W.P. 331.89.00 LOCATION WC 136-10; Sta. 12+347, D-S 24m Lt. ORIGINATED BY IK
 DIST 4 HWY QEW BOREHOLE TYPE Solid Stem, N-Casing, Rock Coring COMPILED BY IK
 DATUM SEE TEXT DATE 94.08.18 & 94.08.18 CHECKED BY TO

SOIL PROFILE			SAMPLES			GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT					UNIT WEIGHT γ kN/m ³	REMARKS & GRAIN SIZE DISTRIBUTION (%) GR SA SI CL	
ELEV DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE	*N* VALUES			SHEAR STRENGTH kPa ○ UNCONFINED ✕ FIELD VANE ● QUICK TRIAXIAL ✕ LAB VANE							WATER CONTENT (%) w _p w w _L
83.5	Ground Surface							20	40	60	80	100			
83.5	Topsoil		1	SS	4		83								
0.1	Het. mixture of silt and clay, some sand, trace gravel (Glacial Till), Very Stiff to Hard, brown		2	SS	80										
82.1	Shale		3	SS	50	150mm	82								
1.5	Bedrock		4	SS	50	150mm	81								
	Poor to Fair		5	NQ RC	REC 97%		80								RQD = 65%
			6	NQ RC	REC 100%		79								
							78								RQD = 73%
77.4															
6.1	END OF BOREHOLE														

RECORD OF BOREHOLE No 136-10-2

1 OF 1

METRIC

W.P. 331-89-00 LOCATION WC 136-10; Sta. 12+347, O-S 3m Rt. ORIGINATED BY IK
DIST 4 HWY QEW BOREHOLE TYPE Solid Stem, Cone Test COMPILED BY IK
DATUM SEE TEXT DATE 94.08.16 & 94.08.16 CHECKED BY TO

SOIL PROFILE			SAMPLES			GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT		PLASTIC LIMIT w _p	NATURAL MOISTURE CONTENT w	LIQUID LIMIT w _L	UNIT WEIGHT γ	REMARKS & GRAIN SIZE DISTRIBUTION (%)
ELEV DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE	"N" VALUES			SHEAR STRENGTH kPa						
84.4	Ground Surface							20 40 60 80 100						
0.0	Mixture of Sand, Silt and Gravel (Fill) Compact		1	SS	9			20 40 60 80 100						
83.4			2	SS	20									
1.1	Shale		3	SS	100	250mm								
	Bedrock		4	SS	60	125mm								
	Poor to Fair		5	SS	50	75mm								
			6	SS	60	50mm								
			7	SS	60	63mm								
			8	SS	65	25mm								
76.8			9	SS	70	25mm								
7.7	END OF BOREHOLE													
	Borehole dry upon completion													

RECORD OF BOREHOLE No 136-10-3

1 OF 1

METRIC

W.P. 331-89-00 LOCATION WC 136-10; Sta. 12+347, O-S 30m Rt. ORIGINATED BY IK
 DIST 4 HWY QEW BOREHOLE TYPE Solid Stem COMPILED BY IK
 DATUM SEE TEXT DATE 94.08.15 & 94.08.15 CHECKED BY TO

SOIL PROFILE			SAMPLES			GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT			UNIT WEIGHT γ kN/m ³	REMARKS & GRAIN SIZE DISTRIBUTION (%)
ELEV DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE	"N" VALUES			SHEAR STRENGTH kPa				
83.0	Ground Surface						83	20 40 60 80 100				
0.0	Het. mixture of Silt and Clay, some sand, trace gravel		1	SS	9			○ UNCONFINED × FIELD VANE ● QUICK TRIAXIAL × LAB VANE				
82.6	(Glacial Till), very stiff to hard, brown		2	SS	50	50mm	82	20 40 60 80 100			10 20 30	0 23 73 5
0.5	Shale		3	SS	50	100mm	81					
	Bedrock		4	SS	50	125mm	80					
	Poor to Fair		5	SS	50	25mm	79					
			6	SS	50	25mm	78					
			7	SS	50	25mm	77					
76.3												
6.7	END OF BOREHOLE											
	Borehole dry upon completion											

RECORD OF BOREHOLE No 136-11-1

1 OF 1

METRIC

W.P. 331-89-00 LOCATION WC 136-11; Sta. 12+675, O-S 25m Lt. ORIGINATED BY IK
DIST 4 HWY QEW BOREHOLE TYPE Solid Stem, N-Casing, Rock Coring COMPILED BY IK
DATUM SEE TEXT DATE 94.08.17 & 94.08.18 CHECKED BY TO

SOIL PROFILE		SAMPLES			GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT		PLASTIC LIMIT w _p	NATURAL MOISTURE CONTENT w	LIQUID LIMIT w _L	UNIT WEIGHT γ kN/m ³	REMARKS & GRAIN SIZE DISTRIBUTION (%) GR SA SI CL							
ELEV DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE			"N" VALUES	SHEAR STRENGTH kPa						WATER CONTENT (%)						
						20	40	60	80	100	20	40	60	80	100	10	20	30		
83.3	Ground Surface																			
83.3 0.2	Topsoil		1	SS	5															
	Het. mixture of Silt and Clay, some sand, trace gravel (Glacial Till), very stiff to hard, brown		2	SS	22															
81.8	Shale		3	SS	50	100mm														
1.5	Bedrock		4	SS	50	50mm														
	Fair to Good																			
			5	NQ RC	REC 97%															ROD = 88%
			6	NQ RC	REC 100%															ROD = 70%
77.1																				
6.2	END OF BOREHOLE																			

RECORD OF BOREHOLE No 136-11-2

1 OF 1

METRIC

W.P. 331-89-00 LOCATION WC 136-11; Sta. 12+675, O.S. 3m Rt. ORIGINATED BY IK
 DIST HWY QEW BOREHOLE TYPE Solid Stem, Cone Test COMPILED BY IK
 DATUM SEE TEXT DATE 94.08.16 & 94.08.16 CHECKED BY TO

SOIL PROFILE			SAMPLES			GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT		PLASTIC LIMIT W _p	NATURAL MOISTURE CONTENT W	LIQUID LIMIT W _L	UNIT WEIGHT γ	REMARKS & GRAIN SIZE DISTRIBUTION (%)
ELEV DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE	*N* VALUES			SHEAR STRENGTH kPa						
84.8	Ground Surface							20 40 60 80 100	20 40 60 80 100	10 20 30				
0.0	Mixture of Sand, Silt and Gravel (Fill), trace clay, compact		1	SS	10			○ UNCONFINED × FIELD VANE						
			2	SS	10			● QUICK TRIAXIAL × LAB VANE						
82.8			3	SS	15									
2.0	Shale		4	SS	60	125mm								
	Bedrock		5	SS	60	60mm								
	Poor to Fair		6	SS	60	63mm								
			7	SS	60	63mm								
			8	SS	60	60mm								
77.1			9	SS	60	50mm								
7.7	END OF BOREHOLE													
	Borehole dry upon completion													

RECORD OF BOREHOLE No 136-11-3

1 OF 1

METRIC

W.P. 331-89-00 LOCATION WC 136-11; Sta. 12+675, O-S 32m Rt. ORIGINATED BY IK
DIST 4 HWY QEW BOREHOLE TYPE Solid Stem COMPILED BY IK
DATUM SEE TEXT DATE 94.08.15 & 94.08.15 CHECKED BY TO

SOIL PROFILE			SAMPLES			GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT		PLASTIC LIMIT W _p	NATURAL MOISTURE CONTENT W	LIQUID LIMIT W _L	UNIT WEIGHT γ	REMARKS & GRAIN SIZE DISTRIBUTION (%)
ELEV DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE	"N" VALUES			SHEAR STRENGTH kPa	WATER CONTENT (%)					
84.5	Ground Surface													
84.8	Topsoil		1	SS	7									
0.2	Het. mixture of Silt and Clay, some sand, trace gravel (Glacial Till), very stiff to hard		2	SS	50	25mm								
83.0			3	SS	50	75mm								
1.5	Shale		4	SS	50	25mm								
	Bedrock		5	SS	50	25mm								
	Poor to Fair		6	SS	50	25mm								
			7	SS	50	100mm								
77.8														
6.7	END OF BOREHOLE													

RECORD OF BOREHOLE No 136-12-1

1 OF 1

METRIC

W.P. 331-89-00 LOCATION WC 136-12; Sta. 12+885, O-S 36m Lt. ORIGINATED BY IK
 DIST HWY QEW BOREHOLE TYPE Solid Stem COMPILED BY IK
 DATUM SEE TEXT DATE 94.08.17 & 94.08.17 CHECKED BY TO

SOIL PROFILE			SAMPLES			GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT		PLASTIC LIMIT W _p	NATURAL MOISTURE CONTENT W	LIQUID LIMIT W _L	UNIT WEIGHT γ kN/m ³	REMARKS & GRAIN SIZE DISTRIBUTION (%) GR SA SI CL
ELEV DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE	*N* VALUES			SHEAR STRENGTH kPa						
83.0	Ground Surface						83	20 40 60 80 100	20 40 60 80 100					
82.8	Topsoil		1	SS	37									
0.2	Shale		2	SS	50	100mm	82							
	Bedrock													
	Poor to Fair		3	SS	50	100mm	81							
			4	SS	50	100mm	80							
			5	SS	50	40mm	79							
			6	SS	50	40mm	78							

RECORD OF BOREHOLE No 136-12-2

1 OF 1

METRIC

W.P. 331-89-00 LOCATION WC 136-12; Sta. 12+885, O-S 3m Rt. ORIGINATED BY IK
DIST 4 HWY QEW BOREHOLE TYPE Solid Stem, Cone Test COMPILED BY IK
DATUM SEE TEXT DATE 94.08.17 & 94.08.17 CHECKED BY TO



SOIL PROFILE			SAMPLES			GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT		PLASTIC LIMIT w _p	NATURAL MOISTURE CONTENT w	LIQUID LIMIT w _L	UNIT WEIGHT γ	REMARKS & GRAIN SIZE DISTRIBUTION (%)
ELEV DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE	"N" VALUES			SHEAR STRENGTH kPa	WATER CONTENT (%)					
84.5	Ground Surface													
0.0	Mixture of Sand, Silt and Gravel (Fill), compact		1	SS	20									
83.7														
0.8	Clayey Silt (Fill), trace sand, very stiff, brown		2	SS	25									
82.9														
1.7	Shale		3	SS	35									
	Bedrock		4	SS	70	100mm								
	Poor to Fair		5	SS	60	25mm								
			6	SS	70	125mm								
			7	SS	60	100mm								
			8	SS	60	50mm								
76.8			9	SS	60	50mm								
7.7	END OF BOREHOLE													

RECORD OF BOREHOLE No 136-12-3

1 OF 1

METRIC

W.P. 331-89-00 LOCATION WC 136-12; Sta. 12+885, O-S 26m Rt. ORIGINATED BY IK
 DIST HWY OFW BOREHOLE TYPE Solid Stem COMPILED BY IK
 DATUM SEE TEXT DATE 94.08.15 & 94.08.15 CHECKED BY TO

SOIL PROFILE			SAMPLES			GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT			UNIT WEIGHT γ kN/m ³	REMARKS & GRAIN SIZE DISTRIBUTION (%) GR SA SI CL
ELEV DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE	"N" VALUES			SHEAR STRENGTH kPa				
								20 40 60 80 100				
83.7	Ground Surface											
0.0	Het. mixture of Silt and Clay, some sand, trace gravel (Glacial Till) Very Stiff to Hard		1	SS	12		83					0 17 65 18
82.2			2	SS	76							
1.5	Shale		3	SS	50	75mm	82					
	Bedrock											
	Poor to Fair		4	SS	50	10mm	81					
			5	SS	50	10mm	80					
			6	SS	50	10mm	79					
							78					
77.5												
6.3	END OF BOREHOLE											
	Borehole dry upon completion											

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

20
15
10

(%) STRAIN AT FAILURE

RECORD OF BOREHOLE No 136-13-1

1 OF 1

METRIC

W.P. 331-89-00 LOCATION WC 136-13; Sta. 13+085, O-S 32m Lt. ORIGINATED BY IK
DIST 4 HWY QEW BOREHOLE TYPE Solid Stem COMPILED BY IK
DATUM SEE TEXT DATE 94.08.17 & 94.08.17 CHECKED BY TO

SOIL PROFILE			SAMPLES			GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT			UNIT WEIGHT γ kN/m ³	REMARKS & GRAIN SIZE DISTRIBUTION (%)
ELEV DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE	"N" VALUES			SHEAR STRENGTH kPa				
82.5	Ground Surface							20 40 60 80 100				
82.2	Topsoil		1	SS	6							
0.3	Het. mixture of Silt and Clay, some sand, trace gravel		2	SS	20		82					
	(Glacial Till)						81					
	Very Stiff to Hard		3	SS	13							
	Brown		4	SS	15		80					
			5	SS	32		79					
78.3			6	SS	33		78					
4.3	Shale											
	Bedrock											
	Poor to Fair						77					
76.3			7	SS	50	100mm						
6.2	END OF BOREHOLE											
	Borehole dry upon completion											

x³, x³: Numbers refer to Sensitivity 20 15 10 (%) STRAIN AT FAILURE

RECORD OF BOREHOLE No 136-13-2

1 OF 1

METRIC

W.P. 331-89-00 LOCATION WC 136-13; Sta. 13+085, O-S 3m Lt. ORIGINATED BY IK
DIST HWY QFW BOREHOLE TYPE Solid Stem, Cone Test COMPILED BY IK
DATUM SEE TEXT DATE 94.08.12 & 94.08.12 CHECKED BY TO

SOIL PROFILE			SAMPLES			GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT		PLASTIC LIMIT w _p	NATURAL MOISTURE CONTENT w	LIQUID LIMIT w _L	UNIT WEIGHT γ	REMARKS & GRAIN SIZE DISTRIBUTION (%)	
ELEV DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE	"N" VALUES			SHEAR STRENGTH kPa							WATER CONTENT (%)
								○ UNCONFINED	× FIELD VANE						
83.7	Ground Surface							20 40 60 80 100	20 40 60 80 100	10 20 30	kN/m ³	GR SA SI CL			
0.0	Silty Sand (Fill), some gravel, compact Brown		1	SS	9										
82.6															
1.1	Het. mixture of Silt and Clay, some sand, trace gravel (Glacial Till) Very Stiff to Hard		2	SS	13										
			3	SS	17										
			4	SS	20										
			5	SS	25										
			6	SS	39										
79.0			7	SS	70	38mm									
4.7	Shale Bedrock Poor to Fair		8	SS	100	75mm									
			9	SS	100	75mm									
76.2															
7.6	END OF BOREHOLE Borehole dry upon completion														

x³ . x³ : Numbers refer to Sensitivity 20 15 10 5 0 (%) STRAIN AT FAILURE

RECORD OF BOREHOLE No 136-13-3

1 OF 1

METRIC

W.P. 331-89-00 LOCATION WC 136-13; Sta. 13+085, O-S 47m Rt. ORIGINATED BY IK
DIST HWY QEW BOREHOLE TYPE Solid Stem COMPILED BY IK
DATUM SEE TEXT DATE 94.08.15 & 94.08.15 CHECKED BY TO

SOIL PROFILE			SAMPLES			GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT					PLASTIC LIMIT W _P	NATURAL MOISTURE CONTENT W	LIQUID LIMIT W _L	UNIT WEIGHT γ kN/m ³	REMARKS & GRAIN SIZE DISTRIBUTION (%) GR SA SI CL
ELEV DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE	"N" VALUES			20	40	60	80	100					
82.8	Ground Surface		1	SS	4												
0.0	Het. mixture of Silt and Clay, some sand, trace gravel (Glacial Till) Very Stiff to Hard Brown Grey		2	SS	4												
			3	SS	18												
			4	SS	50												
79.6			5	SS	50	50mm											
3.3	Shale Bedrock Poor to Fair		6	SS	50	135mm											
			7	SS	50	75mm											
76.2																	
6.7	END OF BOREHOLE																

METRIC

DATUM SEE TEXT DATE 94.08.16 & 94.08.16 CHECKED BY TO

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

RECORD OF BOREHOLE No 136-14-2

1 OF 1

METRIC

W.P. 331-89-00 LOCATION WC 136-14; Sta. 13+278, O-S 3m Lt. ORIGINATED BY IK
DIST HWY QEW BOREHOLE TYPE Solid Stem, Cone Test COMPILED BY IK
DATUM SEE TEXT DATE 84.08.13 & 94.08.13 CHECKED BY TO

SOIL PROFILE			SAMPLES			GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT		PLASTIC LIMIT W _p	NATURAL MOISTURE CONTENT W	LIQUID LIMIT W _L	UNIT WEIGHT γ	REMARKS & GRAIN SIZE DISTRIBUTION (%)
ELEV DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE	"N" VALUES			SHEAR STRENGTH kPa	WATER CONTENT (%)					
83.7	Ground Surface													
83.6	100mm Asphalt													
0.1	Mixture of Sand, Silt and Gravel (Fill), loose, brown		1	SS	9									
82.6														
1.1	Het. mixture of Silt and Clay, some sand, trace gravel		2	SS	8									
	(Glacial Till)		3	SS	19									
	Very Stiff to Hard		4	SS	29									
	Brown		5	SS	18									
			6	SS	8									
			7	SS	7									
			8	SS	130									
			9	SS	37									
76.1														
7.6	END OF BOREHOLE													
	Borehole dry upon completion													

RECORD OF BOREHOLE No 136-14-3

1 OF 1

METRIC

W.P. 331-89-00 LOCATION WC 136-14; Sta. 13+278, O-S 34m Rt. ORIGINATED BY IK
DIST 4 HWY QEW BOREHOLE TYPE Solid Stem COMPILED BY IK
DATUM SEE TEXT DATE 94.08.15 & 94.08.15 CHECKED BY TO

SOIL PROFILE			SAMPLES			GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT					UNIT WEIGHT γ kN/m ³	REMARKS & GRAIN SIZE DISTRIBUTION (%)
ELEV DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE	"N" VALUES			20	40	60	80	100		
83.0	Ground Surface						83							
82.9	Topsoil		1	SS	10		82							
0.3	Het. mixture of Silt and Clay, some sand, trace gravel (Glacial Till) Very Stiff to Hard Brown Grey		2	SS	27		81							
			3	SS	31		80							
			4	SS	25		79							
			5	SS	15		78							
			6	SS	12		77							
76.3			7	SS	45									
6.7	END OF BOREHOLE Borehole dry upon completion													

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

20
15
10
(%) STRAIN AT FAILURE

RECORD OF BOREHOLE No 136-15-1

1 OF 1

METRIC

W.P. 331-89-00 LOCATION WC 136-15; Sta. 13+499, O-S 23m Lt. ORIGINATED BY IK
DIST HWY QEW BOREHOLE TYPE Solid Stem COMPILED BY IK
DATUM SEE TEXT DATE 94.08.16 & 94.08.16 CHECKED BY TO

SOIL PROFILE			SAMPLES			GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT			PLASTIC LIMIT w _p	NATURAL MOISTURE CONTENT w	LIQUID LIMIT w _L	UNIT WEIGHT γ kN/m ³	REMARKS & GRAIN SIZE DISTRIBUTION (%) GR SA SI CL
ELEV DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE	"N" VALUES			20	40	60					
82.6	Ground Surface														
82.6 0.1	Topsoil		1	SS	9										
	Het. mixture of Silt and Clay, some sand, trace gravel		2	SS	32										
	(Glacial Till)		3	SS	28										
	Very Stiff to Hard		4	SS	17										
	Brown Grey		5	SS	11										
			6	SS	11										
			7	SS	41										
75.9	END OF BOREHOLE														
6.7	Borehole dry upon completion														

RECORD OF BOREHOLE No 136-15-2

1 OF 1

METRIC

W.P. 331-89-00 LOCATION WC 136-15; Sta. 13+489, O-S 3m Lt. ORIGINATED BY IK
 DIST 4 HWY QEW BOREHOLE TYPE Solid Stem, Cone Test COMPILED BY IK
 DATUM SEE TEXT DATE 94.08.12 & 94.08.12 CHECKED BY TO

SOIL PROFILE			SAMPLES			GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT		PLASTIC LIMIT WP	NATURAL MOISTURE CONTENT W	LIQUID LIMIT WL	UNIT WEIGHT γ	REMARKS & GRAIN SIZE DISTRIBUTION (%)					
ELEV DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE	*N* VALUES			20	40						60	80	100	20	40
83.6	Ground Surface																		
83.6	50mm Asphalt																		
0.1	Mixture of Sand and Gravel (Fill), trace silt, compact		1	SS	13														
83.2	Het. mixture of Silt and Clay, some sand, trace gravel		2	SS	6														
0.5	(Glacial Till)		3	SS	21														
	Very Stiff to Hard		4	SS	31														
	Brown Grey		5	SS	22														
			6	SS	16														
			7	SS	9														
			8	SS	27														
			9	SS	29														
76.0	END OF BOREHOLE																		
7.6	Borehole dry upon completion																		

RECORD OF BOREHOLE No 136-15-3

1 OF 1

METRIC

W.P. 331-89-00 LOCATION WC 136-15; Sta. 13+499, O-S 21m Rt. ORIGINATED BY IK
 DIST HWY QEW BOREHOLE TYPE Solid Stem COMPILED BY IK
 DATUM SEE TEXT DATE 94.08.15 & 94.08.15 CHECKED BY TO

SOIL PROFILE			SAMPLES			GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT			UNIT WEIGHT γ kN/m ³	REMARKS & GRAIN SIZE DISTRIBUTION (%) GR SA SI CL		
ELEV DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE	"N" VALUES			SHEAR STRENGTH kPa						
								20 40 60 80 100						
								UNCONFINED FIELD VANE QUICK TRIAXIAL LAB VANE						
								WATER CONTENT (%)						
								20 40 60 80 100						
								10 20 30						
82.5	Ground Surface													
82.4	Topsoil		1	SS	7		82							
0.1	Het. mixture of Silt and Clay, some sand, trace gravel		2	SS	35		81							
	(Glacial Till)		3	SS	28		80							
	Very Stiff to Hard		4	SS	24		79							
	Brown Grey		5	SS	14		78							
			6	SS	23		77							
			7	SS	46		76							
75.8														
6.7	END OF BOREHOLE													
	Borehole dry upon completion													

RECORD OF BOREHOLE No 136-16-1

1 OF 1

METRIC

W.P. 331-89-00 LOCATION WC 136-16; Sta. 13+817, O-S 27m Lt. ORIGINATED BY IK
 DIST HWY QEW BOREHOLE TYPE Solid Stem COMPILED BY IK
 DATUM SEE TEXT DATE 94.08.16 & 94.08.16 CHECKED BY TO

SOIL PROFILE			SAMPLES			GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT			UNIT WEIGHT γ kN/m ³	REMARKS & GRAIN SIZE DISTRIBUTION (%)
ELEV DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE	*N* VALUES			SHEAR STRENGTH kPa ○ UNCONFINED × FIELD VANE ● QUICK TRIAXIAL × LAB VANE				
83.4	Ground Surface											
83.4 0.2	Topsoil		1	SS	7		83					
	Mixture of Sand, Silt and Gravel (Fill), loose		2	SS	6		82					
82.0												
1.4	Het. mixture of Silt and Clay, some sand, trace gravel (Glacial Till) Very Stiff to Hard Grey		3	SS	28		81					
			4	SS	37		80					
			5	SS	58		79					
79.2			6	SS	55		78					
4.2	Shale											
	Bedrock											
	Poor to Fair											
77.2			7	SS	50	150mm						
6.3	END OF BOREHOLE											

RECORD OF BOREHOLE No 136-16-2

1 OF 1

METRIC

W.P. 331-89-00 LOCATION WC 136-16; Sta. 13+817, O-S 3m Lt. ORIGINATED BY IK
DIST HWY QEW BOREHOLE TYPE Solid Stem, Cone Test COMPILED BY IK
DATUM SEE TEXT DATE 94.08.12 & 94.08.12 CHECKED BY TO

SOIL PROFILE			SAMPLES			GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT		PLASTIC LIMIT NATURAL MOISTURE CONTENT		UNIT WEIGHT γ kN/m ³	REMARKS & GRAIN SIZE DISTRIBUTION (%)
ELEV DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE	"N" VALUES			SHEAR STRENGTH kPa		WATER CONTENT (%)			
84.7	Ground Surface							20 40 60 80 100		10 20 30			
0.0	Mixture of Sand, Silt and Gravel (Fill) Loose to Compact		1	SS	19								
			2	SS	10								
			3	SS	6								
82.2			4	SS	15								
2.6	Het. mixture of Silt and Clay, some sand, trace gravel (Glacial Till) Very Stiff to Hard Grey		5	SS	60	125mm							
			6	SS	60	125mm							
			7	SS	60	125mm							
78.7			8	SS	60	10mm							
6.1	Shale Bedrock Poor to Fair												
			9	SS	60	25mm							
76.5													
8.2	END OF BOREHOLE												

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

RECORD OF BOREHOLE No 136-16-3

1 OF 1

METRIC

W.P. 331-89-00 LOCATION WC 136-16; Sta. 13+817, O-S 29m Rt. ORIGINATED BY IK
 DIST HWY QEW BOREHOLE TYPE Solid Stem COMPILED BY IK
 DATUM SEE TEXT DATE 94.08.16 & 94.08.16 CHECKED BY TO

SOIL PROFILE			SAMPLES			GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT				PLASTIC LIMIT W _p	NATURAL MOISTURE CONTENT W	LIQUID LIMIT W _L	UNIT WEIGHT γ kN/m ³	REMARKS & GRAIN SIZE DISTRIBUTION (%) GR SA SI CL	
ELEV DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE	"N" VALUES			SHEAR STRENGTH kPa									
83.2	Ground Surface						20	40	60	80	100						
83.1	Topsoil		1	SS	8												
0.1	Silty Sand (Fill), some gravel Loose Brown		2	SS	7												
81.7			3	SS	22												
1.5	Het. mixture of Silt and Clay, some sand, trace gravel (Glacial Till) Very Stiff to Hard Brown		4	SS	60												
79.9			5	SS	100		250mm										
3.3	Shale		6	SS	100	10mm											
	Bedrock																
	Poor to Fair																
77.1			7	SS	50	80mm											
6.2	END OF BOREHOLE																

x³. x³: Numbers refer to
Sensitivity

20
15
10
(%) STRAIN AT FAILURE

RECORD OF BOREHOLE No 138-06-1

1 OF 1

METRIC

W.P. 333-89-00 LOCATION WC 138-06; Sta. 12+489, O-S 42m Lt. ORIGINATED BY IK
DIST 4 HWY QEW BOREHOLE TYPE Solid Stem COMPILED BY IK
DATUM SEE TEXT DATE 94.08.25 & 94.08.25 CHECKED BY TO

SOIL PROFILE			SAMPLES			GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT				UNIT WEIGHT γ kN/m ³	REMARKS & GRAIN SIZE DISTRIBUTION (%)
ELEV DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE	"N" VALUES			SHEAR STRENGTH kPa					
85.7	Ground Surface							20 40 60 80 100					
85.6	Topsoil		1	SS	28		85						
0.1	Silt (Fill), some sand and clay, trace gravel		2	SS	26		84						
	Compact		3	SS	30		83						
	Brown		4	SS	20		82						
82.7			5	SS	23		81						
3.0	Silt, some sand and clay		6	SS	18		80						
	Compact		7	SS	17		79						
	Brown						78						
79.6			8	SS	11		77						
6.1	Silt and Clay, some sand		9	SS	18		76						
	Stiff to Very Stiff		10	SS	20		75						
			11	SS	25		74						
			12	SS	24		73						
72.9													
12.8	END OF BOREHOLE												

x³, x³: Numbers refer to Sensitivity 20 15 10 (%) STRAIN AT FAILURE

RECORD OF BOREHOLE No 138-06-2

1 OF 1

METRIC

W.P. 333-89-00 LOCATION WC 138-06; Sta. 12 + 489, O-S 3m Rt. ORIGINATED BY JK
DIST 4 HWY QEW BOREHOLE TYPE Solid Stem, Cone Test COMPILED BY JK
DATUM SEE TEXT DATE 94.08.17 & 94.08.17 CHECKED BY TO

SOIL PROFILE			SAMPLES			GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT		PLASTIC LIMIT W _p	NATURAL MOISTURE CONTENT W	LIQUID LIMIT W _L	UNIT WEIGHT γ	REMARKS & GRAIN SIZE DISTRIBUTION (%)
ELEV DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE	*N* VALUES			SHEAR STRENGTH kPa	WATER CONTENT (%)					
87.0	Ground Surface						87	20 40 60 80 100	10 20 30					
86.8	Mixture of Sand, Silt and Gravel (Fill)		1	SS	14		86	○ UNCONFINED × FIELD VANE	○					
0.2	Silt (Fill), some sand and clay		2	SS	10		85	● QUICK TRIAXIAL × LAB VANE	○					0 10 76 14
	Loose to Compact						84							
	Brown		3	SS	8		83							
			4	SS	8		82							
84.0							81							
3.0	Silt, some sand and clay		5	SS	17		80							
	Compact		6	SS	26		79							
	Brown		7	SS	19		78							
			8	SS	18		77							
							76							
80.0							75							
7.0	Silt and Clay, some sand		9	SS	7									
	Firm to Very Stiff													
	Grey		10	SS	30									
			11	SS	21									
			12	SS	27									
74.2														
12.8	END OF BOREHOLE													

Numbers refer to Sensitivity (%) STRAIN AT FAILURE

RECORD OF BOREHOLE No 138-06-3

1 OF 1

METRIC

W.P. 333-89-00 LOCATION WC 138-06; Sta. 12+489, O-S 38m Rt. ORIGINATED BY IK
DIST 4 HWY QEW BOREHOLE TYPE Solid Stem COMPILED BY IK
DATUM SEE TEXT DATE 94.08.24 & 94.08.24 CHECKED BY TO

SOIL PROFILE			SAMPLES			GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT			UNIT WEIGHT γ kN/m ³	REMARKS & GRAIN SIZE DISTRIBUTION (%)		
ELEV DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE	"N" VALUES			SHEAR STRENGTH kPa						
								20 40 60 80 100						
								20 40 60 80 100						
			○ UNCONFINED × FIELD VANE			PLASTIC LIMIT NATURAL MOISTURE CONTENT LIQUID LIMIT								
			● QUICK TRIAXIAL × LAB VANE			w _p w w _L			WATER CONTENT (%)					
						20 40 60 80 100			10 20 30					
82.6	Ground Surface													
82.3	Topsoil		1	SS	5									
0.3	Silt, some sand and clay													
	Loose to Compact		2	SS	11									
	Brown		3	SS	4									
			4	SS	11									
78.2			5	SS	8									
3.4	Silt and Clay, some sand													
	Stiff		6	SS	7									
	Brown Grey													
			7	SS	11									
	Very Stiff		8	SS	24									
74.4														
8.2	END OF BOREHOLE													

×³, ×³: Numbers refer to Sensitivity 20 15 10 (% STRAIN AT FAILURE

RECORD OF BOREHOLE No 138-07-1

1 OF 1

METRIC

W.P. 333-89-00 LOCATION WC 138-07; Sta. 13 + 248, O-S 25m Lt. ORIGINATED BY IK
DIST 4 HWY QEW BOREHOLE TYPE Solid Stem COMPILED BY IK
DATUM SEE TEXT DATE 94.08.24 & 94.08.24 CHECKED BY TO

SOIL PROFILE			SAMPLES			GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT					NATURAL MOISTURE CONTENT			UNIT WEIGHT γ _s kN/m ³	REMARKS & GRAIN SIZE DISTRIBUTION (%)
ELEV DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE	"N" VALUES			20	40	60	80	100	W _p	W	W _L		
85.8	Ground Surface																
85.5	Topsoil		1	SS	11												
0.3	Sandy Silt, trace clay																
	Loose to Compact		2	SS	16												
	Brown		3	SS	10												
			4	SS	3												
			5	SS	10												
82.0																	
3.8	Silt and Clay, sandy		6	SS	3												
	Very Stiff																
	Grey																
			7	SS	16												
			8	SS	11												
			9	SS	23												
76.1																	
9.8	END OF BOREHOLE																

RECORD OF BOREHOLE No 138-07-2

1 OF 1

METRIC

W.P. 333-89-00 LOCATION WC 138-07; Sta. 13+248, O-S 3m Rt. ORIGINATED BY IK
DIST 4 HWY QEW BOREHOLE TYPE Solid Stem, Cone Test COMPILED BY IK
DATUM SEE TEXT DATE 94.08.18 & 94.08.18 CHECKED BY TO

SOIL PROFILE			SAMPLES			GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT			UNIT WEIGHT γ kN/m ³	REMARKS & GRAIN SIZE DISTRIBUTION (%) GR SA SI CL
ELEV DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE	"N" VALUES			SHEAR STRENGTH kPa ○ UNCONFINED ✕ FIELD VANE ● QUICK TRIAXIAL ✕ LAB VANE				
86.2	Ground Surface											
85.9	Mixture of Sand Silt and Gravel (Fill)		1	SS	16		86					
0.3	Compact		2	SS	15		85					
	Silt (Fill), some sand, trace clay and gravel		3	SS	14		84					
	Loose to Compact		4	SS	7		83					
	Brown		5	SS	8		82					
82.8	Silt and Clay, some sand		6	SS	3		81					
3.4	Soft		7	SS	3		80					
	Brown Grey						79					
	Very Stiff		8	SS	27		78					
			9	SS	20		77					
			10	SS	16							
76.5												
9.8	END OF BOREHOLE											

RECORD OF BOREHOLE No 138-07-3

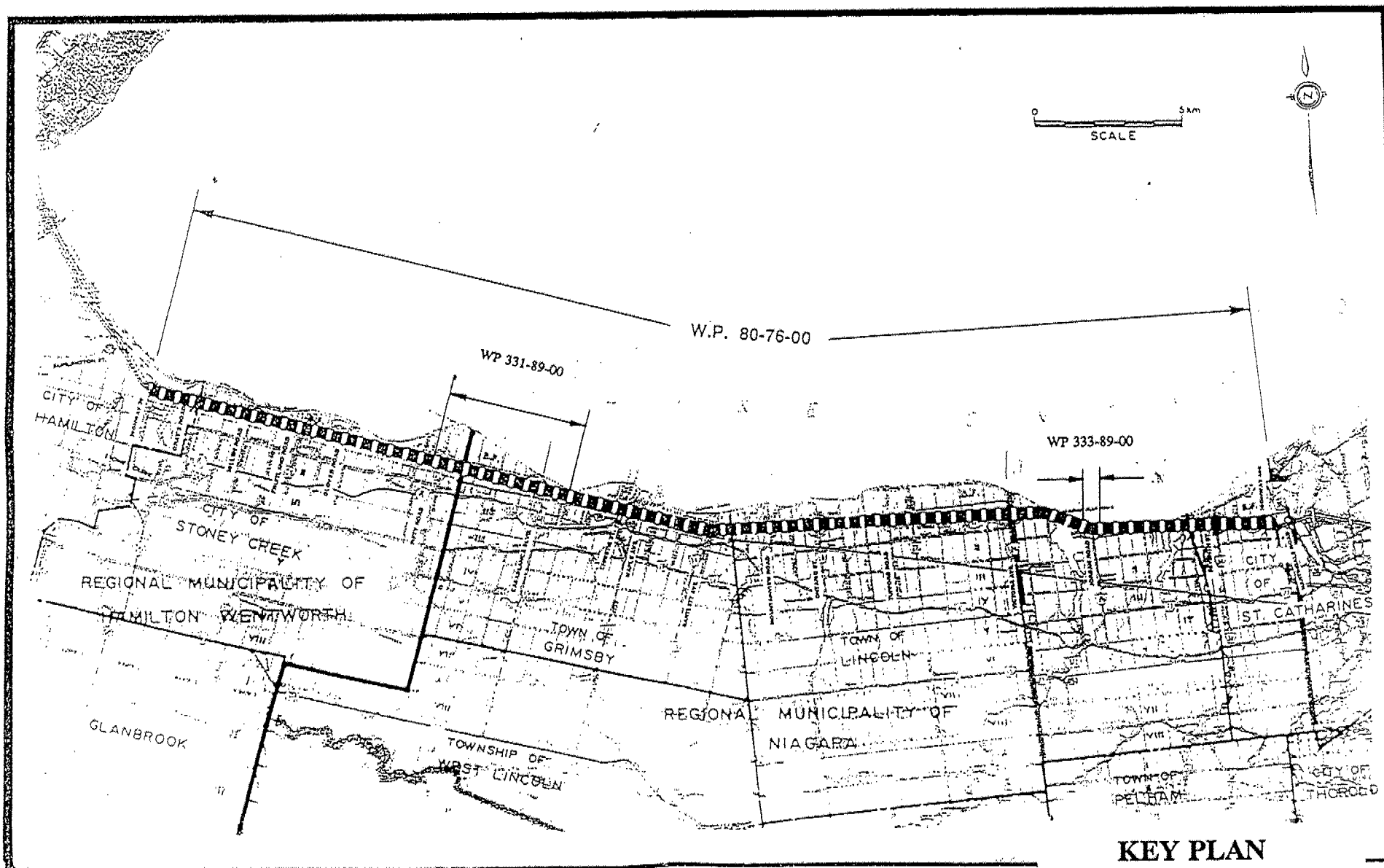
1 OF 1

METRIC

W.P. 333-89-00 LOCATION WC 138-07; Sta. 13+248, O-S 24m Rt. ORIGINATED BY JK
DIST 4 HWY QEW BOREHOLE TYPE Solid Stem COMPILED BY JK
DATUM SEE TEXT DATE 94.08.24 & 94.08.24 CHECKED BY TO

SOIL PROFILE			SAMPLES			GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT			PLASTIC LIMIT W _p	NATURAL MOISTURE CONTENT W	LIQUID LIMIT W _L	UNIT WEIGHT γ kN/m ³	REMARKS & GRAIN SIZE DISTRIBUTION (%) GR SA SI CL			
ELEV DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE	"N" VALUES			SHEAR STRENGTH kPa								WATER CONTENT (%)		
								○ UNCONFINED	× FIELD VANE	● QUICK TRIAXIAL							× LAB VANE	
86.4	Ground Surface						20	40	60	80	100							
86.1	Topsoil		1	SS	9													
0.3	Silt (Fill), some sand, trace clay		2	SS	17													
	Compact		3	SS	11													
	Brown																	
84.0																		
2.4	Silt, some sand and clay, compact, brown		4	SS	9													
			5	SS	11													
82.7																		
3.7	Silt and Clay, some sand, some organics to 5m.		6	SS	5													
	Firm to Stiff																	
	Grey																	
			7	SS	12													
			8	SS	7													
			9	SS	16													
76.7																		
9.8	END OF BOREHOLE																	

APPENDIX 2



**KEY PLAN
FIGURE 1**

TABLE 1
CULVERT DETAILS

Culvert No.	Approx. Sta.	Approx. Elev. Culvert Invert (m)	Approx. Elev. Top of Culvert (m)
WC135-40	31+688	82.0	82.6
WC135-41	32+102	78.2	80.9
WC136-01	10+419	80.8	81.8
WC136-02	10+622	81.0	81.6
WC136-03	10+825	81.0	81.7
WC136-04	11+101	81.4	82.0
WC136-05	11+262	81.4	82.3
WC136-06	11+446	82.0	82.8
WC136-07	11+656	81.8	82.4
WC136-08	11+853	81.6	82.3
WC136-09	12+059	82.4	83.3
WC136-10	12+347	82.6	83.5
WC136-11	12+675	83.3	83.9
WC136-12	12+885	82.9	83.5
WC136-13	13+085	82.3	83.0
WC136-14	13+278	82.6	83.2
WC136-15	13+499	81.3	82.3
WC136-16	13+817	82.6	83.8
WC138-06	12+489	82.8	83.8
WC138-07	13+248	83.4	84.8

TABLE 2**REPORT OF SOIL CHEMISTRY ANALYSIS**

Parameter	LOQ	Units	135-40-2 SS 2	136-01-2 SS 1	136-03-2 SS 1	136-04-3 SS 1	138-06-2 SS 6	136-07-2 SS 2	136-09-2 SS 2	136-13-2 SS 2	Replicate	136-14-3 SS 1	136-16-2 SS 3
Chloride	0.5	mg/kg	620	762	534	1780	314	467	290	906	913	66.2	224
Sulphate	0.5	mg/kg	103	108	746	676	93.8	96.6	102	102	106	216	112
pH	0.01	units	8.03	8.66	7.63	7.52	8.42	8.18	8.40	8.45	8.48	7.75	8.99
Moisture Content	0.01	%	12.1	13.9	6.27	30.6	13.7	9.25	7.81	8.75	10.3	14.9	4.64

Notes:

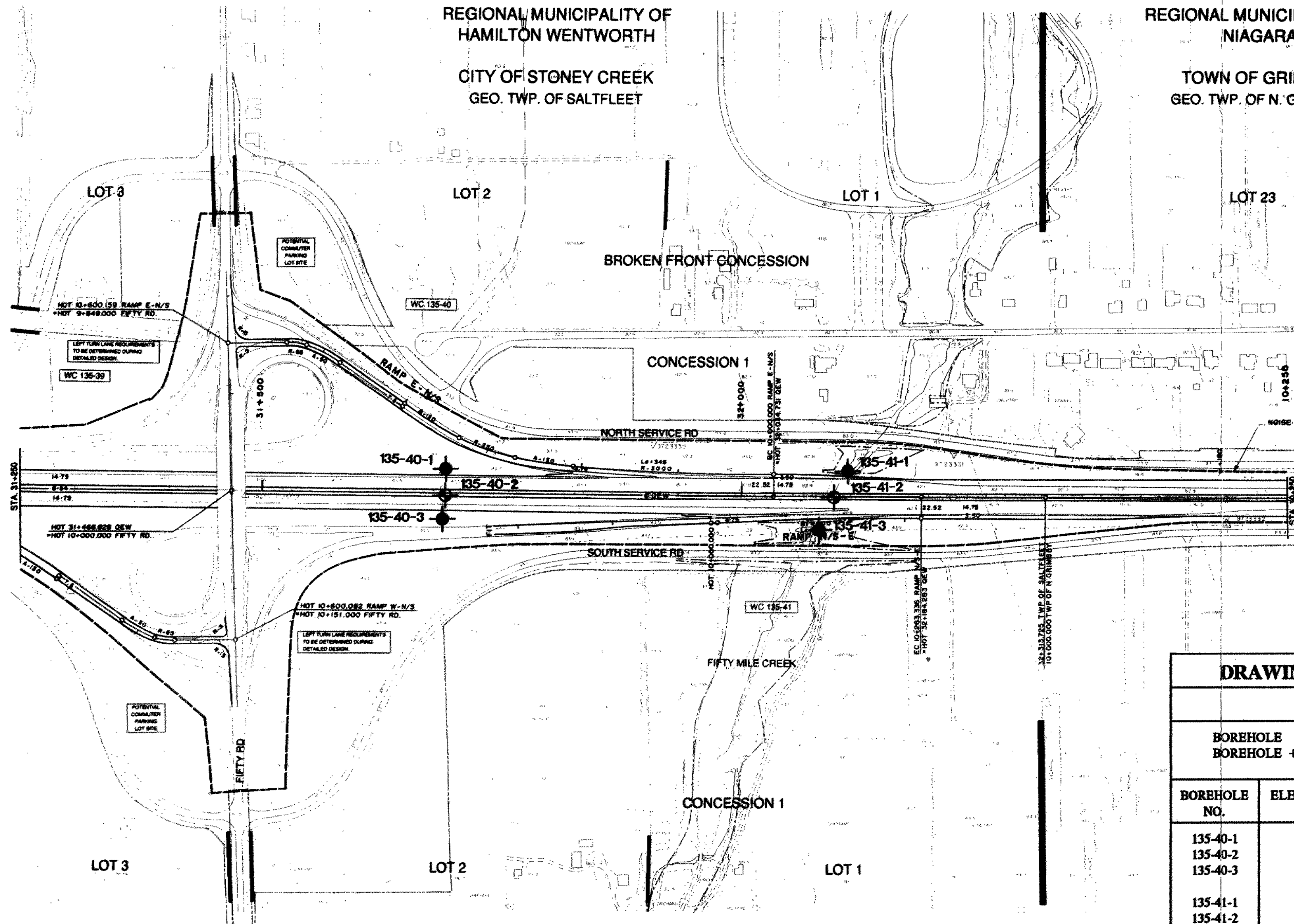
LOQ = Limit of Quantitation = lowest level of the parameter that can be quantified with confidence.

PDR Plates

1:4000

REGIONAL MUNICIPALITY OF
HAMILTON WENTWORTH
CITY OF STONEY CREEK
GEO. TWP. OF SALT FLEET

REGIONAL MUNICIPALITY OF
NIAGARA
TOWN OF GRIMSBY
GEO. TWP. OF N. GRIMSBY



DRAWING NO. 3318900-A

LEGEND

BOREHOLE
BOREHOLE + CONE

BOREHOLE NO.	ELEVATION (m)	STATION	OFFSET
135-40-1	81.8	31+688	25m Lt.
135-40-2	83.5	31+688	4m Rt.
135-40-3	82.0	31+688	28m Rt.
135-41-1	79.9	32+102	30m Lt.
135-41-2	82.1	32+102	3m Rt.
135-41-3	80.5	32+102	36m Rt.

