ENGINEERING MATERIALS OFFICE
FOUNDATION DESIGN SECTION

WP 223-87-02 DIST 4

HWY Q.E.W. STR SITE 10-160

Oakville Creek Bridge Widening

DISTRIBUTION

G.C.E. Burkhardt (3)
R.D. Gunter
A. Wittenberg
J. Smrcka (2)
K. Bassi
J.H. Peer
T. Yakutchuk
G. Szekreny
B. Steeves (Cover Only)
M. MacLean (Cover Only)
File

GEOCRES 30M5-158

DATE DEC 1 1 1987

FOUNDATION INVESTIGATION REPORT

For

Oakville Creek Bridge Widening

Queen Elizabeth Way

WP 223-87-02, Site No. 10-160

District 4, Burlington

INTRODUCTION

This report contains the results of a foundation investigation carried out at the aforementioned site for the proposed bridge widening. The fieldwork was conducted during the period from 87-07-13 to 87-08-17. It consisted of fifteen sampled boreholes with dynamic cone penetration tests. Two boreholes with rock coring were advanced at each of the abutments and at four of the six pier locations in the vicinity of the proposed structure widenings. Two boreholes with sampling only were advanced at the west approach. At Pier 1 only one borehole with coring was advanced, and at Pier 2 no borings were conducted because of its inaccessibility. A skid-mounted diamond drill equipped with BW-sized casing and both track-mounted and truck-mounted auger machines equipped with solid stem augers and BW-sized casing were utilized at this location.

An investigation to determine the elevation of the base of the footings at the abutment and piers of the bridge was conducted in August 1958 by Trow, Soderman and Associates. Their findings have been taken into account.

In addition to the results of the field investigation, this report contains recommendations for the design and construction of the proposed widening of the bridge and approaches.

Site Description

The site is located on the Queen Elizabeth Way at the Oakville Creek, also known as Sixteen Mile Creek, in Oakville, between Trafalgar Road and Kerr St.

The existing structure crossing the Oakville Creek Valley at this site is approximately 187.0 m in length and stands some 22.0 m above the valley floor. The creek itself, at the time of the investigation, was only 7.5 m in width and approximately 0.5 m deep. The creek meanders along the steeply sloped valley and flow is constant except when heavy rains are experienced.

The forward slopes of the approaches to the existing structure exhibit considerable surface erosion mainly due to inadequate drainage. The valley slopes rise on both sides of the creek to heights of 22.0 m to 23.0 m above the creek bed. The terrain adjacent to the valley is flat to gently undulating.

Land use in the vicinity of the site is primarily commercial and industrial. Physiographically, the site is located on a shale plain in the region known as the Iroquois Plain.

SUBSURFACE CONDITIONS

General

The overburden at the boring locations ranges in depth from 0.9 m to 6.8 m . The subsoil consists largely of hard silty clay. It appears in eleven of the fifteen boreholes and is encountered as the surficial deposit in ten of these. There are two types of silty clay present across the area and these are distinguished by their colour and consistency. The more abundant silty clay material is the upper stratum and is red brown and the other is a grey coloured deposit. Both of these deposits appear to have been derived from the underlying bedrock due to glacial action. Granular material varying in composition from sand to gravel to sand to silty sand was found in five of the boreholes. At three of the boring locations the non-cohesive material appears as the surficial deposit varying in thickness from 0.9 m to 4.0 m. In BH 14, sand was found to extend to bedrock.

Bedrock consists of shale and siltstone beds of the Queenston Formation overlying shale with interbedded limestone of the Georgian Bay Formation. At the locations of the borings the bedrock was found to be weathered to depths ranging from 1.0 m to 7.0 m.

The boundaries of the different strata, together with the field and laboratory test results appear on the Record of Borehole sheets appended to this report. Refer to these sheets for the locations and elevations of the boreholes. An estimated stratigraphical profile is shown on Dwg. No. 2238702-A. A description of the different strata is given below.

Silty Clay and Silt to Silty Clay - Red Brown

A cohesive stratum of silty clay, red brown in colour, was encountered in eleven of the fifteen boreholes. It is probably derived from shale of the Queenston Formation and reworked by glacial action. It occurs as the surficial deposit in boreholes advanced at the west approach and at Piers 3, 4, 5 and 6, and beneath the granular deposit on the north side of Pier 1. The material contains varying proportions of sand and gravel and occasional shale and limestone cobbles and boulders. Traces of organic material are present in many of these boreholes near the ground surface. The thickness varies from 1.5 m to 6.8 m . The consistency of the silty clay ranges from soft to hard and it exhibits low to medium plasticity as shown in Figure 1, Plasticity Chart. The 'N' values obtained range from 3 to blows in excess of 120 per 30 cm. The following physical properties were obtained from field and laboratory testing:

		Range
Natural Moisture Content	(%)	11 - 22
Liquid Limit	(%)	22 - 38
Plastic Limit	(%)	16 - 20
Unit Weight	(kN/m^3)	19.6 - 21.4

Refer to Figure 2 for the grain size distribution of the silty clay deposit in an envelope form.

Sand and Sand to Silty Sand

Intermittent granular deposits were encountered across the site. This material is likely backfill material placed during the widening of the structure in 1959. Sand and sand to silty sand material was present in BH's 8, 13, 14 and 15. These deposits range in thickness from 0.9 m to 4.0 m and occur as surficial deposits. They contain some to with gravel, and traces of clay and organics. Occasional silty clay zones and cobbles occur within the granular material. The 'N' values obtained from standard penetration testing range from 4 blows to in excess of 120 blows per 30 cm reflecting a material

that is loose to very dense. Laboratory testing performed on the sand and sand to silty sand material yielded natural moisture contents varying from 6.5% to 10.5%.

Sand and Gravel

Sand and gravel was encountered in BH's 9 and 12 and is probably also fill material placed during the 1959 widening. It occurs as the surficial deposit in BH 9 and was present below the red brown silty clay deposit in BH 12. The thickness of the material varies from 1.8 m in BH 12 to 2.1 m in BH 9 and contains some silt, trace clay, traces of organic material and occasional silty clay zones. 'N' values range from 10 to blows in excess of 120 per 30 cm reflecting a material that is compact to very dense. Natural moisture contents ranging from 6.5% to 9.5% were obtained from laboratory testing. A grain size distribution envelope for this material is sketched in Figure 3.

Silty Clay (Glacial Till)

A deposit of grey silty clay ranging in thickness from 0.7 m to 1.9 m was encountered directly overlying bedrock in BH's 1, 2, and 9. It appears to be derived from the bedrock of the Georgian Bay Formation. It is present beneath the red brown silty clay deposit in BH's 1 and 2 and beneath the sand and gravel deposit in BH 9. The material is composed of silty clay containing varying proportions and sizes of shale fragments. Traces of organic matter were found in BH 2. The silty clay stratum is hard throughout and it exhibits low to medium plasticity. 'N' values obtained for this deposit range from 30 to 79. The following physical properties were obtained from field and laboratory testing:

		Range
Natural Moisture Content	(%)	11 - 21
Liquid Limit	(%)	23 - 42
Plastic Limit	(%)	15 - 22
Unit Weight	(kN/m^3)	21.0

Refer to Figure 4 for the grain size distribution of the silty clay deposit.

Bedrock

Bedrock was found to consist of shale and siltstone beds of the Queenston Formation and shale with interbedded limestone of the Georgian Bay Formation. The upper portion of the bedrock to depths ranging from 1.0 m to 7.0 m below the bedrock surface was found to be weathered to varying degrees ranging randomly from slightly weathered to extensively weathered. It was possible to penetrate most of the weathered rock by washboring methods and most of the bedrock samples were obtained by means of split spoon samplers, for which the N values range from 19 to more than 120 blows per 30 cm. Overall, the weathered rock is extensively fractured, is relatively permeable and thus would be likely to contain numerous water-bearing zones. Below the weathered zone the bedrock is generally intact and relatively impermeable.

Descriptions of the rock core recovered during the investigation have been made by S. A. Senior Geologist, Soils and Aggregate Section, and are appended to this report.

Groundwater Conditions

The following water level elevations were observed at the borehole locations:

Borehole	Elevation
1	91.1m
2	Not observed
3	87.6m
4	86.4m
5	86.5m
6	100.4m
7	100.5m
8	105.8m
9	107.4m

Borehole	Elevation
10	107.8m
11	88.8m
12	Not observed
13	98.8m (estimated)
14	99.7m (estimated)
15	105.9m

The water level in the creek at the time of the investigation was El 86.3m. No artesian groundwater conditions were encountered.

DISCUSSION AND RECOMMENDATIONS

It is proposed to widen the existing 7-span bridge by 4.7m on each side. The original structure was constructed in 1936 and subsequently widened in 1959. It extends across the Oakville Creek Valley for a total length of 187.7m. Forward slopes vary across the site from 2H:1V and flatter to slopes that incline as steeply as 1H:1V. Foundation support is provided by spread footings founded on bedrock.

Structure Foundations

Because of the close proximity of bedrock encountered in each of the boreholes and the nature of the structure and its existing foundations it is recommended that foundation support be provided by spread footings on bedrock. The elevations of the footing bases for the existing abutments and piers are listed below, together with the base of footing elevations recommended for the proposed new widenings.

		1959 Widening Existing Footing Base Elevation	New Widening Recommended Footing Base Elevation
EAST ABUTMENT	North	101.6 m	101.6 m
	South	101.6 m	101.6 m
Pier 1	North	95.8 m	95.8 m
	South	95.8 m	94.8 m
Pier 2	North	83.5 m	83.5 m
	South	83.5 m	83.5 m
Pier 3	North	81.7 m	80.7 m
	South	81.7 m	81.7 m

Pier 1 South

Why 94.8

should it be

95.8

Pier 3 North

80.7 ??

West Abutment

99.4

		1959 Widening Existing Footing Base Elevation	New Widening Recommended Footing Base Elevation
Pier 4	North	84.6 m	84.6 m
	South	84.6 m	84.6 m
Pier 5	North	91.3 m	91.3 m
	South	92.0 m	92.0 m
Pier 6	North	98.4 m	98.4 m
	South	98.4 m	98.4 m
WEST ABUTMENT	North	100.8 m	99.4 m
	South	100.8 m	100.8 m

All of the 1959 widenings appear to be founded on weathered shale bedrock which has nevertheless provided a satisfactory foundation. To avoid excavating below these footings, where possible, the same footing elevations have been recommended for the new widenings. However three of the new footing widenings, if placed at the same elevations as the existing footings, would be founded on unsatisfactory material. As a result the footing elevations at these locations, namely the West Abutment and Piers 1 & 3, have been lowered accordingly by about one metre. Although all of the new footings will be placed on weathered shale bedrock, a satisfactory foundation should be achieved.

In accordance with the O.H.B.D.C., the following design values are recommended for spread footings founded on weathered shale bedrock:

Factored Bearing Capacity at U.L.S.	1000 kPa
Bearing Capacity at S.L.S. Type II	Not Applicable

Footing resistance to sliding may be computed assuming a coefficient of friction equal to tan 25°. If further resistance is required a suitable key should be constructed along the centre of the footing in which event a safe resisting pressure of 0.8 MPa should be achieved on the vertical side of the key.

The exposed footing bases should be covered with a 15cm thick mass concrete pad within eight hours of exposure to prevent possible weathering of the shale bedrock.

The concrete for the footings should be placed 'in the dry'.

The frost protection required in this area is a minimum of 1.2 m of earth cover.

Lateral Earth Pressure

Backfill to the structure should consist of granular material as designated in the MTC SPP #121 (83 10). Earth pressure should be computed as per Subsection 6.6.1.2.2 of the O.H.B.D.C.. An 'at rest' condition may be assumed to apply.

The physical properties of the backfill are as follows:

	ϕ	γ
Granular 'A'	35°	22.3 kN/m^3
Granular 'B'	30°	21.2 kN/m^3

Dewatering

As mentioned previously, the weathered bedrock is relatively permeable and groundwater levels should be monitored during construction. The East Abutment, Piers 1, 5 and 6 and the West Abutment are located well above the creek level, and as a result, unwatering should not pose a problem. The footings at Piers 2, 3 and 4 will be located well below the creek level and will be subjected to a 5 m head of water or greater. Due to the weathered and permeable nature of the bedrock earlier described, a dewatering scheme at each of these pier widenings will be necessary.

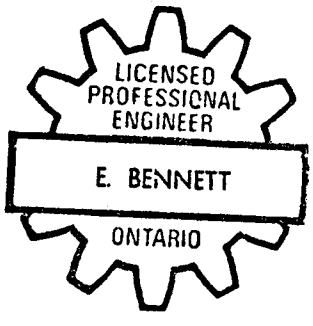
Furthermore, because of the permeability of the foundation material, a special provision should be included in the contract advising bidders of this fact.

Slope Stability

All forward slopes to the structure should be regraded so as not to be steeper than 2H:1V. In addition, all erosion gullies should be filled and suitable drainage provided to ensure adequate protection against further surface erosion by runoff water. Additional erosion protection should be provided in accordance with hydrological requirements.

MISCELLANEOUS

The fieldwork for this foundation investigation was carried out by B. Bennett, Jr. Foundation Engineer. The drilling equipment was owned and operated by Master Soil Investigation Limited. The report was written by Mrs. B. Bennett and approved by Mr. K.G. Selby, Chief Foundation Engineer.



B Bennett

B. Bennett, P.Eng.
Jr. Foundation Engineer

K. G. Selby

K.G. Selby, P.Eng.
Chief Foundation Engineer (West)

APPENDIX

EXPLANATION OF TERMS USED IN REPORT

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

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

SOILS ARE DESCRIBED BY THEIR COMPOSITION AND CONSISTENCY OR DENSENESS.

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

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

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

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

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

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

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

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

JOINTING AND BEDDING:

