

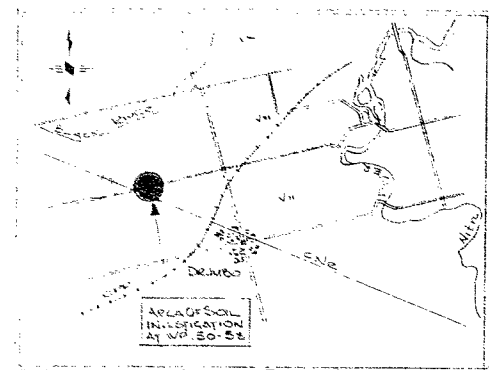
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W.P.# 150-58

CON. RD. SITE

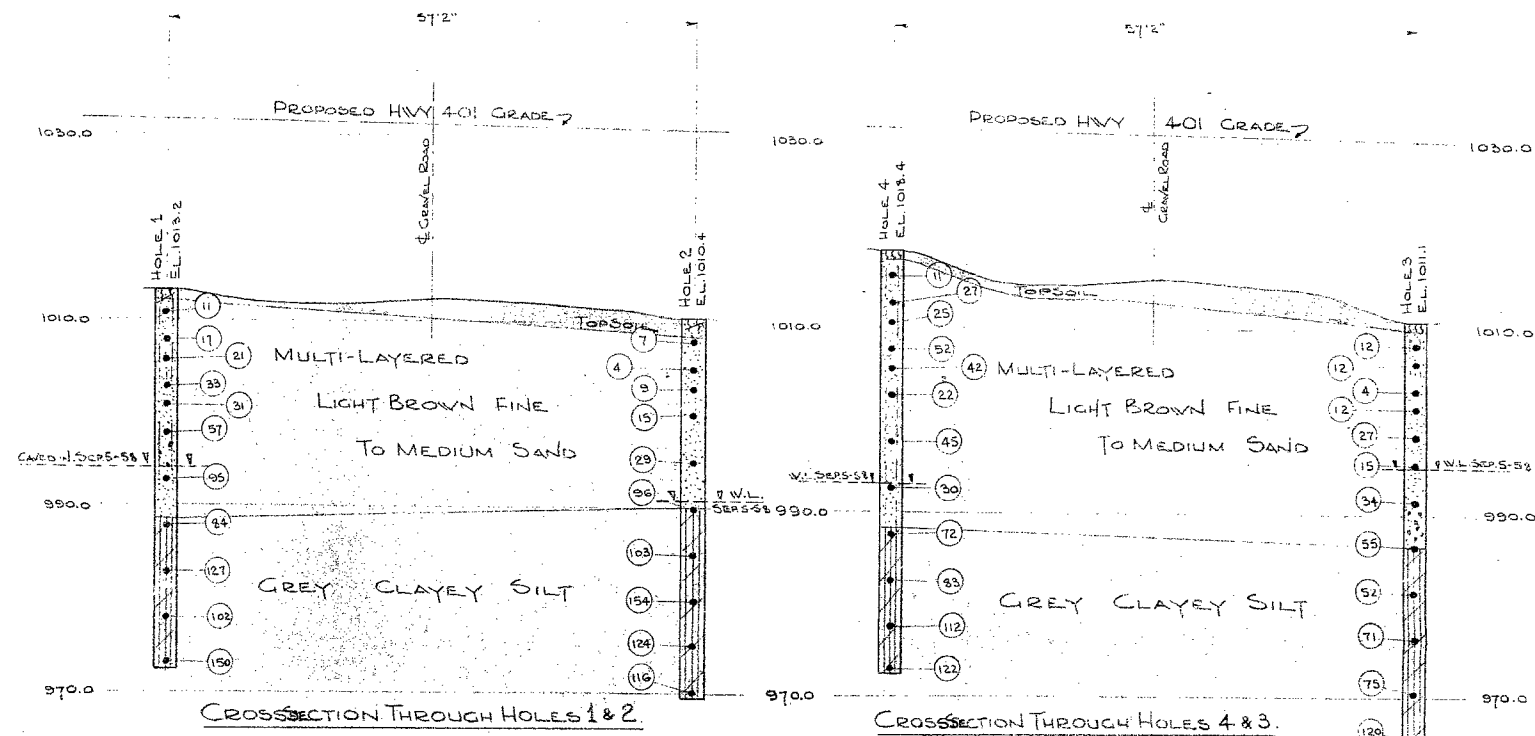
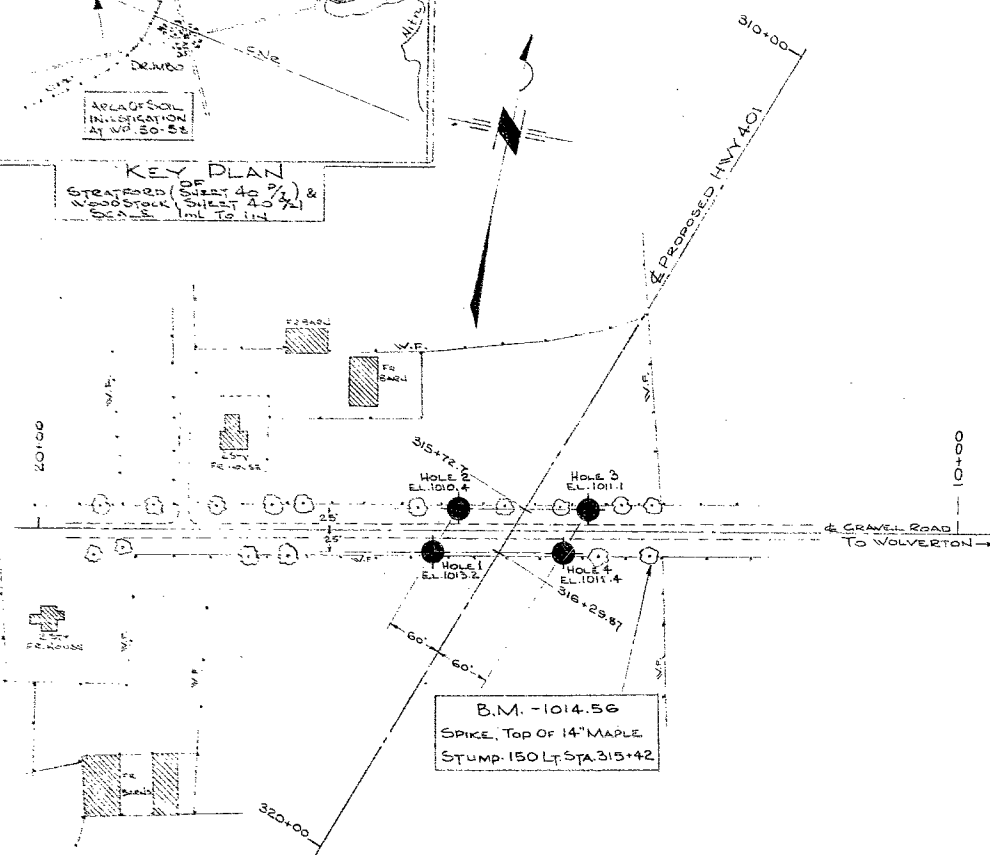
INVESTIGATION