PLATE
C4-8

ULTIMATE PHASE
STA. 31+250 TO STA. 10+250

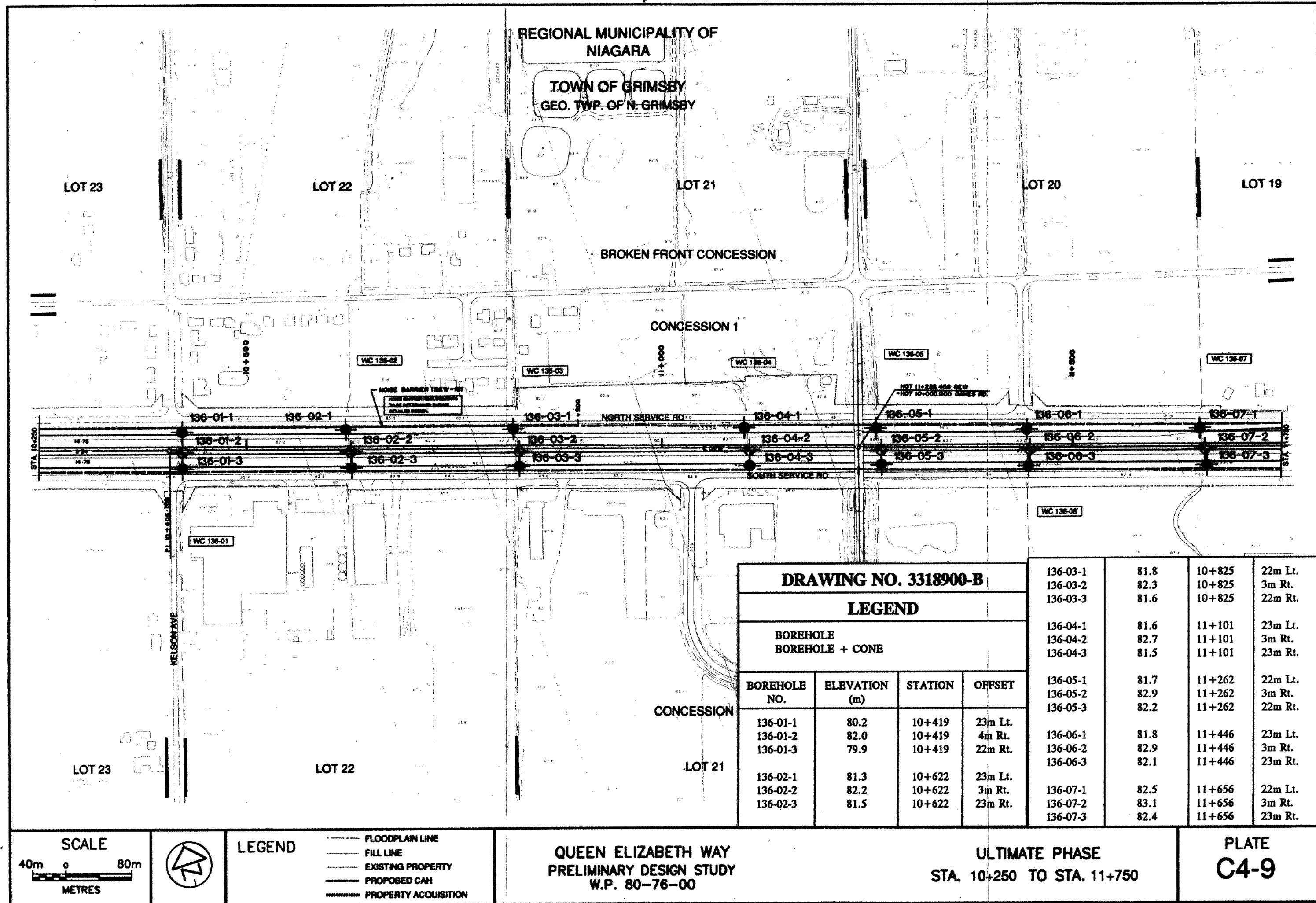
QUEEN ELIZABETH WAY
PRELIMINARY DESIGN STUDY
W.P. 80-76-00

LEGEND

- FLOODPLAIN LINE
- FILL LINE
- EXISTING PROPERTY
- PROPOSED CAH
- PROPERTY ACQUISITION



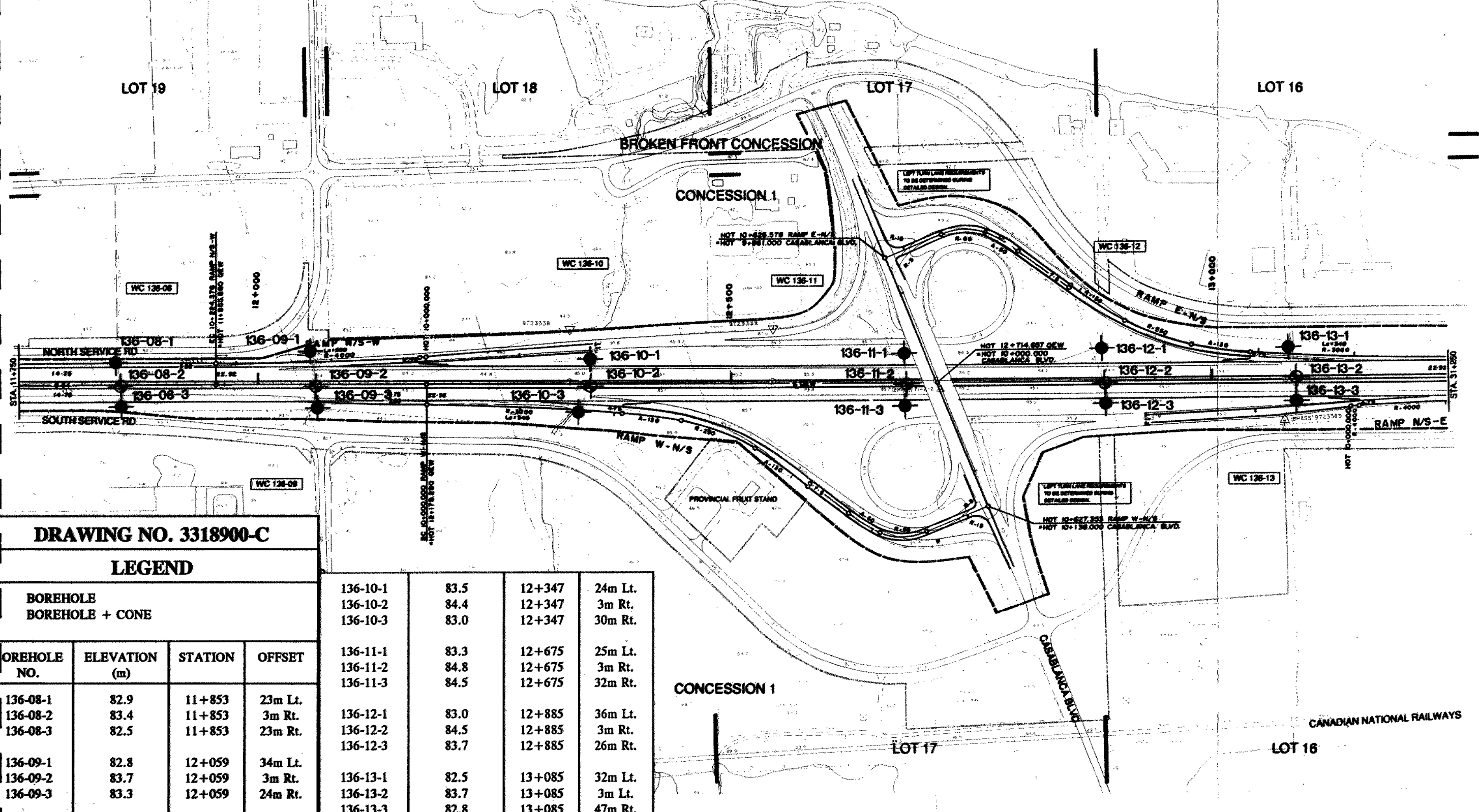
SCALE
40m 0 80m
METRES



REGIONAL MUNICIPALITY OF
NIAGARA

TOWN OF GRIMSBY
GEO. TWP. OF N. GRIMSBY

LAKE ONTARIO



DRAWING NO. 3318900-C

LEGEND

BOREHOLE							
BOREHOLE + CONE							
BOREHOLE NO.	ELEVATION (m)	STATION	OFFSET				
136-08-1	82.9	11+853	23m Lt.	136-10-1	83.5	12+347	24m Lt.
136-08-2	83.4	11+853	3m Rt.	136-10-2	84.4	12+347	3m Rt.
136-08-3	82.5	11+853	23m Rt.	136-10-3	83.0	12+347	30m Rt.
136-09-1	82.8	12+059	34m Lt.	136-11-1	83.3	12+675	25m Lt.
136-09-2	83.7	12+059	3m Rt.	136-11-2	84.8	12+675	3m Rt.
136-09-3	83.3	12+059	24m Rt.	136-11-3	84.5	12+675	32m Rt.
				136-12-1	83.0	12+885	36m Lt.
				136-12-2	84.5	12+885	3m Rt.
				136-12-3	83.7	12+885	26m Rt.
				136-13-1	82.5	13+085	32m Lt.
				136-13-2	83.7	13+085	3m Lt.
				136-13-3	82.8	13+085	47m Rt.

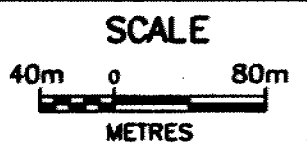
PLATE
C4-10

ULTIMATE PHASE
STA. 11+750 TO STA. 13+250

QUEEN ELIZABETH WAY
PRELIMINARY DESIGN STUDY
W.P. 80-76-00

LEGEND

- FLOODPLAIN LINE
- FILL LINE
- EXISTING PROPERTY
- PROPOSED CAH
- PROPERTY ACQUISITION



REGIONAL MUNICIPALITY OF
NIAGARA
TOWN OF GRIMSBY
GEO. TWP. OF N. GRIMSBY

LAKE ONTARIO

LOT 15

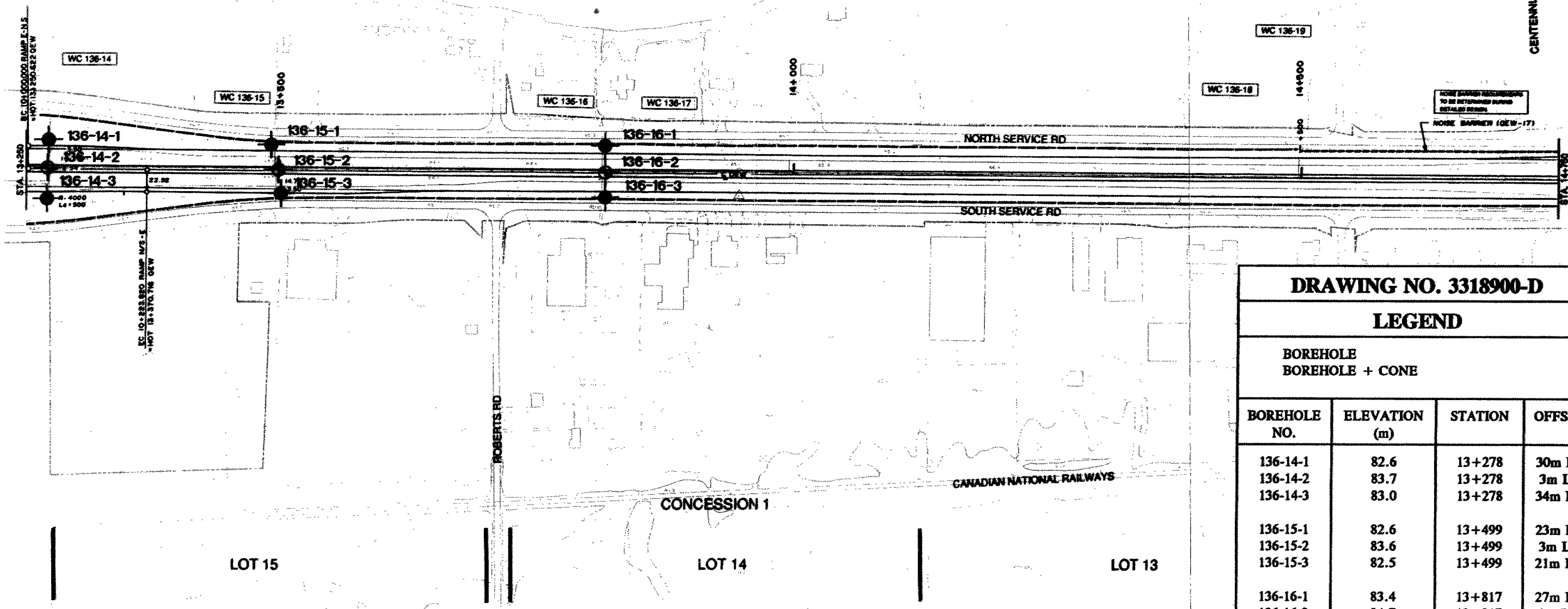
LOT 14

LOT 13

LOT 12

CONCESSION 1

CENTENNIAL DR

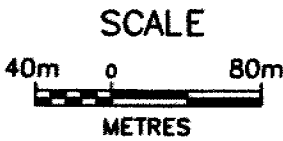


DRAWING NO. 3318900-D

LEGEND

BOREHOLE
BOREHOLE + CONE

BOREHOLE NO.	ELEVATION (m)	STATION	OFFSET
136-14-1	82.6	13+278	30m Lt.
136-14-2	83.7	13+278	3m Lt.
136-14-3	83.0	13+278	34m Rt.
136-15-1	82.6	13+499	23m Lt.
136-15-2	83.6	13+499	3m Lt.
136-15-3	82.5	13+499	21m Rt.
136-16-1	83.4	13+817	27m Lt.
136-16-2	84.7	13+817	3m Lt.
136-16-3	83.2	13+817	29m Rt.



LEGEND

- FLOODPLAIN LINE
- FILL LINE
- EXISTING PROPERTY
- PROPOSED CAH
- PROPERTY ACQUISITION

QUEEN ELIZABETH WAY
PRELIMINARY DESIGN STUDY
W.P. 80-76-00

ULTIMATE PHASE
STA. 13+250 TO STA. 14+750

PLATE
C4-11

REGIONAL MUNICIPALITY OF
NIAGARA

TOWN OF LINCOLN
GEO. TWP. OF LOUTH

LOT 19

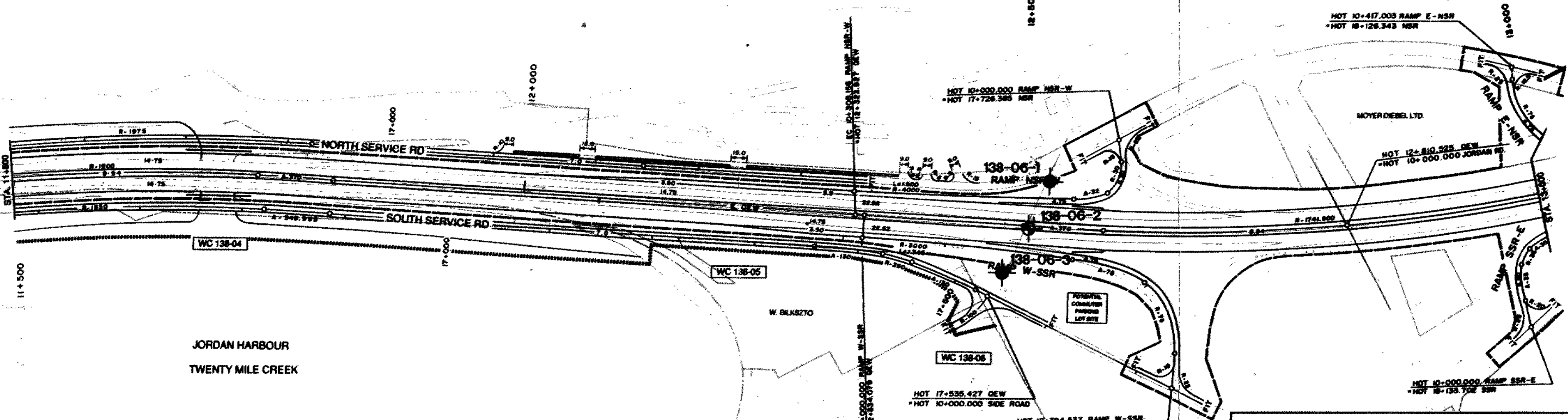
LOT 18

LOT 17

LOT 16

BROKEN FRONT CONCESSION

LAKE ONTARIO

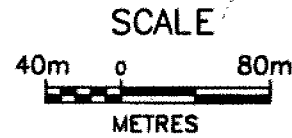


DRAWING NO. 3338900-A

LEGEND

BOREHOLE
BOREHOLE + CONE

BOREHOLE NO.	ELEVATION (m)	STATION	OFFSET
138-06-1	85.7	12+489	42m Lt.
138-06-2	87.0	12+489	3m Rt.
138-06-3	82.6	12+489	38m Rt.



LEGEND
— FLOODPLAIN LINE
— FILL LINE
— EXISTING PROPERTY
— PROPOSED CAH
— PROPERTY ACQUISITION

QUEEN ELIZABETH WAY
PRELIMINARY DESIGN STUDY
W.P. 80-76-00

ULTIMATE PHASE
STA. 11+500 TO STA. 13+000

PLATE
C4-23

REGIONAL MUNICIPALITY OF
NIAGARA

TOWN OF LINCOLN
GEO. TWP. OF LOUTH

LOT 16

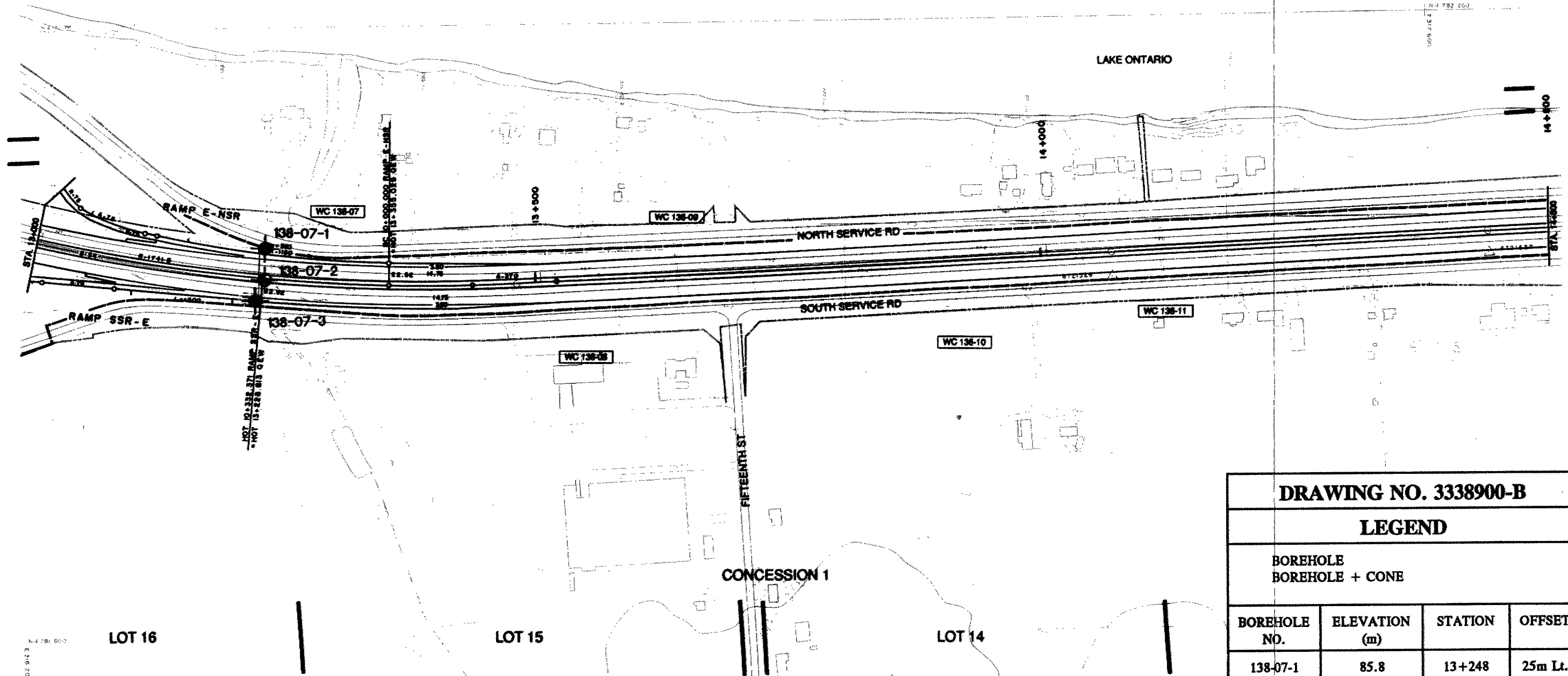
LOT 15

LOT 14

LOT 13

BROKEN FRONT CONCESSION

LAKE ONTARIO



DRAWING NO. 3338900-B

LEGEND

BOREHOLE
BOREHOLE + CONE

BOREHOLE NO.	ELEVATION (m)	STATION	OFFSET
138-07-1	85.8	13+248	25m Lt.
136-07-2	86.2	13+248	3m Rt.
136-07-3	86.4	13+248	24m Rt.

PLATE
C4-24

ULTIMATE PHASE
STA. 13+000 TO STA. 14+500

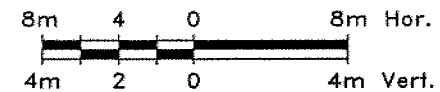
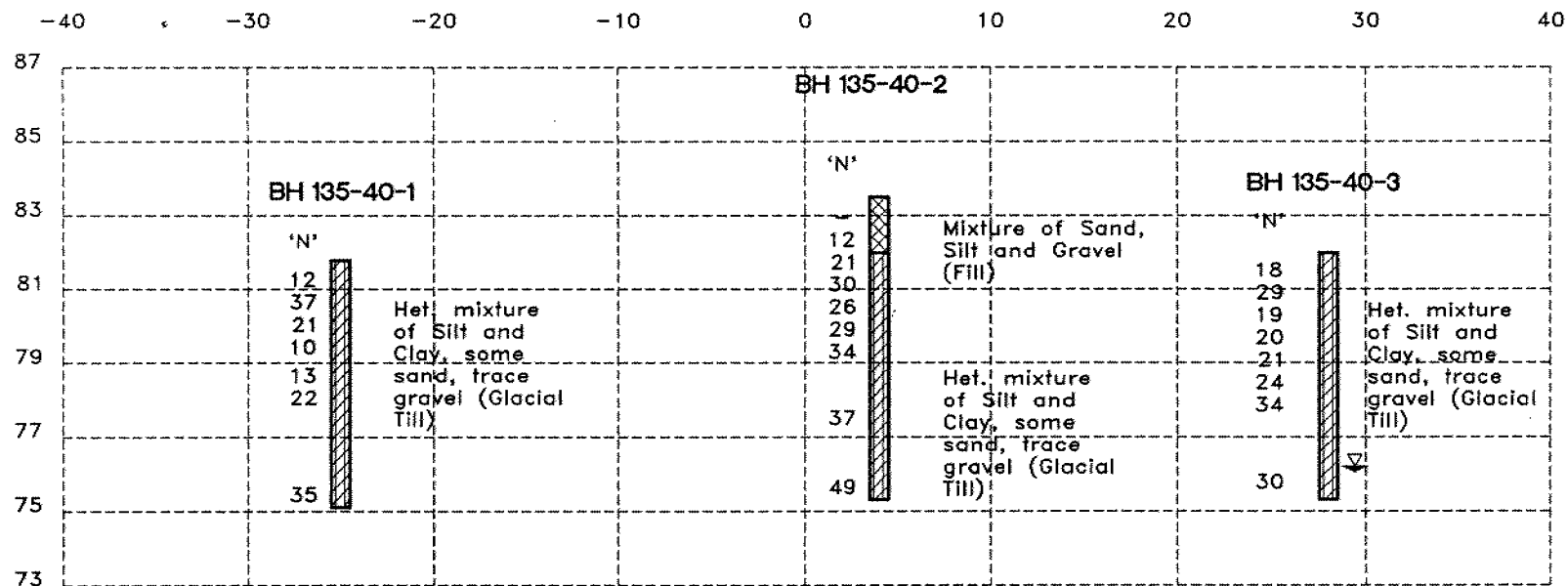
QUEEN ELIZABETH WAY
PRELIMINARY DESIGN STUDY
W.P. 80-76-00

LEGEND

- FLOODPLAIN LINE
- FILL LINE
- EXISTING PROPERTY
- PROPOSED CAN
- PROPERTY ACQUISITION



SCALE
40m 0 80m
METRES



WC 135-40 - C PROFILE STATION 31+688

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WP 331-89-00

Dwg. No.:
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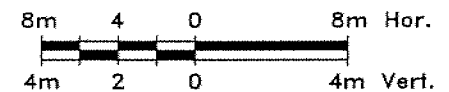
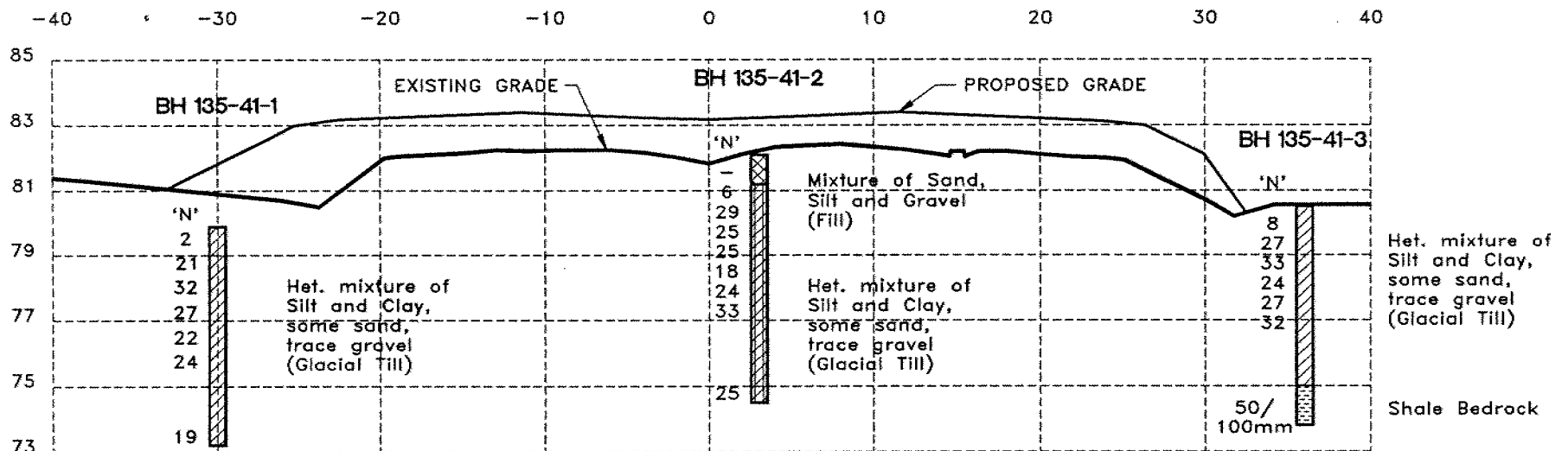
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94/09/06

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TA

Appd.:
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Whitford



WC 135-41 - C PROFILE STATION 32+102

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WP 331-89-00

Dwg. No.:
3318900-F

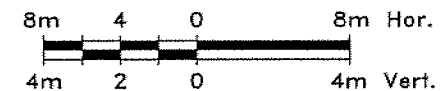
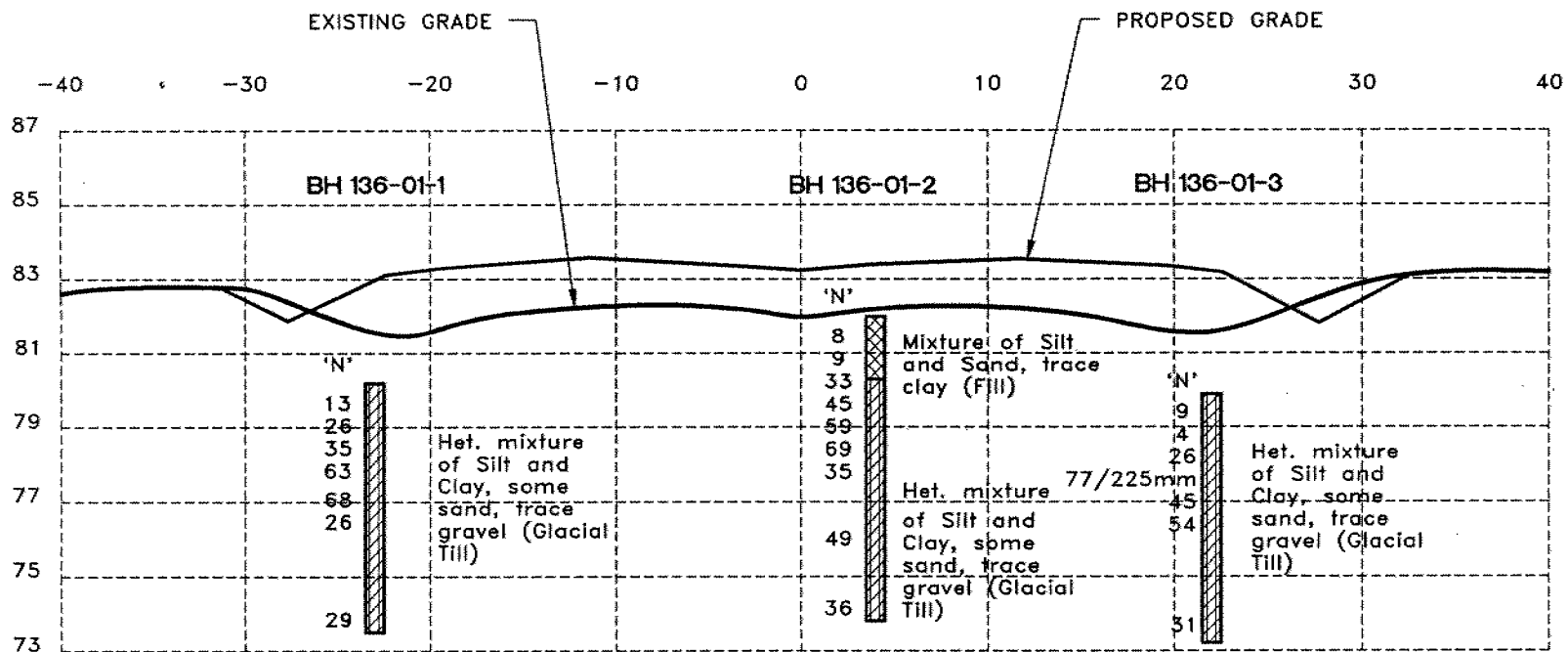
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WC 136-01 - ζ PROFILE STATION 10+419

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WP 331-89-00

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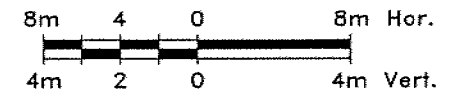
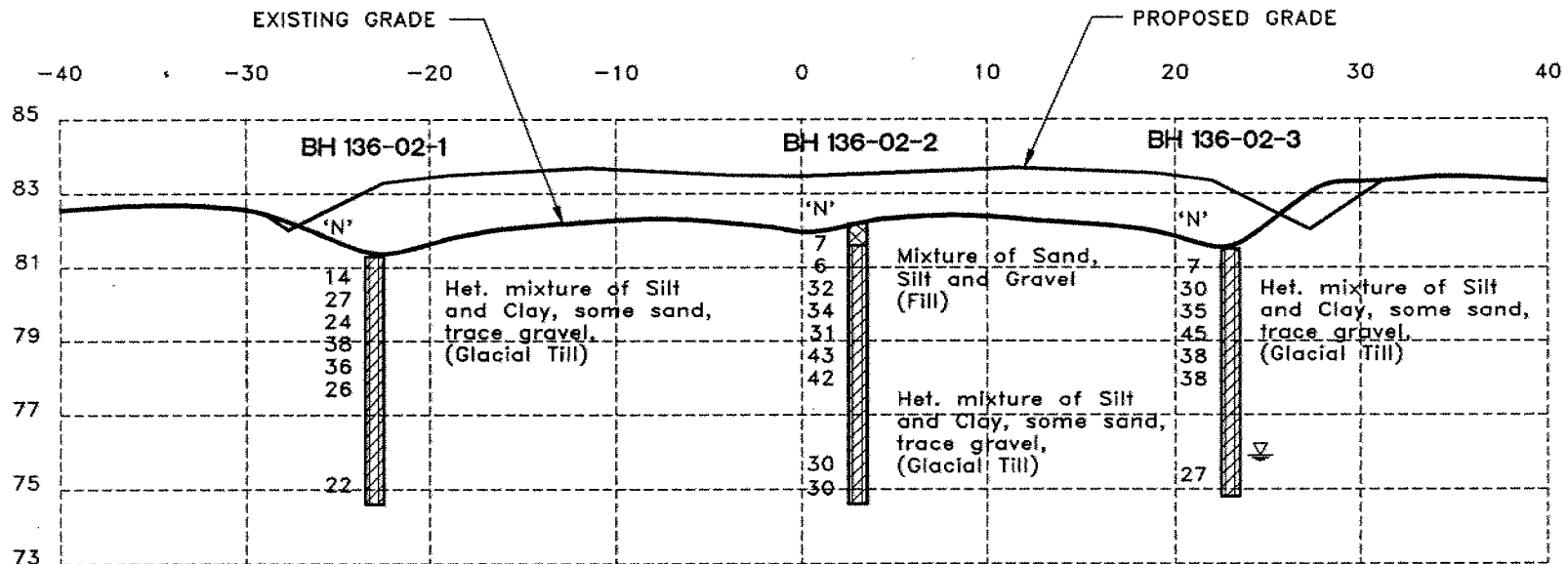
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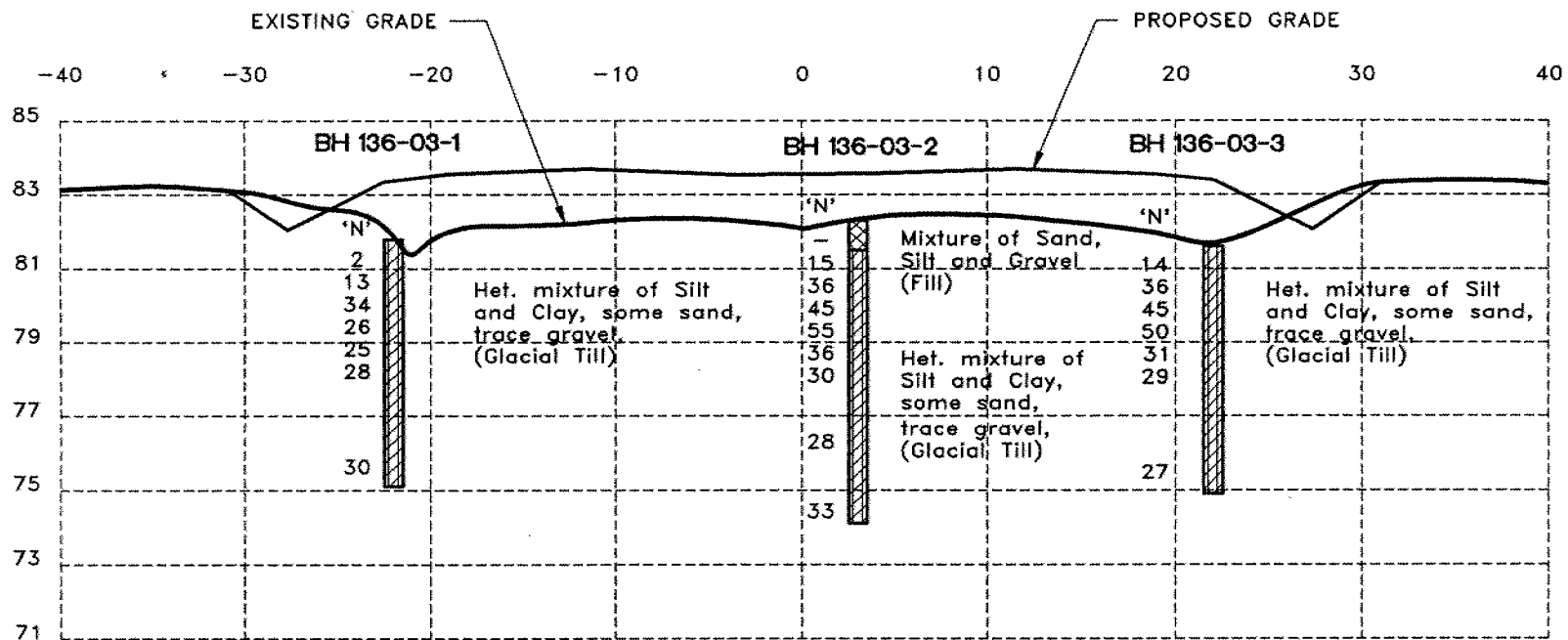
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WC 136-03 - C PROFILE STATION 10+825

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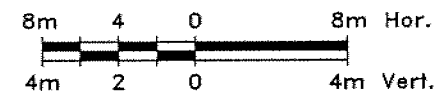
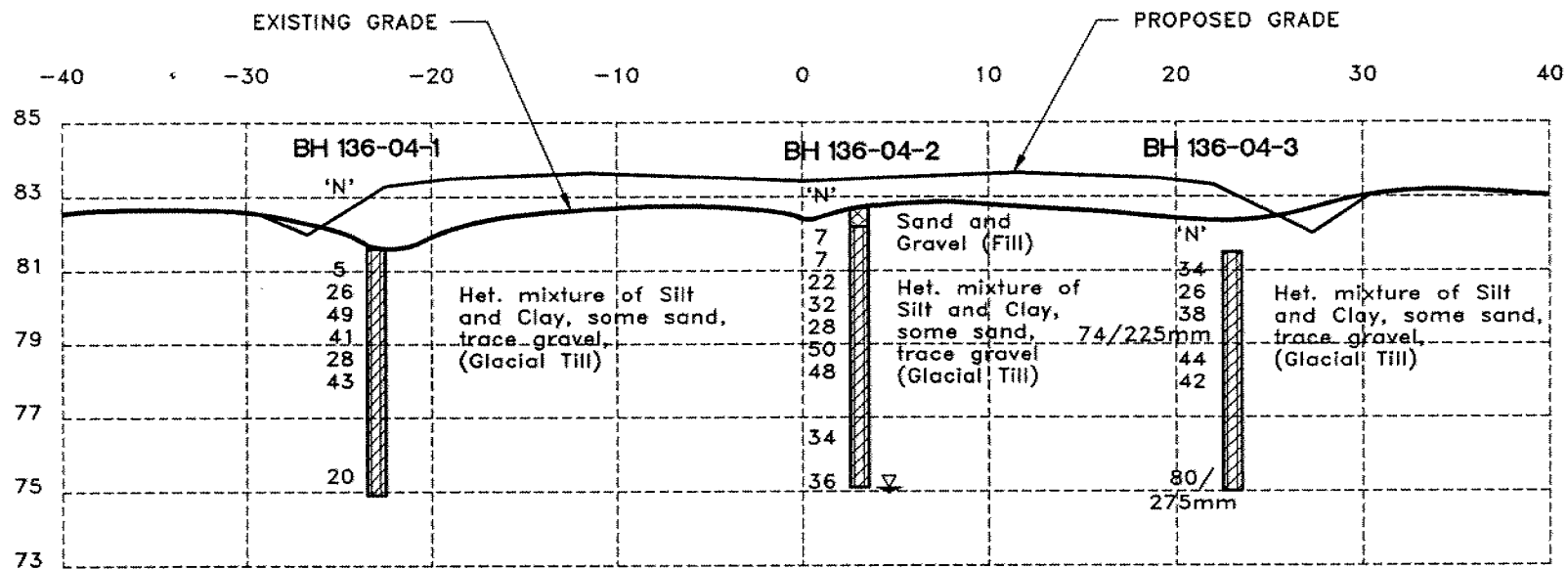
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WC 136-04 - ξ PROFILE STATION 11+101

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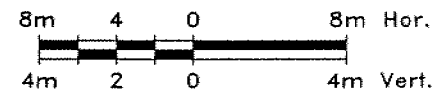
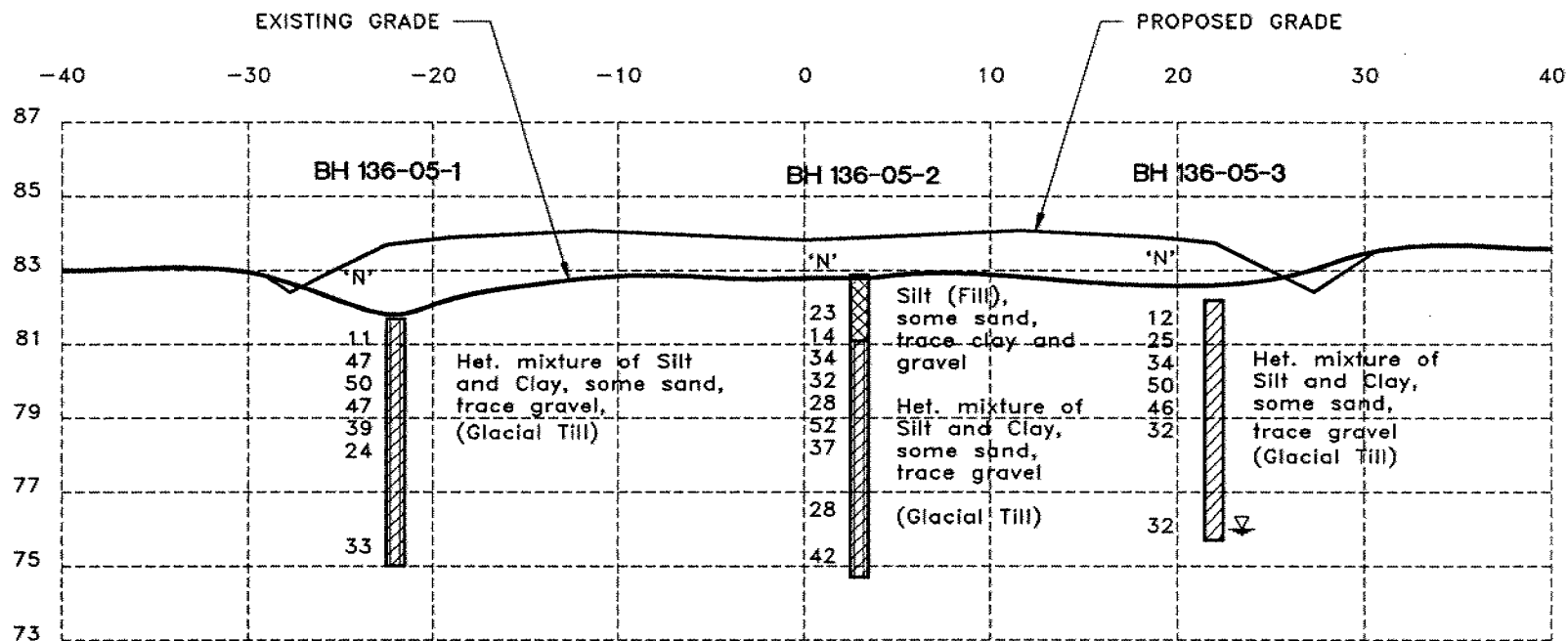
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WC 136-05 - C PROFILE STATION 11+262

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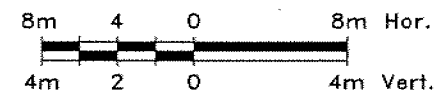
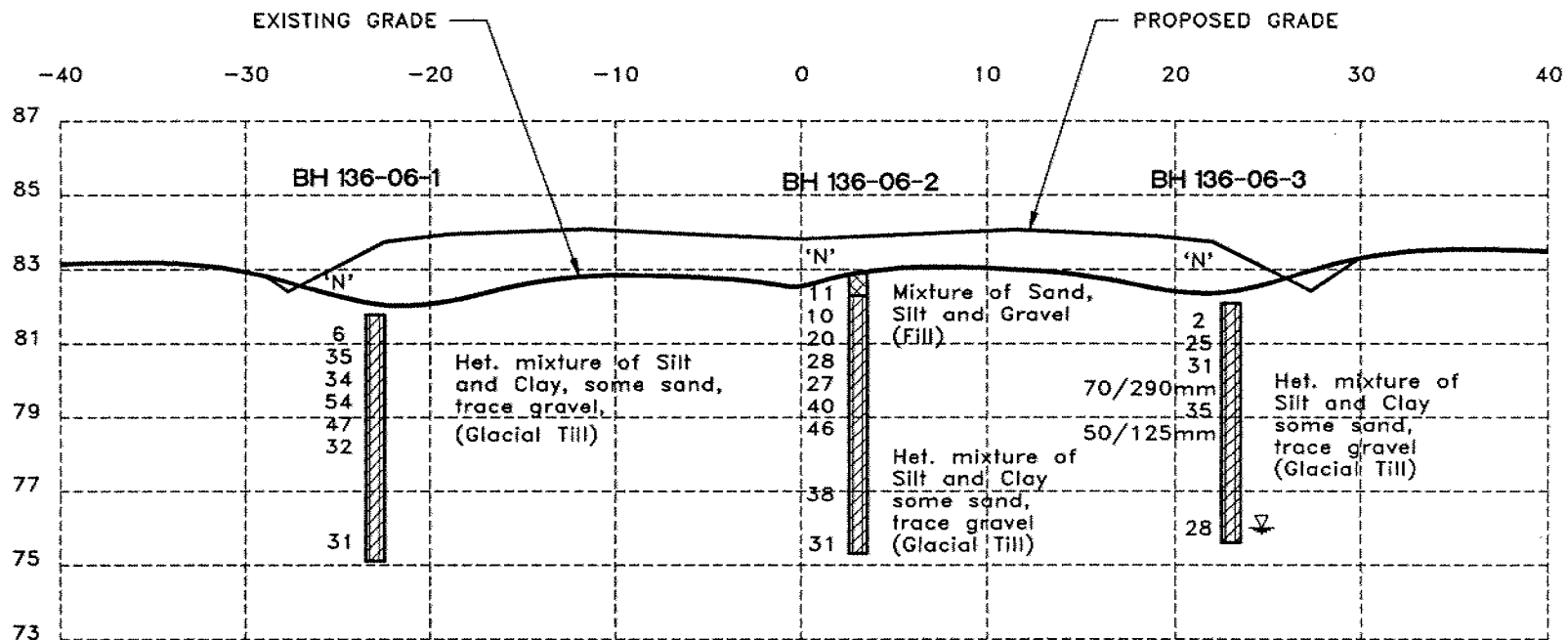
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WC 136-06 - C PROFILE STATION 11+446

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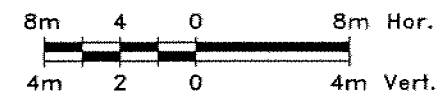
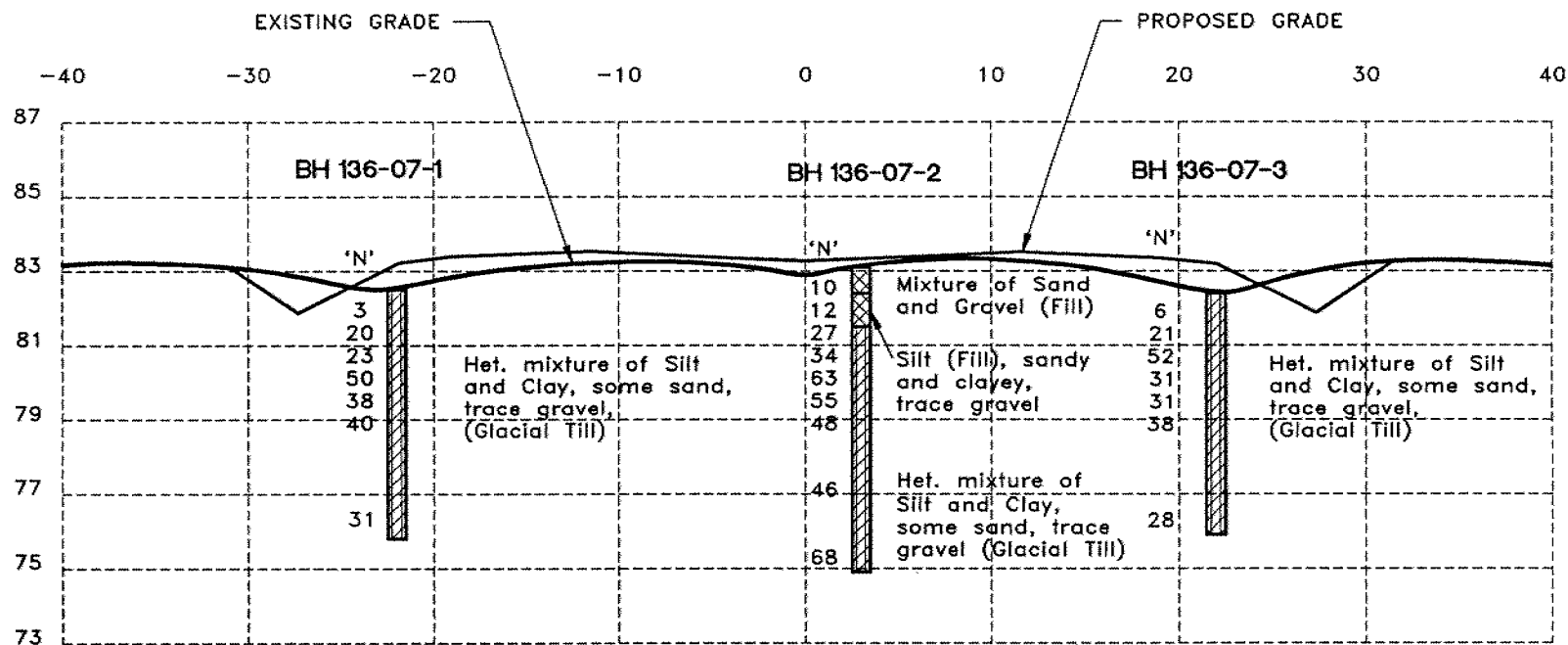
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WC 136-07 - C PROFILE STATION 11+656

