

REMARKS: _____

MINISTRY OF TRANSPORTATION AND COMMUNICATIONS, ONTARIO

MEMORANDUM

31C-121

TO: Mr. G. C. E. Burkhardt, (3)
Regional Structural Planning Eng.,
Central Region,
3501 Dufferin St., Downsview.

FROM: Foundations Office,
Design Services Branch,
West Bldg., Downsview.

ATTENTION:

DATE: October 30, 1973.

OUR FILE REF.

IN REPLY TO NOV 6 1973

SUBJECT:

FOUNDATION INVESTIGATION REPORT

For

The Proposed Culvert Structure at the
Crossing of Hwy. #2 and Butler Creek
Twp. of Brighton, County of Northumberland
District #7 (Pcrt Hope)

W.O. 73-11084

--

W.P. 725-72-01

Supervised by

144-73-02

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 design requirements. Should additional information be required, please do not hesitate to contact our Office.

AGS/ao

Attch.

c.c. E. J. Orr
B. R. Davis
A. Rutka
R. S. Pillar
D. P. Collins
B. J. Giroux
C. Mirza
G. A. Wrong
B. A. Singh

Alf Stemas
A. G. Stermac,
PRINCIPAL FOUNDATIONS ENGINEER.

Foundations Files
Documents

TABLE OF CONTENTS

1. INTRODUCTION.
 2. DESCRIPTION OF THE SITE AND GEOLOGY.
 3. FIELD AND LABORATORY WORK.
 4. SUBSOIL CONDITIONS.
 - 4.1) General.
 - 4.2) Surficial Alluvial Deposit.
 - 4.3) Heterogeneous Mixture of Silt, Sand and Gravel (Glacial Till).
 5. GROUNDWATER CONDITIONS.
 6. DISCUSSION AND RECOMMENDATIONS.
 - 6.1) General.
 - 6.2) Foundations.
 - 6.3) Embankment Fill.
 - 6.4) Detour (Refer to B.H.'s #5 and #6).
 7. MISCELLANEOUS.
-

FOUNDATION INVESTIGATION REPORT
For
The Proposed Culvert Structure at the
Crossing of Hwy. #2 and Butler Creek
Twp. of Brighton, County of Northumberland
District #7 (Port Hope)
W.O. 73-11084 -- W.P. 125-72-01

1. INTRODUCTION:

It is proposed to replace the existing structure at the crossing of Hwy. #2 and Butler Creek with a new 18 x 8 foot concrete box culvert.

The Foundations Office was requested to carry out a subsurface investigation at the above-mentioned site. The request was contained in a memo from Mr. G.C.E. Burkhardt, Structural Planning Engineer, Central Region, dated September 20, 1973. Subsequently, an investigation was carried out by this office to determine the subsoil and groundwater conditions at the site.

This report presents the factual information obtained from this investigation, together with recommendations pertaining to the foundation design of the proposed culvert and the stability of the associated approaches.

2. DESCRIPTION OF THE SITE AND GEOLOGY:

The site is located at the western outskirts of the Village of Brighton, Twp. of Brighton, County of Northumberland. The topography of the terrain is flat to undulating in relief. The land is used for farming.

The site is in the physiographic region known as "Iroquois Plain." The characteristic deposit in this region

is mainly lacustrine deposits composed of sands and silts. However, in the vicinity of this site, the subsoil consists of a deposit of glacial origin.

3. FIELD AND LABORATORY WORK:

The subsoil investigation consisted of six sampled boreholes, four for the proposed culvert structure and two for the proposed temporary Bailey bridge, about 45 ft. to the south of the present crossing. The borings were advanced by means of a C.M.E. 55 auger machine with Hollow Stem augers adapted for soil sampling purposes.

Sampling in the glacial till material was carried out by means of a 2" O.D. split spoon sampler in accordance with the specifications for the Standard Penetration Test. Groundwater levels were observed in the open boreholes during the period of investigation.

The soil and groundwater conditions encountered at the boring locations are presented in the Record of Borehole sheets. The locations and elevations of the various boreholes were surveyed by personnel from Engineering Surveys Office, Central Region. The elevations in this report are referenced to a Geodetic Datum. Boring locations referenced to a co-ordinate system, and elevations together with estimated stratigraphical sections are shown on Drawing No. 73-11084A.

All samples were subjected to a careful visual examination in the field and subsequently in the laboratory. Following this examination, various laboratory tests were carried out on representative samples to determine the physical properties of the overburden; namely,

Atterberg Limits

Natural Moisture Contents

Grain-Size Distributions

The results of these tests are plotted on the Record of Borehole sheets and summarized on Fig. 1 and Fig. 2, all contained in the Appendix of this report.

