



Memorandum

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GEOCRES No.

To: Mr. A.P. Watt (2)
Regional Structural Planning Engineer
Southwestern Region, London

From: Soil Mechanics Section
Geotechnical Office
West Building, Downsview

Attention:

Date: February 4, 1976

Our File Ref.

In Reply to

FEB 10 1976

Subject:

FOUNDATION INVESTIGATION REPORT

W.P. 40-66-08/09
Hwy. 402, District 2
Concession 3 Road Overpass (EBL/WBL)
2.6 Miles West of Hwy. 2

Attached we are forwarding to you our detailed Foundation Investigation Report on the subsoil conditions existing at the above mentioned site.

We believe that the factual data and recommendations contained therein will prove adequate for your requirements. Should additional information be required, please do not hesitate to contact our Office.

K.G. Selby

K.G. SELBY
Supervising Engineer

cc: R.S. Pillar
C.S. Grebski
B.J. Giroux
G.A. Wrong
A. Wittenberg
J.R. Roy
D.P. Collins
R. Hore
J. Anderson)
A. Crowley) memo only
G. Sloan)
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Record Services

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FOUNDATION INVESTIGATION REPORT

for

W.P. 40-66-08/09
Hwy. 402, District 2
Concession 3 Road Overpass (EBL/WBL)
2.6 Miles West of Hwy. 2

1. INTRODUCTION

A foundation investigation consisting of eight boreholes was carried out at the above described location to determine the subsoil conditions.

This report contains factual and interpreted soil data, together with recommendations for the design and construction of the proposed structures and approaches.

2. SITE DESCRIPTION

The proposed overpass structures will be located approximately 1.7 miles north of the intersection of Co. Rd. #14 and Hwy. #81. The surrounding terrain is flat and gently rising due north. Cultivated farm land is located west of Con. Rd. III and mixed hardwood bush on the east side. A shallow and narrow drainage ditch runs parallel of the gravel road which was dry during the field investigation.

Physiographically, the site is situated in the region referred to as the Caradoc Sand Plains. Sands and other light textured waterlaid deposits are characteristics for this region.

3. SUBSURFACE CONDITIONS

(3.1) General

Generally, uniform subsoil conditions were found to prevail over the area investigated. The subsoil consists of a deep deposit of cohesionless (sand and silt) deposit containing layers and zones of cohesive material, followed by a clayey silt to silty clay with some sand stratum, followed by a bouldery zone. The

boundaries between different deposits are shown on the Record of Borehole Sheets attached to the Appendix. The estimated stratigraphical profile of Drawing 406608 and 09A is based upon this information.

From ground level downward, the various strata are described in some detail with regard to soil types and soil properties, as follows:

(3.2) Silty Sand to Sandy Silt

This deposit was intersected in all borings and extends immediately below the ground surface down to elev. 688 \pm (B.H. #1).

The material in the stratum consists of sands and silts with varying proportion. Grain size analyses performed on selected samples indicate that with a few exceptions, the sand is the predominant fraction. Traces of clay were also encountered (Fig. 1).

An approximate 4 to 10 ft. thick silt with some clay and traces of sand was also discovered in most of the borings between the upper and lower portion of the main deposit at approximate elevation 750.

Below the silt layer there is a rapid increase in the silt content (Fig. 2).

Borings (#1 and #3) which were advanced below elevation 718-715 were found to contain occasional layers of clayey silt and silt.

Standard penetration tests carried out within this deposit indicate that the relative density varies randomly from loose to very dense. The obtained 'N' values varied from 4 to over 100 blows/ft. References should be made to the Record of Borehole Sheets for 'N' values. Refusals (150 blows/ft.) to dynamic cone penetration tests were reached at approximate elevation 775 in Borehole's No. 1, 3, 4, 5 and 7. The refusal level in Borehole's No. 2, 6 and 8 was found to be at elevation 745 \pm .

The natural moisture content ranges from 2% to 31%, the average being in the order of 17%.

(3.3) Clayey Silt to Silty Clay, Traces of Sand

This stratum was found to underlie the silty sand to sandy silt deposit in Borehole No. 1. At other locations, the borings were terminated at higher elevations.

The thickness is about 37 ft., the lower boundary being at elevation 651. A limited number of tests carried out indicate the following physical properties:

Natural Moisture Content: (%)	21 - 23
Liquid Limit: (%)	28 - 38
Plastic Limit: (%)	16 - 19

The consistency may be described as very stiff to hard.

(3.4) Bouldery Zone

Refusal to conventional washboring technique was reached at elevation 651. The borehole was advanced by drilling BXL core barrel for an approximate distance of 3 ft. A 6 inch long limestone core, together with some till material (mixture of gravel, sand, silt and clay) containing limestone fragments was recovered.

4. GROUNDWATER CONDITIONS

In general, the groundwater level was observed at 9 - 15 ft. below existing groundlevel. The following groundwater levels were established in the boreholes during the field investigation:

Borehole #1	Elev.:	784.0
" #2	"	784.5
" #3	"	788.0
" #4	"	788.0
" #5	"	788.5
" #6	"	786.5

5. DISCUSSION AND RECOMMENDATIONS

(5.1) General

Two types of twin overpass structures are being considered at this location.

- (A) Three-span (43.4' - 38.4' - 43.4') with perched abutments
- (B) Single-span (95 ft. long) with closed abutments

The profile grade of scheme 'A' is proposed to be at elevation 826 and of scheme 'B', at elevation 819 (Sta. 480+76.92, Line A).

The existing ground level, in general, is at elevation 797+.

(5.2) Foundations

(5.2.1) Pile Support

All of the footings (abutments and piers) for both schemes may be supported on one of the following pile types:

(5.2.1.1) Franki Piles

Franki type displacement caissons may be used for footing support. The bulb of the pile can be formed at approximate elevation 780. For different sizes of piles the following safe design loads are recommended:

- 14 in. - 70 tons
- 18 in. - 125 tons
- 22 in. - 150 tons

(5.2.1.2) Steel Tube Piles

The footings may be supported on piles driven to approximate elevation 746+. In the case of 12 3/4 " O.D. and 1/4" thick wall steel tube piles, a safe design load of 40 tons per pile may be used. Pile driving should be controlled by employing the Hiley Dynamic Pile Driving Formula (MTC Standard SS3-10 or 11).

(5.2.1.3) End-Bearing Piles

As a second alternative, the footings (abutments and piers) may be founded on end-bearing steel 'H' piles driven to practical refusal. It is expected that the piles will meet refusal at approximate elevation 650 - 651. The maximum allowable load for the particular steel section may be assumed for design purposes (ie. 95 tons for HP12 x 74 piles).

Construction using this type of piling appears to be the most uneconomical. The pile driving should be controlled by the Hiley Dynamic Pile Driving Formula.

(5.2.2) Spread Footings of Compacted Fill

The abutments of scheme 'A' may be supported on spread footings placed on well compacted suitable granular material within the approach fills. A safe design load of 2.0 tsf. may be assumed. The granular material should consist of granular 'A' and should be fully compacted according to the current MTC standards. A construction scheme is outlined on Figure 3 of the Appendix.

(5.2.3) Frost Protection

The pile caps and the base of spread footings should be protected against frost action with a minimum of 4 ft. of earth cover.

(5.2.4) Dewatering

The observed groundwater level is located at least 4 ft. below the footing levels. Therefore, no major dewatering problems are anticipated.

6. APPROACH EMBANKMENTS

(6.1) Stability

The maximum height of the proposed approaches (scheme 'A') is in the order of 29 ft. Since the encountered subsoil is basically granular type material, no stability problems are expected. The slopes of the approaches should be constructed with 2 horizontal to 1 vertical.

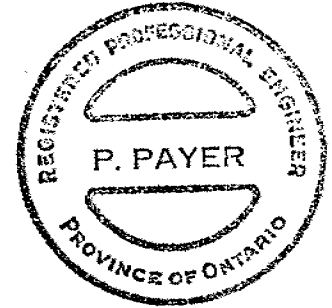
(6.2) Embankment Material

The fill should consist of well compacted acceptable material. Care should be taken to ensure that no bouldery fill is placed within the approaches through which piles have to be driven and it is recommended that this portion of the fill contain grain sizes not larger than 3 inches.

