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G.I.-30 SEPT. 1976

GEOCRES No. 30M5-134

DIST. 4 REGION

W.P. No. 152-75-06/07

CONT. No. 83-41

W. O. No.

STR. SITE No. 36-1336-142
~~36-1336-271~~

HWY. No. Q.E.W.

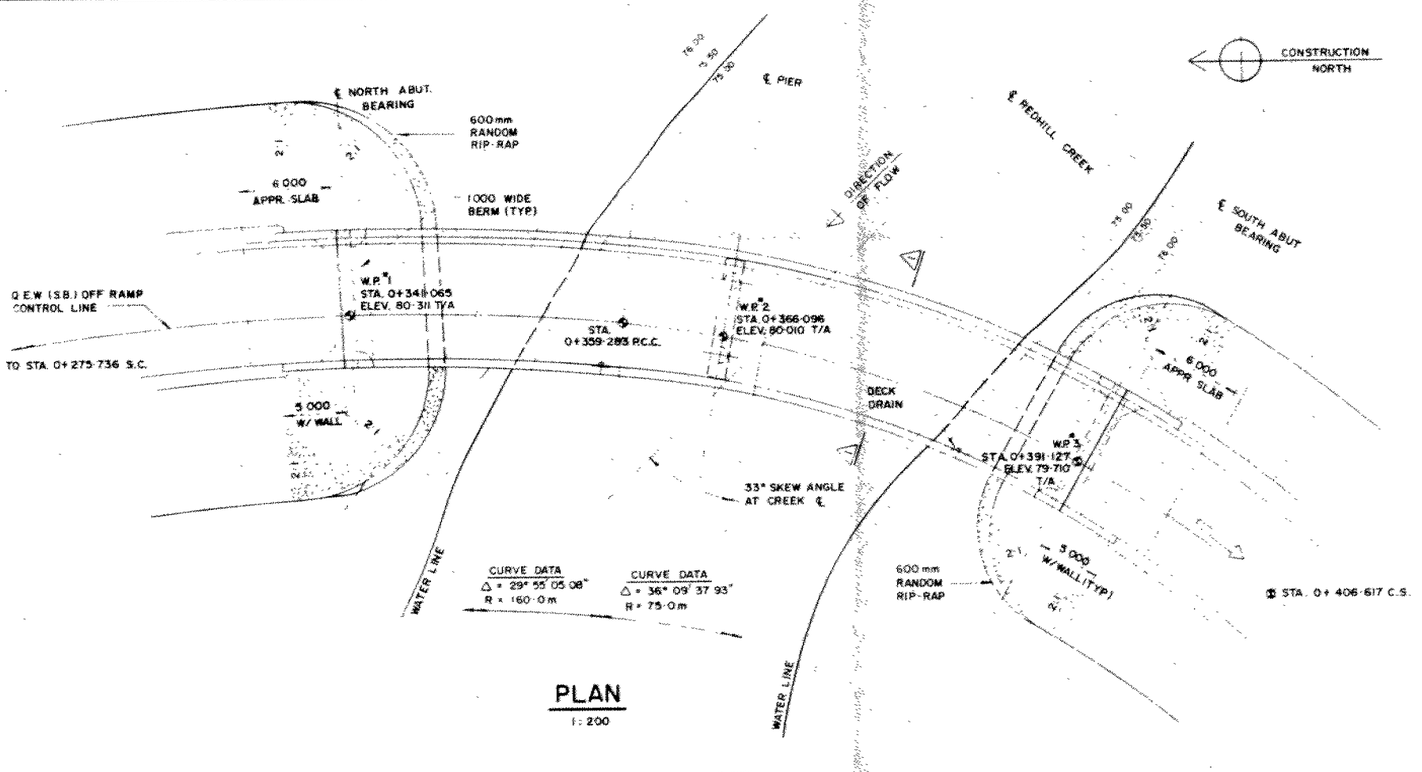
LOCATION Burlington Skyway
Redhill Creek

No. of PAGES -

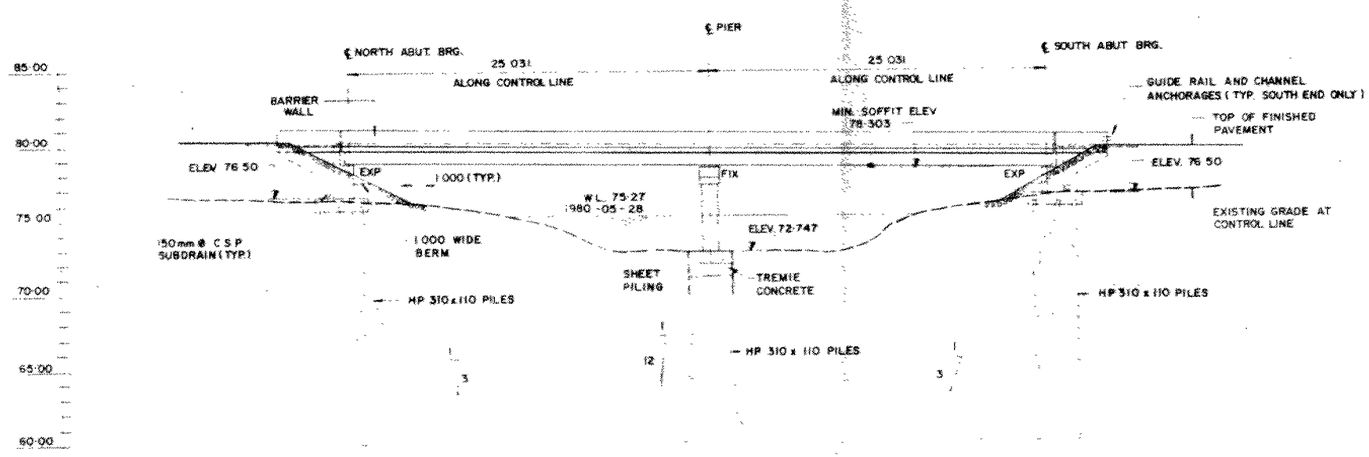
OVERSIZE DRAWINGS TO BE INCLUDED WITH THIS REPORT.

REMARKS:

MINISTRY OF TRANSPORTATION AND COMMUNICATIONS ONTARIO DIR BR 1364 79 1/R



PLAN
1:200



ELEVATION
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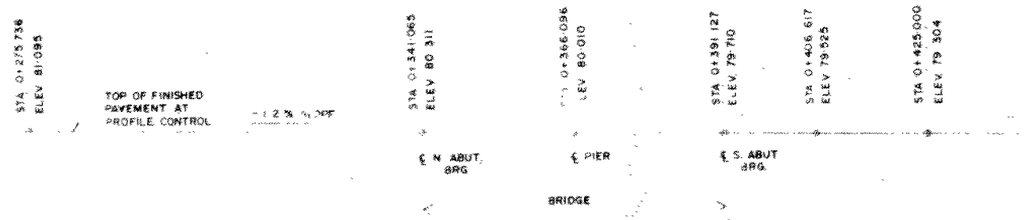


PROFILE AT Q.E.W. (S.B.) OFF RAMP CONTROL LINE
1:500

METRIC

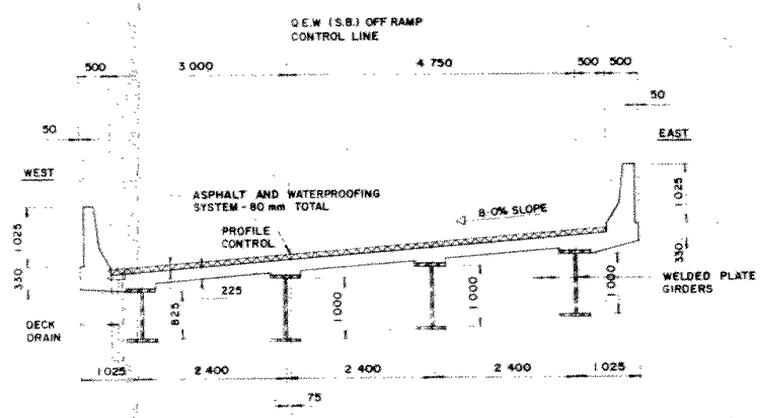
DIMENSIONS ARE IN MILLIMETRES UNLESS OTHERWISE SHOWN.
ELEVATIONS, COORDINATES, CURVE AND ALIGNMENT DATA ARE IN METRES.
STATIONS ARE IN KILOMETRES + METRES.

DIST No 4
CONT No
WP No 152-75-07

Q.E.W. N-W RAMP BRIDGE OVER RED HILL CREEK
GENERAL ARRANGEMENT

SHEET

Gregg and Edens Limited
engineers planners : economists.



1:50

LIST OF DRAWINGS

1. GENERAL ARRANGEMENT
2. BOREHOLE LOCATIONS AND SOIL STRATA
3. ABUTMENT FOOTINGS AND PILE LAYOUT
4. PIER FOOTING AND PILE LAYOUT
5. NORTH ABUTMENT AND WINGWALLS
6. SOUTH ABUTMENT AND WINGWALLS
7. PIER
8. STRUCTURAL STEEL - SHEET 1
9. STRUCTURAL STEEL - SHEET 2
10. DECK LAYOUT AND REINFORCING
11. MISCELLANEOUS DETAILS
12. BEARINGS AND DECK JOINTS
13. BARRIER WALLS
14. APPROACH SLABS
15. BRIDGE DATE AND SITE NUMBER DATA
16. AS CONSTRUCTED ELEVATIONS AND DIMENSIONS
17. PILE DRIVING - STEAM AND DIESEL HAMMERS

GENERAL NOTES

1. CLASS OF CONCRETE :
   PIER AND ABUTMENTS, WINGWALLS, DECK AND BARRIER WALLS ..... 30 MPa
   REMAINDER ..... 20 MPa
2. REINFORCING STEEL
   GRADE 400
   COATED BARS TO HAVE A SUFFIX "C"
3. W.P. DENOTES WORKING POINT
   T/A DENOTES TOP OF FINISHED PAVEMENT
4. CLEAR COVER TO REINFORCING STEEL :
   FOOTINGS ..... 100 ± 25 mm
   DECK TOP .. 70 ± 20 mm & BOT. 40 ± 10 mm
   ABUTMENTS AND WING WALL FRONT FACE. 80 ± 20 mm
   BACK FACE. . 70 ± 20 mm
   REMAINDER UNLESS NOTED OTHERWISE . . 70 ± 20 mm
5. CONSTRUCTION NOTES:
   THE CONTRACTOR SHALL FINISH BEARING SEATS TO A LEVEL TO THE SPECIFIED ELEVATIONS TO A TOLERANCE OF ± 3 mm

QUANTITIES

STRUCTURAL STEEL ..... 66 TONNES

CONCRETE QUANTITIES FOR LUMP SUM TENDER ITEMS:

CONCRETE IN PIER ABUTMENTS & WINGWALLS ..... 108 m^3
CONCRETE IN DECK ..... 119 m^3
CONCRETE IN APPROACH SLABS ..... 25 m^3
CONCRETE IN BARRIER WALLS ..... 42 m^3

G.B.M. 65-U-138 ELEVATION 77·654

CONCRETE BRIDGE ON QUEEN ELIZABETH WAY OVER WOODWARD AVENUE IMMEDIATELY SOUTH OF BEACH BOULEVARD. TABLET IN WEST FACE OF EAST ABUTMENT 0·030 METRES FROM NORTH END SLIGHTLY ABOVE GROUND LEVEL

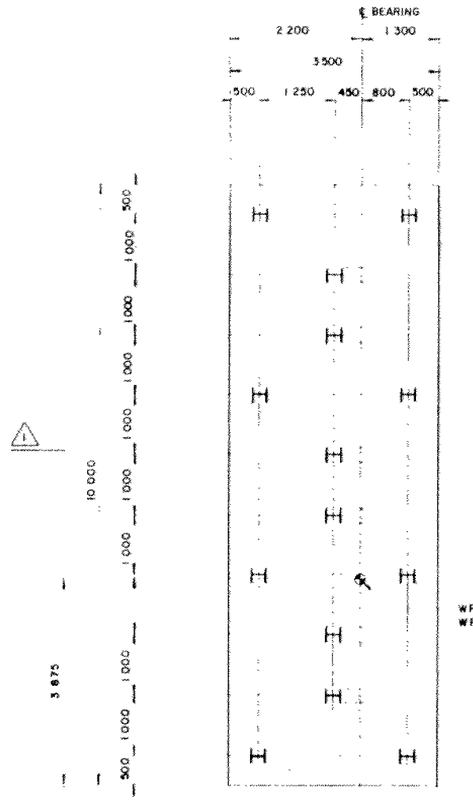
J. T. GREGG
REGISTERED PROFESSIONAL ENGINEER PROVINCE OF ONTARIO

T. J. FISHER
REGISTERED PROFESSIONAL ENGINEER PROVINCE OF ONTARIO

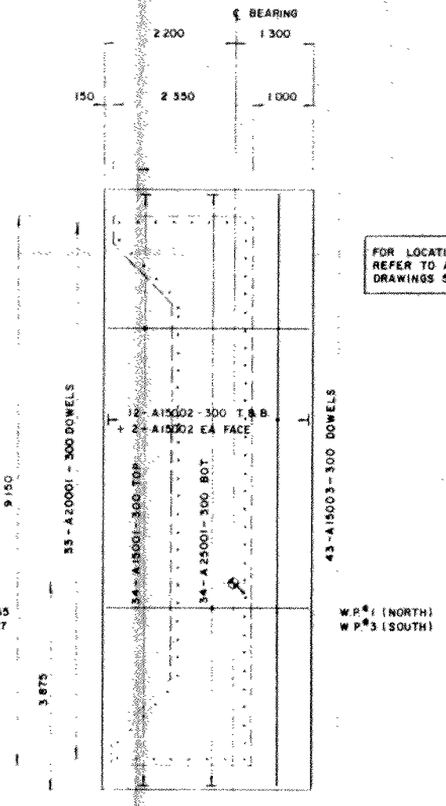
DRAWING NOT TO BE SCALED
100 mm ON ORIGINAL DRAWING

REVISIONS			
	DATE	BY	DESCRIPTION
DESIGN M.S.	CHECK J.T.G.	LOADING OHBDC-A-79	DATE DEC. 81
DRAWING B.D.	CHECK M.S.	SITE No 36-336-275	DWG 1