4. SUBSOIL CONDITIONS:

4.1) General:

The predominant stratum at this site is a heterogeneous mixture of silt, sand and gravel (glacial till) which was investigated to a maximum depth of 18 ft. In the vicinity of the existing structure, the glacial till is covered by up to 8 feet of surficial alluvial deposit (silt, sand and gravel with organics). Elsewhere the glacial till is found immediately beneath a thin layer of organic topsoil (1.5 feet).

The boundaries between the different strata as determined in the boreholes, are shown on the accompanying Record of Borehole sheets. The stratigraphical sections, shown on Drawing No. 73-11084A, have been inferred from this data.

4.2) Surficial Alluvial Deposit:

This deposit was encountered at some of the boreholes put down close to the existing creek channel. It is composed of silt, sand, gravel and organics. In addition, occasional thin seams of clayey silt are present randomly within this deposit. It is believed that this surficial material was recently laid down by the action of the creek and consequently this deposit is of alluvial nature. The thickness of this stratum ranges from 2.5 feet (B.H. #12) to 8 feet (B.H. #4). The relative density of this deposit is estimated to be generally loose with random compact zones.

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

The predominant stratum across the site is a deposit of glacial origin. It is essentially granular in nature and composed of silt, sand and gravel with a trace of clay. The lower boundary of this deposit was not established. The boreholes were terminated within this stratum ranging in elevations from 302 to 295.

The results of the various laboratory tests are shown on the Record of Borehole sheets and on the plasticity chart (Fig. 1). The Atterberg Limits testing results are as follows:

	<u>Range</u>	<u>Average</u>
Liquid Limit (W_L) %	14 - 16	15
Plastic Limit (W_P) %	10 - 12	11
Natural Moisture Content (W) %	5 - 12	8

Based on the above values, the matrix can be classified as inorganic silt (ML).

Grain size distribution curves for samples obtained in this stratum are shown in Fig. 2 in the Appendix.

The standard penetration tests, carried out within this glacial deposit, are plotted on the Record of Boreholes sheets. The "N" values obtained from these tests range from 27 blows per foot to 100 blows per 2 inches. It is estimated that the relative density of the glacial till varies from compact to very dense, generally increasing with depth.

5. GROUNDWATER CONDITIONS:

The groundwater levels were observed in the open boreholes during the period of field investigation (October 1973). The results of the readings are shown on the Record of Borehole sheets as well as on Drawing No. 73-11084A.

The observations indicate that the groundwater level varies from elevations 310 (B.H. #2) to 312 (B.H. #4).

At the time of the investigation the water level of the creek was at approximate elevation 309.5. It may be concluded that the general drainage path is towards the creek.

6. DISCUSSION AND RECOMMENDATIONS:

6.1) General:

It is proposed to widen the existing Hwy. #2 in the vicinity of the Butler Creek, in conjunction with the resurfacing

of Hwy. 401 in this general area. The present proposal is to replace the existing structure with a new 18' x 8' concrete box culvert.

The revised grade of Hwy. 2 at this crossing will be at about elevation 324. The invert elevation of the new box culvert will be at approximate elevation 309. It is estimated that the maximum height of the approach fills of the widened portion of Hwy. 2 in the vicinity of the new culvert is 15 ft. above the creek bed.

The predominant stratum across the site is a compact to very dense glacial till (heterogeneous mixture of silt, sand and gravel traces of clay).

6.2) Foundations:

It is recommended that the concrete box culvert be supported on mat foundation within the granular till. The combined thickness of the granular bedding and the base slab of the culvert should be 4 feet in order to fulfill the frost protection requirements.

Footings founded as such could be designed using an allowable bearing value of up to 4 t.s.f.

The foundation excavations for the culvert will extend some 4 - 5 ft. below the prevailing groundwater or creek water level established during the course of field investigation. In view of the clay binder within the glacial deposit, no major dewatering problems are anticipated provided that the creek is temporarily diverted during the construction periods. It is believed that any minor seepage or surface runoff into the excavations could be controlled by employing conventional techniques such as pumping from sumps.

The culvert will be designed as a rigid frame structure. A coefficient of earth pressure at rest (K_0) of 0.5 should be assumed for the granular backfill behind the wall when designing the wall sections. In addition, the design should incorporate the full effect of the surcharge located above the walls.

In order to relieve the buildup of excess hydrostatic

pressure behind the walls, suitable drainage measures should be provided. Weep holes located at the base of the walls could be employed for this purpose; these holes should be spaced not more than 10 ft. apart.

6.3) Embankment Fill:

No stability problems are anticipated for an embankment of the height contemplated (max. 15 ft.) provided that

- 1) 2:1 slopes are employed,
- 2) all surficial organic material between the plan limits of the present and future embankments is completely removed prior to the construction of the embankment widening, and
- 3) the fill is properly compacted and keyed to the existing embankment in accordance with current M.T.C. Standard No. DD-414.

In addition, adequate scour protection measures should be provided for the creek banks as per hydrological requirements.