BLENHEIM



Lot 5  
Con. VI

Lot 15  
Con. VI



#### LEGEND

- TEST HOLE
- BLOWS/FOOT

NOTE: PLEASE SEE BOREHOLE LOGS  
FOR COMPLETE SOIL DETAILS.

NOTE: THE BOUNDARIES BETWEEN SOIL  
STRATA HAVE BEEN ESTABLISHED  
ONLY AT BOREHOLE LOCATIONS.

A LINEAR VARIATION IN SOIL  
STRATIGRAPHY HAS BEEN  
ASSUMED BETWEEN BOREHOLES,  
AND THIS MAY ACTUALLY DIFFER  
FROM THAT SHOWN.



**e.m. peto & associates Ltd.**

SOIL SITE INVESTIGATION  
AT

HWY 401 - BLENHEIM TWP No. 5  
CONCESSION ROAD CROSSING  
FOR  
DEPARTMENT OF HIGHWAYS OF ONTARIO

OUR JOB No. 58103 DATE SEP 16-58  
CLIENTS PLAN No. V.P. 150-58 PER. C.T.

**e. m. peto associates ltd.**

YOUR REFERENCE:- **W. P. 150 - 58**

OUR REFERENCE:- **58103**

**850 roselawn avenue,**

**TORONTO, ONTARIO.**

**RUssell 1 - 4955.**

**September 17th, 1958.**

58 F 2380

**The Department of Highways of Ontario,  
280 Davenport Road,  
Toronto, Ontario.**

**Attention: Mr. J. C. McAllister**

**Re: Soil Site Investigation,  
Blenheim Township #5**

**Dear Sirs:**

**In reference to your verbal request we are forwarding herewith four (4) copies of our report covering this investigation for your attention.**

**We have considered the site conditions in detail in the attached soils report. Here for your convenience is a summary of our findings and recommendations.**

- 1. The topsoil is a 1 to 2 ft. thick layer of a dark brown sandy loam mixed with organic matter.**

**Below the topsoil and to the varying depth of 20'6" to 30'0" a multi-layered deposit of light to pale brown fine to medium sand was found with occasional silt seams and grits.**

**Below the brown sand in all four holes a continuous layer of grey clayey silt was found. The test holes were terminated in this material.**

2. The ground water table was found between elevation 990.6 and 995.2. The level of the free water in the nearby well was at elevation 989.3
3. In general the sand in the profile was compact and the silt was hard, however, there was a wide scattering of the penetration test results, indicating non uniform conditions.

Average penetration above elevation 1008 was 18.5 and below this elevation in the sand it was 20.0. The range of penetration values in the silt was between 52 to 154 blows per foot.

4. Using spread footings, foundation elevation below elevation 1007.0 is desirable.
5. The allowable bearing capacity for spread footings with a minimum surcharge of 4 feet for footings of,
  - a) minimum width of 10.0 ft. 2.7 tons per sq. ft.
  - b) minimum width of 5.0 ft. 1.7 tons per sq. ft.

The above given values are based on a standard penetration value of 20 blows per foot with a minimum factor of safety of three and one inch limiting settlement.

It should be pointed out here that as the density of the sand was not uniform some differential settlement may be expected. The vibration of the foundation may magnify the settlement.

6. If the superstructure design is such that differential settlement of ordinary magnitude (about one inch) cannot be tolerated, the foundation load will have to be carried by displacement piles into the grey clayey silt.
7. Displacement piles can be used, however, as the sand in some places is dense to very dense it may be necessary to use jetting in order to penetrate the material.

8. In order to obtain uniform support a specific set of 8 - 10 blows for the last inch should be specified, assuming that the driving equipment is a standard heavy duty pile driving hammer.
9. Based on the above considerations it is our opinion that a spread footing foundation is to be preferred to piled footings, if the design of the superstructure is such that it can tolerate some differential settlement.
10. The safe side slopes of the embankment are 1-1/2 horizontal on 1 vertical, assuming controlled construction practice (optimum moisture, maximum density) and the use of local sand material for construction; furthermore there is no danger of a base failure of the embankment.
11. The topsoil should be stripped to 1 to 2 feet before placing the fill.
12. For computing the active pressure on the retaining wall, assuming the fill is a well compacted granular material, the lateral earth pressure coefficient " $K_a$ " suggested:-
  - a) for unyielding structure is  $K_a = 0.70$
  - b) For yielding structure is  $K_a = 0.26$ .

The suggested value of the angle of wall friction is  $\delta = 0.75\phi = 27^\circ$ .

13. Some of the sands in the stratified profile are frost susceptible. There is a possibility that at some location the frost susceptible soil will be near the subgrade and together with a high water table or poor drainage condition, it can be a potential cause of frost heave.

We trust we have covered all the technical matters arising from this investigation. However, should you require any additional advice or amplification of our recommendations, we shall be pleased to be of further service.