MINISTRY OF TRANSPORTATION AND COMMUNICATIONS ONTARIO DRAWN 1981 81-06



PILE LAYOUT

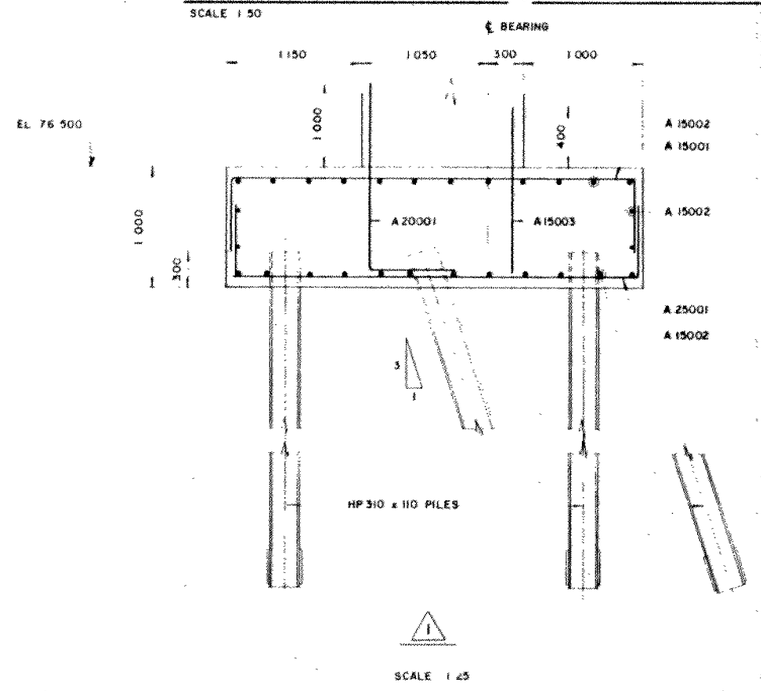


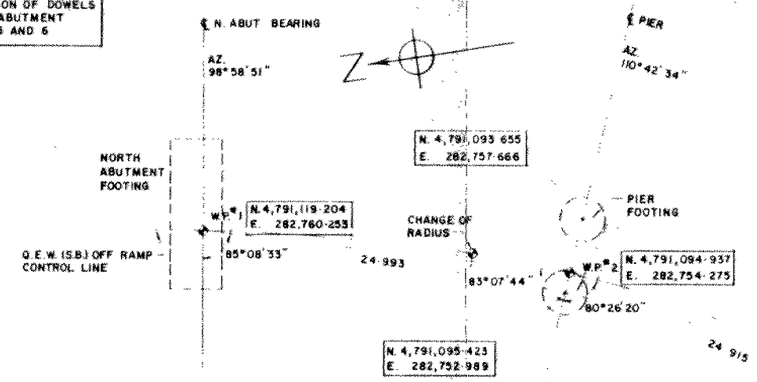
REINFORCING DETAILS

FOR LOCATION OF DOWELS REFER TO ABUTMENT DRAWINGS 5 AND 6

PLAN - NORTH ABUTMENT (SOUTH SIMILAR BUT OPP. HAND)

SCALE 1:50





LAYOUT OF FOOTINGS AND LOCATION OF WORKING POINTS

SCALE 1:200

PILE DATA						DESIGN DATA	
LOCATION	TYPE	QTY.	BATTER	LENGTH	CUT-OFF ELEVATION	LOAD AT SLS. TYPE II	FACTORED CAPACITY U.L.S.
N. ABUT.	HP 310 x 110	8	—	15 800	75·800	800 kN	1600 kN
N. ABUT.	HP 310 x 110	6	3:1	16 650	75·800	800 kN	1600 kN
S. ABUT.	HP 310 x 110	8	—	15 800	75·800	800 kN	1600 kN
S. ABUT.	HP 310 x 110	6	3:1	16 650	75·800	800 kN	1600 kN
PIER	HP 310 x 110	12	12:1	12 200	72·147	800 kN	1600 kN

1. PILE LENGTHS SHOWN ARE THE THEORETICAL LENGTHS BELOW THE CUT-OFF ELEVATION
2. PILE LAYOUT DIMENSIONS ARE TO BE MEASURED AT THE UNDERSIDE OF FOOTINGS
3. PILES TO BE DRIVEN IN ACCORDANCE WITH STANDARD SS 103-10 OR SS 103-11 USING AN ULTIMATE CAPACITY OF 2400 kN PER PILE BUT MUST BE DRIVEN BELOW EL. 60·000
4. FOR PILE SPLICE AND SHOE DETAILS SEE OD 3301
5. ⊢ DENOTES BATTERED PILE
   ⊢ DENOTES VERTICAL PILE

METRIC

DIMENSIONS ARE IN MILLIMETRES UNLESS OTHERWISE SHOWN.
ELEVATIONS, COORDINATES, CURVE AND ALIGNMENT DATA ARE IN METRES
STATIONS ARE IN KILOMETRES + METRES.

DIST No 4
CONT No
WP No 152-75-07

Q.E.W. N.W. RAMP BRIDGE OVER RED HILL CREEK
ABUTMENT FOOTINGS & PILES

SHEET

Gregg and Edens Limited
engineers planners : economists

J. T. GREGG

REGISTERED PROFESSIONAL ENGINEER
T. J. FISHER
PROVINCE OF ONTARIO

DRAWING NOT TO BE SCALED
100 mm ON ORIGINAL DRAWING

REVISIONS			
DATE	BY	DESCRIPTION	
DESIGN TJF	CHECK JTG	LOADING OHBDC A-79	DATE FEB 1982
DRAWING BD	CHECK TJF	SITE 36-1336-271	DWG 3

FOUNDATION INVESTIGATION REPORT

CONTRACT NO 83 - 41

Ontario

Ministry of
Transportation and
Communications

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3	M.T.C. Soil Classification
4- 12	Foundation Investigation Report For W.P. 152-75-07; Site 36-1336-271 Q.E.W. N-W Ramp Bridge Over Redhill Creek

NOTE: For purposes of the contract this report supercedes all other foundation reports prepared by or for the Ministry in connection with the above-mentioned project.

EXPLANATION OF TERMS USED IN REPORT

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

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

SOILS ARE DESCRIBED BY THEIR COMPOSITION AND CONSISTENCY OR DENSENESS.

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

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

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

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

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

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

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

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

JOINTING AND BEDDING:

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

ABBREVIATIONS AND SYMBOLS

FIELD SAMPLING

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

STRESS AND STRAIN

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

MECHANICAL PROPERTIES OF SOIL

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

PHYSICAL PROPERTIES OF SOIL

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

e	1, %	VOID RATIO
n	1, %	POROSITY
w	1, %	WATER CONTENT
S_r	%	DEGREE OF SATURATION
w_L	%	LIQUID LIMIT
w_p	%	PLASTIC LIMIT
w_s	%	SHRINKAGE LIMIT
I_p	%	PLASTICITY INDEX = $w_L - w_p$
I_L	1	LIQUIDITY INDEX = $\frac{w - w_p}{I_p}$
I_C	1	CONSISTENCY INDEX = $\frac{w_L - w}{I_p}$
e_{max}	1, %	VOID RATIO IN LOOSEST STATE
e_{min}	1, %	VOID RATIO IN DENSEST STATE
I_D	1	DENSITY INDEX = $\frac{e_{max} - e}{e_{max} - e_{min}}$
D	mm	GRAIN DIAMETER
D_n	mm	n PERCENT - DIAMETER
C_U	1	UNIFORMITY COEFFICIENT
h	m	HYDRAULIC HEAD OR POTENTIAL
q	m^3/s	RATE OF DISCHARGE
v	m/s	DISCHARGE VELOCITY
i	1	HYDRAULIC GRADIENT
k	m/s	HYDRAULIC CONDUCTIVITY
j	kN/m^3	SEEPAGE FORCE

EXTENDED CASAGRANDE SOIL CLASSIFICATION SYSTEM

FIELD IDENTIFICATION PROCEDURES

(EXCLUDING PARTICLES LARGER THAN 75 mm AND BASING FRACTIONS ON ESTIMATED MASS)

					GROUP SYMBOL	TYPICAL NAMES
COARSE GRAINED SOILS (MORE THAN HALF OF MATERIAL IS LARGER THAN 75 μm)	GRAVELS (MORE THAN HALF OF COARSE FRACTION IS LARGER THAN 4.75 mm)	CLEAN GRAVELS (LITTLE OR NO FINES)	WIDE RANGE IN GRAIN SIZE & SUBSTANTIAL AMOUNTS OF ALL INTERMEDIATE PARTICLE SIZE		GW	WELL GRADED GRAVELS, GRAVEL-SAND MIXTURES; LITTLE OR NO FINES
			PREDOMINANTLY ONE SIZE OF A RANGE OF SIZES WITH SOME INTERMEDIATE SIZES MISSING		GP	POORLY GRADED GRAVELS, GRAVEL-SAND MIXTURES; LITTLE OR NO FINES
		GRAVEL WITH FINES (APPRECIABLE AMOUNT OF FINES)	NON-PLASTIC FINES (FOR IDENTIFICATION PROCEDURES SEE ML BELOW)		GM	SILTY GRAVELS, POORLY GRADED GRAVEL-SAND-SILT MIXTURES
			PLASTIC FINES (FOR IDENTIFICATION PROCEDURES SEE CL BELOW)		GC	CLAYEY GRAVELS, POORLY GRADED GRAVEL-SAND-CLAY MIXTURES
	SANDS (MORE THAN HALF OF COARSE FRACTION IS SMALLER THAN 4.75 mm)	CLEAN SANDS (LITTLE OR NO FINES)	WIDE RANGE IN GRAIN SIZES & SUBSTANTIAL AMOUNTS OF ALL INTERMEDIATE PARTICLE SIZES		SW	WELL GRADED SANDS, GRAVELLY SANDS; LITTLE OR NO FINES
			PREDOMINANTLY ONE SIZE OR A RANGE OF SIZES WITH SOME INTERMEDIATE SIZES MISSING		SP	POORLY GRADED SANDS, GRAVELLY SANDS: LITTLE OR NO FINES
		SANDS WITH FINES (APPRECIABLE AMOUNT OF FINES)	NON-PLASTIC FINES (FOR IDENTIFICATION PROCEDURES SEE ML BELOW)		SM	SILTY SANDS, POORLY GRADED SAND-SILT MIXTURES
			PLASTIC-FINES (FOR IDENTIFICATION PROCEDURES SEE CL BELOW)		SC	CLAYEY SANDS, POORLY GRADED SAND-CLAY MIXTURES
FINE GRAINED SOILS (MORE THAN HALF OF MATERIAL IS SMALLER THAN 75 μm / 75 μm IS ABOUT THE SMALLEST PARTICLE VISIBLE TO THE NAKED EYE)	IDENTIFICATION PROCEDURES ON FRACTION SMALLER THAN 425 μm		DRY STRENGTH (CRUSHING CHARACTERISTICS)	DILATANCY (REACTION TO SHAKING)	TOUGHNESS (CONSISTENCY NEAR PLASTIC LIMIT)		
	SILTS AND CLAYS	LIQUID LIMIT LESS THAN 35%	NONE	QUICK	NONE	ML	INORGANIC SILTS & SANDY SILTS OF SLIGHT PLASTICITY, ROCK FLOUR
			MEDIUM TO HIGH	NONE TO VERY SLOW	MEDIUM	CL	CLAYEY SILTS (INORGANIC), GRAVELLY CLAYS, SANDY CLAYS, LEAN CLAYS
			SLIGHT TO MEDIUM	SLOW	SLIGHT	OL	ORGANIC SILT OF LOW PLASTICITY, ORGANIC SANDY SILTS
		LIQUID LIMIT BETWEEN 35% AND 50%	NONE TO SLIGHT	SLOW TO QUICK	SLIGHT	MI	INORGANIC COMPRESSIBLE FINE SANDY SILT WITH CLAY OF MEDIUM PLASTICITY, CLAYEY SILTS
			HIGH	NONE	MEDIUM TO HIGH	CI	SILTY CLAYS (INORGANIC) OF MEDIUM PLASTICITY
			SLIGHT TO MEDIUM	VERY SLOW	SLIGHT	OI	ORGANIC SILTY CLAYS OF MEDIUM PLASTICITY
		LIQUID LIMIT GREATER THAN 50%	SLIGHT TO MEDIUM	SLOW TO NONE	MEDIUM	MH	INORGANIC SILTS, HIGHLY COMPRESSIBLE MICACEOUS OR DIATOMACEOUS FINE SANDY SILTS, ELASTIC SILTS
			HIGH TO VERY HIGH	NONE	HIGH	CH	CLAYS (INORGANIC) OF HIGH PLASTICITY, FAT CLAYS
			MEDIUM TO HIGH	NONE TO VERY SLOW	SLIGHT TO MEDIUM	OH	ORGANIC CLAYS OF HIGH PLASTICITY
HIGHLY ORGANIC SOILS			READILY IDENTIFIED BY COLOUR, ODOUR, SPONGY FEEL & FREQUENTLY BY FIBROUS TEXTURE			Pt	PEAT & OTHER HIGHLY ORGANIC SOILS

INFORMATION REQUIRED FOR DESCRIBING SOILS

GIVE TYPE; NAME, IF NECESSARY; INDICATE APPROX. % OF SAND & GRAVEL; MAX. SIZE; ANGULARITY, SURFACE CONDITION, & HARDNESS OF THE COARSE GRAINS; LOCAL OR GEOLOGIC NAME & OTHER PERTINENT DESCRIPTIVE INFORMATION; & SYMBOL IN PARENTHESIS.

FOR UNDISTURBED SOILS ADD INFORMATION ON STRATIFICATION, DEGREE OF COMPACTNESS, CEMENTATION, MOISTURE CONDITIONS & DRAINAGE CHARACTERISTICS.

GIVE TYPE; NAME, IF NECESSARY, INDICATE DEGREE & CHARACTER OF PLASTICITY, AMOUNT & MAXIMUM SIZE OF COARSE GRAINS, COLOUR IN WET CONDITION, ODOUR, IF ANY, LOCAL OR GEOLOGIC NAME & OTHER PERTINENT DESCRIPTIVE INFORMATION & SYMBOL IN PARENTHESES.

FOR UNDISTURBED SOILS ADD INFORMATION ON STRUCTURE, STRATIFICATION, CONSISTENCY IN UNDISTURBED & REMOULDED STATES, MOISTURE & DRAINAGE CONDITIONS.

USE GRAIN SIZE CURVE IN IDENTIFYING THE FRACTIONS AS GIVEN UNDER FIELD IDENTIFICATION

LABORATORY CLASSIFICATION CRITERIA

DETERMINE PERCENTAGES OF GRAVEL & SAND FROM GRAIN SIZE CURVE. DEPENDING ON PERCENTAGE OF FINES (FRACTION SMALLER THAN 75 μm) COARSE GRAINED SOILS ARE CLASSIFIED AS FOLLOWS:

LESS THAN 5%	GW, GP, SW, SP
MORE THAN 12%	GM, GC, SM, SC
5% TO 12%	BORDERLINE CASES REQ. USE OF DUAL SYMBOLS

$C_u = \frac{D_{60}}{D_{10}}$ GREATER THAN 4

$C_c = \frac{(D_{30})^2}{D_{10} \times D_{60}}$ BETWEEN ONE AND 3

NOT MEETING ALL GRADATION REQUIREMENTS FOR GW

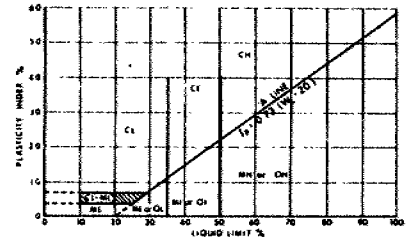
ATTERBERG LIMITS BELOW A-LINE, OR I_p LESS THAN 4	ABOVE A-LINE WITH I_p BETWEEN 4 AND 7 ARE BORDERLINE CASES REQUIRING USE OF DUAL SYMBOLS
ATTERBERG LIMITS ABOVE A-LINE WITH I_p GREATER THAN 7	

$C_u = \frac{D_{60}}{D_{10}}$ GREATER THAN 6

$C_c = \frac{(D_{30})^2}{D_{10} \times D_{60}}$ BETWEEN ONE AND 3

NOT MEETING ALL GRADATION REQUIREMENTS FOR SW

ATTERBERG LIMITS BELOW A-LINE OR I_p LESS THAN 4	ABOVE A-LINE WITH I_p BETWEEN 4 AND 7 ARE BORDERLINE CASES REQUIRING USE OF DUAL SYMBOLS
ATTERBERG LIMITS ABOVE A-LINE WITH I_p GREATER THAN 7	



PLASTICITY CHART
FOR LABORATORY CLASSIFICATION OF FINE GRAINED SOILS

BOUNDARY CLASSIFICATIONS: SOILS POSSESSING CHARACTERISTICS OF TWO GROUPS ARE DESIGNATED BY COMBINATIONS OF GROUP SYMBOLS. FOR EXAMPLE GW-GC, WELL GRADED GRAVEL-SAND MIXTURE WITH CLAY BINDER

FOUNDATION INVESTIGATION REPORT

For

Q.E.W. N-W Ramp Bridge Over Redhill Creek

W.P. 152-75-07; Site 36-1336-271

District 4, Hamilton

1.0 INTRODUCTION

An evaluation of soil conditions has been completed in Hamilton, Ontario where a proposed off-ramp from the Queen Elizabeth Way Highway crosses Redhill Creek. This report describes the site conditions and discusses some considerations for the design of the structure foundations and approaches. A more general summary of soil conditions and design considerations was submitted to Mr. K. Selby, P. Eng. in a letter dated August 25, 1981. The study was completed under the terms of agreement No. 4242-9081-45.