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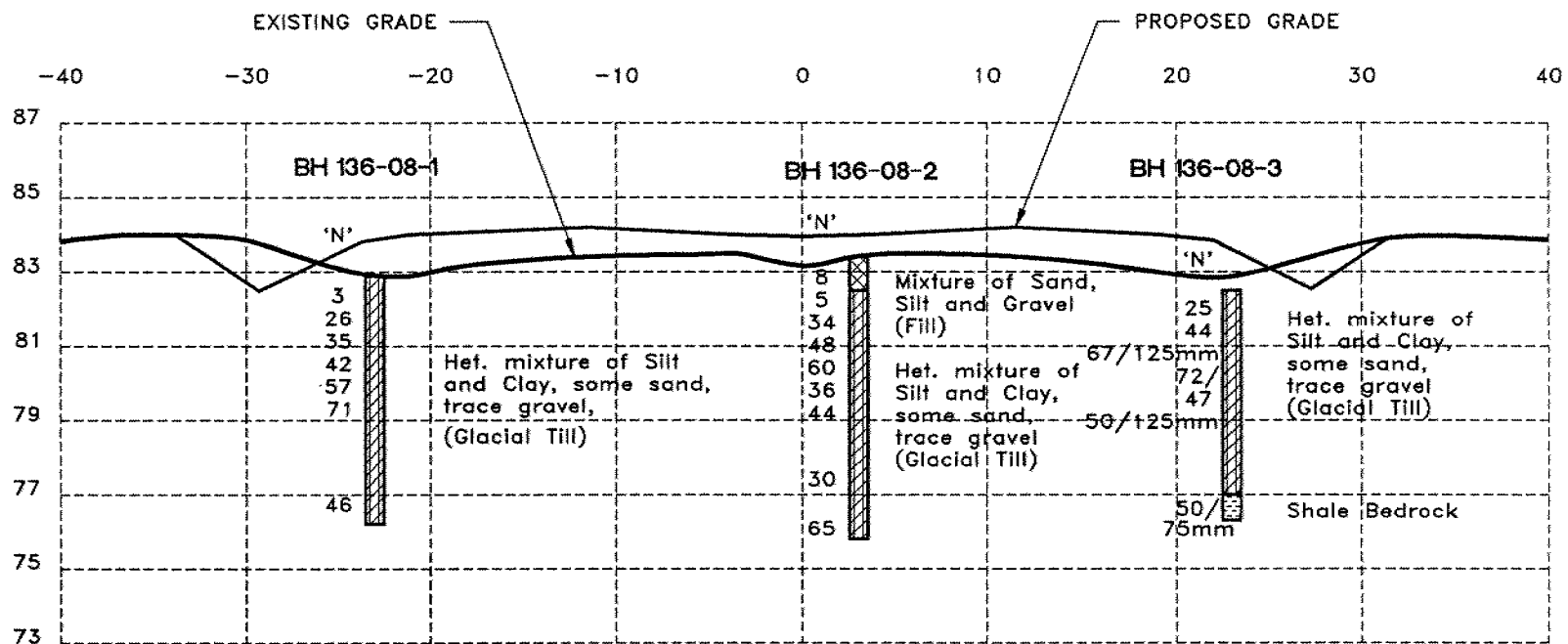
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Whitford



WC 136-08 - C PROFILE STATION 11+853

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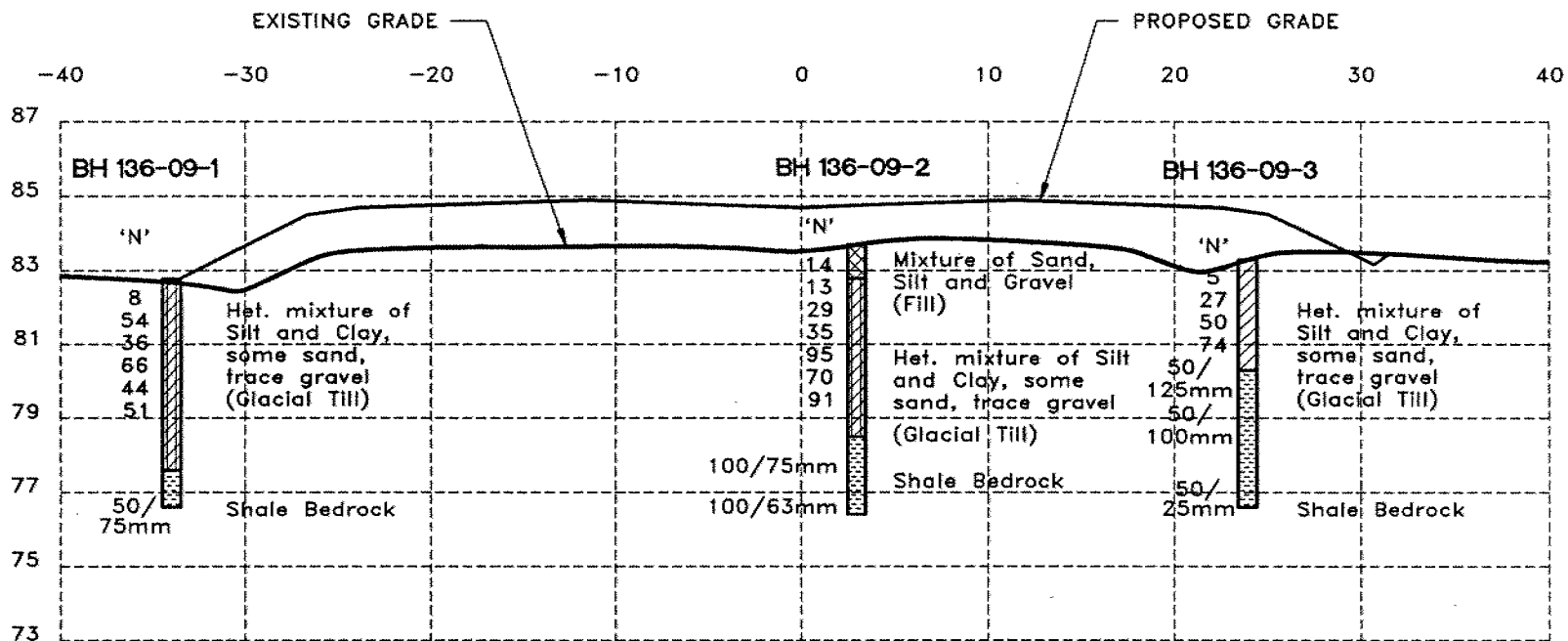
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WC 136-09 - C PROFILE STATION 12+059

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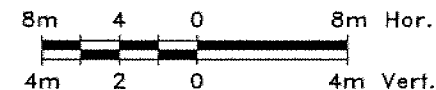
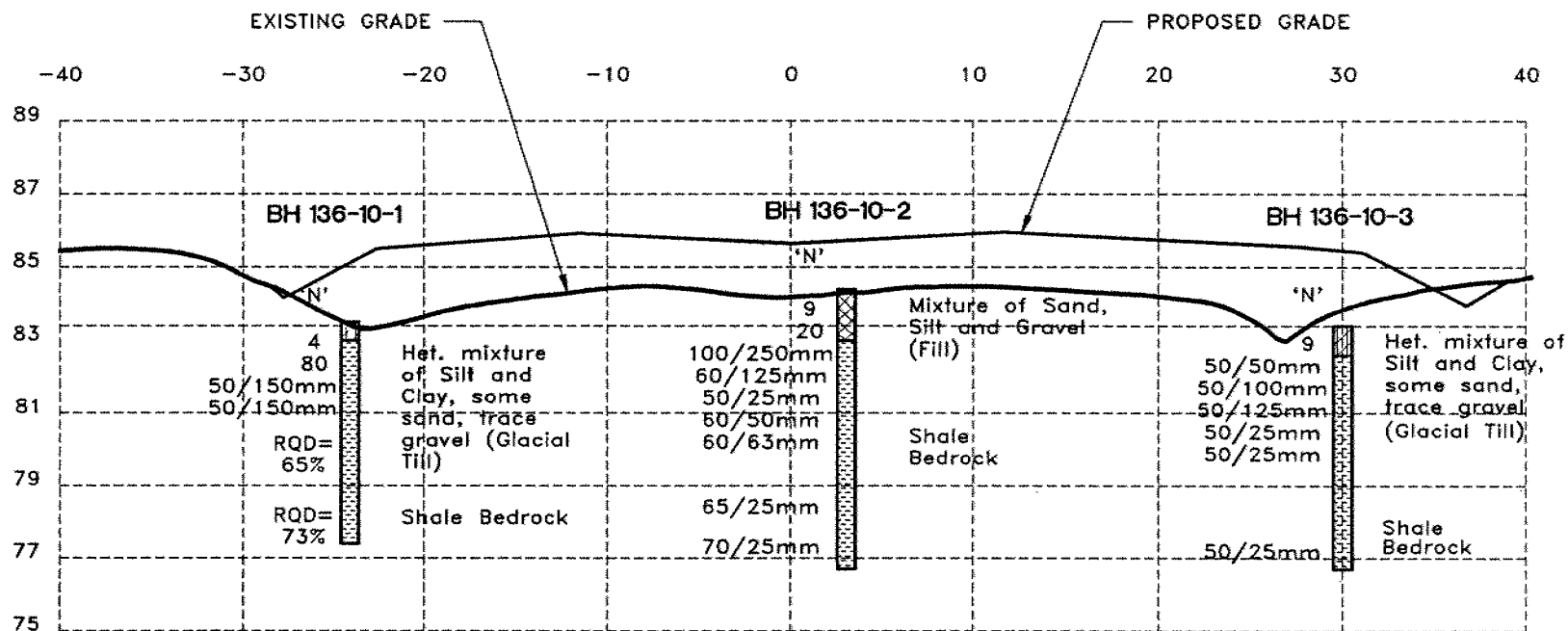
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Whitford



WC 136-10 - C PROFILE STATION 12+347

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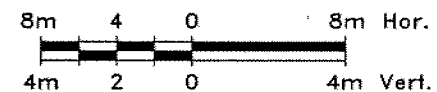
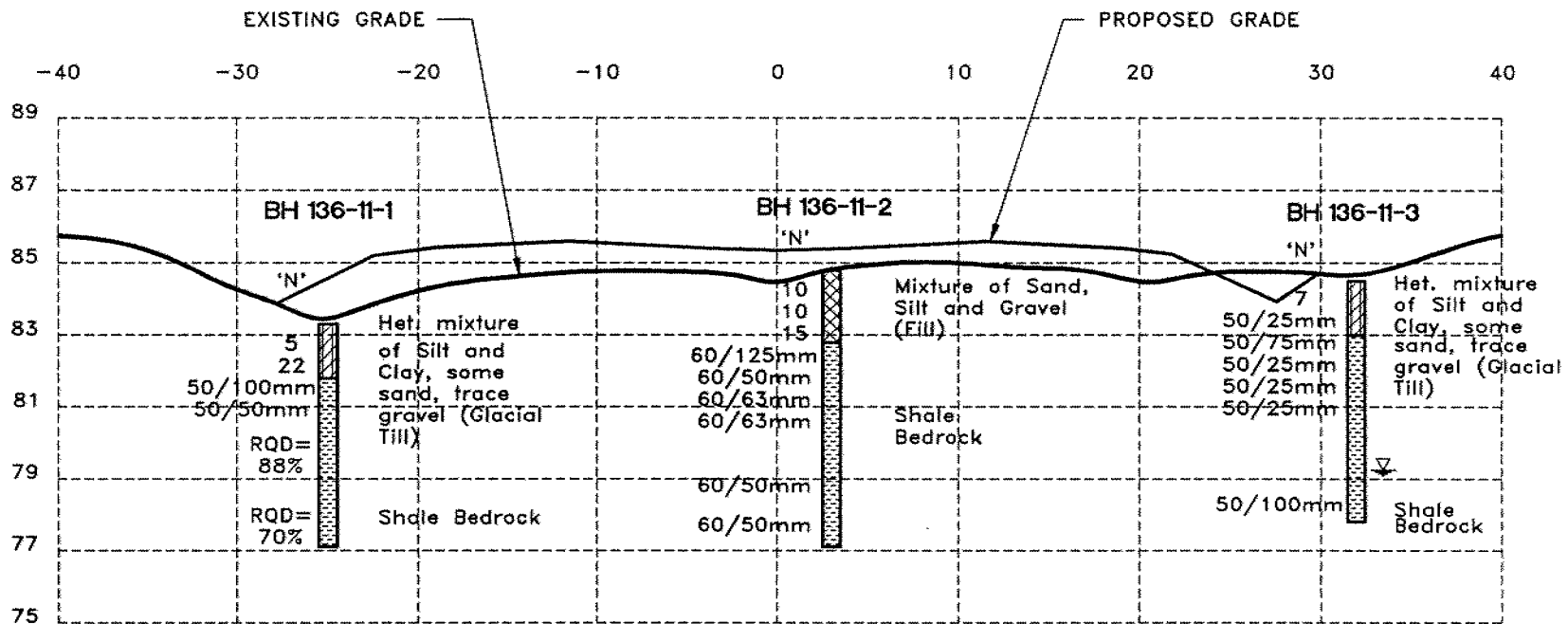
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WC 136-11 - C PROFILE STATION 12+675

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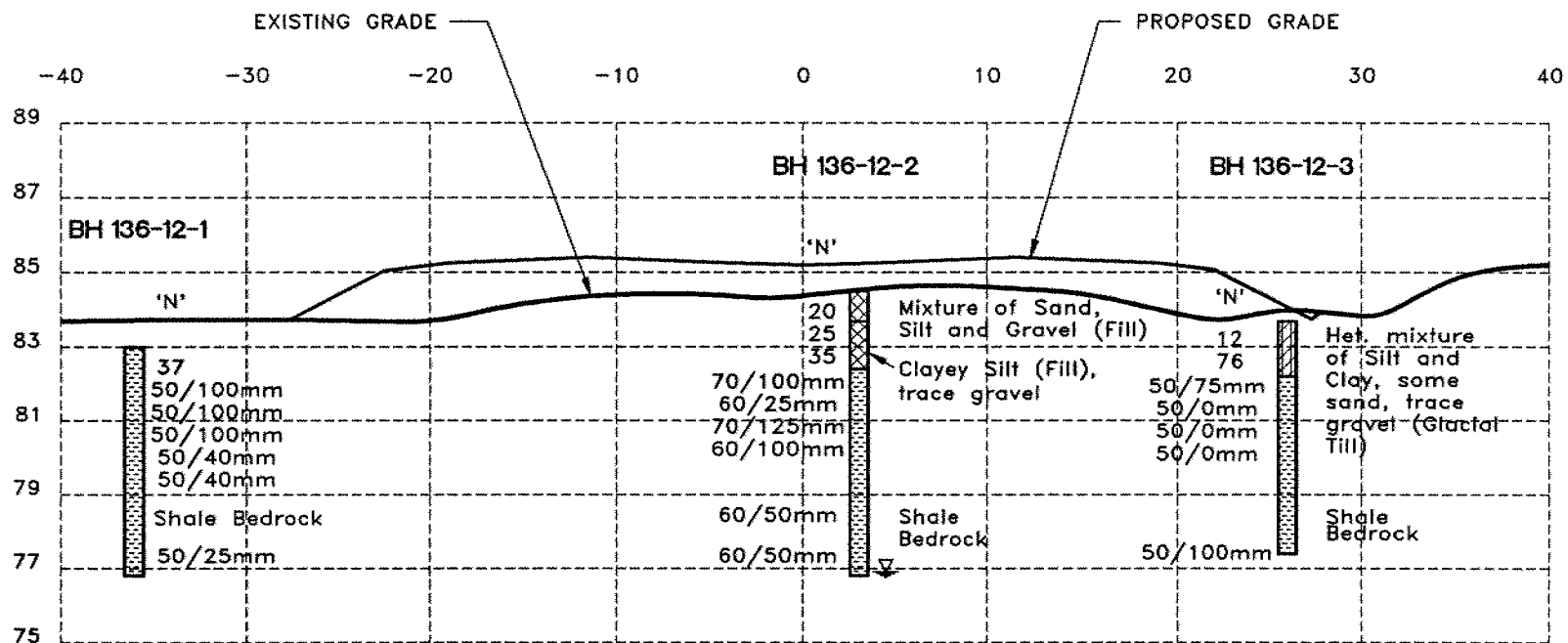
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WC 136-12 - C PROFILE STATION 12+885

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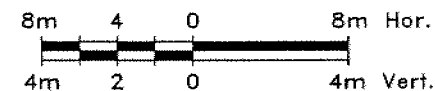
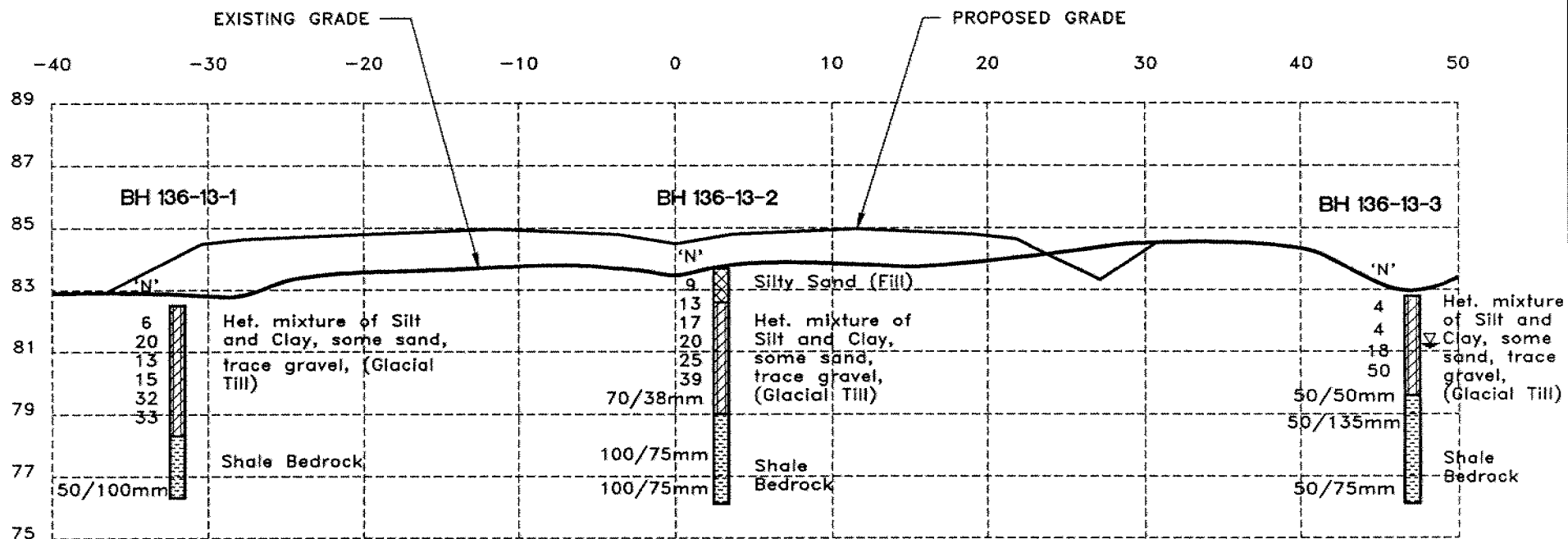
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WC 136-13 - C PROFILE STATION 13+085

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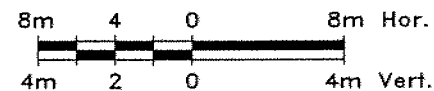
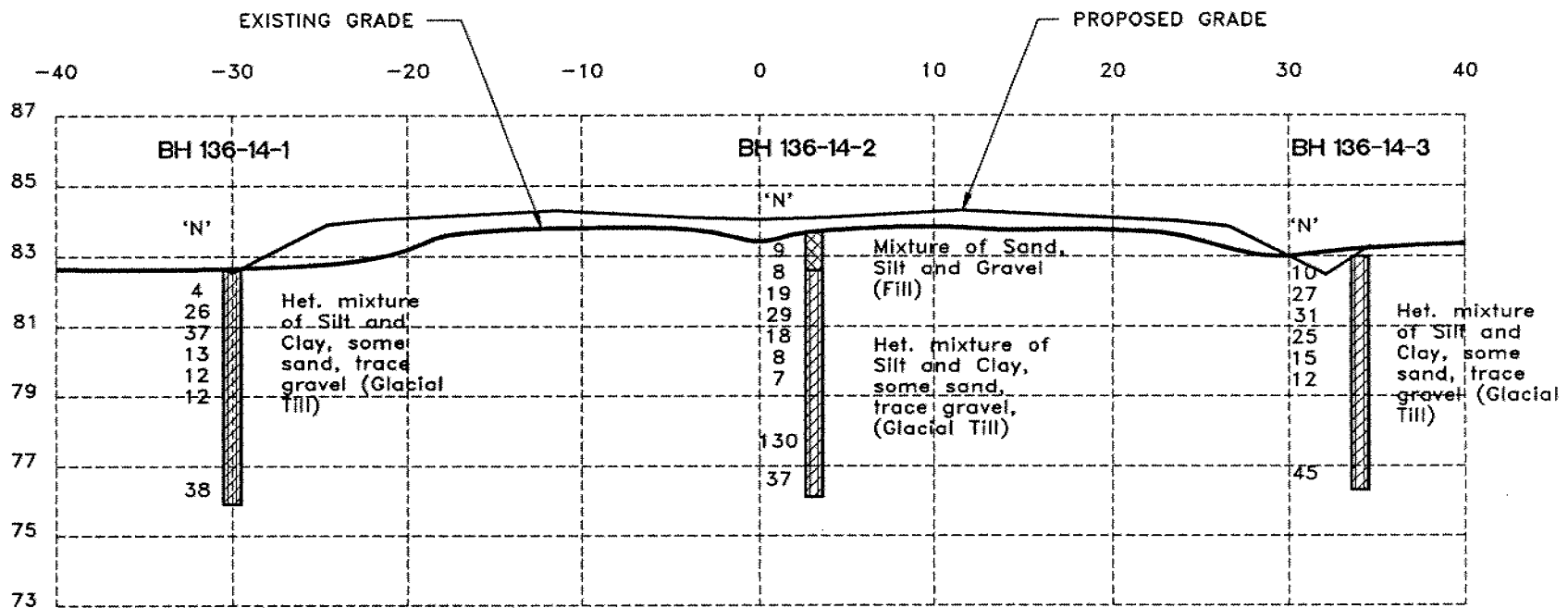
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WC 136-14 - C PROFILE STATION 13+278

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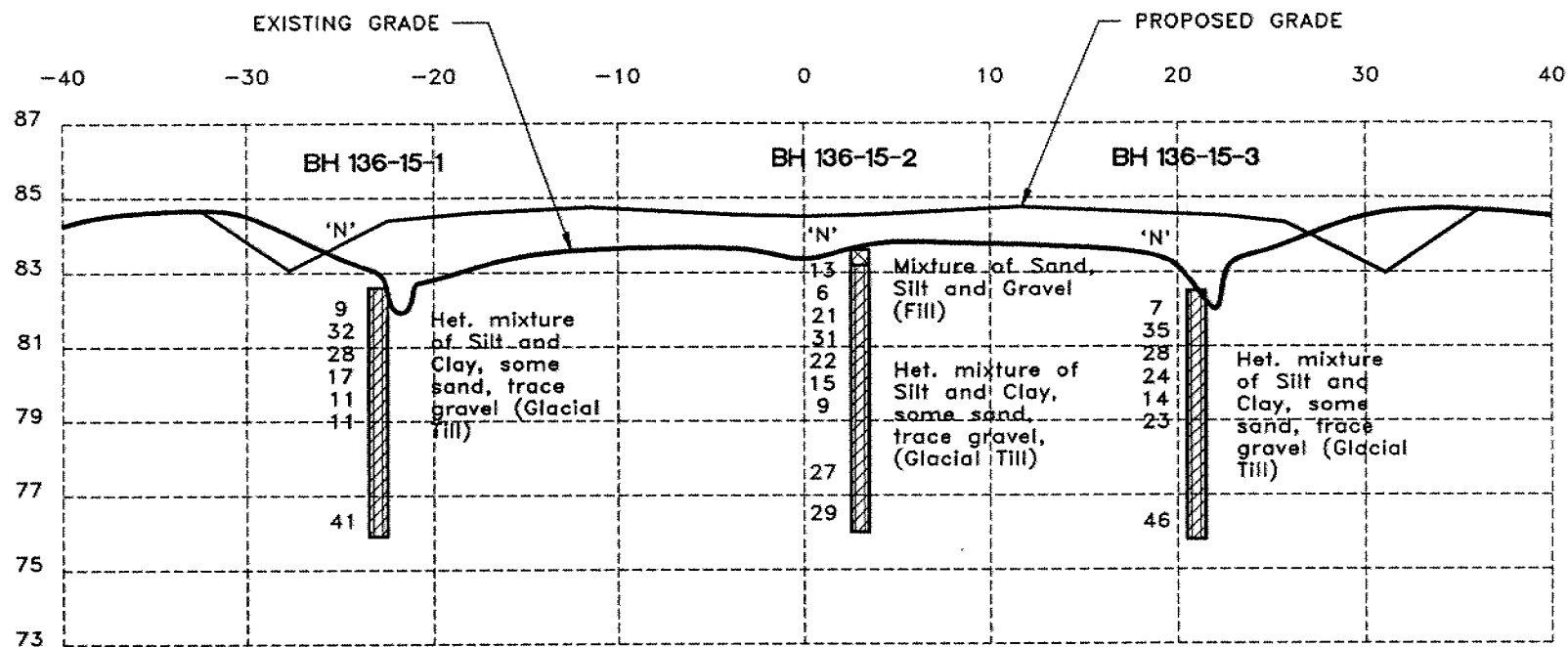
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3318900-T



WC 136-15 - C PROFILE STATION 13+499

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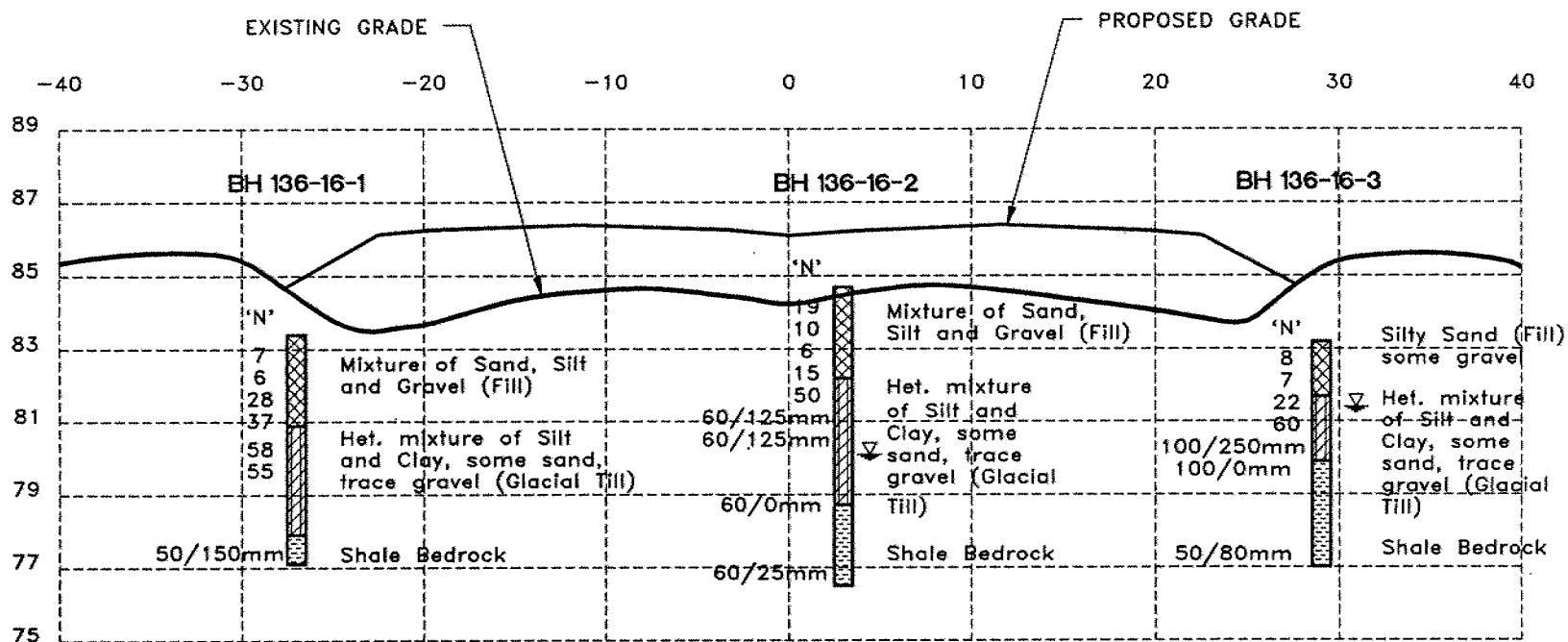
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WC 136-16 - C PROFILE STATION 13+817

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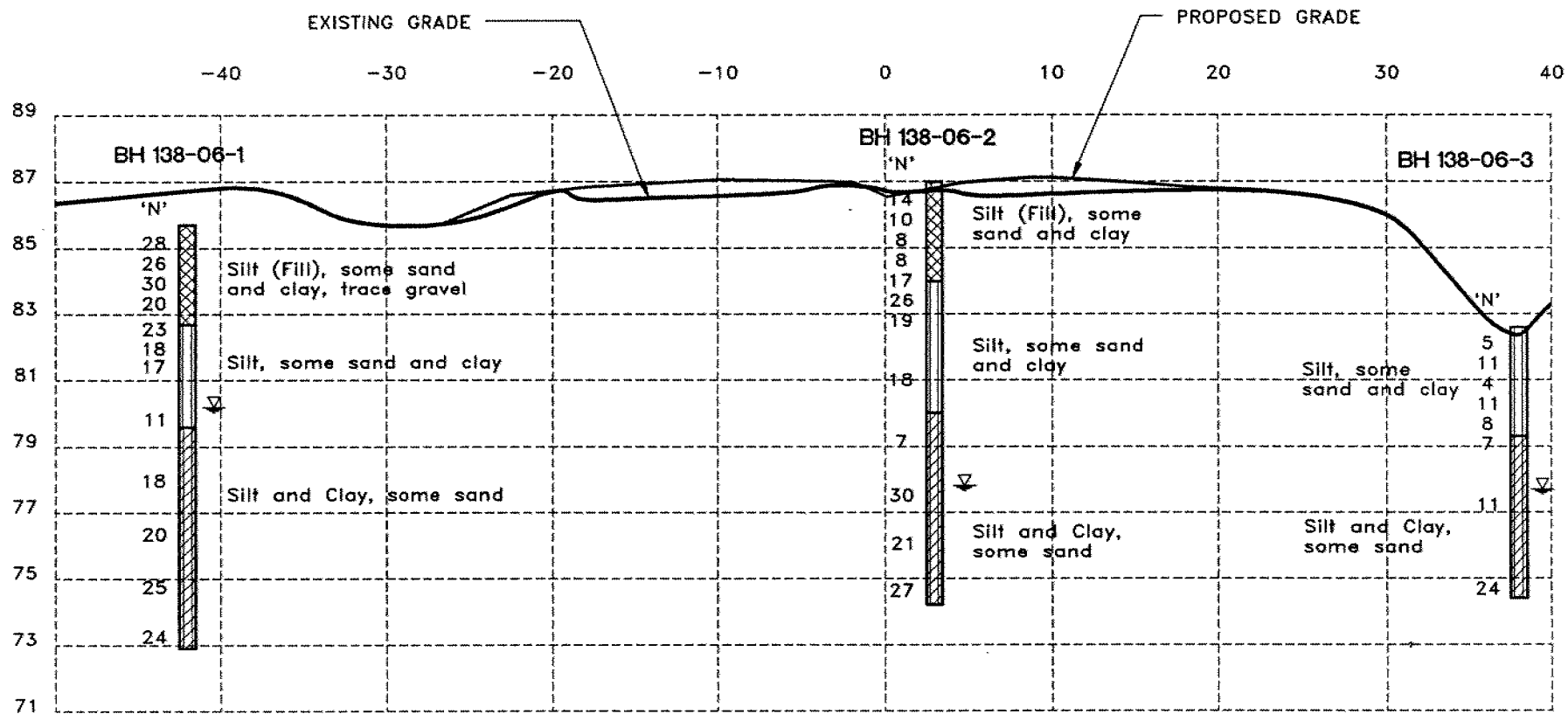
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3318900-V



WC 138-06 - C PROFILE STATION 12+489

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Dwg. No.:
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Date:
94/09/06

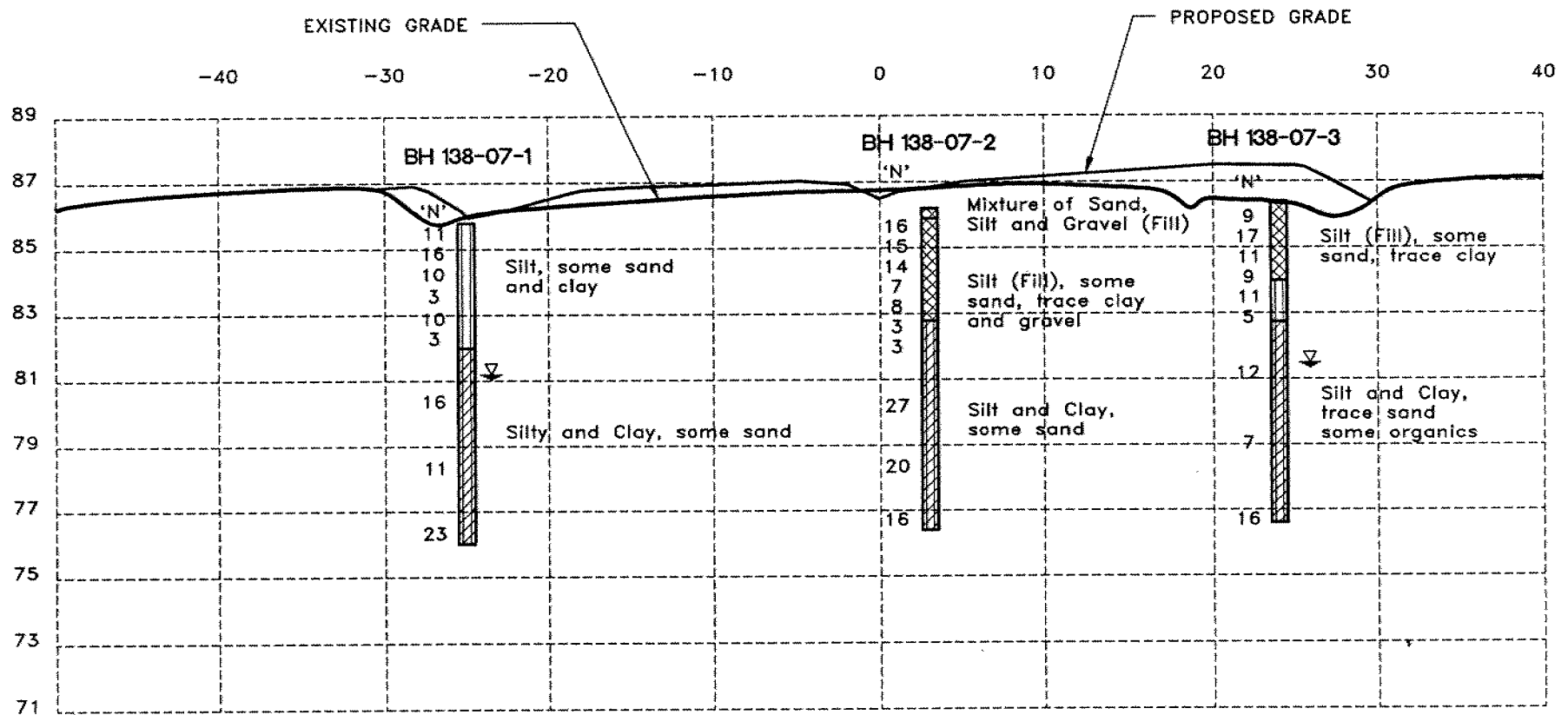
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3338900C



WC 138-07 - ϕ PROFILE STATION 13+248

Job No.:
WP 333-89-00

Dwg. No.:
3338900-D

Date:
94/09/06

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TA

Appd.:
TO



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Whitford

DOCUMENT MICROFILMING IDENTIFICATION

GEOCRES No. 30M4-70

DIST. 4 REGION

W.P. No. 319-89-00

CONT. No. 93-85

W. O. No.

STR. SITE No.

HWY. No. Q.E.W.

LOCATION Gray Rd. to Fifty Rd.
(Culverts)

No of PAGES -

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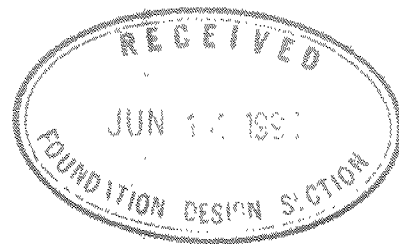
OVERSIZE DRAWINGS TO BE INCLUDED WITH THIS REPORT.

REMARKS:

G.I.-30 SEPT. 1976

FOUNDATION INVESTIGATION REPORT

CONTRACT NO. 93-85



**Ministry of
Transportation**

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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

2

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

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

SOILS ARE DESCRIBED BY THEIR COMPOSITION AND CONSISTENCY OR DENSENESS.

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

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

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

N (BLOWS/0.3m)	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_f	1	SENSITIVITY = $\frac{c_u}{\tau_r}$

PHYSICAL PROPERTIES OF SOIL

ρ_s	kg/m ³	DENSITY OF SOLID PARTICLES	e	1, %	VOID RATIO	e_{min}	1, %	VOID RATIO IN DENSEST STATE
γ_s	kn/m ³	UNIT WEIGHT OF SOLID PARTICLES	n	1, %	POROSITY	I_D	1	DENSITY INDEX = $\frac{e_{max} - e}{e_{max} - e_{min}}$
ρ_w	kg/m ³	DENSITY OF WATER	w	1, %	WATER CONTENT	D	mm	GRAIN DIAMETER
γ_w	kn/m ³	UNIT WEIGHT OF WATER	S_r	%	DEGREE OF SATURATION	D_n	mm	n PERCENT - DIAMETER
ρ	kg/m ³	DENSITY OF SOIL	w_L	%	LIQUID LIMIT	C_u	1	UNIFORMITY COEFFICIENT
γ	kn/m ³	UNIT WEIGHT OF SOIL	w_p	%	PLASTIC LIMIT	h	m	HYDRAULIC HEAD OR POTENTIAL
ρ_d	kg/m ³	DENSITY OF DRY SOIL	w_s	%	SHRINKAGE LIMIT	q	m ³ /s	RATE OF DISCHARGE
γ_d	kn/m ³	UNIT WEIGHT OF DRY SOIL	I_p	%	PLASTICITY INDEX = $w_L - w_p$	v	m/s	DISCHARGE VELOCITY
ρ_{sat}	kg/m ³	DENSITY OF SATURATED SOIL	I_L	1	LIQUIDITY INDEX = $\frac{w - w_p}{I_p}$	i	1	HYDRAULIC GRADIENT
γ_{sat}	kn/m ³	UNIT WEIGHT OF SATURATED SOIL	I_C	1	CONSISTENCY INDEX = $\frac{w_L - w}{I_p}$	k	m/s	HYDRAULIC CONDUCTIVITY
ρ'	kg/m ³	DENSITY OF SUBMERGED SOIL	e_{max}	1, %	VOID RATIO IN LOOSEST STATE	j	kn/m ³	SEEPAGE FORCE
γ'	kn/m ³	UNIT WEIGHT OF SUBMERGED SOIL						

FOUNDATION INVESTIGATION REPORT
For
Q.E.W. Culverts
(Between Gray's Road and Fifty Road)
W.P. 319-89-00
District 4, Burlington

INTRODUCTION

This report summarizes the results of a foundation investigation conducted in conjunction with nine (9) proposed reinforced concrete box culverts that will carry the Q.E.W. and in some cases the North and South Service Roads. The proposed new culverts will replace existing culverts within the site limits defined by Gray's Road and Winona Road at or adjacent to the existing culverts. The culvert replacement project is associated with the Q.E.W. widening to a 6 lane divided highway.

SITE DESCRIPTION

The site is located within the area bounded by the North Service Road and the South Service Road along the Q.E.W. corridor between Gray's Road and Fifty Road in the Town of Stoney Creek, Regional Municipality of Hamilton-Wentworth. The existing Q.E.W. is a four lane median divided highway and grassland separates the Q.E.W. and the North and South Service Roads. Nine (9) separate sites (Sites A to I inclusive) were investigated within the overall site limits.

Numerous open footing and box culverts exist within the site limits facilitating the transmission of creek waters to Lake Ontario in a northerly direction beneath the service roads and the Q.E.W. The existing culverts vary in dimension and appear to have been constructed as early as the 1930's. Minimal depths of cover (up to approximately 2 to 3 metres) generally exist above the culvert roofs. The culverts appear to be of sound quality and no significant visible signs of concrete deterioration were observed.

A number of Q.E.W. underpass structures exist within the site limits. Underpass structures proceeding from west to east include Millen Road, Fruitland Road, Glover Road and Winona Road. The structures are four span structures with approach fills in the order of magnitude of 7-8 metres. The terrain across the

site is generally flat accentuated by creek slopes at the culvert inlets and outlets. Depths of water in the creeks were shallow at the time of the investigation and generally were less than one (1) metre. As mentioned earlier, grassland covers the area between the asphaltic Q.E.W. roadway and the service roads.

Land use in the area is divided into residential north of the existing North Service Road and industrial south of the existing South Service Road. In addition, an MTO district garage is located at the South Service Road just west of Winona Road. Truck Inspection Stations are also located within the site limits.

Physiographically, the site is located in the region known as the "Iroquois Plain". The Iroquois Plain is the product of the advance and retreat of the Wisconsin ice sheet which covered the area during the Pleistocene epoch (over 12,000 years ago). The lowland bordering Lake Ontario, when the last glacier was receding was inundated by the glacial lake called Lake Iroquois at the site. Conditions in the old lake plain vary greatly within the Iroquois Plain. At the site location, overburden consists of a heterogeneous mixture of clayey silt, sand, and gravel, which is a till deposit of glacial origin. At some locations, the surficial cohesive deposit is underlain by a cohesionless heterogeneous mixture of silt, sand and gravel. The overburden at the site is underlain by shale bedrock of the Queenston Formation in thickness ranging from approximately 25 metres at the western limits of the site to approximately 10 metres at the eastern limits of the site.

INVESTIGATION PROCEDURE

Soil and rock data and inherent properties were obtained by in situ and laboratory testing. The procedures employed in the foundation investigation are discussed below.

Field Investigation

The fieldwork for the investigation was carried out between 91 10 28 and 91 11 12 and consisted of twenty-five (25) sampled boreholes advanced to depths

ranging from 12.2 m to 15.7 m below the existing ground surface. Diesel powered track mounted drilling rigs equivalent to Central Mining Equipment (CME) 55 units, were used to advance the boreholes employing conventional hollow stem augering and solid stem augering techniques. It was determined that the subsoil conditions enabled the application of solid stem augering techniques exclusively at the site which resulted in improved productivity.

Subsoil samples were retrieved at 0.7 m intervals for the surficial 6.5 m and at 1.5 m intervals thereafter. Disturbed subsoil samples were retrieved employing a standard split spoon sampler in accordance with the Standard Penetration Test (ASTM D1586). All subsoil samples were identified in the field and then placed in sealed plastic jars to ensure the preservation of the natural moisture contents. Samples were subsequently transported to the laboratory for applicable testing.

Bedrock was cored at one (1) location (site I) where shallower thicknesses of overburden were encountered. The bedrock was cored in NX size using conventional rock coring procedures. At a few locations (sites A, B, and C), in situ vane tests were conducted to determine the in situ undrained shear strength of some weaker soil present at these locations. Standard MTO 'N' vanes were used to conduct the test in accordance with ASTM D2573.

Groundwater levels were determined by monitoring the levels in the open boreholes throughout the duration of the field investigation. All boreholes were backfilled upon completion of the fieldwork.

The survey related to the location and elevations of the individual boreholes was provided by Central Region Surveys and Plans.

Laboratory Analyses

To identify the behaviour, gradation and pertinent properties of the soil present at the site, various laboratory testing were conducted. These tests included:

- 1) Atterberg Limits
- 2) Grain Size Distributions
- 3) Natural Moisture Contents
- 4) Bulk Unit Weights

The tests were carried out in accordance with standard procedures.

Laboratory test results have been summarized below in the subsequent section of this report entitled "Subsurface Conditions", and are illustrated on the corresponding boreholes and figures included in the Appendix of this report.

Subsurface Conditions

The ground surface elevation varies both within each individual site and also from site to site. The variation within each individual site is a reflection of the creek channels present at the existing culvert locations and is generally in the order of 2.5 m to 5.0 m from the top of fill material above the culvert roof to the channel floor. The ground surface elevation increases in an easterly direction from approximately 76.1 m (Site A) to 83 m (Site I).

The entire site area has been inundated by a surficial deposit of glacial till consisting of a cohesive heterogeneous mixture of clayey silt, sand and gravel with random boulders and cobbles. The deposit was explored to depths up to 15.7 m and has generally been weathered and oxidized for up to approximately 5 metres from the ground surface. Hence, the soil is generally brown within this surficial depth and grey (unoxidized) below. At some sites, the lower thickness of the deposit has taken a red colour indicative of iron oxide compounds in the soil. Some black organic enriched soil was also found within the surficial one (1) to two (2) metres at various sites.

At sites, E, F, and G the surficial native cohesive material is underlain by a cohesionless heterogeneous mixture of silt, sand and gravel. This deposit, also of glacial till origin, was found at depths of 10.7 m to 13.7 m below the ground surface. The thickness of this deposit explored ranged upto 2.0 m.

At Site I, the surficial native cohesive heterogeneous mixture of clayey silt, sand and gravel is underlain by shale bedrock at depths ranging from 9.8 m to 11.0 m (Elevation 72.3 m to 70.5 m).

The native heterogeneous mixture of clayey silt, sand and gravel is overlain by fill material at some locations across the site. At sites D, H and I for instance, thicknesses of an irregular mixture of clayey silt, sand and gravel fill material for a thickness up to approximately 2.1 metres was also encountered.

The boundaries between the various soil types, in situ and laboratory test results as well as groundwater levels established at the time of investigation are shown on the attached Record of Borehole sheets in the Appendix. A plan of the site illustrating the locations and elevations of the boreholes and a subsoil stratigraphical section are provided on Dwg. No. 3198900-A, B and C.

A detailed description of the subsurface conditions encountered is given below.

Irregular Mixture of Clayey Silt, Sand and Gravel (Fill Material)

A cohesive irregular mixture of clayey silt, sand and gravel identified as fill material was encountered at some sites extending from the surface to a depth of approximately 2.1 m. It appears that this material was used as backfill material to the existing culvert at the various sites.

A grain size distribution as determined by hydrometer and mechanical sieve analyses on a representative sample of fill material (see Record of Borehole H1 in the Appendix) reveals that approximately 89% of the material is finer than 75 micrometres.

An Atterberg Limit Test was carried out on the fine grained portion of the fill material (less than 75 micrometres) to define the behaviour and plasticity of the material. The results reveal that the material has a Liquid Limit (w L) of 34% and a Plasticity Index (I P) of 16.5%. Consequently, the material is classified as a clayey silt of low plasticity. The natural moisture content of the material is 21%.

The 'N' values as determined by the Standard Penetration Test (SPT) revealed a range of 7 blows/0.3 m to 10 blows/0.3 m for the samples retrieved in this material. This reveals a consistency ranging from firm to stiff.

Heterogeneous Mixture of Clayey Silt, Sand and Gravel (Glacial Till)

Underlying the fill material and occurring surficially elsewhere at the site, a native deposit consisting of a cohesive heterogeneous mixture of clayey silt, sand and gravel exists. Boulders and cobbles as inferred in the augering process during the borehole advancement also comprise the deposit. Random zones of a heterogeneous mixture of silt, sand and gravel are also found in this deposit. Red shale fragments are also present within the lower depths of the investigated deposit. The deposit was explored to a maximum thickness of 15.7 metres and is of minimum thickness at Site I (9.8 m thickness).

The upper 2.7 to 4.9 metres or so has been oxidized and in areas where organic material is not present within the surficial thickness, soil colour is brown. Organic dominated soils were found at some locations, usually within the surficial 2 metres and this material is black in colour. Below the oxidized and/or organic surficial material, the soil is unoxidized and grey throughout most of the deposit thickness. At some locations, the lower 2 to 3 metres is red in colour and random red zones are interbedded within the grey material.

The main component of this unsorted, unstratified deposit is the clayey silt material. This material matrix essentially binds the coarser sands and gravels within the deposit. A grain size distribution envelope for the deposit as determined by mechanical sieve and hydrometer analyses is given in Figure 1 in the Appendix. The envelope includes particle sizes up to 75 mm (coarse gravel)

and hence excludes the boulder and cobble sizes. The envelope does reveal that the fine grained portions (less than 75 micrometres) contribute to more than approximately 70% of the material of this deposit.