(6.3) Settlement

Settlement of the subsoil due to the construction of the structure approaches, should be immediate as loading is applied and should, therefore, not affect the structure.

P. Payer
P. Payer
Senior Engineer



K.G. Selby
K.G. Selby
Supervising Engineer

February, 1976

APPENDIX

MINISTRY OF TRANSPORTATION AND COMMUNICATIONS-ONTARIO
ENGINEERING SERVICES BRANCH-GEOTECHNICAL OFFICE-SOIL MECHANICS SECTION

RECORD OF BOREHOLE No 1

WP 40-66-08/09 LOCATION Co-ords. 15,598,885 N; 1,275,764 E. ORIGINATED BY MK
DIST 2 HWY 402 BORING DATE October 22 to 29, 1975 COMPILED BY GP
DATUM Geodetic BOREHOLE TYPE Hollow Stem Auger, BX Casing, BxL Rock Core CHECKED BY

SOIL PROFILE		SAMPLES			GROUND WATER ELEV	DYNAMIC CONE PENETRATION RESISTANCE PLOT					LIQUID LIMIT W_L PLASTIC LIMIT W_P WATER CONTENT W			UNIT WEIGHT γ	REMARKS
ELEV DEPTH	DESCRIPTION	STRAT. PLOT	NUMBER	TYPE	VALUES	25	50	75	100	125	W_P	W	W_L		
798.2	Ground Level														
0.0															
	Silty sand to sandy		1	SS	6										0 59 (41)
			2	SS											
			3	SS	17										
	silt, trace of clay		4	SS	14										
			5	SS	26										
			6	SS	25										
			7	SS	27										0 28 70 2
			8	SS	67										
			9	SS	35										
			10	SS	41										
			11	SS	81										
			12	SS	48										
			13	SS	95										
			14	SS	31										
	silt some clay trace of sand		15	SS	114										0 67 28 5
	Loose to Very Dense		16	SS	33										0 37 (63)
			17	SS	33										0 24 74 2
	occasional layers of clayey silt and silt		18	SS	41										
			19	SS	26										0 0 82 18 0 0 92 8
694.2															
104.0															

cont.

20
15 ϕ 5 % STRAIN AT FAILURE
10

MINISTRY OF TRANSPORTATION AND COMMUNICATIONS-ONTARIO
ENGINEERING SERVICES BRANCH-GEOTECHNICAL OFFICE-SOIL MECHANICS SECTION

RECORD OF BOREHOLE NO 1 cont.

WP 40-66-08/09 LOCATION Co-ords. 15,598,885 N; 1,275,764 E. ORIGINATED BY MK
DIST 2 HWY 402 BORING DATE October 22 to October 29, 1975 COMPILED BY GP
DATUM Geodetic BOREHOLE TYPE Hollow Stem Auger, BX Casing, BXL Rock Core CHECKED BY

SOIL PROFILE			SAMPLES			GROUND WATER ELEV	DYNAMIC CONE PENETRATION RESISTANCE PLOT					LIQUID LIMIT —WL PLASTIC LIMIT —WP WATER CONTENT —W			UNIT WEIGHT γ	REMARKS
ELEV DEPTH	DESCRIPTION	STRAT. PLOT	NUMBER	TYPE	'N' VALUES		25	50	75	100	125	Wp	W	WL		
694.2	continued															
104.0																
688.2																
110.0	Clayey silt to silty clay, some sand		20	SS	24											0 0 55 45
	Very Stiff to Hard		21	SS	55											0 0 43 57
651.0																
147.2	Boulder, gravel, sand,		22	RC	Rec											
648.0	silt & clay			BXL	19%											
150.2	End of Borehole															

ENGINEERING SERVICES BRANCH - GEOTECHNICAL OFFICE - SOIL MECHANICS SECTION

WP 40-66-08/09 LOCATION Co-ords. 15,598,975 N; 1,275,652 E. ORIGINATED BY MK
DIST 2 HWY 402 BORING DATE October 23 and 24, 1975 COMPILED BY GP
DATUM Geodetic BOREHOLE TYPE Hollow Stem Auger CHECKED BY _____

15 ϕ 5 20
10
% STRAIN AT FAILURE

OFFICE REPORT ON SOIL EXPLORATION

MINISTRY OF TRANSPORTATION AND COMMUNICATIONS-ONTARIO
ENGINEERING SERVICES BRANCH-GEOTECHNICAL OFFICE-SOIL MECHANICS SECTION

RECORD OF BOREHOLE NO 3

WP 40-66-08/09 LOCATION Co-ords. 15,599,034 N; 1,275,732 E. ORIGINATED BY MK
DIST 2 HWY 402 BORING DATE October 24 to 27, 1975 COMPILED BY GP
DATUM Geodetic BOREHOLE TYPE Hollow Stem Auger CHECKED BY

SOIL PROFILE			SAMPLES			GROUND WATER ELEV	DYNAMIC CONE PENETRATION RESISTANCE PLOT					LIQUID LIMIT W_L PLASTIC LIMIT W_P WATER CONTENT W			UNIT WEIGHT γ	REMARKS
ELEV DEPTH	DESCRIPTION	STRAT. PLOT	NUMBER	TYPE	N' VALUES		25	50	75	100	125	W_P	W	W_L		
798.8	Ground Level															GR SA SI CL
0.0			1	SS	4											0 96 (4)
			2	SS	14											
			3	SS	26											
	Silty sand to sandy		4	SS	46											
	silt, traces of clay		5	SS	37											
			6	SS	14											
			7	SS	8											0 93 (7)
			8	SS	24											
			9	SS	113	9"										
			10	SS	49											
	Loose to Very Dense		11	SS	95											
			12	SS	61											0 90 (10)
			13	SS	49											
			14	SS	66											
	silt		15	SS	58											
	some		16	SS	31											
	clay		17	SS	98	9"										
			18	SS	98											
			19	SS	69											
	occasional layers of		20	SS	26											
	clayey silt and silt		21	SS	44											
692.3																
106.5	End of Borehole															

20
15 \diamond 5 % STRAIN AT FAILURE
10

MINISTRY OF TRANSPORTATION AND COMMUNICATIONS-ONTARIO
ENGINEERING SERVICES BRANCH-GEOTECHNICAL OFFICE-SOIL MECHANICS SECTION

RECORD OF BOREHOLE NO 4

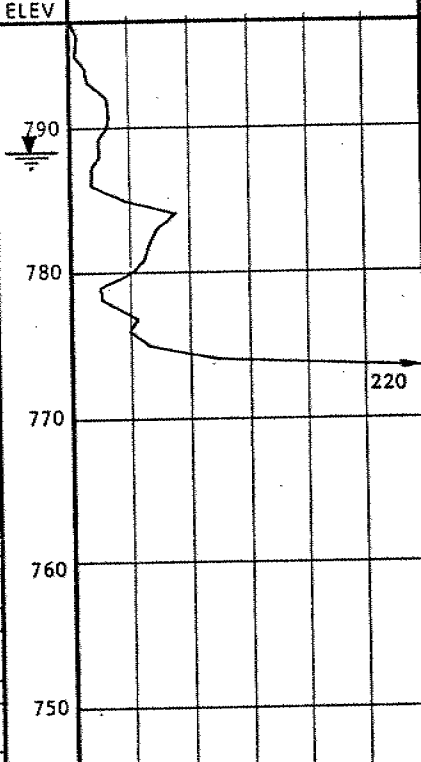
WP 40-66-08/09 LOCATION CoOrds. 15,598,962 N; 1,275,832 E. ORIGINATED BY MK
 DIST 2 HWY 402 BORING DATE October 28, 1975 COMPILED BY GP
 DATUM Geodetic BOREHOLE TYPE Hollow Stem Auger CHECKED BY _____