Yours very truly,

E. M. PETO ASSOCIATES LTD.,



E. M. Peto, P. Eng.

GYS:sb

**THE DEPARTMENT OF HIGHWAYS OF ONTARIO**

**BLENNHEIM TOWNSHIP #5**

**W. P. 150-58**

**SOILS REPORT**

**by**

**e. m. peto associates ltd.**

**Toronto, Ontario**

**September, 1958**

e. m. peto associates ltd., 850 roselawn avenue, Toronto 10, Ontario

Job No. 58103

Client's Ref. No. W. P. 100-58

Date September 17th/58

Report on

58-F-238 c.

**SOIL SITE INVESTIGATION**

at

**BLENNHEIM TOWNSHIP #5**

for

**THE DEPARTMENT OF HIGHWAYS OF ONTARIO.**

**INTRODUCTION:**

We were authorized verbally on August 27th, 1958, by Mr. J. C. McAllister to carry out a soil investigation at this site.

The object of the investigation was to determine:-

- a) The existing soil and water conditions.
- b) The types of foundation suitable for such soil conditions.
- c) The elevation for such foundations together with the appropriate bearing capacities.
- d) Any other information pertinent to the design and construction of the proposed structure.

**PROGRAMME:**

August 28th, 1958: Location and reconnaissance of site by Field Engineer.

August 29th, 1958: Test holes set out, staked and levelled by Field Engineer.

September 2nd, 1958: Rig #1 moved onto site and started sampling hole #1.

September 3rd, 1958: Rig #2 completed hole #1.



**PROGRAMME: (Cont'd)**

September 4th, 1958: Rig #1. Started and completed hole #4.  
Rig #3. Moved off W. P. 187-58 onto this site, started and completed hole #3.  
Rig #4 moved off W. P. 149-58 onto this site, started and completed hole #2.

September 5th, 1958: Final check of water levels, all rigs moved off site.

**GENERAL INFORMATION:**

a) Test holes were driven and sampled in accordance with our standard procedure detailed in Appendix II. Four test holes were driven to depths detailed below.

Borehole #1 to a depth of 41 ft. below ground level.  
Borehole #2 to a depth of 41 ft. below ground level.  
Borehole #3 to a depth of 46 ft. below ground level.  
Borehole #4 to a depth of 46 ft. below ground level.

b) The ground elevation of the test holes was referred to your bench mark, which was a spike in top of 1.2 ft. Maple stump 150.0 feet left of Sta. 315 + 42. The elevation of this benchmark was taken at 1014.56.

c) Descriptions and details of the soils and conditions are entered up on a borehole log prepared for each test hole. These are included with the soils report.

d) Locations of the test holes are shown on a plan prepared from your Drawing No. F3526. Two soil profiles through holes #1 and 2 and 3 and 4 have also been prepared, and together with the plan, form part of the Appendices to the report.

e) Test result details are given in Appendix I entitled "Laboratory Test Results".

**SITE AND GEOLOGY:**

The site is located on Concession Road VIII, 0.75 miles West of the intersection of the Drumbo - Washington Road and Concession Road VIII, in the Township of Blenheim. The Concession Road is gravel surfaced and 20 feet wide approximately. At the site it traverses the Northern slopes of a local ridge, and consequently the ground falls fairly rapidly from South to North. There are trees lining each side of the road in the immediate vicinity of the proposed overpass.

The site is located in an extension of the physiographic region known as the Ingersoll moraine, and forms part of a series of disconnected morainic hills between Woodstock and the Nith River. This moraine consists of a loose, loamy or sandy till.

**SITE CONDITIONS:**

The soil condition at the site is uniform. Below the thin layer of sandy loam topsoil there is a layer of brown sand about 20 - 28 feet thick. In all four boreholes the sand was underlain by a grey clayey silt. The holes were terminated in this material.

**Topsoil**

The topsoil is a 1 to 2 ft. thick layer of a dark brown sandy loam mixed with organic matter. In general this layer is loose and moist.

**Brown Sand**

Below the topsoil and to the varying depth of 20'6" to 30'0" a multi-layered deposit of light to pale brown fine to medium sand was found with occasional silt seams and grits. In borehole #1 the fine sand contained some silt.

Wide variation was found in the natural moisture contents of the sand samples. The range was 2.3% to 26.0%. The variation in natural moisture contents reflects the difference in the textural composition of the different sand layers. Moisture contents above 20% indicates silt seams of very fine silty sands.

The standard penetration values are variable, however, except for a few low values the sand was compact.

SITE CONDITIONS: (Cont'd)

Grey Silt

Below the brown sand in all four holes a continuous layer of grey clayey silt was encountered. The boreholes were terminated in this material.

The natural moisture content of the layer was between 13.2% and 15.7%, drier than the plastic limit of the material. As the samples were very well consolidated, the volumetric analyses revealed that the silt was saturated.

The standard penetration values were scattered, nevertheless the silt was hard.

WATER CONDITIONS:

In order to determine the ground water table, all holes were bailed upon completion. After 12 hours, on September 5th, 1958, at 7:15 a. m. a water level check was made and the following results were obtained.

Borehole #1 caved in at 18'9" depth, dry.

Borehole #2 depth to water was 19'10".

Borehole #3 caved in at 16'3", depth to water 15'11"

Borehole #4 caved in at 25'3", depth to water 24'11".

As the cave in of a borehole in a sandy material is a fair indication that the ground water is near to the depth where the cave in occurred, it can be reasonably assumed, that in borehole #1 the ground water level was at the depth of 18'9".

The measurements taken indicate a ground water level between elevation 990.6 and 995.2.

The level of free water was measured in a nearby well some 500 feet South-West from the site, on September 4th, 1958 it was 989.30.

report

for Department of Highways of Ontario.

Sheet No.

5.

**TEST RESULTS:****Standard Penetration Test.**

The penetration profile based on continuous testing in the four boreholes is given in the Appendix I. It is evident from the profile that the material is non-uniform. As a rough estimate for the bearing capacity evaluation, from the data available, an average penetration profile was determined.

Above elevation 1008 an average standard penetration of 18.5 was obtained with actual values ranging between 11 and 27.