Borings at abutment locations encountered competent subsoils at or close to the creek bottom level. Consequently the structure can be supported by conventional footings or on piles.

Recommendations and discussions included in this report are provided for the guidance of the structural design engineers for preparing design drawings and cost estimates. In no case should they be construed as specific instructions for contractors. Interpretations of soil profiles have been completed for similar reasons. While these interpretations are believed to be a good representation of soil conditions, some irregularities should be expected. Tender documents and project cost allowances should allow for such irregularities and actual soil strata limits should be confirmed by observations during construction.

2.0 FIELD WORK

Two boreholes were drilled at the site to evaluate soil conditions. The locations of borings and a soil profile are shown on Fig.No. 1 (Dwg. No. 1527507-A)*. More detailed soil profile and field test data summaries are provided on the attached Records of Boreholes.

Boreholes were completed on August 13 to 19, 1981 using a truck-mounted CME 75 power drill equipped with 82 mm internal diameter hollow stem augers.

Soil samples were obtained with 50 mm "split spoon" samplers driven using standard penetration test procedures. Additional indications of soil variability and density were obtained by driving 50 mm dynamic cone probes with the hammer energy similar to that used for the standard penetration test (63.5 kg hammer falling 760 mm).

3.0 SOIL CONDITIONS

3.1 General

The site area outside the limits of the creek channel is underlain by a mixed fill that includes lenses of silty clay, silt, sand and organic silt. Part of the zone classified as fill may actually be natural deposits in the flood plain of Redhill Creek. The 2 to 3 meter thick fill extends approximately to the creek bottom level.

The stratum classified as fill is underlain by till-textured silty clay soils. A thick lense of sandy gravel exists below elevation 60.5 meters at borehole 203. Boreholes were terminated in very dense or hard soil near elevation 59 meters or roughly 17 meters below the ground surface adjacent to the creek channel.

Conditions were similar at both abutments and a radically different soil profile within the creek channel is unlikely.

* Drawing No. 2 of the Contract Drawings

3.2 Fill

The fill soils, which may include some native flood plain deposits, consist of a relatively soft or loose mixture of soil types that include silty clay, silt, sand and organic silt. Clayey fill soils are predominant at borehole #203 at the north abutment while silt and sand soils are more common at the south abutment (borehole #202). Organic lenses or seams at the borehole locations are relatively thin.

Standard penetration resistances of 3 blows per 0.3 m are indicative of the generally soft or loose nature of the fill. We assume that it was loose dumped or pushed into its current position.

3.3 Silty Clay (Glacial Till)

The silty clay soil contains a trace to some sand and gravel and is classified as glacial till for the purposes of this report. Standard penetration resistances of 15 to more than 100 blows per 0.3 m are indicative of very stiff to hard soils. The very stiff soil zone is sandwiched between hard zones with the upper hard zone extending to depths of 3.5 to 5 meters below the creek bottom.

The clayey soils have low to medium plasticity characteristics with liquid limits generally less than 25 percent. Natural moisture contents are in the 14 to 17 percent range for soils above elevation 63 meters while values of 9 to 11 percent were measured in the extremely hard soils below elevation 63 meters.

3.4 Sandy Gravel

The sandy gravel stratum encountered near the bottom of borehole 203 is believed to be a lense within the till-textured silty clay soils. Standard penetration resistances of 92 and 93 blows per 0.3 m in the sandy gravel zone are indicative of very dense soil.

3.5 Groundwater

Groundwater levels were at or close to the water level of the adjacent creek at the time of drilling. A similar close relationship in the upper sediments is expected to prevail as water levels in the creek fluctuate. There was no evidence of artesian conditions in either of the boreholes.

NOTE: This report is a copy of a report prepared for the Ministry by Site Investigation Services Ltd. dated Oct., 1981. The original report was signed by R. Martilla, P. Eng.

Ministry of Transportation and Communications
Ontario

RECORD OF BOREHOLE No 202

8 METRIC

W P 152-75-07 LOCATION Co-ords. 4,791,077 N; 282,745 E. ORIGINATED BY P.S.

DIST 4 HWY Q.E.W. BOREHOLE TYPE 82mm Hollow Stem Auger COMPILED BY D.W.N.

DATUM Geodetic DATE 1981-08-13 to 1981-08-14 CHECKED BY R.E.M.

SOIL PROFILE			SAMPLES			GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT (20 40 60 80 100)	WATER CONTENT (%) (PLASTIC LIMIT W_P — NATURAL MOISTURE CONTENT W — LIQUID LIMIT W_L; 10 20 30)	UNIT WEIGHT γ	REMARKS & GRAIN SIZE DISTRIBUTION (%)
ELEV / DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE	'N' VALUES			SHEAR STRENGTH: ○ UNCONFINED ● QUICK TRIAXIAL + FIELD VANE × LAB VANE			GR SA SI CL
76.09	Ground Level						76				
0.0	Fill-mixture of sand, silt and clay. Traces of gravel and organics. Loose.						75				
73.30	Dark grey.		1	SS	3		74				
2.29	Silty clay, some sand. Trace of gravel. (Glacial till)		2	SS	44		73		○		
	Generally hard.		3	SS	43		72				
	Very stiff seam between 6.0 and 8.5m depth.		4	SS	18		71		○		
	Brown to grey		5	SS	15		70				
			6	SS	25		69		○		1 16 33 50
			7	SS	30		68				
			8	SS	40		67		○		
	Reddish grey below 13.71 m.		9	SS	100		66				
			10	SS	50/.075m		65		○		
59.25			11	SS	50/.075m		64				
16.84	End of Borehole						63		○		
	Note: Groundwater level not observed						62		○		
							61		○		
							60				
							59				

OFFICE REPORT ON SOIL EXPLORATION

+3, ×5 : Numbers refer to Sensitivity

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

Ministry of Transportation and Communications
Ontario

RECORD OF BOREHOLE No 203

METRIC 9

W P 152-75-07 LOCATION Co-ords. 4,791,109 N; 282,762 E. ORIGINATED BY D.B.

DIST 4 HWY Q.E.W. BOREHOLE TYPE 82mm Hollow Stem Auger & Cone Test COMPILED BY D.B.

DATUM Geodetic DATE 1981-08-18 to 1981-08-19 CHECKED BY R.E.M.

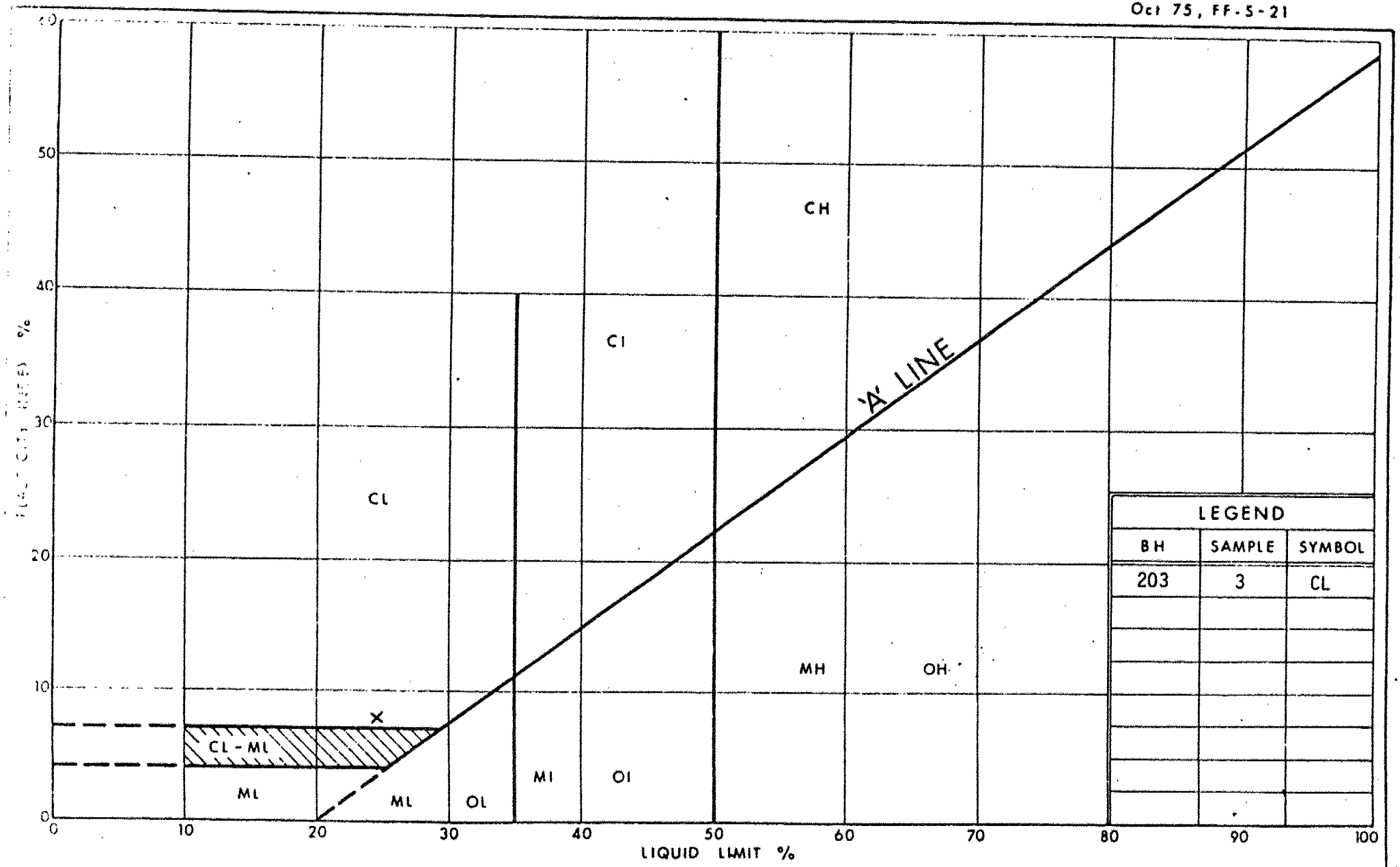
ELEV / DEPTH	DESCRIPTION	STRAT PLOT	SAMPLES NUMBER	SAMPLES TYPE	SAMPLES 'N' VALUES	GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT (20 40 60 80 100) / SHEAR STRENGTH (o UNCONFINED, • QUICK TRIAXIAL, + FIELD VANE, × LAB VANE)	PLASTIC LIMIT Wp / NATURAL MOISTURE CONTENT W / LIQUID LIMIT WL — WATER CONTENT (%) (10 20 30)	UNIT WEIGHT γ	REMARKS & GRAIN SIZE DISTRIBUTION (%) GR SA SI CL
76.08	Ground Level						76				
0.0	Fill - Silty clay, traces of gravel. Light brown. Firm.					▼	75				
74.40							74				
1.68	Fill - Lenses of organic silt and silty clay. Firm.		1	SS	3		73		o		
73.03							72				
3.05	Silty clay, trace to some sand and gravel. (Glacial Till) Less clay above 5m. Very stiff to hard. Mottled brown-grey above 5.18m. Reddish grey to grey below 5.18m.		2	SS	29		71		o—I		
			3	SS	42		70		o		
			4	SS	28		69		o		
			5	SS	28		68		o		
			6	SS	22		67		o		
			7	SS	22		66		o		
			8	SS	24		65		o		
			9	SS	47		64		o		
60.54			10	SS	92		63		o		
15.54	Sandy gravel Trace of silt. Very dense. Grey.		11	SS	93		62				
58.86							61				
17.22	End of Borehole						60				
							59				
							58				

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

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

OFFICE REPORT ON SOIL EXPLORATION

Oct 75, FF-5-21



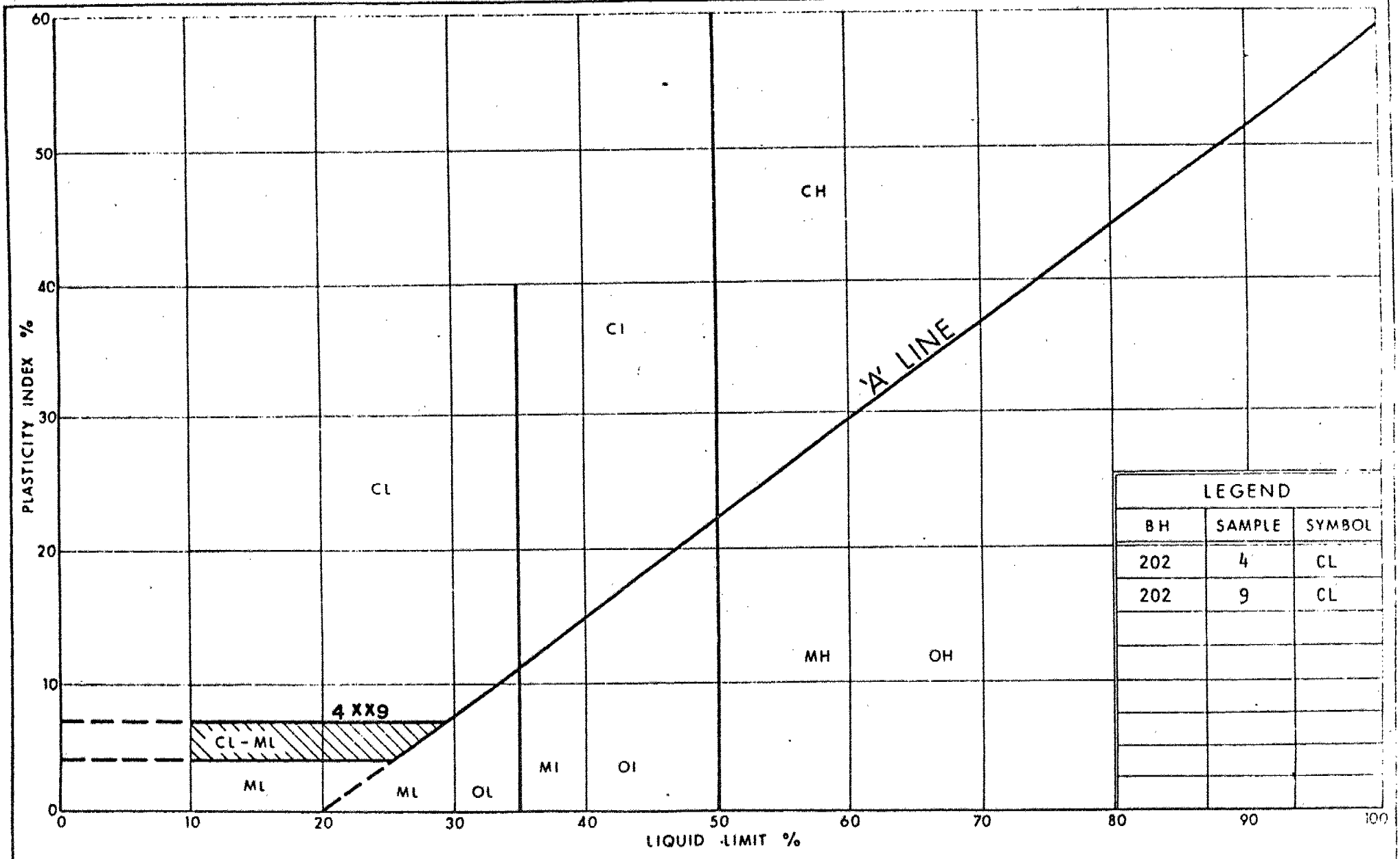
Ministry of Transportation and Communications
Ontario