SOIL PROFILE			SAMPLES			GROUND WATER ELEV	DYNAMIC CONE PENETRATION RESISTANCE PLOT					LIQUID LIMIT w_L PLASTIC LIMIT w_P WATER CONTENT w w_p — w — w_L WATER CONTENT % 10 20 30	UNIT WEIGHT γ	REMARKS % GR SA SI CL
ELEV DEPTH	DESCRIPTION	STRAT. PLOT	NUMBER	TYPE	'N' VALUES		25	50	75	100	125			
799.2	Ground Level													
0.0			1	SS	5									
			2	SS	8									
			3	SS	25									
	Silty sand to sandy		4	SS	28	790								0 24 70 6
			5	SS	41									
	silt, traces of clay		6	SS	31									
			7	SS	22	780								
			8	SS	37									
			9	SS	62									0 95 (5)
	Loose to Very Dense		10	SS	100/9"	770								
			11	SS	44									
			12	SS	46									
			13	SS	100	760								
			14	SS	36									
	silt some clay		15	SS	102/9"	750								
			16	SS	51									
737.7			17	SS	109	740								0 71 (29)
61.5	End of Borehole													

OFFICE REPORT ON SOIL EXPLORATION

MINISTRY OF TRANSPORTATION AND COMMUNICATIONS-ONTARIO
ENGINEERING SERVICES BRANCH-GEOTECHNICAL OFFICE-SOIL MECHANICS SECTION
RECORD OF BOREHOLE NO 5

WP 40-66-08/09 LOCATION Co-ords. 15,599,002 N; 1,275,805 E. ORIGINATED BY MK
DIST 2 HWY 402 BORING DATE October 28, 1975 COMPILED BY GP
DATUM Geodetic BOREHOLE TYPE Hollow Stem Auger CHECKED BY

SOIL PROFILE			SAMPLES			GROUND WATER ELEV	DYNAMIC CONE PENETRATION RESISTANCE PLOT					LIQUID LIMIT w_L PLASTIC LIMIT w_P WATER CONTENT w w_P w w_L WATER CONTENT % 10 20 30			UNIT WEIGHT γ	REMARKS % GR SA SI CL	
ELEV DEPTH	DESCRIPTION	STRAT. PLOT	NUMBER	TYPE	'N' VALUES		SHEAR STRENGTH										
							○ UNCONFINED + FIELD VANE ● QUICK TRIAXIAL x LAB VANE										
797.1	Ground Level																
0.0	Silty sand to sandy silt, traces of clay Loose to Very Dense	.	1	SS	6												
			2	SS	12												
			3	SS	6												
			4	SS	7												
			5	SS	33												
			6	SS	11												
			7	SS	14												
			8	SS	24												
			9	SS	57												
			10	SS	30												
			11	SS	62												
			12	SS	62												
			13	SS	51												
745.6			14	SS	127												
51.5	End of Borehole																

MINISTRY OF TRANSPORTATION AND COMMUNICATIONS-ONTARIO
ENGINEERING SERVICES BRANCH-GEOTECHNICAL OFFICE - SOIL MECHANICS SECTION

RECORD OF BOREHOLE NO 6

WP 40-66-08/09 LOCATION Co-ords. 15,598,916 N: 1,275,722 E. ORIGINATED BY MK
DIST 2 HWY 402 BORING DATE October 29, 1975 COMPILED BY GP
DATUM Geodetic BOREHOLE TYPE Hollow Stem Auger CHECKED BY _____

SOIL PROFILE		SAMPLES			GROUND WATER ELEV	DYNAMIC CONE PENETRATION RESISTANCE PLOT					LIQUID LIMIT W_L PLASTIC LIMIT W_P WATER CONTENT W		UNIT WEIGHT γ	REMARKS	
ELEV DEPTH	DESCRIPTION	STRAT. PLOT	NUMBER	TYPE		'N' VALUES	25	50	75	100	125	WATER CONTENT %			
796.5	Ground Level														
0.0	Silty sand to sandy silt, traces of clay Loose to Very Dense <div style="text-align: center;">silt some clay</div>		1	SS	4										
			2	SS	18										
			3	SS	13										
			4	SS	12										
			5	SS	22										
			6	SS	33										
			7	SS	30										
			8	SS	29										
			9	SS	47										
			10	SS	39										
			11	SS	35										
			12	SS	57										
			13	SS	64										
			14	SS	72										
			15	SS	136										
740.0				16	SS	123									
56.5	End of Borehole														

MINISTRY OF TRANSPORTATION AND COMMUNICATIONS-ONTARIO
ENGINEERING SERVICES BRANCH-GEOTECHNICAL OFFICE-SOIL MECHANICS SECTION

RECORD OF BOREHOLE NO 7

WP 40-66-08/09 LOCATION Co-ords. 15,599,001 N; 1,275,768 E. ORIGINATED BY MK
DIST 2 HWY 402 BORING DATE October 29, 1975 COMPILED BY GP
DATUM Geodetic BOREHOLE TYPE Cone Test Only CHECKED BY _____

SOIL PROFILE			SAMPLES			GROUND WATER ELEV	DYNAMIC CONE PENETRATION RESISTANCE PLOT					LIQUID LIMIT <u>WL</u> PLASTIC LIMIT <u>WP</u> WATER CONTENT <u>W</u>			UNIT WEIGHT γ	REMARKS
ELEV DEPTH	DESCRIPTION	STRAT. PLOT	NUMBER	TYPE	'N' VALUES		25	50	75	100	125	SHEAR STRENGTH ○ UNCONFINED + FIELD VANE ● QUICK TRIAXIAL x LAB VANE				
798.2	Ground Level															
0.0	Probably Silty Sand to Sandy Silt															
773.4	End of Cone Test															
24.8																

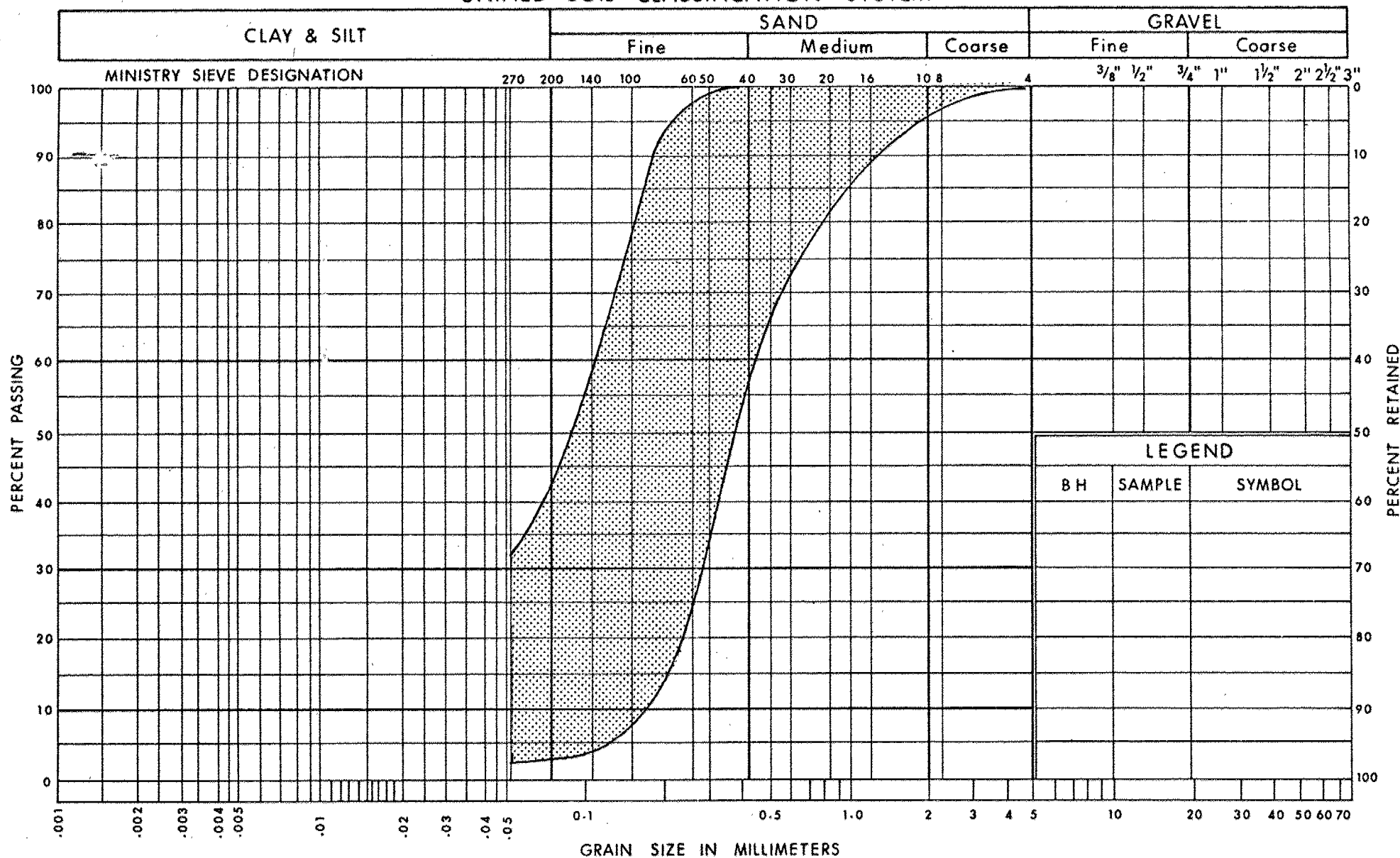
MINISTRY OF TRANSPORTATION AND COMMUNICATIONS-ONTARIO
ENGINEERING SERVICES BRANCH-GEOTECHNICAL OFFICE-SOIL MECHANICS SECTION