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

ABBREVIATIONS AND SYMBOLS

FIELD SAMPLING

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

STRESS AND STRAIN

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

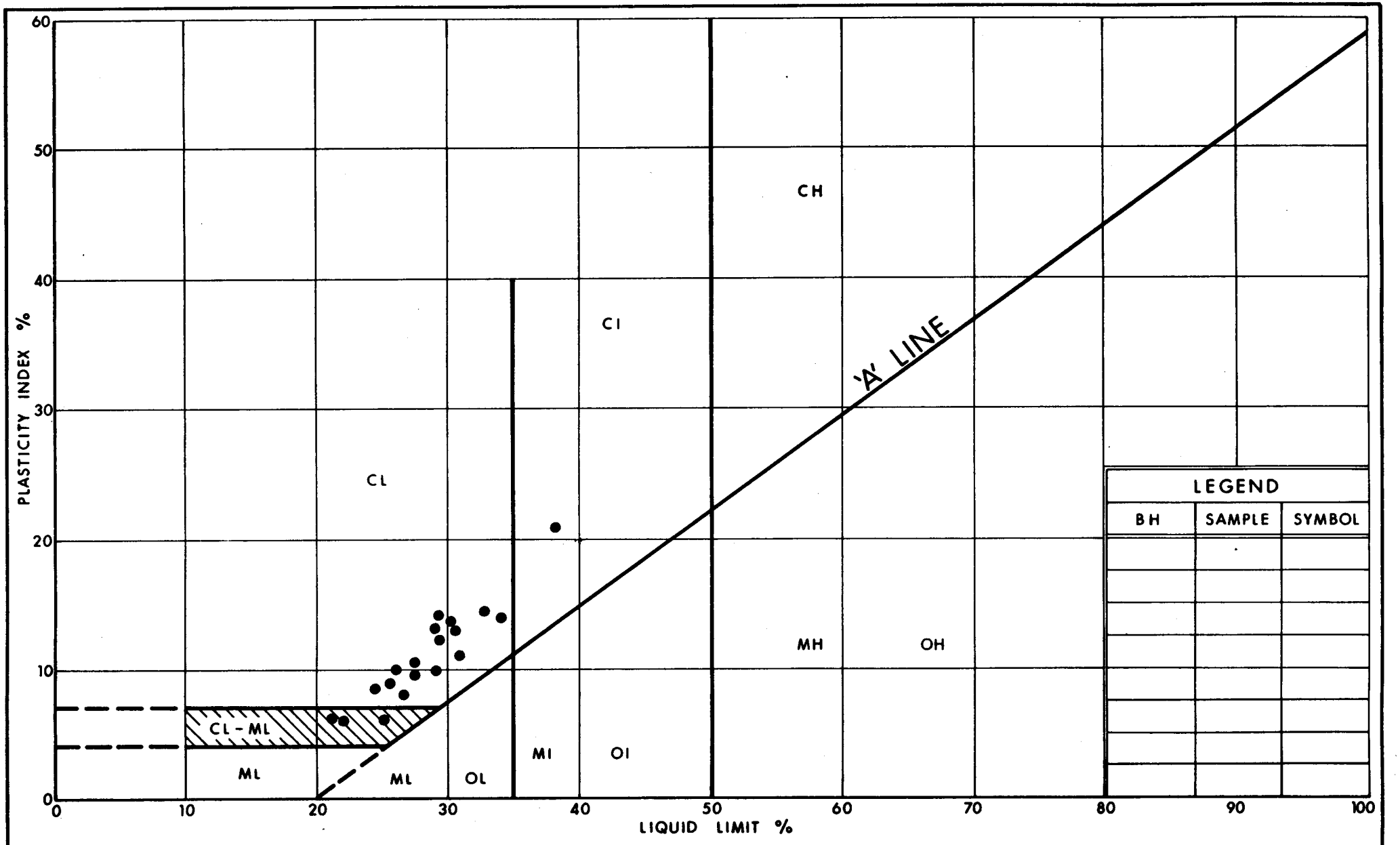
MECHANICAL PROPERTIES OF SOIL

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

PHYSICAL PROPERTIES OF SOIL

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

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

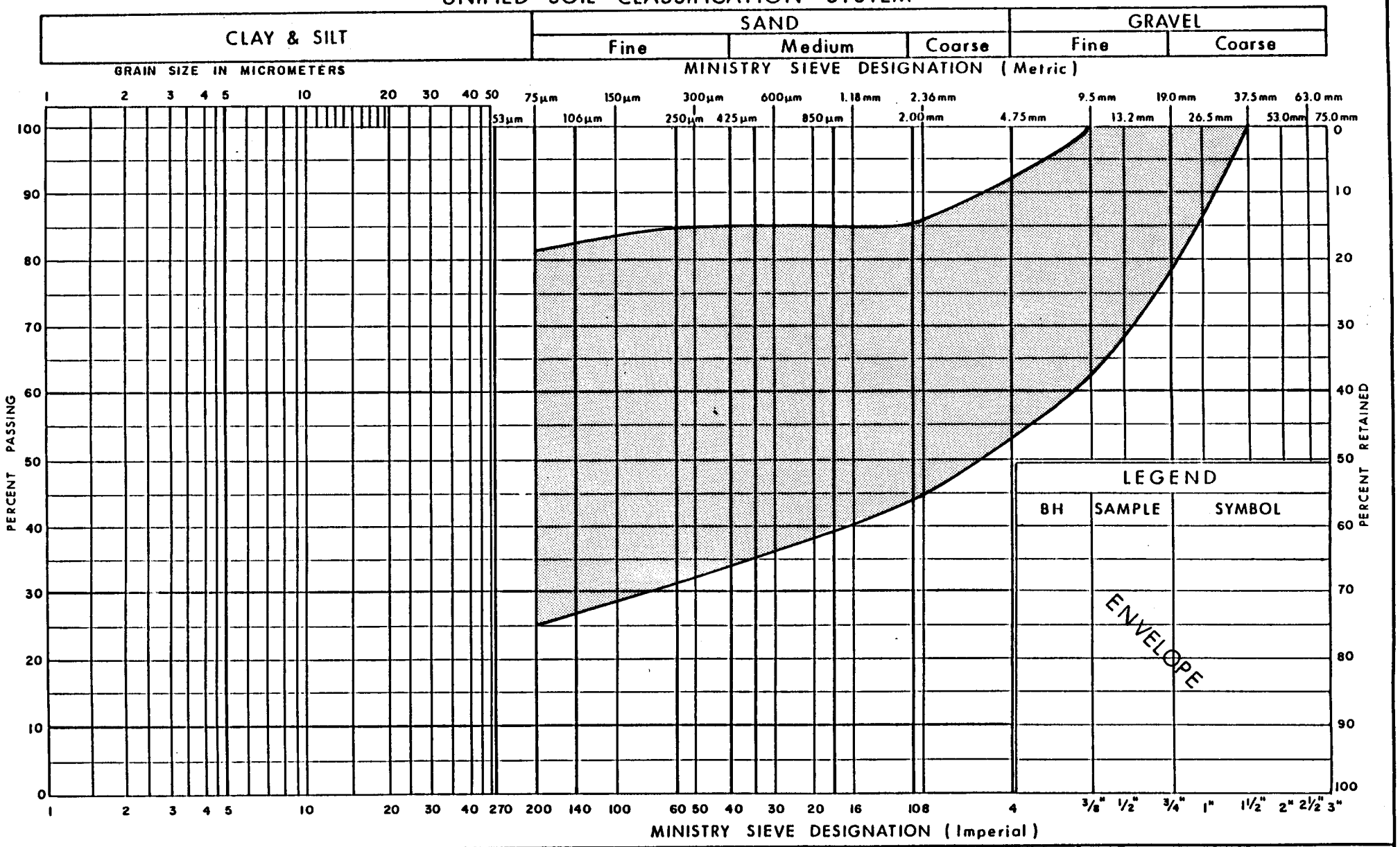


Ministry of Transportation and Communications
Ontario

PLASTICITY CHART
SILTY CLAY - RED BROWN

FIG No 1
WP 223-87-02

UNIFIED SOIL CLASSIFICATION SYSTEM

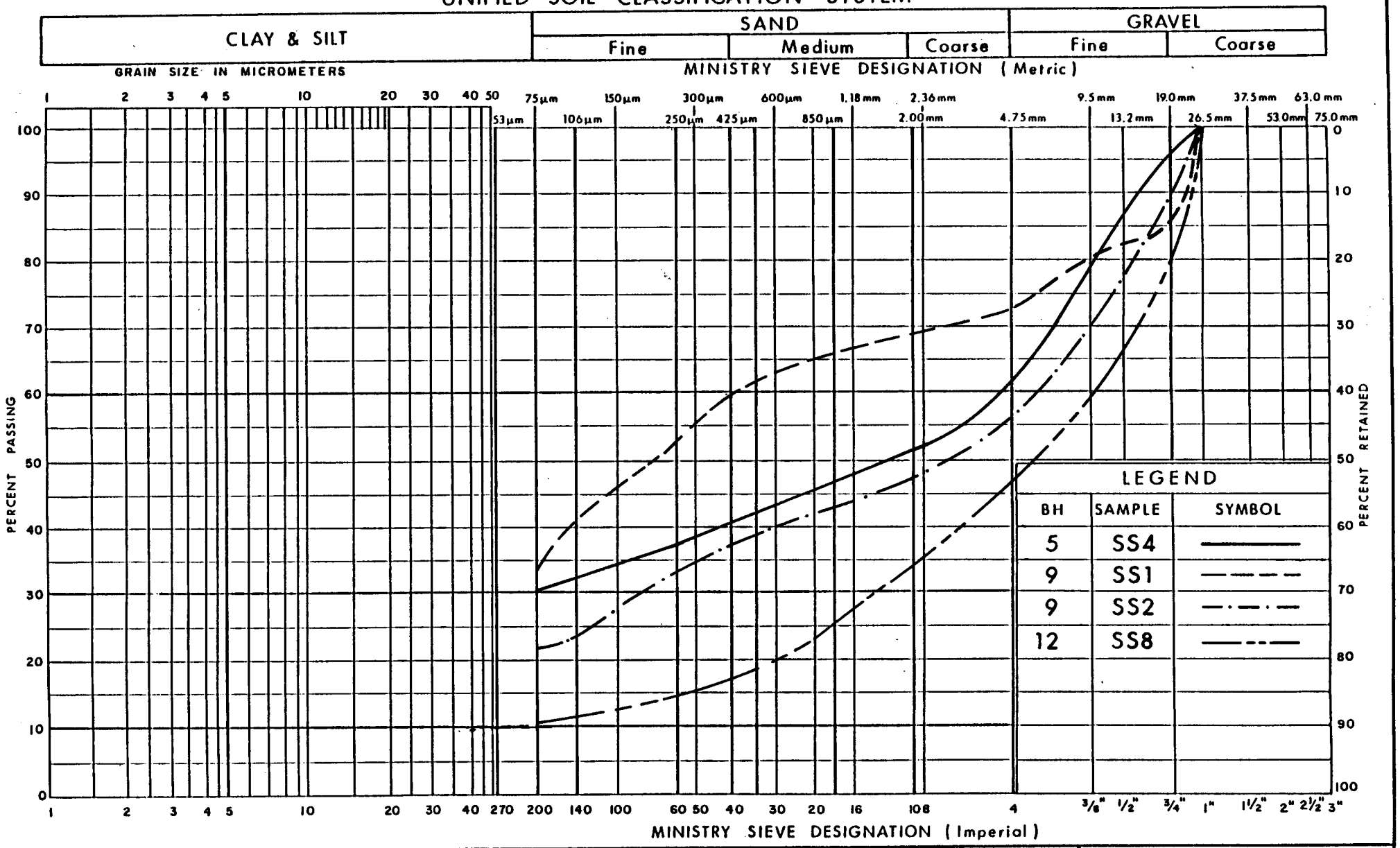


Ministry of Transportation and Communications
Ontario

GRAIN SIZE DISTRIBUTION
SILTY CLAY - RED BROWN

FIG No 2
W P 223-87-02

UNIFIED SOIL CLASSIFICATION SYSTEM

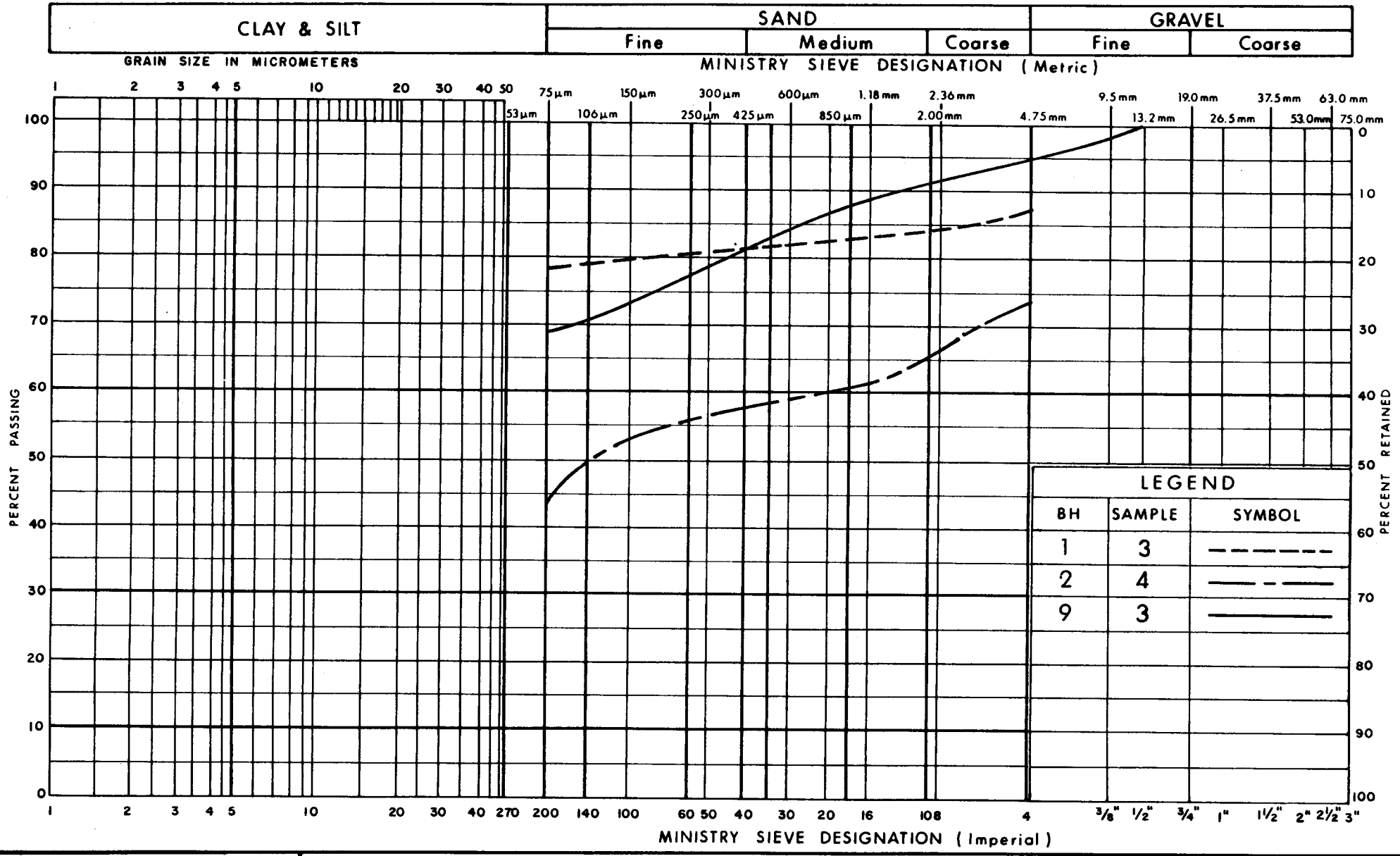


Ministry of Transportation and Communications
Ontario

GRAIN SIZE DISTRIBUTION
SAND & GRAVEL
SOME SILT, TRACE CLAY Loose to Very Dense

FIG No 3
W P 223-87-02

UNIFIED SOIL CLASSIFICATION SYSTEM



Ministry of Transportation
Ontario

GRAIN SIZE DISTRIBUTION
SILTY CLAY - Glacial Till

FIG No 4
WP 223-87-02

DESCRIPTION OF ROCK CORE - WP 223-87-02

	CORE RECOVERY			CORE DESCRIPTION	
HOLE #	DEPTH (m)	%CR*	%RQD*	DEPTH (m)	DESCRIPTION
1	4.70- 4.93	78	0	4.70- 9.17	**SHALE**, medium grey; very fine grained; very thinly laminated; very weak to extremely weak rock; slightly to moderately weathered, extremely close spaced fractures; interbedded with **LIMESTONE** (27%), light brown to greyish brown; fine to medium grained; medium strong to weak rock; slightly weathered to unweathered.
	4.93- 5.00	100	0		
	5.00- 5.13	80	0		
	5.13- 5.33	not cored			
	5.31- 6.32	59	0		
	5.99- 6.25	re-cored			
	6.20- 6.83	52	20		
	6.83- 7.65	72	0		
	7.65- 7.95	58	0		
	7.95- 9.17	25	0		
2	6.71- 8.18	67	0		**SHALE**, medium to dark grey; very fine grained; very thinly laminated; very weak rock; slightly weathered to unweathered; extremely close spaced fractures; interbedded with **LIMESTONE** (32%), brownish grey to grey medium grained; medium strong to weak rock; slightly weathered to unweathered.
	8.18- 9.53	87	8		

*CR = CORE RECOVERY
RQD = ROCK QUALITY DESIGNATION

DESCRIPTION OF ROCK CORE - WP 223-87-02

	CORE RECOVERY			CORE DESCRIPTION	
HOLE #	DEPTH (m)	%CR*	%RQD*	DEPTH (m)	DESCRIPTION
3	6.71- 7.92 7.92- 8.15 8.15- 8.46	42 56 0	0 0 0	6.71- 8.15	**SHALE**, dark grey; very fine grained; very thinly laminated; very weak rock; moderately weathered to slightly weathered; very close to extremely close spaced fractures; interbedded with **LIMESTONE** (28%), medium to light grey; medium to fine grained; medium strong to weak rock; slightly weathered to unweathered.
4	6.83- 8.23	84	19	6.83- 8.23	**SHALE**, medium to dark grey; very fine grained; very thinly laminated; very weak rock; slightly weathered to unweathered; very close to extremely close spaced fractures; interbedded with **LIMESTONE** (22%); brownish grey; medium grained; beds up to 20 cm; medium strong to weak rock; unweathered to slightly weathered; closely spaced fractures.
5	6.05- 7.62 7.62- 9.19	48 76	0 18	6.05- 9.19	**SHALE**, dark grey; very fine grained; very thinly laminated; very weak to extremely weak rock; moderately weathered to slightly weathered; very close to extremely close spaced fractures; interbedded with **LIMESTONE** (29%), grey; medium grained; thinly bedded; medium strong to weak rock; slightly weathered to unweathered; moderately close spaced to close spaced fractures.

*CR = CORE RECOVERY
*RQD = ROCK QUALITY DESIGNATION

2../3

DESCRIPTION OF ROCK CORE - WP 223-87-02

	CORE RECOVERY			CORE DESCRIPTION	
HOLE #	DEPTH (m)	%CR*	%RQD*	DEPTH (m)	DESCRIPTION
6	3.86- 5.41 5.41- 6.96	80 97	0 18	3.86- 6.96	**SHALE**, red-brown with interbanded with dark grey; very fine grained; very thinly laminated; very weak to extremely weak rock; slightly weathered to moderately weathered, highly weathered zone @ 5.08-5.33 m; very close to extremely close spaced fractures; interbedded with **LIMESTONE** (12%), brown red to medium grey; medium grained; medium bedded; medium strong rock; slightly weathered to unweathered; closely spaced fractures.

*CR = CORE RECOVERY
*RQD = ROCK QUALITY DESIGNATION

DESCRIPTION OF ROCK CORE - WP 223-87-02

CORE RECOVERY				CORE DESCRIPTION	
HOLE #	DEPTH (m)	%CR*	%RQD*	DEPTH (m)	DESCRIPTION
7	3.76- 5.44	85	6	3.76- 5.49	**SHALE**, interbedded red and green; very fine grained; very weak rock; slightly weathered; very close to extremely close spaced fractures.
	5.44- 6.12	89	0		
	6.12- 6.76	60	0	5.49- 9.19	SHALE, medium to dark grey; very fine grained; very weak to extremely weak rock; slightly to moderately weathered; very close to extremely close spaced fractures; interbedded with **LIMESTONE** (13%), light to brownish grey; fine to medium grained; medium strong to weak rock; slightly weathered to unweathered.
	6.76- 8.38	94	0		
	8.38- 9.19	91	13		
8	6.60- 7.98	85	7	6.60- 7.39	**SHALE**, red, with interbedded green **SILTSTONE** (39%); fine to very fine grained; weak to very weak rock; slightly weathered to unweathered; very close to extremely close spaced fractures.
				7.39- 7.59	**LIMESTONE**, reddish grey; medium grained; medium strong to weak rock; slightly weathered to unweathered; very close to extremely close spaced fractures.
				7.59- 7.98	**SHALE**, red; fine grained; weak to very weak rock; slightly weathered to unweathered; very close to extremely close spaced fractures.

*CR = CORE RECOVERY
*RQD = ROCK QUALITY DESIGNATION

DESCRIPTION OF ROCK CORE - WP 223-87-02

	CORE RECOVERY			CORE DESCRIPTION	
HOLE #	DEPTH (m)	%CR*	%RQD*	DEPTH (m)	DESCRIPTION
9	6.86- 7.82	84	16	6.86- 8.08	**SILTSTONE**, greyish green; medium to fine grained; **weak** rock; slightly weathered to unweathered; closely spaced fractures, extremely close spaced fractures from 7.82-7.98 m; interbedded with red SHALE (27%) as below.
	7.82- 7.98	83	0		
	7.98- 8.55	82	18		
	8.55-10.08	95	43	8.08- 9.45	**SHALE**, red to dark brownish red; very fine grained; weak to very weak rock; slightly weathered to unweathered, extremely weathered zone from 8.38-8.53 m; close to very closely spaced fractures; interbedded with **SILTSTONE** (4%).
				9.45-10.08	**SHALE**, dark grey to black; very fine grained; weak to very weak rock; slightly weathered to unweathered; closely spaced fractures; interbedded with red **SHALE** (40%).
11	2.95- 4.42	48	10	2.95- 3.40	**LIMESTONE**, grey brown, spotted white; medium to fine grained; medium strong rock; slightly weathered to unweathered; closely spaced fractures.
	4.42- 5.97	69	0		
	5.97- 7.49	80	8	3.40- 6.91	**SHALE**, medium to dark grey; very fine grained; very weak to extremely weak rock; slightly weathered to moderately weathered, completely weathered from 3.43-4.42 m, extremely weathered from 5.49-5.97 m; very close to extremely close spaced fractures.
				6.91- 7.49	**LIMESTONE**, medium grey; fine grained; medium strong rock; unweathered; very close to closely spaced fractures; interbedd with grey **SHALE** (9%) as above.

*CR = CORE RECOVERY
*RQD = ROCK QUALITY DESIGNATION

DESCRIPTION OF ROCK CORE - WP 223-87-02

	CORE RECOVERY			CORE DESCRIPTION	
HOLE #	DEPTH (m)	%CR*	%RQD*	DEPTH (m)	DESCRIPTION
13	6.71- 8.23 8.23- 9.70	67 59	0 0	6.71- 9.70	**SHALE**, medium to dark grey, very fine grained; weak to very weak rock; slightly weathered to moderately weathered, extremely weathered form 7.21-8.05 m; very close to extremely close spaced fractures; interbedded with **LIMESTONE** (15%), greyish brown, spotted white; medium to fine grained; medium strong rock; slightly weathered to unweathered; closely spaced fractures.
14 5.	3.66- 5.18 8- 6.71	50 93	0 9	3.66- 6.71	**SHALE**, medium brown red, with interbedded dark grey (15%); fine to very fine grained; weak to extremely weak rock; slightly to moderately weathered; highly weathered from 5.51-5.56 m, clay seam from 5.64-5.74 m; close to extremely spaced fractures; minor **LIMESTONE** from 5.74-5.87 m.
15	6.10- 7.62	88	0	6.10- 7.62	**SHALE**, medium brown red; interbanded grey-green (15%); very fine grained; weak to very weak rock; slightly weathered; very close to extremely close spaced fractures.

*CR = CORE RECOVERY
*RQD = ROCK QUALITY DESIGNATION

Ministry of Transportation and Communications
Ontario

RECORD OF BOREHOLE No 1 METRIC

W P 223-87-02 LOCATION Pier #5; N 4 812 187.7, E 289 065.0 ORIGINATED BY BB
DIST 4 HWY Q.E.W. BOREHOLE TYPE Washbore, BW Casing, BQ Rock Core COMPILED BY BB
DATUM Geodetic DATE 87 07 13 - 16 CHECKED BY DT

ELEV / DEPTH	DESCRIPTION	NUMBER	TYPE	'N' VALUES	GROUND WATER CONDITIONS	UNIT WEIGHT γ kN/m³	REMARKS & GRAIN SIZE DISTRIBUTION (%) GR SA SI CL
97.1	Ground Surface						
0.0	Silty Clay (Red Brown) with Sand Some Gravel Firm to Very Stiff	1	SS	7			
		2	SS	20		19.6	17 31 (52)
95.6							
1.5	Silty Clay Trace Organics Some Shale Fragments Hard (Glacial Till)	3	SS	79			13 9 (78)
94.6							
2.5	Bedrock	4	SS	60/15 cm			
		5	SS	60/13 cm		20.8	1 4 (95)
		6	SS	60/10 cm			
	Weathered	7	SS	60/5 cm			
	Unweathered	8	RC	78% Rec			
		9	RC	100% Rec			
		10	RC	80% Rec			
	Shale Interbedded with Limestone	11	RC	59% REC			
		12	RC	52% REC			
		13	RC	72% Rec			
		14	RC	58% Rec			
		15	RC	25% REC			
87.9							
9.2	End of Borehole						

ELEVATION SCALE: 97, 96, 95, 94, 93, 92, 91, 90, 89, 88

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 (%) 10 20 30

+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 2 METRIC

W P 223-87-02 LOCATION Pier #5; N 4 812 209.4, E 289 037.7 ORIGINATED BY BB
DIST 4 HWY Q.E.W. BOREHOLE TYPE Washbore, BW Casing, BQ Rock Core COMPILED BY BB
DATUM Geodetic DATE 87 08 20 - 21 CHECKED BY DT

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 kN/m³	REMARKS & GRAIN SIZE DISTRIBUTION (%) GR SA SI CL
97.3	Ground Surface										
0.0	Trace Organics		1	SS	4	*	97				
	Silt to Silty Clay (Red Brown) with Sand trace/some gravel		2	SS	18					21.4	2 30 (68)
95.2	Soft to Very Stiff		3	SS	8		96				
2.1	Silty Clay With Shale Fragments Hard		4	SS	39		95			21.0	27 30 (43)
94.5	(Glacial Till)										
2.8	Bedrock		5	SS	60/4 cm		94				
			6	SS	60/0 cm						
			7	SS	60/8 cm		93				5 15 (80)
			8	SS	114/25 cm						
			9	SS	60/13 cm		92				4 18 (78)
	Weathered / Unweathered		10	SS	60/5 cm		91				
			11	RC	67% REC		90				
	Shale Interbedded with Limestone						89				
			12	RC	87% REC						
87.8							88				
9.5	End of Borehole										

* Groundwater Level Not Observed

+3, ×5 : Numbers refer to Sensitivity

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

OFFICE REPORT ON SOIL EXPLORATION

Ministry of Transportation and Communications
Ontario

RECORD OF BOREHOLE No 3 METRIC

W P 223-87-02 LOCATION Pier #4; N 4 812 223.7, E 289 048.3 ORIGINATED BY BB
DIST 4 HWY QEW BOREHOLE TYPE Washbore, BW Casing, BQ Rock Core COMPILED BY BB
DATUM Geodetic DATE 87 07 22-23 CHECKED BY

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 kN/m³	REMARKS & GRAIN SIZE DISTRIBUTION (%) GR SA SI CL
91.3	Ground Surface										
0.0	Trace Organics		1	SS	14		91				
			2	SS	25				○	21.2	17 32 (51)
	Silty Clay (Red Brown) with Sand										
	some Gravel		3	SS	24		90				
	Occasional Boulders		4	SS	14		89				
	Stiff to Very Stiff		5	SS	25	▽	88		○		21 38 (41)
			6	SS	11						
86.5			7	SS	60/5 cm		87				
4.8	Bedrock		8	SS	70/15 cm		86				
			9	SS	60/ 5 cm				○		16 31 (53)
			10	SS	60/ 6 cm		85				
	Weathered / Unweathered		11	SS	60/ 5 cm						
	Bedrock Shale Interbedded with Limestone		12	RC	42% REC		84				
			13	RC	56% REC						
82.8			14	RC	0% REC		83				
8.5	End of Borehole										

+3, ×5 : Numbers refer to Sensitivity

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

OFFICE REPORT ON SOIL EXPLORATION

Ministry of Transportation and Communications
Ontario

RECORD OF BOREHOLE No 4 METRIC

W P 223-87-02 LOCATION Pier #3; N 4 812 256.8, E 289 076.5 ORIGINATED BY BB
DIST 4 HWY Q.E.W. BOREHOLE TYPE S.S. Auger, B.W. Casing, BQ Rock Core COMPILED BY BB
DATUM Geodetic DATE 87 07 27 CHECKED BY

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 (○ 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 kN/m³	REMARKS & GRAIN SIZE DISTRIBUTION (%) GR SA SI CL
87.6	Ground Surface										
0.0	Silty Clay (Red Brown) With Sand Some/With Gravel Trace Organics Stiff to Hard		1	SS	11		87				
			2	SS	60/8 cm	▼	86				18 33 (49)
			3	SS	16		85				
			4	SS	21		84				
			5	SS	8						
			6	SS	13		83			21.0	21 31 (48)
			7	SS	9		82				
80.8			8	SS	18		81				35 27 (38)
6.8	Weathered / Unweathered Bedrock Shale Interbedded with Limestone		9	RC	84% REC		80				
79.4											
8.2	End of Borehole										

+3, ×5 : Numbers refer to Sensitivity

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

OFFICE REPORT ON SOIL EXPLORATION

Ministry of Transportation and Communications
Ontario

RECORD OF BOREHOLE No 5 METRIC

W P 223-87-02 LOCATION Pier #3; N 4 812 236.8, E 289 103.1 ORIGINATED BY BB
DIST 4 HWY Q.E.W. BOREHOLE TYPE S.S. Auger, BW Casing, BQ Rock Core COMPILED BY BB
DATUM Geodetic DATE 87 07 27 CHECKED BY