Below elevation 1008 and to the layer of silt, the sand was compact and the average standard penetration was 20.0. This average was computed disregarding penetration results obtained in borehole #4 as these values were consistently and considerably higher than those obtained in the other holes. The range of the actual values was from 4 to 57 blows per foot of penetration.

The grey silt was hard. No attempt was made to compute an average standard penetration, as the range of the values was between 52 and 154 blows per foot of penetration.

**Mechanical Analysis.**

Mechanical analyses were made on different sand samples taken from the multi-layered brown sand and from the grey clayey silt layer for the proper identification and classification of the material. The results of these tests are given in a graphical form in Appendix I and in a tabular form below.

<u>Sample Description</u>	<u>Borehole</u>	<u>Depth</u>	<u>Gravel<sup>x</sup></u>	<u>Sand<sup>x</sup></u>	<u>Silt<sup>x</sup></u>	<u>Clay<sup>x</sup></u>	<u>Classifi- cation.</u>
a) Light brown fine sand.	1	12'0" - 13'0"		84	15	1	A-2-4
b) Grey Clayey Silt	1	25'0" - 26'0"		4	68	28	A-4 (8)
c) Lt. Brown fine to medium sand	2	10'0" - 11'0"	2	94	4		A-3
d) Grey clayey silt.	2	40'0" - 41'0"		4	69	27	A-4 (8)

**TEST RESULTS****Mechanical Analysis (Cont'd)**

<u>Sample Description</u>	<u>Borehole</u>	<u>Depth</u>	<u>Gravel</u> <sup>x</sup>	<u>Sand</u> <sup>x</sup>	<u>Silt</u> <sup>x</sup>	<u>Clay</u> <sup>x</sup>	<u>Classification</u>
e) Pale brown fine sand	3	9'0" - 10'6"	1	91	8		A-3
f) Grey clayey silt	3	29'0" - 30'0"		3	62	35	A-4 (8)
g) Grey Clayey silt	3	34'0" - 35'0"		4	62	34	A-4 (8)
h) Pale brown very fine sand, some silt	4	7'0" - 8'0"	4	77	19		A-2-4

<sup>x</sup> M. I. T. Classification.

The soils found in the profile belong to three distinct groups, according to the Revised U. S. Public Roads Administration classification system. The first group, soils (a) and (h) belong to the group, A-2-4, fairly uniformly graded fine to medium sands with some coarse sand and silt. The second group, A-3, soils (c) and (e) are poorly graded fine to medium sands. The third group A-4 (8), soils (b), (d), (f) and (g), are fairly well graded silts with 27% to 35% of clay and some fine to medium sand content.

**Atterberg Limits**

In order to have an indication for the degree of plasticity and compressibility of the cohesive grey clayey silt and for classification purposes, the liquid and plastic limit was determined for this material on representative samples. The following results were obtained:

<u>Borehole</u>	<u>Depth</u>	<u>L. L.</u>	<u>P. L.</u>	<u>P. I.</u>	<u>% Passing #200 Sieve</u>	<u>Classification</u>
1	30' - 31'	30.6	18.6	12.0	~97	A-4 (8)
3	40' - 41'	32.6	18.7	13.9	~97	A-4 (8)
3	45' - 46'	30.6	17.4	13.2	~97	A-4 (8)

report

for Department of Highways of Ontario.

Sheet No. 7.

**TEST RESULTS:****Atterberg Limits (Cont'd)**

Based on these investigations the grey clayey silt is a low plasticity and compressibility soil. As the Plasticity index of the soil tested was slightly higher than 10%, it could have been classified as an A-6 soil, but since it was a border case we felt that, the classification A-4 (8) was more indicative of its characteristics. According to the Casagrande classification system the soil is an inorganic clayey silt (CL) falling fairly close to the "A" line, which is another indication that the classification as A-4 is more realistic.

**Field Density Tests**

For the determination of the density and the degree of saturation of the grey clayey silt material field density tests were performed on 9 samples taken by the split spoon sampler. The following results were obtained.

<u>Borehole</u>	<u>Depth</u>	<u>Moisture Content</u>	<u>Wet Density</u>	<u>Dry Density</u>	<u>Degree of Saturation</u>	<u>Void ratio</u>
1	25' - 26'	13.5	125.0	110.0	69.0	0.530
1	30' - 31'	15.3	127.5	110.5	78.5	0.525
2	35' - 36'	12.9	135.0	120.5	62.0	0.400
2	40' - 41'	13.5	143.0	126.0	100.0	0.335
3	24' - 25'	12.5	141.5	125.5	99.2	0.340
3	29' - 30'	13.3	138.0	121.5	97.0	0.385
3	34' - 35'	13.3	138.0	121.5	97.0	0.385
3	40' - 41'	13.4	145.5	128.0	62.6	0.312
3	45' - 46'	14.5	138.0	119.0	93.5	0.420

There is a distinct difference between the densities obtained on samples taken from borehole #1 and all the other samples tested. The average dry density of the samples was 110.25 p. c. f. in borehole #1, against 123.50 p. c. f., the average in all the other boreholes.

report

for Department of Highways of Ontario

Sheet No. 8.

**TEST RESULTS: (Cont'd)****Triaxial Compression Test.**

A conservative angle of internal friction value  $\phi$  was obtained for the pale brown fine sand material, the typical sand in the profile, using the quick drained triaxial compression test technique.

A series of two tests were performed "A" and "B" at comparable densities, but at different moisture contents.

	<u>Moisture Content</u>	<u>Dry Density</u>	<u>Degree of Saturation</u>	<u>Angle of Internal Friction</u>
"A"	9.5	102.5 pcf	41.0%	36.0°
"B"	17.0	101.5 pcf	71.8%	36.5°

The samples were tested at 10, 30 and 60 p.s.i. minimum principal pressures. There was no indication that the moisture content of the samples influences the internal friction value under drained condition.

Four quick, drained triaxial compression tests were made on the grey clayey silt at a very low minimum pressure value (5 p.s.i.) in order to get an indication for the shear strength of the soil due to cohesion. Two tests were made on the material with low dry density (110.25 p.c.f.) and two on the material with high dry density (123.50). Shear strength values obtained were 4700 p.s.f. and 13900 p.s.f. respectively.