RECORD OF BOREHOLE NO 8

WP 40-66-08/09 LOCATION Co-ords. 15,598,934 N; 1,275,701 E. ORIGINATED BY MK
DIST 2 HWY 402 BORING DATE October 29, 1975 COMPILED BY GP
DATUM Geodetic BOREHOLE TYPE Cone Test Only CHECKED BY

SOIL PROFILE			SAMPLES			GROUND WATER ELEV	DYNAMIC CONE PENETRATION RESISTANCE PLOT					LIQUID LIMIT w_L PLASTIC LIMIT w_p WATER CONTENT w		UNIT WEIGHT γ	REMARKS
ELEV DEPTH	DESCRIPTION	STRAT. PLOT	NUMBER	TYPE	'N' VALUES		25	50	75	100	125	WATER CONTENT % w_p w w_L			
797.8	Ground Level														
0.0	Probably Silty Sand to Sandy Silt														
748.1	End of Cone Test														
49.7															

UNIFIED SOIL CLASSIFICATION SYSTEM

Ministry of
Transportation and
Communications

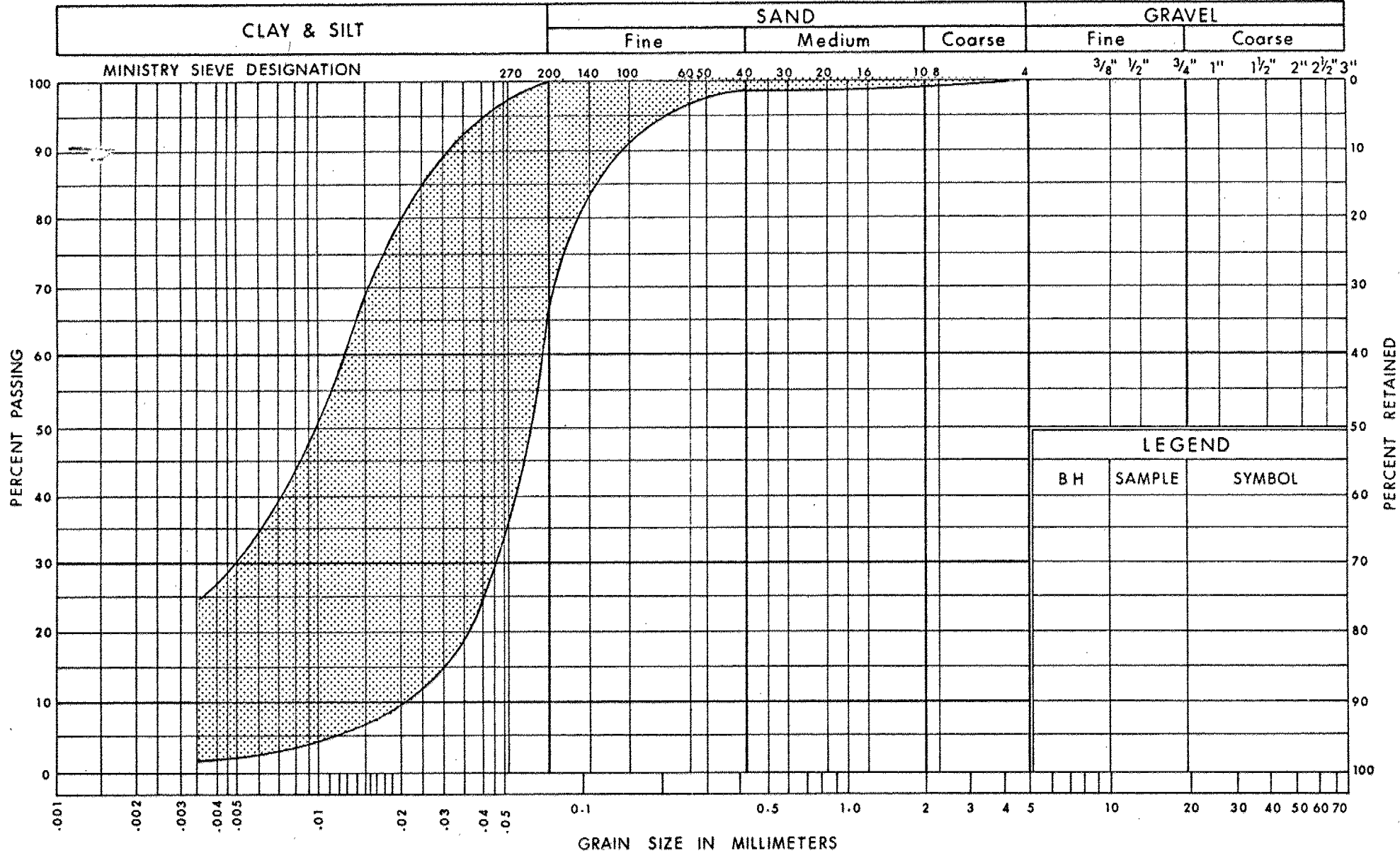
Ontario
ENGINEERING SERVICES BRANCH

GRAIN SIZE DISTRIBUTION SILTY SAND TO SANDY SILT UPPER ZONE

FIG No 1

W P 40-66-08/09

UNIFIED SOIL CLASSIFICATION SYSTEM



Ministry of
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Communications

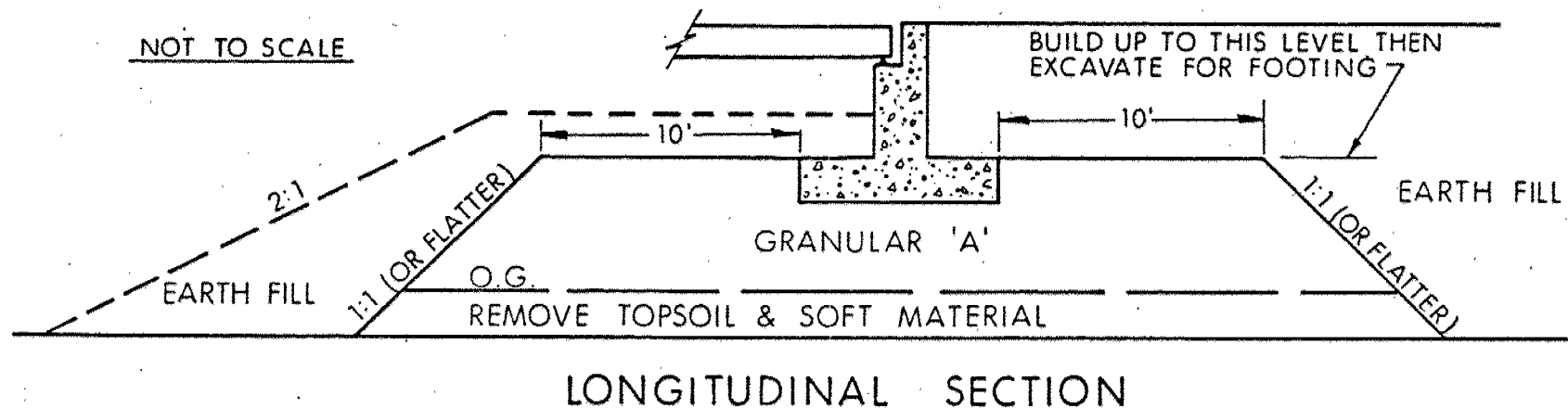
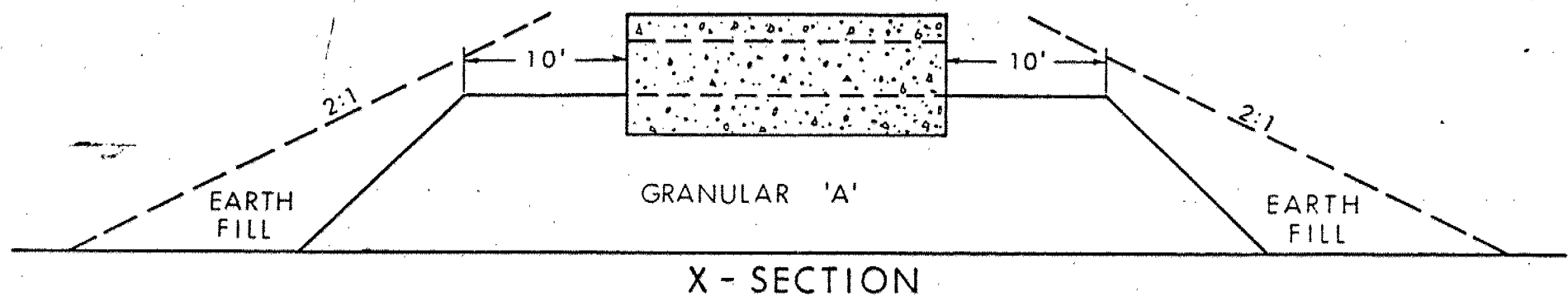
Ontario
ENGINEERING SERVICES BRANCH

GRAIN SIZE DISTRIBUTION
SILTY SAND TO SANDY SILT
LOWER ZONE

FIG No 2

W P 40-66-08/09

ABUTMENT ON COMPACTED FILL SHOWING GRANULAR 'A' CORE



NOTES

- 1 - REMOVE TOPSOIL &/OR SOFT SUBSOIL UNDER AREA OF COMPACTED GRANULAR 'A'.
- 2 - PLACE GRANULAR 'A' TO TOP OF FOOTING LEVEL, COMPACTED ACCORDING TO CURRENT M.T.C. STANDARDS.
- 3 - EXCAVATE COMPACTED GRANULAR 'A' MATERIAL FOR FOOTING.

ABBREVIATIONS & SYMBOLS USED IN THIS REPORTPENETRATION RESISTANCE

'N'-STANDARD PENETRATION RESISTANCE : - THE NUMBER OF BLOWS REQUIRED TO ADVANCE A STANDARD SPLIT SPOON SAMPLER 12 INCHES INTO THE SUBSOIL, DRIVEN BY MEANS OF A 140 POUND HAMMER FALLING FREELY A DISTANCE OF 30 INCHES.

DYNAMIC PENETRATION RESISTANCE : - THE NUMBER OF BLOWS REQUIRED TO ADVANCE A 2 INCH, 60 DEGREE CONE, FITTED TO THE END OF DRILL RODS, 12 INCHES INTO THE SUBSOIL, THE DRIVING ENERGY BEING 350 FOOT POUNDS PER BLOW.

DESCRIPTION OF SOIL

THE CONSISTENCY OF COHESIVE SOILS AND THE RELATIVE DENSITY OR DENSENESS OF COHESIONLESS SOILS ARE DESCRIBED IN THE FOLLOWING TERMS :-

<u>CONSISTENCY</u>	<u>c LB./SQ. FT.</u>	<u>DENSENESS</u>	<u>'N' BLOWS / FT.</u>