Atterberg Limit Tests were carried out to define the behaviour and plasticity of the fine grained portion of the soil and the results are plotted in Figure 2. A summary of the indices is provided in Table 1 below. Bulk Unit Weights are also included in the table.

Table 1 - Heterogeneous Mixture of Clayey Silt
Sand and Gravel (Glacial Till)

	Range	No. of Tests
Natural Moisture Content (w%)	13-21	29
Liquid Limit (w L %)	22-35	29
Plastic Limit (w P %)	14-18	29
Plasticity Index (I P %)	10-18	29
Unit Weight (kN/m ³)	19-22.3	29

The test results reveal that the fine grained portion of the deposit is of low plasticity and hence is defined as clayey silt. Natural moisture contents are generally less than or equivalent to the plastic limit of the soil indicating that the soil is in a plastic to semi-solid state.

The results of Atterberg Limit Test conducted on an organic enriched material retrieved at a depth of 1.5 m at BH B2 revealed a liquid limit (w L %) of 66%, a plasticity index (I P %) of 31% and a natural moisture content (w%) of 45%. This material would plot as an organic clay of high plasticity on the plasticity chart.

Standard Penetration Test (SPT) carried out in this deposit revealed 'N' values ranging from 5 blows/0.3 m to 54 blows/0.3 m revealing a probable firm to hard range of soil consistency. The lower values are generally indicative of localized weaker material and/or organic enriched material. In general, 'N' values are in the 12 blows/0.3 m to 25 blows/0.3 m and hence the soil is considered as stiff to very stiff.

At depths where the 'N' values were considered "low" (usually less than 10 blows/0.3 m), in situ vane tests were conducted. In general, the vanes could not be torqued and undrained shear strength values exceeded 100 kPa. The minimum undrained shear strength value obtained was 80 kPa but this lower value can be considered as an isolated weak zone within the deposit. It should be cautioned, however, that the presence of the coarse grained sand and gravel in the deposit may have influenced the accuracy of the test. It is concluded however, that the consistency ranges from stiff to hard.

Heterogeneous Mixture of Silt, Sand and Gravel (Glacial Till)

At Sites E, F, and G the cohesive heterogeneous mixture of clayey silt, sand and gravel is underlain by a cohesionless heterogeneous mixture of silt, sand and gravel at a depth ranging from 10.7 m to 13.7 m (Elevation 69.4 m to 71.8 m). Layers of silt with some sand are also present in this deposit in thicknesses up to approximately 0.5 m. The deposit is red in colour and as inferred by auger grinding, boulders and cobbles are also present within this deposit. Red shale fragments are also contained within the deposit.

Grain Size Distribution curves illustrating the gradation of the deposit and determined by mechanical sieve and hydrometer analysis are shown in Figure 3 in the Appendix. Boulder and cobble sizes are not illustrated on the Figure.

Standard Penetration Tests carried out in this deposit revealed 'N' values ranging from 77 blows/0.3 m to 100 blows/0.2 m indicating that the deposit is in a very dense state of denseness.

Bedrock

Shale bedrock with interbedded siltstone of the Queenston Shale Formation underlies the overburden at Site I at a depth of 9.8 m to 11 m (Elevation 72.3 m to 70.5 m). Bedrock core was retrieved in NX size for a thickness of 2.84 m at BH I2.

The shale bedrock is generally greyish red and has randomly interbedded greenish grey siltstone layers. The rock is horizontally bedded and is an extremely friable material. The rock contains moderately close to extremely closed spaced

fractures that are generally flat, planar to undulating and smooth. The rock generally is unweathered to slightly weathered.

Core recoveries and Rock Quality Designations (RQD) were determined in situ to evaluate the competence and integrity of the rock. Core recoveries were 100% and RQD's ranged from 52% to 74%. Based on these measurements, the rock can be considered to be of fair quality.

Based on index property identification, the rock is classified as weak to very weak in strength.

GROUNDWATER CONDITIONS

Observation of the groundwater level was carried out by measuring the water level in the open boreholes throughout the duration of the field investigation. Groundwater levels, in general, are depressed at depths ranging from 10 m to 12 m below the natural ground surface (Elevation 66 m to 68 m).

Groundwater levels were however at some locations measured at shallow depths ranging from 2 to 4 metres below the natural ground surface (76.5 m to 77 m). These water levels illustrate the effect of the subartesian condition present in the heterogeneous mixture of silt, sand and gravel deposit below the cohesive heterogeneous mixture of clayey silt, sand and gravel.

Groundwater levels were not established at the borehole locations advanced on the shoulders of the Q.E.W. and the Service Roads because these boreholes were backfilled immediately for safety reasons.

Groundwater levels, in general, are subject to seasonal fluctuations and hence can vary from the values given in this report.

MISCELLANEOUS

The fieldwork for this investigation was carried out under the supervision of T. Sangiuliano, Foundation Engineer and F. Reijerse, Student Engineer, utilizing equipment owned and operated by Malone's Soil Samples.

The project was carried out by T. Sangiuliano under the general supervision of P. Payer, Senior Foundation Engineer. The report was written by T. Sangiuliano, reviewed by P. Payer and approved by M. Devata, Chief Foundation Engineer.



A handwritten signature in dark ink, appearing to read "P. Payer".

P. Payer, P. Eng.
Senior Foundation Engineer

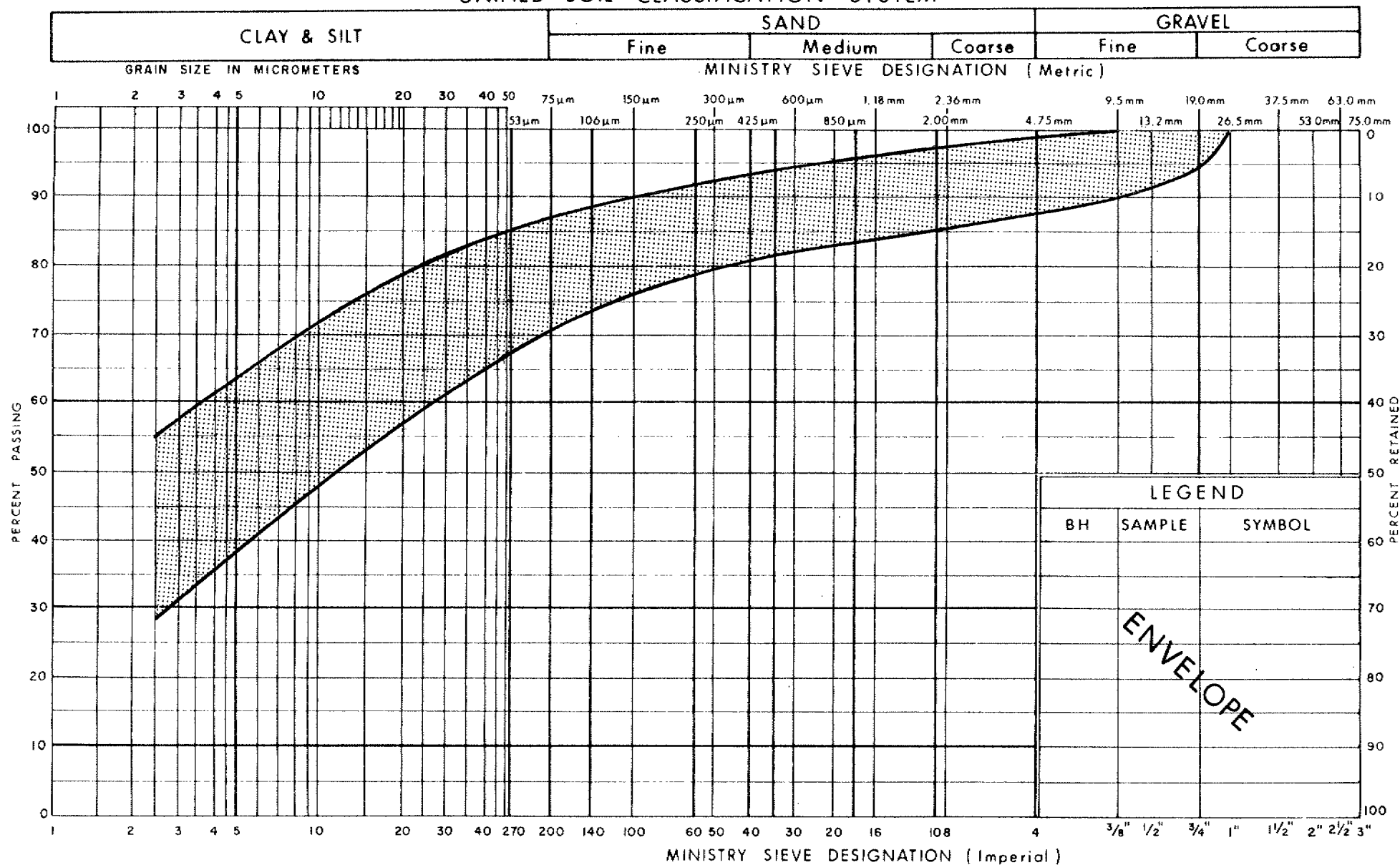


A handwritten signature in dark ink, appearing to read "M.S. Devata".

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

APPENDIX

UNIFIED SOIL CLASSIFICATION SYSTEM

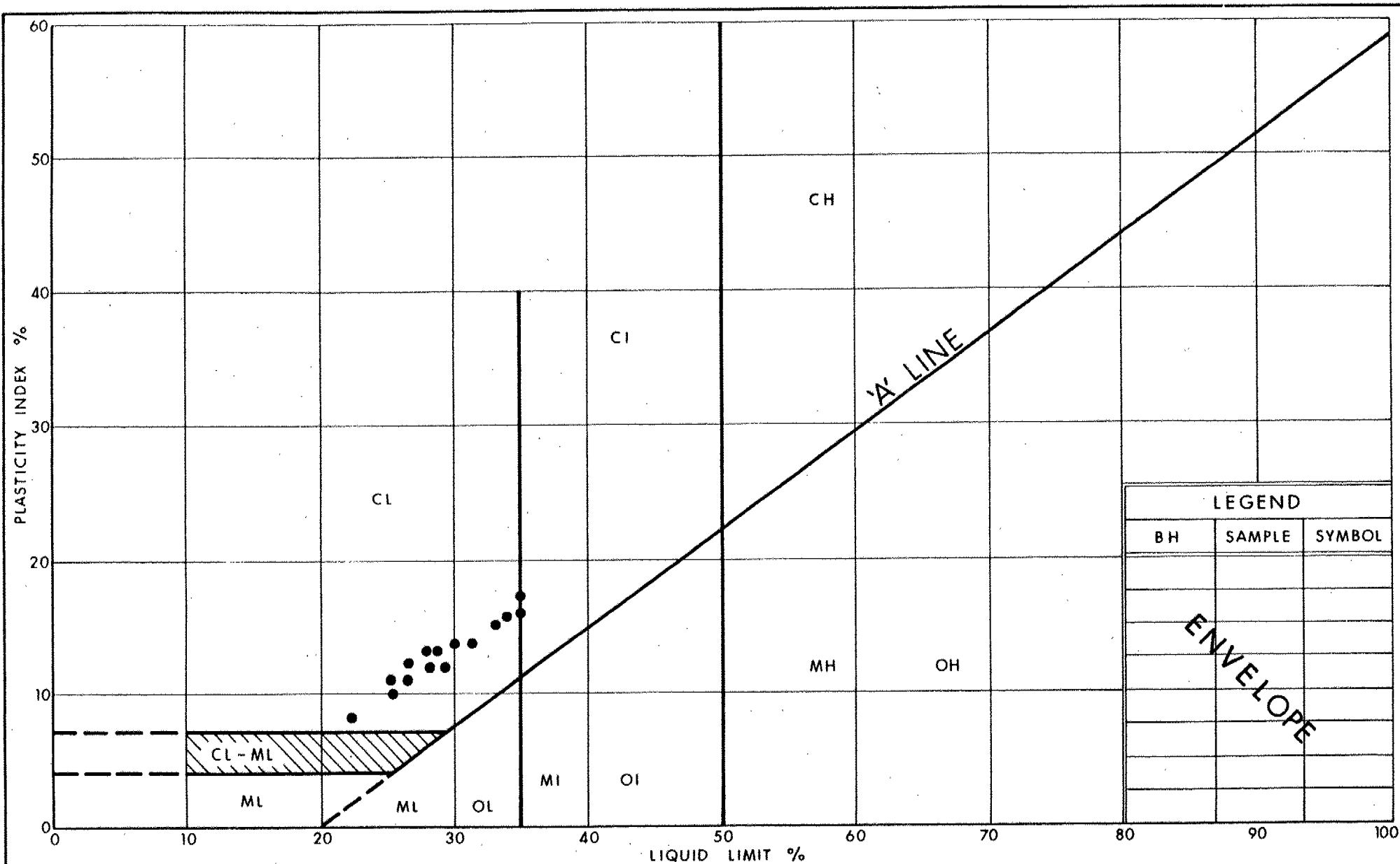


Ministry of
Transportation

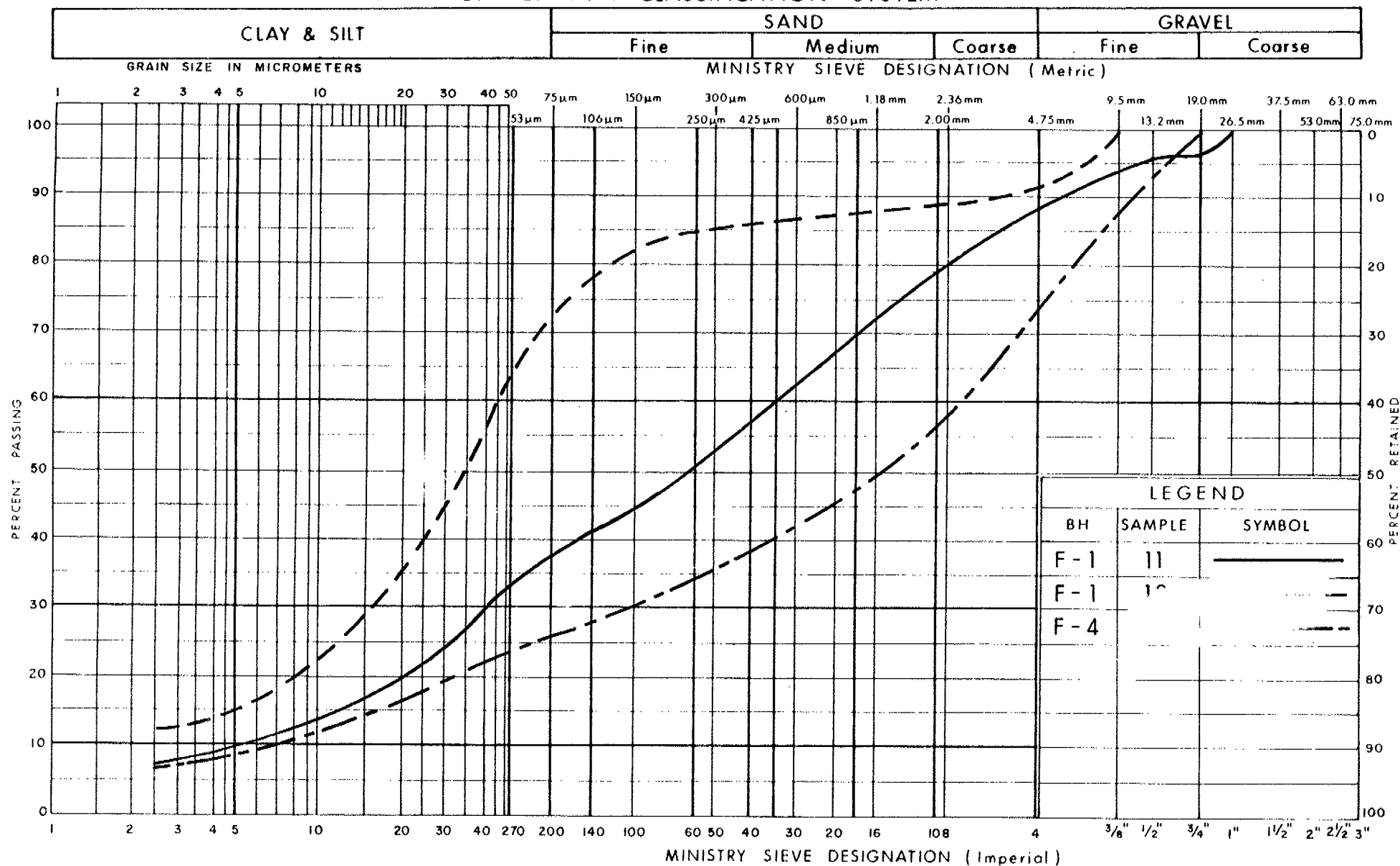
GRAIN SIZE DISTRIBUTION
HET MIXTURE OF CLAYEY SILT
SAND & GRAVEL (Glacial Till)

FIG No 1

W P 319 - 89 - 00



UNIFIED SOIL CLASSIFICATION SYSTEM



Ministry of
Transportation

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

FIG No 3

W P 319-89-00

ROCK CORE DESCRIPTION

WP 319-89-00

Page 1 of 1

CORE RECOVERY					CORE DESCRIPTION	
BH#	RC#	DEPTH (m)	% CR*	% RQD*	DEPTH (m)	DESCRIPTION
I2	11	9.60-10.92	100	51	9.60-12.44	SHALE, greyish red, with interbedded greenish grey SILTSTONE (18%); very fine grained; weak to very weak; unweathered to slightly weathered (moderately weathered, 9.60-9.75 m and 10.87-10.92 m); fractures moderately close to extremely close spaced, flat to near vertical, planar to undulating, smooth.
	12	10.92-12.44	100	74		

*CR = CORE RECOVERY

*RQD = ROCK QUALITY DESIGNATION

(NOTE: Depths are approximated where core recovery is less than 100%)

Logged by: DAW, Soils and Aggregates Section

RECORD OF BOREHOLE No A-1

1 OF 1

METRIC

W.P. 319-89-00 LOCATION Co-ords: N 4 788 623; E 286 160 ORIGINATED BY TS
DIST 4 HWY Q.E.W. BOREHOLE TYPE HS Auger COMPILED BY TS
DATUM Geodetic DATE 91 10 28 CHECKED BY PP

SOIL PROFILE			SAMPLES			GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT		PLASTIC LIMIT NATURAL MOISTURE CONTENT LIQUID LIMIT			UNIT WEIGHT 7 kN/m ³	REMARKS & GRAIN SIZE DISTRIBUTION (%) GR SA SI CL
ELEV DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE	'N' VALUES			20 40 60 80 100	20 40 60 80 100	W _p	W	W _L		
76.6	Ground Surface													
0.0	Black, some Organics Brown		1	SS	25									
			2	SS	22									
			3	SS	18									
			4	SS	32									
	Grey		5	SS	24									
			6	SS	12									
	Heterogeneous Mixture of Clayey Silt, Sand and Gravel (Glacial Till)		7	SS	33									
			8	SS	20									
	Very Stiff to Hard		9	SS	14									
			10	SS	15									
			11	SS	21									
			12	SS	19									
60.9			13	SS	20									
15.7	End of Borehole # 91 10 29													

RECORD OF BOREHOLE No A-2

1 of 1

METRIC

W.P. 319-89-00 LOCATION Co-ords: N 4 788 675:E 286 146 ORIGINATED BY FR
DIST 4 HWY Q.E.W. BOREHOLE TYPE HS Auger COMPILED BY TS
DATUM Geodetic DATE 91 10 31 CHECKED BY PP

SOIL PROFILE			SAMPLES			GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT					PLASTIC LIMIT w _p	NATURAL MOISTURE CONTENT w	LIQUID LIMIT w _L	UNIT WEIGHT γ	REMARKS & GRAIN SIZE DISTRIBUTION (%)
ELEV DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE	'N' VALUES			20	40	60	80	100					
76.1	Ground Surface																
0.0	Black, some organics, Firm Brown, Grey		1	SS	7												
			2	SS	23												
			3	SS	17												
			4	SS	16												
			5	SS	16												
			6	SS	16												
			7	SS	11												
			8	SS	9												
	Heterogeneous Mixture of Clayey Silt, Sand and Gravel (Glacial Till) Stiff to Very Stiff		9	SS	12												
			10	SS	8												
			11	SS	14												
63.5			12	SS	15												
12.6	End of Borehole • 91 11 01																

RECORD OF BOREHOLE No B-1

1 OF 1

METRIC

W.P. 319-89-00 LOCATION Co-ords: N 4 788 514; E 286 485 ORIGINATED BY FR
DIST 4 HWY Q.E.W. BOREHOLE TYPE HS Auger COMPILED BY TS
DATUM Geodetic DATE 91 10 29 CHECKED BY PP

SOIL PROFILE		SAMPLES			GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT					PLASTIC NATURAL LIQUID LIMIT MOISTURE CONTENT LIMIT			UNIT WEIGHT γ kN/m ³	REMARKS & GRAIN SIZE DISTRIBUTION (%) GR SA SI CL
ELEV DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE	'N' VALUES		20	40	60	80	100	W _P	W	W _L		
77.0	Ground Surface															
0.0	Black, some Organics		1	SS	6											
	Firm		2	SS	5											
	Brown, trace Organics		3	SS	9											
			4	SS	22											
			5	SS	20											
			6	SS	16											
	Grey		7	SS	13											
			8	SS	13											
	Heterogeneous Mixture of Clayey Silt, Sand and Gravel (Glacial Till)		9	SS	12											
	Stiff to Very Stiff		10	SS	10											
			11	SS	13											
64.4			12	SS	13											
12.6	End of Borehole															
	• 91 10 30															

RECORD OF BOREHOLE No B-2

1 OF 1

METRIC

W.P. 319-89-00 LOCATION Co-ords: N 4 788 549; E 286 508 ORIGINATED BY FR
DIST 4 HWY G.E.W. BOREHOLE TYPE HS Auger COMPILED BY TS
DATUM Geodetic DATE 91 10 30 CHECKED BY PP

SOIL PROFILE			SAMPLES			GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT					PLASTIC LIMIT W _p	NATURAL MOISTURE CONTENT W	LIQUID LIMIT W _L	UNIT WEIGHT γ	REMARKS & GRAIN SIZE DISTRIBUTION (%)
ELEV DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE	'N' VALUES			20	40	60	80	100					
77.7	Ground Surface																
0.0	trace Organics		1	SS	7		76										
	Firm		2	SS	8												
			3	SS	10		74										
			4	SS	18												
	Brown		5	SS	20		72										
	Grey		6	SS	15												
			7	SS	13		70										
	Heterogenous Mixture of Clayey Silt, Sand and Gravel (Glacial Till)		8	SS	13		68										
	Stiff to Very Stiff		9	SS	19		66										
65.1			10	SS	21												
12.6	End of Borehole • 91 10 31																

RECORD OF BOREHOLE No C-1

1 OF 1

METRIC

W.P. 319-89-00 LOCATION Co-ords: N 4 788 409; E 286 829 ORIGINATED BY FR
DIST 4 HWY Q.E.W. BOREHOLE TYPE HS Auger COMPILED BY TS
DATUM Geodetic DATE 91 10 29 CHECKED BY PP

SOIL PROFILE			SAMPLES			GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT					UNIT WEIGHT 7 kN/m ³	REMARKS & GRAIN SIZE DISTRIBUTION (%) GR SA SI CL
ELEV DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE	'N' VALUES			20 40 60 80 100	20 40 60 80 100	20 40 60 80 100	20 40 60 80 100	20 40 60 80 100		
78.2	Ground Surface													
0.0			1	SS	7									
	Black, some Organics		2	SS	6									
	Red		3	SS	12									
	Brown		4	SS	16									
			5	SS	19									
			6	SS	21									
	Grey		7	SS	16									
			8	SS	13									
	Heterogeneous Mixture of Clayey Silt, Sand and Gravel (Glacial Till)		9	SS	12									
	Stiff to Very Stiff		10	SS	11									
			11	SS	15									
65.6			12	SS	27									
12.6	End of Borehole													
	* 91 10 30													

RECORD OF BOREHOLE No C-2

1 OF 1

METRIC

W.P. 319-89-00 LOCATION Co-ords: N 4 788 457; E 286 800 ORIGINATED BY FR
DIST 4 HWY Q.E.W. BOREHOLE TYPE HS Auger COMPILED BY TS
DATUM Geodetic DATE 91 10 30 CHECKED BY PP

SOIL PROFILE			SAMPLES			GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT					PLASTIC LIMIT W _p	NATURAL MOISTURE CONTENT W	LIQUID LIMIT W _L	UNIT WEIGHT γ kN/m ³	REMARKS & GRAIN SIZE DISTRIBUTION (%) GR SA SI CL
ELEV DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE	'N' VALUES			20	40	60	80	100					
76.8	Ground Surface																
0.0	Black, trace Organics Brown		1	SS	23		76										
			2	SS	5		74										
			3	SS	22		72										
			4	SS	18		70										
	Grey		5	SS	13		68										
			6	SS	12		66										
			7	SS	14												
	Heterogenous Mixture of Clayey Silt, Sand and Gravel (Glacial Till)		8	SS	15												
	Stiff to Very Stiff		9	SS	25												
64.2			10	SS	26												
			11	SS	30												
12.6	End of Borehole * 91 10 31																

RECORD OF BOREHOLE No D-1

1 OF 1

METRIC

W.P. 319-89-00 LOCATION Co-ords: N 4 788 049; E 287 778 ORIGINATED BY FR
DIST 4 HWY O.E.W. BOREHOLE TYPE SS Auger COMPILED BY TS
DATUM Ceodetic DATE 91 11 01 CHECKED BY PP

SOIL PROFILE			SAMPLES			GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT					PLASTIC LIMIT w _p	NATURAL MOISTURE CONTENT w	LIQUID LIMIT w _L	UNIT WEIGHT γ	REMARKS & GRAIN SIZE DISTRIBUTION (%) GR SA SI CL
ELEV DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE	'N' VALUES			20	40	60	80	100					
79.8	Ground Surface																
0.0 79.0	Sand and Gravel (Fill Material)					*											
0.8	Firm		1	SS	5		78										
			2	SS	29												
			3	SS	22												
	Brown		4	SS	17		76										
	Grey		5	SS	12												
			6	SS	25												
			7	SS	14		74										
	Heterogeneous Mixture of Clayey Silt, Sand and Gravel (Glacial Till)		8	SS	13												
			9	SS	14		72										
	Stiff to Very Stiff		10	SS	14		70										
			11	SS	12												
67.2			12	SS	16		68										
12.6	End of Borehole • CWL not established																

RECORD OF BOREHOLE No D-2

1 OF 1

METRIC

W.P. 319-89-00 LOCATION Co-ords: N4 788 077; E 287 788 ORIGINATED BY FR
DIST 4 HWY Q.E.W. BOREHOLE TYPE HS Auger COMPILED BY TS
DATUM Geodetic DATE 91 10 31 to 91 11 01 CHECKED BY PP

SOIL PROFILE			SAMPLES			GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT					PLASTIC LIMIT w _p	NATURAL MOISTURE CONTENT w	LIQUID LIMIT w _L	UNIT WEIGHT γ kN/m ³	REMARKS & GRAIN SIZE DISTRIBUTION (%) GR SA SI CL
ELEV DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE	'N' VALUES			20 40 60 80 100	20 40 60 80 100	20 40 60 80 100	20 40 60 80 100	20 40 60 80 100					
79.1	Ground Surface																
0.0			1	SS	23		78										
			2	SS	27												
			3	SS	21												
	Brown Grey		4	SS	13		76									21.4	2 22 44 32
			5	SS	13												
			6	SS	24												
			7	SS	13		74										
	Heterogeneous Mixture of Clayey Silt, Sand and Gravel (Glacial Till)		8	SS	12											21.8	7 15 45 33
	Stiff to Very Stiff.		9	SS	14		72										
			10	SS	15		70										
			11	SS	22												
66.5			12	SS	20		68										
12.6	End of Borehole																
	• 91 11 02																

RECORD OF BOREHOLE No D-3

1 OF 1

METRIC

W.P. 319-89-00 LOCATION Co-ords: N 4 788 128; E 287 805 ORIGINATED BY FR
DIST 4 HWY Q.E.W. BOREHOLE TYPE SS Auger COMPILED BY TS
DATUM Geodetic DATE 91 11 04 CHECKED BY PP

SOIL PROFILE			SAMPLES			GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT					PLASTIC LIMIT W _P	NATURAL MOISTURE CONTENT W	LIQUID LIMIT W _L	UNIT WEIGHT 7 kN/m ³	REMARKS & GRAIN SIZE DISTRIBUTION (%) GR SA SI CL
ELEV DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE	'N' VALUES			20	40	60	80	100					
78.3	Ground Surface																
0.0			1	SS	26		78										
			2	SS	21												
			3	SS	15		76										
	Brown		4	SS	15												
	Grey		5	SS	12		74										
			6	SS	13												
	Heterogeneous Mixture of		7	SS	12		72										
	Clayey Silt, Sand and Gravel		8	SS	14												
	(Glacial Till)																
	Stiff to Very Stiff		9	SS	17		70										
			10	SS	17												
			11	SS	22		68										
65.7	Hard		12	SS	49		66										
12.6	End of Borehole																
	* 91 11 05																

RECORD OF BOREHOLE No D-4

1 OF 1

METRIC

W.P. 319-89-00 LOCATION Co-ords: N 4 788 171; E 287 805 ORIGINATED BY FR
DIST 4 HWY Q.E.W. BOREHOLE TYPE SS Auger COMPILED BY TS
DATUM Geodetic DATE 91 11 04 CHECKED BY PP

SOIL PROFILE			SAMPLES			GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT					PLASTIC LIMIT W _p	NATURAL MOISTURE CONTENT W	LIQUID LIMIT W _L	UNIT WEIGHT γ kN/m ³	REMARKS & GRAIN SIZE DISTRIBUTION (%) GR SA SI CL
ELEV DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE	'N' VALUES			20	40	60	80	100					
78.3	Ground Surface																
0.0			1	SS	20		78										
			2	SS	30												
			3	SS	18		76										
			4	SS	20												
	Brown		5	SS	12		74										
	Grey		6	SS	16												
	Heterogeneous Mixture of		7	SS	12												
	Clayey Silt, Sand and Gravel		8	SS	10		72										
	(Glacial Till)																
	Stiff to Very Stiff		9	SS	13		70										
			10	SS	20												
			11	SS	20		68										
65.7			12	SS	28		66										
12.6	End of Borehole																
	* 91 11 05																

RECORD OF BOREHOLE No E-1

1 OF 1

METRIC

W.P. 319-89-00 LOCATION Co-ords: N 4 787 897; E 288 323 ORIGINATED BY FR
DIST 4 HWY Q.E.W. BOREHOLE TYPE SS Auger COMPILED BY TS
DATUM Geodetic DATE 91 11 01 CHECKED BY PP

SOIL PROFILE			SAMPLES			GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT					PLASTIC LIMIT W _p	NATURAL MOISTURE CONTENT w	LIQUID LIMIT W _L	UNIT WEIGHT γ	REMARKS & GRAIN SIZE DISTRIBUTION (%)
ELEV DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE	'N' VALUES			20	40	60	80	100					
78.5	Ground Surface																
0.0			1	SS	23		78										
			2	SS	35												
	Brown		3	SS	27		76									21.4	6 24 44 26
	Grey		4	SS	25												
			5	SS	20												
	Heterogeneous Mixture of Clayey Silt, Sand and Gravel (Glacial Till)		6	SS	19		74										
			7	SS	20												
	Stiff to Very Stiff		8	SS	17		72										
			9	SS	14		70									22.0	1 21 48 30
			10	SS	19												
64.8			11	SS	22		68										
			12	SS	29		66										
13.7	Heterogeneous Mixture of Silt, Sand and Gravel (Glacial Till)		13	SS	60	/13cm	64										
62.8	Red, Very Dense		14	SS	100												
15.7	End of Borehole • 91 11 04 (subartesian condition)																

RECORD OF BOREHOLE No E-2

1 OF 1

METRIC

W.P. 319-89-00 LOCATION Co-ords: N 4 787 954; E 288 361 ORIGINATED BY FR
DIST 4 HWY Q.E.W. BOREHOLE TYPE SS Auger COMPILED BY TS
DATUM Geodetic DATE 91 11 05 CHECKED BY PP

SOIL PROFILE			SAMPLES			GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT					PLASTIC LIMIT w _p	NATURAL MOISTURE CONTENT w	LIQUID LIMIT w _L	UNIT WEIGHT γ kN/m ³	REMARKS & GRAIN SIZE DISTRIBUTION (%) GR SA SI CL
ELEV DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE	'N' VALUES			20	40	60	80	100					
77.8	Ground Surface																
0.0	Firm		1	SS	6												
			2	SS	17												
			3	SS	26												
	Brown		4	SS	23												
	Grey		5	SS	20												
			6	SS	15												
			7	SS	22												
			8	SS	18												
	Heterogeneous Mixture of Clayey Silt, Sand and Gravel (Glacial Till)		9	SS	18												
	Very Stiff to Hard		10	SS	36												
			11	SS	27												
65.2			12	SS	24												
12.6	End of Borehole = 91 11 06																

RECORD OF BOREHOLE No F-1

1 OF 1

METRIC

W.P. 319-89-00 LOCATION Co-ords: N 4 787 618; E 289 082 ORIGINATED BY FR
DIST 4 HWY Q.E.W. BOREHOLE TYPE SS Auger COMPILED BY TS
DATUM Geodetic DATE 91 11 05 CHECKED BY PP

SOIL PROFILE			SAMPLES			GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT					PLASTIC LIMIT w _p	NATURAL MOISTURE CONTENT w	LIQUID LIMIT w _L	UNIT WEIGHT γ	REMARKS & GRAIN SIZE DISTRIBUTION (%)
ELEV DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE	'N' VALUES			20	40	60	80	100					
80.1	Ground Surface																
0.0			1	SS	16		78									21.6	3 17 44 36
			2	SS	30												
			3	SS	26												
	Brown		4	SS	20												
	Grey		5	SS	14		76										
			6	SS	15												
	Heterogeneous Mixture of Clayey Silt, Sand and Gravel		7	SS	32												
	(Glacial Till)		8	SS	17		74									21.2	8 18 42 32
	Stiff to Hard		9	SS	24		72										
69.4			10	SS	22		70										
10.7	Heterogeneous Mixture of Silt, Sand and Gravel (Glacial Till) Red, Very Dense		11	SS	100	/20cm	68										12 50 33 5
67.5	Silt, trace Sand		12	SS	110												8 18 61 13
12.6	End of Borehole																
	• 91 11 07																

RECORD OF BOREHOLE No F-2

1 OF 1

METRIC

W.P. 319-89-00 LOCATION Co-ords: N 4 787 655; E 289 087 ORIGINATED BY PC
DIST 4 HWY Q.E.W. BOREHOLE TYPE SS Auger COMPILED BY TS
DATUM Ceodetic DATE 91 11 05 CHECKED BY PP

SOIL PROFILE			SAMPLES			GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT					PLASTIC LIMIT w _p	NATURAL MOISTURE CONTENT w	LIQUID LIMIT w _L	UNIT WEIGHT γ	REMARKS & GRAIN SIZE DISTRIBUTION (%)
ELEV DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE	'N' VALUES			20	40	60	80	100					
79.9	Ground Surface																
0.0			1	SS	24												
			2	SS	34												
			3	SS	33												
			4	SS	15												
			5	SS	13												
			6	SS	13												
			7	SS	14												
			8	SS	19												
			9	SS	16												
			10	SS	22												
69.2																	
10.7	Heterogeneous Mixture of Silt, Sand and Gravel (Glacial Till) Red, Very Dense		11	SS	93												
67.3	Silt, trace Sand		12	SS	77												
12.6	End of Borehole = 91 11 05 subortesian condition																

RECORD OF BOREHOLE No F-3

1 OF 1

METRIC

W.P. 319-89-00 LOCATION Co-ords: N 4 787 690; E 289 096 ORIGINATED BY TS
DIST 4 HWY Q.E.W. BOREHOLE TYPE SS Auger COMPILED BY TS
DATUM Geodetic DATE 91 11 08 CHECKED BY PP

SOIL PROFILE		SAMPLES			GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT					PLASTIC NATURAL LIQUID LIMIT MOISTURE CONTENT			UNIT WEIGHT γ kN/m ³	REMARKS & GRAIN SIZE DISTRIBUTION (%) GR SA SI CL
ELEV DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE			'N' VALUES	20	40	60	80	100	W _P	W		
79.4	Ground Surface															
0.0			1	SS	26											
			2	SS	23											
			3	SS	21											
	Brown Grey		4	SS	17											
			5	SS	16											
			6	SS	13											
			7	SS	14											
	Heterogeneous Mixture of Clayey Silt, Sand and Gravel (Glacial Till) Stiff to Very Stiff		8	SS	16											
			9	SS	19											
			10	SS	20											
			11	SS	25											
67.2																
12.2	Het. Mixt. of Silt, Sand & Gravel															
66.8	(Glacial Till) Very Dense		12	SS	100											
12.6	End of Borehole • 91 11 11															

RECORD OF BOREHOLE No F-4

1 OF 1

METRIC

W.P. 319-89-00 LOCATION Co-ords: N 4 787 724; E 289 108 ORIGINATED BY TS
DIST 4 HWY Q.E.W. BOREHOLE TYPE SS Auger COMPILED BY TS
DATUM Geodetic DATE 91 11 08 CHECKED BY PP

SOIL PROFILE			SAMPLES			GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT					UNIT WEIGHT γ kN/m ³	REMARKS & GRAIN SIZE DISTRIBUTION (%) GR SA SI CL
ELEV DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE	N' VALUES			20 40 60 80 100	100	100	100	100		
79.4	Ground Surface													
0.0						*								
	trace Organics		1	SS	32		78							
	Hard		2	SS	31									
	Brown		3	SS	26									
	Grey		4	SS	13		76						22.3	1 17 43 39
			5	SS	12									
			6	SS	12									
			7	SS	12		74							
			8	SS	13								21.1	7 21 42 30
	Heterogeneous Mixture of Clayey Silt, Sand and Gravel (Glacial Till) Stiff to Very Stiff		9	SS	15		72							
			10	SS	20		70							
			11	SS	21		68							
67.2														
12.2	Het. Mixt. of Silt, Sand & Gravel (Glacial Till) Very Dense		12	SS	100									26 48 19 7
66.8														
12.6	End of Borehole													
	* GWL not established													

+3, x5: Numbers refer to
Sensitivity

20
15-5 (%) STRAIN AT FAILURE
10

RECORD OF BOREHOLE No G-1

1 OF 1

METRIC

W.P. WP 319-89-00 LOCATION Co-ords: N 4 787 460; E 289 623 ORIGINATED BY PC
 DIST 4 HWY Q.E.W. BOREHOLE TYPE SS Auger COMPILED BY FR
 DATUM Geodetic DATE 91 11 06 CHECKED BY PP

SOIL PROFILE			SAMPLES			GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT					UNIT WEIGHT γ kN/m ³	REMARKS & GRAIN SIZE DISTRIBUTION (%) GR SA SI CL
ELEV DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE	'N' VALUES			20 40 60 80 100	20 40 60 80 100	20 40 60 80 100	20 40 60 80 100	20 40 60 80 100		
80.1	Ground Surface													
0.0			1	SS	30		78							
			2	SS	33									
	Brown		3	SS	24									
	Grey		4	SS	14									
			5	SS	13									
			6	SS	13									
	Het. Mixt. of Silt, Sand and Gravel (Glacial Till)		7	SS	23									
			8	SS	54									
	Heterogeneous Mixture of Clayey Silt, Sand and Gravel (Glacial Till)		9	SS	23									
69.4	Stiff to Very Stiff		10	SS	28									
10.7	Heterogeneous Mixture of Silt, Sand and Gravel (Glacial Till)		11	SS	98	/15cm								
67.5	Red, Very Dense		12	SS	95									
12.6	End of Borehole • 91 11 07													

RECORD OF BOREHOLE No G-2

1 OF 1

METRIC

W.P. 319-89-00 LOCATION Co-ords: N 4 787 520; E 289 623 ORIGINATED BY TS
DIST 4 HWY Q.E.W. BOREHOLE TYPE SS Auger COMPILED BY TS
DATUM Geodetic DATE 91 11 08 CHECKED BY PP

SOIL PROFILE			SAMPLES			GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT					PLASTIC LIMIT W _P	NATURAL MOISTURE CONTENT W	LIQUID LIMIT W _L	UNIT WEIGHT γ	REMARKS & GRAIN SIZE DISTRIBUTION (%)
ELEV DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE	'N' VALUES			20	40	60	80	100					
80.1	Ground Surface																
0.0			1	SS	32												
			2	SS	40												
	Hard		3	SS	30		78									22.3	1 14 45 40
	Brown		4	SS	24												
	Grey		5	SS	13		76										
			6	SS	11												
			7	SS	12												
			8	SS	17		74									21.7	0 14 46 40
			9	SS	17												
	Heterogeneous Mixture of Clayey Silt, Sand and Gravel (Glacial Till)		10	SS	17		72										
	Stiff to Very Stiff		11	SS	24		70										
67.5			12	SS	25		68										
12.6	End of Borehole • 91 11 11																

RECORD OF BOREHOLE No G-3

1 OF 1

METRIC

W.P. 319-89-00 LOCATION Co-ords: N 4 787 475 E 289 627 ORIGINATED BY PC
DIST 4 HWY Q.E.W. BOREHOLE TYPE SS Auger COMPILED BY TS
DATUM Geodetic DATE 91 11 05 CHECKED BY PP

SOIL PROFILE		SAMPLES			GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT					PLASTIC NATURAL LIQUID LIMIT MOISTURE LIMIT CONTENT			UNIT WEIGHT 7 kN/m ³	REMARKS & GRAIN SIZE DISTRIBUTION (%) GR SA SI CL
ELEV DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE			'N' VALUES	20	40	60	80	100	W _p	W		
80.2	Ground Surface															
0.0						DRY *										
			1	SS	17											
			2	SS	28											
			3	SS	27											
	Brown		4	SS	13											
	Grey		5	SS	14											
	Heterogeneous Mixture of Cloyey Silt, Sand and Gravel		6	SS	12											
	(Glacial Till)		7	SS	14											
	Stiff to Very Stiff		8	SS	17											
	Red, Hard		9	SS	17											
			10	SS	31											
			11	SS	36											
67.6			12	SS	88											
12.5	End of Borehole • 91 11 07															

RECORD OF BOREHOLE No H-1

1 OF 1

METRIC

W.P. WP 319-89-00 LOCATION Co-ords: N 4 787 966; E 291 092 ORIGINATED BY FR
 DIST 4 HWY O.E.W. BOREHOLE TYPE SS Auger COMPILED BY FR
 DATUM Geodetic DATE 91 11 12 CHECKED BY PP

SOIL PROFILE			SAMPLES			GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT					UNIT WEIGHT 7 kN/m ³	REMARKS & GRAIN SIZE DISTRIBUTION (%) GR SA SI CL
ELEV DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE	'N' VALUES			20 40 60 80 100	20 40 60 80 100	20 40 60 80 100	20 40 60 80 100	20 40 60 80 100		
81.4	Ground Surface													
0.0	Irregular Mixture of Clayey Silt, Sand and Gravel (Fill Material)		1	SS	10	DRY *	80						19.1	0 11 47 42
79.3	Brown, Firm to Stiff		2	SS	8									
2.1			3	SS	18		78							
			4	SS	18									
			5	SS	22									
	Brown		6	SS	14		76							
	Grey		7	SS	15									
			8	SS	13									
	Heterogeneous Mixture of Clayey Silt, Sand and Gravel (Glacial Till) Stiff to Hard		9	SS	16		74							
			10	SS	22		72							
			11	SS	36		70							
68.8			12	SS	35									
12.6	End of Borehole * Dry Upon Completion													

RECORD OF BOREHOLE No H-3

1 OF 1

METRIC

W.P. 319-89-00 LOCATION Co-ords: N 4 787 011; E 291 111 ORIGINATED BY TS
DIST 4 HWY Q.E.W. BOREHOLE TYPE SS Auger COMPILED BY FR
DATUM Geodetic DATE 91 11 11 CHECKED BY PP

SOIL PROFILE			SAMPLES			GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT		PLASTIC NATURAL LIQUID LIMIT MOISTURE CONTENT			UNIT WEIGHT 7 kN/m ³	REMARKS & GRAIN SIZE DISTRIBUTION (%) GR SA SI CL
ELEV DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE	'N' VALUES			20 40 60 80 100	20 40 60 80 100	W _P	W	W _L		
80.7	Ground Surface													
0.0						DRY	80							
			1	SS	29									
			2	SS	27									
			3	SS	22		78					20.9	12 15 37 36	
			4	SS	31									
	Brown Grey		5	SS	20		76							
			6	SS	15									
	Heterogeneous Mixture of Clayey Silt, Sand and Gravel		7	SS	15									
	(Glacial Till)		8	SS	14		74					21.9	6 18 48 28	
	Stiff to Very Stiff		9	SS	16									
68.1			10	SS	12		72							
			11	SS	24		70							
12.6	End of Borehole • Dry Upon Completion		12	SS	28									

RECORD OF BOREHOLE No H-4

1 OF 1

METRIC

W.P. WP 319-89-00 LOCATION Co-ords: N 4 787 045; E 291 107 ORIGINATED BY TS
 DIST 4 HWY O.E.W. BOREHOLE TYPE SS Auger COMPILED BY FR
 DATUM Geodetic DATE 91 11 08 CHECKED BY PP

SOIL PROFILE			SAMPLES			GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT					PLASTIC LIMIT W _p	NATURAL MOISTURE CONTENT W	LIQUID LIMIT W _L	UNIT WEIGHT γ kN/m ³	REMARKS & GRAIN SIZE DISTRIBUTION (%) GR SA SI CL
ELEV DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE	'N' VALUES			20	40	60	80	100					
80.1	Ground Surface																
0.0						DRY *											
	Hard		1	SS	30												
			2	SS	32		78										
			3	SS	26												
	Brown		4	SS	27												
	Grey		5	SS	17		76										
			6	SS	15												
	Heterogeneous Mixture of Clayey Silt, Sand and Gravel (Glacial Till) Stiff to Very Stiff		7	SS	16		74										
			8	SS	17												
			9	SS	15		72										
			10	SS	17		70										
			11	SS	29												
67.5			12	SS	25		68										
12.6	End of Borehole * Dry Upon Completion																

RECORD OF BOREHOLE No 1-1

1 OF 1

METRIC

W.P. 319-89-00 LOCATION Co-ords: N 4 786 590; E 292 183 ORIGINATED BY FR
DIST 4 HWY Q.E.W. BOREHOLE TYPE SS Auger COMPILED BY TS
DATUM Geodetic DATE 91 11 08 CHECKED BY PP

SOIL PROFILE			SAMPLES			GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT					PLASTIC LIMIT W _P	NATURAL MOISTURE CONTENT W	LIQUID LIMIT W _L	UNIT WEIGHT γ	REMARKS & GRAIN SIZE DISTRIBUTION (%)
ELEV DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE	'N' VALUES			20	40	60	80	100					
83.0	Ground Surface																
0.0			1	SS	17		82										
			2	SS	25												
			3	SS	23		80										
	Brown		4	SS	15												
	Grey		5	SS	18												
			6	SS	16		78										
	Heterogeneous Mixture of Clayey Silt, Sand and Gravel (Glacial Till)		7	SS	21												
			8	SS	23		76										
			9	SS	23												
	Stiff to Very Stiff		10	SS	17		74										
72.3			11	SS	70	/15cm	72										
10.7	Bedrock - Shale																
	Red, Unweathered to slightly																
70.8	Weathered, Weak to Very Weak					/3cm											
12.2	End of Borehole																
	* GWL not established																

+3, x5: Numbers refer to
Sensitivity

20
15-5 (%) STRAIN AT FAILURE
10

RECORD OF BOREHOLE No 1-2

1 OF 1

METRIC

W.P. WP 319-89-00 LOCATION Co-ords: N 4 786 606; E 292 193 ORIGINATED BY FR
 DIST 4 HWY O.E.W. BOREHOLE TYPE SS Auger, NW Casing, NX Core COMPILED BY FR
 DATUM Cedetic DATE 91 11 11 CHECKED BY PP

SOIL PROFILE			SAMPLES			GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT					UNIT WEIGHT 7 kN/m ³	REMARKS & GRAIN SIZE DISTRIBUTION (%) GR SA SI CL
ELEV DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE	'N' VALUES			20 40 60 80 100	20 40 60 80 100	20 40 60 80 100	20 40 60 80 100	20 40 60 80 100		
82.1	Ground Surface						82							
0.0			1	SS	54								22.8	4 20 43 33
	Brown		2	SS	29		80							
	Grey		3	SS	19									
			4	SS	13									
	Heterogeneous Mixture of Clayey Silt, Sand and Gravel (Glacial Till)		5	SS	15		78						21.5	5 20 43 32
	Stiff to Very Stiff		6	SS	18									
			7	SS	23		76							
			8	SS	27									
			9	SS	22		74						21.8	2 18 41 39
72.3			10	SS	23									
9.8	Bedrock - Shale with interbedded siltstone		11	RC	REC 100%		72							RQD = 52%
	Red, Unweathered to Slightly Weathered, Weak to Very Weak		12	RC	REC 100%		70							RQD = 74%
69.7														
12.4	End of Borehole • 91 11 12 GWL not established													

RECORD OF BOREHOLE No 1-4

1 OF 1

METRIC

W.P. 319-89-00 LOCATION Co-ords: N 4 786 670; E 292 215 ORIGINATED BY TS
DIST 4 HWY Q.E.W. BOREHOLE TYPE SS Auger COMPILED BY TS
DATUM Geodetic DATE 91 11 08 CHECKED BY PP

SOIL PROFILE			SAMPLES			GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT					PLASTIC NATURAL LIQUID LIMIT MOISTURE CONTENT			UNIT WEIGHT 7 kN/m ³	REMARKS & GRAIN SIZE DISTRIBUTION (%) GR SA SI CL
ELEV DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE	'N' VALUES			20 40 60 80 100	20 40 60 80 100	20 40 60 80 100	20 40 60 80 100	20 40 60 80 100	W _P	W	W _L		
81.5	Ground Surface																
0.0	Irregular Mixture of Clayey Silt, Sand and Gravel (Fill Material)		1	SS	7	*											
80.3																	
1.2	Heterogeneous Mixture of Clayey Silt, Sand and Gravel (Glacial Till)		2	SS	13		80										
			3	SS	22												
			4	SS	25												
			5	SS	22												
			6	SS	18												
			7	SS	20												
			8	SS	18												
			9	SS	20												
			10	SS	18												
70.5			11	SS	111												
11.0	Bedrock - Shale Red, Unweathered to slightly Weathered, Weak to Very Weak				**												
69.3																	
12.2	End of Borehole * GWL not established ** Sampler bouncing																



Ministry
of
Transportation

File

FOUNDATION DESIGN SECTION

**foundation
investigation and
design report**

ENGINEERING MATERIALS OFFICE
FOUNDATION DESIGN SECTION

CONT 93-85

WP 319-89-00 DIST 4

HWY QEW STR SITE -

Q.E.W. Culverts
(Between Gray's Road and Fifty Road)

DISTRIBUTION

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FOUNDATION INVESTIGATION REPORT
For
Q.E.W. Culverts
(Between Gray's Road and Fifty Road)
W.P. 319-89-00
District 4, Burlington

INTRODUCTION

This report summarizes the results of a foundation investigation conducted in conjunction with nine (9) proposed reinforced concrete box culverts that will carry the Q.E.W. and in some cases the North and South Service Roads. The proposed new culverts will replace existing culverts within the site limits defined by Gray's Road and Winona Road at or adjacent to the existing culverts. The culvert replacement project is associated with the Q.E.W. widening to a 6 lane divided highway.