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 ○ 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
87.6	Ground Surface										
0.0	Trace Organics		1	SS	16	▽	87				
	Silty Clay (Red Brown) With Sand With Gravel		2	SS	27		86		○		48 26 (26)
			3	SS	6		85				
			4	SS	6				⊣○⊢		37 31 (32)
	Firm to Stiff		5	SS	7		84				
	Occasional Shale Zones		6	SS	9		83		⊣○⊢		36 28 (36)
82.4											
5.2	Bedrock		7	SS	66		82				
			8	SS	60%	0 cm					
			9	RC	48% REC		81				
	Weathered Unweathered						80				
	Shale Interbedded with Limestone		10	RC	76% REC		79				
78.4											
9.2	End of Borehole										

+3, ×5 : Numbers refer to Sensitivity

20
15 ⊹ 5 (%) STRAIN AT FAILURE
10

OFFICE REPORT ON SOIL EXPLORATION

Ministry of Transportation and Communications
Ontario

RECORD OF BOREHOLE No 6 METRIC

W P 223-87-02 LOCATION Pier #6; N 4812 174.7, E 289 052.8 ORIGINATED BY BB
DIST 4 HWY Q.E.W. BOREHOLE TYPE S.S. Auger, BW Casing, BQ Rock Core COMPILED BY BB
DATUM Geodetic DATE 87 07 28 - 29 CHECKED BY

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 (○ 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
101.6	Ground Surface										
0.0	Silty Clay (Red Brown) Some Sand Some Gravel Trace Organics Hard		1	SS	60/	14 cm	101		○		13 17 (70)
100.1											
1.5	Bedrock		2	SS	41		100				
			3	SS	68		99				
			4	SS	60/	13 cm					
	Weathered						98				
	Unweathered		5	SS	60/	15 cm					
	Shale Interbedded with Limestone		6	RC	80% Rec		97				
			7	RC	97% Rec		96				
94.6							95				
7.0	End of Borehole										

+3, ×5 : Numbers refer to Sensitivity

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

OFFICE REPORT ON SOIL EXPLORATION

Ministry of Transportation and Communications
Ontario

RECORD OF BOREHOLE No 7 METRIC

W P 223-87-02 LOCATION Pier #6: N 4 812 195.3, E 289 027.6 ORIGINATED BY BB
DIST 4 HWY Q.E.W. BOREHOLE TYPE S.S. Auger, BW Casing, BQ Rock Core COMPILED BY BB
DATUM Geodetic DATE 87 07 29 - 30 CHECKED BY

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 ○ 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
101.7	Ground Surface										
0.0	Silty Clay (Red Brown) With Sand, Trace Gravel, Trace Organics, Hard		1	SS	60/13 cm	▼	101				5 35 (60)
100.2											
1.5	Bedrock		2	SS	43		100				
			3	SS	60/ 5 cm		99				
			4	SS	60/13 cm						
	Weathered — Unweathered						98				
	Shale Interbedded With Limestone		5	RC	85% Rec		97				
			6	RC	89% Rec		96				
			7	RC	60% Rec						
			8	RC	94% Rec		95				
							94				
			9	RC	91% Rec		93				
92.5											
9.2	End of Borehole										

+3, ×5 : Numbers refer to Sensitivity

20
15 ◇ 5 (%) STRAIN AT FAILURE
10

OFFICE REPORT ON SOIL EXPLORATION

Ministry of Transportation and Communications
Ontario

RECORD OF BOREHOLE No 8 METRIC

W P 223-87-02 LOCATION Pier #1; N 4 812 314.2, E 289 110.8 ORIGINATED BY BB
DIST 4 HWY Q.E.W. BOREHOLE TYPE S.S. Auger, B.W. Casing, BQ Rock Core COMPILED BY BB
DATUM Geodetic DATE 87 07 30-31 CHECKED BY

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 (○ 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 kN/m³	REMARKS & GRAIN SIZE DISTRIBUTION (%) GR SA SI CL
108.2	Ground Surface										
0.0	Sand Some Gravel Some Silt Trace Clay Trace Organics		1	SS	5		108				
	Loose		2	SS	4		107		○		16 66 (18)
106.1											
2.1	Silty Clay (Red Brown)		3	SS	4	▼	106		○		17 46 (37)
	With Sand Trace/Some Gravel		4	SS	6		105		○	20.0	9 34 (57)
	Soft to Hard		5	SS	15		104				
102.9			6	SS	33				○		2 7 (91)
5.3	Bedrock		7	SS	80		103				
	Weathered Unweathered		8	SS	60/13 cm		102				
	Shale Interbedded with Limestone and Siltstone		9	RC	85% REC		101				
100.2											
8.0	End of Borehole										

+3, ×5 : Numbers refer to Sensitivity

20
15 ◇ 5 (%) STRAIN AT FAILURE
10

OFFICE REPORT ON SOIL EXPLORATION

Ministry of Transportation and Communications
Ontario

RECORD OF BOREHOLE No 9 METRIC

W P 223-87-02 LOCATION East Abutment; N 4 812 325.7, E 289 128.4 ORIGINATED BY BB
DIST 4 HWY Q.E.W. BOREHOLE TYPE S.S. Auger, BW Casing, BQ Rock Core COMPILED BY BB
DATUM Geodetic DATE 87 07 31 - 87 08 06 CHECKED BY

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
107.9	Ground Surface										
0.0	Sand and Gravel Some Silt Trace Clay Red Brown Very Dense		1	SS	60/5 cm		107				28 40 (32)
			2	SS	60/10 cm						44 34 (22)
							106				
	Silty Clay With Shale Fragments Hard (Glacial Till)		3	SS	30						5 27 (68)
103.9			4	SS	30		105				
4.0			5	SS	49		104				
	Bedrock		6	SS	60/8 cm						11 8 (81)
	Shale Interbedded with Siltstone		7	SS	60/13 cm		103				
			8	SS	60/4 cm		102				
	Weathered Unweathered		9	RC	84% REC		101				
			10	RC	83% REC		100				
			11	RC	82% REC						
			12	RC	95% REC		99				
97.8							98				
10.1	End of Borehole										

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

20
15 ◇ 5 (%) STRAIN AT FAILURE
10

OFFICE REPORT ON SOIL EXPLORATION

Ministry of Transportation and Communications
Ontario

OFFICE REPORT ON SOIL EXPLORATION

RECORD OF BOREHOLE No 10 METRIC

W P 223-87-02 LOCATION West Approach; N 4 812 175.3, E 289 011.0 ORIGINATED BY BB
DIST 4 HWY Q.E.W. BOREHOLE TYPE S.S. Auger COMPILED BY BB
DATUM Geodetic DATE 87 08 06 - 07 CHECKED BY

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 Wl — WATER CONTENT (%) (10 20 30)	UNIT WEIGHT γ kN/m³	REMARKS & GRAIN SIZE DISTRIBUTION (%) GR SA SI CL
108.9	Ground Surface										
0.0			1	SS	7	▼	108				11 34 (55)
	Trace Organics		2	SS	17						
	Silty Clay (Red Brown) With Sand Some/With Gravel Firm to Hard		3	SS	19		107				
			4	SS	15		106				21.1 32 31 (37)
			5	SS	9		105				
			6	SS	12		104				
103.1			7	SS	8						29 34 (37)
5.8	Bedrock Shale Interbedded with Limestone		8	SS	50		103				
			9	SS	60/8 cm		102				
			10	SS	60/10 cm						
			11	SS	60/13 cm		101				
99.8			12	SS	60/5 cm		100				
9.1	End of Borehole										

+3, ×5 : Numbers refer to Sensitivity

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

Ministry of Transportation and Communications
Ontario

RECORD OF BOREHOLE No 11 METRIC

W P 223-87-02 LOCATION Pier #4; N 4 812 202.5, E 289 077.5 ORIGINATED BY BB
DIST 4 HWY Q.E.W. BOREHOLE TYPE S.S. Auger, BW Casing, BQ Rock Core COMPILED BY BB
DATUM Geodetic DATE 1987 08 11 - 12 CHECKED BY

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 ○ 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
89.7	Ground Surface										
0.0	Silty Clay (Red Brown) Trace Sand Trace Gravel Stiff to Very Stiff		1	SS	11	▼	89				
87.9			2	SS	18		88				0 5 55 40
1.8	Bedrock — Weathered / Unweatherd		3	SS	60/10 cm						
			4	RC	48% REC		87				
	Shale Interbedded with Limestone		5	RC	69% REC		86				
							85				
			6	RC	80% REC		84				
82.2							83				
7.5	End of Borehole										

OFFICE REPORT ON SOIL EXPLORATION

+3, x5 : Numbers refer to Sensitivity

20
15 ◇ 5 (%) STRAIN AT FAILURE
10

Ministry of Transportation and Communications
Ontario

RECORD OF BOREHOLE No 12 METRIC

W P 223-87-02 LOCATION West Approach; N 4 812 155.6, E 289 038.9 ORIGINATED BY BB
DIST 4 HWY Q.E.W. BOREHOLE TYPE S.S. Auger COMPILED BY BB
DATUM Geodetic DATE 1987 08 11 CHECKED BY

ELEV / DEPTH	SOIL PROFILE 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
108.5	Ground Surface										
0.0	Silty Clay (Red Brown) With Sand Some Gravel Trace Organics Very Soft to Very Stiff		1	SS	3	*	108				
			2	SS	6		107		o —		17 51 (32)
			3	SS	18		106				
			4	SS	16						
			5	SS	10		105				
103.6			6	SS	8		104		o —		29 39 (32)
4.9	Sand and Gravel Some Silt Occasional Silty Clay Zones Trace Organics Compact		7	SS	10						
101.8			8	SS	10		103		o —		52 36 (12)
6.7	Bedrock Weathered Shale Interbedded with Limestone		9	SS	81		102		o —		19 28 (53)
100.4			10	SS	77		101				
8.1 100.3	End of Borehole										
8.2	End of Cone Test										

* No Groundwater Level Observed

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

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

OFFICE REPORT ON SOIL EXPLORATION

Ministry of Transportation and Communications
Ontario

RECORD OF BOREHOLE No 13 METRIC

W P 223-87-02 LOCATION West Abutment; N 4 812 158.1, E 289 048.2 ORIGINATED BY BB
DIST 4 HWY Q.E.W. BOREHOLE TYPE S.S. Auger, BW Casing, BQ Rock Core COMPILED BY BB
DATUM Geodetic DATE 87 08 13 CHECKED BY

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						
101.9	Ground Surface										
0.0	Sand to Silty Sand With Gravel Trace Clay Trace Organics Compact										
101.0			1	SS	25		101				32 40 (28)
0.9											33 17 (50)
			2	SS	19		100				16 14 (70)
	Bedrock		3	SS	71						
			4	SS	60/	▽ 10 cm	99				
			5	SS	60/13 cm		98				
	Shale Interbedded with Limestone		6	SS	60/10 cm		97				
			7	SS	60/ 8 cm		96				
	Weathered / Unweathered		8	RC	67% REC		95				
							94				
			9	RC	59% REC		93				
92.2											
9.7	End of Borehole										
	* Cave-In at 3.1 m										

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 14

METRIC

W P 223-87-02 LOCATION West Abutment; N 4 812 184.9, E 289 015.4 ORIGINATED BY BB
DIST 4 HWY Q.E.W. BOREHOLE TYPE S.S. Auger, BW Casing, BQ Rock Core COMPILED BY BB
DATUM Geodetic DATE 87 08 14 CHECKED BY

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 (○ 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
101.8	Ground Level										
0.0	Sand Some Gravel Some Silt Occasional Silty Clay Zones Occasional Cobbles Loose to Very Dense		1	SS	12	*	101		○		24 56 (20)
			2	SS	5	▽	100		○		11 64 (25)
99.4			3	SS	65/28 cm						
2.4	Bedrock Weathered Shale Interbedded with Limestone		4	SS	60/20 cm		99				
			5	RC	50% REC		98				
			6	RC	93% REC		97				
95.1							96				
6.7	End of Borehole * Cave-in at 2.1 m										

+3, ×5 : Numbers refer to Sensitivity

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

OFFICE REPORT ON SOIL EXPLORATION

Ministry of Transportation and Communications
Ontario

RECORD OF BOREHOLE No 15 METRIC

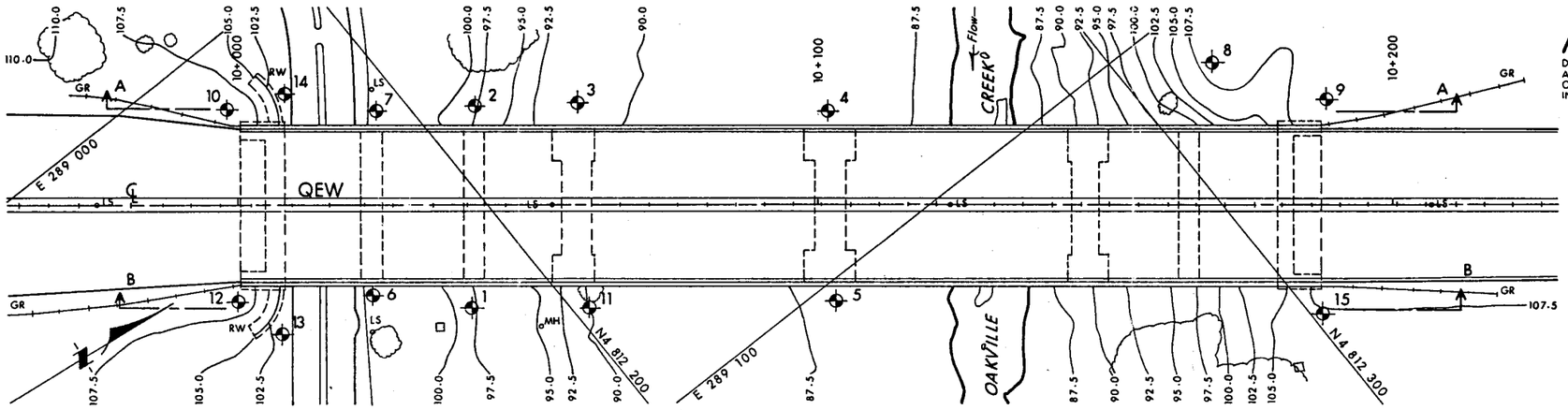
W P 223-87-02 LOCATION East Abutment; N 4 812 301.6, E 289 157.7 ORIGINATED BY BB
DIST 4 HWY Q.E.W. BOREHOLE TYPE S.S. Auger, BW Casing, BQ Rock Core COMPILED BY BB
DATUM Geodetic DATE 87 08 17 CHECKED BY

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						
107.4	Ground Surface										
0.0	Sand to Silty Sand, Some Gravel, Occasional Silty Clay Zones, Trace Organics, Loose to Compact		1	SS	18		107		o H		19 56 (25)
			2	SS	6	▽	106		o H		11 50 (39)
			3	SS	14		105				
			4	SS	9		104		o H		21 53 (26)
103.4											
4.0	Bedrock		5	SS	75/23 cm				o H		24 29 (47)
			6	SS	58		103				
			7	SS	60/10 cm		102				
	Weathered / Unweathered										
	Shale Interbedded with Limestone		8	RC	88% REC		101				
99.8							100				
7.6	End of Borehole										

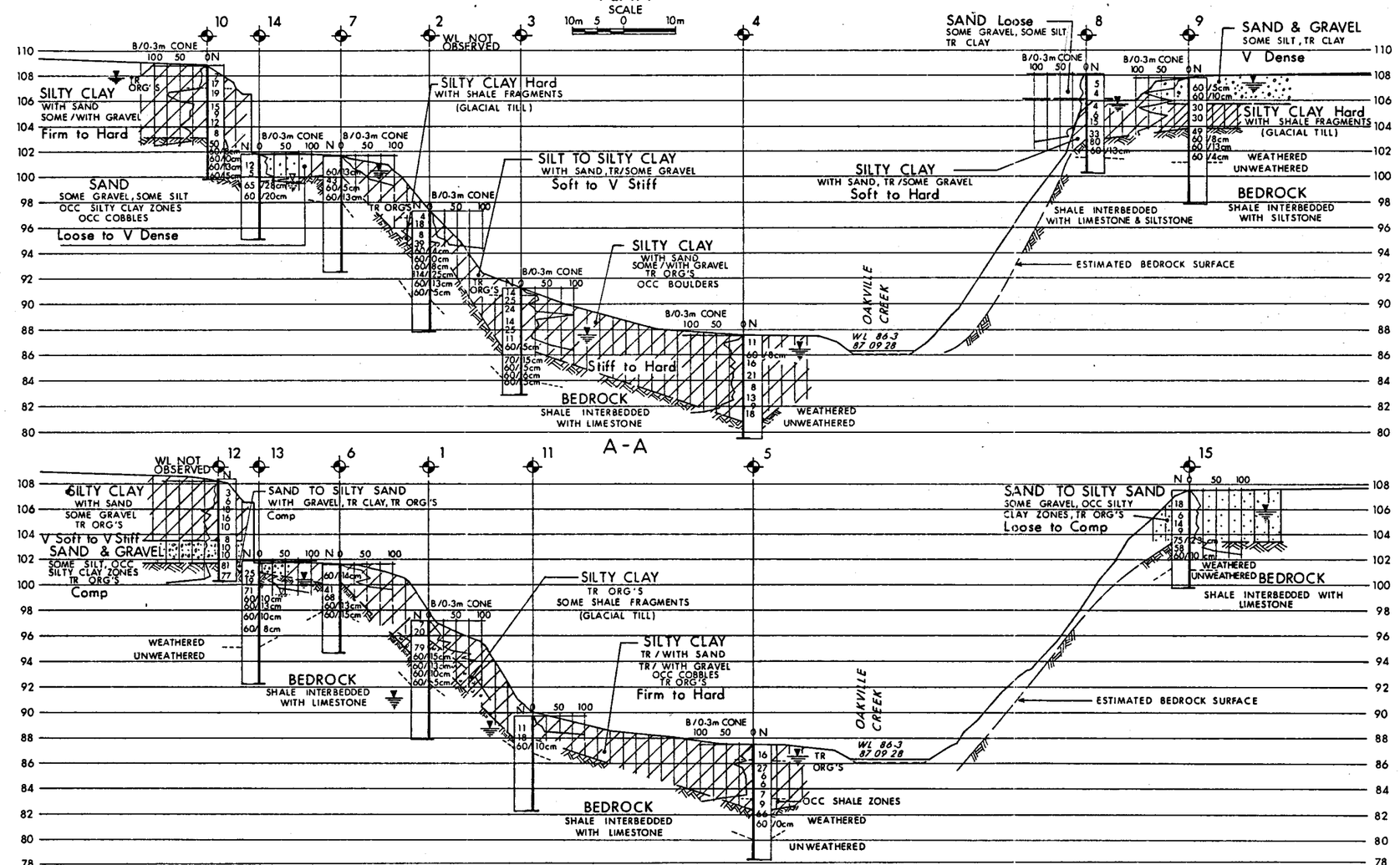
+3, ×5 : Numbers refer to Sensitivity

20
15 ◇ 5 (%) STRAIN AT FAILURE
10

OFFICE REPORT ON SOIL EXPLORATION



PLAN
SCALE 10m 5 0 10m



A-A

B-B

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

METRIC

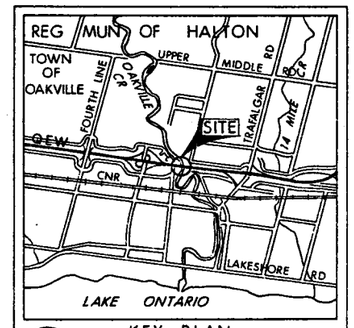
DIMENSIONS ARE IN METRES AND/OR MILLIMETRES UNLESS OTHERWISE SHOWN. STATIONS IN KILOMETRES + METRES.

CONT No
WP No 223-87-02

OAKVILLE CREEK

BORE HOLE LOCATIONS & SOIL STRATA

SHEET



KEY PLAN
SCALE 1·0km 0 1·0km

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 87 07
- Cave - in

No	ELEVATION	CO-ORDINATES NORTH	EAST
1	97.1	4 812 187·7	289 065·0
2	97.3	4 812 209·4	289 037·7
3	91.3	4 812 223·7	289 048·3
4	87.6	4 812 256·8	289 076·5
5	87.6	4 812 236·8	289 103·1
6	101.6	4 812 174·7	289 052·8
7	101.7	4 812 195·3	289 027·6
8	108.2	4 812 314·2	289 110 ·8
9	107.9	4 812 325·7	289 128 ·4
10	108.9	4 812 175·3	289 011 ·0
11	89.7	4 812 202·5	289 077 ·5
12	108.5	4 812 155·6	289 038·9
13	101.9	4 812 158·1	289 048·2
14	101.8	4 812 184·9	289 015·4
15	107.4	4 812 301·6	289 157·7

NOTE

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

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

REV.	DATE	BY	DESCRIPTION

Geocres No 30M5-158

HWY No QEW			DIST 4
SUBM'D BB	CHECKED	DATE 87 10 28	SITE 10-160
DRAWN DT	CHECKED	APPROVED	DWG 2238702-A

GEOCON REPORT

SUBSURFACE CONDITIONS & ENGINEERING STUDY
CROSS AVENUE CONNECTION
LANE "N"
OAKVILLE, ONTARIO

FOUNDATION OF CANADA
ENGINEERING CORPORATION LIMITED

SR 9A

GEOCON LTD

Rexdale, Ontario
May 18, 1973

Foundation of Canada Engineering
Corporation Limited
1 Yonge Street
Toronto 1, Ontario

Attention: Mr. M.C. Douglas, P. Eng.,
Chief Engineer, Transportation

Re: Soil Condition and Engineering Study
Addendum Report-Cross Avenue Connection Lane 'N'
Speers Road Extension Project
Oakville, Ontario

Dear Sirs:

This letter accompanies our addendum report on the supplementary soil investigation carried out along alternate Lane "N" for the Cross Avenue Connection to the Speers Road Extension.

We find that within the valley section of Lane "N" alignment, a variable thickness of fill, composed of generally loose to dense clayey and sandy silt with organics, overlies gravel, cobbles and boulders with sandy silt and clay, and then weathered and/or relatively sound shale, siltstone and limestone. Along the slope and at the crest of the north Bank, compact to very dense sandy silt with weathered shale layers, was encountered overlying weathered then sounder shale, siltstone and limestone. The subsurface conditions at the site indicate that there is a gradual decreasing degree of weathering of the shale and limestone with depth. Therefore, distinct boundary changes from the overburden to relatively sound rock, can not be made precisely and have thus been made primarily on the percentage of rock core recovered.