VERY SOFT	0 - 250	VERY LOOSE	0 - 4
SOFT	250 - 500	LOOSE	4 - 10
FIRM	500 - 1000	COMPACT	10 - 30
STIFF	1000 - 2000	DENSE	30 - 50
VERY STIFF	2000 - 4000	VERY DENSE	> 50
HARD	> 4000		

TERMS TO BE USED IN DESCRIBING SOILS:-

TRACE < 10 % , SOME 10-25 % , WITH 25-40 % , > 40 % SILTY, SANDY, GRAVELLY, CLAYEY ETC.

TYPE OF SAMPLE

S.S.	SPLIT SPOON	T.W.	THINWALL OPEN
W.S.	WASHED SAMPLE	T.P.	THINWALL PISTON
S.T.	SLOTTED TUBE SAMPLE	O.S.	OESTERBERG SAMPLE
A.S.	AUGER SAMPLE	F.S.	FOIL SAMPLE
C.S.	CHUNK SAMPLE	R.C.	ROCK CORE

P.H. SAMPLE ADVANCED HYDRAULICALLY

P.M. SAMPLE ADVANCED MANUALLY

SOIL TESTS

U	UNCONFINED COMPRESSION	L.V.	LABORATORY VANE
UU	UNCONSOLIDATED UNDRAINED TRIAXIAL	F.V.	FIELD VANE
CIU	CONSOLIDATED ISOTROPIC UNDRAINED TRIAXIAL	C	CONSOLIDATION
CID	" " DRAINED "	S	SENSITIVITY
CAU	" ANISOTROPIC UNDRAINED "		
CAD	" " DRAINED "		

ABBREVIATIONS & SYMBOLS USED IN THIS REPORTSOIL PROPERTIES

γ	UNIT WEIGHT OF SOIL (BULK DENSITY)
γ_s	UNIT WEIGHT OF SOLID PARTICLES
γ_w	UNIT WEIGHT OF WATER
γ_d	UNIT DRY WEIGHT OF SOIL (DRY DENSITY)
γ'	UNIT WEIGHT OF SUBMERGED SOIL
G	SPECIFIC GRAVITY OF SOLID PARTICLES $G = \frac{\gamma_s}{\gamma_w}$
e	VOID RATIO
n	POROSITY
w	WATER CONTENT
S_r	DEGREE OF SATURATION
w_L	LIQUID LIMIT
w_p	PLASTIC LIMIT
I_p	PLASTICITY INDEX
w_s	SHRINKAGE LIMIT
I_L	LIQUIDITY INDEX = $\frac{w - w_p}{I_p}$
I_c	CONSISTENCY INDEX = $\frac{w_L - w}{I_p}$
e_{max}	VOID RATIO IN LOOSEST STATE
e_{min}	VOID RATIO IN DENSEST STATE
I_D	DENSITY INDEX = $\frac{e_{max} - e}{e_{max} - e_{min}}$
	RELATIVE DENSITY D_r IS ALSO USED
h	HYDRAULIC HEAD OR POTENTIAL
q	RATE OF DISCHARGE
v	VELOCITY OF FLOW
i	HYDRAULIC GRADIENT
k	COEFFICIENT OF PERMEABILITY
j	SEEPAGE FORCE PER UNIT VOLUME
m_v	COEFFICIENT OF VOLUME CHANGE = $\frac{-\Delta e}{(1+e)\Delta\sigma'}$
c_v	COEFFICIENT OF CONSOLIDATION
C_c	COMPRESSION INDEX = $\frac{\Delta e}{\Delta \log_{10} \sigma'}$
T_v	TIME FACTOR = $\frac{c_v t}{d^2}$ (d, DRAINAGE PATH)
U	DEGREE OF CONSOLIDATION
τ_f	SHEAR STRENGTH
c'	EFFECTIVE COHESION INTERCEPT
ϕ'	EFFECTIVE ANGLE OF SHEARING RESISTANCE, OR FRICTION
c_u	APPARENT COHESION
ϕ_u	APPARENT ANGLE OF SHEARING RESISTANCE, OR FRICTION
μ	COEFFICIENT OF FRICTION
S_t	SENSITIVITY