SITE DESCRIPTION

The site is located within the area bounded by the North Service Road and the South Service Road along the Q.E.W. corridor between Gray's Road and Fifty Road in the Town of Stoney Creek, Regional Municipality of Hamilton-Wentworth. The existing Q.E.W. is a four lane median divided highway and grassland separates the Q.E.W. and the North and South Service Roads. Nine (9) separate sites (Sites A to I inclusive) were investigated within the overall site limits.

Numerous open footing and box culverts exist within the site limits facilitating the transmission of creek waters to Lake Ontario in a northerly direction beneath the service roads and the Q.E.W. The existing culverts vary in dimension and appear to have been constructed as early as the 1930's. Minimal depths of cover (up to approximately 2 to 3 metres) generally exist above the culvert roofs. The culverts appear to be of sound quality and no significant visible signs of concrete deterioration were observed.

A number of Q.E.W. underpass structures exist within the site limits. Underpass structures proceeding from west to east include Millen Road, Fruitland Road, Glover Road and Winona Road. The structures are four span structures with approach fills in the order of magnitude of 7-8 metres. The terrain across the

site is generally flat accentuated by creek slopes at the culvert inlets and outlets. Depths of water in the creeks were shallow at the time of the investigation and generally were less than one (1) metre. As mentioned earlier, grassland covers the area between the asphaltic Q.E.W. roadway and the service roads.

Land use in the area is divided into residential north of the existing North Service Road and industrial south of the existing South Service Road. In addition, an MTO district garage is located at the South Service Road just west of Winona Road. Truck Inspection Stations are also located within the site limits.

Physiographically, the site is located in the region known as the "Iroquois Plain". The Iroquois Plain is the product of the advance and retreat of the Wisconsin ice sheet which covered the area during the Pleistocene epoch (over 12,000 years ago). The lowland bordering Lake Ontario, when the last glacier was receding was inundated by the glacial lake called Lake Iroquois at the site. Conditions in the old lake plain vary greatly within the Iroquois Plain. At the site location, overburden consists of a heterogeneous mixture of clayey silt, sand, and gravel, which is a till deposit of glacial origin. At some locations, the surficial cohesive deposit is underlain by a cohesionless heterogeneous mixture of silt, sand and gravel. The overburden at the site is underlain by shale bedrock of the Queenston Formation in thickness ranging from approximately 25 metres at the western limits of the site to approximately 10 metres at the eastern limits of the site.

INVESTIGATION PROCEDURE

Soil and rock data and inherent properties were obtained by in situ and laboratory testing. The procedures employed in the foundation investigation are discussed below.

Field Investigation

The fieldwork for the investigation was carried out between 91 10 28 and 91 11 12 and consisted of twenty-five (25) sampled boreholes advanced to depths

ranging from 12.2 m to 15.7 m below the existing ground surface. Diesel powered track mounted drilling rigs equivalent to Central Mining Equipment (CME) 55 units, were used to advance the boreholes employing conventional hollow stem augering and solid stem augering techniques. It was determined that the subsoil conditions enabled the application of solid stem augering techniques exclusively at the site which resulted in improved productivity.

Subsoil samples were retrieved at 0.7 m intervals for the surficial 6.5 m and at 1.5 m intervals thereafter. Disturbed subsoil samples were retrieved employing a standard split spoon sampler in accordance with the Standard Penetration Test (ASTM D1586). All subsoil samples were identified in the field and then placed in sealed plastic jars to ensure the preservation of the natural moisture contents. Samples were subsequently transported to the laboratory for applicable testing.

Bedrock was cored at one (1) location (site I) where shallower thicknesses of overburden were encountered. The bedrock was cored in NX size using conventional rock coring procedures. At a few locations (sites A, B, and C), in situ vane tests were conducted to determine the in situ undrained shear strength of some weaker soil present at these locations. Standard MTO 'N' vanes were used to conduct the test in accordance with ASTM D2573.

Groundwater levels were determined by monitoring the levels in the open boreholes throughout the duration of the field investigation. All boreholes were backfilled upon completion of the fieldwork.

The survey related to the location and elevations of the individual boreholes was provided by Central Region Surveys and Plans.

Laboratory Analyses

To identify the behaviour, gradation and pertinent properties of the soil present at the site, various laboratory testing were conducted. These tests included:

- 1) Atterberg Limits
- 2) Grain Size Distributions
- 3) Natural Moisture Contents
- 4) Bulk Unit Weights

The tests were carried out in accordance with standard procedures.

Laboratory test results have been summarized below in the subsequent section of this report entitled "Subsurface Conditions", and are illustrated on the corresponding boreholes and figures included in the Appendix of this report.

Subsurface Conditions

The ground surface elevation varies both within each individual site and also from site to site. The variation within each individual site is a reflection of the creek channels present at the existing culvert locations and is generally in the order of 2.5 m to 5.0 m from the top of fill material above the culvert roof to the channel floor. The ground surface elevation increases in an easterly direction from approximately 76.1 m (Site A) to 83 m (Site I).

The entire site area has been inundated by a surficial deposit of glacial till consisting of a cohesive heterogeneous mixture of clayey silt, sand and gravel with random boulders and cobbles. The deposit was explored to depths up to 15.7 m and has generally been weathered and oxidized for up to approximately 5 metres from the ground surface. Hence, the soil is generally brown within this surficial depth and grey (unoxidized) below. At some sites, the lower thickness of the deposit has taken a red colour indicative of iron oxide compounds in the soil. Some black organic enriched soil was also found within the surficial one (1) to two (2) metres at various sites.

At sites, E, F, and G the surficial native cohesive material is underlain by a cohesionless heterogeneous mixture of silt, sand and gravel. This deposit, also of glacial till origin, was found at depths of 10.7 m to 13.7 m below the ground surface. The thickness of this deposit explored ranged upto 2.0 m.

At Site I, the surficial native cohesive heterogeneous mixture of clayey silt, sand and gravel is underlain by shale bedrock at depths ranging from 9.8 m to 11.0 m (Elevation 72.3 m to 70.5 m).

The native heterogeneous mixture of clayey silt, sand and gravel is overlain by fill material at some locations across the site. At sites D, H and I for instance, thicknesses of an irregular mixture of clayey silt, sand and gravel fill material for a thickness up to approximately 2.1 metres was also encountered.

The boundaries between the various soil types, in situ and laboratory test results as well as groundwater levels established at the time of investigation are shown on the attached Record of Borehole sheets in the Appendix. A plan of the site illustrating the locations and elevations of the boreholes and a subsoil stratigraphical section are provided on Dwg. No. 3198900-A, B and C also included in the Appendix.

A detailed description of the subsurface conditions encountered is given below.

Irregular Mixture of Clayey Silt, Sand and Gravel (Fill Material)

A cohesive irregular mixture of clayey silt, sand and gravel identified as fill material was encountered at some sites extending from the surface to a depth of approximately 2.1 m. It appears that this material was used as backfill material to the existing culvert at the various sites.

A grain size distribution as determined by hydrometer and mechanical sieve analyses on a representative sample of fill material (see Record of Borehole H1 in the Appendix) reveals that approximately 89% of the material is finer than 75 micrometres.

An Atterberg Limit Test was carried out on the fine grained portion of the fill material (less than 75 micrometres) to define the behaviour and plasticity of the material. The results reveal that the material has a Liquid Limit (w_L) of 34% and a Plasticity Index (I_P) of 16.5%. Consequently, the material is classified as a clayey silt of low plasticity. The natural moisture content of the material is 21%.

The 'N' values as determined by the Standard Penetration Test (SPT) revealed a range of 7 blows/0.3 m to 10 blows/0.3 m for the samples retrieved in this material. This reveals a consistency ranging from firm to stiff.

Heterogeneous Mixture of Clayey Silt, Sand and Gravel (Glacial Till)

Underlying the fill material and occurring surficially elsewhere at the site, a native deposit consisting of a cohesive heterogeneous mixture of clayey silt, sand and gravel exists. Boulders and cobbles as inferred in the augering process during the borehole advancement also comprise the deposit. Random zones of a heterogeneous mixture of silt, sand and gravel are also found in this deposit. Red shale fragments are also present within the lower depths of the investigated deposit. The deposit was explored to a maximum thickness of 15.7 metres and is of minimum thickness at Site I (9.8 m thickness).

The upper 2.7 to 4.9 metres or so has been oxidized and in areas where organic material is not present within the surficial thickness, soil colour is brown. Organic dominated soils were found at some locations, usually within the surficial 2 metres and this material is black in colour. Below the oxidized and/or organic surficial material, the soil is unoxidized and grey throughout most of the deposit thickness. At some locations, the lower 2 to 3 metres is red in colour and random red zones are interbedded within the grey material.

The main component of this unsorted, unstratified deposit is the clayey silt material. This material matrix essentially binds the coarser sands and gravels within the deposit. A grain size distribution envelope for the deposit as determined by mechanical sieve and hydrometer analyses is given in Figure 1 in the Appendix. The envelope includes particle sizes up to 75 mm (coarse gravel)

and hence excludes the boulder and cobble sizes. The envelope does reveal that the fine grained portions (less than 75 micrometres) contribute to more than approximately 70% of the material of this deposit.

Atterberg Limit Tests were carried out to define the behaviour and plasticity of the fine grained portion of the soil and the results are plotted in Figure 2. A summary of the indices is provided in Table 1 below. Bulk Unit Weights are also included in the table.

Table 1 - Heterogeneous Mixture of Clayey Silt
Sand and Gravel (Glacial Till)

	Range	No. of Tests
Natural Moisture Content (w%)	13-21	29
Liquid Limit (w L %)	22-35	29
Plastic Limit (w P %)	14-18	29
Plasticity Index (I P %)	10-18	29
Unit Weight (kN/m ³)	19-22.3	29

The test results reveal that the fine grained portion of the deposit is of low plasticity and hence is defined as clayey silt. Natural moisture contents are generally less than or equivalent to the plastic limit of the soil indicating that the soil is in a plastic to semi-solid state.

The results of Atterberg Limit Test conducted on an organic enriched material retrieved at a depth of 1.5 m at BH B2 revealed a liquid limit (w L %) of 66%, a plasticity index (I P %) of 31% and a natural moisture content (w%) of 45%. This material would plot as an organic clay of high plasticity on the plasticity chart.

Standard Penetration Test (SPT) carried out in this deposit revealed 'N' values ranging from 5 blows/0.3 m to 54 blows/0.3 m revealing a probable firm to hard range of soil consistency. The lower values are generally indicative of localized weaker material and/or organic enriched material. In general, 'N' values are in the 12 blows/0.3 m to 25 blows/0.3 m and hence the soil is considered as stiff to very stiff.

At depths where the 'N' values were considered "low" (usually less than 10 blows/0.3 m), in situ vane tests were conducted. In general, the vanes could not be torqued and undrained shear strength values exceeded 100 kPa. The minimum undrained shear strength value obtained was 80 kPa but this lower value can be considered as an isolated weak zone within the deposit. It should be cautioned, however, that the presence of the coarse grained sand and gravel in the deposit may have influenced the accuracy of the test. It is concluded however, that the consistency ranges from stiff to hard.

Heterogeneous Mixture of Silt, Sand and Gravel (Glacial Till)

At Sites E, F, and G the cohesive heterogeneous mixture of clayey silt, sand and gravel is underlain by a cohesionless heterogeneous mixture of silt, sand and gravel at a depth ranging from 10.7 m to 13.7 m (Elevation 69.4 m to 64.8 m). Layers of silt with some sand are also present in this deposit in thicknesses up to approximately 0.5 m. The deposit is red in colour and as inferred by auger grinding, boulders and cobbles are also present within this deposit. Red shale fragments are also contained within the deposit.

Grain Size Distribution curves illustrating the gradation of the deposit and determined by mechanical sieve and hydrometer analysis are shown in Figure 3 in the Appendix. Boulder and cobble sizes are not illustrated on the Figure.

Standard Penetration Tests carried out in this deposit revealed 'N' values ranging from 77 blows/0.3 m to 100 blows/0.2 m indicating that the deposit is in a very dense state of denseness.

Bedrock

Shale bedrock with interbedded siltstone of the Queenston Shale Formation underlies the overburden at Site I at a depth of 9.8 m to 11 m (Elevation 72.3 m to 70.5 m). Bedrock core was retrieved in NX size for a thickness of 2.84 m at BH I2.

The shale bedrock is generally greyish red and has randomly interbedded greenish grey siltstone layers. The rock is horizontally bedded and is an extremely friable material. The rock contains moderately close to extremely closed spaced

fractures that are generally flat, planar to undulating and smooth. The rock generally is unweathered to slightly weathered.

Core recoveries and Rock Quality Designations (RQD) were determined in situ to evaluate the competence and integrity of the rock. Core recoveries were 100% and RQD's ranged from 52% to 74%. Based on these measurements, the rock can be considered to be of fair quality.

Based on index property identification, the rock is classified as weak to very weak in strength.

GROUNDWATER CONDITIONS

Observation of the groundwater level was carried out by measuring the water level in the open boreholes throughout the duration of the field investigation. Groundwater levels, in general, are depressed at depths ranging from 10 m to 12 m below the natural ground surface (Elevation 66 m to 68 m).

Groundwater levels were however at some locations measured at shallow depths ranging from 2 to 4 metres below the natural ground surface (76.5 m to 77 m). These water levels illustrate the effect of the subartesian condition present in the heterogeneous mixture of silt, sand and gravel deposit below the cohesive heterogeneous mixture of clayey silt, sand and gravel.

Groundwater levels were not established at the borehole locations advanced on the shoulders of the Q.E.W. and the Service Roads because these boreholes were backfilled immediately for safety reasons.

Groundwater levels, in general, are subject to seasonal fluctuations and hence can vary from the values given in this report.

DISCUSSION AND RECOMMENDATIONS

As part of the planned widening of the Q.E.W. from four (4) lanes to six (6) lanes and to satisfy hydrological requirements at the site, it has been proposed to remove existing open footing concrete culverts and replace them with new reinforced concrete box culverts. A total of nine (9) individual site locations as shown on Dwg. No. 3198900-A, B and C in the Appendix were investigated and a summary of the individual project scope of work is summarized in Table 3a. The dimensions of the proposed culverts and the maximum cover over the roof slab are also included in Table 3a. Table 3b summarizes proposed culvert invert elevations and roadway profile grades.

The extent of the culvert replacement varies from the replacement between the North and South Service Roads to an entire replacement that includes replacement of the culverts beneath the service roads. Culvert lengths therefore range from 50 m to 146 m in a northerly alignment. The proposed Q.E.W. and Service Road grades vary from 78.5 m to 81.2 m within the project site limits and culvert invert elevations range from 75.1 m to 78.1 m. Culvert heights range from 1.3 m to 2.30 m and the maximum cover over the slab roof ranges from 1.3 m to 2.8 m. The maximum height of approach fill required at the culvert sides is 4.8 m. The culvert spans vary from triple culverts at 2.4 m width to a 5 m single span box culvert.

Recommendations pertaining to the following foundation and geotechnical considerations are included in the purview of this report.

- 1) Structure Foundations
- 2) Backfill to Structure
- 3) Construction Considerations

Table 3a - Project Description and Culvert Details

Site	WP	Station	<u>Culvert Description</u>			Max Cover Over Slab (m) (F)	<u>Description</u>
			<u>Span</u> (S)	<u>Height</u> (H)	<u>Length</u> (L)		
A	135-07	23+561	3.08	1.34	61	1.9	Remove existing Q.E.W.
B	135-08	23+924	3.65	1.98	50	2.8	Culvert and Connect
C	135-09	24+247	4.24	1.52	70	2.2	New Culvert to NSR and SSR Culvert
D	135-13	25+289	4.0	1.52	146	1.4	Twin Cell with 25+294
		25+294	3.06	1.52	84	1.4	Remove existing Q.E.W. Culvert and Connect New Culvert to NSR and SSR Culverts
E	135-15	25+866	4.27	2.3	85	1.3	Remove existing Q.E.W. Culvert. Connect New Culvert to NSR Culvert
F	135-19	26+653	5.0	1.8	102	2.0	Remove and Replace existing Q.E.W., EB Ramp and WB Ramp Culverts
G	135-20	27+215	2x2.4	1.6	71	2.5	Remove existing Q.E.W. Culvert and Replace with Twin Culverts
H	135-27	28+771	2x2.4	1.8	115	2.2	Remove existing Q.E.W. SSR & NSR Culverts and Replace with Twin Cell Culverts
I	135-32	29+926	3x2.4	1.8	105	3	Remove existing Q.E.W. SSR & NSR Culverts

Table 3b - Proposed Culvert Invert Elevations
and Profile Grade Elevations

Site	WP	<u>Culvert Invert Elevations (m)</u>		<u>Profile Grade Elevation (m)*</u>
		<u>South</u>	<u>North</u>	
A	135-07	75.7	75.4	78.6
B	135-08	75.5	75.1	80.2
C	135-09	75.6	75.5	79.2
D	135-13	77.2	76.9	80.2
E	135-15	77.2	76.5	80.2
F	135-19	76.7	76.0	80.4
G	135-20	78.1	77.8	81.4
H	135-27	77.6	77.1	81.4
I	135-32	78.0	76.6	81.6

* Highest Elevation

1) Structure Foundations

All culvert foundations can be founded at the proposed invert elevations within the surficial cohesive heterogeneous mixture of clayey silt, sand and gravel deposit supported by the box culvert slab on grade shallow foundation. In view of the uniform conditions across the entire site, bearing capacities at the proposed invert elevations are also uniform and are summarized in Table 4 below.

Table 4 - Spread Footing Soil Capacity

Factored Capacity at U.L.S. (kPa)	300
Bearing Capacity at S.L.S. (kPa)	200

Settlements developed as the result of the applied pressures in Table 4 are expected to be within 25 mm magnitude and because the deformations will be recompression in nature should occur immediately during construction. It is recommended that any new culvert be articulated from any existing culvert to allow for these deformations to be realized without influencing the existing structure.

All softened and/or organic material encountered at the founding elevation shall be removed and replaced with mass concrete or granular material such as Granular 'A'. Any granular material must be placed and compacted to achieve 100% of the Proctor maximum drydensity as outlined in OPSS 501.08.02. Inspection of the founding material at sites A to C inclusive in particular shall be implemented because of organic material encountered at these locations during the field investigation. At Site B, it is recommended that the native material be subexcavated to Elevation 74.

To protect the founding soil from disturbance as a result of weathering, and construction related activities, it is recommended that a concrete working slab be placed on the founding soil.

The footings must be protected against the scouring forces of the creek water. This can be obtained by constructing aprons and rip-rap at the culvert inlet and outlet. The design of the scour protection shall be made in conjunction with applicable hydrological parameters.

Adequate frost protection cover shall be provided for footings subject to frost penetration as for instance during winter construction.

2) Backfill to Structure

Fill material in the order of 1.3 m to 2.3 m will be required at the culvert sides and an additional 1.3 to 2.8 m will be required above the culvert roof elevation. Recommendations pertaining to the selection of material type, stability and settlement of the approach fills and method of construction are given below.

Material

It is recommended that the backfill material against the culvert wall consist of a granular material such as Granular 'A' or Granular 'B' to prevent hydrostatic pressure build-up on the culvert walls. Design parameters of the soil are given in Table 5 below. Weep holes should also be designed in the walls to facilitate the drainage.

Table 5 - Backfill Properties

	<u>Granular 'A'</u>	<u>Granular 'B'</u>
Unfactored Angle of Internal Friction (ϕ)	35°	30°
Unit Weight (kN/m ³) γ	22.8	21.2
Coefficient of Earth Pressure at Rest (K_o)*		
- S.L.S. Type II	0.43	0.5
- U.L.S.	0.51	0.58

*Horizontal surface backfill only.

The backfill beyond the granular wedge as illustrated on OPSD series can consist of acceptable borrow material as defined in OPSS 212.05

Stability

There are no longitudinal fill slope instabilities anticipated for slopes constructed at 2H:1V. All slopes should be protected against surface erosion using conventional methods.

Settlement

It is anticipated that approximately 10 mm of settlement within the fill itself and as a result of the elastic recompression of the native subsoil at the site can be realized. These settlements will be realized during or immediately following construction.

Backfill Construction

In the placement of the backfill material, all softened and/or organic material should be excavated for their full depth within the plan limits prior to fill placement.

The backfill to the culvert walls shall be constructed in accordance with OPSS 902 series and applicable OPSD 803 series. The backfill shall be constructed in 300 mm lifts on alternating sides of the culvert so that the maximum differential in backfill at any time does not exceed 300 mm. Compaction of the backfill material shall be carried out in accordance with OPSS 501 series. Excessive vibratory equipment loadings should be prevented from inducing any additional lateral pressure on the culvert walls during the compaction procedure.

3) Construction Considerations

Temporary Shoring

To facilitate the removal and construction of the replacement culverts, a temporary roadway diversion and roadway protection scheme will be required in order to maintain traffic during the execution of the work. A staged construction sequence therefore appears to be a necessary construction procedure.

Two (2) shoring schemes have been summarized below. The alternative that proves to be the most economical and technically feasible from both a design and construction point of view shall be selected. The shoring scheme shall be reviewed by this office in the preliminary stages of design.

(a) Cantilever Soldier Pile - Timber Lagging Wall

One method of roadway protection is the application of the conventional cantilever soldier pile - timber lagging wall based on the principles of limiting equilibrium. To facilitate the design of the cantilever type wall and the required soldier pile embedment depth, the soil parameters in Table 6 are provided.

Table 6 - Roadway Protection Soil Parameters

<u>Soil</u>	<u>Unfactored Angle of Internal Friction (ϕ)</u>	<u>*Coefficient of Active Earth Pressure</u>		<u>*Coefficient of Passive Earth Pressure</u>	
		<u>S.L.S. Type II</u>	<u>U.L.S.</u>	<u>S.L.S. Type II</u>	<u>U.L.S.</u>
Het. Mix. of Clayey Silt, Sand and Gravel (Glacial Till)	30°	0.33	0.4	3	2.5
Het. Mix. of Silt, Sand and Gravel (Glacial Till)	35°	0.27	0.34	3.7	2.9

* These earth pressure coefficients apply to horizontal backfill surfaces only. The design of the shoring system shall include the appropriate earth pressures computed in accordance with Section 6.6.1.2 of the O.H.B.D.C. The loadings induced by the surcharge traffic and adjustment for any sloping surface shall be incorporated in the design.

Soldier piles can be installed using conventional pile driving methods or alternatively in preaugered drilled shafts. For soldier piles installed in preaugered holes, a concrete toe is recommended to anchor the soldier pile toe and a lean mix concrete (0.7 MPa) is recommended as backfill for the annular space along the shaft of the predrilled hole. In view of the cohesive and impervious nature of the material, conventional augering equipment can be used to excavate the shaft and place the soldier pile assembly in the dry. An NSSP, however, should be included in the tender documents that indicates that larger boulders and cobbles are characteristic components of glacial till deposits and hence can be found at the site. In addition, the Contractor shall be informed that the drilled hole shall be maintained throughout the installation of the soldier pile.

(b) Raker Supported Soldier Pile - Timber Lagging Wall

Should alternative (a) produce excessive, uneconomical soldier pile embedment lengths, rakers can be used to resist the induced lateral earth pressures. The raker foundations can be founded within the surficial heterogeneous mixture of clayey silt, sand and gravel at or below the site specific culvert invert elevations using the bearing capacities tabulated in Table 4.

Rakers must be installed while an earth berm remains in front of the soldier pile. Slots should be cut into this berm to install rakers before the supporting berm is removed. Soldier piles and lagging can be installed as previously described.

Dewatering

No dewatering problems are anticipated in the construction of the structure foundations in view of the impervious nature of the native subsoil. Furthermore, the groundwater table at the time of the investigation was below the proposed culvert invert elevation. Conventional sump pump techniques will suffice in discharging any surface runoff or localized seepage from the excavation.

Inflow from the existing creeks must be prevented to enable construction in the "dry". The contractor shall take any special measures to ascertain this flow impediment. One such method can include the construction of impervious earth dikes composed of suitable clay material (see OPSS 1205).

Temporary Slopes

Temporary slopes to facilitate the excavation and construction of the culvert shall not be steeper than $1\frac{1}{2}:1V$.

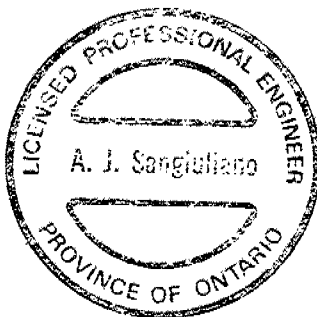
Excavation

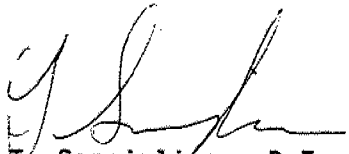
The excavation for the proposed concrete culverts adjacent to any existing culverts shall be carefully controlled to avoid undermining the existing culvert foundations.

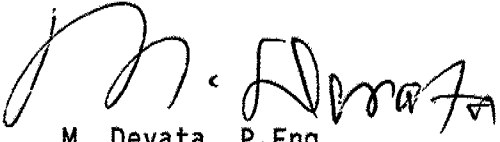
MISCELLANEOUS

The fieldwork for this investigation was carried out under the supervision of T. Sangiuliano, Foundation Engineer and F. Reijerse, Student Engineer, utilizing equipment owned and operated by Malone's Soil Samples.

The project was carried out by T. Sangiuliano under the general supervision of P. Payer, Senior Foundation Engineer. The report was written by T. Sangiuliano, reviewed by P. Payer and approved by M. Devata, Chief Foundation Engineer.

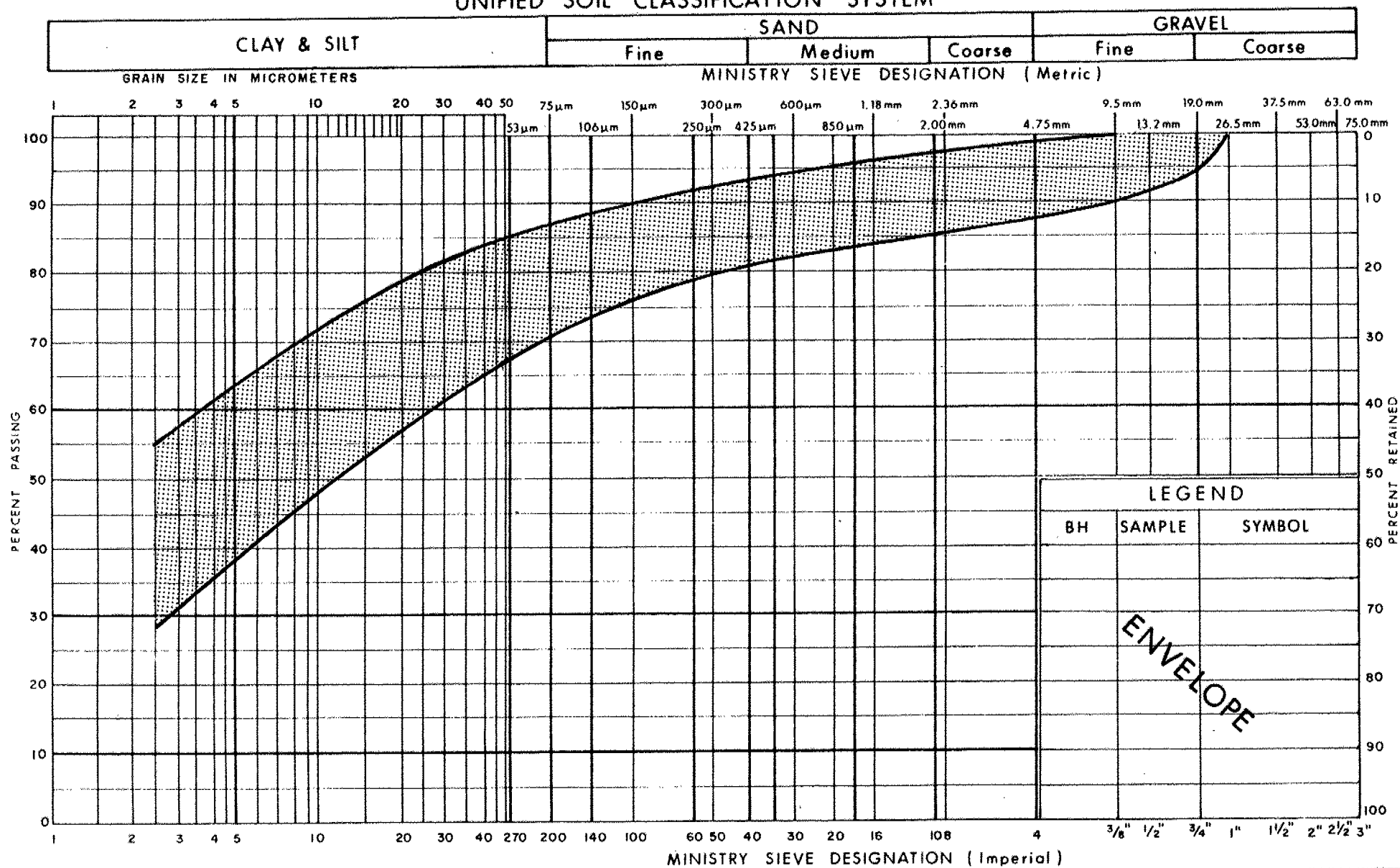



T. Sangiuliano, P.Eng.
Foundation Engineer


M. Devata, P.Eng.
Chief Foundation Engineer

APPENDIX

UNIFIED SOIL CLASSIFICATION SYSTEM

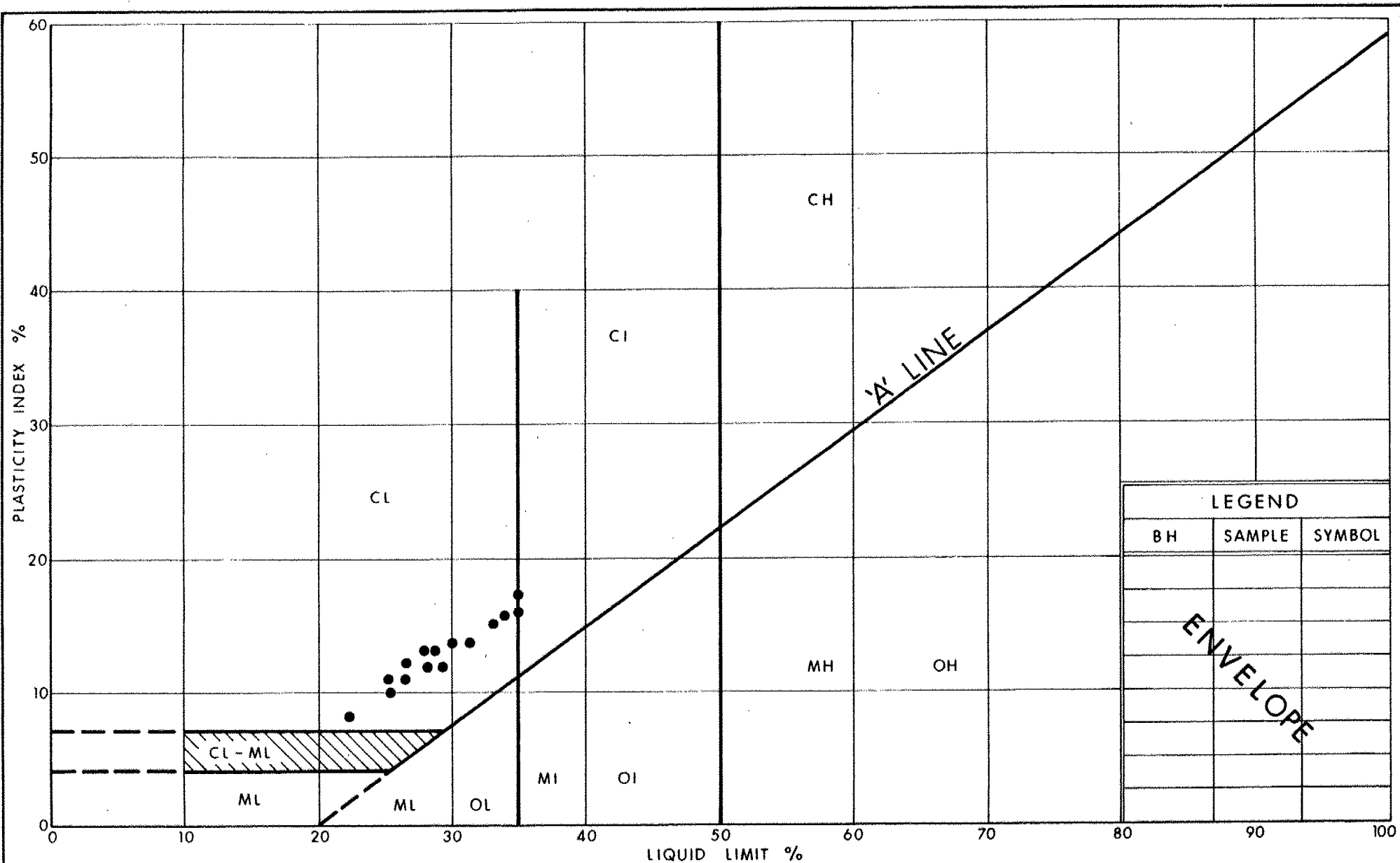


Ministry of
Transportation

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

FIG No 1

W P 319 - 89 - 00

Ministry of
Transportation

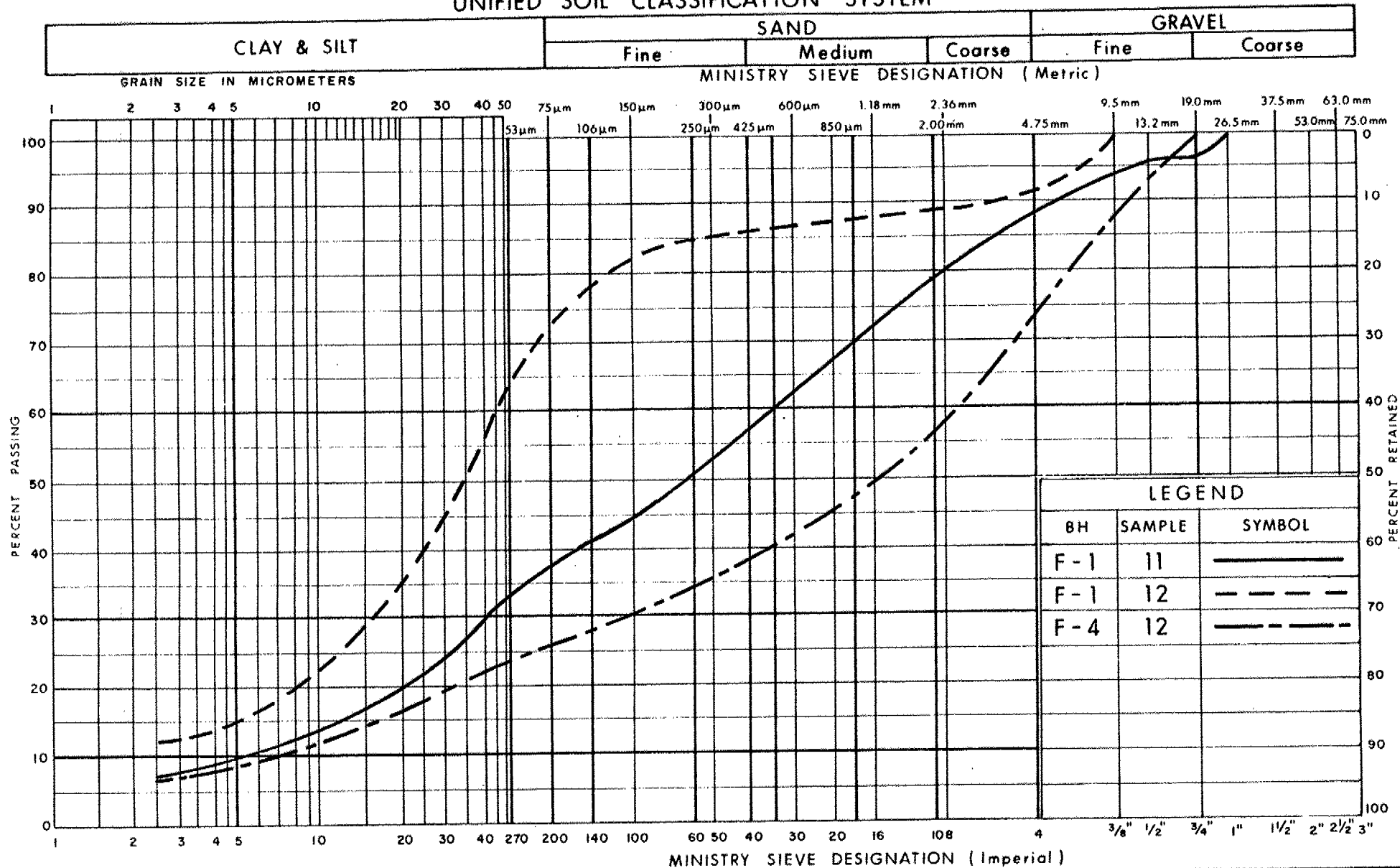
Ontario

PLASTICITY CHART
HET MIXTURE OF CLAYEY SILT,
SAND & GRAVEL (Glacial Till)

FIG No 2

W P 319-89-00

UNIFIED SOIL CLASSIFICATION SYSTEM



Ontario

Ministry of
Transportation

GRAIN SIZE DISTRIBUTION

HET MIXTURE OF

SILT, SAND & GRAVEL (Glacial Till)

FIG No 3

W P 319-89-00

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

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 = $\frac{c_u}{\tau_r}$

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

PHYSICAL PROPERTIES OF SOIL

ρ_s	kg/m ³	DENSITY OF SOLID PARTICLES	e	1, %	VOID RATIO	e_{min}	1, %	VOID RATIO IN DENSEST STATE
γ_s	kN/m ³	UNIT WEIGHT OF SOLID PARTICLES	n	1, %	POROSITY	I_D	1	DENSITY INDEX = $\frac{e_{max} - e}{e_{max} - e_{min}}$
ρ_w	kg/m ³	DENSITY OF WATER	w	1, %	WATER CONTENT	D	mm	GRAIN DIAMETER
γ_w	kN/m ³	UNIT WEIGHT OF WATER	S_r	%	DEGREE OF SATURATION	D_n	mm	n PERCENT - DIAMETER
ρ	kg/m ³	DENSITY OF SOIL	w_L	%	LIQUID LIMIT	C_u	1	UNIFORMITY COEFFICIENT
γ	kN/m ³	UNIT WEIGHT OF SOIL	w_p	%	PLASTIC LIMIT	h	m	HYDRAULIC HEAD OR POTENTIAL
ρ_d	kg/m ³	DENSITY OF DRY SOIL	w_s	%	SHRINKAGE LIMIT	q	m ³ /s	RATE OF DISCHARGE
γ_d	kN/m ³	UNIT WEIGHT OF DRY SOIL	I_p	%	PLASTICITY INDEX = $w_L - w_p$	v	m/s	DISCHARGE VELOCITY
ρ_{sat}	kg/m ³	DENSITY OF SATURATED SOIL	I_L	1	LIQUIDITY INDEX = $\frac{w - w_p}{I_p}$	i	1	HYDRAULIC GRADIENT
γ_{sat}	kN/m ³	UNIT WEIGHT OF SATURATED SOIL	I_C	1	CONSISTENCY INDEX = $\frac{w_L - w}{I_p}$	k	m/s	HYDRAULIC CONDUCTIVITY
ρ'	kg/m ³	DENSITY OF SUBMERGED SOIL	e_{max}	1, %	VOID RATIO IN LOOSEST STATE	j	kN/m ³	SEEPAGE FORCE
γ'	kN/m ³	UNIT WEIGHT OF SUBMERGED SOIL						

RECORD OF BOREHOLE No A-1

1 OF 1

METRIC

W.P. 319-89-00 LOCATION Co-ords: N 4 788 623; E 286 160 ORIGINATED BY TS
DIST 4 HWY Q.E.W. BOREHOLE TYPE HS Auger COMPILED BY TS
DATUM Geodetic DATE 91 10 28 CHECKED BY PP

SOIL PROFILE			SAMPLES			GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT		PLASTIC LIMIT W _P	NATURAL MOISTURE CONTENT W	LIQUID LIMIT W _L	UNIT WEIGHT γ kN/m ³	REMARKS & GRAIN SIZE DISTRIBUTION (%) GR SA SI CL
ELEV DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE	IN VALUES			20 40 60 80 100	20 40 60 80 100					
76.6	Ground Surface													
0.0														
	Black, some Organics		1	SS	25		76							
	Brown		2	SS	22									
			3	SS	18		74						20.7	3 19 51 27
			4	SS	32									
	Grey		5	SS	24		72							
			6	SS	12									
	Heterogeneous Mixture of Clayey Silt, Sand and Gravel (Glacial Till)		7	SS	33		70						19.9	9 18 47 25
	Very Stiff to Hard		8	SS	20									
			9	SS	14		68						19.0	1 12 36 51
			10	SS	15		66							
			11	SS	21		64							
			12	SS	19									
60.9			13	SS	20		62							
15.7	End of Borehole = 91 10 29													

RECORD OF BOREHOLE No A-2

1 OF 1

METRIC

W.P. 319-89-00 LOCATION Co-ords: N 4 788 675;E 286 146 ORIGINATED BY FR
DIST 4 HWY Q.E.W. BOREHOLE TYPE HS Auger COMPILED BY TS
DATUM Geodetic DATE 91 10 31 CHECKED BY PP

SOIL PROFILE			SAMPLES			GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT					PLASTIC LIMIT w _p	NATURAL MOISTURE CONTENT w	LIQUID LIMIT w _L	UNIT WEIGHT γ kN/m ³	REMARKS & GRAIN SIZE DISTRIBUTION (%) GR SA SI CL
ELEV DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE	'N' VALUES			20	40	60	80	100					
76.1	Ground Surface																
0.0	Black, some organics, Firm Brown, Grey Heterogeneous Mixture of Clayey Silt, Sand and Gravel (Glacial Till) Stiff to Very Stiff		1	SS	7												
			2	SS	23												
			3	SS	17												
			4	SS	16												
			5	SS	16												
			6	SS	16												
			7	SS	11												
			8	SS	9												
			9	SS	12												
			10	SS	8												
			11	SS	14												
63.5			12	SS	15												
12.6	End of Borehole - 91 11 01																

RECORD OF BOREHOLE No B-1

1 OF 1

METRIC

W.P. 319-89-00 LOCATION Co-ords: N 4 788 514; E 286 485 ORIGINATED BY FR
DIST 4 HWY Q.E.W. BOREHOLE TYPE HS Auger COMPILED BY TS
DATUM Geodetic DATE 91 10 29 CHECKED BY PP

SOIL PROFILE		SAMPLES			GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT					PLASTIC LIMIT w _p	NATURAL MOISTURE CONTENT w	LIQUID LIMIT w _L	UNIT WEIGHT γ KN/m ³	REMARKS & GRAIN SIZE DISTRIBUTION (%)
ELEV DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE	'N' VALUES		20	40	60	80	100					
77.0	Ground Surface															
0.0	Black, some Organics		1	SS	6											
	Firm		2	SS	5											
	Brown, trace Organics		3	SS	9											
			4	SS	22											
			5	SS	20											
			6	SS	16											
	Grey		7	SS	13											
			8	SS	13											
	Heterogeneous Mixture of Clayey Silt, Sand and Gravel (Glacial Till)		9	SS	12											
	Stiff to Very Stiff		10	SS	10											
			11	SS	13											
64.4			12	SS	13											
12.6	End of Borehole															
	+ 91 10 30															

RECORD OF BOREHOLE No B-2

1 OF 1

METRIC

W.P. 319-89-00 LOCATION Co-ords: N 4 788 549; E 286 508 ORIGINATED BY FR
DIST 4 HWY Q.E.W. BOREHOLE TYPE HS Auger COMPILED BY TS
DATUM Geodetic DATE 91 10 30 CHECKED BY PP

SOIL PROFILE			SAMPLES			GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT					PLASTIC LIMIT w _p	NATURAL MOISTURE CONTENT w	LIQUID LIMIT w _L	UNIT WEIGHT 7 kN/m ³	REMARKS & GRAIN SIZE DISTRIBUTION (%)
ELEV DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE	'N' VALUES			20	40	60	80	100					
77.7	Ground Surface																
0.0	trace Organics		1	SS	7												
	Firm		2	SS	8												
			3	SS	10												
			4	SS	18												
	Brown		5	SS	20												
	Grey		6	SS	15												
	Heterogenous Mixture of Clayey Silt, Sand and Gravel (Glacial Till)		7	SS	13												
	Stiff to Very Stiff		8	SS	13												
			9	SS	19												
65.1			10	SS	21												
12.6	End of Borehole + 91 10 31																