The wide variation of the strength values obtained reflects the considerable influence of the density on strength and probably the heterogeneity of the material.

**ENGINEERING CONSIDERATIONS:**

1. At the time of the investigation the ground water table was between elevation 990.6 and 995.2 well below the ground surface (1010 - 1018).

**ENGINEERING CONSIDERATIONS: (Cont'd)**

2. There are two possible alternatives for the type of foundation structure suitable for the soil condition at the site.
  - a) Spread footings founded on the compact brown sand.
  - b) Piles, carrying the load from the superstructure down into the grey clayey silt.
3. The foundation elevation for spread footings will be determined by the soil condition and the depth of frost penetration and it will be limited by the geometry of the two intersecting road profiles.

Foundation elevation below elevation 1007.0 is desirable.

Using the value of dry density 100.0 p.c.f. and a minimum surcharge of four feet the following bearing capacity figures are obtained.

for footing, minimum width of 10.0 ft. 2.7 tons per sq. ft.  
for footing, minimum width of 5.0 ft. 1.7 tons per sq. ft.

The above given values are based on a standard penetration of 20 blows per foot with a minimum factor of safety of three and one inch limiting settlement, however, the penetration profile obtained indicates that the density of the sand is not uniform consequently the designer should take into consideration the differential settlement, which may occur. This settlement will take place very quickly.

It should be realized that the vibration caused by the traffic on the bridge may consolidate the loose spots which may be the cause of additional settlement not accounted for in the figure given for the settlement at the allowable bearing capacity.

4. If the superstructure design will not tolerate differential settlement of ordinary magnitude (about one inch), the foundation load should be carried down through the compact sand into the grey clayey silt by using displacement piles.

On account of the variation of the shear strength of the grey clayey silt it is advisable for the piles to penetrate 1 - 2 feet into this layer.



**ENGINEERING CONSIDERATIONS:**

**4. (Cont'd)**

As an additional precaution it will be advisable to specify uniform set (8 - 10 blows for the last inch with standard heavy duty pile driver) in order to insure uniform pile support.

At some places the sand is dense to very dense. It may be necessary to resort to jetting in order to penetrate this material.

- 5. The overpass will necessitate the construction of a fill about 20 feet high. Suitable granular material for fill construction can be obtained by opening borrow pits at a nearby site.**

Two samples obtained from the brown sand layer were tested in the laboratory for the determination of their strength characteristics at about field density, and at and above optimum moisture content. On the basis of these tests it can be stated that side slopes 1-1/2 horizontal and 1 vertical can be used assuming that the granular fill is compacted to maximum density (standard) at optimum moisture content.

It was found during the testing programme that variation in the actual moisture content of the sand did not cause variations in its strength under free drainage conditions.

As the underlying layer is sand, there is no danger of base failure of the embankment.

It will be necessary to remove the topsoil (1-2 feet) before placing the fill in order to minimize the deformation of the fill after the road surface is laid.

**ENGINEERING CONSIDERATIONS: (Cont'd)**

6. The active pressure exerted on the retaining structure will depend on the rigidity of the structure assuming the placement of the fill is controlled (optimum moisture, maximum density).

If the outward displacement of the wall is assumed to be 0.1% of its height, the active pressure exerted by the wall can be computed using  $\phi = 36^\circ$  and the relationship

$$P_a = K_a \cdot w \cdot h.$$

where  $K_a = \tan^2 (45 - \phi/2)$

$$w = 125 \text{ p.c.f.}$$

$h$  = depth in feet where the active pressure  $P_a$  (p.s.f.) is to be determined.

Alternatively if the wall is rigid and will not yield viz. a rigid frame structure,  $K_a = 0.7$  should be used. The friction angle between the wall and the sand can be taken as  $0.75 \phi \approx 27^\circ$ .

Drains should be provided in the wall slightly above the lower ground surface level if there is any danger of hydrostatic pressure "build up" which can endanger the stability of the embankment.

7. It may be worthwhile to point out that some of the sands in the stratified profile are frost susceptible. There is a possibility that at some location the frost susceptible soil will be near to the subgrade, and together with a high water table or poor drainage condition, this can be the potential cause of frost heave.

E. M. PETO ASSOCIATES LTD.,



E. M. Peto, P. Eng.

GYS:sb

# BOREHOLE LOG

Checked By ..... C. F. F.

W. T. GROUND WATER TABLE IN SOIL

SOIL DESCRIPTION	COLOUR	Density or Consistency	Depth Elevation	Legend	Sample No. and Condition	Sample Type	No. of Blows per Ft.	WATER LEVELS, SOIL MOISTURE & REMARKS
Ground Surface			0' 0"					
Sandy loam & organic matter	Dk. brown		1013.2	{ }	1 X bag			moist
Vt silty sand some org. matter	Lt yellowish brown			/ \	2 X			sample from casing s. moist
Sandy loam	reddish brown	stiff		/ \	3 X S.S.	11	M.C. 6.3%	moist
			5' 0"					
Sand, fine	pale brown	compact			4 X S.S.	17	M.C. 18.6%	moist
Sand, very fine silty	light brown	compact			5 X S.S.	21	M.C. 20.2%	moist
			10' 0"					
Sandy silt, very fine Sand, fine to medium	v. light brown light brown	dense			6 X S.S.	33	M.C. 9.7% 22.4%	wet
Sand, fine	light brown	dense			7 X S.S.	31	M.C. 10.2%	moist
			15' 0"					
Sand, fine to medium some silt occasional grits	lt. brown	very dense			8 X S.S.	57	M.C. 10.8%	moist
			-- Z -- + -- Z --					Hole caved in at 18' 9" Sept. 5, 1958
			20' 0"					
Sand, fine to medium	lt. brown	very dense			9 X S.S.	95	M.C. 16.0%	wet
			24' 0" 989.2					
Silt, clayey	grey	hard			10 [diagonal hatching] S.S.	84	M.C. 15.7% Drier than plastic limit	
			30' 0"					
Silt, clayey	grey	hard			11 [diagonal hatching] S.S.	127	M.C. 14.0% Drier than plastic limit	
			35' 0"					
As above	grey	hard			12 X S.S.	102	M.C. 14.8% Drier than plastic limit	
As above	-ll-				13 W.S.			
			40' 0"					
			41' 0" 972.2		14 [solid black] W.S.	150		
			Hole terminated					

**e. m. peto associates ltd.**  
SOIL ENGINEERING SERVICE - TORONTO, ONTARIO  
**BOREHOLE LOG**

Job Name Blenheim Twp. No 5

Job No. 58 103

Borehole No. 2

Client Dept. of Highways of Ontario

Casing B.X.