GENERAL

π	= 3.1416
e	BASE OF NATURAL LOGARITHMS 2.7183
$\log_e \sigma$ OR $\ln \sigma$	NATURAL LOGARITHM OF σ
$\log_{10} \sigma$ OR $\log \sigma$	LOGARITHM OF σ TO BASE 10
t	TIME
g	ACCELERATION DUE TO GRAVITY
V	VOLUME
W	WEIGHT
M	MOMENT
F	FACTOR OF SAFETY

STRESS AND STRAIN

u	PORE PRESSURE
σ	NORMAL STRESS
σ'	NORMAL EFFECTIVE STRESS ($\bar{\sigma}$ IS ALSO USED)
τ	SHEAR STRESS
ϵ	LINEAR STRAIN
γ	SHEAR STRAIN
ν	POISSON'S RATIO (μ IS ALSO USED)
E	MODULUS OF LINEAR DEFORMATION (YOUNG'S MODULUS)
G	MODULUS OF SHEAR DEFORMATION
K	MODULUS OF COMPRESSIBILITY
η	COEFFICIENT OF VISCOSITY

EARTH PRESSURE

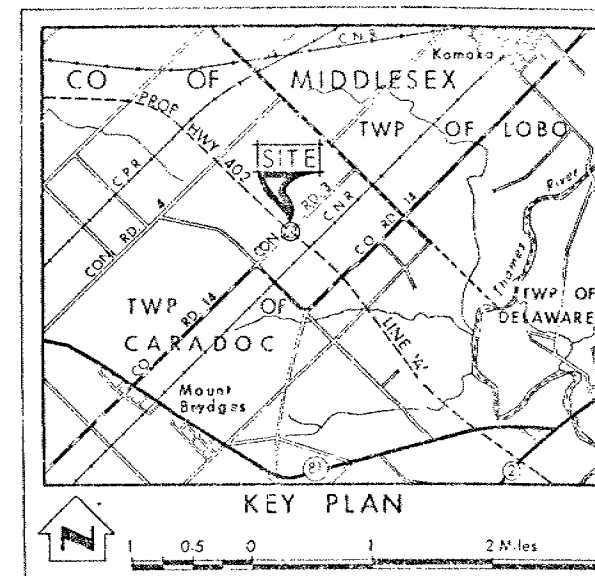
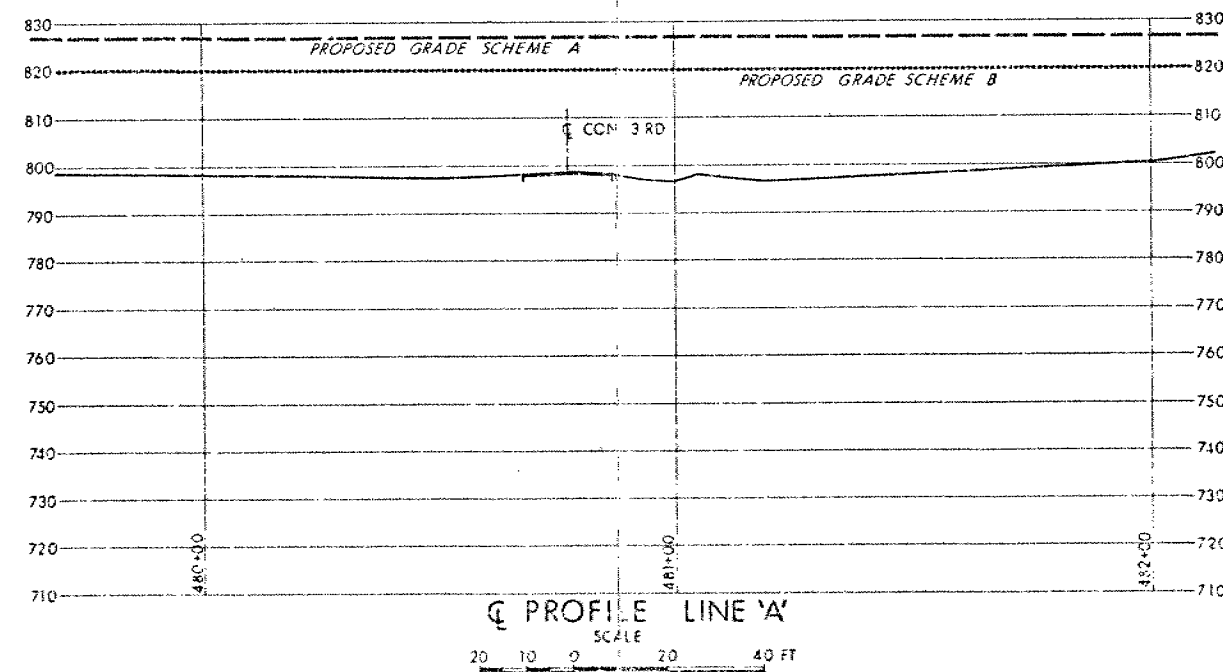
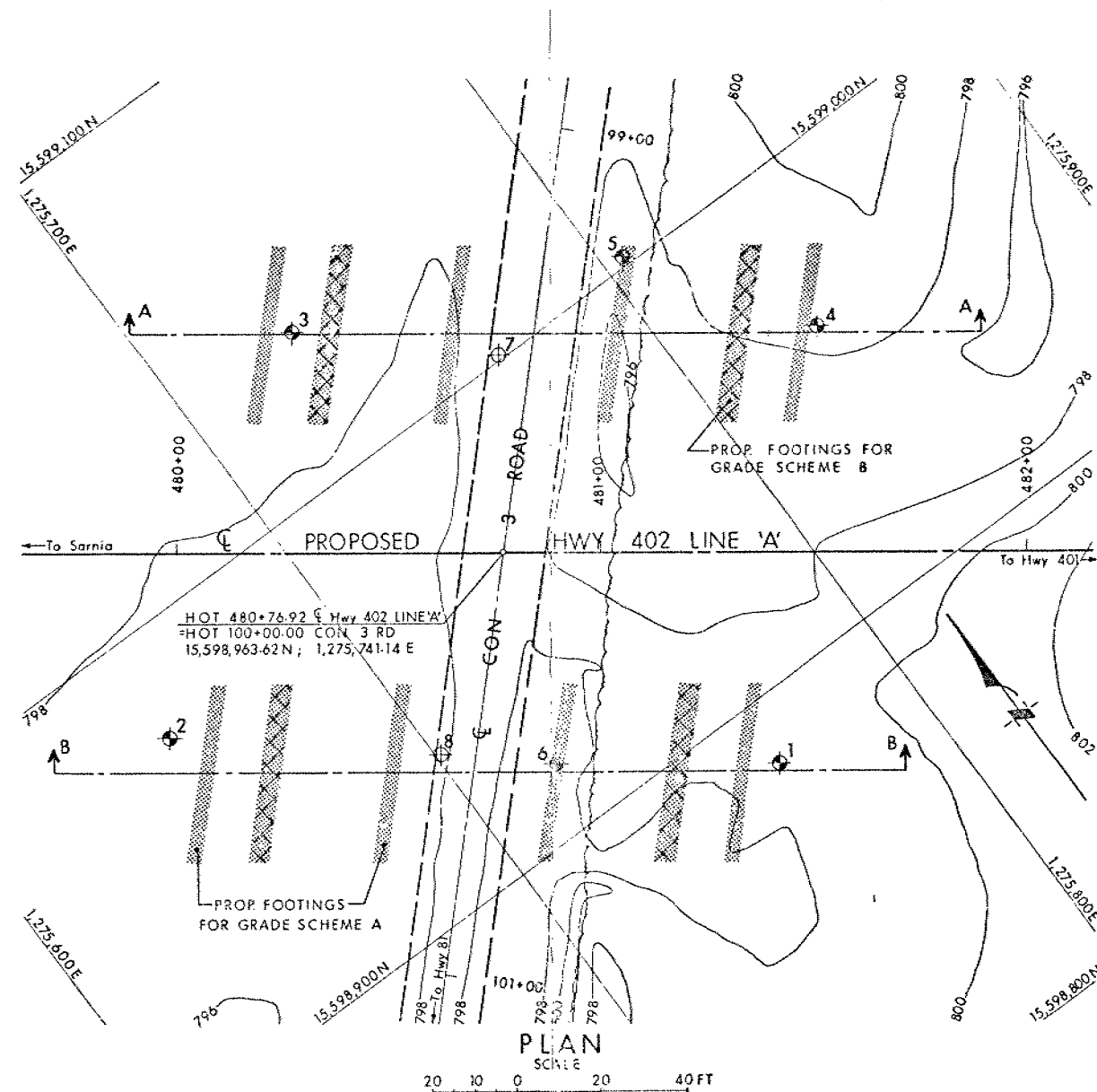
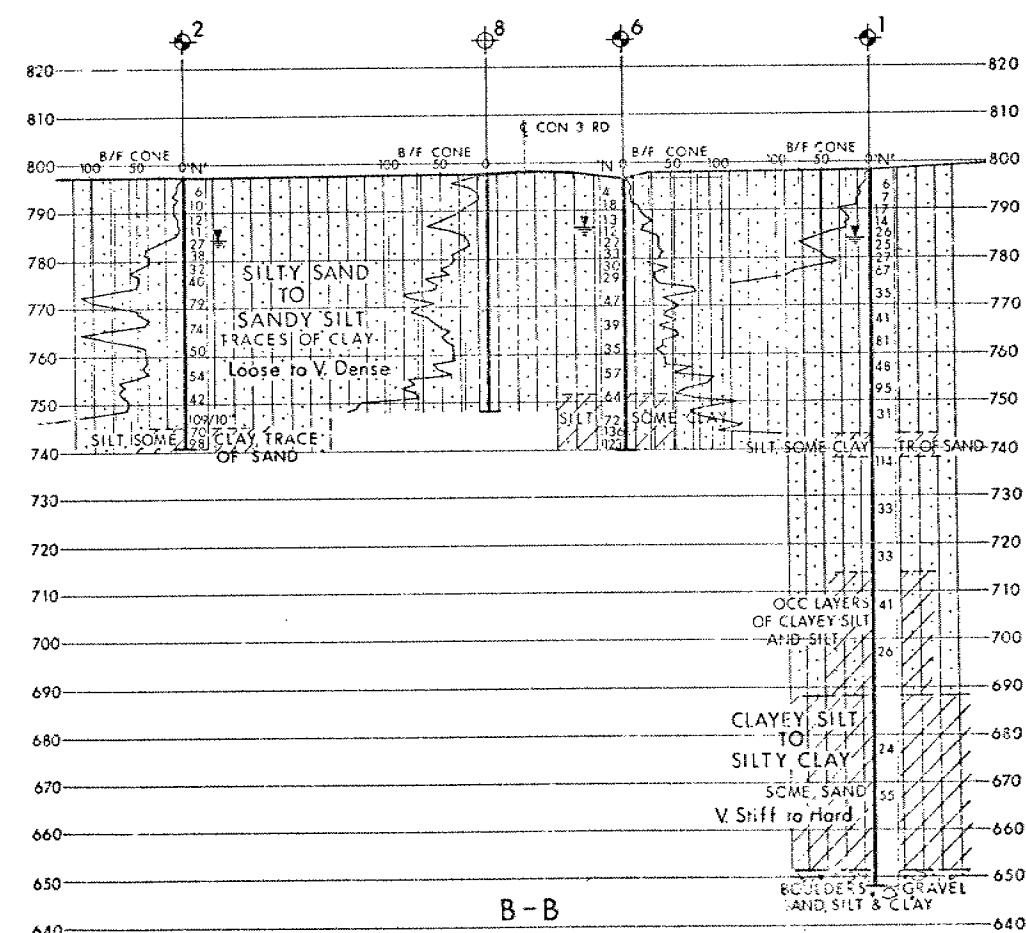
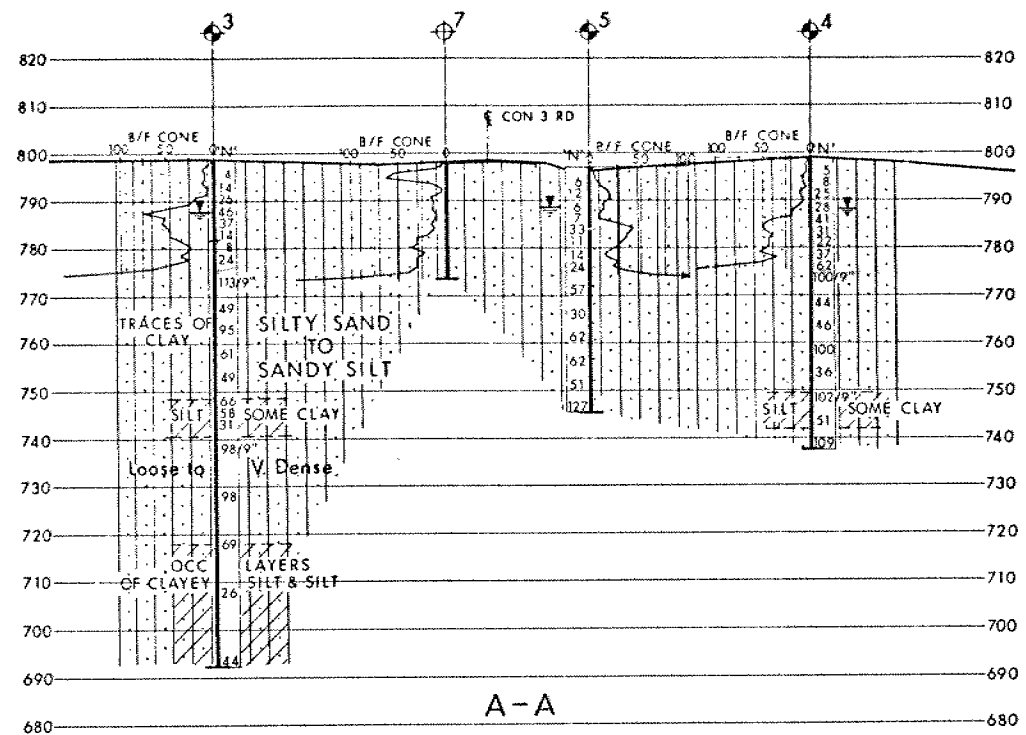
d	DISTANCE FROM TOP OF WALL TO POINT OF APPLICATION OF PRESSURE
δ	ANGLE OF WALL FRICTION
K	DIMENSIONLESS COEFFICIENT TO BE USED WITH VARIOUS SUFFIXES IN EXPRESSIONS REFERRING TO NORMAL STRESS ON WALLS
K_0	COEFFICIENT OF EARTH PRESSURE AT REST