RECORD OF BOREHOLE No C-1

1 OF 1

METRIC

W.P. 319-89-00 LOCATION Co-ords: N 4 788 409; E 286 829 ORIGINATED BY FR
 DIST 4 HWY Q.E.W. BOREHOLE TYPE HS Auger COMPILED BY TS
 DATUM Geodetic DATE 91 10 29 CHECKED BY PP

SOIL PROFILE			SAMPLES			GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT					PLASTIC LIMIT w _p	NATURAL MOISTURE CONTENT w	LIQUID LIMIT w _L	UNIT WEIGHT 7 kN/m ³	REMARKS & GRAIN SIZE DISTRIBUTION (%) GR SA SI CL
ELEV DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE	'N' VALUES			20	40	60	80	100					
78.2	Ground Surface																
0.0			1	SS	7												
	Black, some Organics		2	SS	6												
	Red		3	SS	12												
	Brown		4	SS	16												
			5	SS	19												
			6	SS	21												
	Grey		7	SS	16												
			8	SS	13												
	Heterogeneous Mixture of Clayey Silt, Sand and Gravel (Glacial Till)		9	SS	12												
	Stiff to Very Stiff		10	SS	11												
			11	SS	15												
65.6			12	SS	27												
12.6	End of Borehole																
	* 91 10 30																

RECORD OF BOREHOLE No C-2

1 OF 1

METRIC

W.P. 319-89-00 LOCATION Co-ords: N 4 788 457; E 286 800 ORIGINATED BY FR
DIST 4 HWY Q.E.W. BOREHOLE TYPE HS Auger COMPILED BY TS
DATUM Geodetic DATE 91 10 30 CHECKED BY PP

SOIL PROFILE			SAMPLES			GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT		PLASTIC LIMIT NATURAL MOISTURE CONTENT LIQUID LIMIT			UNIT WEIGHT 7 kN/m ³	REMARKS & GRAIN SIZE DISTRIBUTION (%) GR SA SI CL			
ELEV DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE	'N' VALUES			SHEAR STRENGTH kPa							WATER CONTENT (%)		
76.8	Ground Surface							20 40 60 80 100									
0.0																	
	Black, trace Organics		1	SS	23		76										
	Brown		2	SS	5												
			3	SS	22		74										
			4	SS	18												
	Grey		5	SS	13		72										
			6	SS	12												
			7	SS	14		70										
	Heterogenous Mixture of Clayey Silt, Sand and Gravel (Glacial Till)		8	SS	15												
	Stiff to Very Stiff		9	SS	25		68										
			10	SS	26		66										
64.2			11	SS	30												
12.6	End of Borehole * 91 10 31																

RECORD OF BOREHOLE No D-1

1 OF 1

METRIC

W.P. 319-89-00 LOCATION Co-ords: N 4 788 049; E 287 778 ORIGINATED BY FR
DIST 4 HWY Q.E.W. BOREHOLE TYPE SS Auger COMPILED BY TS
DATUM Geodetic DATE 91 11 01 CHECKED BY PP

SOIL PROFILE			SAMPLES			GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT					PLASTIC LIMIT W _P	NATURAL MOISTURE CONTENT W	LIQUID LIMIT W _L	UNIT WEIGHT γ kN/m ³	REMARKS & GRAIN SIZE DISTRIBUTION (%) GR SA SI CL
ELEV DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE	'N' VALUES			20	40	60	80	100					
79.8	Ground Surface																
79.0	Sand and Gravel (Fill Material)					*											
0.8	Firm		1	SS	5												
			2	SS	29												
			3	SS	22												
	Brown		4	SS	17												
	Grey		5	SS	12												
			6	SS	25												
			7	SS	14												
	Heterogeneous Mixture of Clayey Silt, Sand and Gravel (Glacial Till)		8	SS	13												
			9	SS	14												
	Stiff to Very Stiff		10	SS	14												
			11	SS	12												
67.2			12	SS	16												
12.6	End of Borehole * GWL not established																

RECORD OF BOREHOLE No D-2

1 OF 1

METRIC

W.P. 319-89-00 LOCATION Co-ords: N4 788 077; E 287 788 ORIGINATED BY FR
DIST 4 HWY Q.E.W. BOREHOLE TYPE HS Auger COMPILED BY TS
DATUM Geodetic DATE 91 10 31 to 91 11 01 CHECKED BY PP

SOIL PROFILE		SAMPLES			GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT		PLASTIC LIMIT w _p	NATURAL MOISTURE CONTENT w	LIQUID LIMIT w _L	UNIT WEIGHT γ kN/m ³	REMARKS & GRAIN SIZE DISTRIBUTION (%) GR SA SI CL
ELEV DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE			'N' VALUES	20 40 60 80 100					
79.1	Ground Surface												
0.0			1	SS	23								
			2	SS	27								
			3	SS	21								
	Brown Grey		4	SS	13							21.4	2 22 44 32
			5	SS	13								
			6	SS	24								
			7	SS	13								
	Heterogeneous Mixture of Clayey Silt, Sand and Gravel (Glacial Till)		8	SS	12							21.8	7 15 45 33
	Stiff to Very Stiff.		9	SS	14								
			10	SS	15								
			11	SS	22								
66.5			12	SS	20								
12.6	End of Borehole												
	* 91 11 02												

RECORD OF BOREHOLE No D-3

1 OF 1

METRIC

W.P. 319-89-00 LOCATION Co-ords: N 4 788 128; E 287 805 ORIGINATED BY FR
DIST 4 HWY G.E.W. BOREHOLE TYPE SS Auger COMPILED BY TS
DATUM Geodetic DATE 91 11 04 CHECKED BY PP

SOIL PROFILE		SAMPLES			GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT		PLASTIC LIMIT NATURAL MOISTURE CONTENT LIQUID LIMIT			UNIT WEIGHT 7 kN/m ³	REMARKS & GRAIN SIZE DISTRIBUTION (%) GR SA SI CL
ELEV DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE			'N' VALUES	20 40 60 80 100	20 40 60 80 100	w _p	w		
78.3	Ground Surface												
0.0													
			1	SS	26								
			2	SS	21								
			3	SS	15								
	Brown		4	SS	15								
	Grey		5	SS	12								
			6	SS	13								
	Heterogeneous Mixture of Cloyey Silt, Sand and Gravel (Glacial Till)		7	SS	12								
	Stiff to Very Stiff		8	SS	14								
			9	SS	17								
			10	SS	17								
			11	SS	22								
65.7	Hard		12	SS	49								
12.6	End of Borehole												
	* 91 11 05												

RECORD OF BOREHOLE No D-4

1 OF 1

METRIC

W.P. 319-89-00 LOCATION Co-ords: N 4 788 171; E 287 805 ORIGINATED BY FR
DIST 4 HWY Q.E.W. BOREHOLE TYPE SS Auger COMPILED BY TS
DATUM Geodetic DATE 91 11 04 CHECKED BY PP

SOIL PROFILE			SAMPLES			GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT		PLASTIC LIMIT W _P	NATURAL MOISTURE CONTENT W	LIQUID LIMIT W _L	UNIT WEIGHT γ kN/m ³	REMARKS & GRAIN SIZE DISTRIBUTION (%) GR SA SI CL
ELEV DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE	'N' VALUES			20	40					
78.3	Ground Surface													
0.0			1	SS	20									
			2	SS	30									
			3	SS	18									
	Brown		4	SS	20								20.9	3 22 49 26
	Grey		5	SS	12									
	Heterogeneous Mixture of Clayey Silt, Sand and Gravel (Glacial Till)		6	SS	16									
			7	SS	12									
	Stiff to Very Stiff		8	SS	10								20.7	10 19 45 26
			9	SS	13									
			10	SS	20									
			11	SS	20									
65.7			12	SS	28									
12.6	End of Borehole													
	• 91 11 05													

RECORD OF BOREHOLE No E-1

1 OF 1

METRIC

W.P. 319-89-00 LOCATION Co-ords: N 4 787 897; E 288 323 ORIGINATED BY FR
 DIST 4 HWY Q.E.W. BOREHOLE TYPE SS Auger COMPILED BY TS
 DATUM Geodetic DATE 91 11 01 CHECKED BY PP

SOIL PROFILE			SAMPLES			GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT		PLASTIC LIMIT w _p	NATURAL MOISTURE CONTENT w	LIQUID LIMIT w _L	UNIT WEIGHT γ kN/m ³	REMARKS & GRAIN SIZE DISTRIBUTION (%) GR SA SI CL
ELEV DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE	'N' VALUES			20 40 60 80 100	20 40 60 80 100					
78.5	Ground Surface													
0.0			1	SS	23									
			2	SS	35									
	Brown		3	SS	27									
	Grey		4	SS	25									
			5	SS	20									
	Heterogeneous Mixture of Clayey Silt, Sand and Gravel (Glacial Till)		6	SS	19									
			7	SS	20									
			8	SS	17									
	Stiff to Very Stiff		9	SS	14									
			10	SS	19									
			11	SS	22									
			12	SS	29									
64.8														
13.7	Heterogeneous Mixture of Silt, Sand and Gravel (Glacial Till)		13	SS	60	/13cm								
62.8	Red, Very Dense		14	SS	100									
15.7	End of Borehole • 91 11 04 (subartesian condition)													

RECORD OF BOREHOLE No E-2

1 OF 1

METRIC

W.P. 319-89-00 LOCATION Co-ords: N 4 787 954; E 288 361 ORIGINATED BY FR
 DIST 4 HWY O.E.W. BOREHOLE TYPE SS Auger COMPILED BY TS
 DATUM Geodetic DATE 91 11 05 CHECKED BY PP

SOIL PROFILE			SAMPLES			GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT		PLASTIC NATURAL LIQUID LIMIT MOISTURE CONTENT			UNIT WEIGHT 7 kN/m ³	REMARKS & GRAIN SIZE DISTRIBUTION (%) GR SA SI CL
ELEV DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE	'N' VALUES			20 40 60 80 100	20 40 60 80 100	W _P W W _L	10 20 30			
77.8	Ground Surface													
0.0			1	SS	6									
			2	SS	17									
			3	SS	26									
			4	SS	23									
			5	SS	20									
			6	SS	15									
			7	SS	22									
			8	SS	18									
			9	SS	18									
			10	SS	36									
			11	SS	27									
			12	SS	24									
65.2														
12.6	End of Borehole • 91 11 06													

RECORD OF BOREHOLE No F-2

1 OF 1

METRIC

W.P. 319-89-00 LOCATION Co-ords: N 4 787 655; E 289 087 ORIGINATED BY PC
 DIST 4 HWY Q.E.W. BOREHOLE TYPE SS Auger COMPILED BY TS
 DATUM Geodetic DATE 91 11 05 CHECKED BY PP

SOIL PROFILE			SAMPLES			GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT		PLASTIC LIMIT NATURAL MOISTURE CONTENT LIQUID LIMIT			UNIT WEIGHT γ kN/m ³	REMARKS & GRAIN SIZE DISTRIBUTION (%) GR SA SI CL
ELEV DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE	'N' VALUES			20 40 60 80 100	20 40 60 80 100	w _p w w _L	10 20 30			
79.9	Ground Surface													
0.0			1	SS	24									
			2	SS	34									
			3	SS	33									
			4	SS	15									
			5	SS	13									
			6	SS	13									
			7	SS	14									
			8	SS	19									
			9	SS	16									
			10	SS	22									
69.2														
10.7	Heterogeneous Mixture of Silt, Sand and Gravel (Glacial Till) Red, Very Dense		11	SS	93									
67.3	Silt, trace Sand		12	SS	77									
12.6	End of Borehole • 91 11 05 subortesion condition													

RECORD OF BOREHOLE No F-3

1 OF 1

METRIC

W.P. 319-89-00 LOCATION Co-ords: N 4 787 690; E 289 096 ORIGINATED BY TS
DIST 4 HWY Q.E.W. BOREHOLE TYPE SS Auger COMPILED BY TS
DATUM Geodetic DATE 91 11 08 CHECKED BY PP

SOIL PROFILE			SAMPLES			GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT					PLASTIC LIMIT W _P	NATURAL MOISTURE CONTENT W	LIQUID LIMIT W _L	UNIT WEIGHT γ KN/m ³	REMARKS & GRAIN SIZE DISTRIBUTION (%) GR SA SI CL
ELEV DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE	'N' VALUES			20	40	60	80	100					
79.4	Ground Surface																
0.0			1	SS	26		78										
			2	SS	23												
			3	SS	21												
			4	SS	17		76										
			5	SS	16												
			6	SS	13												
			7	SS	14		74										
			8	SS	16												
			9	SS	19		72										
			10	SS	20		70										
			11	SS	25												
67.2							68										
12.2	Het. Mixt. of Silt, Sand & Gravel																
66.8	(Glacial Till) Very Dense		12	SS	100												
12.6	End of Borehole * 91 11 11																

RECORD OF BOREHOLE No F-4

1 OF 1

METRIC

W.P. 319-89-00 LOCATION Co-ords: N 4 787 724; E 289 108 ORIGINATED BY TS
 DIST 4 HWY Q.E.W. BOREHOLE TYPE SS Auger COMPILED BY TS
 DATUM Geodetic DATE 91 11 08 CHECKED BY PP

SOIL PROFILE			SAMPLES			GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT					UNIT WEIGHT γ kN/m ³	REMARKS & GRAIN SIZE DISTRIBUTION (%)
ELEV DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE	'N' VALUES			20	40	60	80	100		
79.4	Ground Surface													
0.0						*								
	trace Organics		1	SS	32		78							
	Hard		2	SS	31									
	Brown		3	SS	26									
	Grey		4	SS	13		76						22.3	1 17 43 39
			5	SS	12									
			6	SS	12									
			7	SS	12		74							
			8	SS	13								21.1	7 21 42 30
			9	SS	15		72							
			10	SS	20		70							
			11	SS	21									
67.2							68							
12.2	Het. Mixt. of Silt, Sand & Gravel													
66.8	(Glacial Till) Very Dense		12	SS	100									26 48 19 7
12.6	End of Borehole													
	* GWL not established													

RECORD OF BOREHOLE No G-1

1 OF 1

METRIC

W.P. WP 319-89-00 LOCATION Co-ords: N 4 787 460; E 289 623 ORIGINATED BY PC
 DIST 4 HWY Q.E.W. BOREHOLE TYPE SS Auger COMPILED BY FR
 DATUM Geodetic DATE 91 11 06 CHECKED BY PP

SOIL PROFILE			SAMPLES			GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT					PLASTIC LIMIT W _P	NATURAL MOISTURE CONTENT W	LIQUID LIMIT W _L	UNIT WEIGHT γ kN/m ³	REMARKS & GRAIN SIZE DISTRIBUTION (%) GR SA SI CL
ELEV DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE	'N' VALUES			20	40	60	80	100					
80.1	Ground Surface																
0.0			1	SS	30												
			2	SS	33												
	Brown		3	SS	24		78									21.4	11 15 43 31
	Grey		4	SS	14												
			5	SS	13		76										
			6	SS	13												
	Het. Mixt. of Silt, Sand and Gravel (Glacial Till)		7	SS	23		74									22.2	48 33 15 4
			8	SS	54												
	Heterogeneous Mixture of Clayey Silt, Sand and Gravel (Glacial Till)		9	SS	23		72										
			10	SS	28												
69.4	Stiff to Very Stiff						70										
10.7	Heterogeneous Mixture of Silt, Sand and Gravel (Glacial Till)		11	SS	98	/15cm											
67.5	Red, Very Dense		12	SS	95		68										
12.6	End of Borehole • 91 11 07																

RECORD OF BOREHOLE No G-2

1 OF 1

METRIC

W.P. 319-89-00 LOCATION Co-ords: N 4 787 520; E 289 623 ORIGINATED BY TS
 DIST 4 HWY Q.E.W. BOREHOLE TYPE SS Auger COMPILED BY TS
 DATUM Geodetic DATE 91 11 08 CHECKED BY PP

SOIL PROFILE			SAMPLES			GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT					PLASTIC LIMIT NATURAL MOISTURE CONTENT LIQUID LIMIT			UNIT WEIGHT 7 kN/m ³	REMARKS & GRAIN SIZE DISTRIBUTION (%) GR SA SI CL
ELEV DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE	'N' VALUES			20	40	60	80	100	w _p	w	w _L		
60.1	Ground Surface																
0.0			1	SS	32												
			2	SS	40												
	Hard		3	SS	30										22.3	1 14 45 40	
	Brown		4	SS	24												
	Grey		5	SS	13												
			6	SS	11												
			7	SS	12												
			8	SS	17										21.7	0 14 46 40	
	Heterogeneous Mixture of Clayey Silt, Sand and Gravel (Glacial Till)		9	SS	17												
	Stiff to Very Stiff		10	SS	17												
			11	SS	24												
67.5			12	SS	25												
12.6	End of Borehole • 91 11 11																

RECORD OF BOREHOLE No G-3

1 OF 1

METRIC

W.P. 319-89-00 LOCATION Co-ords: N 4 787 475 E 289 627 ORIGINATED BY PC
 DIST 4 HWY Q.E.W. BOREHOLE TYPE SS Auger COMPILED BY TS
 DATUM Geodetic DATE 91 11 05 CHECKED BY PP

SOIL PROFILE			SAMPLES			GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT		PLASTIC LIMIT W _p	NATURAL MOISTURE CONTENT W	LIQUID LIMIT W _L	UNIT WEIGHT γ kN/m ³	REMARKS & GRAIN SIZE DISTRIBUTION (%) GR SA SI CL
ELEV DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE	'N' VALUES			20	40					
80.2	Ground Surface													
0.0			1	SS	17	DRY *								
			2	SS	28									
	Brown		3	SS	27									
	Grey		4	SS	13									
	Heterogeneous Mixture of Clayey Silt, Sand and Gravel (Glacial Till)		5	SS	14									
			6	SS	12									
	Stiff to Very Stiff		7	SS	14									
			8	SS	17									
	Red, Hard		9	SS	17									
			10	SS	31									
			11	SS	36									
67.6			12	SS	88									
12.6	End of Borehole													
	• 91 11 07													

RECORD OF BOREHOLE No H-1

1 OF 1

METRIC

W.P. WP 319-89-00 LOCATION Co-ords: N 4 787 966; E 291 092 ORIGINATED BY FR
 DIST 4 HWY Q.E.W. BOREHOLE TYPE SS Auger COMPILED BY FR
 DATUM Geodetic DATE 91 11 12 CHECKED BY PP

SOIL PROFILE		SAMPLES			GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT		PLASTIC LIMIT		NATURAL MOISTURE CONTENT		LIQUID LIMIT		UNIT WEIGHT	REMARKS & GRAIN SIZE DISTRIBUTION (%)
ELEV DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE	'N' VALUES		20 40 60 80 100	20 40 60 80 100	W _p	W	W _p	W	W _L	W		
81.4	Ground Surface															
0.0	Irregular Mixture of Clayey Silt, Sand and Gravel (Fill Material)		1	SS	10	DRY										
79.3	Brown, Firm to Stiff		2	SS	8										19.1	0 11 47 42
2.1			3	SS	18											
			4	SS	18											
			5	SS	22											
			6	SS	14											
			7	SS	15											
			8	SS	13											
			9	SS	16											
			10	SS	22											
			11	SS	36											
68.8			12	SS	35											
12.6	End of Borehole • Dry Upon Completion															

RECORD OF BOREHOLE No H-3

1 OF 1

METRIC

W.P. 319-89-00 LOCATION Co-ords: N 4 787 011; E 291 111 ORIGINATED BY TS
DIST 4 HWY Q.E.W. BOREHOLE TYPE SS Auger COMPILED BY FR
DATUM Geodetic DATE 91 11 11 CHECKED BY PP

SOIL PROFILE		SAMPLES			GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT		PLASTIC LIMIT w _p	NATURAL MOISTURE CONTENT w	LIQUID LIMIT w _L	UNIT WEIGHT 7 kN/m ³	REMARKS & GRAIN SIZE DISTRIBUTION (%) GR SA SI CL
ELEV DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE			'N' VALUES	20 40 60 80 100					
80.7	Ground Surface												
0.0													
			1	SS		29							
			2	SS		27							
			3	SS		22							
			4	SS		31							
	Brown Grey		5	SS		20							
			6	SS		15							
			7	SS		15							
	Heterogeneous Mixture of Clayey Silt, Sand and Gravel (Glacial Till)		8	SS		14							
			9	SS		16							
			10	SS		12							
	Stiff to Very Stiff		11	SS		24							
68.1			12	SS		28							
12.6	End of Borehole • Dry Upon Completion												

RECORD OF BOREHOLE No H-4

1 OF 1

METRIC

W.P. WP 319-89-00 LOCATION Co-ords: N 4 787 045; E 291 107 ORIGINATED BY TS
 DIST 4 HWY Q.E.W. BOREHOLE TYPE SS Auger COMPILED BY FR
 DATUM Geodetic DATE 91 11 08 CHECKED BY PP

SOIL PROFILE			SAMPLES			GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT		PLASTIC LIMIT NATURAL MOISTURE CONTENT LIQUID LIMIT			UNIT WEIGHT γ kN/m ³	REMARKS & GRAIN SIZE DISTRIBUTION (%) GR SA SI CL
ELEV DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE	'N' VALUES			20 40 60 80 100	20 40 60 80 100	W _p W W _L	10 20 30			
80.1	Ground Surface													
0.0			1	SS	30	DRY *								
	Hard		2	SS	32									
			3	SS	26									
	Brown		4	SS	27									
	Grey		5	SS	17									
			6	SS	15									
	Heterogeneous Mixture of Clayey Silt, Sand and Gravel		7	SS	16									
	(Glacial Till)		8	SS	17									
	Stiff to Very Stiff		9	SS	15									
			10	SS	17									
			11	SS	29									
67.5			12	SS	25									
12.6	End of Borehole • Dry Upon Completion													

RECORD OF BOREHOLE No 1-1

1 OF 1

METRIC

W.P. 319-89-00 LOCATION Co-ords: N 4 786 590; E 292 183 ORIGINATED BY FR
DIST 4 HWY Q.E.W. BOREHOLE TYPE SS Auger COMPILED BY TS
DATUM Geodetic DATE 91 11 08 CHECKED BY PP

SOIL PROFILE			SAMPLES			GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT					PLASTIC LIMIT w _p	NATURAL MOISTURE CONTENT w	LIQUID LIMIT w _L	UNIT WEIGHT γ kN/m ³	REMARKS & GRAIN SIZE DISTRIBUTION (%) GR SA SI CL
ELEV DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE	'N' VALUES			20	40	60	80	100					
83.0	Ground Surface																
0.0			1	SS	17		82										
			2	SS	25												
			3	SS	23												
	Brown		4	SS	15		80										
	Grey		5	SS	18												
			6	SS	16		78										
	Heterogeneous Mixture of Clayey Silt, Sand and Gravel		7	SS	21												
	(Glacial Till)		8	SS	23												
			9	SS	23		76										
	Stiff to Very Stiff		10	SS	17		74										
72.3			11	SS	70	/15cm	72										
10.7	Bedrock - Shale																
	Red, Unweathered to slightly																
70.8	Weathered, Weak to Very Weak					/3cm											
12.2	End of Borehole																
	• GWL not established																

RECORD OF BOREHOLE No 1-2

1 OF 1

METRIC

W.P. WP 319-89-00 LOCATION Co-ords: N 4 786 606; E 292 193 ORIGINATED BY FR
 DIST 4 HWY O.E.W. BOREHOLE TYPE SS Auger, NW Casing, NX Core COMPILED BY FR
 DATUM Geodetic DATE 91 11 11 CHECKED BY PP

SOIL PROFILE			SAMPLES			GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT				UNIT WEIGHT γ kN/m ³	REMARKS & GRAIN SIZE DISTRIBUTION (%) GR SA SI CL
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		
82.1	Ground Surface												
0.0	Brown Grey Heterogeneous Mixture of Clayey Silt, Sand and Gravel (Glacial Till) Stiff to Very Stiff		1	SS	54	*	82					22.8	4 20 43 33
			2	SS	29		80						
			3	SS	19								
			4	SS	13								
			5	SS	15		78					21.5	5 20 43 32
			6	SS	18								
			7	SS	23		76						
			8	SS	27								
			9	SS	22		74					21.8	2 18 41 39
			10	SS	23								
72.3	Bedrock — Shale with interbedded siltstone Red, Unweathered to Slightly Weathered, Weak to Very Weak		11	RC	REC 100%		72						RQD = 52%
9.8			12	RC	REC 100%		70						RQD = 74%
69.7	End of Borehole												
12.4	• 91 11 12 GWL not established												

RECORD OF BOREHOLE No 1-4

1 OF 1

METRIC

W.P. 319-89-00 LOCATION Co-ords: N 4 786 670; E 292 215 ORIGINATED BY TS
DIST 4 HWY Q.E.W. BOREHOLE TYPE SS Auger COMPILED BY TS
DATUM Geodetic DATE 91 11 08 CHECKED BY PP

SOIL PROFILE			SAMPLES			GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT					PLASTIC LIMIT w _p	NATURAL MOISTURE CONTENT w	LIQUID LIMIT w _L	UNIT WEIGHT γ kN/m ³	REMARKS & GRAIN SIZE DISTRIBUTION (%) GR SA SI CL
ELEV DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE	'N' VALUES			20 40 60 80 100	20 40 60 80 100	20 40 60 80 100	20 40 60 80 100	20 40 60 80 100					
81.5	Ground Surface																
0.0	Irregular Mixture of Clayey Silt, Sand and Gravel (Fill Material)		1	SS	7	*											
80.3			2	SS	13		80										
1.2	Heterogeneous Mixture of Clayey Silt, Sand and Gravel (Glacial Till)		3	SS	22												
			4	SS	25		78										
			5	SS	22												
			6	SS	19												
	Brown		7	SS	20		76										
	Grey		8	SS	18												
	Stiff to Very Stiff		9	SS	20		74										
70.5			10	SS	18		72										
11.0	Bedrock - Shale		11	SS	111		70										
69.3	Red, Unweathered to slightly Weathered, Weak to Very Weak				**												
12.2	End of Borehole																
	• GWL not established																
	** Sampler bouncing																

ROCK CORE DESCRIPTION

WP 319-89-00

Page 1 of 1

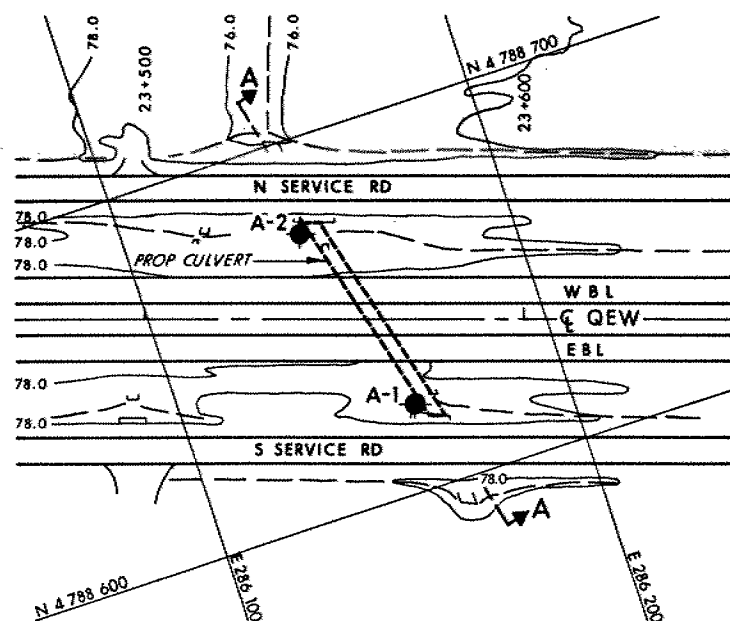
CORE RECOVERY					CORE DESCRIPTION	
BH#	RC#	DEPTH (m)	% CR*	% RQD*	DEPTH (m)	DESCRIPTION
12	11	9.60-10.92	100	51	9.60-12.44	SHALE, greyish red, with interbedded greenish grey SILTSTONE (18%); very fine grained; weak to very weak; unweathered to slightly weathered (moderately weathered, 9.60-9.75 m and 10.87-10.92 m); fractures moderately close to extremely close spaced, flat to near vertical, planar to undulating, smooth.
	12	10.92-12.44	100	74		

*CR = CORE RECOVERY

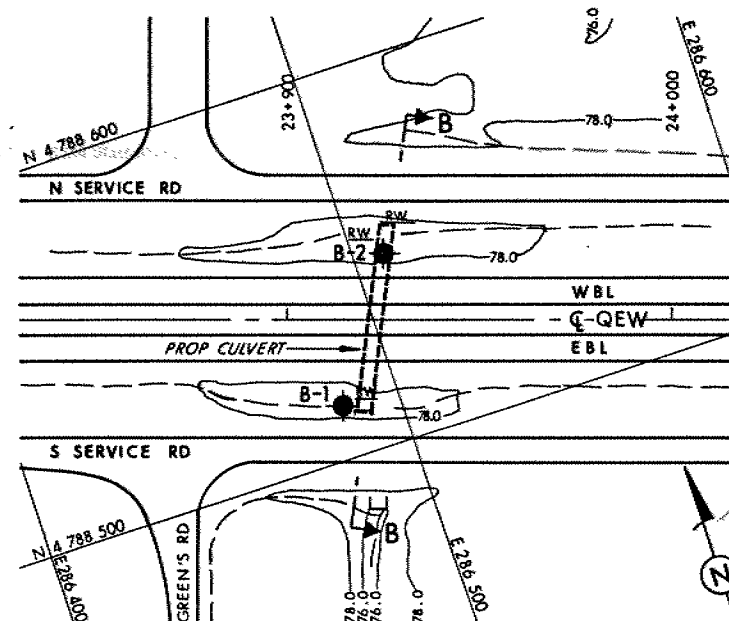
*RQD = ROCK QUALITY DESIGNATION

(NOTE: Depths are approximated where core recovery is less than 100%)

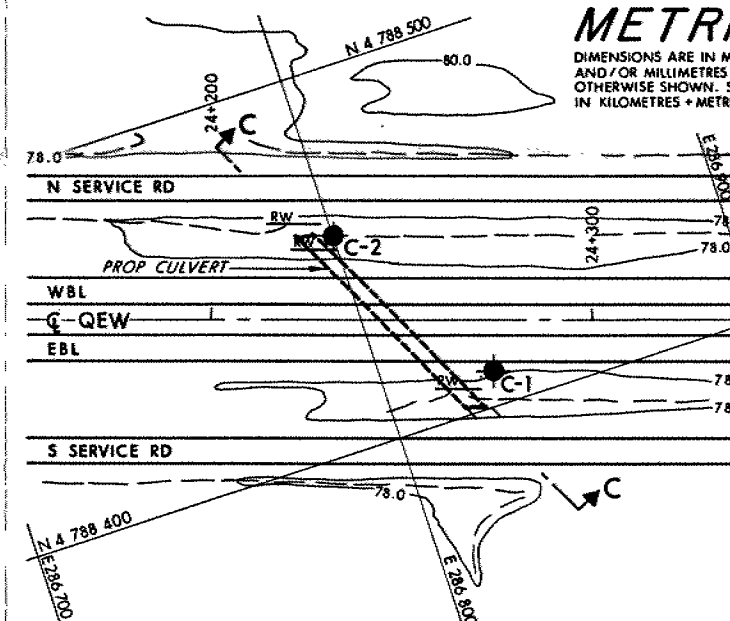
Logged by: DAW, Soils and Aggregates Section



SITE A



SITE B



SITE C

METRIC

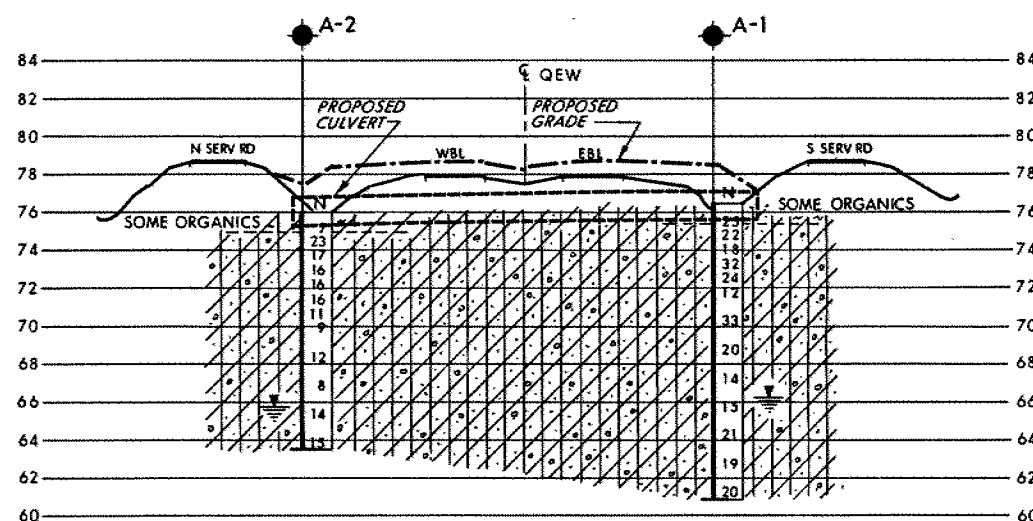
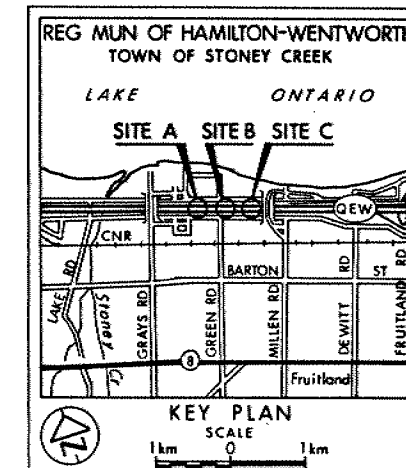
DIMENSIONS ARE IN METRES
AND/OR MILLIMETRES UNLESS
OTHERWISE SHOWN. STATIONS
IN KILOMETRES + METRES.

CONT No
WP No 319-89-00

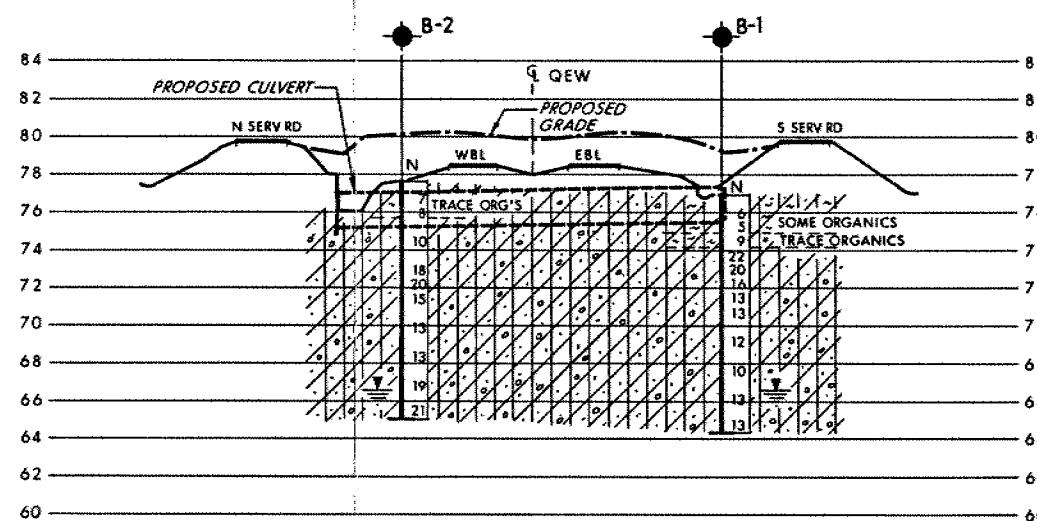
CULVERTS, SITES A, B & C
[Between Grays Rd & Millen Rd]
BORE HOLE LOCATIONS & SOIL STRATA



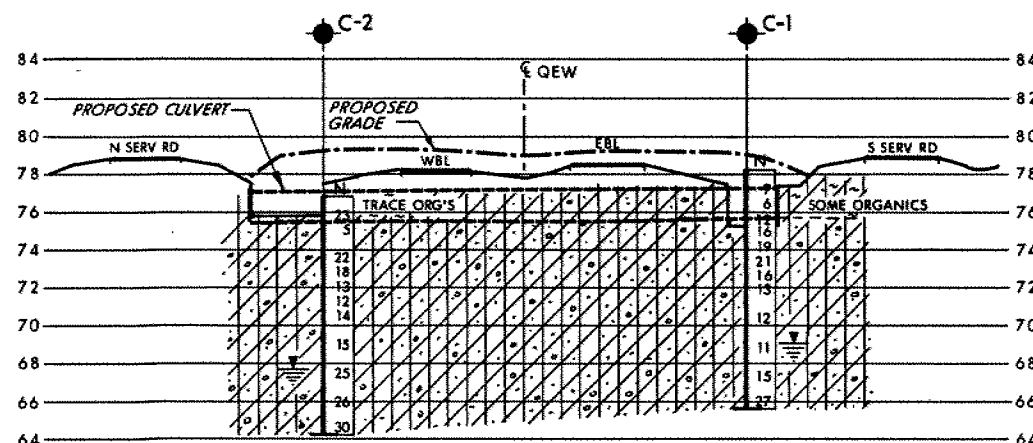
SHEET



SECTION A-A



SECTION B-B



SECTION C-C

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 1991 10 and 11.

No	ELEVATION	CO-ORDINATES	
		NORTH	EAST
A-1	76.6	4 788 623	286 160
A-2	76.1	4 788 675	286 146
B-1	77.0	4 788 514	286 485
B-2	77.7	4 788 549	286 508
C-1	78.2	4 788 409	286 829
C-2	76.8	4 788 457	286 800

SOIL STRATIGRAPHY LEGEND



HETEROGENEOUS MIXTURE OF
CLAYEY SILT, SAND & GRAVEL
Firm to Hard (Glacial Till)

NOTE

For Sites D, E & F refer to Dwg 3198900-B
For Sites G, H & I refer to Dwg 3198900-C

=NOTE=

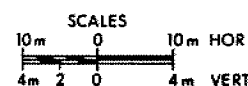
The boundaries between soil strata have been established only at Bore Hole locations. Between Bore Holes the boundaries are assumed from geological evidence.

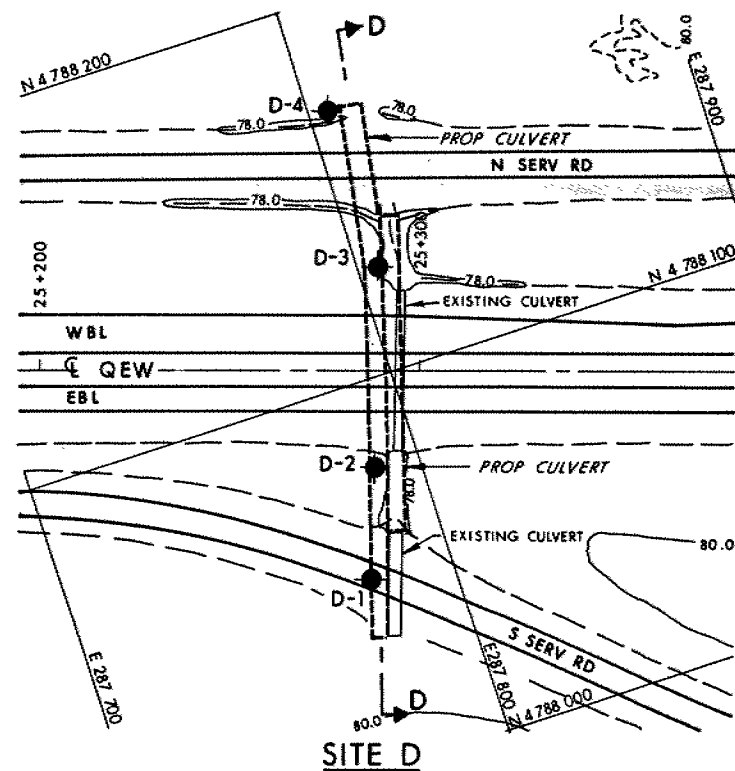
NOTE: The complete foundation investigation and design report for this project and other related documents may be examined at the Engineering Materials Office, Downsview. Information contained in this report and related documents is specifically excluded in accordance with the conditions of Section 102-2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

REV	DATE	BY	DESCRIPTION

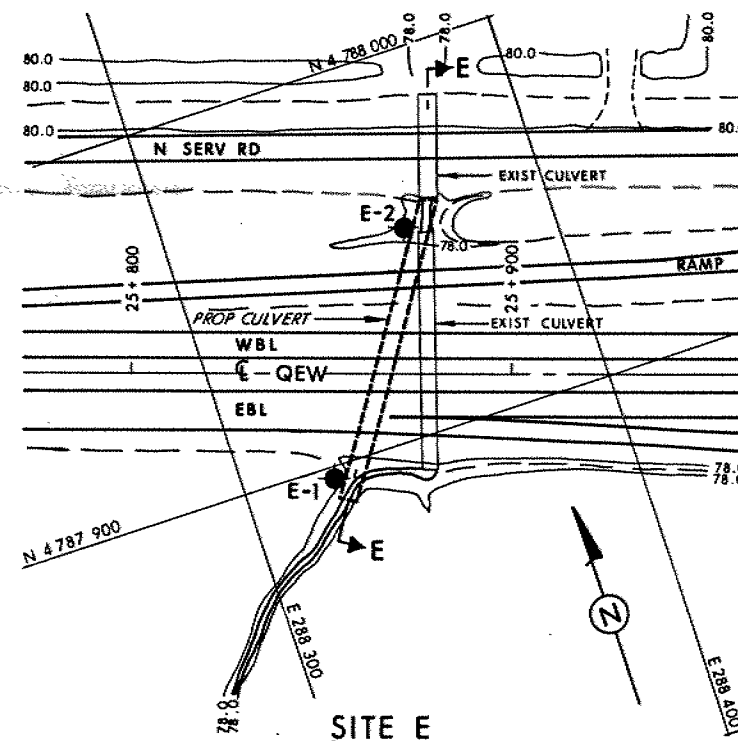
Geocres No 30M4-70

HWY No QEW	SUBM'D T.S.	CHECKED	DATE 1992 04 07	DIST 4
DRAWN R.S.	CHECKED	APPROVED		SITE
				DWG 3198900-A

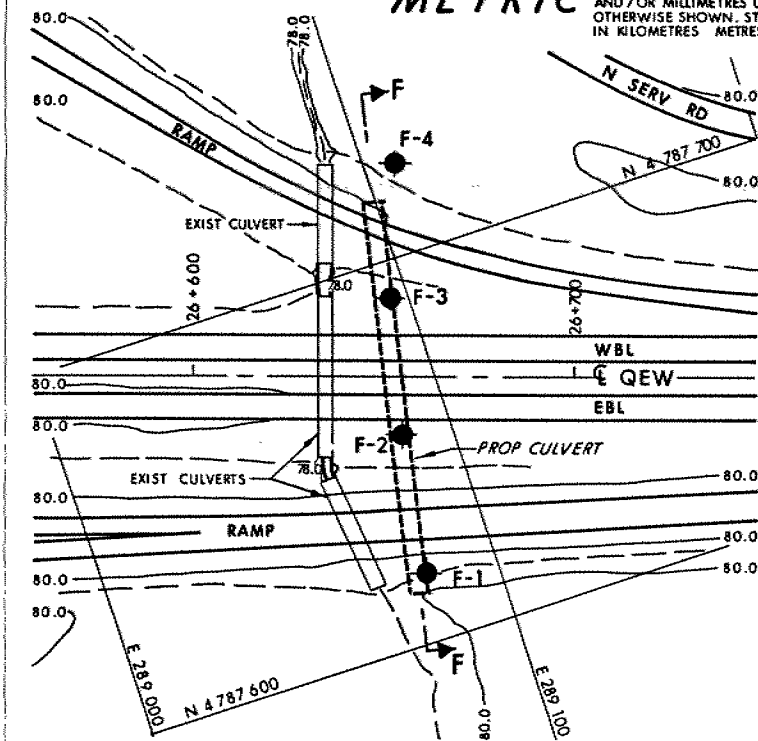




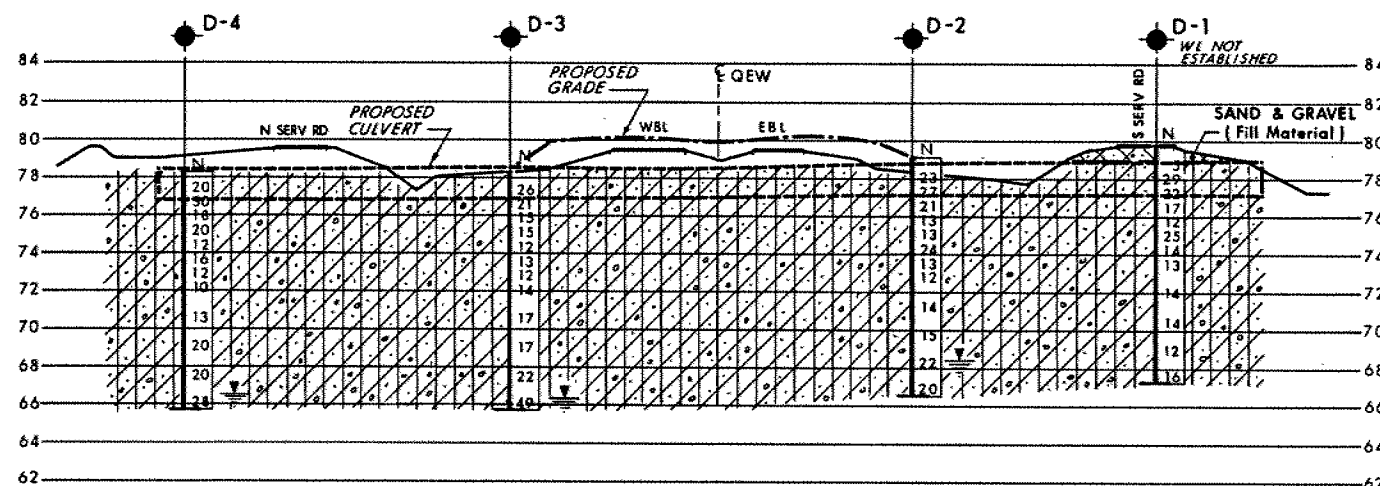
SITE D



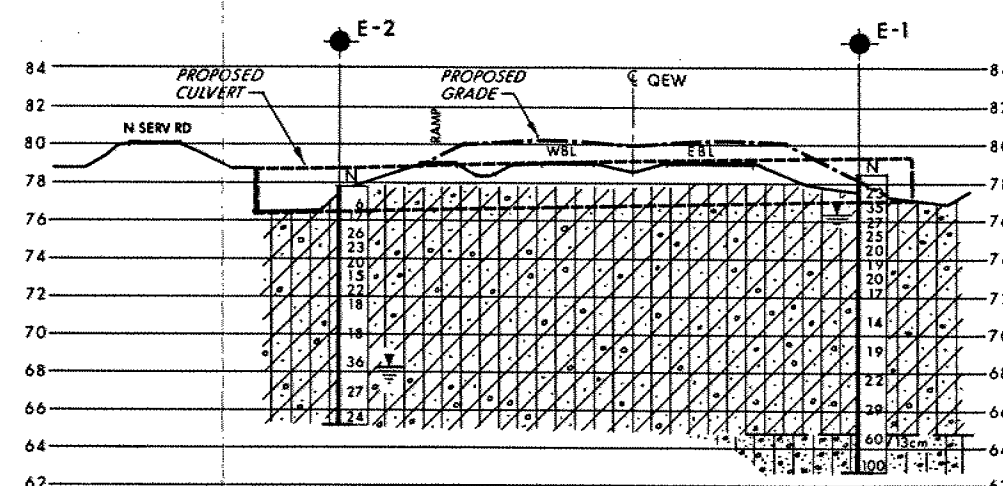
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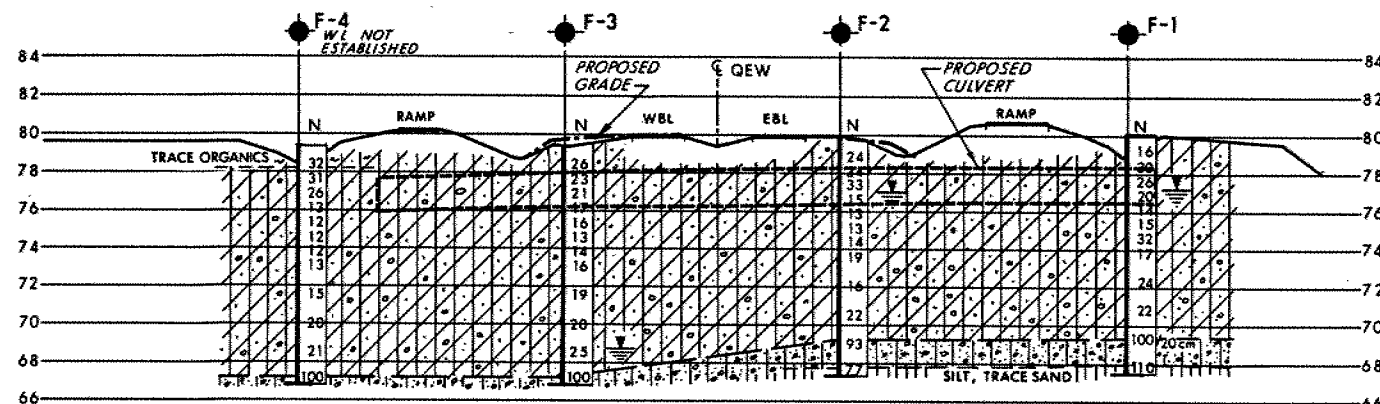
SITE F



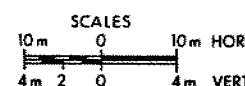
SECTION D-D



SECTION E-E



SECTION F-F



SOIL STRATIGRAPHY LEGEND

HETEROGENEOUS MIXTURE OF CLAYEY SILT, SAND & GRAVEL Firm to Hard (Glacial Till)

HETEROGENEOUS MIXTURE OF SILT, SAND & GRAVEL Very Dense (Glacial Till)

NOTE

For Sites A, B & C refer to Dwg 3198900-A
For Sites G, H & I refer to Dwg 3198900-C

REF No B-135-QEW 1988 09

METRIC

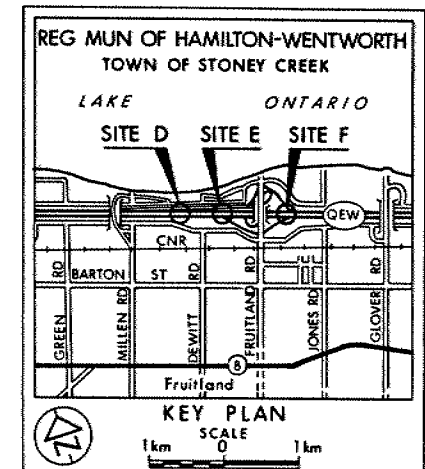
DIMENSIONS ARE IN METRES AND/OR MILLIMETRES UNLESS OTHERWISE SHOWN. STATIONS IN KILOMETRES METRES.