PLASTICITY CHART

SILTY CLAY (Some Gravel)

FIG No 1

W P 152-75-07 10



LEGEND		
BH	SAMPLE	SYMBOL
202	4	CL
202	9	CL

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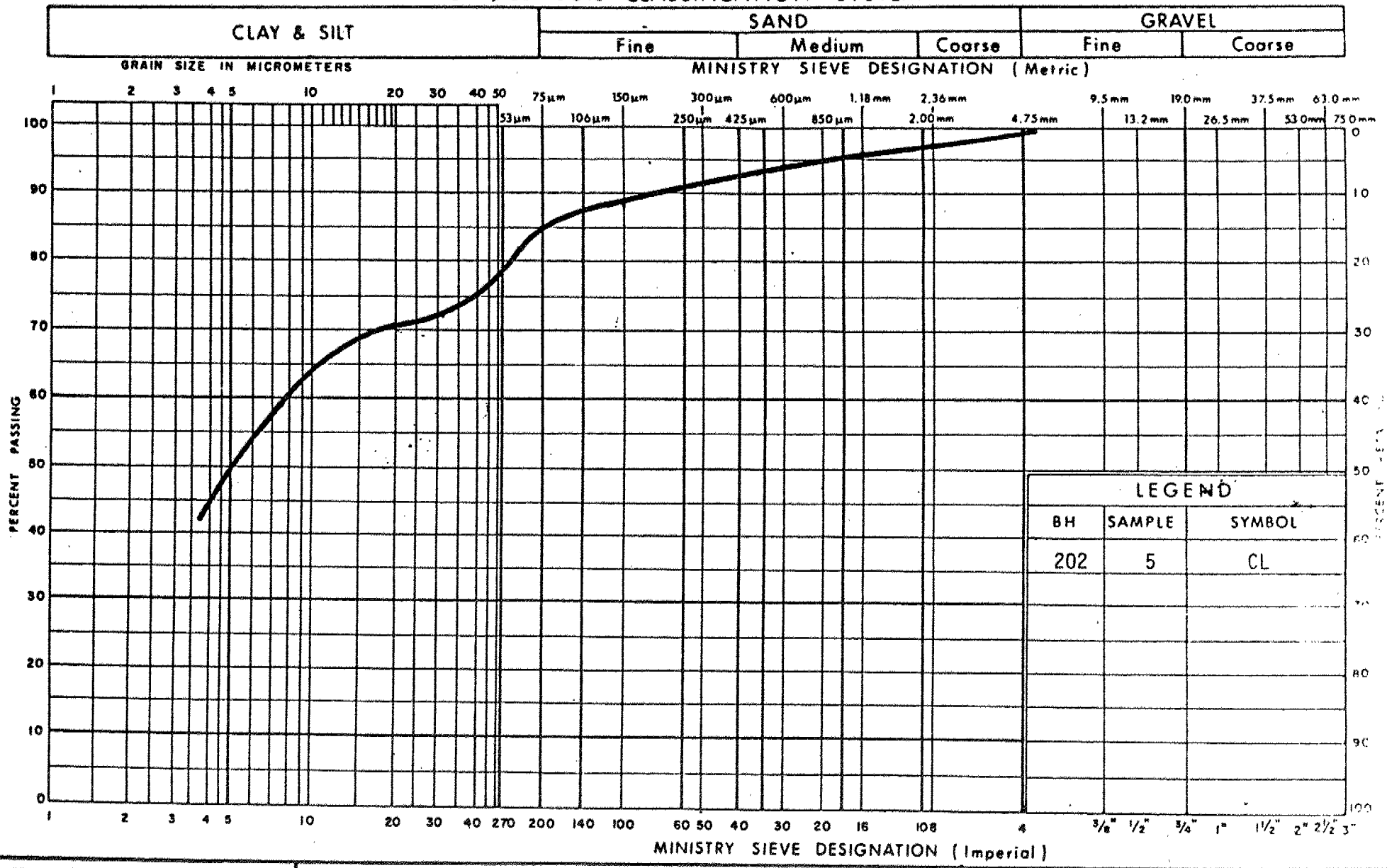
Ontario

PLASTICITY CHART
SANDY SILTY CLAY (TILL)

FIG No 2
W P 152-75-07

UNIFIED SOIL CLASSIFICATION SYSTEM



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GRAIN SIZE DISTRIBUTION
SANDY SILTY CLAY (TILL)

FIG No 3
W P 152-75-07

Ontario Ministry of Transportation and Communications

RECORD OF BOREHOLE No 1

METRIC

W P 152-75-06 LOCATION Co-ords. 4,791,260 N; 282,609 E. ORIGINATED BY P.S.

DIST 4 HWY Q.E.W. BOREHOLE TYPE Washboring, NX Casing COMPILED BY D.N.

DATUM Geodetic DATE 1981-03-26 to 1981-03-27 CHECKED BY R.E.M.

ELEV / DEPTH	DESCRIPTION	STRAT PLOT	SAMPLES NUMBER	TYPE	'N' VALUES	GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT (20 40 60 80 100) / SHEAR STRENGTH (○ UNCONFINED ● QUICK TRIAXIAL + FIELD VANE × LAB VANE)	PLASTIC LIMIT Wp / NATURAL MOISTURE CONTENT W / LIQUID LIMIT W_L — WATER CONTENT (%) (10 20 30)	UNIT WEIGHT γ	REMARKS & GRAIN SIZE DISTRIBUTION (%) GR SA SI CL
74.688	Water Level										
0.0 73.91	Water						74				
.770 72.68	Organic sandy silt. Some peaty material. Soft Black		1	SS	3		73				
2.00	Silty clay, some sand trace of gravel. Trace of root fibres above 3.5 M (glacial till). Low plasticity Stiff to hard Brown		2	SS	9		72		o		
69.18			3	SS	65		71		o		
5.50	Silty clay, some sand trace of gravel (glacial till). Very stiff to hard. Light grey		4	SS	25		70		⊢○⊣		
66.48			5	SS	32		69		o		4 15 (81)
8.20	Silty clay, some sand trace to some gravel (glacial till)		6	SS	41		68		⊢○⊣		
	Hard		7	SS	39		67		o		5 20 (75)
	Dark grey						66				
	Reddish brown below 11.5 M		8	SS	47		65		a⊣		
			9	SS	80		64		o		
			10	SS	110+		63				
	Some cobbles and boulders below 16.5 m		11	RC BX	14%		62				
56.58							61				
18.10	End of Borehole						60				
							59				
							58				
							57				
							56				

+3, ×5 : Numbers refer to Sensitivity

20
15 ◇ 5 (%) STRAIN AT FAILURE
10

Ontario Ministry of Transportation and Communications

RECORD OF BOREHOLE No 2

METRIC

W P 152-75-104 LOCATION Sta. 18+883 (11.0 M Rt) ORIGINATED BY P.S.

DIST 4 HWY Q.E.W. BOREHOLE TYPE Washboring COMPILED BY D.N.

DATUM Geodetic DATE 1981-04-01 to 1981-04-02 CHECKED BY R.E.M.

SOIL PROFILE ELEV/DEPTH	DESCRIPTION	STRAT PLOT	SAMPLES NUMBER	TYPE	'N' VALUES	GROUND WATER CONDITIONS	ELEVATION SCALE
74.688	Water Level						
0.0 74.08	Water						74
606 72.69	Organic silt. Very soft. Black		1	SS	Sank		73
2.00 70.98	Organic silt and peat. Very soft. Brown		2	SS	1/460 mm		72
3.70 70.08	Fine sand. Reddish brown.		3	TW	PM		71
4.60	Sandy silty clay, trace of gravel. Some sandy seams. (Glacial till) Hard Grey Reddish grey and very hard below 12.1 M		4	SS	60		70
			5	SS	40		69
			6	SS	33		68
			7	SS	40		67
			8	SS	40		66
			9	SS	150		65
			10	SS	100/ 100mm		64
			11	SS	100/ 100mm		63
56.68			12	SS	100/ 100mm		62
18.00	End of Borehole						61
							60
							59
							58
							57
							56

DYNAMIC CONE PENETRATION RESISTANCE PLOT 20 40 60 80 100

SHEAR STRENGTH
o UNCONFINED + FIELD VANE
● QUICK TRIAXIAL × LAB VANE

PLASTIC LIMIT W_P | NATURAL MOISTURE CONTENT W | LIQUID LIMIT W_L

WATER CONTENT (%) 10 20 30

W=51%

W=137.8%

UNIT WEIGHT γ

REMARKS & GRAIN SIZE DISTRIBUTION (%) GR SA SI CL

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

20
15 ⊹ 5 (%) STRAIN AT FAILURE
10

Ministry of Transportation and Communications
Ontario

RECORD OF BOREHOLE No 3

METRIC

W P 152-75-06 LOCATION Co-ords. 4,791,303 N; 282,603 E. ORIGINATED BY P.S.

DIST 4 HWY Q.E.W. BOREHOLE TYPE Washboring, NX Casing COMPILED BY D.N.

DATUM Geodetic DATE 1981-03-30 to 1981-03-31 CHECKED BY R.E.M.

SOIL PROFILE ELEV/DEPTH	DESCRIPTION	STRAT PLOT	SAMPLES NUMBER	TYPE	'N' VALUES	GROUND WATER CONDITIONS	ELEVATION SCALE
74.688	Water Level						
0.0 / 73.91	Water						74
.770 / 72.88	Organic silty sand. Loose Black		1	SS	3		73
1.80	Sand, fine to medium. Loose Dark grey		2	SS	5		72
70.28							71
4.67 / 69.68	Organic silt. Fibrous Soft Dark grey		3	SS	4		70
5.00 / 68.18	Fine sand, traces of gravel. Loose Dark grey		4	SS	3		69
6.50 / 67.08	Gravelly sand, medium to coarse. Layered. Dense Grey		5	SS	30		68
7.60	Silty sand, some gravel (Glacial till) Very dense		6	SS	100/	150mm	67
64.68	Grey						66
10.00	Silty clay, some sand trace of gravel. (Glacial till)		7	SS	19		65
	Very stiff to hard		8	SS	32		64
	Reddish to grey		9	SS	127		63
			10	SS	100/	.15m	62
	Bouldery below 17 M		11	SS	100/	.075m	61
			12	SS	100/	.15m	60
56.58							59
18.10	End of Borehole						58
							57
							56

DYNAMIC CONE PENETRATION RESISTANCE PLOT 20 40 60 80 100

SHEAR STRENGTH
○ UNCONFINED + FIELD VANE
● QUICK TRIAXIAL × LAB VANE

PLASTIC LIMIT Wp | NATURAL MOISTURE CONTENT W | LIQUID LIMIT W_L

WATER CONTENT (%) 10 20 30

UNIT WEIGHT γ

REMARKS & GRAIN SIZE DISTRIBUTION (%)

GR SA SI CL

18 72 10 0

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

20
15 ⊹ 5 (%) STRAIN AT FAILURE
10

Ontario Ministry of Transportation and Communications

RECORD OF BOREHOLE No 4

METRIC

W P 152-75-104 LOCATION Sta. 18+829 (11 M Rt) ORIGINATED BY P.S.

DIST 4 HWY Q.E.W. BOREHOLE TYPE Washboring COMPILED BY D.N.

DATUM Geodetic DATE 1891-04-03 to 1981-04-07 CHECKED BY R.E.M.

SOIL PROFILE			SAMPLES			GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT (20 40 60 80 100) / SHEAR STRENGTH (○ UNCONFINED ● QUICK TRIAXIAL + FIELD VANE × LAB VANE)	PLASTIC LIMIT Wp / NATURAL MOISTURE CONTENT W / LIQUID LIMIT W_L — WATER CONTENT (%) (10 20 30)	UNIT WEIGHT γ	REMARKS & GRAIN SIZE DISTRIBUTION (%) GR SA SI CL
ELEV / DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE	'N' VALUES						
74.688	Water Level										
0.0	Water						74				
	Organic silt. Very soft Black		1	TW	PM		73				
72.68											
2.00	Fibrous peat. Soft Wet Brown		2	TW	PM		72				
							71		W=708%		
			3	SS	1/460 mm		70		W=656%		
69.68											
5.00	Sand, trace to some gravel. Trace of root fibres.		4	SS	4		69				
	Loose above 7.2 M						68				
	Dense below 7.2 M		5	SS	43		67				
	Coarse gravelly sand, some cobbles from 10 M to 11.6 M.		6	SS	90		66				11 85 4 0
	Grey						65				
63.38			7	SS	30		64				1 95 4 0
11.30	Sandy clayey silt to silty clay, trace of gravel. (Glacial till)		8	SS	37		63				
	Very dense		9	SS	90		62				
	Gravelly sand seam at 16.7 M depth.		10	SS	80/ 150mm		61				
	Brown to grey		11	SS	100/ 150mm		60				
57.58			12	SS	100/ 150mm		59				
17.10	End of Borehole						58				
							57				

+3, ×5 : Numbers refer to Sensitivity

20
15 ⊹ 5 (%) STRAIN AT FAILURE
10

Ontario Communications

RECORD OF BOREHOLE No 5 & 6

METRIC

W P 152-75-104 LOCATION BH#5 Sta. 18+962 (12.5 M Rt)/BH#6 Sta.18+788(3 M Rt) ORIGINATED BY P.S.

DIST 4 HWY Q.E.W. BOREHOLE TYPE Washboring COMPILED BY D.N.

DATUM Geodetic DATE BH#5 1981-04-08/BH#6 1981-04-08 CHECKED BY R.E.M.