This report includes a discussion of a number of factors related to design and construction of the embankment fill and the effect of embankment construction of the existing CNR Trestle. Since the design

... /2

of the embankment will involve various sources of borrow material which will come from other construction in the area, we would appreciate the opportunity to meet with you and refine certain of the recommendations taking into consideration factors such as the overall sequence of construction that is planned to better define what materials will be available for construction.

We trust that this report provides all of the information required at this time, and we are at your disposal to provide further input on this project during the detailed design stage.

Yours very truly,

GEOCON LTD

D. B. Oates, P. Eng.,
Regional Engineer

DBO/vg
T9442A

T9442A

REPORT

TO

FOUNDATION OF CANADA ENGINEERING

CORPORATION LIMITED

ON

SOIL CONDITION AND ENGINEERING STUDY

ADDENDUM REPORT-CROSS AVENUE CONNECTION LANE 'N'

SPEERS ROAD EXTENSION PROJECT

OAKVILLE ONTARIO

Distribution:

9 copies - Foundation of Canada Engineering
Corporation Limited

3 copies - Geocon Ltd

GEOCON

INDEX

1.0 INTRODUCTION

Geocon Ltd has been retained by Foundation of Canada Engineering Corporation Limited (FENCO) in accordance with their verbal instructions on September 30th, 1971 to carry out a soils investigation and engineering study for the alternative alignment for Cross Avenue Connection referred to as Lane "N" in Oakville, Ontario. The purpose of this investigation was to determine the subsurface and groundwater conditions along this alternative alignment of the Cross Avenue Connection to the Speers Road Extension and to provide recommendations from a Soil Mechanics standpoint for design and construction of foundations, retaining structures and embankments.

This additional investigation is further to a detailed subsurface investigation reported on in Geocon Report T9442, dated October 12th, 1971. Background on the overall scope of this project is given in the previous report. The findings of this subsurface investigation are given in detail in Appendix I and on the Office Reports on Soil Exploration. Laboratory test results are given in Appendix II of this report.

2.0 SUMMARIZED SUBSURFACE CONDITIONS

A total of eight boreholes were put down to investigate subsoil conditions along the proposed Lane "N" Alternate Alignment. Of these six were located in the main valley and to the west of the existing Sixteen Mile Creek. The other two boreholes, N7 and N8, were located on the east side of the Creek, N7 being on the slope between the high ground and the valley and N8 on high ground. Clayey silt or sandy silt fill with organics was encountered in three of the boreholes in the valley, the depth of the fill ranging between 5 and 9 feet. Underlying this fill in these three boreholes and commencing from the ground surface in other boreholes in the valley, a stratum of gravel, cobbles and boulders with sand, silt and clay was encountered. This stratum in turn was underlain by either weathered or relatively sounder shale siltstone and limestone at elevations varying between 244 and 257 in the valley.

Boreholes N7 and N8 encountered about 8 to 15 feet of compact to very dense brown clayey silt with weathered shale underlain by shale siltstone and limestone.

In all boreholes, a gradual transition from overburden to shale, siltstone and limestone was observed.

.../2

3.0 DISCUSSION

3.1 General

The proposed alignment is to provide a connection between Cross Avenue at Lyons Lane (Sixth Line Road) on the north side to Speers Road Extension on the south side at a point a little south of the existing C.N.R. trestle in the Sixteen Mile Creek Valley. The alignment will cross the present course of the Sixteen Mile Creek twice. It is proposed to divert the Creek to the west of this proposed Extension thus avoiding these crossings and also to channelize the creek. The location of the proposed Line "N" alignment and of the Sixteen Mile Creek are shown in Drawing T9442A-1.

It is understood that the choice for the proposed roadway has been narrowed down to that of embankment fill. Therefore the discussion is confined to this alternative. Should you, however require specific comments in respect of other alternatives involving either a continuous structure or a combination of structure or embankment, we shall be pleased to do so.

Although the findings of the soil investigation along alignment Lane "N" are presented herein separately from the investigation for the other roadway structures in the Speers Road Extension, the interpretations of the findings of the investigation along Lane "N" are, in general, similar to those presented in our previous report T9442. This report is therefore considered to be an Addendum to the above report and it is recommended that, with the exception of the special design considerations discussed below, the recommendations presented in the above report be followed.

The special design considerations in the context of the present discussion are:

(i) Side slopes of the embankment will have a maximum height of the order of 65 feet.

(ii) The footings of the piers of the existing CNR Trestle will have embankment fill surcharge of the order of 20 feet.

(iii) Stability of existing or modified slopes of the valley in the vicinity of the proposed embankment requires consideration.

.../3

3.0 DISCUSSION (continued)

3.2 Embankment Fill

As proposed, a maximum height of 65 feet approximately would be involved.

As discussed in our previous report, the existing fill below the valley floor south of the CNR Trestle consists predominantly of garbage, and should be removed from beneath the roadway fill. North of the CNR Trestle the surficial fills encountered in some of the boreholes in the "N" series contains some traces of organics but based on the samples recovered from the boreholes, the fill is predominantly sandy or clayey silt. Consideration could, of course, be given to removing all fill materials prior to placing the embankment fill. As an alternative, the existing fill could be left in place, ground surface beneath the limits of the embankment cleared of surface vegetation and proof rolled; any areas exposed as being entirely garbage or particularly soft, could then be individually excavated.

In our previous report under the section for roadway fills, recommendations were given for slopes up to 20 feet in height and use of the shale as embankment fill; the comments regarding the shale still apply for the embankment along the Line "N". Since the embankment will be constructed likely from fill obtained from a number of excavations, the creek diversion, and the south bank, it is difficult to predict at this time what the overall properties of the fill will be and we would like to meet with you following your receipt of this report to expand on the guidelines given below.

(a) Although in the previous report for embankments up to 20 feet in height, side slopes of 2 horizontal to 1 vertical were considered satisfactory, for the higher fills, it may be necessary depending on the position of the different types of fill in the section to use somewhat flatter slopes.

(b) Where shale is used, the embankment section should be designed to prevent frost action on the shale or saturation with water since both these effects will produce breakdown with time. It is recommended that the shale should be restricted to the centre of the embankment with outer zones of sand and gravel of sufficient width to permit proper compaction; a width of at least 10 feet is suggested for this purpose.

3.0 DISCUSSION (continued)

3.2 Embankment Fill (continued)

(c) The shale should be excavated in such a way to avoid large slabs being produced since their inclusion in the fill could result in excessive voids and prevent uniform compaction. Where practical, slabs of hard more durable rock should be stockpiled for use as possible slope protection.

(d) Depending on the characteristics of the shale being excavated and from previous experience with field compaction on weathered Queenston Shale, the fill produced by compaction could be predominantly cohesive to the extent that pore pressures will be set up during fill placement. In this event layers of free-draining granular material should be incorporated in the fill at intervals of, say 10 feet, to improve the internal drainage.

(e) Where the embankment fill is placed against the slope of the valley, it is recommended that a drainage zone be placed to intercept seepage from the valley slope and prevent saturation of the embankment fill; this drainage zone should preferably be connected to a perforated pipe drain at the base.

(f) Since the embankment will likely consist of fill from a number of sources, consideration will have to be given to the need for filter layers where fills of widely different gradation characteristics are placed next to each other.

(g) The embankment fill should be placed and compacted using compaction equipment best suited for the particular fill being used. The degree of compaction equivalent to 95 percent of Modified A.A.S.H.O. Maximum Dry Density should be used for control of placement. It is recommended that the fill be placed under engineering supervision to check the uniformity and degree of compaction and to monitor pore pressures within the fill; for this reason, it is recommended that the fill be instrumented with piezometers.

(h) During final design of the embankment section, it is recommended that a final check on stability be made. This should be done once the most likely form of zoned section has been decided.

3.0 DISCUSSION (continued)

3.3 C.N.R. Bridge

The proposed embankment will cause a surcharge on the pier footings of the CNR Trestle bridge; it is understood that a height of 20 feet could be involved. Information from the drawing of the bridge, dated 1892 indicates that individual pier foundations for the bridge are founded partly on bedrock and partly on overburden overlying the bedrock. No boreholes were put down specifically through the piers or immediately adjacent to the piers and the closest two boreholes are numbers 20 and 21 in our previous report; these boreholes indicate some 20 to 30 feet of overburden, part of which is fill. Although we do not have the correlation between Geodetic Datum and the datum used on the 1892 drawing, the latter drawing shows a founding elevation only about 6 to 7 feet below original ground surface or 14 to 15 feet below the original high water level. Since the fill proposed in the area of the bridge involves a pressure of between 2 and 3 kips per square foot, some settlement with a resulting tilt of the bridge pier particularly where founded partly on bedrock and partly on overburden could be expected. In view of this and the lack of as-built data, consideration should be given to underpinning the piers in question, or to reducing the fill surcharge. To establish the most suitable underpinning methods, further investigation of the actual foundation conditions beneath the piers would be necessary.

3.4 Valley Slopes

Recommendations have been given in our previous report regarding the permanent side slopes for cuts within the overburden and shale. These should be referred to in the design of the slopes where the embankment meets the north bank of the valley.

4.0 PERSONNEL

The field work for this investigation was carried out under the supervision of Mr. M. Nitsch. This report was written by Mr. E.I. Jurgens and Mr. D.B. Oates and reviewed by Mr. L.S. Brzezinski.

Respectfully submitted,
GEOCON LTD

D.B. Oates, P. Eng.,
Regional Engineer

DBO/vg
T9442A

GEOCON

APPENDIX I

PROCEDURE

FIELD EQUIPMENT

SITE AND GEOLOGY

SOIL CONDITIONS

WATER CONDITIONS

OFFICE REPORTS ON SOIL EXPLORATION

1.0 PROCEDURE

The field work for this investigation was carried out between October 4th and October 22nd, 1971. A total of eight boreholes was put down using a skid-mounted diamond drill rig along the proposed Lane "N" Alignment for the Cross Avenue Connection from the Canadian National Railways right of way to Lyons Lane or Sixth Line Road. Of this total, six boreholes were put down in the valley section, one borehole was put down approximately half way up the valley slope and one borehole was put down at the crest of the slope.

The boreholes were extended to depths ranging between 19 and 34 feet and generally were about 25 feet in depth. BX and NX size casing was used in advancing the boreholes. Samples of overburden were obtained at maximum 5 foot intervals using a 2 inch diameter split spoon sampler. The weathered and sounder shale, siltstone and limestone and in a number of cases, the coarse granular overburden was cored in BXL and NXL size. Plastic water level observation standpipes were installed in boreholes.

The location of the boreholes and the inferred soil stratigraphy is shown on Drawing T9442A-1. A detailed log of each borehole is given on the Office Reports on Soil Exploration included in this Appendix. The location of the boreholes were given to us by the Survey Staff of Foundation of Canada Engineering Corporation Limited, (FENCO). All the elevations referred to in this report are with respect to Geodetic Datum and were supplied by the Survey Staff of FENCO.

Laboratory testing of selected soil and rock samples was carried out in the Soil Mechanics Laboratory of Geocon Ltd in Toronto. Results of the tests are plotted on the Office Reports on Soil Exploration in this Appendix and on the Figures in Appendix II. Samples remaining after testing will be stored until October, 1972 at which time you will be contacted for instructions regarding their disposal.

2.0 FIELD EQUIPMENT

All boreholes were put down using a standard skid-mounted diamond drill rig in either BX or NX size casing and rock core was recovered in both BX and NX sizes. At Borehole N-7 located on the valley slope of the Sixteen Mile Creek, a temporary timber crib was constructed as a working platform for the drilling operation.

.../2

3.0 SITE AND GEOLOGY

This subsurface investigation was limited to a portion of the Cross Avenue Connection from the CNR trestle to Lyons Lane or Sixth Line Road. The alternative Lane "N" Alignment is part of the Cross Avenue Connection to the Speers Road Extension Project. In the vicinity of the CNR trestle, the Sixteen Mile Creek valley is about 500 feet wide. The north bank slopes near the abutment to the CNR trestle are in the order of about 1 3/4 horizontal to 1 vertical. In this section the Creek runs near the center of the valley. Further north about 600 feet from the CNR trestle at the point where the Lane "N" Alignment is proposed to cut through the north bank slope to Cross Avenue, the valley is about 600 feet wide. At this location the Creek is located immediately adjacent to the north bank and as such has cut the bank to an overall slope of as steep as 1 horizontal to 1 vertical. The upper part of the approximately 80 feet high slope at this section is partially wooded; just above creek level at the base of the slope horizontally bedded exposures of shale, siltstone and limestone are visible. Ground surface elevations on the crest of the north bank are relatively flat at about elevation 330.

Information regarding the geology of the general area has been given in detail in Report T9442 dated October 12th, 1971.

4.0 SUBSURFACE CONDITIONS

The principal strata encountered in the boreholes of this investigation are described below:

4.1 Loose to Very Dense Reddish Brown Sandy and Clayey Silt Fill with Organics

At Boreholes N3 to N5 located on the south and west side of the Sixteen Mile Creek, a layer of loose to very dense fill was encountered from ground surface to a depth ranging from 5 to about 9 feet. The fill contained primarily clay, silt and sand sizes. Throughout the fill organics and traces of wood fibres were encountered. Traces of sand and gravel sizes of weathered shale and limestone were encountered also throughout the fill.

Standard Penetration Test "N" values were found to range from 6 to greater than 100 blows per foot indicating a wide range of relative densities ranging from loose to very dense.

.../3

4.0 SUBSURFACE CONDITIONS (continued)

4.2 Compact to Very Dense Brown Sandy Silt with Weathered Shale Layers

At Boreholes N7 and N8 located part way down the north valley slope and on top of the valley respectively, a stratum of compact to very dense brown sandy silt with weathered shale layers was encountered. This stratum was encountered to depths below ground surface ranging from about 8 to 15 feet. In general, the stratum contained primarily sand and silt sizes with weathered layers of shale occurring with greater frequency with depth.

The results of two mechanical analysis tests on samples from this stratum are presented as grain size distribution curves on Figure 1 of Appendix II. The tests were carried out on only that portion of the sample that was smaller than the 2 inch size. The samples tested consists of from 11 to 36 percent gravel, 27 to 42 percent sand, 29 to 39 percent silt, and up to about 8 percent clay sizes.

Standard Penetration Test "N" values in this stratum ranged from 20 to greater than 100 blows per foot indicating a relative density range of compact to very dense.

4.3 Gravel, Cobbles and Boulders with Sandy Silt and Clay

From ground surface at Boreholes N1, N2 and N6 and underlying the fill at Boreholes N3 to N5, is a stratum of gravel, cobbles and boulders with sandy silt and clay. All of these boreholes are situated in the valley floor section of Lane "N" Alignment. This stratum ranged in depth from about 4 feet at Boreholes N2 and N6 below ground surface to as deep as 17 feet below ground surface at Boreholes N1, N4 and N5. Primarily rock coring techniques were required to sample material in this stratum and core recovery averaged about 60 percent. This stratum is distinguished from the weathered shale siltstone and limestone by the evidence of sub-rounded to sub-angular shaped core, and the fact that some of the shale and limestone core is of a different formation than the Queenston or Meaford formations at this site. Nevertheless, because of the difficulty of sampling the stratum, the boundary with the underlying shale cannot be established precisely.

.../4

4.0 SUBSURFACE CONDITIONS (continued)

4.3 Gravel, Cobbles and Boulders with Sandy Silt and Clay (cont'd)

The results of a single mechanical analysis test carried out on the minus 2 inch size fraction from a sample recovered at N3 indicates 54 percent gravel, 26 percent sand, 18 percent silt, and about 2 percent clay sizes. The test results are shown on the grain size distribution curve on Figure 2 of Appendix II.

A single Standard Penetration Test "N" value of 22 blows per foot was obtained on one split spoon sample. The results of this test indicate a relative density of compact.

4.4 Weathered Shale Siltstone and Limestone

At Boreholes N1 and N2 located near the CNR trestle in the valley section and at Boreholes N7 and N8 located near and at the top of the valley slope weathered shale siltstone and limestone was cored. The transition between the highly weathered shale layers of the overburden and the relatively sounder shale siltstone and limestone is very gradual thus making a definite boundary between overburden and the shale, siltstone and limestone difficult to determine. The weathered and layered shale siltstone and limestone with silty clay seams was based on that part of the stratigraphy were primarily rock core drilling was required and where rock core recoveries were generally less than an average of about 70 percent. The depths at which clay layers were encountered from the observation of the core recovery are noted on the individual Office Reports on Soil Exploration. In many cases the clay layers were lost due to water used in the coring operation.

Relatively sounder shale siltstone and limestone was defined as that part of the stratigraphy where rock core recovery generally exceeded about 70 percent. No vertical or inclined fractures of any note were observed in the core from any of the boreholes. Bedding thicknesses were observed at exposures immediately above creek level and were noted to be variable ranging from only a few inches for the grey shale and siltstone to several feet for the limestone. The lengths of core recovered averaged generally around 2 to 3 inches with the maximum length of core no greater than about 6 inches.

.../5

4.0 SUBSURFACE CONDITIONS (continued)

4.4 Weathered Shale Siltstone and Limestone (continued)

The top of the weathered shale siltstone and limestone surface was encountered from about 4 feet to a maximum of about 17 feet below ground surface.

Rock core recovery ranged from about 25 to 100 percent within the weathered shale siltstone and limestone and averaged about 57 percent.

4.5 Shale, Siltstone and Limestone

Shale, siltstone and limestone was encountered at all boreholes except Borehole N1 in this investigation. The rock core recovery averaged about 73 percent although recoveries as low as 17 percent were encountered especially in the shale beds. Core recovery was about 80 percent after the larger NXL size core barrel was used in the drilling operation.

The elevation of the surface of the shale, siltstone and limestone ranges from about elevation 243 to 257 within the valley section and was found to generally slope from the CNR trestle in the direction of increasing chainage.

5.0 WATER CONDITIONS

Water level observations were made at all the boreholes with standpipe installations on the dates as shown on the individual Office Reports on Soil Exploration. At those boreholes located within the bottom of the valley section, the groundwater level observed ranged from about elevation 256 to 259, generally reflecting the water level of the Sixteen Mile Creek at the time of the investigation. At Borehole N7 the groundwater elevation recorded in the standpipe was elevation 307.4. Borehole N8 caved at the time of completion and withdrawal of the casing, and no water was encountered within the casing during the drilling operation.

EXPLANATION OF THE FORM "OFFICE REPORT ON SOIL EXPLORATION"

The object of this form is to enable a comprehensive study of the soil to be made by combining on one sheet all of the information obtained from the boring. An explanation of the various columns of the report follows.

ELEVATION AND DEPTH

This column gives the elevation and depth of boundaries between the various soil strata. The elevation is referred to the datum shown in the general heading.

WATER CONDITIONS

In this column the water level in the casing at the time of boring or the water table in the ground, determined by a series of observations in a piezometer or standpipe, is indicated to scale by a horizontal line with the symbol W.L. or W.T. above the line. A notation of any complicated groundwater conditions will be made in this column.

DESCRIPTION

A description of the soil, using standard terminology, is contained in this column. The consistency of cohesive soils and the relative density of non-cohesive soils are described by the following terms:

Consistency	U-Strength Tons/sq. ft.	Relative Density	Standard Penetration Resistance. Blows/ft.
Very soft	0.03 to 0.25	Very loose	0 to 4
Soft	0.25 to 0.5	Loose	4 to 10
Firm	0.5 to 1.0	Compact	10 to 30
Stiff	1.0 to 2.0	Dense	30 to 50
Very stiff	2.0 to 4.0	Very dense	over 50
Hard	over 4.0		

STRATIGRAPHIC PLOT

The stratigraphic plot follows the standard symbols of the National Research Council, Canada.

ELEVATION SCALE

The information in all columns is plotted to a true elevation scale which is shown in this column.

GRAPHS

The main body of the report forms a graph which is used to plot to correct elevation the important soil properties which are obtained through field and laboratory tests. The scales and symbols for the plotting are shown at the head of the column.

OTHER TESTS

In this column are shown, by symbol, the other field or laboratory tests which have been performed on the soil and for which the results have not been plotted on the above graph.

SAMPLES

The first three columns describe the condition, type and number of each sample obtained from the boring. The location and extent of each sample is plotted to scale.

In the last column is shown the penetration resistance in blows of 4200 inch-pounds required to drive one foot of the sampler into the ground. When a 2 inch Drive Sampler is used the result obtained is termed the "Standard Penetration Resistance".