6.4) Detour (Refer to B.H.'s #5 and #6):

The subsoil conditions at the proposed detour crossing are similar to those encountered at the proposed culvert location. At the time of the preparation of this report, no details were available as to what type of detour structure contemplated. However, the subsoil conditions are generally favourable for a spread footing type of support with an allowable bearing pressure up to 4 t.s.f.

This office will provide pertinent recommendations once the detour design details are available.

7. MISCELLANEOUS:

The field work, performed during the period of October 9 to 11, 1973, was supervised by Mr. V. Korlu, Project Foundation Engineer, who also prepared this report.

Equipment was owned and operated by P.V.K. Co.,
Burford, Ontario.

The investigation was carried out under the general
supervision of Mr. M. Devata, Supervising Foundations Engineer,
who also reviewed the report.

V. Korlu
V. Korlu, P. Eng.



VK/ao
Oct. 30, 1973.

M. Devata
M. Devata, P. Eng.

APPENDIX I

DESIGN SERVICES BRANCH

FOUNDATIONS OFFICE

RECORD OF BOREHOLE No 1

JOB 73-11084

LOCATION Sta. 110 + 30 o/s 32' Lt.

ORIGINATED BY VK

W.P. 125-72-01

BORING DATE Oct. 9/73

COMPILED BY VK

DATUM Geodetic

BOREHOLE TYPE Auger and Sample with CME 55

CHECKED BY *[Signature]*

SOIL PROFILE			SAMPLES			ELEV. SCALE	DYNAMIC PENETRATION RESISTANCE					LIQUID LIMIT — w_L			BULK DENSITY	REMARKS
ELEV. DEPTH	DESCRIPTION	STRAT. PLOT	NUMBER	TYPE	BLOWS/FOOT		BLOWS / FOOT					PLASTIC LIMIT — w_p				
							20	40	60	80	100	WATER CONTENT — w				
SHEAR STRENGTH P.S.F.							w_p — w — w_L			WATER CONTENT %			P.C.F.	GR. SA. SI. CL.		
○ UNCONFINED + FIELD VANE																
● QUICK TRIAXIAL × LAB VANE																
312.5	Ground Level															
0.0	Silty sand, gravel & organics with trace of clay.					310									311.0	
309.0			1	SS	27										31 32 28 9	
3.5	Het. mix. of silt, sand, gravel & some clay (Glacial Till)		2	SS	16	11"									13 42 36 9	
			3	SS	11	10"										
302.4	Compact to Very Dense		4	SS	100	1"										
10.1	End of Borehole					300										

OFFICE REPORT SOIL EXPLORATION

DESIGN SERVICES BRANCH

FOUNDATIONS OFFICE

RECORD OF BOREHOLE NO 2

JOB 73-11084

LOCATION Sta. 110 + 72 o/s 32' Lt.

ORIGINATED BY VK

W.P. 125-72-01

BORING DATE Oct. 10, 1973

COMPILED BY VK

DATUM Geodetic

BOREHOLE TYPE Auger & Sample with CME 55

 CHECKED BY *[Signature]*

SOIL PROFILE			SAMPLES			ELEV. SCALE	DYNAMIC PENETRATION RESISTANCE BLOWS / FOOT			LIQUID LIMIT W_L PLASTIC LIMIT W_P WATER CONTENT W			BULK DENSITY γ P.C.F.	REMARKS
ELEV. DEPTH	DESCRIPTION	STRAT. PLOT	NUMBER	TYPE	BLOWS/FOOT		SHEAR STRENGTH P.S.F.			W_P W W_L				
							O UNCONFINED + FIELD VANE ● QUICK TRIAXIAL x LAB VANE			WATER CONTENT % 10 20 30				
310.1	Ground Level													
0.0	Silt, sand, gravel and organics, with trace clay.					310								
307.6														
2.5	Het. mix. of silt, sand, gravel & some clay (Glacial Till)		1	SS	110									62 24 (14)
			2	SS	116									
			3	SS	110	6"								
			4	SS	100	3"	300							
295.9	Very Dense		5	SS	100	2"								
14.2	End of Borehole					290								

DESIGN SERVICES BRANCH

FOUNDATIONS OFFICE

RECORD OF BOREHOLE NO 3

JOB 73-11084

LOCATION Sta. 110 + 30 o/s 32' Rt.