SOIL PROFILE ELEV/DEPTH	DESCRIPTION	STRAT PLOT	SAMPLES NUMBER	TYPE	'N' VALUES	GROUND WATER CONDITIONS	ELEVATION SCALE
	BH#5						
74.688	Water Level						
0.0	Water						74
73.18	Organic silt to peat. Soft Brown to black		1	SS	10		73
1.50	Gravelly clayey sandy silt. Very dense						72
71.48	Grey		2	SS	85		71
3.20	End of Borehole						70
	BH#6						
74.688	Water Level						
0.0	Water						74
609.70	Organic silt and sand.						
73.48	Soft Black to grey		1	SS	1/460mm		73
1.20	Fibrous peat. Soft Brown		2	TW	PM		72
70.88							71
3.80	Sand, fine to medium. Saturated Loose Grey		3	SS	6		70
68.38	Gravelly below 6.4 M		4	SS	28		69
6.30	End of Borehole						68

DYNAMIC CONE PENETRATION RESISTANCE PLOT 20 40 60 80 100

SHEAR STRENGTH
○ UNCONFINED + FIELD VANE
● QUICK TRIAXIAL × LAB VANE

PLASTIC LIMIT W_P | NATURAL MOISTURE CONTENT W | LIQUID LIMIT W_L

WATER CONTENT (%)

UNIT WEIGHT γ

REMARKS & GRAIN SIZE DISTRIBUTION (%) GR SA SI CL

W=78%

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

15 20 10 5 (%) STRAIN AT FAILURE

MINISTRY OF TRANSPORTATION & COMMUNICATIONS

1201 WILSON AVENUE

DOWNSVIEW, ONTARIO

CONT 83-41

REPORT ON SOIL CONDITIONS

OFF-RAMP STRUCTURE OVER REDHILL CREEK

SITE: 36-1336-271

W.P. 152-75-07

SITE INVESTIGATION SERVICES LIMITED

677 CROWN DRIVE

PETERBOROUGH, ONTARIO

K9J 6W2

(705) 743-6850

JOB #2573

OCTOBER, 1981

GEOCRES #2 30M5-134

OFF-RAMP STRUCTURE OVER REDHILL CREEK - SITE 36-271

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OFF-RAMP STRUCTURE OVER REDHILL CREEK - SITE 36-1336-271

1.0 INTRODUCTION

An evaluation of soil conditions has been completed in Hamilton, Ontario where a proposed off-ramp from the Queen Elizabeth Way Highway crosses Redhill Creek. This report describes the site conditions and discusses some considerations for the design of the structure foundations and approaches. A more general summary of soil conditions and design considerations was submitted to Mr. K. Selby, P. Eng. in a letter dated August 25, 1981. The study was completed under the terms of agreement No. 4242-9081-45.

Borings at abutment locations encountered competent subsoils at or close to the creek bottom level. Consequently the structure can be supported by conventional footings or on piles.

Recommendations and discussions included in this report are provided for the guidance of the structural design engineers for preparing design drawings and cost estimates. In no case should they be construed as specific instructions for contractors. Interpretations of soil profiles have been completed for similar reasons. While these interpretations are believed to be a good representation of soil conditions, some irregularities should be expected. Tender documents and project cost allowances should allow for such irregularities and actual soil strata limits should be confirmed by observations during construction.

2.0 FIELD WORK

Two boreholes were drilled at the site to evaluate soil conditions. The locations of borings and a soil profile are shown on Fig.No. 1 (Dwg. No. 1527507-A). More detailed soil profile and field test data summaries are provided on the attached Records of Boreholes.

Boreholes were completed on August 13 to 19, 1981 using a truck-mounted CME 75 power drill equipped with 82 mm internal diameter hollow stem augers.

2.0 FIELD WORK (cont.)

Soil samples were obtained with 50 mm "split spoon" samplers driven using standard penetration test procedures. Additional indications of soil variability and density were obtained by driving 50 mm dynamic cone probes with the hammer energy similar to that used for the standard penetration test (63.5 kg hammer falling 760 mm).

3.0 SOIL CONDITIONS

3.1 General

The site area outside the limits of the creek channel is underlain by a mixed fill that includes lenses of silty clay, silt, sand and organic silt. Part of the zone classified as fill may actually be natural deposits in the flood plain of Redhill Creek. The 2 to 3 meter thick fill extends approximately to the creek bottom level.

The stratum classified as fill is underlain by till-textured silty clay soils. A thick lense of sandy gravel exists below elevation 60.5 meters at borehole 203. Boreholes were terminated in very dense or hard soil near elevation 59 meters or roughly 17 meters below the ground surface adjacent to the creek channel.

Conditions were similar at both abutments and a radically different soil profile within the creek channel is unlikely.

3.2 Fill

The fill soils, which may include some native flood plain deposits, consist of a relatively soft or loose mixture of soil types that include silty clay, silt, sand and organic silt. Clayey fill soils are predominant at borehole #203 at the north abutment while silt and sand soils are more common at the south abutment (borehole #202). Organic lenses or seams at the borehole locations are relatively thin.

Standard penetration resistances of 3 blows per 0.3 m are indicative of the generally soft or loose nature of the fill. We assume that it was loose dumped or pushed into its current position.

3.0 SOIL CONDITIONS (cont.)

3.3 Silty Clay (Glacial Till)

The silty clay soil contains a trace to some sand and gravel and is classified as glacial till for the purposes of this report. Standard penetration resistances of 15 to more than 100 blows per 0.3 m are indicative of very stiff to hard soils. The very stiff soil zone is sandwiched between hard zones with the upper hard zone extending to depths of 3.5 to 5 meters below the creek bottom.

The clayey soils have low to medium plasticity characteristics with liquid limits generally less than 25 percent. Natural moisture contents are in the 14 to 17 percent range for soils above elevation 63 meters while values of 9 to 11 percent were measured in the extremely hard soils below elevation 63 meters.

3.4 Sandy Gravel

The sandy gravel stratum encountered near the bottom of borehole 203 is believed to be a lense within the till-textured silty clay soils. Standard penetration resistances of 92 and 93 blows per 0.3 m in the sandy gravel zone are indicative of very dense soil.

3.5 Groundwater

Groundwater levels were at or close to the water level of the adjacent creek at the time of drilling. A similar close relationship in the upper sediments is expected to prevail as water levels in the creek fluctuate. There was no evidence of artesian conditions in either of the boreholes.

4.0 DESIGN AND CONSTRUCTION CONSIDERATIONS

4.1 General

It is our understanding that the proposed two or three span bridge will have a total length of about 42 meters and that the bridge and approach fill grade will extend 3.5 to 4 meters above the surface of the fill that now exists adjacent to the creek channel.

Site conditions are such that the structure can be supported on conventional spread footings or on piles depending on the economics of the two systems. Both alternatives are discussed in the report.

The discussions and recommendations in this report are related to the concepts and requirements of the current Ontario Highway Bridge Design Code.

4.2 Footings

The native very stiff to hard silty clay till soils below the site are competent to support conventional footings. The following bearing values are recommended for footings greater than 2 meters in width founded on the till below elevation 73 meters.

Factored bearing capacity at Ultimate Limit State	600 kPa
Bearing capacity at Serviceability Limit State, Type II	400 kPa

Settlements under the recommended Serviceability Limit State stresses should be well within the 25 mm limit.

The depth of footings below streambed will depend on scour protection provided and on results of hydrology analyses. However, a cover of at least 1.5 meters should be provided. At least 1.3 meters of soil cover should be provided for frost protection.

4.0 DESIGN AND CONSTRUCTION CONSIDERATIONS (cont.)

4.3 Excavation Considerations

The excavations will extend into very stiff to hard clayey soils in which little or no sloughing is expected. Seepage through these soils should be minimal.

The overlying fill and sediments are loose or soft but the shallow depth at abutments precludes the possibility of extensive sloughing in these areas. More extensive sediments may exist at the pier location, however, and procedures such as sheeting may be required to control seepage and sloughing.

A concrete skim coat or at least 150 mm crushed stone should be placed over the exposed clay base to prevent progressive deterioration of the base from foot traffic. If crushed stone is used, a sump or sumps should be provided to keep it drained.

4.4 Piles

Steel H-piles could be used at this site provided that the pile tips are reinforced to prevent damage on cobbles and to increase the effective end area.

Piles driven to refusal on the very hard or very dense soils below elevation 61 meters, approximately, are expected to develop full capacities in combined end bearing and adhesion. For design based on Ontario Highway Bridge Design Code criteria the following capacities can be assumed for 310 X 110 steel H-piles:

Factored capacity at Ultimate Limit State	1600 kN per pile
Capacity at Serviceability Limit State, Type II	800 kN per pile

Settlements for the Serviceability State conditions should be well within the 25 mm limit.

4.0 DESIGN AND CONSTRUCTION CONSIDERATIONS (cont.)

Silty clay till soils above elevation 61 meters are very stiff to hard and assistance such as pre-augering may be required to achieve full penetration of piles to or near elevation 61 meters. Full allowable capacity might be achieved for piles that meet refusal above elevation 61 meters but field load tests would be required for confirmation.

Piles should be installed in accordance with Ministry of Transportation and Communications Standards SS 103-10 and SS 103-11.

4.5 Abutments and Wingwalls

All existing fill and organic sediments within 5 meters of the abutments should be removed. All replacement fill and backfill should consist of clean free-draining sand and gravel (MTC granular 'B'). The fill should be compacted in 300 mm maximum lifts to 100 percent of standard proctor density (ASTMD D 698 standard). Compaction equipment should be restricted to hand operated tampers and rollers. Large self-propelled rollers can create high lateral pressures through wedging effects.

Earth pressures for abutments and retaining walls should be computed in accordance with section 6.6.1.2.2 of the Ontario Highway Bridge Design Code. All spread footings or pile caps should have a minimum of 1.3 meters of earth cover for frost protection.

4.6 Scour Protection

The till-textured subsoils have good resistance to erosion. However, the overlying layered or lensed loose fill and flood plain sediments are easily eroded and some form of scour protection should be provided to protect the footings.

Detailed design of scour protection is beyond the scope of this report. As a minimum, however, the design should place footings at least 1.5 meters below existing streambed level and should provide riprap or more positive concrete sill protection near footings.

4.0 DESIGN AND CONSTRUCTION CONSIDERATIONS (cont.)

4.7 Approach Fills

Sub-excavation of existing fill and organic sediments within 5 meters of abutments will permit use of relatively steep side slopes in those areas. Slopes as steep as 1.5 horizontal to 1 vertical could be considered if the slope is covered to prevent surface erosion. A transition slope of 5.0 horizontal to 1 vertical should be provided adjacent to the sub-excavated area.

Side slope of 3.0 horizontal to 1 vertical are recommended where embankments are placed directly on the existing fill. Fill should be placed in full width horizontal lifts of 300 mm maximum thickness.

Settlements in excess of 150 mm may occur in embankments placed on the more clayey fill soils near the north abutment. More than half the settlement is expected to occur within several weeks of the fill placement.

Submitted by:

SITE INVESTIGATION SERVICES LIMITED

R. Marttila

R. Marttila, P. Eng.

RM/lp

Ministry of Transportation and Communications
Ontario

RECORD OF BOREHOLE No 202

METRIC

W P 152-75-07 LOCATION Co-ords. 4,791,077 N; 282,745 E. ORIGINATED BY P.S.

DIST 4 HWY Q.E.W. BOREHOLE TYPE 82mm Hollow Stem Auger COMPILED BY D.W.N.

DATUM Geodetic DATE 1981-08-13 to 1981-08-14 CHECKED BY R.E.M.

ELEV / DEPTH	DESCRIPTION	STRAT PLOT	SAMPLES NUMBER	SAMPLES TYPE	SAMPLES 'N' VALUES	GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT (20 40 60 80 100) / SHEAR STRENGTH (o UNCONFINED, • QUICK TRIAXIAL, + FIELD VANE, × LAB VANE)	PLASTIC LIMIT Wp / NATURAL MOISTURE CONTENT W / LIQUID LIMIT Wl — WATER CONTENT (%) (10 20 30)	UNIT WEIGHT γ	REMARKS & GRAIN SIZE DISTRIBUTION (%) GR SA SI CL
76.09	Ground Level										
0.0	Fill-mixture of sand, silt and clay. Traces of gravel and organics. Loose.		1	SS	3		75				
73.80	Dark grey.						74				
2.29	Silty clay, some sand. Trace of gravel. (Glacial till)		2	SS	44		73		o		
	Generally hard.		3	SS	43		72		o		
	Very stiff seam between 6.0 and 8.5m depth.		4	SS	18		71				
	Brown to grey		5	SS	15		70				1 16 33 50
			6	SS	25		69		o		
			7	SS	30		68		o		
			8	SS	40		67		o		
	Reddish grey below 13.71 m.		9	SS	100		66		o		
			10	SS	50/.075m		65		o		
59.25			11	SS	50/.075m		64				
16.84	End of Borehole						63				
	Note: Groundwater level not observed						62				
							61				
							60				
							59				

+3, ×5 : Numbers refer to Sensitivity

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

OFFICE REPORT ON SOIL EXPLORATION

Ministry of Transportation and Communications
Ontario

RECORD OF BOREHOLE No 203

METRIC

W P 152-75-07 LOCATION Co-ords. 4,791,109 N; 282,762 E. ORIGINATED BY D.B.

DIST 4 HWY Q.E.W. BOREHOLE TYPE 82mm Hollow Stem Auger & Cone Test COMPILED BY D.B.

DATUM Geodetic DATE 1981-08-18 to 1981-08-19 CHECKED BY R.E.M.