GEOCON

APPENDIX I

GEOCON

OFFICE REPORT ON SOIL EXPLORATION

CONTRACT T9442A BORING # N11 DATUM GEODETIC CASING BX
BORING DATE OCT. 12-13/71 REPORT DATE OCT. 25/71 COMPILED BY MN CHECKED BY DBO
SAMPLER HAMMER WT. — LBS. DROP — INCHES (PENETRATION RESISTANCES CONVERTED TO BLOWS OF 4200 IN - LBS. ENERGY)

SAMPLE CONDITION
DISTURBED
FAIR
GOOD
LOST

SAMPLE TYPES
A.S. - AUGER SAMPLE
S.T. - SLOTTED TUBE
W.S. - WASHED SAMPLE
D.O. - DRIVE-OPEN
D.F. - DRIVE-FOOT VALVE
C.S. - CHUNK SAMPLE
F.S. - FOIL SAMPLE
S.O. - SLEEVE-OPEN
S.F. - SLEEVE-FOOT VALVE
T.O. - THIN WALLED OPEN
R.C. - ROCK CORE

ABBREVIATIONS
V - IN-SITU VANE TEST
M - MECHANICAL ANALYSIS
U - UNCONFINED COMPRESSION
Qc - TRIAXIAL CONSOLIDATED UNDRAINED
Q - TRIAXIAL UNDRAINED
S - TRIAXIAL DRAINED
γ - WET UNIT WEIGHT
K - PERMEABILITY
C - CONSOLIDATION
WL - WATER LEVEL IN CASING
WT - WATER TABLE IN SOIL

SOIL PROFILE				ELEVATION SCALE	WATER CONTENT W% — G NAT. ⊡ Lw ▲ Pw	OTHER TESTS R.C. RE.COV.	SAMPLES			
ELEVN. / DEPTH	WATER CONDITIONS	DESCRIPTION	STRAT. PLOT		DYNAMIC PENETRATION TEST BLOWS PER FOOT		CONDITION	TYPE	NUMBER	PENETRATION RESISTANCE BLOWS/FT.
259.8 / 0.0		GROUND LEVEL		260	N1					
	WL. @ EL. 255.6 OCT 12, 1971	GRAVEL COBBLES AND BOULDERS WITH SANDY SILT AND CLAY		255		83%			1	
						64%			2	
				250		32%			3	
						92%			4	
				245		42%			5	
242.8 / 17.0						68%			6	
		WEATHERED SHALE SILTSTONE & LIMESTONE (clay layers between 18' and 25')		240		100%			7	
						63%			8	
234.8 / 25.0		END OF HOLE		235		56%			9	
				230						

R.C. — BXL

APPENDIX I

GEOCON

OFFICE REPORT ON SOIL EXPLORATION

CONTRACT T9442A BORING # N2 DATUM GEODETIC CASING NX & BX
BORING DATE OCT 13-14/71 REPORT DATE OCT. 25/71 COMPILED BY MN CHECKED BY DTB
SAMPLER HAMMER WT. — LBS. DROP — INCHES (PENETRATION RESISTANCES CONVERTED TO BLOWS OF 4200 IN - LBS. ENERGY)

SAMPLE CONDITION
DISTURBED
FAIR
GOOD
LOST

SAMPLE TYPES
A.S. - AUGER SAMPLE
S.T. - SLOTTED TUBE
W.S. - WASHED SAMPLE
D.O. - DRIVE-OPEN
D.F. - DRIVE-FOOT VALVE
C.S. - CHUNK SAMPLE
F.S. - FOIL SAMPLE
S.O. - SLEEVE-OPEN
S.F. - SLEEVE-FOOT VALVE
T.O. - THIN WALLED OPEN
R.C. - ROCK CORE

ABBREVIATIONS
V - IN-SITU VANE TEST
M - MECHANICAL ANALYSIS
U - UNCONFINED COMPRESSION
Qc - TRIAXIAL CONSOLIDATED UNDRAINED
Q - TRIAXIAL UNDRAINED
S - TRIAXIAL DRAINED
γ - WET UNIT WEIGHT
K - PERMEABILITY
C - CONSOLIDATION
WL - WATER LEVEL IN CASING
WT - WATER TABLE IN SOIL

ELEVN. / DEPTH	WATER CONDITIONS	DESCRIPTION	STRAT. PLOT	ELEVATION SCALE	OTHER TESTS % R.C. RECOV.	SAMPLES: CONDITION	TYPE	NUMBER	PENETRATION RESISTANCE BLOWS/FT.
256.3 / 0.0	WL. @ EL. 256.3 OCT. 14, 1971	GROUND LEVEL		260					
		GRAVEL, COBBLES & BOULDERS WITH SANDY SILT AND CLAY		255					
252.3 / 4.0		WEATHERED SHALE SILTSTONE & LIMESTONE (clay layers 5.3' to 7.0')		250	59%		NXL RC	1	
					41%			2	
244.3 / 12.0				245	43%			3	
		SHALE SILTSTONE & LIMESTONE		240	80%			4	
					75%			5	
					28%			6	
				235	23%		BXL RC	7	
232.9 / 23.4		END OF HOLE			58%			8	
				230					

WATER CONTENT W% ——— ⊙ NAT. ⊡ LW △ PW
DYNAMIC PENETRATION TEST BLOWS PER FOOT

N2

0
5
10
15
20

APPENDIX I

GEOCON

OFFICE REPORT ON SOIL EXPLORATION

CONTRACT T9442A BORING # N3 DATUM GEODETIC CASING NX
BORING DATE OCT. 14-15/71 REPORT DATE OCT. 25/71 COMPILED BY MN CHECKED BY DTD
SAMPLER HAMMER WT. 140 LBS. DROP 30 INCHES (PENETRATION RESISTANCES CONVERTED TO BLOWS OF 4200 IN - LBS. ENERGY)

SAMPLE CONDITION
DISTURBED
FAIR
GOOD
LOST

SAMPLE TYPES
A.S. - AUGER SAMPLE
S.T. - SLOTTED TUBE
W.S. - WASHED SAMPLE
D.O. - DRIVE-OPEN
D.F. - DRIVE-FOOT VALVE
C.S. - CHUNK SAMPLE
F.S. - FOIL SAMPLE
S.O. - SLEEVE-OPEN
S.F. - SLEEVE-FOOT VALVE
T.O. - THIN WALLED OPEN
R.C. - ROCK CORE

ABBREVIATIONS
V - IN-SITU VANE TEST
M - MECHANICAL ANALYSIS
U - UNCONFINED COMPRESSION
Qc - TRIAXIAL CONSOLIDATED UNDRAINED
Q - TRIAXIAL UNDRAINED
S - TRIAXIAL DRAINED
γ - WET UNIT WEIGHT
K - PERMEABILITY
C - CONSOLIDATION
WL - WATER LEVEL IN CASING
WT - WATER TABLE IN SOIL

ELEVN. / DEPTH	WATER CONDITIONS	DESCRIPTION	STRAT. PLOT	ELEVATION SCALE
262.2 / 0.0		GROUND LEVEL		265
		LOOSE TO COMPACT REDDISH BROWN CLAYEY SILT FILL WITH ORGANICS		260
258.2 / 9.0		GRAVEL, COBBLES AND BOULDERS WITH SANDY SILT AND CLAY		255
247.2 / 15.0	WL. @ EL. 255.6 OCT. 14, 1971	SHALE SILTSTONE & LIMESTONE		250
				245
				240
235.9 / 26.3		END OF HOLE		235

WATER CONTENT W% ____ ⊙ NAT. ⊡ Lw △ Pw
DYNAMIC PENETRATION TEST BLOWS PER FOOT

OTHER TESTS & RECOV.	SAMPLES: CONDITION	TYPE	NUMBER	PENETRATION RESISTANCE BLOWS/FT.
		2" D.O.	1	18
		2" D.O.	2	8
35%		NXL R.C.	3	
M		2" D.O.	4	22
80%		NXL R.C.	5	—
77%			6	—
88%			7	—

0 5 10 15 20 25

APPENDIX I

GEOCON

OFFICE REPORT ON SOIL EXPLORATION

CONTRACT T9442A BORING # N4 DATUM GEODETIC CASING NX

BORING DATE OCT. 18-19/71 REPORT DATE OCT 25/71 COMPILED BY MN CHECKED BY DBD

SAMPLER HAMMER WT. 140 LBS. DROP 30 INCHES (PENETRATION RESISTANCES CONVERTED TO BLOWS OF 4200 IN - LBS. ENERGY)

SAMPLE CONDITION

- DISTURBED
- FAIR
- GOOD
- LOST

SAMPLE TYPES

A.S. - AUGER SAMPLE
S.T. - SLOTTED TUBE
W.S. - WASHED SAMPLE
D.O. - DRIVE-OPEN
D.F. - DRIVE-FOOT VALVE
C.S. - CHUNK SAMPLE
F.S. - FOIL SAMPLE
S.O. - SLEEVE-OPEN
S.F. - SLEEVE-FOOT VALVE
T.O. - THIN WALLED OPEN
R.C. - ROCK CORE

ABBREVIATIONS

V - IN-SITU VANE TEST
M - MECHANICAL ANALYSIS
U - UNCONFINED COMPRESSION
Qc - TRIAXIAL CONSOLIDATED UNDRAINED
Q - TRIAXIAL UNDRAINED
S - TRIAXIAL DRAINED
γ - WET UNIT WEIGHT
K - PERMEABILITY
C - CONSOLIDATION
WL - WATER LEVEL IN CASING
WT - WATER TABLE IN SOIL

ELEVN. / DEPTH	WATER CONDITIONS	DESCRIPTION	STRAT. PLOT	ELEVATION SCALE
263.6		GROUND LEVEL		265
2.0		COMPACT TO VERY DENSE REDDISH BROWN SANDY SILT FILL WITH ORGANICS		260
258.6	▼ WL. @ EL. 258.9 OCT. 19, 1971			
5.0		GRAVEL, COBBLES AND BOULDERS WITH SANDY SILT AND CLAY		255
246.6				250
17.0		SHALE SILTSTONE & LIMESTONE		245
239.3				240
24.3		END OF HOLE		
				235

WATER CONTENT W% ____ ○ NAT. ⊡ Lw △ Pw

DYNAMIC PENETRATION TEST BLOWS PER FOOT

N4

OTHER TESTS R.C. RECOV.	CONDITION	TYPE	NUMBER	PENETRATION RESISTANCE BLOWS/FT.
		2" O.D.	1	22
		2"	2	>100
56%		NXL R.C.	3	
57%			4	
50%			5	
53%			6	
76%			7	
78%			8	
64%			9	
82%			10	
100%			11	

SAMPLES

0 5 10 15 20

APPENDIX I

GEOCON

OFFICE REPORT ON SOIL EXPLORATION

CONTRACT T9442A BORING # N5 DATUM GEODETIC CASING NX

BORING DATE OCT. 20-21/71 REPORT DATE OCT. 25/71 COMPILED BY MN CHECKED BY [illegible]

SAMPLER HAMMER WT. 140 LBS. DROP 30 INCHES (PENETRATION RESISTANCES CONVERTED TO BLOWS OF 4200 IN - LBS. ENERGY)

SAMPLE CONDITION

- DISTURBED
- FAIR
- GOOD
- LOST

SAMPLE TYPES

A.S. - AUGER SAMPLE
S.T. - SLOTTED TUBE
W.S. - WASHED SAMPLE
D.O. - DRIVE-OPEN
D.F. - DRIVE-FOOT VALVE
C.S. - CHUNK SAMPLE
F.S. - FOIL SAMPLE
S.O. - SLEEVE-OPEN
S.F. - SLEEVE-FOOT VALVE
T.O. - THIN WALLED OPEN
R.C. - ROCK CORE

ABBREVIATIONS

V - IN-SITU VANE TEST
M - MECHANICAL ANALYSIS
U - UNCONFINED COMPRESSION
Qc - TRIAXIAL CONSOLIDATED UNDRAINED
Q - TRIAXIAL UNDRAINED
S - TRIAXIAL DRAINED
γ - WET UNIT WEIGHT
K - PERMEABILITY
C - CONSOLIDATION
WL - WATER LEVEL IN CASING
WT - WATER TABLE IN SOIL

SOIL PROFILE ELEVN. / DEPTH	WATER CONDITIONS	DESCRIPTION	STRAT. PLOT	ELEVATION SCALE	WATER CONTENT W% ⊙ NAT. ⊡ Lw △ Pw / DYNAMIC PENETRATION TEST BLOWS PER FOOT	OTHER TESTS Rc. RECOV.	SAMPLES CONDITION	TYPE	NUMBER	PENETRATION RESISTANCE BLOWS/FT.
265.8 / 0.0		GROUND LEVEL		270	N5					
		LOOSE TO VERY DENSE REDDISH BROWN CLAYEY SILT FILL WITH ORGANICS		265				2" D.O.	1	6
				260				2" D.O.	2	6
256.8 / 9.0	WL. @ EL. 257.4 OCT. 21, 1971	GRAVEL, COBBLES AND BOULDERS WITH SANDY SILT AND CLAY		255		91% / 83%		NXL R.C.	3 / 4	— / —
				250		0% / 28% / 86% / 68%		NXL R.C.	5 / 6 / 7 / 8	— / — / — / —
248.3 / 17.5		SHALE SILTSTONE & LIMESTONE		245						
241.3 / 24.5		END OF HOLE		240						

0 5 10 15 20

APPENDIX I

GEOCON

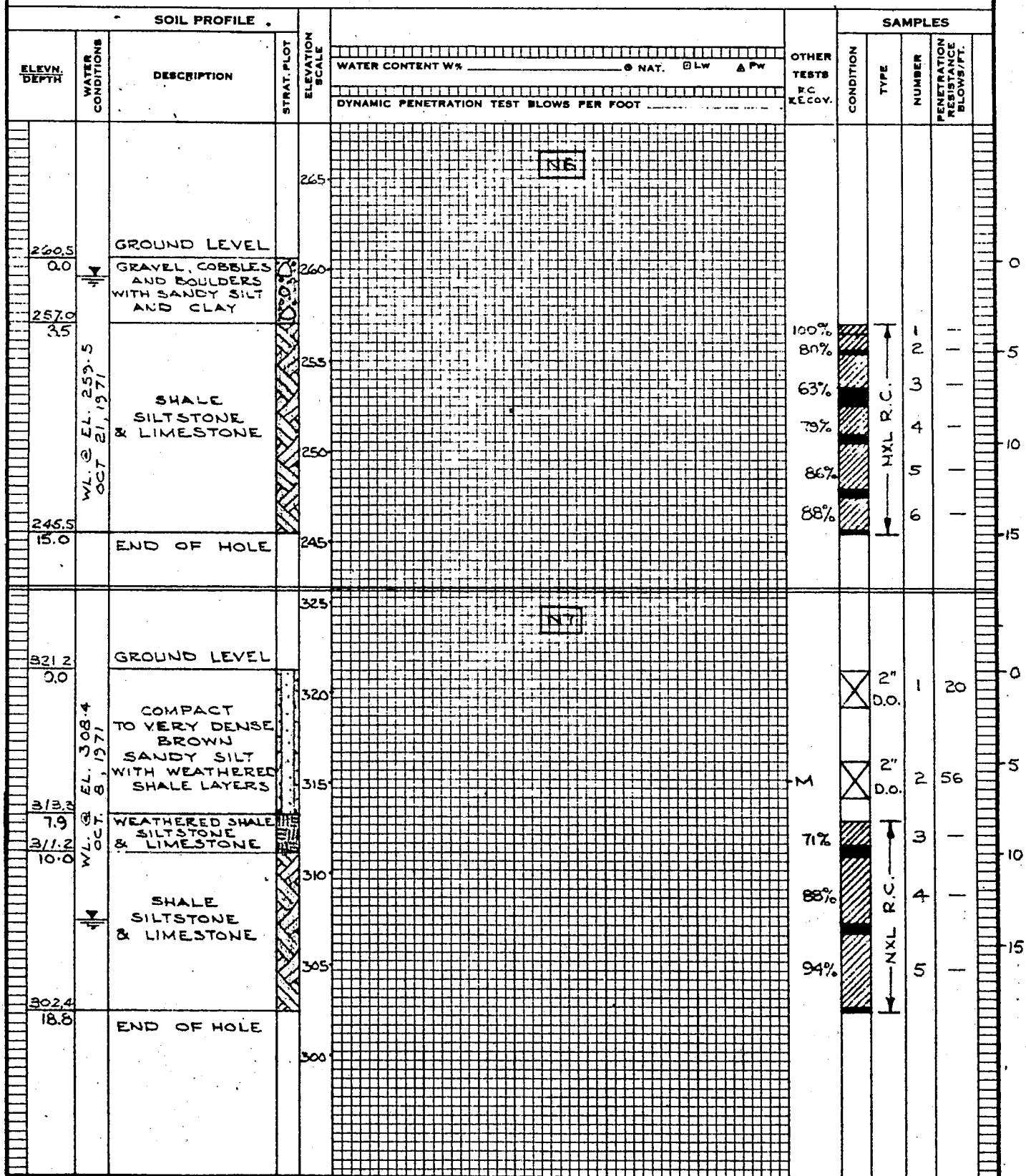
OFFICE REPORT ON SOIL EXPLORATION

CONTRACT T9442A BORING # N6 & N7 DATUM GEODETIC CASING NX
BORING DATE OCT 7-21/71 REPORT DATE OCT 25/71 COMPILED BY MN CHECKED BY DBD
SAMPLER HAMMER WT. 140 LBS. DROP 30 INCHES (PENETRATION RESISTANCES CONVERTED TO BLOWS OF 4200 IN - LBS. ENERGY)

SAMPLE CONDITION
DISTURBED
FAIR
GOOD
LOST

SAMPLE TYPES
A.S. - AUGER SAMPLE
S.T. - SLOTTED TUBE
W.S. - WASHED SAMPLE
D.O. - DRIVE-OPEN
D.F. - DRIVE-FOOT VALVE
C.S. - CHUNK SAMPLE
F.S. - FOIL SAMPLE
S.O. - SLEEVE-OPEN
S.F. - SLEEVE-FOOT VALVE
T.O. - THIN WALLED OPEN
R.C. - ROCK CORE

ABBREVIATIONS
V - IN-SITU VANE TEST
M - MECHANICAL ANALYSIS
U - UNCONFINED COMPRESSION
Qc - TRIAXIAL CONSOLIDATED UNDRAINED
Q - TRIAXIAL UNDRAINED
S - TRIAXIAL DRAINED
γ - WET UNIT WEIGHT
K - PERMEABILITY
C - CONSOLIDATION
WL - WATER LEVEL IN CASING
WT - WATER TABLE IN SOIL



APPENDIX I

GEOCON

OFFICE REPORT ON SOIL EXPLORATION

CONTRACT T9442A BORING # N8 DATUM GEODETIC CASING BX
BORING DATE OCT. 4-5/71 REPORT DATE OCT. 25/71 COMPILED BY MN CHECKED BY MD
SAMPLER HAMMER WT. 140 LBS. DROP 30 INCHES (PENETRATION RESISTANCES CONVERTED TO BLOWS OF 4200 IN - LBS. ENERGY)

SAMPLE CONDITION
DISTURBED
FAIR
GOOD
LOST

SAMPLE TYPES
A.S. - AUGER SAMPLE
S.T. - SLOTTED TUBE
W.S. - WASHED SAMPLE
D.O. - DRIVE-OPEN
D.F. - DRIVE-FOOT VALVE
C.S. - CHUNK SAMPLE
F.S. - FOIL SAMPLE
S.O. - SLEEVE-OPEN
S.F. - SLEEVE-FOOT VALVE
T.O. - THIN WALLED OPEN
R.C. - ROCK CORE

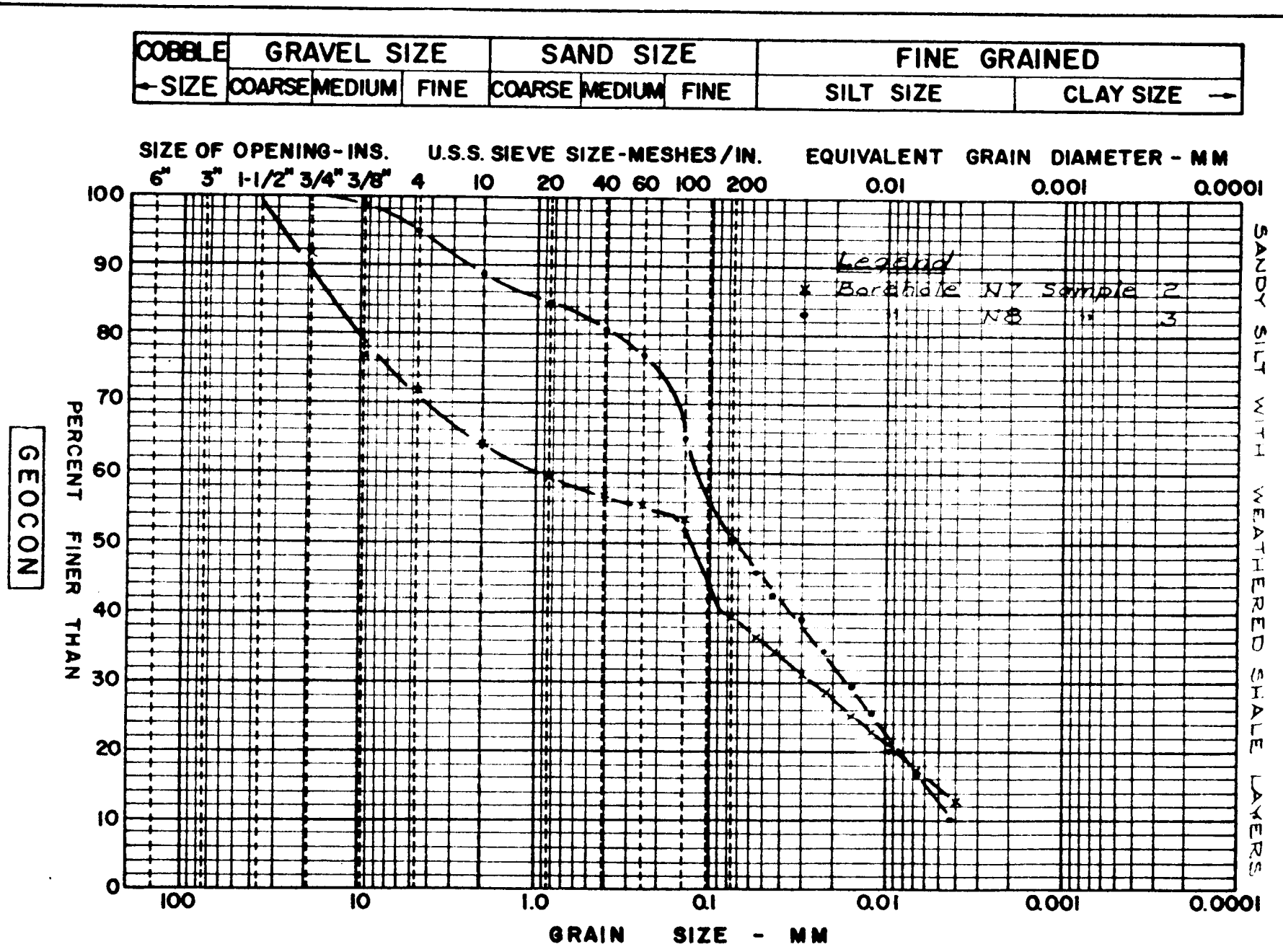
ABBREVIATIONS
V - IN-SITU VANE TEST
M - MECHANICAL ANALYSIS
U - UNCONFINED COMPRESSION
Qc - TRIAXIAL CONSOLIDATED UNDRAINED
Q - TRIAXIAL UNDRAINED
S - TRIAXIAL DRAINED
γ - WET UNIT WEIGHT
K - PERMEABILITY
C - CONSOLIDATION
WL - WATER LEVEL IN CASING
WT - WATER TABLE IN SOIL