ORIGINATED BY VK

W.P. 125-72-01

BORING DATE Oct. 11, 1973

COMPILED BY VK

DATUM Geodetic

BOREHOLE TYPE Auger and sample with CME 55

CHECKED BY

SOIL PROFILE			SAMPLES			ELEV. SCALE	DYNAMIC PENETRATION RESISTANCE				LIQUID LIMIT ——— w_L			BULK DENSITY	REMARKS
ELEV. DEPTH	DESCRIPTION	STRAT. PLOT	NUMBER	TYPE	BLOWS/FOOT		BLOWS / FOOT				PLASTIC LIMIT ——— w_p				
							SHEAR STRENGTH P.S.F.				WATER CONTENT ——— w				
313.8	Ground Level														
0.0	Silt, sand, gravel and organics with trace of clay.														
309.8			1	SS	19	310								Org. 310.3	310.3
4.0	Het. mix. of silt, sand, gravel, some clay (Glacial Till)		2	SS	62										
			3	SS	114										
301.8	Brown		4	SS	100	5"									
12.0	Grey					300									
296.7	Very Dense		5	SS	100	11"									
17.1	End of Borehole					290									

DESIGN SERVICES BRANCH

FOUNDATIONS OFFICE

RECORD OF BOREHOLE N^o4

JOB 73-11084

LOCATION Sta. 110 + 70 o/s 32' Rt.

ORIGINATED BY VK

W.P. 125-72-01

BORING DATE Oct. 10, 1973

COMPILED BY VK

DATUM Geodetic

BOREHOLE TYPE Auger and sample with CME 55

CHECKED BY *[Signature]*

SOIL PROFILE			SAMPLES			ELEV. SCALE	DYNAMIC PENETRATION RESISTANCE BLOWS / FOOT 20 40 60 80 100	LIQUID LIMIT — w_L PLASTIC LIMIT — w_p WATER CONTENT — w w_p — w — w_L	BULK DENSITY γ P.C.F.	REMARKS
ELEV. DEPTH	DESCRIPTION	STRAT. PLOT	NUMBER	TYPE	BLOWS/FOOT					
314.7	Ground Level									
0.0	Silt, sand, gravel and organics with traces of clay.	<i>[Stratigraphic Column Diagram]</i>	1	SS	6	310				Org. 1.53
306.7			2	SS	38					
8.0	Het. mix. of silt, sand, gravel & some clay (Glacial Till)		3	SS	76					
			4	SS	127	11"				
			5	SS	100	3"				
296.5	Very Dense		6	SS	100	2"				
18.2	End of Borehole					290				

OFFICE REPORT SOIL EXPLORATION

DESIGN SERVICES BRANCH

FOUNDATIONS OFFICE

RECORD OF BOREHOLE NO 5

JOB 73-1108h

LOCATION Sta. 110 + 27 o/s 65' Rt.

ORIGINATED BY VK

W.P. 125-72-01

BORING DATE Oct. 10/73

COMPILED BY VK

DATUM Geodetic

BOREHOLE TYPE Auger and sample with CME 55

CHECKED BY *[Signature]*

SOIL PROFILE			SAMPLES			ELEV. SCALE	DYNAMIC PENETRATION RESISTANCE					LIQUID LIMIT ——— w_L			BULK DENSITY	REMARKS
ELEV. DEPTH	DESCRIPTION	STRAT. PLOT	NUMBER	TYPE	BLOWS/FOOT		BLOWS / FOOT ———					PLASTIC LIMIT ——— w_p				
							SHEAR STRENGTH P.S.F.					WATER CONTENT ——— w			γ	GR. SA. SI. CL.
							○ UNCONFINED + FIELD VANE					w_p ——— w ——— w_L				
							● QUICK TRIAXIAL x LAB VANE					WATER CONTENT %				
												10 20 30				
312.5	Ground Level															
311.0	Topsoil															
1.5	Het. mix. of silt to silty sand with grav. and some clay (Glacial Till)		1	SS	30	310									310.5	
			2	SS	109										20 42 29 9	
302.5	Dense to Very Dense		3	SS	135	10"									38 40 17 5	
10.0	End of Borehole					300										

DESIGN SERVICES BRANCH

FOUNDATIONS OFFICE

RECORD OF BOREHOLE N^o6

JOB 73-11084

LOCATION Sta. 110 + 80 o/s 85' Rt.

ORIGINATED BY VK

W.P. 125-72-01

BORING DATE Oct. 10, 1973

COMPILED BY VK

DATUM Geodetic

BOREHOLE TYPE Auger and sample with CME 55

CHECKED BY *[Signature]*

SOIL PROFILE			SAMPLES			ELEV. SCALE	DYNAMIC PENETRATION RESISTANCE BLOWS / FOOT				LIQUID LIMIT — w_L PLASTIC LIMIT — w_p WATER CONTENT — w w_p — w — w_L			BULK DENSITY γ P.C.F.	REMARKS
ELEV. DEPTH	DESCRIPTION	STRAT. PLOT	NUMBER	TYPE	BLOWS/FOOT		SHEAR STRENGTH P.S.F. ○ UNCONFINED + FIELD VANE ● QUICK TRIAXIAL × LAB VANE				WATER CONTENT % 10 20 30				
312.1	Ground Level														
310.6	Topsoil														
1.5	Het. mix. of silt to silty sand with grav. and some clay (Glacial Till)		1	SS	31	310									310.1
			2	SS	120										12 42 38 8
301.6	Dense to Very Dense		3	SS	187	10"									13 40 36 11
10.5	End of Borehole					300									