SOIL PROFILE ELEV/DEPTH	DESCRIPTION	STRAT PLOT	SAMPLES NUMBER	TYPE	'N' VALUES	GROUND WATER CONDITIONS	ELEVATION SCALE
76.08	Ground Level						
0.0	Fill - Silty clay, traces of gravel. Light brown. Firm.						
74.40							
1.68	Fill - Lenses of organic silt and silty clay. Firm.		1	SS	3		
73.03							
3.05	Silty clay, trace to some sand and gravel. (Glacial Till) Less clay above 5m. Very stiff to hard. Mottled brown-grey above 5.18m. Reddish grey to grey below 5.18m.		2	SS	29		
			3	SS	42		
			4	SS	28		
			5	SS	28		
			6	SS	22		
			7	SS	22		
			8	SS	24		
			9	SS	47		
60.54			10	SS	92		
15.54	Sandy gravel Trace of silt. Very dense. Grey.						
58.86			11	SS	93		
17.22	End of Borehole						

DYNAMIC CONE PENETRATION RESISTANCE PLOT 20 40 60 80 100

SHEAR STRENGTH
o UNCONFINED + FIELD VANE
● QUICK TRIAXIAL × LAB VANE

PLASTIC LIMIT W_p NATURAL MOISTURE CONTENT W LIQUID LIMIT W_L

WATER CONTENT (%) 10 20 30

UNIT WEIGHT γ

REMARKS & GRAIN SIZE DISTRIBUTION (%) GR SA SI CL

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

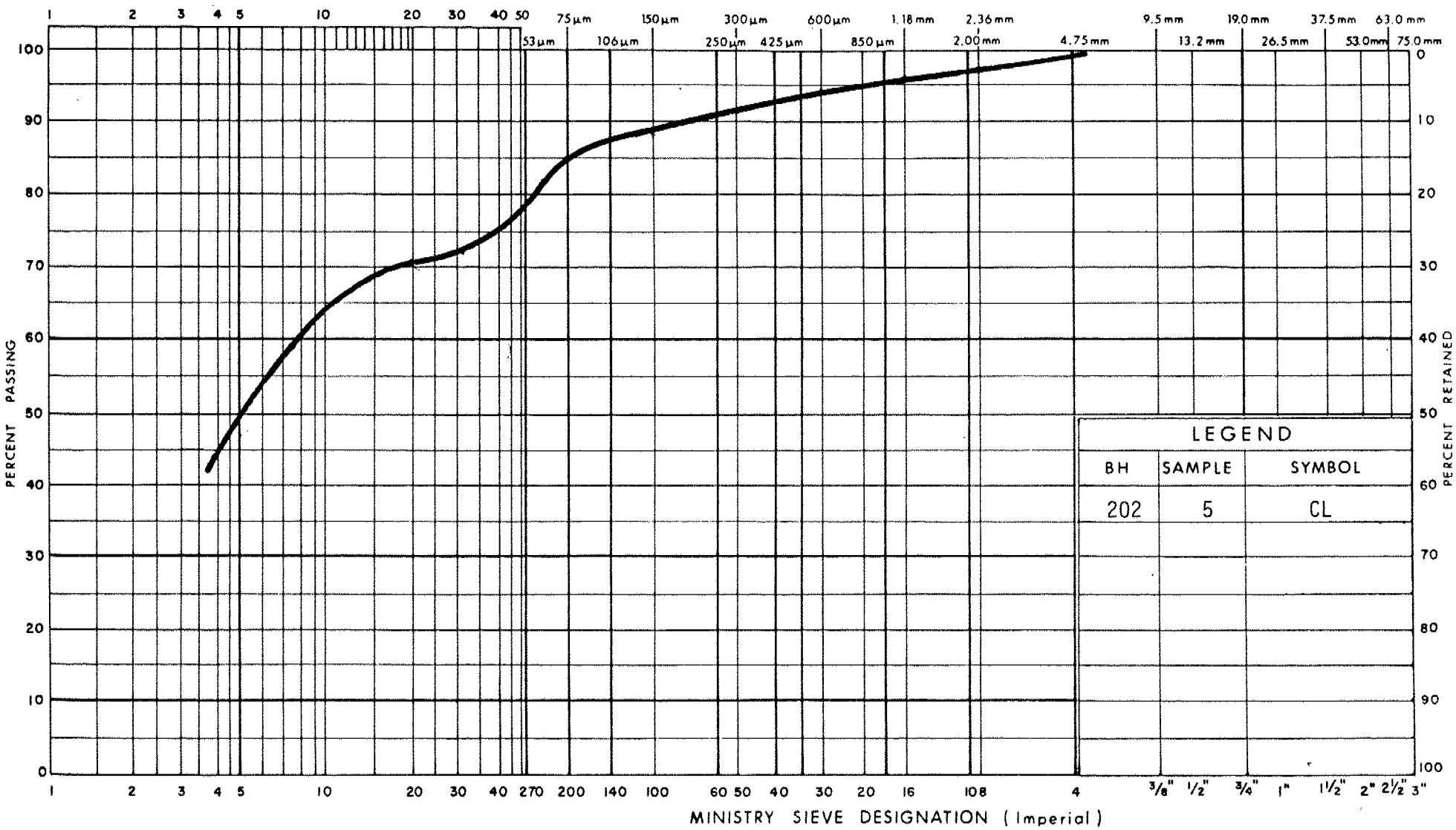
20 15 5 10 (%) STRAIN AT FAILURE

OFFICE REPORT ON SOIL EXPLORATION

78 12 M

UNIFIED SOIL CLASSIFICATION SYSTEM

CLAY & SILT	SAND			GRAVEL	
	Fine	Medium	Coarse	Fine	Coarse



LEGEND		
BH	SAMPLE	SYMBOL
202	5	CL

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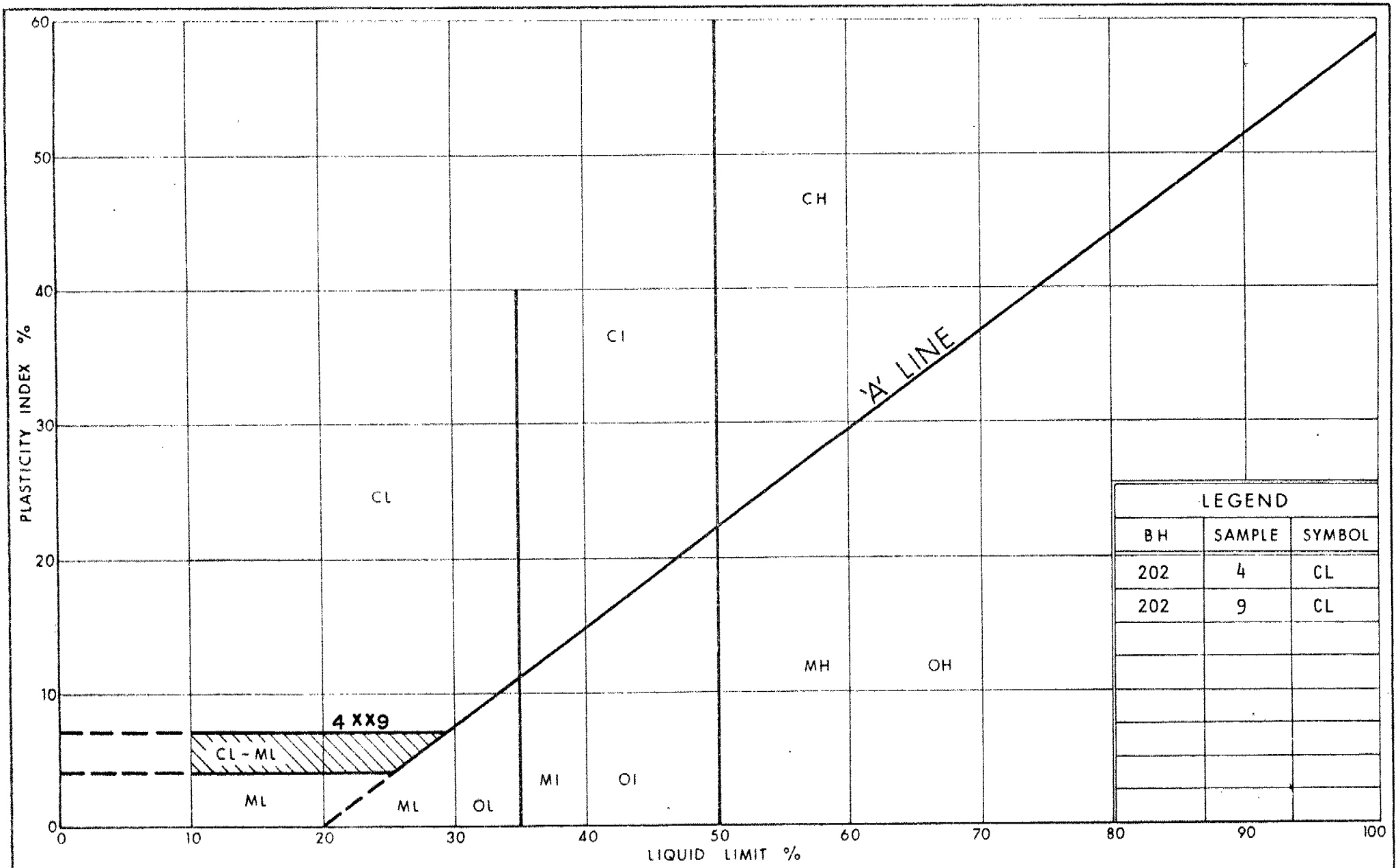
Ontario

GRAIN SIZE DISTRIBUTION
SANDY SILTY CLAY (TILL)

FIG No ~~2~~ 1

W P 152-75-~~104~~ 07

Oct 75, FF-S-21



LEGEND		
BH	SAMPLE	SYMBOL
202	4	CL
202	9	CL

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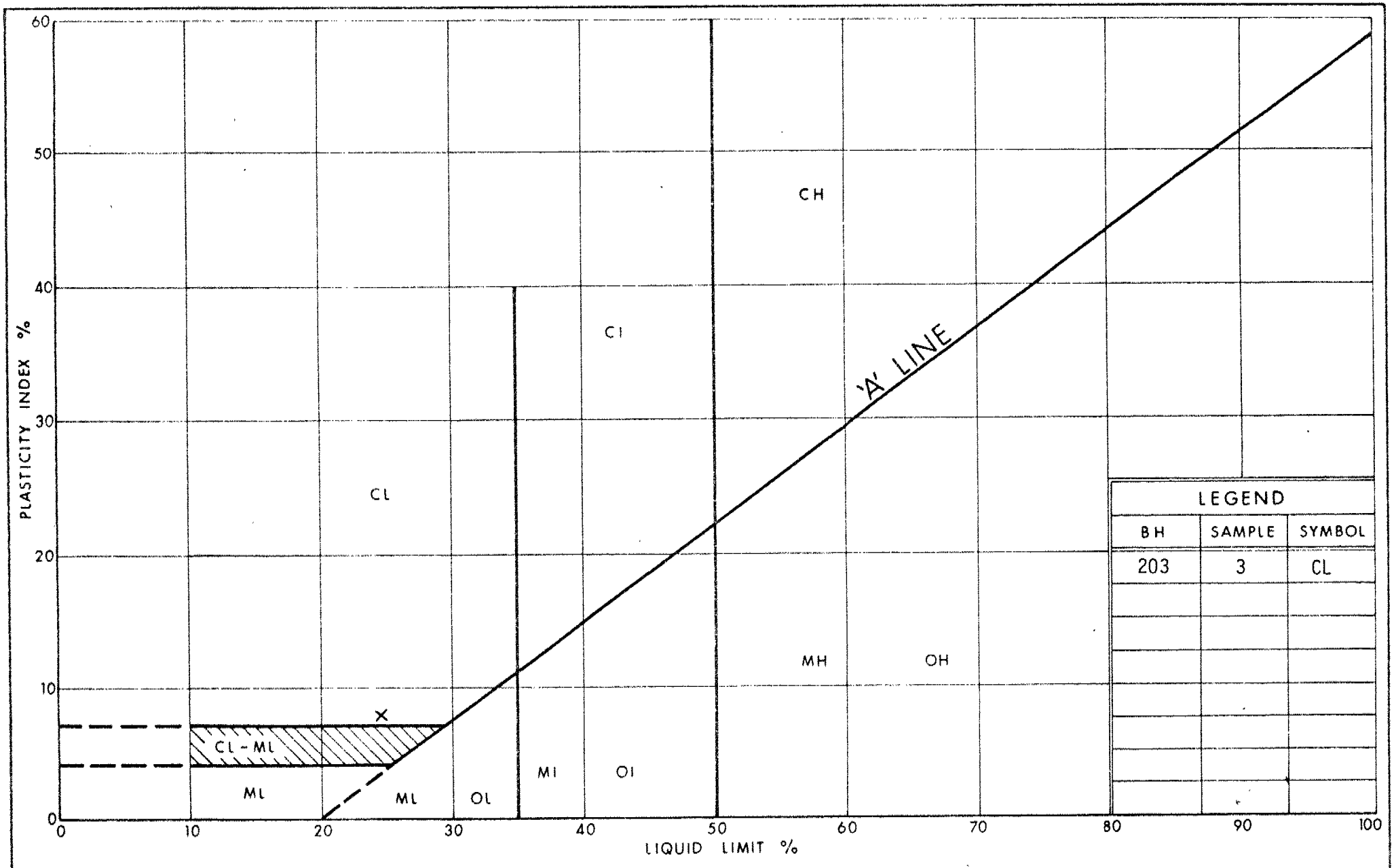
PLASTICITY CHART
SANDY SILTY CLAY (TILL)

FIG No ~~3~~ 2
W P 152-75-~~10~~ 07



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Ontario

PLASTICITY CHART

SILTY CLAY (Some Gravel)

FIG No 4-3

W P 152-75-~~104~~ 107

EXPLANATION OF TERMS USED IN REPORT

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

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

SOILS ARE DESCRIBED BY THEIR COMPOSITION AND CONSISTENCY OR DENSENESS.

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

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

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

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

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

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

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

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

JOINTING AND BEDDING:

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

ABBREVIATIONS AND SYMBOLS

FIELD SAMPLING

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

STRESS AND STRAIN

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

MECHANICAL PROPERTIES OF SOIL

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

PHYSICAL PROPERTIES OF SOIL

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

e	1,%	VOID RATIO
n	1,%	POROSITY
w	1,%	WATER CONTENT
S_r	%	DEGREE OF SATURATION
w_L	%	LIQUID LIMIT
w_p	%	PLASTIC LIMIT
w_S	%	SHRINKAGE LIMIT
I_p	%	PLASTICITY INDEX = $w_L - w_p$
I_L	1	LIQUIDITY INDEX = $\frac{w - w_p}{I_p}$
I_C	1	CONSISTENCY INDEX = $\frac{w_L - w}{I_p}$
e_{max}	1,%	VOID RATIO IN LOOSEST STATE
e_{min}	1,%	VOID RATIO IN DENSEST STATE
I_D	1	DENSITY INDEX = $\frac{e_{max} - e}{e_{max} - e_{min}}$
D	mm	GRAIN DIAMETER
D_n	mm	n PERCENT - DIAMETER
C_U	1	UNIFORMITY COEFFICIENT
h	m	HYDRAULIC HEAD OR POTENTIAL
q	m^3/s	RATE OF DISCHARGE
v	m/s	DISCHARGE VELOCITY
i	1	HYDRAULIC GRADIENT
k	m/s	HYDRAULIC CONDUCTIVITY
j	kN/m^3	SEEPAGE FORCE

memorandum

Ontario

To: Mr. F. Chan,
Structural Section,
Central Region

Date: 81 09 08

From: Pavement & Foundation Design Section,
Room 315, Central Building

Re: Structures over Red Hill Creek,
Burlington, Ontario W. P.'s 152-75-06/07
Site Nos. 36-1336-142 and 36-1336-271
District 4 (Hamilton)

We have received a preliminary report from Site Investigation Service Ltd. who have recently completed the fieldwork for the foundation investigation for the above-mentioned project. Based on this report, we are providing you with recommendations pertaining to the design and construction of the widening of the existing bridge over Red Hill Creek and the new bridge to be built over the creek on the future Ramp N-W. A copy of the Consultant's letter, which is dated August 25, 1981, has already been given to you.

Site 36-1336-142

The widened portions of this structure should be supported on 310x110 steel H piles driven to approximate el 59 at which depth design loads of up to 800 kN per pile should be achieved. These piles should be fitted with reinforced tips and pile driving in the field should be controlled in accordance with M. T. C. Standards SS 103-10 and SS 103-11. The new portions of the piers and abutments should be rigidly connected to the existing portions by dowelling. Design loads to be imposed on the existing and new piers in the future should not exceed what is being taken now by the existing piers and abutments since we do not know the details of the installation of the existing piles.

For purposes of the O.H.B.D.C., the following recommendations apply to the 310x110 steel H piles driven as specified above:

Factored Capacity at U. L. S. = 1600 kN per pile
Capacity at S. L. S. Type II = 800 kN per pile

Earth pressures should be computed in accordance with Section 6.6.1.2.2 of the Code. All pile caps should have a minimum cover of 1.3 m for frost protection.