SOIL PROFILE				ELEVATION SCALE	WATER CONTENT W% ○ NAT. ⊡ LW △ PW / DYNAMIC PENETRATION TEST BLOWS PER FOOT	OTHER TESTS R.C. RECOV.	SAMPLES				
ELEVN. / DEPTH	WATER CONDITIONS	DESCRIPTION	STRAT. PLOT				CONDITION	TYPE	NUMBER	PENETRATION RESISTANCE BLOWS/FT.	
838.0 / 0.0		GROUND LEVEL		340	N8						0
		COMPACT TO VERY DENSE BROWN SANDY SILT WITH WEATHERED SHALE LAYERS		335				C.S. 2" D.O.	1 1A	— 21	5
				330				2" D.O.	2	73	
				325		M		"	3	>100	10
823.0 / 15.0		WEATHERED SHALE SILTSTONE & LIMESTONE		320		25%			4	>100	15
316.5 / 21.5		SHALE SILTSTONE & LIMESTONE		315		60%			5	—	20
				310		17%		BXL. R.C.	6	—	25
				305		92%			7	—	30
303.8 / 34.2		END OF HOLE		300					8	—	

APPENDIX II

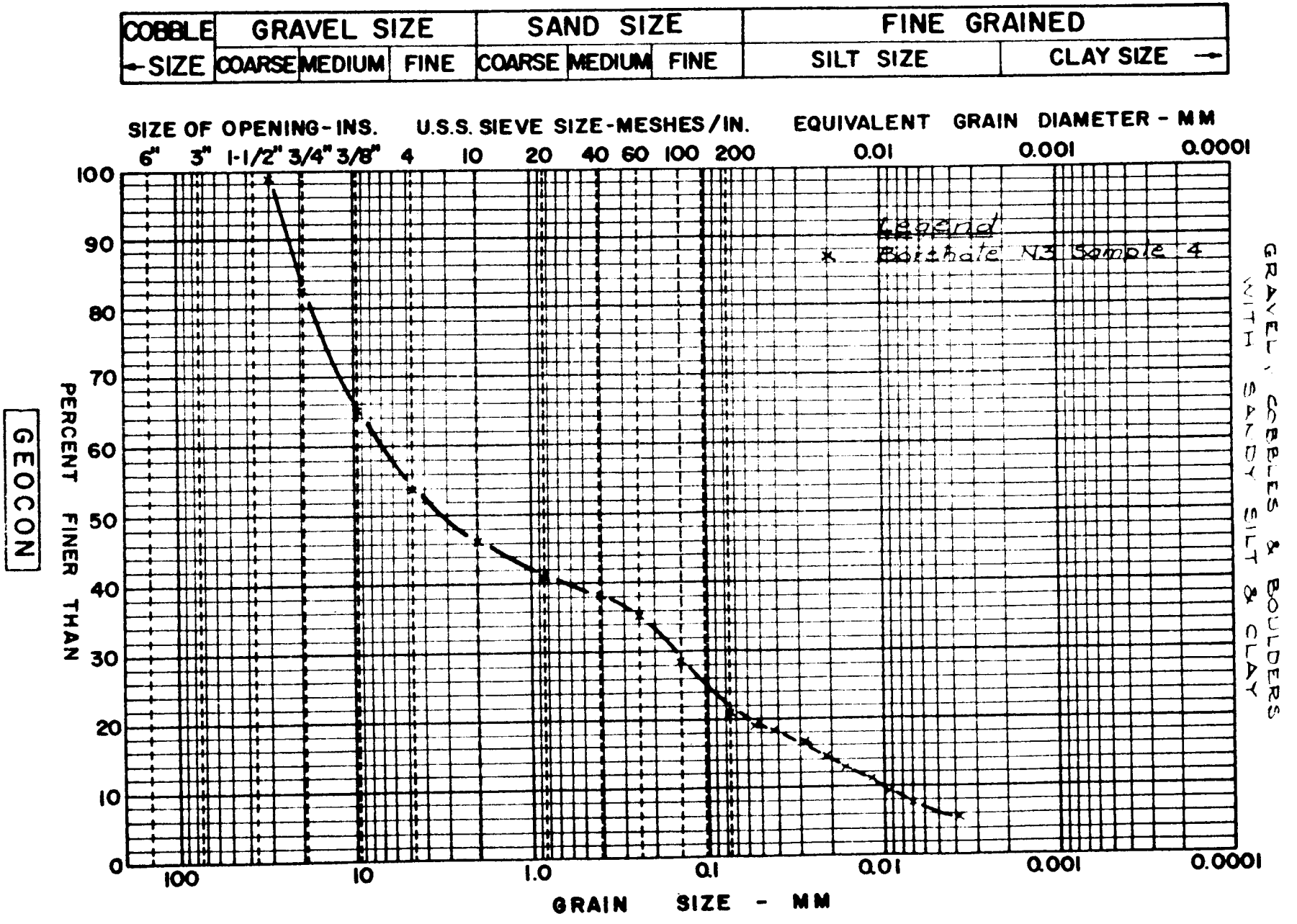
FIGURES – LABORATORY TESTING

GRAIN SIZE DISTRIBUTION



APPENDIX II
FIGURE 1
PROJECT T9442A

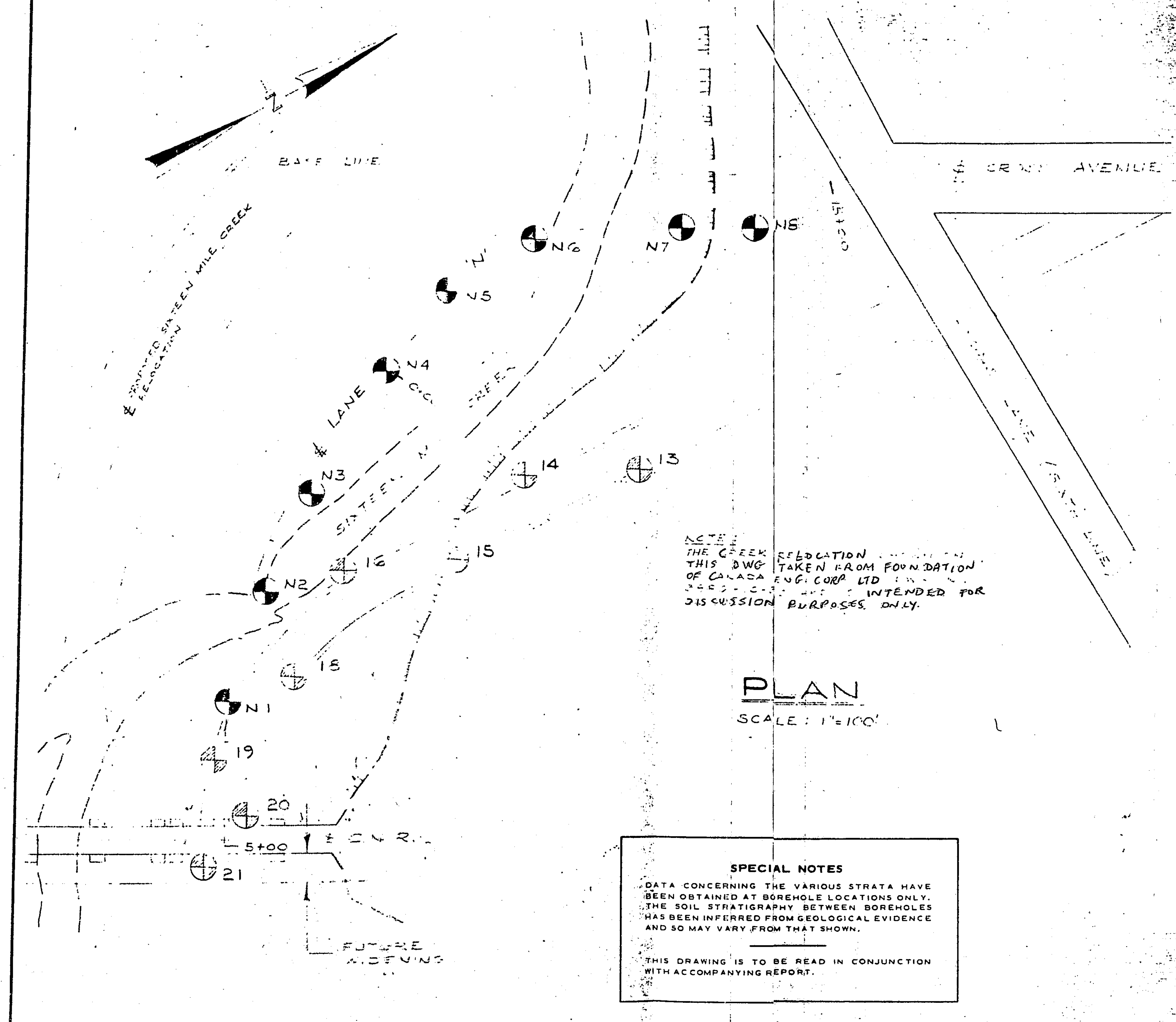
GRAIN SIZE DISTRIBUTION



GEOCON

M.I.T. GRAIN SIZE SCALE

APPENDIX II
FIGURE 2
PROJECT T9442A



NOTE:
THE CREEK RELOCATION … THIS DWG TAKEN FROM FOUNDATION OF CANADA ENG. CORP LTD … INTENDED FOR DISCUSSION PURPOSES ONLY.

PLAN

SCALE: 1"=100'

LEGEND

- N2 — BOREHOLE IN PLAN
- (N2) — BOREHOLE IN SECTION
- 20 — BOREHOLE IN PLAN (PREVIOUS INVESTIGATION)
- (20) — BOREHOLE IN SECTION (PREVIOUS INVESTIGATION)
- WATER LEVEL - OCT 1971

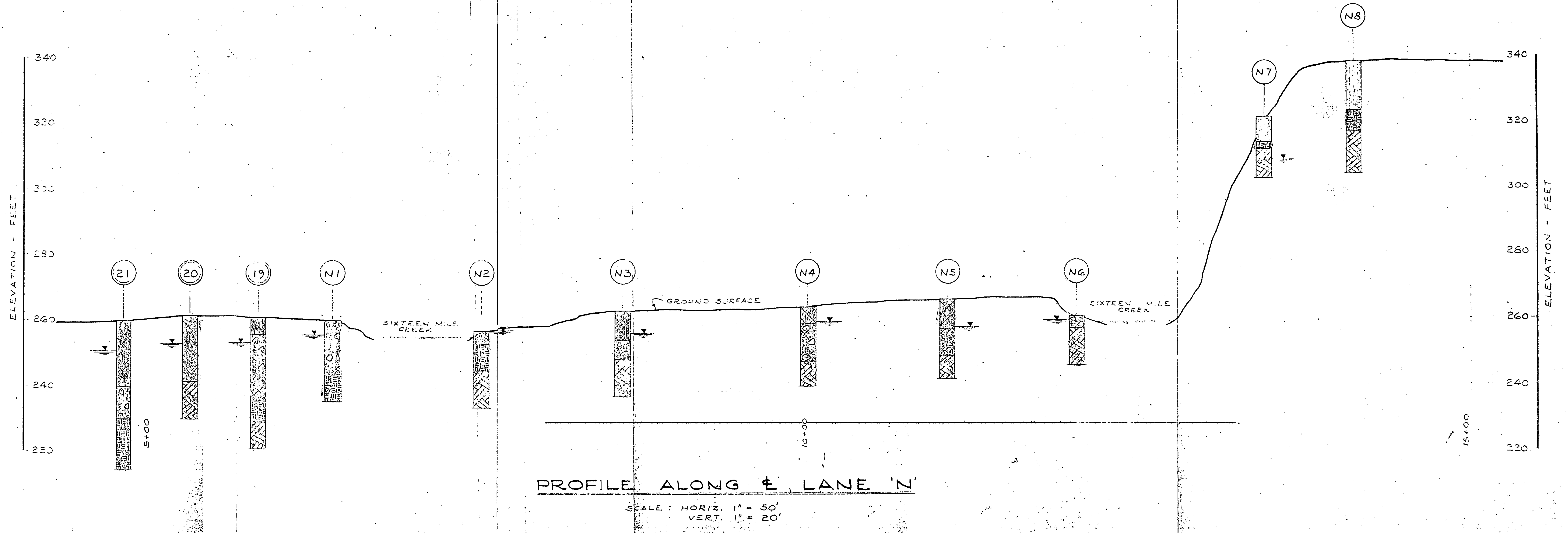
STRATIGRAPHY

- LOOSE TO VERY DENSE REDDISH BROWN SANDY SILT FILL WITH ORGANICS
- COMPACT TO VERY DENSE BROWN SANDY SILT WITH WEATHERED SHALE LAYERS
- GRAVEL, COBBLES AND BOULDERS WITH SANDY SILT AND CLAY
- WEATHERED SHALE, SILTSTONE AND LIMESTONE.
- SHALE, SILTSTONE AND LIMESTONE

SPECIAL NOTES

DATA CONCERNING THE VARIOUS STRATA HAVE BEEN OBTAINED AT BOREHOLE LOCATIONS ONLY. THE SOIL STRATIGRAPHY BETWEEN BOREHOLES HAS BEEN INFERRED FROM GEOLOGICAL EVIDENCE AND SO MAY VARY FROM THAT SHOWN.

THIS DRAWING IS TO BE READ IN CONJUNCTION WITH ACCOMPANYING REPORT.



PROFILE ALONG ℄ LANE 'N'

SCALE: HORIZ. 1" = 50'
VERT. 1" = 20'

REFERENCE	
DWG. NO	DESCRIPTION
3686-1C-13	FOUNDATION OF CANADA ENGINEERING CORPORATION LIMITED - TOWN OF OAKVILLE CROSS AVE. EXTENSION TO SPEERS RD. -BOREHOLE LOCATIONS.
T9442	GEOCON LTD REPORT. SPEERS ROAD EXTENSION DATED: OCT. 12, 1971

FOUNDATION OF CANADA ENGINEERING CORPORATION LIMITED
TORONTO ONTARIO

CROSS AVENUE CONNECTION
LANE 'N'
OAKVILLE ONTARIO
SOIL AND ROCK STRATIGRAPHY

GEOCON LTD.

DATE NOV 8, 1971 SCALE AS SHOWN

MADE	CHKD	APPD	
AEL	KKT	DBO	No. T9442A-1

GEOCON REPORT
SOIL CONDITIONS

SIXTEEN MILE CREEK RELOCATION
OAKVILLE, ONTARIO

FOUNDATION OF CANADA
ENGINEERING CORPORATION LIMITED

CR 9

GEOCON LTD

Rexdale, Ontario
June 7, 1973

Foundation of Canada Engineering
Corporation Limited
1 Yonge Street
Toronto, Ontario
M5E 1E7

Attention: Mr. M.C. Douglas, P. Eng.,
Chief Engineer, Transportation

Re: Supplementary Soil Investigation-Test Pits
Speers Road Project
Oakville, Ontario

Dear Sirs:

This letter reports the results of a series of Test Pits excavated on June 5th, 1973 at a number of locations within the valley. The purpose of the Test Pits was to permit observation of the characteristics of the fill en mass as a result of concern expressed by the writer at the meeting at your Offices on May 31st, 1973 that the small scale of the boreholes did not permit a comprehensive evaluation of fill characteristics in such a deposit.

The locations of the Test Pits were recorded by your site representatives during the test-pitting. The Test Pits were excavated using a Massey Ferguson Backhoe with a 1/3 cubic yard bucket.

The results of the Test Pits are summarized in Table 1 accompanying this letter.

In summary, at each Test Pit location ground surface is underlain by up to 2 feet of essentially clean fill of clay, sand and organics (topsoil) followed by miscellaneous fill, (garbage). In some of the Test Pits, there is evidence of clay, sand and gravel mixed within the garbage although it is obvious from all the Test Pits that any such clean fill occurs randomly and represents only a small percentage of the fill. The fill in Test Pit Number 3 is followed by boulders, cobbles with some sand and gravel in the matrix; the backhoe was able to excavate to a depth of 3 feet in this material and it is possible that this represents a fill associated with the

.../2

adjacent railway pier excavation. In all the remaining Test Pits, the backhoe was unable for all practical purposes to excavate into the underlying material. Repeated attempts with the small bucket of the backhoe were met with refusal. From all of our boreholes, it is inferred that this stratum is the boulder, cobble and gravel stratum described on the Office Reports on Exploration in the various reports submitted by us on this project. As described in our reports, in most boreholes it was necessary to diamond drill the casing to achieve penetration of this formation. Since it was possible to drive the 2 inch split-spoon sampler and the Dynamic Penetration Tests to varying degrees within this formation, this formation is not the bedrock even though the high boulder and cobble percentage gives the appearance of the bedrock, particularly in small scale excavations.

As noted on the Test Pit Summaries, groundwater was encountered towards the base of the fill with high seepage flows noted particularly at the contact between the fill and the underlying natural formation.

We trust that this letter which will form an addendum to the soils information already submitted in our three reports on this project, is sufficient for your present purposes. Should you have any questions or wish our assistance further, we would be pleased if you would call us.

Yours very truly,

GEOCON LTD

D.B. Oates

DBO/vg
T9673

D. B. Oates, P. Eng.,
Regional Engineer

TABLE I

TEST PIT No. 1	0-2'.0	sand-clay fill and organics (topsoil)
	2'0"-8'0"	garbage (occasional gravel, sand)
	8'0"*	
	Water seepage at 7' 6"	
TEST PIT No. 2	0-16"	reddish brown clay sand fill with organics (topsoil)
	16"-8'2"	garbage (occasional clay fill)
	8'2"-9'6"	boulders, cobbles
	9'6"*	
	Water seepage at 8'0"	
TEST PIT No. 3	0-12"	clay sand fill and organics (topsoil)
	1'0"-6'0"	garbage
	6'0"-9'0"	boulders, cobbles and gravel (possibly fill)
	9'6"*	
	Water level at 7' 4"	
TEST PIT No. 4	0'6"	topsoil
	6"-3'6"	sand fill with traces of organics, and lumber
	3'6"-5'6"	reddish brown weathered shale fill
	5'6"-7'6"	boulders, cobbles and gravel
	7'6"*	
TEST PIT No. 5	0'5"	topsoil
	5"-7'0"	garbage
	7'0"-7'6"	boulders, cobbles
	7'6"*	
	Water seepage at 6'6"	
TEST PIT No. 6	0"-2'4"	sand silty clay fill with organics (topsoil)
	2'4"-8'4"	garbage (some clay fill, occasional boulders)
	8'4"	
	Water seepage at 6'0"	
TEST PIT No. 7	0'7"	reddish brown shale ; weathered shale
	7"-14'0"	garbage (occasional sand, gravel)
	14'0"*	
	Water seepage at 7.0'	

* Refusal to the backhoe - inferred boulder, cobble and gravel stratum

.../2

TABLE I (continued)

TEST PIT No. 8	0-12"	brown clay (topsoil)
	12"-7'4"	garbage (some clay fill)
	7'4"*	

Water seepage at 6'9"

* Refusal to backhoe - inferred boulder, cobble and gravel stratum

SK 4

GEOCON LTD

Rexdale, Ontario
May 23, 1973

Foundation of Canada Engineering
Corporation Limited
1 Yonge Street
Toronto, Ontario
M5E 1E7

Attention: Mr. M.C. Douglas, P. Eng.,
Chief Engineer, Transportation

Re: Soil Conditions
Sixteen Mile Creek Relocation
Oakville, Ontario

Dear Sir:

This letter reports the results of the above soil investigation carried out in accordance with our proposal of April 19th, 1973. The object of the investigation was to determine the soil and groundwater conditions at the site pertinent to the design and construction of the above diversion.

1.0 PROCEDURE AND FIELD EQUIPMENT

The field work was carried out between April 17th, and May 3rd, 1973. A total of 11 boreholes and 10 Dynamic Cone Penetration Tests were put down using a skid-mounted diamond drill rig; a bulldozer was used to move the drill rig from borehole to borehole.

Sampling of the overburden at the boreholes was carried out at intervals of 5 feet or closer using a 2 inch O.D. standard split-spoon sampler. NX size casing was used in all the boreholes except Borehole C1A. The shale, siltstone and limestone where encountered and in most cases the granular overburden were cored in NX size. Standpipes were installed in every borehole but some of them were destroyed by vandalism during the time when the field crew were off duty.

... /2

T9673

REPORT

TO

FOUNDATION OF CANADA ENGINEERING

CORPORATION LIMITED

ON

SOIL CONDITIONS

SIXTEEN MILE CREEK RELOCATION

OAKVILLE ONTARIO

Distribution:

9 copies - Foundation of Canada Engineering Corporation Limited

3 copies - Geocon Ltd

GEOCON

1.0 PROCEDURE AND FIELD EQUIPMENT (continued)

The locations of the boreholes together with the inferred soil stratigraphy are shown on Drawing T9673-1 at the rear of this report. Detailed logs of the boreholes are given on the Office Report on Soil Exploration in Appendix I.

The samples remaining after testing will be stored until May, 1974 at which time you will be contacted for instructions regarding their disposal.

The locations and ground elevations at the boreholes were obtained by our engineering staff. The corners of the CNR bridge piers were used as reference points in determining the location of the boreholes. The bench mark in the vicinity of the CNR bridge at the north bank of the creek was used as a reference point in determining the elevations. It is understood that this bench mark has an elevation of 258.86 referred to Geodetic Datum.

2.0 SOIL CONDITIONS

The principal strata encountered by the boreholes are as follows.

2.1 Topsoil - Pt

Extending from the ground surface at all borehole locations except C3, a thin layer of topsoil was encountered. The thickness of the topsoil ranged from about 1 inch at Borehole C9 to 6 inches at Boreholes C1 and C4.

2.2 Miscellaneous Fill

Extending from the ground surface at Borehole C3 and underlying the topsoil in all the other boreholes with the exception of Borehole C10, a stratum of fill was encountered. The samples recovered in the boreholes indicate a surficial layer of clay, sand and gravel immediately beneath the topsoil followed by a wide variety of material that includes waste such as paper, rags, metal, etc. along with evidence of gravel, sand and clay. The thickness of this stratum varied approximately from 5.0 feet in Borehole C3 to 12.0 feet in Borehole C8.

2.0 SOIL CONDITIONS (continued)

2.2 Miscellaneous Fill (continued)

Standard Penetration Tests carried out in the fill stratum gave "N" values ranging from 3 to over 100 blows per foot. Because of the characteristics of the fill, these values are meaningless in terms of relative density.