CONT No
WP No 319-89-00

CULVERTS, SITES D, E & F
(Between Millen Rd & Jones Rd)
BORE HOLE LOCATIONS & SOIL STRATA



SHEET



LEGEND

- ◆ Bore Hole
- ⊕ Dynamic Cone Penetration Test (Cone)
- ⊕ Bore Hole & Cone
- N Blows/0.3m (Std Pen Test, 475 J/blow)
- CONE Blows/0.3m (60° Cone, 475 J/blow)
- W L at time of investigation 1991 11

No	ELEVATION	CO-ORDINATES	
		NORTH	EAST
D-1	79.8	4788 049	287 778
D-2	79.1	4788 077	287 788
D-3	78.3	4788 128	287 805
D-4	78.3	4788 171	287 805
E-1	78.5	4787 897	288 323
E-2	77.8	4787 954	288 361
F-1	80.1	4787 618	289 082
F-2	79.9	4787 655	289 087
F-3	79.4	4787 690	289 096
F-4	79.4	4787 724	289 108

NOTE

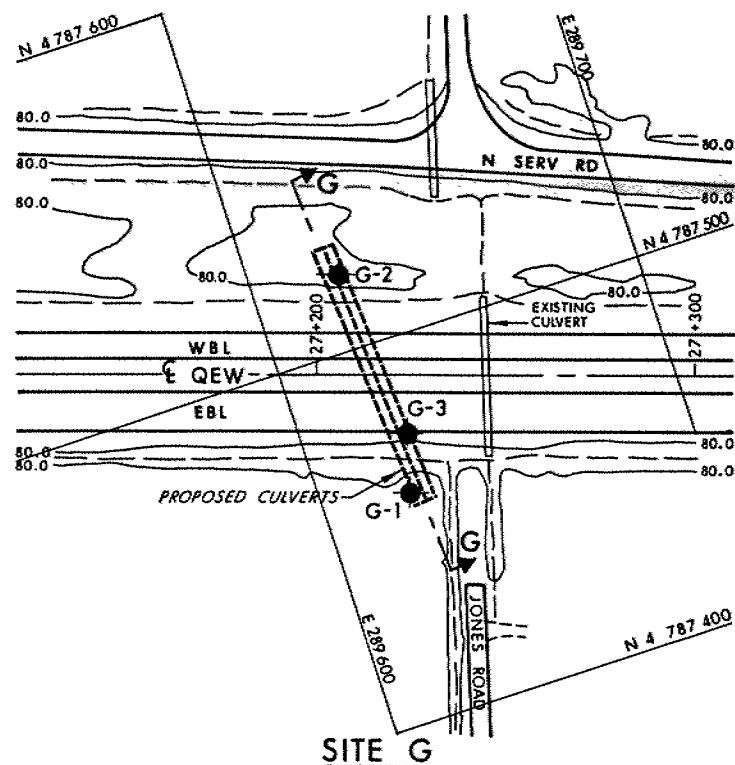
The boundaries between soil strata have been established only at Bore Hole locations. Between Bore Holes the boundaries are assumed from geological evidence.

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.

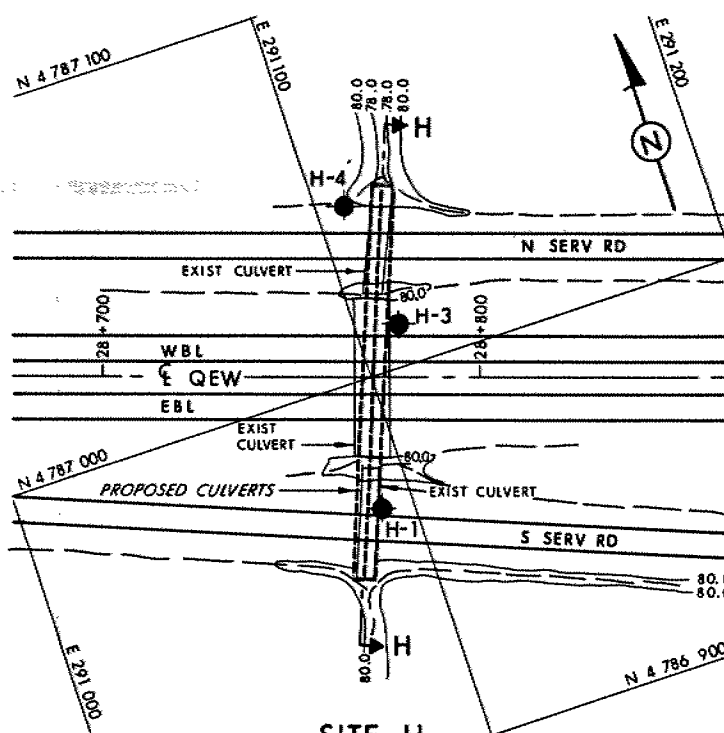
DATE	BY	DESCRIPTION
1992 04 07	RS	DATE 1992 04 07 SITE
1992 04 07	RS	DATE 1992 04 07 SITE
1992 04 07	RS	DATE 1992 04 07 SITE

Geocres No 30 M4-70

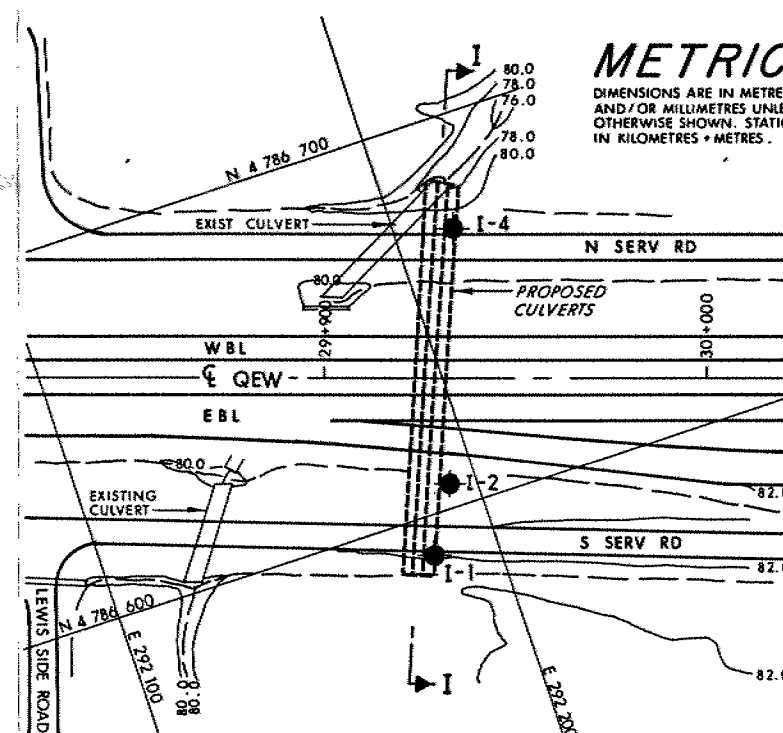
HWY No QEW	SUBM'D TS	CHECKED TS	DATE 1992 04 07	DIST 4
DRAWN RS	CHECKED RS	APPROVED		DWG 3198900-B



SITE G



SITE H



SITE I

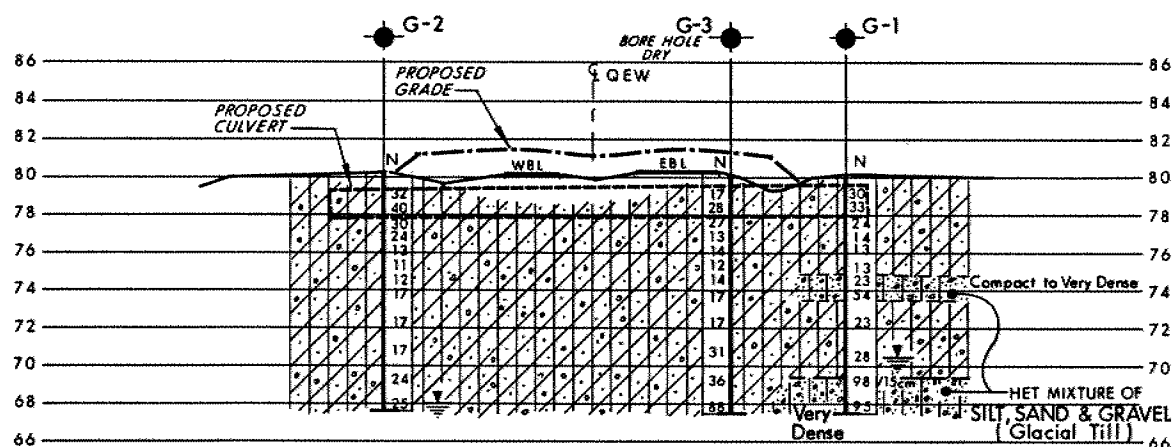
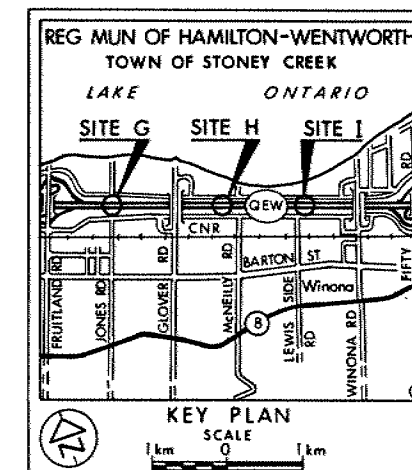
METRIC
DIMENSIONS ARE IN METRES
AND/OR MILLIMETRES UNLESS
OTHERWISE SHOWN. STATIONS
IN KILOMETRES + METRES.

CONT No
WP No 319-89-00

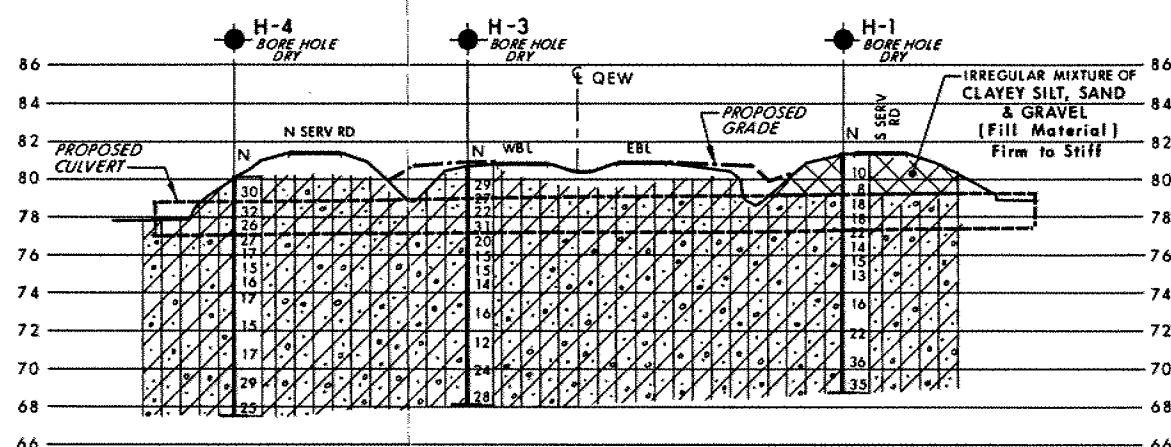
CULVERTS, SITES G, H & I
(Between Jones Rd & Winona Rd)
BORE HOLE LOCATIONS & SOIL STRATA



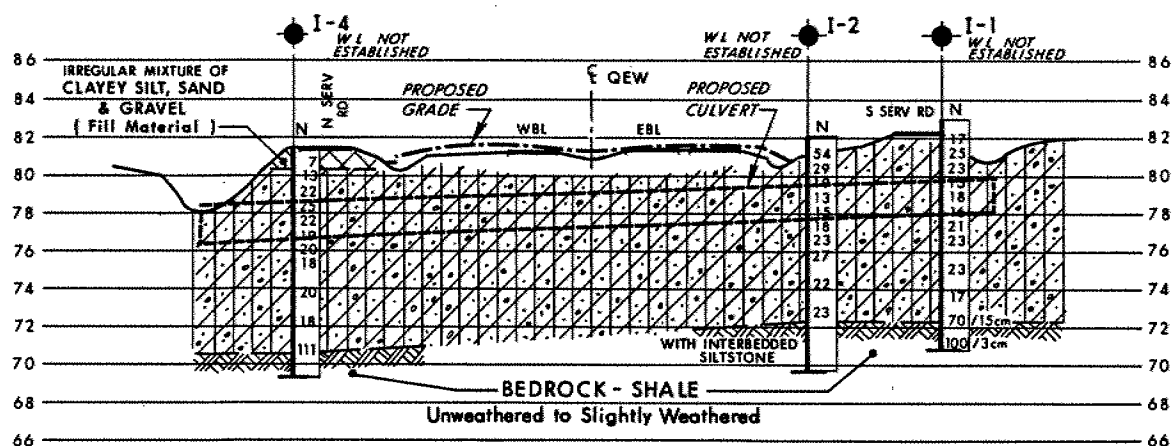
SHEET



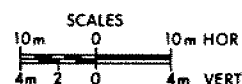
SECTION G-G



SECTION H-H



SECTION I-I



SOIL STRATIGRAPHY LEGEND

HETEROGENEOUS MIXTURE OF
CLAYEY SILT, SAND & GRAVEL
Stiff to Hard (Glacial Till)

NOTE

For Sites A, B & C refer to Dwg 3198900-A
For Sites D, E & F refer to Dwg 3198900-B

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 1991 II

No	ELEVATION	CO-ORDINATES NORTH	EAST
G-1	80.1	4 787 460	289 623
G-2	80.1	4 787 520	289 623
G-3	80.2	4 787 475	289 627
H-1	81.4	4 787 966	291 092
H-3	80.7	4 787 011	291 111
H-4	80.1	4 787 045	291 107
I-1	83.0	4 786 590	292 183
I-2	82.1	4 786 606	292 193
I-4	81.5	4 786 670	292 215

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 30M4-70

HWY No QEW	CHECKED TS	DATE 1992 04 07	DIST 4
SUBM'D TS	CHECKED TS		SITE
DRAWN RS	CHECKED TS		DWG 3198900-C

P. 1 OF 3



HIGH MAST POLE PROPOSED LOCATION (LOOKING EAST)
AT WEST OF FIFTY RD I/C (ADJACENT TO S. SERVICE RD.)

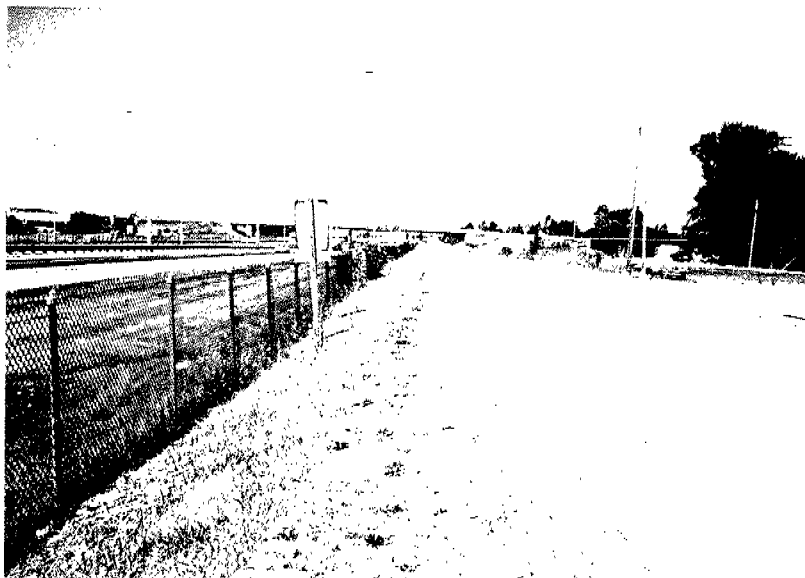


HIGH MAST POLE PROPOSED LOCATION (LOOKING NORTH)
AT WEST OF FRUITLAND RD I/C (ADJACENT TO S. SERVICE RD.)

P. 20F3



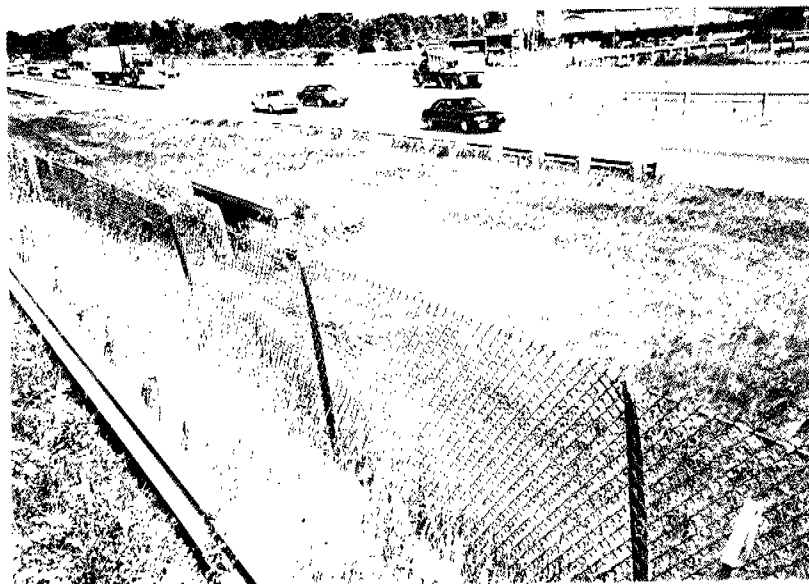
HIGH MAST POLE PROPOSED LOCATION (LOOKING WEST)
AT EAST OF FRUITLAND RD I/C (ADJACENT TO N. SERVICE RD.)



NOISE BARRIER PROPOSED LOCATION (LOOKING WEST)
(FOR STA. 23+042 TO 23+600) ADJACENT TO N. SERVICE RD.



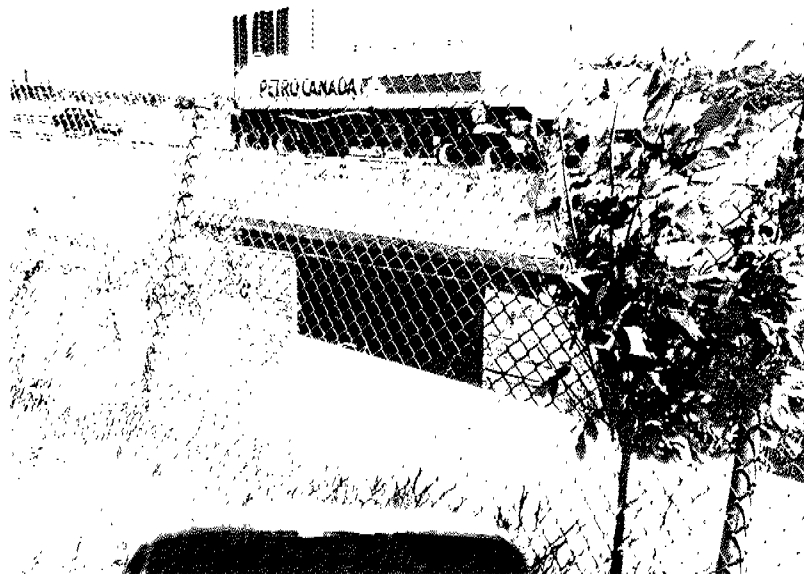
NOISE BARRIER PROPOSED LOCATION (LOOKING WEST)
(FOR STA. 28+700 TO 30+200) (ADJACENT TO N. SERVICE RD.)



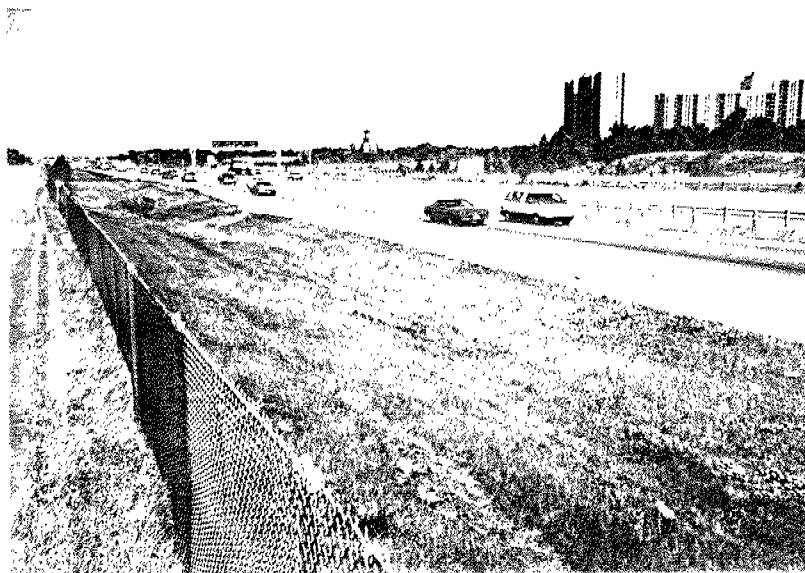
CULVERT 135-08, LOOKING WEST



CULVERT 135-07, LOOKING WEST



CULV. 135-09, LOOKING NW AT EXISTING CULVERT



CULV. 135-09, LOOK. NW AT PROPOSED CULVERT LOCATION



CULV. 135 - 13, LOOKING NORTH



CULV. 135-13, LOOKING NORTH



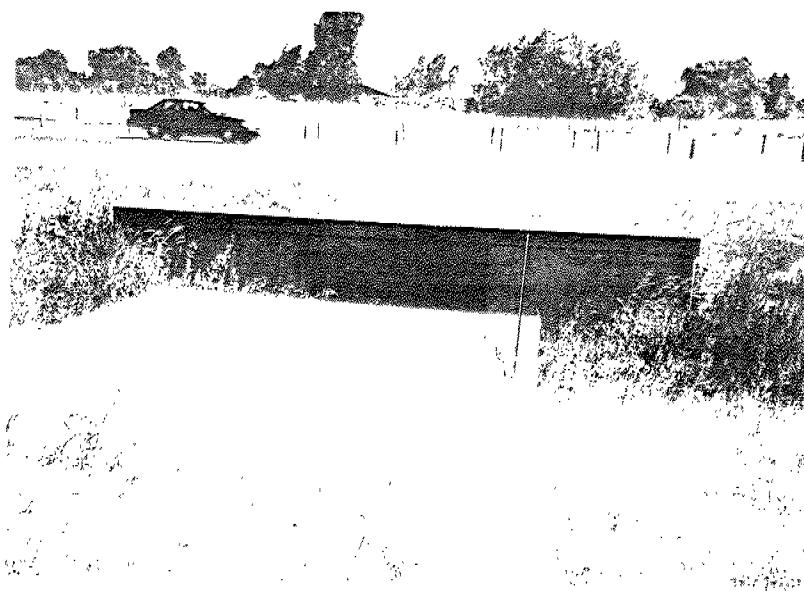
CULV. 137-15 , LOOKING SOUTH



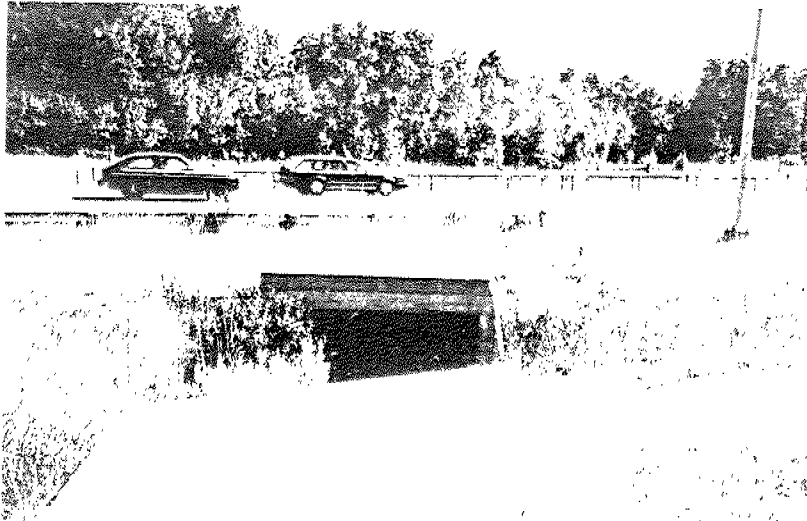
CULV. 137-19 , LOOKING SW



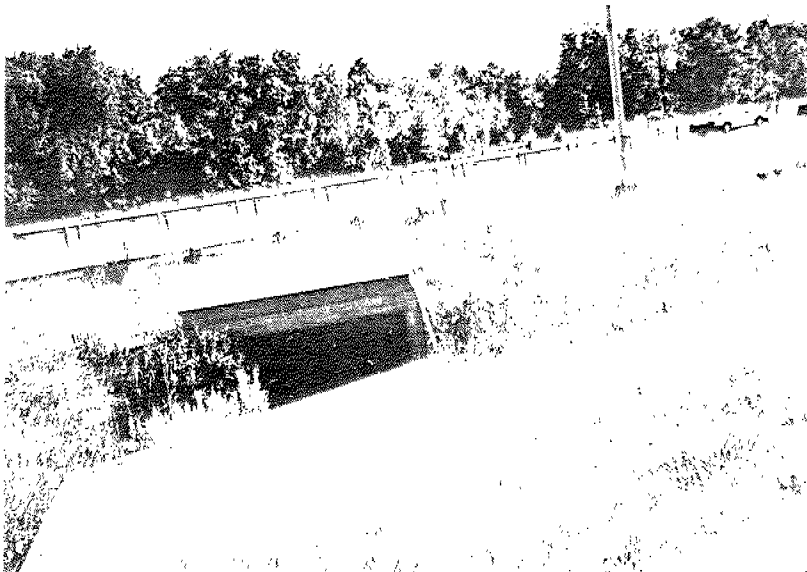
CULV. 135-20 , LOOKING SOUTH



CULV. 135-27 , LOOKING NORTH



CULV. 135- 32 , LOOKING NE



CULV. 135 - 32 , LOOKING NE

DOCUMENT MICROFILMING IDENTIFICATION

G.I.-30 SEPT. 1976

GEOCRES No. 30M4-70
30M4-76

DIST. Central REGION

W.P. No. 331-89-00 & 333-89-00
434-92-00 &

CONT. No. 95-45

W. O. No.

STR. SITE No.

HWY. No. QEW

LOCATION 20 Culverts

Fifty Rd. to Jordan Rd.

No of PAGES -

=====

OVERSIZE DRAWINGS TO BE INCLUDED WITH THIS REPORT.

REMARKS:

FOUNDATION INVESTIGATION REPORT

CONTRACT NO. 95-45



Ministry of
Transportation

Ontario

INDEX

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	Foundation Investigation Report for
3 - 19	Q.E.W. Culverts Fruitland Road to Fifty Road W.P. 434-92-01 Hwy. Q.E.W., Central Region, Burlington
20 - 49	Q.E.W. Culverts Fifty Road to Casablanca Blvd. W.P. 434-92-02 Hwy. Q.E.W., Central Region, Burlington

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 projects.

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	e	1, %	VOID RATIO	e_{min}	1, %	VOID RATIO IN DENSEST STATE
γ_s	kN/m ³	UNIT WEIGHT OF SOLID PARTICLES	n	1, %	POROSITY	i_D	1	DENSITY INDEX = $\frac{e_{max} - e}{e_{max} - e_{min}}$
ρ_w	kg/m ³	DENSITY OF WATER	w	1, %	WATER CONTENT	D	mm	GRAIN DIAMETER
γ_w	kN/m ³	UNIT WEIGHT OF WATER	S_r	%	DEGREE OF SATURATION	D_n	mm	n PERCENT - DIAMETER
ρ	kg/m ³	DENSITY OF SOIL	w_L	%	LIQUID LIMIT	C_u	1	UNIFORMITY COEFFICIENT
γ	kN/m ³	UNIT WEIGHT OF SOIL	w_p	%	PLASTIC LIMIT	h	m	HYDRAULIC HEAD OR POTENTIAL
ρ_d	kg/m ³	DENSITY OF DRY SOIL	w_s	%	SHRINKAGE LIMIT	q	m ³ /s	RATE OF DISCHARGE
γ_d	kN/m ³	UNIT WEIGHT OF DRY SOIL	I_p	%	PLASTICITY INDEX = $w_L - w_p$	v	m/s	DISCHARGE VELOCITY
ρ_{sat}	kg/m ³	DENSITY OF SATURATED SOIL	I_L	1	LIQUIDITY INDEX = $\frac{w - w_p}{I_p}$	i	1	HYDRAULIC GRADIENT
γ_{sat}	kN/m ³	UNIT WEIGHT OF SATURATED SOIL	I_C	1	CONSISTENCY INDEX = $\frac{w_L - w}{I_p}$	k	m/s	HYDRAULIC CONDUCTIVITY
ρ'	kg/m ³	DENSITY OF SUBMERGED SOIL	e_{max}	1, %	VOID RATIO IN LOOSEST STATE	j	kN/m ³	SEEPAGE FORCE
γ'	kN/m ³	UNIT WEIGHT OF SUBMERGED SOIL						

FOUNDATION INVESTIGATION REPORT
For
Q.E.W. Culverts
(Between Fruitland Road and Fifty Road)
W.P. 434-92-01
Central Region, Burlington

INTRODUCTION

This report summarizes the results of a foundation investigation conducted in conjunction with three (3) proposed reinforced concrete box culverts that will carry the Q.E.W. and in some cases the North and South Service Roads. The proposed new culverts will replace existing culverts between Fruitland Road and Fifty Road at or adjacent to the existing culverts. The culvert replacement project is associated with the Q.E.W. widening.

SITE DESCRIPTION

The site is in the Town of Stoney Creek, Regional Municipality of Hamilton-Wentworth. The existing Q.E.W. is a four lane median divided highway and grassland separates the Q.E.W. and the North and South Service Roads.

The terrain across the site is generally flat accentuated by creek slopes at the culvert inlets and outlets. Depths of water in the creeks were shallow at the time of the investigation and generally were less than one (1) metre.

Land use in the area is divided into residential north of the existing North Service Road and industrial south of the existing South Service Road.

INVESTIGATION PROCEDURE

Soil and rock properties were obtained by in situ and laboratory testing. The procedures employed in the foundation investigation are discussed below.

Field Investigation

The fieldwork for the investigation was carried out between 91 11 05 and 91 11 12. Track mounted drilling rigs were used to advance the boreholes employing conventional hollow stem and solid stem augering techniques.

Subsoil samples were retrieved at 0.7 m intervals for the surficial 6.5 m and at 1.5 m intervals thereafter. Disturbed subsoil samples were retrieved employing a standard split spoon sampler in accordance with the Standard Penetration Test (ASTM D1586). All subsoil samples were identified in the field and then placed in sealed plastic jars to ensure the preservation of the natural moisture contents. Samples were subsequently transported to the laboratory for applicable testing.

Groundwater levels were determined by monitoring the levels in the open boreholes throughout the duration of the field investigation. All boreholes were backfilled upon completion of the fieldwork.

The survey related to the location and elevations of the individual boreholes was provided by Central Region Surveys and Plans.

Laboratory Analyses

To identify the behaviour, gradation and pertinent properties of the soil present at the site, various laboratory testing were conducted. These tests included:

- 1) Atterberg Limits
- 2) Grain Size Distributions
- 3) Natural Moisture Contents
- 4) Bulk Unit Weights

The tests were carried out in accordance with standard procedures.

Laboratory test results have been summarized below in the subsequent section of this report entitled "Subsurface Conditions", and are illustrated on the corresponding boreholes and figures included in the Appendix of this report.

SUBSURFACE CONDITIONS

The ground surface elevation varies both within each individual site and also from site to site. The variation within each individual site is a reflection of the creek channels present at the existing culvert locations and is generally in the order of 2.5 m to 5.0 m from the top of fill material above the culvert roof to the channel floor. The ground surface elevation increases in an easterly direction.

Across the entire site area, the overburden consists of glacial till consisting of a cohesive heterogeneous mixture of clayey silt, sand and gravel with random boulders and cobbles.

At some locations, the cohesive glacial till is underlain by a cohesionless heterogeneous mixture of silt, sand and gravel. This deposit, also of glacial till origin, has thicknesses ranging up to 2.0 m.

At Site I, the surficial native cohesive heterogeneous mixture of clayey silt, sand and gravel is underlain by shale bedrock at depths ranging from 9.8 m to 11.0 m (Elevation 72.3 m to 70.5 m).

The native heterogeneous mixture of clayey silt, sand and gravel is overlain by fill material at some locations across the site. At sites H and I for instance, thicknesses of an irregular mixture of clayey silt, sand and gravel fill material for a thickness up to approximately 2.1 metres was also encountered.

The boundaries between the various soil types, in situ and laboratory test results as well as groundwater levels established at the time of investigation are shown on the attached Record of Borehole sheets in the Appendix. A plan of the site illustrating the locations and elevations of the boreholes and a subsoil stratigraphical section are provided on Dwg. No. 4349201-A (Sheet 371-1 of the Contract Drawings).

Details of subsurface materials encountered at borehole locations are illustrated in the Record of Borehole Sheets

Irregular Mixture of Clayey Silt, Sand and Gravel (Fill Material)

A cohesive irregular mixture of clayey silt, sand and gravel identified as fill material was encountered at some sites extending from the surface to a depth of approximately 2.1 m. It appears that this material was used as backfill material to the existing culvert at the various sites.

An Atterberg Limit Test reveals that the material has a Liquid Limit (w_L) of 34% and a Plasticity Index (I_p) of 16.5%. Consequently, the material is classified as a clayey silt of low plasticity. The natural moisture content of the material is 21%.

The 'N' values as determined by the Standard Penetration Test (SPT) revealed a consistency ranging from firm to stiff.

Heterogeneous Mixture of Clayey Silt, Sand and Gravel (Glacial Till)

Underlying the fill material and occurring surficially elsewhere at the site, a native deposit consisting of a cohesive heterogeneous mixture of clayey silt, sand and gravel exists. Boulders and cobbles as inferred in the augering process during the borehole advancement also comprise the deposit. Random zones of a heterogeneous mixture of silt, sand and gravel are also found in this deposit. Red shale fragments are also present within the lower depths of the investigated deposit. The deposit was explored to a maximum thickness of 12.6 metres and is of minimum thickness at Site I (9.8 m thickness).

The main component of this unsorted, unstratified deposit is the clayey silt material. This material matrix essentially binds the coarser sands and gravels within the deposit. A grain size distribution envelope for the deposit as determined by mechanical sieve and hydrometer analyses is given in Figure 1 in the Appendix. The envelope includes particle sizes up to 75 mm (coarse gravel) and hence excludes the boulder and cobble sizes. The envelope does reveal that the fine grained portions (less than 75 micrometres) contribute to more than approximately 70% of the material of this deposit.

Atterberg Limit Tests were carried out to at these and nearby sites define the behaviour and plasticity of the fine grained portion of the soil and the results are plotted in Figure 2. A summary of the indices is provided in Table 1 below. Bulk Unit Weights are also included in the table.

Table 1 - Heterogeneous Mixture of Clayey Silt
Sand and Gravel (Glacial Till)

	Range
Natural Moisture Content (w%)	13-21
Liquid Limit (w L %)	22-35
Plastic Limit (w P %)	14-18
Plasticity Index (I P %)	10-18
Unit Weight (kN/m ³)	19-22.3

The test results reveal that the fine grained portion of the deposit is of low plasticity and hence is defined as clayey silt. Natural moisture contents are generally less than or equivalent to the plastic limit of the soil indicating that the soil is in a plastic to semi-solid state.

Standard Penetration Test (SPT) carried out in this deposit revealed 'N' values ranging from 11 blows/0.3 m to 54 blows/0.3 m revealing a probable stiff to hard range of soil consistency. In general, 'N' values are in the 12 blows/0.3 m to 25 blows/0.3 m and hence the soil is considered as stiff to very stiff.

Heterogeneous Mixture of Silt, Sand and Gravel (Glacial Till)

At Site G the cohesive heterogeneous mixture of clayey silt, sand and gravel is underlain by a cohesionless heterogeneous mixture of silt, sand and gravel at a depth ranging from 10.7 m to 12.6 m (Elevation 69.4 m to 67.5 m). Layers of silt with some sand are also present in this deposit in thicknesses up to approximately 0.5 m. The deposit is red in colour and as inferred by auger grinding, boulders and cobbles are also present within this deposit. Red shale fragments are also contained within the deposit.

Bedrock

Based on tests in the general area, shale bedrock with interbedded siltstone of the Queenston Shale Formation underlies the overburden at Site I at a depth of 9.8 m to 11 m (Elevation 72.3 m to 70.5 m). Bedrock core was retrieved in NX size for a thickness of 2.84 m at BH I2.

The shale bedrock is generally greyish red and has randomly interbedded greenish grey siltstone layers. The rock is horizontally bedded and is an extremely friable material. The rock contains moderately close to extremely closed spaced fractures that are generally flat, planar to undulating and smooth. The rock generally is unweathered to slightly weathered.

Core recoveries and Rock Quality Designations (RQD) were determined in situ to evaluate the competence and integrity of the rock. Core recoveries were 100% and RQD's ranged from 52% to 74%. Based on these measurements, the rock can be considered to be of fair quality.

Based on index property identification, the rock is classified as weak to very weak in strength.

GROUNDWATER CONDITIONS

Observation of the groundwater level was carried out by measuring the water level in the open boreholes throughout the duration of the field investigation.

Groundwater conditions at the borehole locations are illustrated on the Record of Borehole Sheets. Some higher water levels in the area illustrate the effect of the subartesian condition present in the heterogeneous mixture of silt, sand and gravel deposit below the cohesive heterogeneous mixture of clayey silt, sand and gravel.

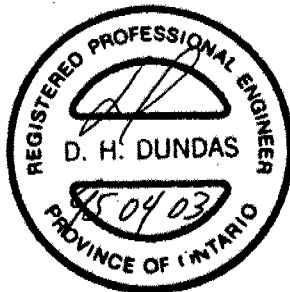
Groundwater levels were not established at the borehole locations advanced on the shoulders of the Q.E.W. and the Service Roads because these boreholes were backfilled immediately for safety reasons.

Groundwater levels, in general, are subject to seasonal fluctuations and hence can vary from the values given in this report.

MISCELLANEOUS

The fieldwork for this investigation was carried out under the supervision of T. Sangiuliano, Foundation Engineer and F. Reijerse, Student Engineer, utilizing equipment owned and operated by Malone's Soil Samples.

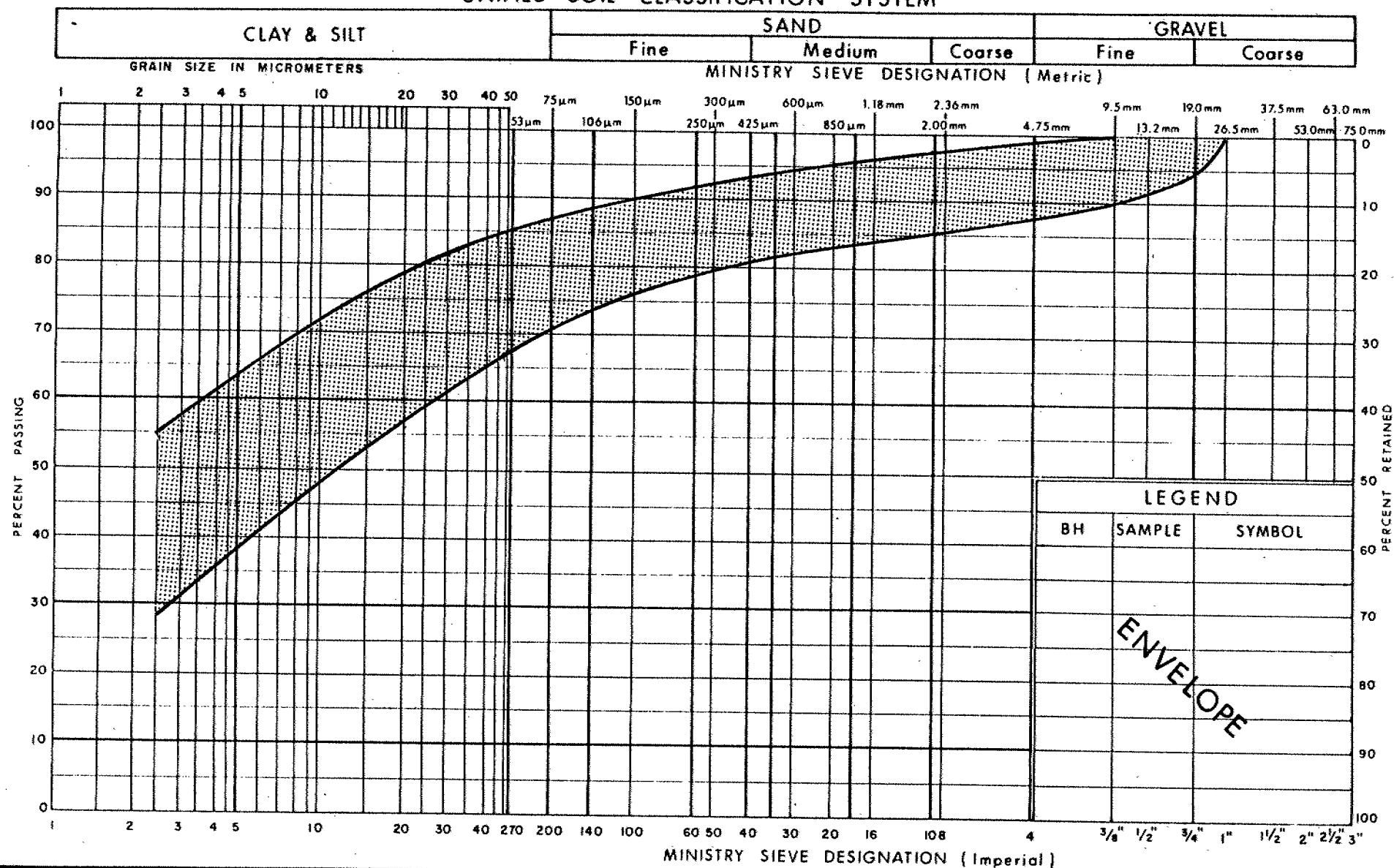
The project was carried out by T. Sangiuliano under the general supervision of P. Payer, Senior Foundation Engineer. The report was written by T. Sangiuliano, reviewed by P. Payer and approved by M. Devata, Chief Foundation Engineer.



D. Dundas
D. Dundas, P.Eng.
Senior Foundation Engineer

APPENDIX

UNIFIED SOIL CLASSIFICATION SYSTEM

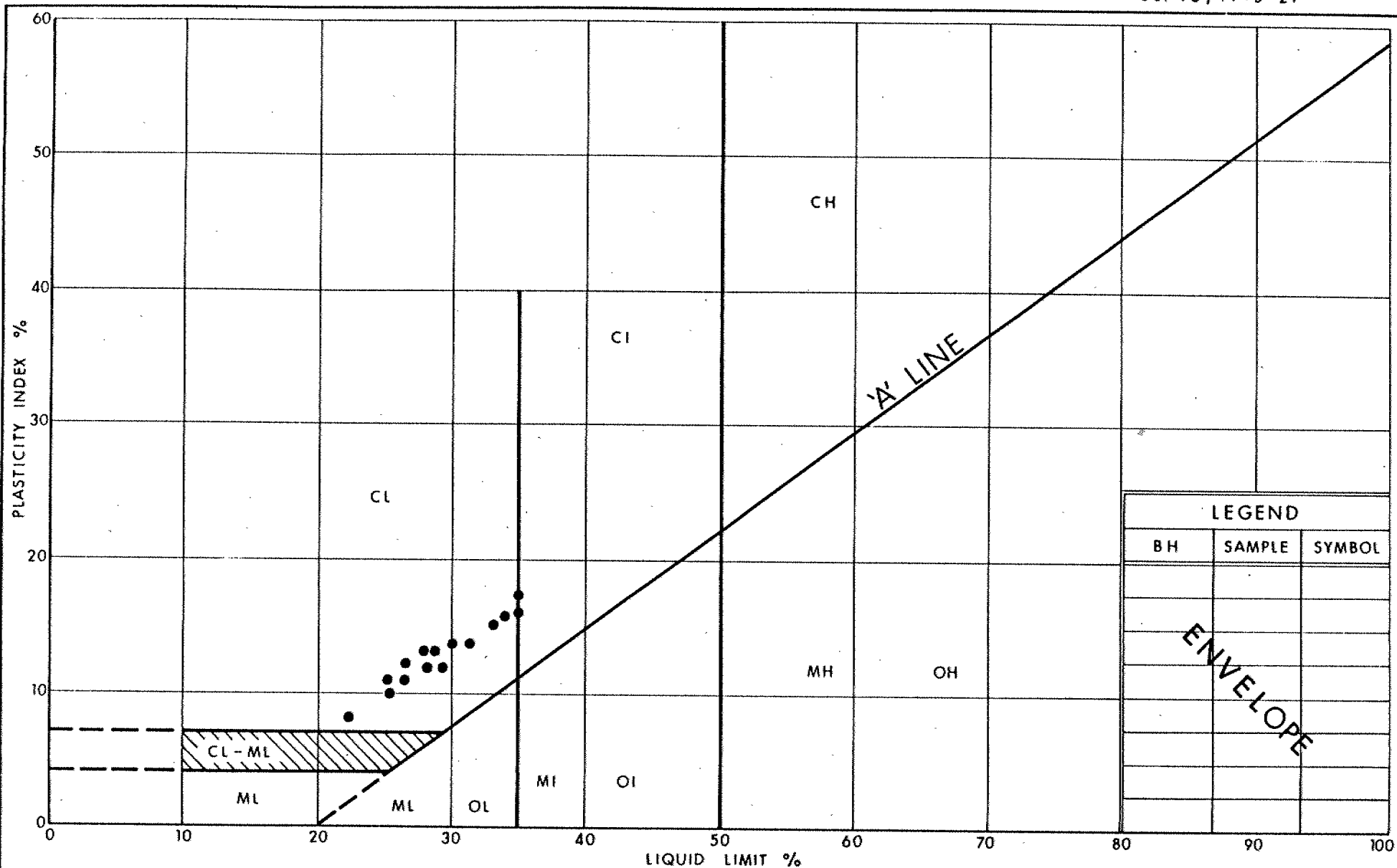


Ministry of
Transportation

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

FIG No 1

W P 434-92-01

Ministry of
Transportation

PLASTICITY CHART
HET MIXTURE OF CLAYEY SILT,
SAND & GRAVEL (Glacial Till)

FIG No 2

W P 434-92-01

RECORD OF BOREHOLE No G-1

1 OF 1

METRIC

W.P. 434-92-01 LOCATION Co-ords: N 4 787 460; E 289 623 ORIGINATED BY PC
DIST 4 HWY G.E.W. BOREHOLE TYPE SS Auger COMPILED BY FR
DATUM Geodetic DATE 91 11 06 CHECKED BY PP

SOIL PROFILE			SAMPLES			GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT		PLASTIC NATURAL LIQUID LIMIT MOISTURE CONTENT			UNIT WEIGHT γ kN/m ³	REMARKS & GRAIN SIZE DISTRIBUTION (%) GR SA SI CL			
ELEV DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE	'N' VALUES			20 40 60 80 100							w _p	w	w _L
								SHEAR STRENGTH kPa									
								○ UNCONFINED	+ FIELD VANE								
								● QUICK TRIAXIAL	* LAB VANE								
								20 40 60 80 100									
80.1	Ground Surface																
0.0																	
			1	SS	30												
			2	SS	33												
	Brown		3	SS	24		78										
	Grey		4	SS	14								21.4	11 15 43 31			
			5	SS	13		76										
			6	SS	13												
			7	SS	23		74						22.2	48 33 15 4			
	Het. Mixt. of Silt, Sand and Gravel (Glacial Till)		8	SS	54												
			9	SS	23		72										
	Heterogeneous Mixture of Clayey Silt, Sand and Gravel (Glacial Till)		10	SS	28		70										
69.4	Stiff to Very Stiff																
10.7	Heterogeneous Mixture of Silt, Sand and Gravel (Glacial Till)		11	SS	98	/15cm											
67.5	Red, Very Dense		12	SS	95		68										
12.6	End of Borehole = 91 11 07																

RECORD OF BOREHOLE No G-2

1 OF 1

METRIC

W.P. 434-92-01

LOCATION Co-ords: N 4 787 520; E 289 623

ORIGINATED BY TS

DIST 4 HWY Q.E.W.