Site 36-1336-271

A new two span structure is proposed for this site. The proposed abutments and pier may be supported either on spread footings or on piled foundations depending on the economics of these two methods. For spread footings, a net design pressure of 400 kPa can be achieved at or below el. 73. For piled foundations 310x110 steel H piles fitted with reinforced tips should achieve a design load of 800 kN per pile if driven to el. 60. Pile driving should be controlled in the field in accordance with M. T. C. Standards SS 103-10 and SS 103-11. Footings and pile caps should have a minimum cover of 1.3 m for frost protection. For purposes of the O.H.B.D.C., the following values are recommended:

310x110 steel H piles driven as specified above

Factored capacity at U. L. S. = 1600 kN per pile
Capacity at S. L. S. Type II = 800 kN per pile

Spread footings at el. 73.0 or lower

Factored bearing capacity at U. L. S. = 600 kPa
Capacity at S. L. S. Type II = 400 kPa

Earth pressures should be computed in accordance with Section 6.6.1.2.2 of the Code.

P. Payer
for K. G. Selby,
Senior Foundations Engineer

cc: W. Lin

SITE INVESTIGATION SERVICES
LIMITED

677 CROWN DRIVE PETERBOROUGH, ONT. PHONE 743-6850

MINISTRY OF TRANSPORTATION
AND COMMUNICATIONS
Pavement and Foundations Design Section
Room 315, Central Building
DOWNSVIEW, Ontario

August 25, 1981

Attention: Mr. K. G. Selby, P. Eng.

Re: Structures Over Red Hill Creek, Burlington
W.P. 152-75-06/07, Sites 36-1336-142 and 36-1336-271
District 4, Hamilton

Dear Sir,

We have completed soil borings at the above site. This letter presents a brief summary of our findings and also discusses some of the main factors to consider for designs. A detailed report is in the process of preparation.

FIELD WORK

The locations of 6 boreholes are shown on the attached plan. Boreholes #1 and #3 were drilled from a raft as part of an investigation for a previously proposed structure located about 40 meters west. Boreholes 200 to 203 were drilled specifically for the two currently proposed structures. These borings were completed with a CME 75 power drill equipped with 82mm hollow stem augers.

SITE 36-142

Soil Profile - The northerly part of the structure (boreholes #3 and #200) is underlain by relatively soft and loose fill, silt, organics and sand to about elevation 68 meters. This is roughly 6 meters below existing streambed level. Penetration resistances as low as 3 blows per 305mm were measured in this zone. The underlying 2.5 to 4 meters of soil consists of dense layered sand and gravelly sand which in turn is underlain by very stiff to hard till-textured silty clay. Penetration resistances of 11 to more than 200 blows per 305mm were measured in these till-textured soils.

Borings in the southerly part of the structure (boreholes #1 and #201) encountered relatively shallow depths of loose or soft sediments. The surface of the very stiff to hard till-textured silty and clayey silt soils extends above elevation 72 meters (ie within 1.5 meters of the existing streambed).

Design Considerations - We understand that the new structure will incorporate part of the existing bridge abutments and piers. A westerly extension of the abutments and piers will also be required. The existing structure is reported to be set on driven H-piles. The abutment extensions will extend over existing retaining walls and it may be feasible to incorporate part of the retaining wall foundation in the new bridge. Additional piles could consist of steel tube piles or steel H-piles. At boreholes #3 and #200 we expect that steel tube piles will meet refusal in the dense sand layer above elevation 65 meters. The depth of steel H-piles is much more difficult to predict and full capacities may not develop until the tips have penetrated below elevation 61 meters. H-piles should be provided with built up protective tips to prevent damage on cobbles and to increase the effective end area. Settlements of the piles under load are unlikely to exceed 15 mm. Piles driven through or adjacent to existing footings should consist of low displacement H-piles.

Piles for the south abutment and pier extension (boreholes #1 and #201) would derive support from both adhesion and end bearing within the very stiff to hard clayey till-textured soils. Pile capacities and refusal depths are difficult to predict. If the piles are driven to the very hard soils below elevation 61 meters there is no doubt that full allowable pile capacities will be achieved in combined end bearing and side adhesion. We expect, however, that pre-augering would be required to ensure this depth of pile penetration. Full allowable loads might be achieved at shallower depths but a load test would be required for confirmation.

From an economic point of view it may be appropriate to accept less than full pile capacity to minimize the required depth of pile penetration. For costing purposes a working capacity of each pile in kN can be computed as $1500A + 50CL$ where A is the effective end area of the pile (square meters), C is the effective perimeter of the pile (meters) and L is the pile length (meters) embedded in the clayey till-textured soils.

We have considered the use of conventional footings for the additions to the south pier and abutment. While such footings are feasible (with allowable loads of up to 300 kPa) it would be more appropriate to maintain the pile support throughout.

Differential Settlements - The extended pier and abutment sections will settle relative to the existing piers and abutments. For design purposes we recommend assuming differential settlements of up to 15 mm. We expect that most of the settlement will be completed within several days of load application.

SITE 36-271

Soil Profile - Borings #202 and #203 located on either side of the creek channel, encountered very stiff to hard till textured clayey silt and silty clay below elevation 73 to 74 meters. Penetration resistances in these soils generally are in the range of 20 to more than 100 blows per 305 mm. The shallow covering soils consists of a soft or loose mixture of sand, silt, clay and organics. Conditions in the creek channel are unlikely to be radically different.

Design Considerations - The site is suitable for the use of conventional footings to support the bridge structure. Allowable stresses of up to 400 kPa can be assumed for designing footings on the very stiff to hard soils found below elevation 74 and 73 meters at boreholes #201 and #202 respectively.

Should you have any queries concerning this preliminary report, please do not hesitate to contact me. The final report is being prepared and should be available next week if appropriate 1:500 base drawings and drawing forms are received Thursday or Friday.

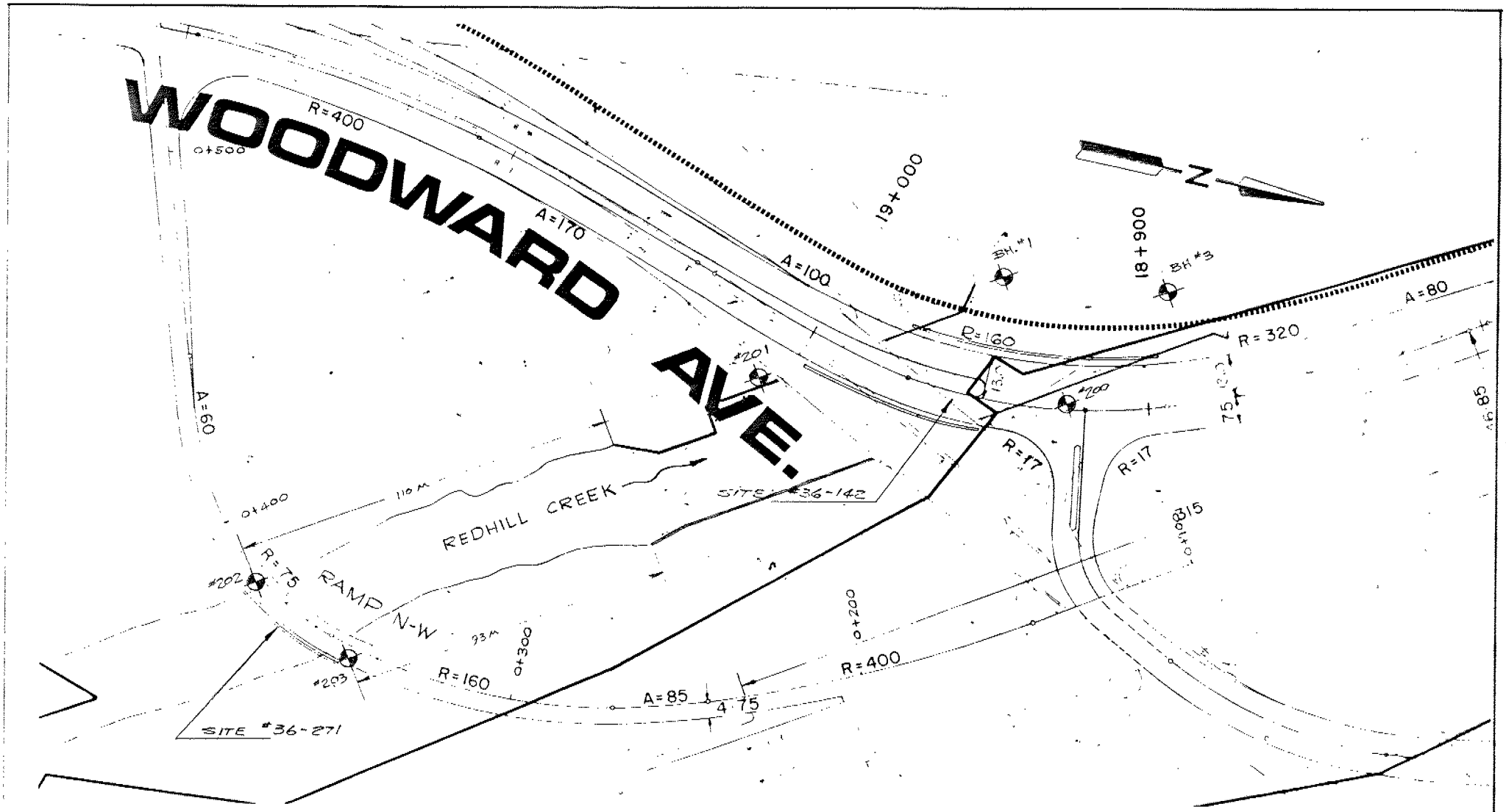
Yours very truly,

R. Marttila

R. Marttila, P. Eng.

SITE INVESTIGATION SERVICES LIMITED

RM/lp



JOB NO. 3573	SCALE HORIZ. 1:1000	SITE INVESTIGATION SERVICES LIMITED	FIGURE
DATE AUG. 1981	VERT.	STRUCTURES OVER REDHILL CREEK PRELIMINARY LOCATION PLAN	
APP'D BY	DRAWN BY K.W.N.		

Ministry of Transportation and Communications
Ontario

RECORD OF BOREHOLE No 1

METRIC

W P 152-75-104 LOCATION ORIGINATED BY P.S.

DIST 4 HWY Q.E.W. BOREHOLE TYPE Washboring, NX Casing COMPILED BY D.N.

DATUM Geodetic DATE 1981-03-26 to 1981-03-27 CHECKED BY R.E.M.

SOIL PROFILE			SAMPLES			GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT (20 40 60 80 100) / SHEAR STRENGTH (o UNCONFINED, • QUICK TRIAXIAL, + FIELD VANE, × LAB VANE)	PLASTIC LIMIT W_P / NATURAL MOISTURE CONTENT W / LIQUID LIMIT W_L — WATER CONTENT (%) 10 20 30	UNIT WEIGHT γ	REMARKS & GRAIN SIZE DISTRIBUTION (%) GR SA SI CL
ELEV / DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE	'N' VALUES						
74.688	Water Level										
0.0 / 73.91	Water						74				
.770 / 72.68	Organic sandy silt. Some peaty material. Soft Black		1	SS	3		73				
2.00	Sandy clayey silt, trace of gravel. Trace of root fibres above 3.5 M (glacial till). Very dense below 3.8 M.		2	SS	9		72		o		
69.18	Brown		3	SS	65		71		o		
5.50	Sandy silty clay, trace of gravel (glacial till). Very stiff to hard. Light grey		4	SS	25		70				
66.48			5	SS	32		69				4 15 (81)
8.20	Sandy silty clay, trace to some gravel (glacial till)		6	SS	41		68				
	Hard		7	SS	39		67				5 20 (75)
	Dark grey		8	SS	47		66				
	Reddish brown below 11.5 M		9	SS	80		65				
	Bouldery below 16.5 M		10	SS	110+		64				
56.58			11	BX Core			63				
18.10	End of Borehole						62				
							61				
							60				
							59				
							58				
							57				
							56				

OFFICE REPORT ON SOIL EXPLORATION

+3, ×5 : Numbers refer to Sensitivity

15 20/10 5 (%) STRAIN AT FAILURE

Ministry of Transportation and Communications
Ontario

RECORD OF BOREHOLE No 3

METRIC

W P 152-75-104 LOCATION ORIGINATED BY P.S.

DIST 4 HWY Q.E.W. BOREHOLE TYPE Washboring, NX Casing COMPILED BY D.N.

DATUM Geodetic DATE 1981-03-30 to 1981-03-31 CHECKED BY R.E.M.

SOIL PROFILE			SAMPLES			GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT (20 40 60 80 100) / SHEAR STRENGTH (○ UNCONFINED ● QUICK TRIAXIAL + FIELD VANE × LAB VANE)	PLASTIC LIMIT Wp / NATURAL MOISTURE CONTENT W / LIQUID LIMIT Wl — WATER CONTENT (%) 10 20 30	UNIT WEIGHT γ	REMARKS & GRAIN SIZE DISTRIBUTION (%) GR SA SI CL
ELEV DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE	'N' VALUES						
74.688	Water Level										
0.0 / 73.91	Water										
.770 / 72.88	Organic silty sand. Loose Black		1	SS	3						
1.80	Sand, fine to medium. Loose Dark grey		2	SS	5						
70.28											
4.67 / 69.68	Organic silt. Fibrous Soft Dark grey		3	SS	4						
5.00 / 68.18	Fine sand, traces of gravel. Loose Dark grey		4	SS	3						
6.50 / 67.08	Gravelly sand, medium to coarse. Layered. Dense Grey		5	SS	30						18 72 10 0
7.60 / 64.68	Gravelly silty sand. (Glacial till) Very dense Grey		6	SS	100/	150mm					
10.00 / 60.28	Sandy silty clay, trace of gravel. (Glacial till) Very stiff to hard Reddish to grey		7	SS	19						
			8	SS	32						
			9	SS	127						
14.40 / 56.58	Clayey sandy silt. (Glacial till) Bouldery below 17 M Very dense. Reddish grey		10	SS	100/	150mm					
			11	SS	100/	75mm					
			12	SS	100/	150mm					
18.10	End of Borehole										

ELEVATION SCALE: 74 73 72 71 70 69 68 67 66 65 64 63 62 61 60 59 58 57 56

OFFICE REPORT ON SOIL EXPLORATION

+3, ×5 ; Numbers refer to Sensitivity

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

Ministry of Transportation and Communications
Ontario

RECORD OF BOREHOLE No 200

METRIC

W P 152-75-4 LOCATION
DIST 4 HWY Q.E.W. BOREHOLE TYPE 82mm Hollow Stem Auger & Cone Test
DATUM Geodetic DATE 1981-08-17 to 1981-08-18

ORIGINATED BY D.B.
COMPILED BY D.B.
CHECKED BY R.E.M.