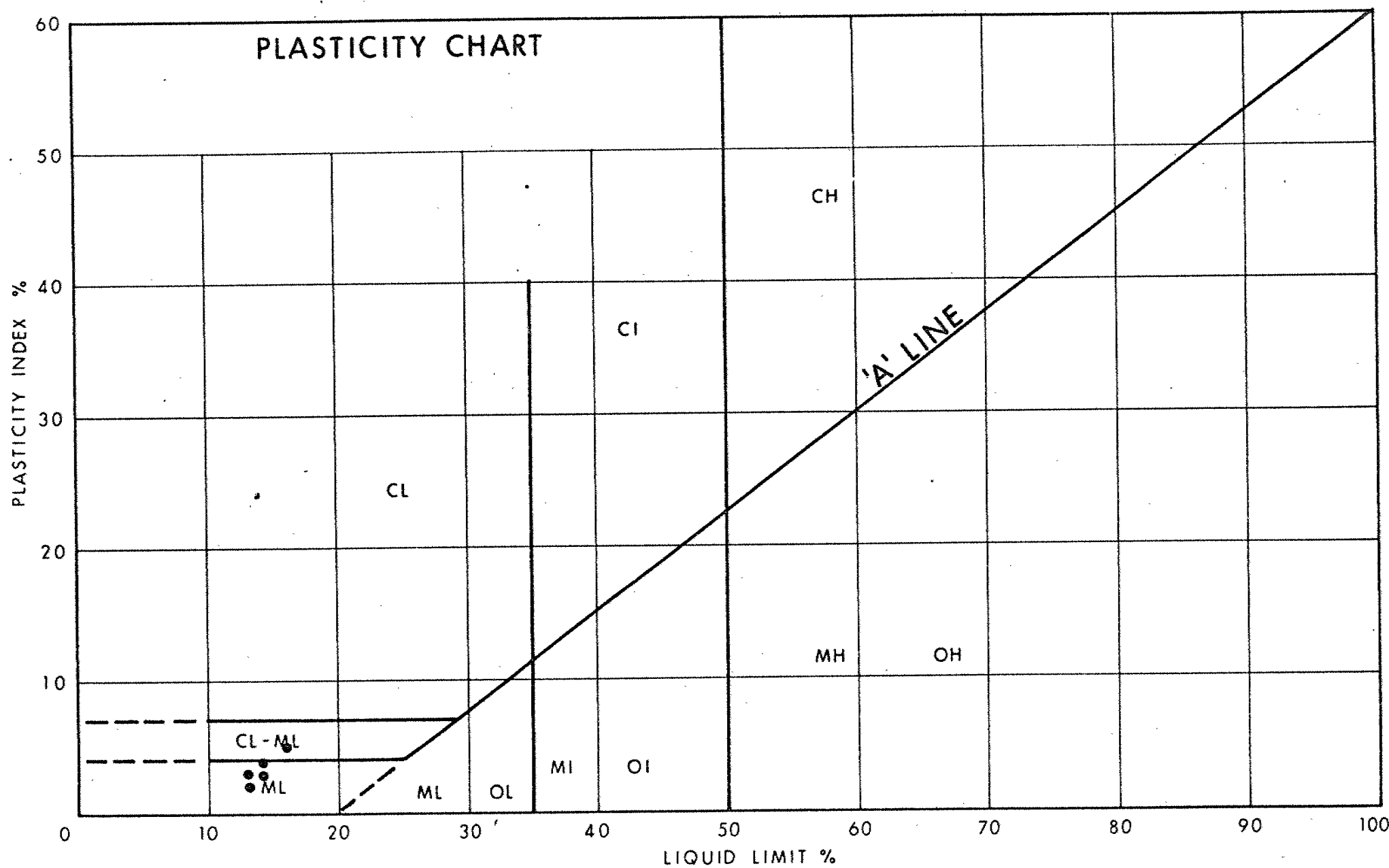
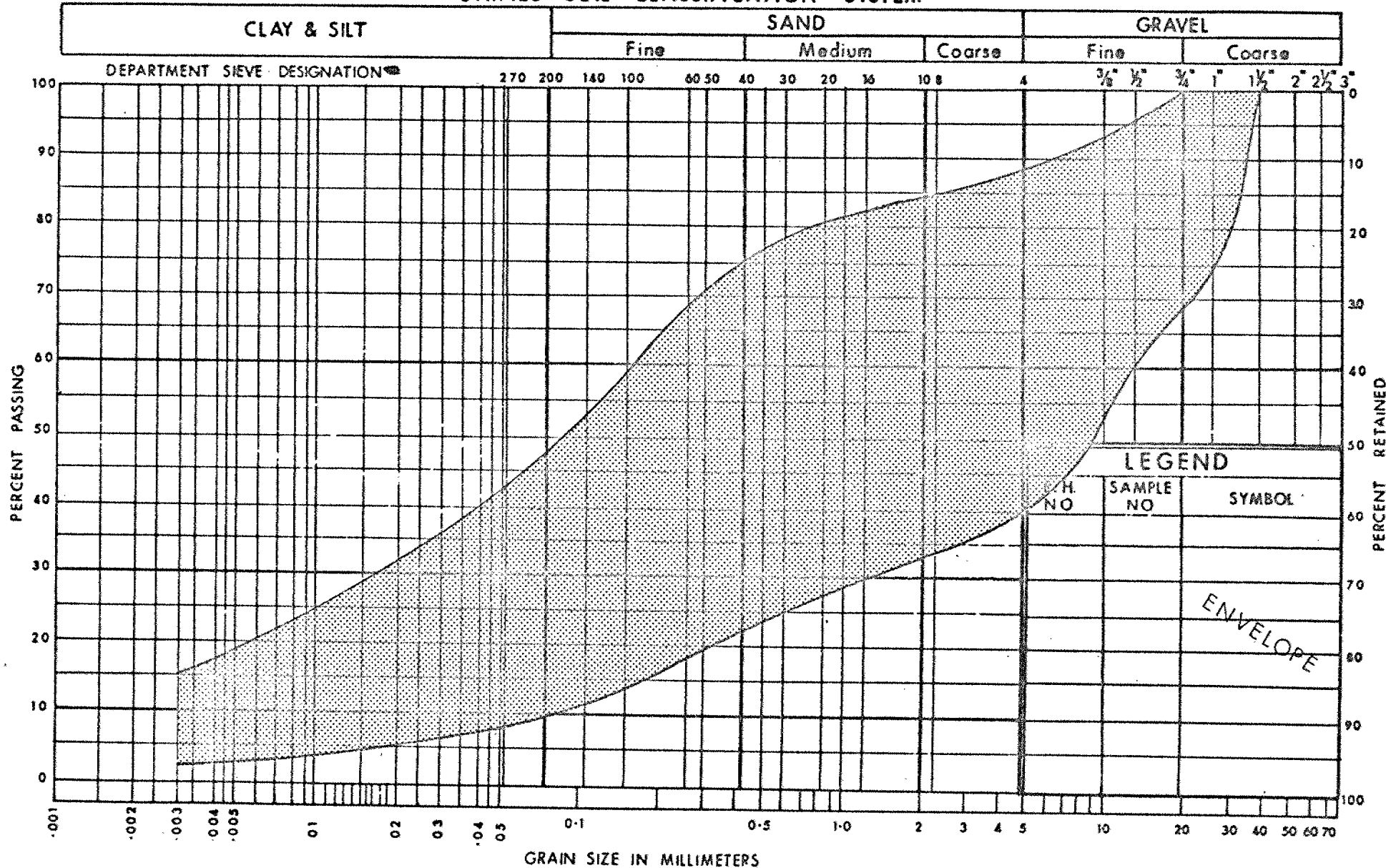