BOREHOLE TYPE SS Auger

COMPILED BY TS

DATUM Geodetic

DATE 91 11 08

CHECKED BY PP

SOIL PROFILE			SAMPLES			GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT		PLASTIC LIMIT NATURAL MOISTURE CONTENT LIQUID LIMIT			UNIT WEIGHT	REMARKS & GRAIN SIZE DISTRIBUTION (%)
ELEV DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE	'N' VALUES			20	40	60	80	100		
80.1	Ground Surface													
0.0			1	SS	32									
			2	SS	40									
	Hard		3	SS	30									
	Brown		4	SS	24									
	Grey		5	SS	13									
			6	SS	11									
			7	SS	12									
			8	SS	17									
	Heterogeneous Mixture of Clayey Silt, Sand and Gravel (Glacial Till)		9	SS	17									
	Stiff to Very Stiff		10	SS	17									
			11	SS	24									
67.5			12	SS	25									
12.6	End of Borehole • 91 11 11													

RECORD OF BOREHOLE No G-3

1 OF 1

METRIC

W.P. 434-92-01

LOCATION Co-ords: N 4 787 475 E 289 627

ORIGINATED BY PC

DIST 4 HWY Q.E.W.

BOREHOLE TYPE SS Auger

COMPILED BY TS

DATUM Geodetic

DATE 91 11 05

CHECKED BY PP

SOIL PROFILE			SAMPLES			GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT		PLASTIC LIMIT NATURAL MOISTURE CONTENT LIQUID LIMIT			UNIT WEIGHT 7 kN/m ³	REMARKS & GRAIN SIZE DISTRIBUTION (%) GR SA SI CL			
ELEV DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE	'N' VALUES			SHEAR STRENGTH kPa							WATER CONTENT (%)		
								20 40 60 80 100							10 20 30		
80.2	Ground Surface																
0.0	<div>Brown</div> <div>Grey</div> <div>Heterogeneous Mixture of Clayey Silt, Sand and Gravel (Glacial Till)</div> <div>Stiff to Very Stiff</div> <div>Red, Hard</div>		1	SS	17	DRY *	80										
			2	SS	28												
			3	SS	27		78										
			4	SS	13												
			5	SS	14		76										
			6	SS	12												
			7	SS	14		74										
			8	SS	17												
			9	SS	17		72										
			10	SS	31		70										
			11	SS	36												
67.6					12		SS	88	68								
12.6	End of Borehole • 91 11 07																

RECORD OF BOREHOLE No H-1 1 OF 1 METRIC

W.P. 434-92-01 LOCATION Co-ords: N 4 787 966; E 291 092 ORIGINATED BY FR
DIST 4 HWY Q.E.W. BOREHOLE TYPE SS Auger COMPILED BY FR
DATUM Ceodetic DATE 91 11 12 CHECKED BY PP

SOIL PROFILE		SAMPLES			GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT					PLASTIC LIMIT W _P	NATURAL MOISTURE CONTENT W	LIQUID LIMIT W _L	UNIT WEIGHT γ	REMARKS & GRAIN SIZE DISTRIBUTION (%)
ELEV DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE	'N' VALUES		20	40	60	80	100					
81.4	Ground Surface															
0.0	Irregular Mixture of Clayey Silt, Sand and Gravel (Fill Material)		1	SS	10											
79.3	Brown, Firm to Stiff		2	SS	8											
2.1			3	SS	18											
			4	SS	18											
			5	SS	22											
	Brown		6	SS	14											
	Grey		7	SS	15											
			8	SS	13											
	Heterogeneous Mixture of Clayey Silt, Sand and Gravel (Glacial Till) Stiff to Hard		9	SS	16											
			10	SS	22											
			11	SS	36											
68.8			12	SS	35											
12.6	End of Borehole • Dry Upon Completion															

RECORD OF BOREHOLE No H-3

1 OF 1

METRIC

W.P. 434-92-01

LOCATION Co-ords: N 4 787 011; E 291 111

ORIGINATED BY TS

DIST 4 HWY Q.E.W.

BOREHOLE TYPE SS Auger

COMPILED BY FR

DATUM Geodetic

DATE 91 11 11

CHECKED BY PP

SOIL PROFILE		SAMPLES			GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT		PLASTIC LIMIT W _p	NATURAL MOISTURE CONTENT W	LIQUID LIMIT W _L	UNIT WEIGHT 7 KN/m ³	REMARKS & GRAIN SIZE DISTRIBUTION (%) GR SA SI CL
ELEV DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE			'N' VALUES	SHEAR STRENGTH kPa ○ UNCONFINED + FIELD VANE ● QUICK TRIAXIAL x LAB VANE					
80.7	Ground Surface					20 40 60 80 100			10 20 30				
0.0			1	SS	29								
			2	SS	27								
			3	SS	22								
			4	SS	31								
			5	SS	20								
			6	SS	15								
			7	SS	15								
			8	SS	14								
			9	SS	16								
			10	SS	12								
			11	SS	24								
68.1			12	SS	28								
12.6	End of Borehole • Dry Upon Completion												

RECORD OF BOREHOLE No H-4

1 OF 1

METRIC

W.P. 434-92-01 LOCATION Co-ords: N 4 787 045; E 291 107 ORIGINATED BY TS
 DIST 4 HWY O.E.W. BOREHOLE TYPE SS Auger COMPILED BY FR
 DATUM Geodetic DATE 91 11 08 CHECKED BY PP

SOIL PROFILE			SAMPLES			GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT					PLASTIC LIMIT W _p	NATURAL MOISTURE CONTENT W	LIQUID LIMIT W _L	UNIT WEIGHT 7 kN/m ³	REMARKS & GRAIN SIZE DISTRIBUTION (%) GR SA SI CL	
ELEV DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE	'N' VALUES			SHEAR STRENGTH kPa										WATER CONTENT (%)
								20	40	60	80	100						
80.1	Ground Surface																	
0.0	Hard ----- Brown ----- Grey Heterogeneous Mixture of Clayey Silt, Sand and Gravel (Glacial Till) Stiff to Very Stiff		1	SS	30	DRY •	78											
			2	SS	32													
			3	SS	26													
			4	SS	27													
			5	SS	17													
			6	SS	15													
			7	SS	16													
			8	SS	17													
			9	SS	15													
			10	SS	17													
			11	SS	29													
67.5			12	SS	25													
12.6	End of Borehole • Dry Upon Completion																	

RECORD OF BOREHOLE No 1-1

1 OF 1

METRIC

W.P. 434-92-01 LOCATION Co-ords: N 4 786 590; E 292 183 ORIGINATED BY FR
DIST 4 HWY Q.E.W. BOREHOLE TYPE SS Auger COMPILED BY TS
DATUM Geodetic DATE 91 11 08 CHECKED BY PP

SOIL PROFILE			SAMPLES			GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT					PLASTIC LIMIT NATURAL MOISTURE CONTENT LIQUID LIMIT			UNIT WEIGHT 7 kN/m ³	REMARKS & GRAIN SIZE DISTRIBUTION (%) GR SA SI CL
ELEV DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE	'N' VALUES			20 40 60 80 100					w _p w w _L				
								SHEAR STRENGTH kPa					WATER CONTENT (%)				
83.0	Ground Surface																
0.0			1	SS	17		82										
			2	SS	25												
			3	SS	23												
	Brown		4	SS	15		80										
	Grey		5	SS	18												
			6	SS	16		78										
	Heterogeneous Mixture of Clayey Silt, Sand and Gravel (Glacial Till)		7	SS	21												
			8	SS	23		76										
	Stiff to Very Stiff																
			9	SS	23		74										
			10	SS	17												
72.3			11	SS	70	/15cm	72										
10.7	Bedrock - Shale																
	Red, Unweathered to slightly																
70.8	Weathered, Weak to Very Weak					/3cm											
12.2	End of Borehole																
	* CWL not established																

RECORD OF BOREHOLE No 1-2

1 OF 1

METRIC

W.P. 434-92-01 LOCATION Co-ords: N 4 786 606; E 292 193 ORIGINATED BY FR
DIST 4 HWY O.E.W. BOREHOLE TYPE SS Auger, NW Casing, NX Core COMPILED BY FR
DATUM Ceodetic DATE 91 11 11 CHECKED BY PP

SOIL PROFILE			SAMPLES			GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT		PLASTIC LIMIT w _p	NATURAL MOISTURE CONTENT w	LIQUID LIMIT w _L	UNIT WEIGHT γ kN/m ³	REMARKS & GRAIN SIZE DISTRIBUTION (%) GR SA SI CL			
ELEV DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE	'N' VALUES			20 40 60 80 100									
								SHEAR STRENGTH kPa ○ UNCONFINED + FIELD VANE ● QUICK TRIAXIAL * LAB VANE									
							WATER CONTENT (%) 10 20 30										
82.1	Ground Surface						82										
0.0	<div>Brown</div> <div>Grey</div> Heterogeneous Mixture of Clayey Silt, Sand and Gravel (Glacial Till) Stiff to Very Stiff		1	SS	54								22.8	4 20 43 33			
			2	SS	29												
			3	SS	19												
			4	SS	13												
			5	SS	15										21.5	5 20 43 32	
			6	SS	18												
			7	SS	23												
			8	SS	27												
			9	SS	22										21.8	2 18 41 39	
			10	SS	23												
72.3																	
9.8	Bedrock - Shale with interbedded siltstone Red, Unweathered to Slightly Weathered, Weak to Very Weak		11	RC	REC 100%									RQD = 52%			
69.7			12	RC	REC 100%									RQD = 74%			
12.4	End of Borehole • 91 11 12 GWL not established																

RECORD OF BOREHOLE No 1-4

1 OF 1

METRIC

W.P. 434-92-01 LOCATION Co-ords: N 4 786 670; E 292 215 ORIGINATED BY TS
 DIST 4 HWY O.E.W. BOREHOLE TYPE SS Auger COMPILED BY TS
 DATUM Geodetic DATE 91 11 08 CHECKED BY PP

SOIL PROFILE			SAMPLES			GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT					UNIT WEIGHT γ kN/m ³	REMARKS & GRAIN SIZE DISTRIBUTION (%) GR SA SI CL
ELEV DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE	'N' VALUES			20	40	60	80	100		
81.5	Ground Surface													
0.0	Irregular Mixture of Clayey Silt, Sand and Gravel (Fill Material)		1	SS	7	*								
80.3			2	SS	13		80							
1.2	Heterogeneous Mixture of Clayey Silt, Sand and Gravel (Glacial Till)		3	SS	22									
			4	SS	25		78							
			5	SS	22									
			6	SS	19		76							
			7	SS	20									
			8	SS	18		74							
			9	SS	20									
			10	SS	18		72							
70.5			11	SS	111									
11.0	Bedrock - Shale						70							
69.3	Red, Unweathered to slightly Weathered, Weak to Very Weak				**									
12.2	End of Borehole													
	* GWL not established													
	** Sampler bouncing													

FOUNDATION INVESTIGATION REPORT

for

Culvert Replacement

W.P. 434-92-02
Queen Elizabeth Way
Fifty Road to Casablanca Boulevard
Stoney Creek and Grimsby

1.0 INTRODUCTION

This report presents the results of a foundation investigation carried out at proposed culvert replacement sites in the City of Stoney Creek, and Town of Grimsby, Ontario. The investigation was carried out in accordance with our proposal dated 94/08/06. Authorization to carry out the work was provided by the Foundation Design Section, Ministry of Transportation, Ontario (MTO).

This report contains factual information pertaining to the subsurface conditions.

2.0 SITE DESCRIPTION AND GEOLOGY

The culvert replacement sites are located along the Queen Elizabeth Way (QEW) between Fifty Road in Stoney Creek and Casablanca Boulevard in Grimsby. Sheets No. 371-2 and 371-3 in the Contract Drawings show the site locations. The terrain surrounding the sites is generally flat and consists of mixed residential, agricultural and industrial land uses. The existing ground surface generally slopes downward gently from south to north, towards Lake Ontario.

At the time of the investigation, the QEW is a four-lane divided highway with gravel shoulders. A North Service Road and South Service Road is located parallel to the QEW on the north and south sides, respectively. Both the North and South Service Roads are two-lane paved roads with gravel shoulders.

Drainage of the existing QEW is provided by highway ditches located on both the north and south sides and in between the QEW and the two service roads. The culverts investigated during this study facilitate drainage of these ditches beneath the QEW towards the north into Lake Ontario.

Physiographically, the sites lie in the area known as the Halton Till Plain, which consists of glacial till with clayey silt to silty clay size particles and little to no cobbles and boulders. Bedrock underlying the overburden consists of Ordovician shale of the Queenston Formation throughout the study area.

3.0 PROCEDURE

3.1 Field Investigation

Prior to the onset of the drilling investigation, the necessary utility check clearances were obtained by our site personnel. Traffic control for this project was provided by Barricade Traffic Services Inc., who were coordinated by MTO.

The field work for this investigation was carried out between August 16 and 25, 1994. Three (3) boreholes were put down at each culvert location. The test locations are indicated on Drawings No. 4349202-A and 4349202-B (Refer to Sheets 371-2 & 371-3 in the Contract Drawings). One dynamic cone penetration test was also conducted at each culvert location.

All boreholes were put down using either a track-mounted or truck-mounted power auger drill suitably equipped for soil and bedrock sampling. Continuous flight solid stem augers and NQ-sized rock coring techniques (where required) were employed during the course of the investigation to advance the boreholes.

The overburden soils encountered were sampled by means of a split spoon sampler during the performance of Standard Penetration Tests (SPT) (ASTM D1586). Where soft to firm cohesive soils were encountered, field vane tests were conducted at selected locations. Sampling was generally conducted on a near continuous basis (intervals of 0.76 m) at the top 4.6 m of the borehole. Below this depth, sampling was conducted in intervals of about 1.5 m.

All soil samples recovered together with bedrock core samples were stored in moisture-proof bags or core boxes, and were returned to our Markham laboratory for detailed classification and testing.

Water levels, where observed, were obtained in the open boreholes upon completion of the drilling. All boreholes were backfilled with auger cuttings and sealed with a minimum 500 mm thick bentonite layer at the ground surface. Boreholes put down at the median where the surface consists of asphaltic concrete were surfaced with a minimum of 50 mm of cold mix asphalt.

3.2 Survey

The borehole and cone penetration test locations and ground surface elevations were surveyed by Jacques Whitford Environment Limited (JWEL) personnel after completion of the field work. The elevations were referenced to existing culvert invert elevations shown on the site plans, provided by MTO. These elevations are assumed to be referenced to the Geodetic datum.

3.3 Laboratory Testing

To identify the properties of the samples collected during the field investigation, the following laboratory tests were carried out on selected samples:

- Detailed visual classification,
- Natural moisture content,
- Sieve and hydrometer analyses,
- Atterberg Limits determination,
- Natural unit weight determination.

4.0 RESULTS OF THE INVESTIGATION

The subsurface conditions observed in the boreholes are presented in detail on the Record of Boreholes provided in the Appendix.

A brief discussion of the observed subsurface conditions is provided below.

4.1 W.P. 434-92-02

4.1.1 Topsoil

Topsoil was encountered at the ground surface in most boreholes except the boreholes located in the median of the QEW. The thickness of the topsoil ranges from 50 mm to 600 mm.

4.1.2 Asphaltic Concrete

Asphaltic concrete was encountered at the ground surface in Boreholes 135-41-2, and 136-04-2 (QEW median locations). The thickness of the asphaltic concrete ranged from 50 mm to 100 mm at the time of the investigation with an average thickness of about 75 mm.

4.1.3 Sand, Silt and Gravel (Fill) / Silt (Fill)

A loose to compact mixture of sand, silt and gravel (fill) layer was encountered at the ground surface or underlying the asphaltic concrete in all QEW median boreholes. The thickness of the fill layer ranged from 0.5 m to 1.8 m. In general, this material was observed to be compact. Based on visual identification and laboratory tests, this fill can be classified as inorganic and cohesionless.

A compact silt (fill) with varying amounts of sand, clay and gravel was encountered underlying the sand, silt and gravel (fill) mentioned above, in Boreholes 135-40-2, 136-01-2, and 136-05-2. The thickness of the fill layer ranged from 1.4 m to 1.5 m. The SPT conducted in this fill layer yielded N values ranging from 9 to 14. The visual observations and laboratory test results indicate that this material is cohesionless.

4.1.4 Heterogeneous Mixture of Silt and Clay, some Sand, trace Gravel (Glacial Till)

This till material can generally be classified as an inorganic, cohesive silt and clay of low to medium plasticity. Seams of cohesionless materials, generally consisting of sands and gravels, are noted at random depths and locations throughout the deposit. Grain size analysis of glacial till samples is limited to the maximum size of the SPT sampling methods that were employed (38 mm). Cobbles and/or boulders can be encountered in a glacial till deposit. Large cobbles or boulders were not detected in any of the boreholes put down as part of this investigation.

Vane shear testing was not possible due to the stiffness of this material. Based on laboratory observations and SPT correlations, the till is typically in the very stiff to hard range.

4.1.5 Bedrock

Based on tests at other locations, the bedrock is a reddish brown to grey, weathered to unweathered shale of the Queenston Formation. The bedrock is of poor to good quality (RQD of the unweathered shale ranging from 65% to 88%). Core recoveries varied between 97% and 100%. The average RQD over 5.8 m of rock cored was 74%, indicating an overall rock mass quality of fair.

4.1.6 Groundwater

The groundwater conditions encountered during the investigation are shown on the Record of Borehole Sheets. Artesian conditions were not encountered in any of the boreholes.

The groundwater levels noted on the Borehole Records were recorded immediately after drilling. Due to the relatively low permeability of the overburden soils, these groundwater levels may not represent the static water levels which would approximately correspond to an adjacent creek level draining into Lake Ontario. Groundwater levels are subject to seasonal fluctuations.

5.0 MISCELLANEOUS

The field work for this investigation was carried out under the supervision of R. Rintjema, P.Eng., N. Lobo and C. Reynolds. Drilling equipment was provided by Master Soil Investigations Ltd. and Eastern Soil Investigation Ltd.

This report was prepared by C. Kwok and T. Olson, Project Engineer, and approved by G. Kack, Project Manager.

NOTE: The preceding report is a copy of the factual information from the Foundation Investigation and Design Report prepared by Jacques Whitford Environment Ltd. (consulting geotechnical engineers for this project), under the technical supervision of the MTO Foundation Design Section.



D. Dundas
D. Dundas, P.Eng.
Sr. Foundation Engineer

APPENDIX

RECORD OF BOREHOLE No 135-40-1

1 OF 1

METRIC

W.P. 434-92-02

LOCATION WC 135-40; Sta. 31+688, O-S 25m Lt.

ORIGINATED BY IK

DIST 4 HWY QEW

BOREHOLE TYPE Solid Stem

COMPILED BY IK

DATUM SEE TEXT

DATE 94.08.24 & 94.09.24

CHECKED BY TO

SOIL PROFILE			SAMPLES			GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT			UNIT WEIGHT γ kN/m ³	REMARKS & GRAIN SIZE DISTRIBUTION (%)	
ELEV DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE	"N" VALUES			SHEAR STRENGTH kPa					
81.8	Ground Surface							20 40 60 80 100					
0.0	Topsoil		1	SS	12								
81.4													
0.5	Het. mixture of Silt and Clay, some sand, trace gravel (Glacial Till) Very Stiff to Hard Brown Grey		2	SS	37		81						
			3	SS	21		80					24.2	
			4	SS	10		78						
			5	SS	13		78						
			6	SS	22		77						
							76						
75.1			7	SS	35								
6.7	END OF BOREHOLE Borehole dry upon completion												

RECORD OF BOREHOLE No 135-40-2

1 OF 1

METRIC

W.P. 434-92-02

LOCATION WC 135-40; Sta. 31+888, O-S 4m Rt.

ORIGINATED BY IK

DIST 4 HWY QEW

BOREHOLE TYPE Solid Stem, Cone Test

COMPILED BY IK

DATUM SEE TEXT

DATE 84.08.10 & 84.08.10

CHECKED BY TO

SOIL PROFILE			SAMPLES			GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT		PLASTIC LIMIT W _p	NATURAL MOISTURE CONTENT W	LIQUID LIMIT W _L	UNIT WEIGHT γ kN/m ³	REMARKS & GRAIN SIZE DISTRIBUTION (%) GR SA SI CL
ELEV DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE	"N" VALUES			SHEAR STRENGTH kPa	WATER CONTENT (%)					
83.5	Ground Surface													
0.0	Mixture of Sand, Silt and Clay, trace gravel, (Fill) Stiff		1	AS										
			2	SS	12									
82.0														
1.5	Het. mixture of Silt and Clay, some sand, trace gravel (Glacial Till) Very Stiff to Hard Brown Brown Grey		3	SS	21									
			4	SS	30									
			5	SS	26									
			6	SS	29									
			7	SS	34									
			8	SS	37									
			9	SS	49									
75.3														
8.2	END OF BOREHOLE Borehole dry upon completion													

RECORD OF BOREHOLE No 135-40-3

1 OF 1

METRIC

W.P. 434-92-02

LOCATION WC 135-40; Sta. 31+688, O-S 28m Rt.

ORIGINATED BY IK

DIST 4 HWY QEW

BOREHOLE TYPE Solid Stem

COMPILED BY IK

DATUM SEE TEXT

DATE 94.08.11 & 94.08.11

CHECKED BY TO

SOIL PROFILE			SAMPLES			GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT		PLASTIC LIMIT	NATURAL MOISTURE CONTENT	LIQUID LIMIT	UNIT WEIGHT & kN/m ³	REMARKS & GRAIN SIZE DISTRIBUTION (%)
ELEV DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE	"N" VALUES			20	40					
82.0	Ground Surface													
0.0	Het. mixture of Silt and Clay, some sand, trace gravel (Glacial Till) Very Stiff to Hard Brown Grey		1	SS	18									
			2	SS	29									
			3	SS	19									
			4	SS	20									
			5	SS	21									
			6	SS	24									
			7	SS	34									
75.3			8	SS	30									
6.7	END OF BOREHOLE													

RECORD OF BOREHOLE No 135-41-1

1 OF 1

METRIC

W.P. 434-92-02

LOCATION WC 135-41; Sta. 32+102, O-S 30m Lt.

ORIGINATED BY IK

DIST 4 HWY QEW

BOREHOLE TYPE Solid Stem

COMPILED BY IK

DATUM SEE TEXT

DATE 94.08.23 & 94.08.23

CHECKED BY TO

SOIL PROFILE			SAMPLES			GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT		PLASTIC LIMIT NATURAL LIMIT MOISTURE CONTENT			UNIT WEIGHT γ kN/m ³	REMARKS & GRAIN SIZE DISTRIBUTION (%) GR SA SI CL			
ELEV DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE	"N" VALUES			SHEAR STRENGTH kPa							WATER CONTENT (%)		
								20 40 60 80 100							WP W WL		
79.9	Ground Surface																
0.0	Topsoil		1	SS	2												
79.3																	
0.6	Het. mixture of Silt and Clay, some sand, trace gravel (Glacial Till) Very Stiff to Hard Brown Grey		2	SS	21		79										
			3	SS	32		78										
			4	SS	27		77										
			5	SS	22		76										
			6	SS	24		75										
							74										
73.2			7	SS	19												
6.7	END OF BOREHOLE Borehole dry upon completion																

RECORD OF BOREHOLE No 135-41-2

1 OF 1

METRIC

W.P. 434-92-02

LOCATION WC 135-41; Sta. 32+102, O-S 3m Rt.

ORIGINATED BY IK

DIST 4 HWY QEW

BOREHOLE TYPE Solid Stem, Cone Test

COMPILED BY IK

DATUM SEE TEXT

DATE 94.08.10 & 94.08.10

CHECKED BY _____ TO _____

[illegible]

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

RECORD OF BOREHOLE No 135-41-3

1 OF 1

METRIC

W.P. 434-92-02

LOCATION WC 135-41; Sta. 32+102, O-S 36m Rt.

ORIGINATED BY JK

DIST 4 HWY QEW

BOREHOLE TYPE Solid Stem

COMPILED BY JK

DATUM SEE TEXT

DATE 94.08.11 & 94.08.11

CHECKED BY TO

SOIL PROFILE			SAMPLES			GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT					UNIT WEIGHT γ kN/m ³	REMARKS & GRAIN SIZE DISTRIBUTION (%)
ELEV DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE	"N" VALUES			20	40	60	80	100		
80.5	Ground Surface													
80.4	50mm Topsoil		1	SS	8		80							
0.1	Het. mixture of Silt and Clay, some sand, trace gravel (Glacial Till) Very Stiff to Hard Brown Grey		2	SS	27		79							
			3	SS	33		78							
			4	SS	24		77							
			5	SS	27		76							
			6	SS	32		75							
75.0							74							
5.6	Shale Bedrock Poor to Fair		7	SS	50	100mm								
73.8														
6.7	END OF BOREHOLE Borehole dry upon completion													

RECORD OF BOREHOLE No 136-01-1

1 OF 1

METRIC

W.P. 434-92-02

LOCATION WC 136-01; Sta. 10+419, O-S 23m Lt.

ORIGINATED BY IK

DIST 4 HWY OEW

BOREHOLE TYPE Solid Stem

COMPILED BY IK

DATUM SEE TEXT

DATE 94.08.23 & 94.08.23

CHECKED BY TO

SOIL PROFILE			SAMPLES			GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT			UNIT WEIGHT γ kN/m ³	REMARKS & GRAIN SIZE DISTRIBUTION (%)
ELEV DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE	"N" VALUES			SHEAR STRENGTH kPa				
80.2	Ground Surface						20 40 60 80 100	PLASTIC LIMIT NATURAL MOISTURE CONTENT LIQUID LIMIT				
79.9	Topsoil						20 40 60 80 100	W P W L				
0.3	Het. mixture of Silt and Clay, some sand, trace gravel (Glacial Till) Very Stiff to Hard Brown Gray -grey shale seam (75mm)		1	SS	13							
			2	SS	26							
			3	SS	35							
			4	SS	63							
			5	SS	68	283mm						
			6	SS	26							

RECORD OF BOREHOLE No 136-01-2

1 OF 1

METRIC

W.P. 434-92-02

LOCATION WC 136-01; Sta. 10+419, O-S 4m Rt.

ORIGINATED BY IK

DIST 4 HWY QEW

BOREHOLE TYPE Solid Stem, Cone Test

COMPILED BY IK

DATUM SEE TEXT

DATE 94.08.11 & 94.08.11

CHECKED BY TO

SOIL PROFILE			SAMPLES			GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT		PLASTIC LIMIT W _P	NATURAL MOISTURE CONTENT W	LIQUID LIMIT W _L	UNIT WEIGHT γ kN/m ³	REMARKS & GRAIN SIZE DISTRIBUTION (%) GR SA SI CL
ELEV DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE	"N" VALUES			SHEAR STRENGTH kPa	WATER CONTENT (%)					
82.0	Ground Surface													
0.0	Mixture of Sand, Silt and Gravel (Fill)		1	SS	8									
81.7	Mixture of Silt and Sand, trace clay (Fill), loose		2	SS	9									
0.3														
80.3	Het. mixture of Silt and Clay, some sand, trace gravel (Glacial Till)		3	SS	33									
1.7	Very Stiff to Hard		4	SS	45									
			5	SS	59									
			6	SS	69									
			7	SS	35									
			8	SS	49									
			9	SS	36									
73.8	END OF BOREHOLE													
8.2	Borehole dry upon completion													

RECORD OF BOREHOLE No 136-01-3

1 OF 1

METRIC

W.P. 434-92-02

LOCATION WC 136-01; Sta. 10+419, O-S 22m Rt.

ORIGINATED BY JK

DIST 4 HWY QEW

BOREHOLE TYPE Solid Stem

COMPILED BY JK

DATUM SEE TEXT

DATE 94.08.11 & 94.08.11

CHECKED BY TO

SOIL PROFILE			SAMPLES			GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT			UNIT WEIGHT γ kN/m ³	REMARKS & GRAIN SIZE DISTRIBUTION (%)
ELEV DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE	"N" VALUES			SHEAR STRENGTH kPa ○ UNCONFINED × FIELD VANE ● QUICK TRIAXIAL × LAB VANE				
79.9	Ground Surface							20 40 60 80 100				
79.8	75mm Topsoil		1	SS	9							
0.1	Het. mixture of Silt and Clay, some sand, trace gravel (Glacial Till) Very Stiff to Hard		2	SS	4		79					0 16 61 33
			3	SS	26		78					
			4	SS	77	225mm	77					
			5	SS	45		76					
			6	SS	64		75					
							74					
73.2			7	SS	31							
6.7	END OF BOREHOLE Borehole dry upon completion											

RECORD OF BOREHOLE No 136-02-1

1 OF 1

METRIC

W.P. 434-92-02

LOCATION WC 136-02; Sta. 10+622, O-S 23m Lt.

ORIGINATED BY IK

DIST 4 HWY QEW

BOREHOLE TYPE Solid Stem

COMPILED BY IK

DATUM SEE TEXT

DATE 94.08.23 & 94.08.23

CHECKED BY TO

SOIL PROFILE			SAMPLES			GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT					UNIT WEIGHT γ kN/m ³	REMARKS & GRAIN SIZE DISTRIBUTION (%)
ELEV DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE	"N" VALUES			20	40	60	80	100		
81.3	Ground Surface													
81.0	Topsoil													
0.3	Het. mixture of Silt and Clay, some sand, trace gravel (Glacial Till) Very Stiff to Hard Brown Grey		1	SS	14		81							
			2	SS	27		80							
			3	SS	24		79							
			4	SS	38		78							
			5	SS	36		77							
			6	SS	26		76							
			7	SS	22		75							
74.6	END OF BOREHOLE													
6.7	Borehole dry upon completion													

RECORD OF BOREHOLE No 136-02-2

1 OF 1

METRIC

W.P. 434-92-02

LOCATION WC 138-02; Sta. 10+822, O-S 3m Rt.

ORIGINATED BY IK

DIST 4 HWY QEW

BOREHOLE TYPE Solid Stem, Cone Test

COMPILED BY IK

DATUM SEE TEXT

DATE 84.08.11 & 84.08.11

CHECKED BY TO

SOIL PROFILE			SAMPLES			GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT			UNIT WEIGHT & kN/m ³	REMARKS & GRAIN SIZE DISTRIBUTION (%)
ELEV DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE	"N" VALUES			20 40 60 80 100	20 40 60 80 100	PLASTIC LIMIT NATURAL MOISTURE CONTENT LIQUID LIMIT		
82.2	Ground Surface											
0.0	Mixture of Sand, Silt and Gravel (Fill), compact		1	SS	7		82					
81.6												
0.6	Het. mixture of Silt and Clay, some sand, trace gravel (Glacial Till)		2	SS	6		81					
	Very Stiff to Hard		3	SS	32		80					
			4	SS	34		79					
			5	SS	31		78					
			6	SS	43		77					
			7	SS	42		76					
			8	SS	30		75					
			9	SS	30							
74.6	END OF BOREHOLE											
7.6	Borehole dry upon completion											

RECORD OF BOREHOLE No 136-02-3

1 OF 1

METRIC

W.P. 434-92-02

LOCATION WC 136-02; Sta. 10+822, O-S 23m Rt.

ORIGINATED BY IK

DIST 4 HWY QEW

BOREHOLE TYPE Solid Stem

COMPILED BY IK

DATUM SEE TEXT

DATE 94.08.11 & 94.08.11

CHECKED BY TO

[illegible]

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

RECORD OF BOREHOLE No 136-03-1

1 OF 1

METRIC

W.P. 434-92-02 LOCATION WC 136-03; Sta. 10+825, O-S 22m Lt. ORIGINATED BY IK
 DIST 4 HWY QEW BOREHOLE TYPE Solid Stem COMPILED BY IK
 DATUM SEE TEXT DATE 84.08.23 & 94.08.23 CHECKED BY TO

SOIL PROFILE			SAMPLES			GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT					UNIT WEIGHT α kN/m ³	REMARKS & GRAIN SIZE DISTRIBUTION (%) GR SA SI CL
ELEV DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE	"N" VALUES			SHEAR STRENGTH kPa						
								20 40 60 80 100						
81.8	Ground Surface													
81.5	Topsoil		1	SS	2									
0.3	Het. mixture of Silt and Clay, some sand, trace gravel (Glacial Till) Very Stiff to Hard Brown Grey		2	SS	13									
			3	SS	34									
			4	SS	26									
			5	SS	25									
			6	SS	28									
			7	SS	30									
75.1														
6.7	END OF BOREHOLE Borehole dry upon completion													

RECORD OF BOREHOLE No 136-03-2

1 OF 1

METRIC

W.P. 434-92-02 LOCATION WC 136-03; Sta. 10+825, O-S 3m Rt. ORIGINATED BY IK
DIST 4 HWY QEW BOREHOLE TYPE Solid Stem, Cone Test COMPILED BY IK
DATUM SEE TEXT DATE 94.08.11 & 94.08.11 CHECKED BY TO

SOIL PROFILE			SAMPLES			GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT		PLASTIC LIMIT NATURAL MOISTURE CONTENT LIQUID LIMIT			UNIT WEIGHT γ kN/m ³	REMARKS & GRAIN SIZE DISTRIBUTION (%) GR SA SI CL
ELEV DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE	"N" VALUES			SHEAR STRENGTH kPa	W P	W	W L			
82.3	Ground Surface													
0.0	Mixture of Sand, Silt and Gravel, (Fill), compact		1	AS										
81.5														
0.8	Het. mixture of Silt and Clay, some sand, trace gravel (Glacial Till) Very Stiff to Hard Brown Grey -100mm sand seam		2	SS	16								5 13 48 34	
			3	SS	36									
			4	SS	45									
			5	SS	55									
			6	SS	36									
			7	SS	30									
			8	SS	28									
74.1			9	SS	33									
8.2	END OF BOREHOLE Borehole dry upon completion													

RECORD OF BOREHOLE No 136-03-3

1 OF 1

METRIC

W.P. 434-92-02

LOCATION WC 136-03; Sta. 10+825, O-S 22m Rt.

ORIGINATED BY JK

DIST 4 HWY QEW

BOREHOLE TYPE Solid Stem

COMPILED BY JK

DATUM SEE TEXT

DATE 94.08.11 & 94.08.11

CHECKED BY TO

SOIL PROFILE			SAMPLES			GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT				UNIT WEIGHT γ kN/m ³	REMARKS & GRAIN SIZE DISTRIBUTION (%)
ELEV DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE	"N" VALUES			20 40 60 80 100	20 40 60 80 100	20 40 60 80 100	20 40 60 80 100		
81.6	Ground Surface												
81.6	Topsoil		1	SS	14		81						
0.1	Het. mixture of Silt and Clay, some sand, trace gravel (Glacial Till) Very Stiff to Hard		2	SS	36		80					21.0	0 15 55 30
			3	SS	45		79						
			4	SS	50		78						
			5	SS	31		77						
			6	SS	28		76						
			7	SS	27		75						
74.9	END OF BOREHOLE												
6.7	Borehole dry upon completion												

*³ X³: Numbers refer to
Sensitivity

20
15
10

(%) STRAIN AT FAILURE

RECORD OF BOREHOLE No 136-04-1

1 OF 1

METRIC

W.P. 434-92-02

LOCATION WC 136-04; Sta. 11+101, O-S 23m Lt.

ORIGINATED BY IK

DIST 4 HWY QEWBOREHOLE TYPE Solid Stem

COMPILED BY IK

DATUM SEE TEXT

DATE 94.08.23 & 94.08.23

CHECKED BY _____ TO _____

[illegible]

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

RECORD OF BOREHOLE No 136-04-2

1 OF 1

METRIC

W.P. 434-92-02

LOCATION WC 136-04; Sta. 11+101, O-S 3m Rt.

ORIGINATED BY JK

DIST 4 HWY QEW

BOREHOLE TYPE Solid Stem, Cone Test

COMPILED BY JK

DATUM SEE TEXT

DATE 94.08.11 & 94.08.11

CHECKED BY TO

SOIL PROFILE			SAMPLES			GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT		PLASTIC LIMIT NATURAL MOISTURE CONTENT LIQUID LIMIT			UNIT WEIGHT kN/m ³	REMARKS & GRAIN SIZE DISTRIBUTION (%) GR SA SI CL
ELEV DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE	"N" VALUES			SHEAR STRENGTH kPa		WATER CONTENT (%)				
								○ UNCONFINED ● QUICK TRIAXIAL	× FIELD VANE × LAB VANE	W _P	W	W _L		
82.7	Ground Surface						20 40 60 80 100							
82.6	75mm ASPHALT													
0.1	Brown Sand and Gravel (Fill)		1	SS	7									
82.2	Het. mixture of Silt and Clay, some sand, trace gravel		2	SS	7									
0.5	(Glacial Till)		3	SS	22									
	Very Stiff to Hard		4	SS	32									
			5	SS	28									
			6	SS	50									
			7	SS	48									
			8	SS	34									
			9	SS	36									
75.1														
7.6	END OF BOREHOLE													

RECORD OF BOREHOLE No 136-04-3

1 OF 1

METRIC

W.P. 434-92-02

LOCATION WC 136-04; Sta. 11+101, O-S 23m Rt.

ORIGINATED BY IK

DIST 4 HWY QEW

BOREHOLE TYPE Solid Stem

COMPILED BY IK

DATUM SEE TEXT

DATE 84.08.12 & 94.08.12

CHECKED BY TO

SOIL PROFILE			SAMPLES			GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT				UNIT WEIGHT γ _s kN/m ³	REMARKS & GRAIN SIZE DISTRIBUTION (%)
ELEV DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE	"N" VALUES			20 40 60 80 100	20 40 60 80 100	20 40 60 80 100	20 40 60 80 100		
81.5	Ground Surface												
81.2	Topsoil		1	SS	34		81						
0.3	Het. mixture of Silt and Clay, some sand, trace gravel (Glacial Till) Very Stiff to Hard - medium to coarse gravel Brown Grey		2	SS	26		80						
			3	SS	38		79						
			4	SS	74	225mm	78						
			5	SS	44		77						
			6	SS	42		76						
							75						
75.0			7	SS	80	275mm							
6.5	END OF BOREHOLE Borehole dry upon completion												

×³ ×³: Numbers refer to Sensitivity 20 15 10 (%) STRAIN AT FAILURE

RECORD OF BOREHOLE No 136-05-1

1 OF 1

METRIC

W.P. 434-92-02

LOCATION WC 136-05; Sta. 11+262, O-S 22m Lt.

ORIGINATED BY IK

DIST 4 HWY QEW

BOREHOLE TYPE Solid Stem

COMPILED BY IK

DATUM SEE TEXT

DATE 94.08.23 & 94.08.23

CHECKED BY TO

SOIL PROFILE			SAMPLES			GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT					UNIT WEIGHT γ kN/m ³	REMARKS & GRAIN SIZE DISTRIBUTION (%) GR SA SI CL
ELEV DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE	"N" VALUES			20	40	60	80	100		
81.7	Ground Surface													
81.0	Topsoil		1	SS	11									
0.3	Het. mixture of Silt and Clay, some sand, trace gravel (Glacial Till) Very Stiff to Hard Brown Grey		2	SS	47		81							
			3	SS	50		80							
			4	SS	47		79							
			5	SS	39		78							
			6	SS	24		77							
							76							
76.0			7	SS	33		75							
6.7	END OF BOREHOLE Borehole dry upon completion													

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

20
15
10

(%) STRAIN AT FAILURE

RECORD OF BOREHOLE No 136-05-2

1 OF 1

METRIC

W.P. 434-92-02

LOCATION WC 136-05: Sta. 11+262, O-S 3m Rt.

ORIGINATED BY IK

DIST 4 HWY QEW

BOREHOLE TYPE Solid Stem, Cone Test

COMPILED BY IK

DATUM SEE TEXT

DATE 94.08.11 & 94.08.12

CHECKED BY TO

SOIL PROFILE			SAMPLES			GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT		PLASTIC LIMIT WP	NATURAL MOISTURE CONTENT W	LIQUID LIMIT WL	UNIT WEIGHT γ kN/m ³	REMARKS & GRAIN SIZE DISTRIBUTION (%)
ELEV DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE	"N" VALUES			20 40 60 80 100	20 40 60 80 100					
82.9	Ground Surface													
82.9	Brown Sand (Fill)		1	SS	23									
0.3	Brown Silt (Fill), some sand, trace clay and gravel		2	SS	14									
	Compact													
81.1	Het. mixture of Silt and Clay, some sand, trace gravel		3	SS	34									
1.8	(Glacial Till)		4	SS	32									
	Very Stiff to Hard		5	SS	28									
			6	SS	52									
	Brown Grey		7	SS	37									
			8	SS	28									
74.7			9	SS	42									
8.2	END OF BOREHOLE													
	Borehole dry upon completion													

RECORD OF BOREHOLE No 136-05-3

1 OF 1

METRIC

W.P. 434-92-02 LOCATION WC 136-05; Sta. 11+262, O-S 22m Rt. ORIGINATED BY IK
DIST 4 HWY QEW BOREHOLE TYPE Solid Stem COMPILED BY IK
DATUM SEE TEXT DATE 84.08.12 & 84.08.12 CHECKED BY TO

SOIL PROFILE			SAMPLES			GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT		PLASTIC LIMIT W _P	NATURAL MOISTURE CONTENT W	LIQUID LIMIT W _L	UNIT WEIGHT γ	REMARKS & GRAIN SIZE DISTRIBUTION (%)					
ELEV DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE	"N" VALUES			20	40						60	80	100	20	40
82.2	Ground Surface																		
82.1	75mm Topsoil		1	SS	12														
0.1	Het. mixture of Silt and Clay, some sand, trace gravel		2	SS	26														
	(Glacial Till)		3	SS	34														
	Very Stiff to Hard		4	SS	50														
	- seams of silty sand		5	SS	46														
	Brown Grey		6	SS	32														
75.5			7	SS	32														
6.7	END OF BOREHOLE																		

RECORD OF BOREHOLE No 136-06-1

1 OF 1

METRIC

W.P. 434-92-02

LOCATION WC 136-06; Sta. 11+446, O-S 23m Lt.

ORIGINATED BY IK

DIST 4 HWY QEW

BOREHOLE TYPE Solid Stem

COMPILED BY IK

DATUM SEE TEXT

DATE 94.08.23 & 94.08.23

CHECKED BY TO

SOIL PROFILE			SAMPLES			GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT		PLASTIC LIMIT W _P	NATURAL MOISTURE CONTENT W	LIQUID LIMIT W _L	UNIT WEIGHT γ kN/m ³	REMARKS & GRAIN SIZE DISTRIBUTION (%) GR SA SI CL
ELEV DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE	"N" VALUES			20 40 60 80 100	20 40 60 80 100					
81.8	Ground Surface													
81.8	Topsoil		1	SS	8									
0.3	Het. mixture of Silt and Clay, some sand, trace gravel (Glacial Till) Very Stiff to Hard Brown Gray		2	SS	35		81						22.0	
			3	SS	34		80							
			4	SS	54		79							
			5	SS	47		78							
			6	SS	32		78							
							77							
							76							
75.1			7	SS	31									
6.7	END OF BOREHOLE Borehole dry upon completion													

RECORD OF BOREHOLE No 136-06-2

1 of 1

METRIC

W.P. 434-92-02

LOCATION WC 136-06; Sta. 11+446, O-S 3.0m Rt.

ORIGINATED BY IK

DIST 4 HWY QEW

BOREHOLE TYPE Solid Stem, Cone Test

COMPILED BY IK

DATUM SEE TEXT

DATE 94.08.11 & 94.08.11

CHECKED BY TO

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	UNIT WEIGHT γ kN/m ³	REMARKS & GRAIN SIZE DISTRIBUTION (%) GR SA SI CL
ELEV DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE	"N" VALUES								
82.9	Ground Surface												
0.0	Mixture of Sand, Silt and Gravel (Fill), compact		1	SS	11								
82.3													
0.6	Het. mixture of Silt and Clay, some sand, trace gravel (Glacial Till)		2	SS	10								
	Very Stiff to Hard		3	SS	20								
			4	SS	28								
			5	SS	27								
			6	SS	40								
			7	SS	46								
			8	SS	38								
			9	SS	31								
75.3													
7.6	END OF BOREHOLE												
	Borehole dry upon completion												

RECORD OF BOREHOLE No 136-06-3

1 OF 1

METRIC

W.P. 434-92-02

LOCATION WC 136-06; Sta. 11+446, O-S 23m Rt.

ORIGINATED BY IK

DIST 4 HWY QEW

BOREHOLE TYPE Solid Stem

COMPILED BY IK

DATUM SEE TEXT

DATE 84.08.12 & 84.08.12

CHECKED BY TO

SOIL PROFILE		SAMPLES			GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT		PLASTIC LIMIT	NATURAL MOISTURE CONTENT	LIQUID LIMIT	UNIT WEIGHT γ	REMARKS & GRAIN SIZE DISTRIBUTION (%)
ELEV DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE			"N" VALUES	20					
82.1	Ground Surface												
82.0	Topsoil		1	SS	2								
0.1	Het. mixture of Silt and Clay, some sand, trace gravel (Glacial Till) Very Stiff to Hard		2	SS	25								
			3	SS	31								
			4	SS	70	290mm							
			5	SS	35								
			6	SS	50	125mm							
	Brown Grey												
75.4			7	SS	28								
6.7	END OF BOREHOLE												

*³, X³: Numbers refer to Sensitivity 20 15-4-5 (%) STRAIN AT FAILURE 10