SOIL PROFILE ELEV/DEPTH	DESCRIPTION	STRAT PLOT	SAMPLES NUMBER	TYPE	'N' VALUES	GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT (20 40 60 80 100) / SHEAR STRENGTH: o UNCONFINED, ● QUICK TRIAXIAL, + FIELD VANE, × LAB VANE	PLASTIC LIMIT Wp / NATURAL MOISTURE CONTENT W / LIQUID LIMIT WL — WATER CONTENT (%) 10 20 30	UNIT WEIGHT γ	REMARKS & GRAIN SIZE DISTRIBUTION (%) GR SA SI CL
0.0	Fill - Gravelly sand to sandy gravel, traces of silt. Compact to dense. Grey		1	S/S	42		76				
73.13			2	S/S	12		75				
3.57	Layers of clayey silt to organic silt. Some silt lenses. Firm to stiff. Brown to dark grey.		3	S/S	6		74				
69.69			4	S/S	11		73		o		
7.01	Sand with organic and clayey silt seams. Loose		5	S/S	4		72		o		
68.17							71				
8.53	Sand, medium to coarse. Some silty lenses.(Some gravel) Dense Brown to grey.		6	S/S	32		70				20 69 11
63.90			7	S/S	---		69				
12.80	Silty clay, traces of sand and gravel. Low plasticity. (Glacial Till) Very stiff to hard. Reddish grey to grey.		8	S/S	30		68				
			9	S/S	29		67				
			10	S/S	78		66				
57.95			11	S/S	65/10 0mm		65				
18.75	End of Borehole						64				
							63		o		
							62				
							61		o		
							60		o		
							59				
							58		o		
							57				

+3, ×5 : Numbers refer to Sensitivity

15 20 10 5 (%) STRAIN AT FAILURE

OFFICE REPORT ON SOIL EXPLORATION

Ministry of Transportation and Communications
Ontario

RECORD OF BOREHOLE No 201

METRIC

W P 152-75-04 LOCATION ORIGINATED BY P.S.
DIST 4 HWY Q.E.W. BOREHOLE TYPE 82mm Hollow Stem Auger COMPILED BY D.W.N.
DATUM Geodetic DATE 1981-08-12 to 1981-08-13 CHECKED BY R.E.M.

SOIL PROFILE			SAMPLES			GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT (20 40 60 80 100) / SHEAR STRENGTH (○ UNCONFINED ● QUICK TRIAXIAL + FIELD VANE × LAB VANE)	PLASTIC LIMIT W_P / NATURAL MOISTURE CONTENT W / LIQUID LIMIT W_L — WATER CONTENT (%) (10 20 30)	UNIT WEIGHT γ	REMARKS & GRAIN SIZE DISTRIBUTION (%)
ELEV / DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE	'N' VALUES						GR SA SI CL
76.41											
0.0 / 75.19	Fill - mixture of silt, sand and gravel. Brown - grey.						76				
1.22 / 73.67	Fill - Gravel. Saturated below 1.52m. Dense. Brown-grey.		1	SS	48		75				
2.74 / 72.14	Gravelly sand (possibly fill). Compact. Grey.		2	SS	12		74				
4.27	Sandy silty clay. Some gravel. (Glacial Till)		3	SS	22		73				44 52 4
			4	SS	11		72				
	Reddish below 6.09m.		5	SS	11		71		o		
	Very stiff above 9m depth.		6	SS	26		70				
	Hard below 9m depth.		7	SS	27		69		o		
	Very hard below 14.63m depth.		8	SS	30		68		o		
			9	SS	45		67		o		
			10	SS	75		66		o		3 24 33 40
			11	SS	120		65		o		
57.66	Sandy gravel.		12	SS	160		64		o		
18.75	End of Borehole.						63				
							62		o		
							61		o		
							60		o		
							59				
							58				48 39 13

OFFICE REPORT ON SOIL EXPLORATION

+3, ×5 : Numbers refer to Sensitivity

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

Ministry of Transportation and Communications
Ontario

RECORD OF BOREHOLE No 202

METRIC

W P 152-75-04 LOCATION ____ ORIGINATED BY P.S.

DIST 4 HWY Q.E.W. BOREHOLE TYPE 82mm Hollow Stem Auger COMPILED BY D.W.N.

DATUM Geodetic DATE 1981-08-13 to 1981-08-14 CHECKED BY R.E.M.

SOIL PROFILE			SAMPLES			GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT (20 40 60 80 100) / SHEAR STRENGTH (○ UNCONFINED ● QUICK TRIAXIAL + FIELD VANE × LAB VANE)	PLASTIC LIMIT Wp / NATURAL MOISTURE CONTENT W / LIQUID LIMIT W_L — WATER CONTENT (%) (10 20 30)	UNIT WEIGHT γ	REMARKS & GRAIN SIZE DISTRIBUTION (%)
ELEV / DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE	'N' VALUES						GR SA SI CL
76.09											
0.0	Fill-mixture of sand, silt and clay. Traces of gravel and organics. Dark grey.		1	SS	3		75				
73.80							74				
2.29	Sandy silty clay. Trace of gravel. (Glacial till) Grey below 6.09m. Generally hard. Very stiff seam between 6.0 and 8.5m depth.		2	SS	44		73		o		
			3	SS	43		72		o		
			4	SS	18		71		o		
			5	SS	15		70		o		
	Very hard below 13.10m.		6	SS	25		69		o		1 16 33 50
			7	SS	30		68		o		
	Reddish below 13.71m.		8	SS	40		67		o		
			9	SS	100		66		o		
			10	SS	50/75mm		65		o		
			11	SS	50/75mm		64		o		
59.25							63		o		
16.84	End of Borehole						62		o		
							61		o		
							60				
							59				

OFFICE REPORT ON SOIL EXPLORATION

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

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

Ministry of Transportation and Communications
Ontario

OFFICE REPORT ON SOIL EXPLORATION

RECORD OF BOREHOLE No 203

METRIC

W P 152-75-04 LOCATION
DIST 4 HWY Q.E.W. BOREHOLE TYPE 82mm Hollow Stem Auger & Cone Test
DATUM Geodetic DATE 1981-08-18 to 1981-08-19

ORIGINATED BY D.B.
COMPILED BY D.B.
CHECKED BY R.E.M.

SOIL PROFILE			SAMPLES			GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT (20 40 60 80 100) / SHEAR STRENGTH (○ UNCONFINED ● QUICK TRIAXIAL + FIELD VANE × LAB VANE)	PLASTIC LIMIT Wp / NATURAL MOISTURE CONTENT W / LIQUID LIMIT WL / WATER CONTENT (%) (10 20 30)	UNIT WEIGHT γ	REMARKS & GRAIN SIZE DISTRIBUTION (%) GR SA SI CL
ELEV / DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE	'N' VALUES						
76.08											
0.0	Fill - Silty clay, traces of gravel. Light brown.						76				
74.40							75				
1.68	Fill - Lenses of organic silt and clayey silt.		1	S/S	3		74				
73.03							73		o		
3.05	Clayey silt, traces of sand and gravel. Fissured, hard. Mottled brown-grey.		2	S/S	29		72				
70.9			3	S/S	42		71		o		
5.18	Silty clay, traces of sand and gravel. (Glacial Till) Very stiff to hard. Reddish grey to grey.		4	S/S	28		70		o		
			5	S/S	28		69				
			6	S/S	22		68		o		
			7	S/S	22		67		o		
			8	S/S	24		66		o		
			9	S/S	47		65		o		
60.54							64		o		
15.54	Sandy gravel, trace to some silt. Very dense. Grey.		10	S/S	92		63		o		
58.86			11	S/S	93		62		o		
17.22	End of Borehole						61				
							60				
							59				
							58				

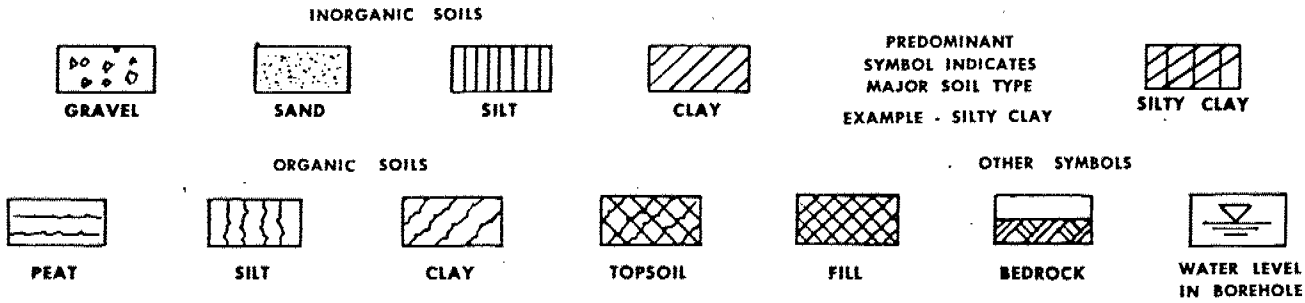
+3, ×5 : Numbers refer to Sensitivity

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

EXPLANATION OF SYMBOLS AND TEST DATA

SOIL DESCRIPTION

A description of visible characteristics of the soil as determined in the field and altered, if necessary, on the basis of laboratory classification tests.



SAMPLES

Condition:

Type:

D.S. - 1⅜" ID Drive Sample
A.S. - Auger Sample
U - Thin-walled Tube Sample
UP - Piston Sample

PENETRATION RESISTANCE:

(N) Indicates number of blows, of a 140-lb. hammer falling 30 inches, required to drive a 2" OD Drive Sampler a distance of 1 foot into the soil. This resistance is used to assess the relative density of cohesionless soils and the relative consistency of cohesive soils.

OTHER TESTS

M - Grain size analysis using seives or hydrometer or both - plotted graphically on a separate sheet.

V_1 - laboratory vane tests.

γ_d - dry unit weight.

C - consolidation test - results on separate sheet.

T - triaxial compression test - results on a separate sheet.

P - proctor compaction test.

K - laboratory permeability test.

SOILS PROFILES:

Where soil profiles are shown on drawings the soil profile applies only to the borehole location and may be different at intermediate locations on the site.

GROUND WATER:

Ground Water levels are generally measured in the open boreholes and apply to conditions at the time of drilling. Seasonal ground water fluctuations should be expected at most sites.

METRIC

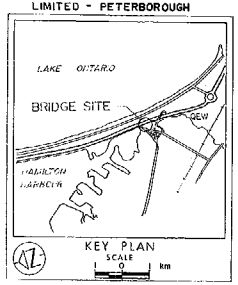
DIMENSIONS ARE IN METRES AND/OR MILLIMETRES UNLESS OTHERWISE SHOWN.
STATIONS ARE IN KILOMETRES & METRES.

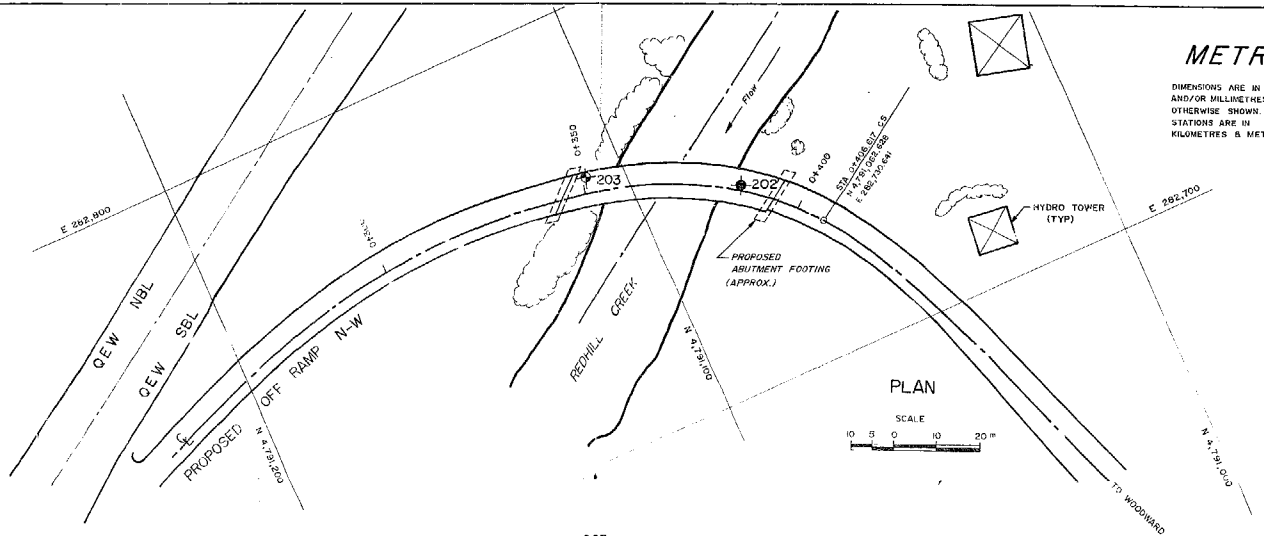
CONT No
WP No 152-75-07

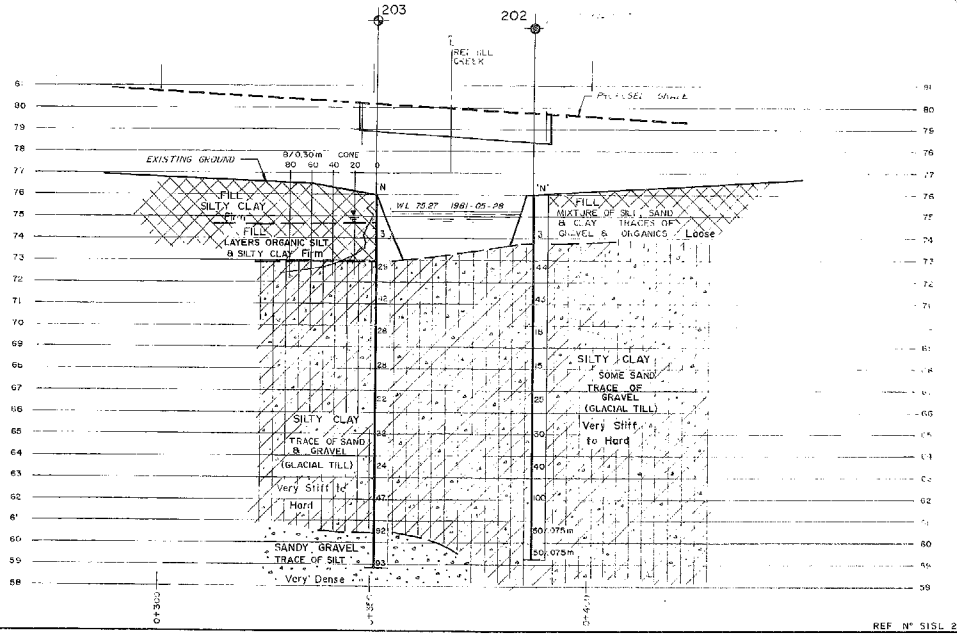
REDHILL CREEK STRUCTURE
Queen Elizabeth Way Highway - Hamilton
BORE HOLE LOCATIONS & SOIL STRATA

SHEET

SITE INVESTIGATION SERVICES
LIMITED - PETERBOROUGH







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)
- WL at time of investigation

No	ELEVATION	CO-ORDINATES NORTH	CO-ORDINATES EAST
202	78.05	4 791 077	282 745
203	78.06	4 791 109	282 762

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

REVISIONS		
DATE	BY	DESCRIPTION

Geocres No 30M5-134

HWY No QEW			DIST 4
SUBMD	CHECKED	DATE SEPT 1981	SITE 38-1336-271
DRAWN KV	CHECKED KP	APPROVED [illegible]	DWG 152T507-A

REF N° SISL 2573 AUG 1981