FIG.1

UNIFIED SOIL CLASSIFICATION SYSTEM



DEPARTMENT
OF
TRANSPORTATION AND COMMUNICATIONS

DESIGN SERVICES
BRANCH

GRAIN SIZE DISTRIBUTION GLACIAL TILL

HET. MIX. OF SILT, SAND, GRAVEL, SOME CLAY

W.P. No. 125-72-01

JOB No. 73-11084

FIG. 2

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 REPORT

SOIL 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
$\log_e a$ or $\ln a$	NATURAL LOGARITHM OF a
$\log_{10} a$ or $\log a$	LOGARITHM OF a 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

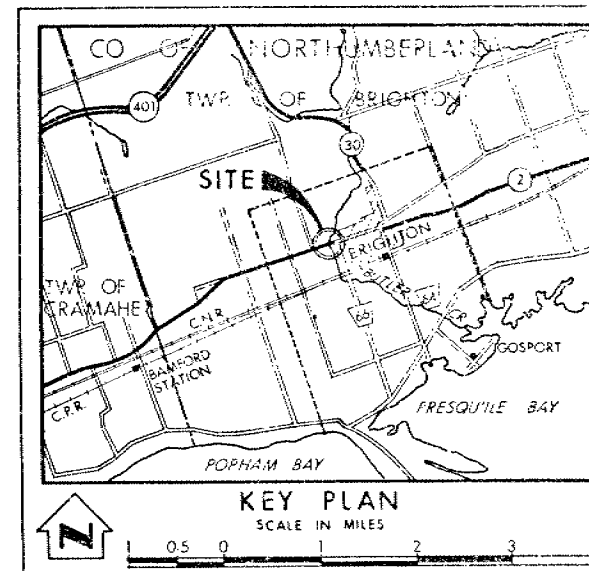
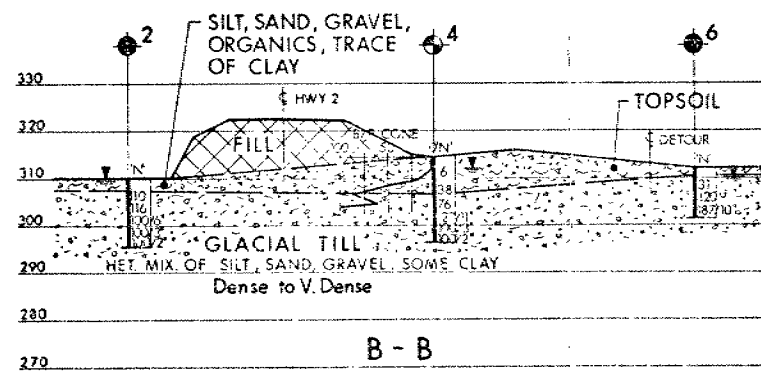
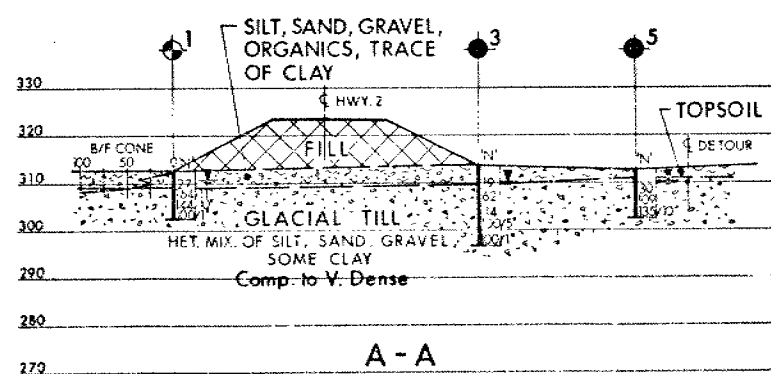
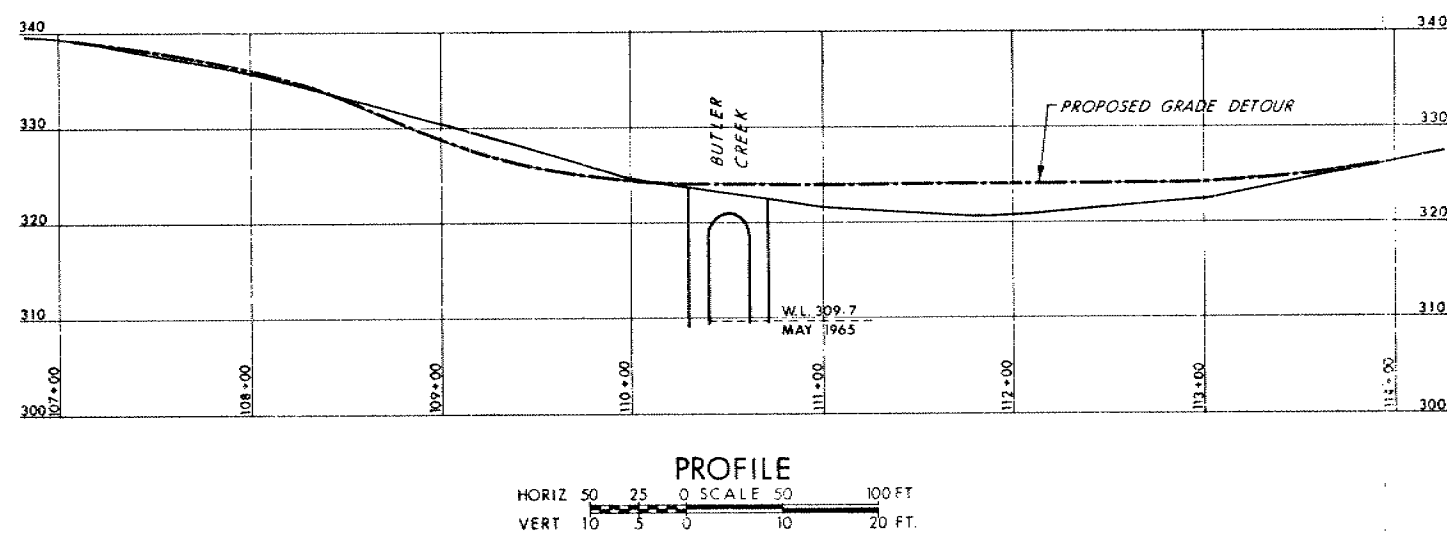
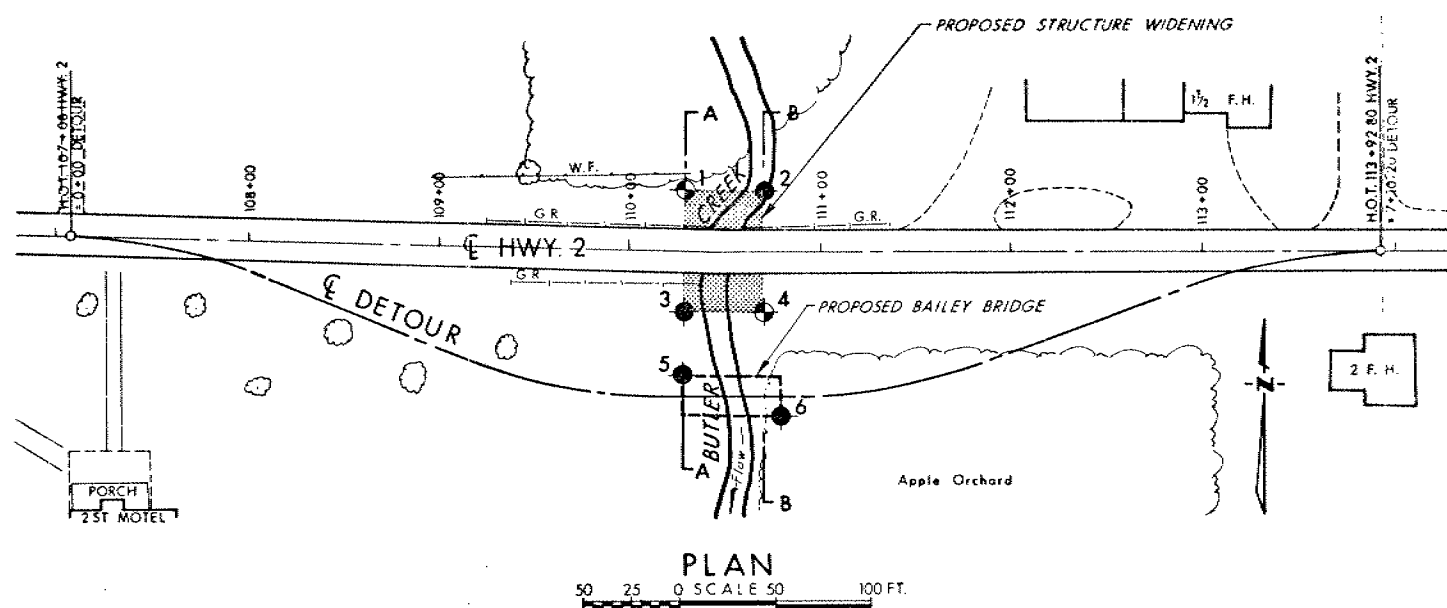
d	DISTANCE FROM TOP OF WALL TO POINT OF APPLICATION OF PRESSURE
δ	ANGLE OF WALL FRICTION
K	DIMENSIONLESS COEFFICIENT TO BE USED WITH VARIOUS SUFFIXES IN EXPRESSIONS REFERRING TO NORMAL STRESS ON WALLS
K_0	COEFFICIENT OF EARTH PRESSURE AT REST