FOUNDATIONS

B	BREADTH OF FOUNDATION
L	LENGTH OF FOUNDATION
D	DEPTH OF FOUNDATION BENEATH GROUND
N	DIMENSIONLESS COEFFICIENT USED WITH A SUFFIX APPLYING TO SPECIFIC GRAVITY, DEPTH AND COHESION ETC. IN THE FORMULA FOR BEARING CAPACITY
k_s	MODULUS OF SUBGRADE REACTION

SLOPES

H	VERTICAL HEIGHT OF SLOPE
D	DEPTH BELOW TOE OF SLOPE TO HARD STRATUM
β	ANGLE OF SLOPE TO HORIZONTAL



LEGEND			
	Bore Hole		
	Dynamic Cone Penetration Resistance Test B/F CONE - Blows/Ft. Cone Test (350 ft. lbs. energy/blow)		
	Bore Hole & Cone Test		
	Water Levels established at time of field investigation, OCT. 1975		
NO.	ELEVATION	CO-ORDINATES	
		NORTH	EAST
1	798.2	15,598,885	1,275,764
2	797.3	15,598,975	1,275,652
3	798.8	15,599,034	1,275,732
4	799.2	15,598,962	1,275,832
5	797.1	15,599,002	1,275,805
6	796.5	15,598,916	1,275,722
7	798.2	15,599,001	1,275,768
8	797.8	15,598,934	1,275,701

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

REVISION	DATE	BY	DESCRIPTION

MINISTRY OF TRANSPORTATION AND COMMUNICATIONS-ONTARIO
ENGINEERING SERVICES BRANCH-GEOTECHNICAL OFFICE-SOIL MECHANICS SECTION

CON 3 ROAD

HIGHWAY NO. Proposed 402 LINE 'A' DIST NO. 2
CO. MIDDLESEX
TWP. CARADOC LOT 23 CON. I & III

BORE HOLE LOCATIONS & SOIL STRATA

SURV. P.P.	CHECKED	W. NO. 40-66-08 & 09	DRAWING NO.
DRAWN	CHECKED	W. NO.	406608&09-A
DATE	4 FEB 1976	SITE NO. 19-531	BRIDGE DRAWING NO.
APPROVED		CONT. NO.	