Boring Date Sept. 4 - 1958

Datum D. H. O.

Compiled By G. Y. S.

Checked By C. F. F.

**SAMPLE CONDITION**

























-  UNDISTURBED
-  FAIR
-  DISTURBED
-  LOST

**SAMPLE TYPE**

- S.S. 2" STANDARD SPLIT TUBE SAMPLE
- S.L. SPLIT BARREL WITH LINERS
- S.T. THIN-WALLED SHELBY TUBE SAMPLE
- W.S. WASH SAMPLE
- R.C. ROCK CORE

**ABBREVIATIONS**

- V.T. IN SITU VANE SHEAR TEST
- Q/u UNCONFINED COMPRESSIVE STRENGTH
- W.L. WATER LEVEL IN CASING
- W.T. GROUND WATER TABLE IN SOIL

SOIL DESCRIPTION	COLOUR	Density or Consistency	Depth Elevation	Legend	Sample No. and Condition	Sample Type	No. of Blows per Ft	WATER LEVELS, SOIL MOISTURE & REMARKS
Ground Surface			0' 0"					
Sandy loam mixed with organic matter	Dr. brown		1010.4		1 	bag		moist
Sand, fine to medium	reddish brown	compact			2 	S.S.	7	M.C. 1.2% slightly moist
			5' 0"					
Sand, fine	lt. brown	very loose			3 	S.S.	4	M.C. 6.1% moist
As above	" "	loose			4 	S.S.	9	M.C. 26.0% moist
			10' 0"					
Sand, fine to medium	" "	compact			5 	S.S.	15	M.C. 3.7% slightly moist
			15' 0"					
As above	" "	compact			6 	S.S.	29	M.C. 16.3% very moist
Sand, fine to medium some coarse	" "				7 	W.S.		
			20' 0"					
Silt, clayey	grey	hard	189.9		8 	S.S.	96	Water level 19' 10" Sept. 5, 1958 Drier than plastic limit
			25' 0"					
Silt, clayey	grey	hard			9 	S.S.	103	Drier than plastic limit
			30' 0"					
As above	" "	" "			10 	S.S.	154	Drier than plastic limit
			35' 0"					
As above	" "	" "			11 	S.S.	125	Drier than plastic limit
			40' 0"					
As above	" "	" "	41' 0"		12 	S.S.	116	Drier than plastic limit
			469.4					
			Hole terminated					

**e. m. peto associates ltd.**  
**SOIL ENGINEERING SERVICE - TORONTO, ONTARIO**  
**BOREHOLE LOG**

Job Name Blenheim Twp. No. 5Job No. 58 103Borehole No. 3Client Dept. of Highways of OntarioCasing B.X.Boring Date Sept. 4, 1958Datum D. H. O.Compiled By G. Y. S.Checked By C. F. E.**SAMPLE CONDITION**

UNDISTURBED



FAIR



DISTURBED



LOST

**SAMPLE TYPE**

S.S. 2" STANDARD SPLIT TUBE SAMPLE

S.L. SPLIT BARREL WITH LINERS

S.T. THIN-WALLED SHELBY TUBE SAMPLE

W.S. WASH SAMPLE

R.C. ROCK CORE

**ABBREVIATIONS**

V.T. IN SITU VANE SHEAR TEST

Q/u UNCONFINED COMPRESSIVE STRENGTH

W.L. WATER LEVEL IN CASING

W.T. GROUND WATER TABLE IN SOIL

SOIL DESCRIPTION	COLOUR	Density or Consistency	Depth Elevation	Legend	Sample No. and Condition	Sample Type	No. of Blows per Ft.	WATER LEVELS, SOIL MOISTURE & REMARKS
Ground Surface			0' 0"					
Organic sandy loam to 4"	Very dk. brown		10' 1"	{ }	1			sample taken from casing moist
Sand, v. fine some org. matter	yellowish brown				2			-11- moist
Sand, v. fine some silt	lt. yellowish brown	compact			3	S.S.	12	M.C. 7.1% slightly moist
As above	pale brown	compact	5' 0"		4	S.S.	12	M.C. 3.4% moist
Sand, v. fine with silt seams	lt. brown	very loose			5	S.S.	4	moist
Sand, fine	pale brown	compact	10' 0"		6	S.S.	12	moist
As above	-11-	compact			7	S.S.	27	M.C. 9.7% moist
			15' 0"					Water level 15' 11" Sept 5, 1958.
As above	-11-	compact			8	S.S.	15	M.C. 23.4% moist
Sand, fine to medium Scattered gravel	brown	dense	20' 0"		9	S.S.	34	M.C. 20.8% moist
Silt, clayey	grey	hard	24' 6" 24' 6"		10	S.S.	55	M.C. 13.2% Drier than plastic limit
As above	-11-	-11-	30' 0"		11	S.S.	52	M.C. 15.0% Drier than plastic limit
As above	-11-	-11-	35' 0"		12	S.S.	71	Drier than plastic limit
As above	-11-	-11-	40' 0"		13	S.S.	75	M.C. 14.0% Drier than plastic limit
As above			45' 0" 46' 0" 46' 5.1"		14	S.S.	120	Drier than plastic limit





**e. m. peto associates ltd.**  
SOIL ENGINEERING SERVICE - TORONTO, ONTARIO  
**BOREHOLE LOG**

Job Name Blenheim Twp. No. 5.  
Client Dept. of Highways of Ontario  
Datum D. H. O.

Job No. 58 103  
Casing B. X.  
Compiled By G. Y. S.