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		
⊕	Cone Penetration Test		
⊗	Bore Hole & Cone Test		
⬇	Water Levels established at time of field investigation, Oct. 1973.		

NO.	ELEVATION	STATION	OFFSET
1	312.5	110+30	32' LT.
2	310.1	110+72	32' LT.
3	313.8	110+30	32' RT.
4	314.7	110+70	32' RT.
5	312.5	110+27	65' RT.
6	312.1	110+80	85' RT.

NOTE FOR CONTRACT DOCUMENT:
The complete foundation investigation report for this structure may be examined at the Structural Office and Foundations Office, Downsview, and at the PORT HOPE District Office.

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

REVISIONS	DATE	BY	DESCRIPTION

MINISTRY OF TRANSPORTATION AND COMMUNICATIONS—ONTARIO
DESIGN SERVICES BRANCH—FOUNDATIONS OFFICE

BUTLER CREEK

HIGHWAY NO. 2 DIST. NO. 7
CO. NORTHUMBERLAND
TWP. BRIGHTON LOT CON

BORE HOLE LOCATIONS & SOIL STRATA

SUBMD. V.K.	CHECKED <u> </u>	WP NO. <u>725-72-01</u>	DRAWING NO. <u>73-11084 A</u>
DRAWN S.R.	CHECKED <u> </u>	WO NO. <u>73-11,84</u>	BRIDGE DRAWING NO. <u> </u>
DATE <u>OCT 18 1973</u>	SITE NO. <u> </u>	CONT NO. <u> </u>	
APPROVED <u> </u>			