FOUNDATIONS OFFICE

REVIEW OF DESIGN DRAWINGS:

W.P. 40-66-08...

W.O.

Foundation Report By:

Review of Design Drawings By:

Design Drawing No.'s:

19-531-1 & 19-531-3

1. Does footing design comply with our report or subsequent memos? YES
2. If answer to 1. is No, is present design acceptable? N/A
3. Has sufficient field work been done? N/A
4. Are estimated pile lengths shown on Drawings correct? If not, make a new list. N/A
5. If excavation of unsuitable soil is recommended, is this shown on Drawings? N/A
6. Are approaches designed in accordance with our report? Check slopes and berm lengths. YES
7. Do you anticipate any construction problems? i.e., dewatering, stability of temporary slopes or excavations.
8. Summarize your comments; on separate sheet if necessary.

A DEWATERING SCHEME WILL BE REQUIRED FOR THE FOOTING (PIER) EXCAVATIONS

Drawings Received MAY 11 1978.
 Reviewed MAY 29 1978.

Signed P. Payr



Memorandum

To: Mr. A. P. Watt
Regional Structural Planning Engineer
Southwestern Region
London, Ontario

From: Soil Mechanics Section
Engineering Materials Office
West Building, Downsview

Attention: Date: December 16, 1976

Our File Ref. In Reply to

Subject: REVISED FOUNDATION RECOMMENDATIONS
FOR

W.P. 40-66-04, Site 19-533
W.P. 40-66-06, Site 19-532
W.P. 40-66-08, Site 19-531

INTRODUCTIONS

The grade for Hwy. #402 has been lowered in the vicinity of the above structure sites. According to the present design, the originally planned overpass structures will become underpasses and subways.

Due to these changes the Soil Mechanics Section have been asked to review the validity of the recommendations contained in the previously issued foundation investigation reports for the structures in question. This memo is in compliance with the request. Our summarized and/or revised recommendations for the individual structures are as follows:

COUNTY ROAD #14 UNDERPASS

W.P. 40-66-04 (Formerly W.P. 40-66-04 & 05)
Site 19-533
Co. Middlesex, Con. 2, Twp. Caradoc
Lot 23
District 2 (London)

General Information

Hwy. #402 centreline: Sta: 511 + 39.85 Line "A"
Proposed Profile Grades:

Hwy. #402, El. 778.5± (Formerly El. 812±)

Co. Rd. #14, El. 801± (Formerly same as the existing grade: El. 790)

Average original ground level: El. 783±

Span Lengths: 111' - 111'

Subsurface Conditions

Descriptions are contained in the original foundation investigation report, issued February, 1976.

Recommendations

Recommendations given in the original foundation report are valid except for the following changes:

- a) 12 3/4" O.D. and 1/4" thick wall steel tube piles should achieve a design load of 50 tons per pile if driven to El. 742±.
- b) Due to the grade change, excavations for pier pile caps may be located below the groundwater level, in which case a dewatering scheme will be required to prevent 'boiling' of the foundation soil which consists of sandy silt or silty sand.
- c) The approaches to the structure will have forward slopes part cut and part fill and side slopes of fill only. Provided 2:1 slopes are constructed, no stability problems are anticipated. No bouldery fill should be placed in the approaches at locations through which piles have to be driven. At these locations, the maximum grain sizes should be restricted to 2 inches.

C.N.R. SUBWAY

W.P. 40-66-06 (Formerly W.P. 40-66-06 & 07)

Site 19-532

Co. Middlesex, Con. 2, Twp. Caradoc,

Lot 23

District 2 (London)

General Information

Hwy. #402 centreline: Sta: 492 + 42.25 Line "A" = 100 + 00 C.N.R. RE of NR
Profile Grades:

Hwy. #402, El. 782± (Proposed) (Formerly El. 832±)

Top of rail, El. 804± (Existing and proposed)

Average original ground level: El. 797±

Span Lengths: 36' - 86' - 74' - 36'

Tentatively proposed culverts:

- a) 48" Ø pipe culvert

Sta: 98 + 95, Invert El. 775±

- b) 8' x 4' concrete box culvert

Sta: 100 + 93, Invert El. 774±

Subsurface Conditions

Description contained in the original foundation investigation report issued December, 1976.

Recommendations

The following changes to recommendations given in the original foundation report are required:

- a) In the case of Franki type piles, the bulbs should be formed at El. 780± for the abutments and at El. 765± for the piers.
- b) For steel tube piles (12 3/4 in. dia.) a design load of 50 tons per pile should be achieved if driven to El. 750±.
- c) The pile caps for the piers will be located below the groundwater level. Therefore, a dewatering scheme will be required to prevent 'boiling' of the fine sand subsoil during excavation.
- d) The pile caps should be protected against frost action with a minimum of 4 feet of earth cover.
- e) Culverts will be located at the following locations: (C.N.R. chainage)
 Sta: 98 + 95: 48" dia. pipe, Invert El. 775±
 Sta: 100 + 93: 8' x 4' conc. box, Invert El. 774±

The inverts of both culverts will be located some 9' - 10' below the observed groundwater level. Consequently, a dewatering scheme will be required for the culverts' installations.

This can be achieved using interlocking steel sheet piles driven to depths below the excavation base equal to the height of the prevailing groundwater level above it.

Both culverts should be installed and backfilled before excavating for the structure footings.

- f) Hwy. #402 will be in an approximate 18 foot deep cut. The lower portion of this cut will be below the groundwater level. It may be necessary to install subdrains at the toes of slopes and an 18" thick blanket of granular 'A' to act as a filter in order to stabilize the lower slopes if they are subject to groundwater seepage. This can be assessed during construction.

The cuts should be constructed with 2:1 slopes.

TWP. ROAD (CON. 3rd) UNDERPASS

W.P. 40-66-08 (Formerly W.P. 40-66-08 & 09)

Site 19-531

Co. Middlesex, Con. 2 & 3, Twp. Caradoc

Lot 23

District 2 (London)

General Information

Hwy. #402 centreline: Sta: 480 + 76.92 Line "A"

Proposed profile grades:

Hwy. #402, El. 787± (Formerly El. 820, Scheme B and El. 826, Scheme A)

Twp. Rd., El. 806± (Formerly same as the existing grade El. 798±)

Average original ground level: El. 797±

Span Lengths: 105' - 105'

Subsurface Conditions

Description contained in the original foundation investigation report issued February, 1976.

Recommendations

According to the new proposal, the following changes in the recommendations are offered:

- a) The underside of the pier footing will be located at El. 780±. At this level, an allowable bearing value of 2.0 t.s.f. may be used for spread footing type foundation.
- b) Franki type displacement piles may be used for footing support. The bulbs of the piles can be formed at El. 780± for the abutments and at El. 770± for the pier.
- c) In the case of 12 3/4" O.D. and 1/4" thick wall steel tube piles, a design load of 50 tons per pile may be achieved at El. 740±.
- d) The observed groundwater level was found to be between El. 784 and El. 788.

Excavations for footings or pile caps carried out below these levels will require a dewatering scheme. The base may 'boil' due to the unbalanced hydrostatic water pressure. If closed interlocking steel sheet piling is incorporated into the scheme, it should be driven to a depth below the base of the excavation equal to the prevailing groundwater pressure head existing above this level.

- e) The embankment material should not contain grain sizes larger than 2 inches.

MISCELLANEOUS

Please ensure that copies of this memorandum are attached to each of the three original foundation investigation reports.



P. Payer

Senior Engineer

For

K. G. Selby

Supervising Engineer

PP/KGS/jf

cc: A.P. Watt (2)

R.S. Pillar

A.E. McKim

B.J. Giroux

G.A. Wrong

A. Wittenberg

J.R. Roy

R. Hore

Files ✓

Record Services