Borehole No. 4.  
Boring Date Sept. 4 - 1958  
Checked By C. F. F.

**SAMPLE CONDITION**















 UNDISTURBED  
 FAIR  
 DISTURBED  
 LOST

**SAMPLE TYPE**

S. S. 2" STANDARD SPLIT TUBE SAMPLE  
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SOIL DESCRIPTION	COLOUR	Density or Consistency	Depth Elevation	Legend	Sample No. and Condition	Sample Type	No. of Blows per Ft	WATER LEVELS, SOIL MOISTURE & REMARKS
Ground Surface			0' 0"					
Sandy loam & organic matter	very dk. brown		1018.4		1 	bag		very moist
Sand, very fine, silty	brown				2 	bag		slightly moist
Sand, fine	reddish brown	compact			3 	S. S.	11	M.C. 3.2% moist
			5' 0"					
Sand, very fine, some silt	pale brown	compact			4 	S. S.	27	M.C. 2.3% slightly moist
As above	- II -	- II -			5 	S. S.	25	M.C. 2.7% slightly moist
			10' 0"					
As above	- II -	Very dense			6 	S. S.	52	M.C. 4.1% moist
Sand, fine to medium	brown	dense			7 	S. S.	42	M.C. 18.2% moist
			15' 0"					
Sand, silty very fine	- II -	compact			8 	S. S.	22	M.C. 22.0% wet
			20' 0"					
As above	- II -	Dense			9 	S. S.	46	M.C. 19.0% wet
			25' 0"					
As above	- II -	- II -			10 	S. S.	30	M.C. 20.5% saturated
			30' 0"					
Silt, clayey	grey	hard	988.4		11 	S. S.	72	M.C. 13.8% drier than plastic limit
			35' 0"					
As above	- II -	- II -			12 	S. S.	83	drier than plastic limit
			40' 0"					
As above	- II -	- II -			13 	S. S.	112	drier than plastic limit
			45' 0"					
As above	- II -	- II -	46' 0" 972.4		14 	S. S.	122	drier than plastic limit

**APPENDIX I**

**LABORATORY TEST RESULTS**





# Quick, drained triaxial compression test

permeable fine sand GF #3, depth 12-13'

Average moisture content 15.3%

Average dry density  $\gamma_d$  108.7 pcf

Average degree of saturation  $S_r$  57%

200

$\sigma_{min}$  11 30 60 psi

$\sigma_{max}$  15.8 15.5 20.5

SHEAR STRESS  $\tau$

100

0

0

100

200

300

NORMAL STRESS  $\sigma$  IN PSI

$\phi = 30^\circ$

A

64.5.  
Sep. 15.58

# Quick, drained triaxial compression test

pressure: fine sand, BE #3, d<sub>50</sub> = 0.25 mm  
Average initial void ratio: 0.708  
Average initial dry density: 1.47 p.c.f.  
Average degree of saturation: 71.8%

Q<sub>max</sub> = 10      2.2      63  
Q<sub>max</sub> = 42.0      18.2      236.0

SHEAR STRESS "T" IN PSI

NORMAL STRESS "G" IN PSI

$\phi = 36.5^\circ$

645  
2016  
7/28

# e. m. peto associates ltd.

## SOIL TESTING LABORATORY

### LIQUID LIMIT TEST

### FLOW LINE CHARTS

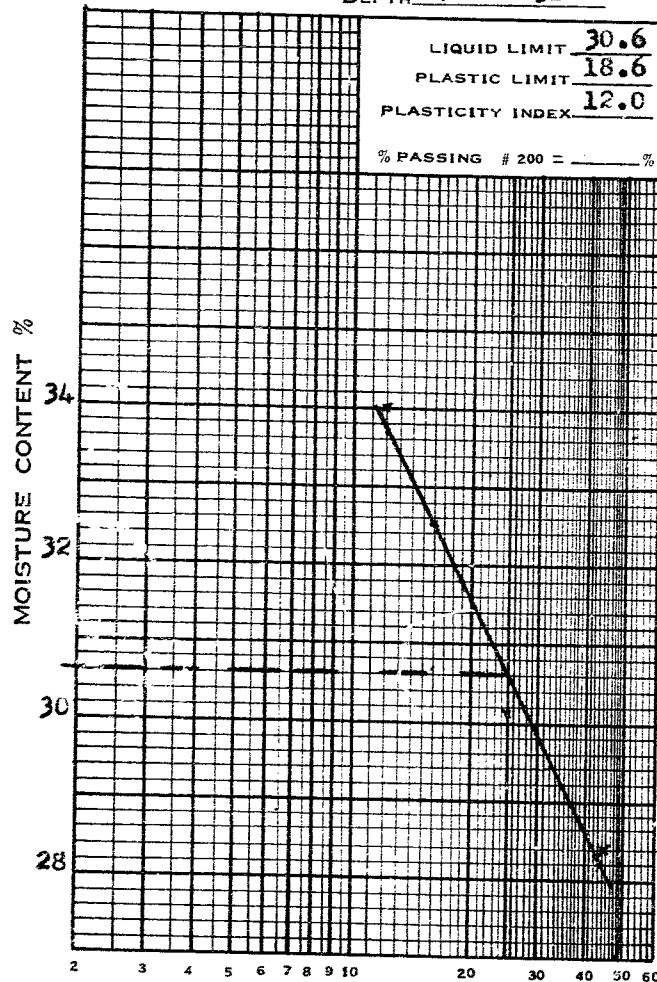
JOB No. 58103 PROJECT Blenheim Twp. Bridge # 5.

SAMPLE FROM B.H. # 1. Sample # 11.