2.3 Boulders, Cobbles and Gravel with Sand to Clay Traces

Underlying the topsoil layer in Borehole C10 and the fill stratum in all other boreholes, a stratum consisting predominantly boulders, cobbles and gravel was encountered. With the exception of Boreholes C1, C6 and C9, all boreholes were terminated in this stratum. Further, with the exception of Boreholes C1A, C8 and the upper 17 feet of C10, it was necessary to drill the casing through this formation. The thickness of this stratum in Boreholes C1, C6 and C9 was 24, 14 and 11.5 feet respectively. The depth of this stratum penetrated in other boreholes ranged from 3.5 feet in Borehole C1A to 21.4 feet in Borehole C10.

Seven Mechanical Analysis Tests were carried out on samples recovered from this stratum; the tests reflect only the minus 1.5 inch fraction. The results of these tests are plotted as grain size distribution curves on Figure 1 of Appendix II and indicate the samples contained 17 to 31 percent gravel, 15 to 28 percent sand and 15 to 56 percent silt and clay sizes. The percentage of gravel and cobble sized core recovered when diamond drilling through this stratum is given on the Office Reports; since core can be lost by grinding during diamond drilling, these percentages would be minimum values of each borehole.

Standard Penetration Tests carried out in this stratum gave "N" values ranging from 13 to over 100 blows per foot indicating the relative density of this stratum to be compact to very dense but generally to be dense to very dense.

.../4

2.0 SOIL CONDITIONS (continued)

2.4 Weathered Shale, Siltstone and Limestone

Underlying the stratum of boulders, cobbles and gravel in Boreholes C6 and C9, weathered shale, siltstone and limestone was encountered which is believed to be the start of the stratum described in 2.5. Penetration into this stratum was achieved only by split-spoon sampler and was about 1.1 feet in Borehole C6 and 2.0 feet in Borehole C9.

Two Standard Penetration Tests carried out in this stratum gave "N" values of 62 and 100 blows per foot.

2.5 Shale, Siltstone and Limestone

Underlying the stratum of boulders, cobbles and gravel in Borehole C1, shale, siltstone and limestone was encountered. The boundary between the overburden and this stratum could not be established precisely. However, from the run of NX rock coring from elevation 227.9 to 222.9, 2 feet of shale, siltstone and limestone was recovered at the end of the core barrel with 16 inches of subangular to angular gravel and cobbles recovered in the upper part of the core barrel. It is inferred the elevation of the surface of this stratum starts at about elevation 224.9. The depth of rock cored was 11.4 feet and the recovery was about 96 to 97 percent.

Examination of the rock core recovered indicates the rock to be grey shale, siltstone and limestone with numerous horizontal planes and occasional thin clay seams. Vertical and inclined fractures were also observed approximately from elevation 220.4 to 218.4. Core lengths generally ranged from 1 inch to a maximum of 5 inches. During drilling of the rock, no loss in drill pressure or water was observed.

3.0 WATER CONDITIONS

Water levels observed inside open boreholes or standpipes at the end of the drilling program are reported on the Office Report on Soil Exploration in Appendix I.

.../5

4.0 DISCUSSION

The proposed configuration of the Creek Relocation has been given to us on your Drawings 3686-1C-30, 31 and 35 and in preliminary discussions with your Mr. R. Treftlin. It is understood that following receipt of this report, we would meet with you to discuss the total construction work including the Speers Road Extension, the Cross Avenue Connection and the Creek Relocation.

As proposed, the new creek will require excavation below ground level ranging from a few feet where the new and existing creeks join to about 12 feet in the vicinity of Borehole C9. For the most part excavation will extend through a surficial miscellaneous fill. The creek bed, for the most part, will expose the stratum of boulders, cobbles, and gravel. Based on the water level observations at the time of investigation, excavation will be required 1 to 3 feet below groundwater level to channel invert and to as much as 6 feet to the base of the gabion linings. As presently envisaged, construction will be carried out isolated from the existing creek but that excavation will have to contend with groundwater seepage. The sides of the channel will be essentially vertical and lined with gabions, the floor of the channel will have gabion protection at a number of places where drops of 1 to 2 feet in the channel level are proposed.

Based on the boreholes put down in this investigation, and discussions with your Mr. R. Treftlin, the following factors should be considered in design and construction.

(a) As mentioned above, excavation will be required to several feet below the groundwater level. The method of excavation and equipment selection will have to take into consideration a number of factors such as the proximity of the excavation to the existing creek, the wide variety of materials that occur in the fill, the very dense nature, and boulder and cobble content in the natural material below the fill and means of handling groundwater seepage from the fill and underlying natural material. Depending on the method of construction selected by the Contractor, consideration might be given to excavation and installation of the gabions in short sections; the intent of this would be to minimize the time of exposure and deterioration of the foundation

.../6

4.0 DISCUSSION (continued)

(a) subsoil the extent of which will depend on the means selected to handle groundwater seepage unless the gabions are installed underwater.

(b) The permanent walls of the channel will be essentially vertical to the level of the 10 year storm water level, formed with gabion baskets, above which slopes will be cut at about 2 horizontal to 1 vertical to meet the existing ground level. Because of the wide variation in characteristics of the fill material, the fill is considered scour susceptible. However, the fill will be protected by the gabion linings except for those water levels computed for the 100 year storm. It will be necessary to provide protective cover to the fill above the gabions, although this could be handled as part of the backfill operations behind the gabions.

(c) Because of the wide variety of gradations, particularly in the fill stratum, there is not one unique material that would satisfy the filter requirements between the gabion baskets and the site material. Material conforming to the gradation of Granular 'A' fill is considered the best selection for backfill in this case.

(d) From examination of the samples recovered in this investigation, it is not possible to judge what the overall characteristics of the fill are, since the samples vary from being essentially "clean" fill to waste materials (garbage). We would be pleased to discuss this point further with you in the light of fill quantity requirements and to decide whether some further investigation is meritted, such as test pits to expose the fill and permit better examination.

The existing boulder, cobble and gravel stratum would be a good source of fill for any embankment construction. However, it would require some stockpiling to reduce the moisture content to below optimum for it to be successfully used in a compacted embankment. Mixing with any miscellaneous fill would also have to be avoided during its excavation.

.../7

5.0 GENERAL

We trust that this report provides all of the information required from us at this time. We are at your disposal to provide further information to you during the course of final design.

Respectfully submitted,

GEOCON LTD

D.B. Oates, P. Eng.,
Regional Engineer

DBO/vg
T9673

APPENDIX I

OFFICE REPORTS ON SOIL EXPLORATION

GEOCON

EXPLANATION OF THE FORM "OFFICE REPORT ON SOIL EXPLORATION"

The object of this form is to enable a comprehensive study of the soil to be made by combining on one sheet all of the information obtained from the boring. An explanation of the various columns of the report follows.

ELEVATION AND DEPTH

This column gives the elevation and depth of boundaries between the various soil strata. The elevation is referred to the datum shown in the general heading.

WATER CONDITIONS

In this column the water level in the casing at the time of boring or the water table in the ground, determined by a series of observations in a piezometer or standpipe, is indicated to scale by a horizontal line with the symbol W.L. or W.T. above the line. A notation of any complicated groundwater conditions will be made in this column.

DESCRIPTION

A description of the soil, using standard terminology, is contained in this column. The consistency of cohesive soils and the relative density of non-cohesive soils are described by the following terms:

Consistency	U-Strength Tons/sq. ft.	Relative Density	Standard Penetration Resistance. Blows/ft.
Very soft	0.03 to 0.25	Very loose	0 to 4
Soft	0.25 to 0.5	Loose	4 to 10
Firm	0.5 to 1.0	Compact	10 to 30
Stiff	1.0 to 2.0	Dense	30 to 50
Very stiff	2.0 to 4.0	Very dense	over 50
Hard	over 4.0		

STRATIGRAPHIC PLOT

The stratigraphic plot follows the standard symbols of the National Research Council, Canada.

ELEVATION SCALE

The information in all columns is plotted to a true elevation scale which is shown in this column.

GRAPHS

The main body of the report forms a graph which is used to plot to correct elevation the important soil properties which are obtained through field and laboratory tests. The scales and symbols for the plotting are shown at the head of the column.

OTHER TESTS

In this column are shown, by symbol, the other field or laboratory tests which have been performed on the soil and for which the results have not been plotted on the above graph.

SAMPLES

The first three columns describe the condition, type and number of each sample obtained from the boring. The location and extent of each sample is plotted to scale.

In the last column is shown the penetration resistance in blows of 4200 inch-pounds required to drive one foot of the sampler into the ground. When a 2 inch Drive Sampler is used the result obtained is termed the "Standard Penetration Resistance".

GEOCON

APPENDIX I

OFFICE REPORT ON SOIL EXPLORATION

CONTRACT T7673 BORING # C1 DATUM GEODETIC CASING NX
BORING DATE APR. 17-19/73 REPORT DATE MAY 3, 1973 COMPILED BY AEL CHECKED BY KKT
SAMPLER HAMMER WT 140 LBS. DROP 30 INCHES (PENETRATION RESISTANCES CONVERTED TO BLOWS OF 4200 IN - LBS ENERGY)

SAMPLE CONDITION
- DISTURBED
- FAIR
- GOOD
- LOST

SAMPLE TYPES
A.S. - AUGER SAMPLE; S.T. - SLOTTED TUBE; W.S. - WASHED SAMPLE; D.O - DRIVE-OPEN; D.F. - DRIVE-FOOT VALVE; C.S. - CHUNK SAMPLE; F.S. - FOIL SAMPLE; S.O - SLEEVE-OPEN; S.F. - SLEEVE-FOOT VALVE; T.O. - THIN WALLED OPEN; R.C - ROCK CORE

ABBREVIATIONS
V - IN-SITU VANE TEST; M - MECHANICAL ANALYSIS; U - UNCONFINED COMPRESSION; Qc - TRIAXIAL CONSOLIDATED UNDRAINED; Q - TRIAXIAL UNDRAINED; S - TRIAXIAL DRAINED; γ - WET UNIT WEIGHT; K - PERMEABILITY; C - CONSOLIDATION; WL - WATER LEVEL IN CASING; WT - WATER TABLE IN SOIL

UNDRAINED SHEAR STRENGTH - PSF (0 / 5 / 10) LAB. U - TEST % STRAIN — FIELD VANE, REMOULDED, LAB. VANE, REMOULDED

WATER CONTENT W% (20, 40, 60, 80) ● NAT. ⊡ Lw ▲ Pw

DYNAMIC PENETRATION TEST BLOWS PER FOOT (20, 40, 60, 80)

ELEVN. / DEPTH	WATER CONDITIONS	DESCRIPTION	STRAT. PLOT	ELEVATION SCALE
258.9 / 0.0		GROUND LEVEL 6" TOPSOIL		260
		MISCELLANEOUS FILL GRAVEL, SAND AND CLAY ORGANICS, RAGS & GLASS PIECES ETC.		255
248.9 / 10.0				250
	WL. @ EL. 251.4 MAY 3, 1973	BOULDERS, COBBLES AND GRAVEL WITH SAND TO CLAY TRACES		245
				240
				235
224.9 / 34.0		SHALE SILTSTONE & LIMESTONE		230
				225
				220
213.5 / 45.4		END OF HOLE		215
				210

C-1

OTHER TESTS (CORE RECOV. % MAX. CORE LENGTH)	CONDITION	TYPE	NUMBER	PENETRATION RESISTANCE BLOWS/FT.
		2" DF	1	3
		" DF	2	7
		" DF	3	8
		" DF	4	24
		" DF	5	31
100% (3½')		NX RC	6	–
35% (1½')		"	7	–
		" DF	8	>100
63% (2½')		NX RC	9	–
		" DF	10	>100
40% (1')		NX RC	11	–
		" DF	12	30
100% (2½')		NX RC	13	–
57% (3')		"	14	–
		" DF	15	>100
67% (4½')			16	–
96% (5')		NX RC	17	–
97% (5')			18	–

DEPTH - FT. 0, 5, 10, 15, 20, 25, 30, 35, 40, 45, 50, 55

GEOCON

APPENDIX I

OFFICE REPORT ON SOIL EXPLORATION

CONTRACT T9673 BORING # C1A DATUM GEODETIC CASING –
BORING DATE MAY 3, 1973 REPORT DATE MAY 9, 1973 COMPILED BY KKT CHECKED BY KKT
SAMPLER HAMMER WT 140 LBS DROP 30 INCHES (PENETRATION RESISTANCES CONVERTED TO BLOWS OF 4200 IN - LBS. ENERGY)

SAMPLE CONDITION
DISTURBED
FAIR
GOOD
LOST

SAMPLE TYPES
A.S - AUGER SAMPLE
S.T - SLOTTED TUBE
W.S - WASHED SAMPLE
D.O. - DRIVE-OPEN
D.F - DRIVE-FOOT VALVE
C.S. - CHUNK SAMPLE
F.S - FOIL SAMPLE
S.O - SLEEVE-OPEN
S.F SLEEVE-FOOT VALVE
T.O - THIN WALLED OPEN
R.C. - ROCK CORE

ABBREVIATIONS
V - IN-SITU VANE TEST
M - MECHANICAL ANALYSIS
U - UNCONFINED COMPRESSION
Qc - TRIAXIAL CONSOLIDATED UNDRAINED
Q - TRIAXIAL UNDRAINED
S - TRIAXIAL DRAINED
γ - WET UNIT WEIGHT
K - PERMEABILITY
C - CONSOLIDATION
WL - WATER LEVEL IN CASING
WT - WATER TABLE IN SOIL

UNDRAINED SHEAR STRENGTH - PSF
LAB. U - TEST 15 0 5 10 % STRAIN
FIELD VANE
REMOULDED
LAB. VANE
REMOULDED
WATER CONTENT W% 20 40 60 80 ⊙ NAT ⊡ Lw △ Pw
DYNAMIC PENETRATION TEST BLOWS PER FOOT 20 40 60 80

ELEVN. / DEPTH	WATER CONDITIONS	DESCRIPTION	STRAT PLOT	ELEVATION SCALE	OTHER TESTS	SAMPLES: CONDITION	TYPE	NUMBER	PENETRATION RESISTANCE BLOWS/FT.	DEPTH - FT.
258.9 / 0.0	W.L. EL 251.4 @ 3 MAY 1973	GROUND LEVEL 5" TOPSOIL		260			2" DF	1	6	0
		MISCELLANEOUS FILL GRAVEL, SAND AND CLAY METAL PIECES, RAGS, ORGANICS ETC.		255			" DF	2	8	
							" DF	3	15	5
							" DF	4	7	
249.9 / 10.0				250			" DF	5	15	
		BOULDERS COBBLES AND GRAVELS WITH SAND TO CLAY TRACES			M		" DF	6	29	10
245.4 / 13.5		END OF HOLE		245			" DF	7	>100	
										15
										20
										25
										30
										35
										40
										45
										50
										55

GEOCON

APPENDIX I

OFFICE REPORT ON SOIL EXPLORATION

CONTRACT 13673 BORING # C2 and C3 DATUM GEODETIC CASING NX
BORING DATE APR. 23, 1973 REPORT DATE MAY 3, 1973 COMPILED BY A.E.L. CHECKED BY K.K.T.
SAMPLER HAMMER WT 140 LBS DROP 30 INCHES (PENETRATION RESISTANCES CONVERTED TO BLOWS OF 4200 IN - LBS. ENERGY)

SAMPLE CONDITION: DISTURBED; FAIR; GOOD; LOST

SAMPLE TYPES: A.S. - AUGER SAMPLE; S.T. - SLOTTED TUBE; W.S. - WASHED SAMPLE; D.O. - DRIVE-OPEN; D.F. - DRIVE-FOOT VALVE; C.S. - CHUNK SAMPLE; F.S. - FOIL SAMPLE; S.O. - SLEEVE-OPEN; S.F. - SLEEVE-FOOT VALVE; T.O. - THIN WALLED OPEN; R.C. - ROCK CORE

ABBREVIATIONS: V - IN-SITU VANE TEST; M - MECHANICAL ANALYSIS; U - UNCONFINED COMPRESSION; Qc - TRIAXIAL CONSOLIDATED UNDRAINED; Q - TRIAXIAL UNDRAINED; S - TRIAXIAL DRAINED; γ - WET UNIT WEIGHT; K - PERMEABILITY; C - CONSOLIDATION; WL - WATER LEVEL IN CASING; WT - WATER TABLE IN SOIL

UNDRAINED SHEAR STRENGTH - PSF (LAB. U - TEST; 0, 5, 10, 15 % STRAIN) — FIELD VANE; REMOULDED; LAB. VANE; REMOULDED

WATER CONTENT W% — G NAT; LW; PW

DYNAMIC PENETRATION TEST BLOWS PER FOOT

C2

ELEVN. / DEPTH	DESCRIPTION	WATER CONDITIONS	STRAT. PLOT
260.2 / 0.0	GROUND LEVEL		
	5" TOPSOIL		
	MISCELLANEOUS FILL GRAVEL, SAND AND CLAY, ORGANICS, RAGS, METAL PIECES ETC.	WL @ EL. 252.5 MAY 3, 1973	
249.2 / 11.0	BOULDERS, COBBLES AND GRAVEL WITH SAND TO CLAY TRACES		
243.7 / 16.5	END OF HOLE		

50 BLOWS - LAST 2" (108, 140)

OTHER TESTS: CORE RECOV. % (MAT. CORE LENGTH %) — 58% (4")

CONDITION	TYPE	NUMBER	PENETRATION RESISTANCE BLOWS/FT.
	2" DF	1	10
	" DF	2	24
	" DF	3	>100
	NX RC	4	-
	" DF	5	>100

C3

ELEVN. / DEPTH	DESCRIPTION	WATER CONDITIONS	STRAT. PLOT
256.8 / 0.0	GROUND LEVEL		
	MISCELLANEOUS FILL GRAVEL, SAND & CLAY, ORGANICS, CINDER.		
251.8 / 5.0	BOULDERS, COBBLES AND GRAVEL WITH SAND TO CLAY TRACES	WL @ EL. 251.8 MAY 3, 1973	
240.8 / 16.0	END OF HOLE		

120 BLOWS - LAST 2" (113)

OTHER TESTS: CORE RECOV. % (MAT. CORE LENGTH %) — 77% (4")

CONDITION	TYPE	NUMBER	PENETRATION RESISTANCE BLOWS/FT.
	2" DF	1	4
	" DF	2	30
	" DF	3	96
	NX RC	4	-
	" DF	5	96

DEPTH - FT.

GEOCON

APPENDIX I

OFFICE REPORT ON SOIL EXPLORATION

CONTRACT T9673 BORING # C4 and C5 DATUM GEODETIC CASING NX
BORING DATE APR. 24-25, 73 REPORT DATE MAY 3, 1973 COMPILED BY AEL CHECKED BY KKT
SAMPLER HAMMER WT 140 LBS DROP 30 INCHES (PENETRATION RESISTANCES CONVERTED TO BLOWS OF 4200 IN - LBS ENERGY)

SAMPLE CONDITION
DISTURBED
FAIR
GOOD
LOST

SAMPLE TYPES
AS - AUGER SAMPLE
ST - SLOTTED TUBE
WS - WASHED SAMPLE
DO - DRIVE-OPEN
DF - DRIVE-FOOT VALVE
CS - CHUNK SAMPLE
FS FOIL SAMPLE
SO SLEEVE-OPEN
SF - SLEEVE FOOT VALVE
TO THIN WALLED OPEN
RC ROCK CORE

ABBREVIATIONS
V - IN-SITU VANE TEST
M - MECHANICAL ANALYSIS
U - UNCONFINED COMPRESSION
Qc - TRIAXIAL CONSOLIDATED UNDRAINED
Q - TRIAXIAL UNDRAINED
S - TRIAXIAL DRAINED
γ - WET UNIT WEIGHT
K - PERMEABILITY
C - CONSOLIDATION
WL - WATER LEVEL IN CASING
WT - WATER TABLE IN SOIL

UNDRAINED SHEAR STRENGTH - PSF
LAB. U - TEST 15 0 5 10 % STRAIN
FIELD VANE
REMOULDED
LAB. VANE
REMOULDED
WATER CONTENT W% 20 40 60 80 ⊙ NAT ⊡ LW △ PW
DYNAMIC PENETRATION TEST BLOWS PER FOOT 20 40 60 80

ELEVN. / DEPTH	WATER CONDITIONS	DESCRIPTION	STRAT PLOT	ELEVATION SCALE	OTHER TESTS (CORE RECOV. % / MAX. CORE LENGTH)	SAMPLES: CONDITION	TYPE	NUMBER	PENETRATION RESISTANCE BLOWS/FT.	DEPTH - FT.
259.0 / 0.0		GROUND LEVEL		260						0
		6" TOPSOIL					2"DF	1	17	
		MISCELLANEOUS FILL GRAVEL, SAND CLAY & ORGANICS		255			DF	2	9	5
252.0 / 7.0	WL @ EL. 255.4 MAY 3, 1973	BOULDERS, COBBLES AND GRAVEL WITH SAND TO CLAY TRACES		250	77% (5")		NX RC	3	-	10
							DF	4	79	
				245	31% (4")		NX RC	5	-	15
242.7 / 16.3		END OF HOLE					DF	7	>100	
				240						20
261.2 / 0.0		GROUND LEVEL		260			2"DF	1	8	0
		2" TOPSOIL								
		MISCELLANEOUS FILL GRAVEL, SAND, CLAY ORGANICS AND METAL		255			DF	2	>100	5
254.2 / 7.0	WL @ EL. 255.4 MAY 3, 1973	BOULDERS, COBBLES AND GRAVEL WITH SAND TO CLAY TRACES		250	22% (4")		NX RC	3	-	10
							DF	4	32	
					57% (5")		NX RC	5	-	15
244.2 / 17.0		END OF HOLE		245			DF	6	86	
				240						20
										25
										30

C4
67 BLOWS - LAST 10"
50 BLOWS - NO ADVANCE

C5
40 BLOWS - LAST 10"
50 BLOWS - NO ADVANCE

GEOCON

APPENDIX I

OFFICE REPORT ON SOIL EXPLORATION

CONTRACT T9673 BORING # CG and C7 DATUM GEODETIC CASING NX
BORING DATE APR. 25-26 '73 REPORT DATE MAY 3, 1973 COMPILED BY AEL CHECKED BY KKT
SAMPLER HAMMER WT. 140 LBS DROP 30 INCHES (PENETRATION RESISTANCES CONVERTED TO BLOWS OF 4200 IN - LBS ENERGY)

SAMPLE CONDITION
DISTURBED
FAIR
GOOD
LOST

SAMPLE TYPES
A S - AUGER SAMPLE
S T. - SLOTTED TUBE
W S - WASHED SAMPLE
D O. - DRIVE-OPEN
D F - DRIVE-FOOT VALVE
C S - CHUNK SAMPLE
F S FOIL SAMPLE
S O - SLEEVE-OPEN
S F - SLEEVE-FOOT VALVE
T O - THIN WALLED OPEN
R C ROCK CORE

ABBREVIATIONS
V - IN-SITU VANE TEST
M - MECHANICAL ANALYSIS
U - UNCONFINED COMPRESSION
Qc - TRIAXIAL CONSOLIDATED UNDRAINED
Q - TRIAXIAL UNDRAINED
S - TRIAXIAL DRAINED
γ - WET UNIT WEIGHT
K - PERMEABILITY
C - CONSOLIDATION
WL - WATER LEVEL IN CASING
WT - WATER TABLE IN SOIL

UNDRAINED SHEAR STRENGTH - PSF (0 – 5 – 10) LAB. Q - TEST % STRAIN
FIELD VANE · REMOULDED · LAB. VANE · REMOULDED
WATER CONTENT W% (20 – 40 – 60 – 80) ⊙ NAT ⊡ LW △ PW
DYNAMIC PENETRATION TEST BLOWS PER FOOT (20 – 40 – 60 – 80)

ELEVN / DEPTH	WATER CONDITIONS	DESCRIPTION	STRAT PLOT	ELEVATION SCALE	OTHER TESTS (CORE RECOV. % / RQD % / MAX. CORE LENGTH)	SAMPLES: CONDITION	TYPE	NUMBER	PENETRATION RESISTANCE BLOWS/FT.	DEPTH - FT.
262.9 / 0.0		GROUND LEVEL								
		MISCELLANEOUS FILL GRAVEL, SAND, CLAY, PAPER, RAGS AND ORGANICS ETC		260			2"DF	1	6	
256.9 / 6.0	WL @ EL. 257.0 MAY 3, 1973	BOULDERS, COBBLES AND GRAVEL WITH SAND TO CLAY TRACES		255			DF	2	12	5
							DF	3	72	10
					81% (3½")		NX RC	4	-	
				250			DF	5	50	15
					31% (1½")		NX RC	6	-	
242.9 / 21.1		WEATHERED SHALE, SILTSTONE AND LIMESTONE		245			DF	7	>100	20
		END OF HOLE		240						25
263.4 / 0.0		GROUND LEVEL		265						
		2" TOPSOIL					2"DF	1	17	
		MISCELLANEOUS FILL GRAVEL, SAND & CLAY, BRICK, RAGS, PAPER & ORGANICS ETC		260			DF	2	4	5
254.4 / 9.0	WL @ EL. 258.1 MAY 3, 1973	BOULDERS, COBBLES AND GRAVEL WITH SAND TO CLAY TRACES		255	100 BLOWS - LAST 6"		DF	3	59	10
										15
				250	67% (4")		NX RC	4	-	
246.4 / 17.0		END OF HOLE					DF	5	59	20
				245						25

GEOCON

APPENDIX I

OFFICE REPORT ON SOIL EXPLORATION

CONTRACT T9673 BORING # C8 and C9 DATUM GEODETIC CASING NX.
BORING DATE APR. 30, 1973 REPORT DATE MAY 4, 1973 COMPILED BY AEL CHECKED BY KST
SAMPLER HAMMER WT 140 LBS DROP 30 INCHES (PENETRATION RESISTANCES CONVERTED TO BLOWS OF 4200 IN - LBS ENERGY)

SAMPLE CONDITION
DISTURBED
FAIR
GOOD
LOST

SAMPLE TYPES
AS - AUGER SAMPLE
ST - SLOTTED TUBE
WS - WASHED SAMPLE
DO - DRIVE-OPEN
DF - DRIVE-FOOT VALVE
CS - CHUNK SAMPLE
FS - FOIL SAMPLE
SO - SLEEVE-OPEN
SF - SLEEVE FOOT VALVE
TO - THIN WALLED OPEN
RC - ROCK CORE

ABBREVIATIONS
V - IN-SITU VANE TEST
M - MECHANICAL ANALYSIS
U - UNCONFINED COMPRESSION
Qc - TRIAXIAL CONSOLIDATED UNDRAINED
Q - TRIAXIAL UNDRAINED
S - TRIAXIAL DRAINED
γ - WET UNIT WEIGHT
K - PERMEABILITY
C - CONSOLIDATION
WL - WATER LEVEL IN CASING
WT - WATER TABLE IN SOIL

UNDRAINED SHEAR STRENGTH - PSF
LAB. U - TEST 15 10 0 5 % STRAIN
FIELD VANE
REMOULDED
LAB. VANE
REMOULDED
WATER CONTENT W% ⊙ NAT ⊡ LW △ PW
DYNAMIC PENETRATION TEST BLOWS PER FOOT

ELEVN / DEPTH	WATER CONDITIONS	DESCRIPTION	STRAT. PLOT	ELEVATION SCALE	OTHER TESTS	SAMPLES: CONDITION	TYPE	NUMBER	PENETRATION RESISTANCE BLOWS/FT.	DEPTH - FT.
267.6 / 0.0		GROUND LEVEL								0
		3" TOPSOIL								
		MISCELLANEOUS FILL GRAVEL SAND CLAY PAPER, RAGS, GLASS AND ORGANICS ETC.		265			2"DF	1	4	5
				260			"DF	2	4	10
255.6 / 12.0	WL. @ EL. 260.8 MAY 3, 1973						"DF	3	42	
		BOULDERS, COBBLES AND GRAVEL WITH SAND TO CLAY TRACES		255						15
				250	M		"DF	4	59	20
245.9 / 21.7		END OF HOLE		245						25

C8: 150 → 136 →
50 BLOWS = LAST 6"
100 BLOWS = LAST INCH

ELEVN / DEPTH	WATER CONDITIONS	DESCRIPTION	STRAT. PLOT	ELEVATION SCALE	OTHER TESTS	SAMPLES: CONDITION	TYPE	NUMBER	PENETRATION RESISTANCE BLOWS/FT.	DEPTH - FT.
270.9 / 0.0		GROUND LEVEL								0
		1" TOPSOIL		270			2"DF	1	9	5
		MISCELLANEOUS FILL GRAVEL, SAND, CLAY WOOD CHIPS, GLASS AND ORGANICS ETC.		265			"DF	2	10	
262.9 / 8.0	WL. @ EL. 260.4 MAY 3, 1973						"DF	3	15	10
		BOULDERS, COBBLES AND GRAVEL WITH SAND TO CLAY TRACES		260			"DF	4	35	15
					61% (2½")		NX RC	5	–	
				255			"DF	6	>100	
		WEATHERED SHALE, SILTSTONE AND LIMESTONE			45° (3")		NX RC	7	–	20
251.4 / 19.5							"DF	8	62	
249.4 / 21.5		END OF HOLE		250						25

C9: 118 → 104 →
150 BLOWS = LAST 6"

GEOCON

APPENDIX I

OFFICE REPORT ON SOIL EXPLORATION

CONTRACT T9673 BORING # C10 DATUM GEODETIC CASING NX

BORING DATE MAY 2, 1973 REPORT DATE MAY 4, 1973 COMPILED BY AEL CHECKED BY KKT

SAMPLER HAMMER WT 140 LBS DROP 30 INCHES (PENETRATION RESISTANCES CONVERTED TO BLOWS OF 4200 IN - LBS. ENERGY)

SAMPLE CONDITION

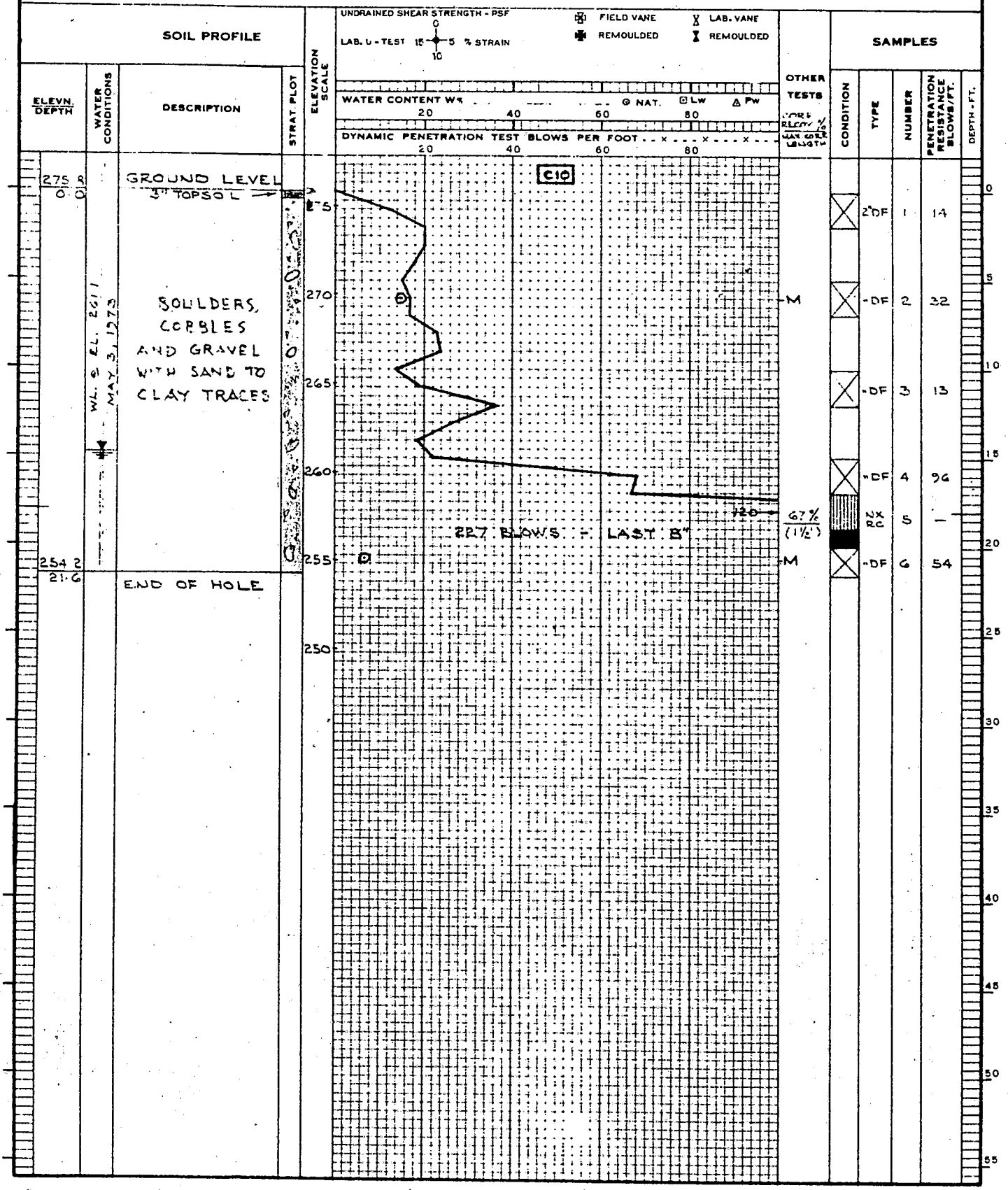
- DISTURBED
- FAIR
- GOOD
- LOST

SAMPLE TYPES

- AS - AUGER SAMPLE
- ST - SLOTTED TUBE
- WS - WASHED SAMPLE
- DO - DRIVE-OPEN
- DF - DRIVE-FOOT VALVE
- CS - CHUNK SAMPLE
- FS - FOIL SAMPLE
- SO - SLEEVE-OPEN
- SF - SLEEVE FOOT VALVE
- TO - THIN WALLED OPEN
- RC - ROCK CORE

ABBREVIATIONS

- V - IN-SITU VANE TEST
- M - MECHANICAL ANALYSIS
- U - UNCONFINED COMPRESSION
- Qc - TRIAXIAL CONSOLIDATED UNDRAINED
- Q - TRIAXIAL UNDRAINED
- S - TRIAXIAL DRAINED
- γ - WET UNIT WEIGHT
- K - PERMEABILITY
- C - CONSOLIDATION
- WL - WATER LEVEL IN CASING
- WT - WATER TABLE IN SOIL



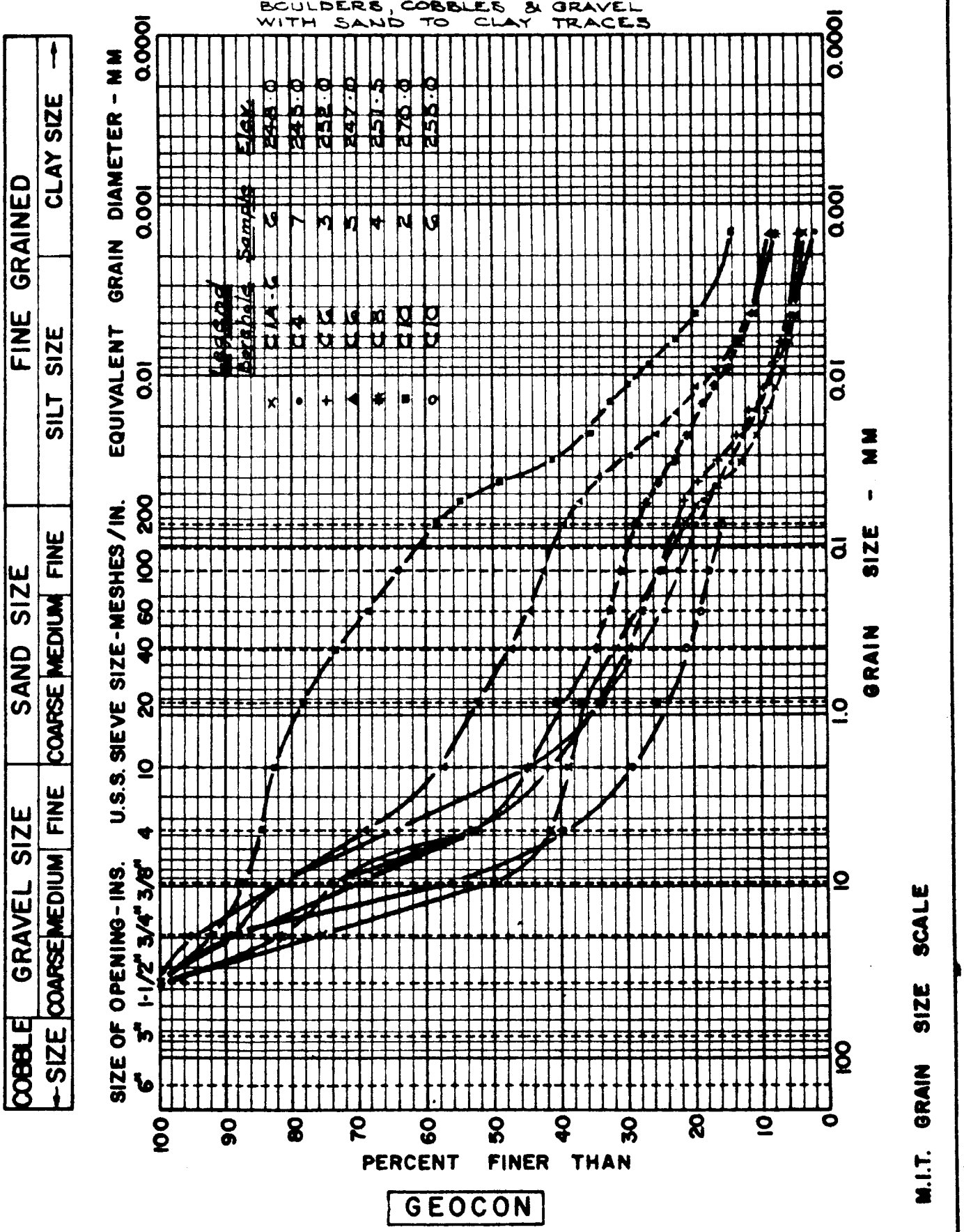
APPENDIX II

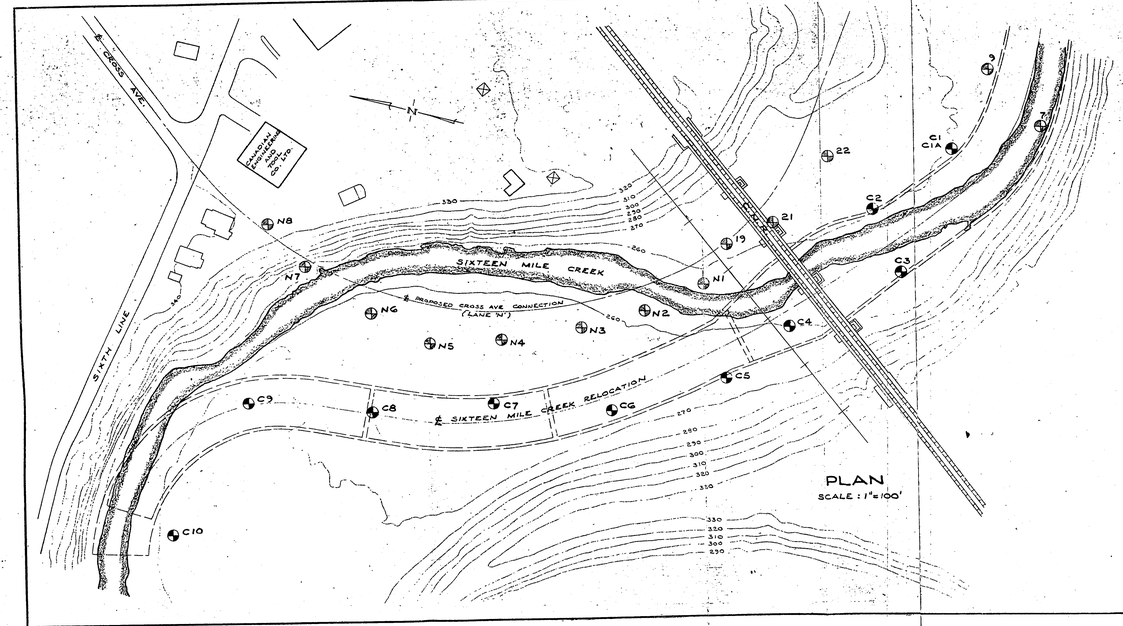
FIGURES – LABORATORY TESTING

GEOCON

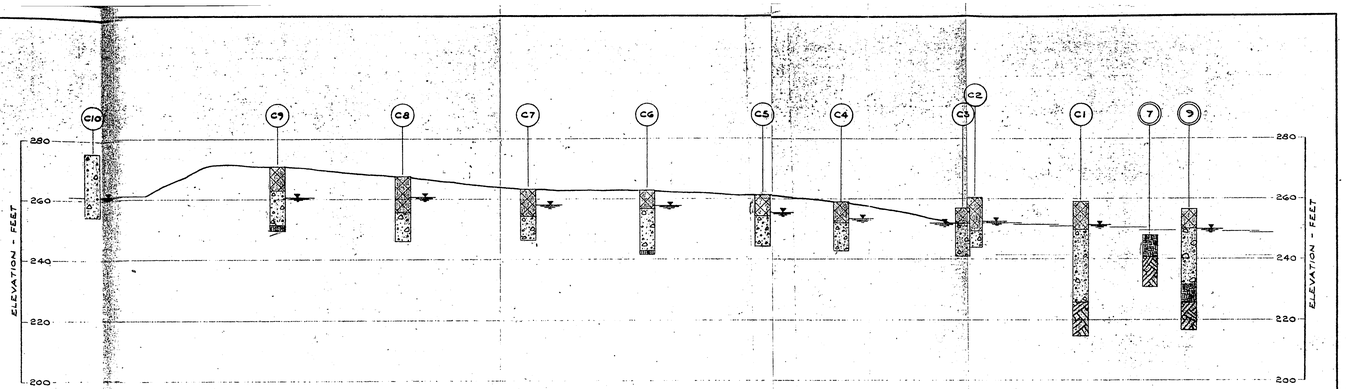
GRAIN SIZE DISTRIBUTION

APPENDIX II
FIGURE 1
PROJECT T9673





PLAN
SCALE : 1"=100'



PROFILE ALONG ℄ PROPOSED SIXTEEN MILE CREEK RELOCATION

SCALE : HORIZ. 1"= 100'
VERT. 1"= 20'

STRATIGRAPHY

- MISCELLANEOUS FILL, GRAVEL, SAND & CLAY, ORGANICS, RAGS, GLASS AND METAL PIECES ETC.
- BOULDERS, COBBLES AND GRAVEL WITH SAND TO CLAY, TRACES
- WEATHERED SHALE, SILTSTONE AND LIMESTONE
- SHALE, SILTSTONE AND LIMESTONE

LEGEND

- BOREHOLE (PRESENT INVESTIGATION)
- BOREHOLE (PREVIOUS INVESTIGATIONS)
- WATER LEVEL - MAY, 1973

SPECIAL NOTES

DATA CONCERNING THE VARIOUS STRATA HAVE BEEN OBTAINED AT BOREHOLE LOCATIONS ONLY. THE SOIL STRATIGRAPHY BETWEEN BOREHOLES HAS BEEN INFERRED FROM GEOLOGICAL EVIDENCE AND SO MAY VARY FROM THAT SHOWN.

THIS DRAWING IS TO BE READ IN CONJUNCTION WITH ACCOMPANYING REPORT.

REFERENCE

DWG. NO.	DESCRIPTION
3666-1C-30	FOUNDATION OF CANADA ENGINEERING CORPN. LTD. - PLAN SHOWING PROPOSED ALIGNMENT OF SIXTEEN MILE CREEK RELOCATION - ℄ CROSS AVE. CONNECTION - ENFRANCHISEMENT SCHEME 118
	GEOCON LTD. REPORTS 73448 & 73448A TO FOUNDATION OF CANADA ENG. CORP. LTD. - SPEERS RD. EXTENSION & CROSS AVE. CONNECTION - DATED: OCT. 1973

FOUNDATION OF CANADA ENGINEERING CORPORATION LIMITED
TORONTO ONTARIO

PROPOSED SIXTEEN MILE CREEK RELOCATION

OAKVILLE ONTARIO

BORING PLAN & SOIL STRATIGRAPHY

GEOCON LTD.

DATE MAY 16, 1973 SCALE AS SHOWN

DESIGN	DRAWN	CHKD	APP'D
A.C.L.	K.K.T.	D.P.	

DWG. NO. T9673-1