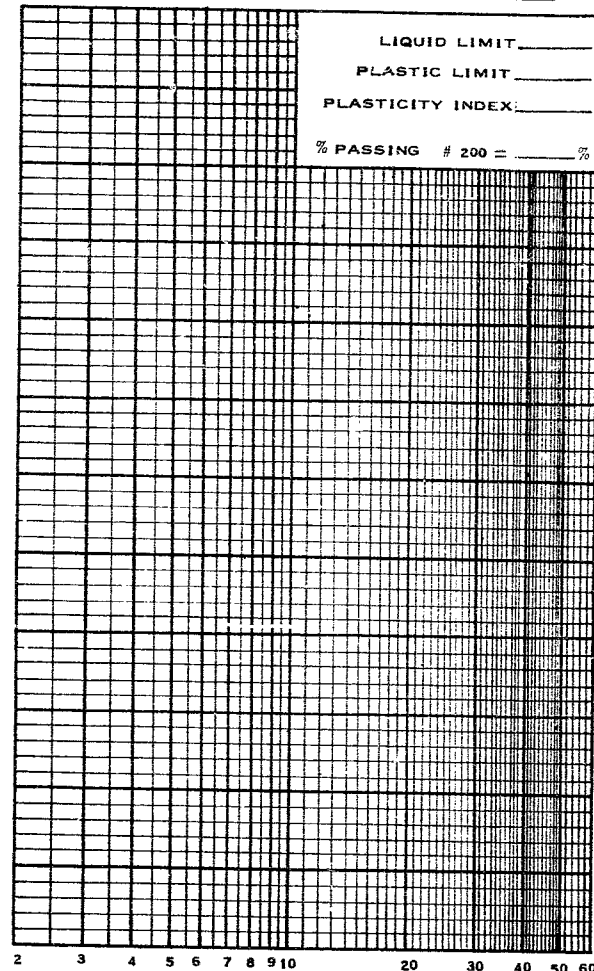
DEPTH 30' - 31'

SAMPLE FROM \_\_\_\_\_

DEPTH \_\_\_\_\_



MOISTURE CONTENT %



NO. OF BLOWS (LOG SCALE)

# e. m. peto associates ltd.

## SOIL TESTING LABORATORY

### LIQUID LIMIT TEST

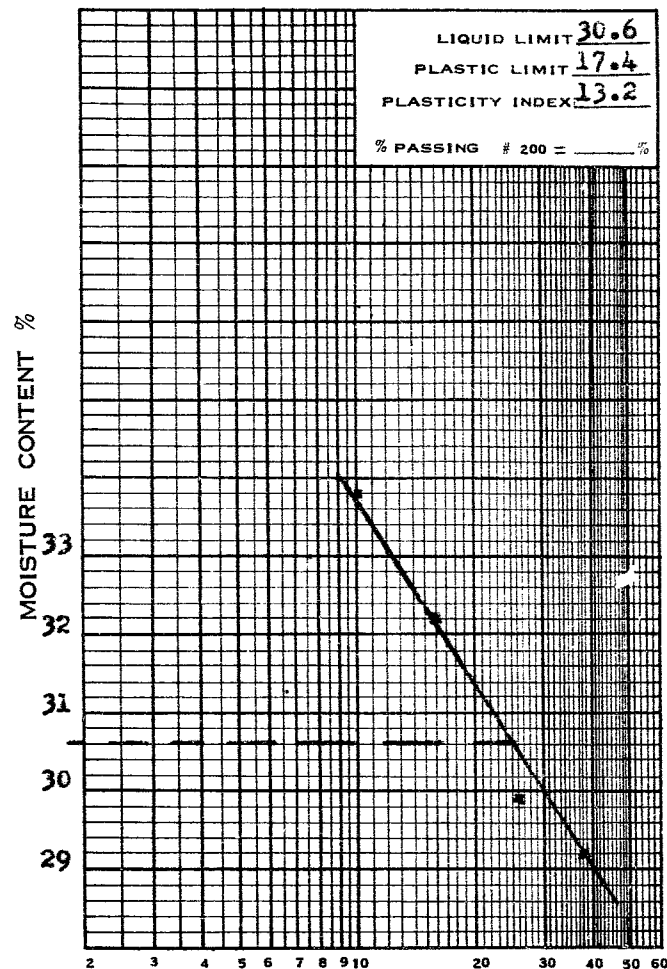
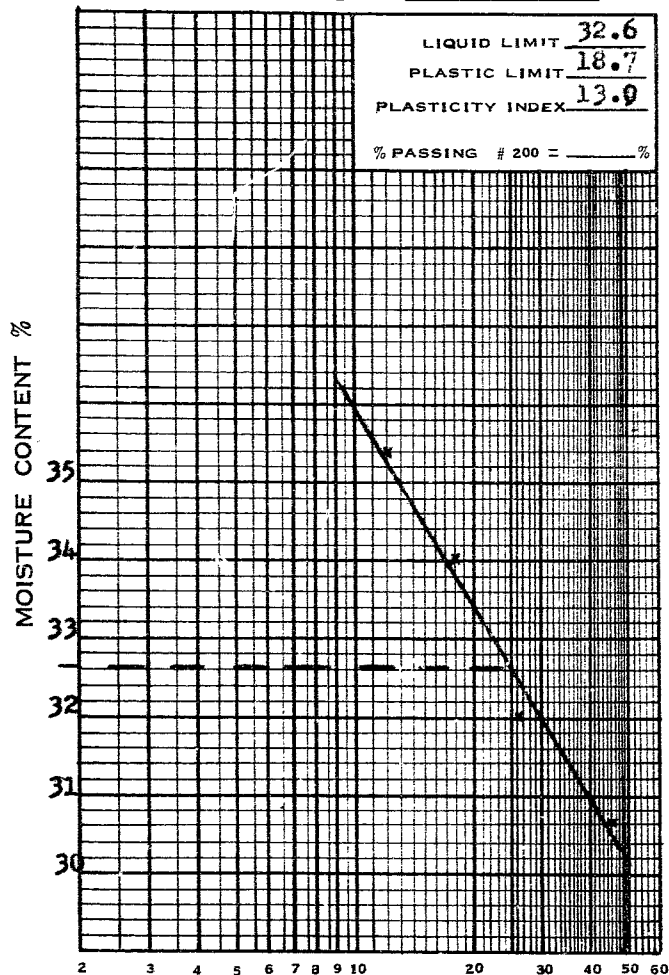
### FLOW LINE CHARTS

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 SAMPLE FROM B.H. # 3. Sample # 13.

SAMPLE FROM B.H. # 3 . Sample # 14.

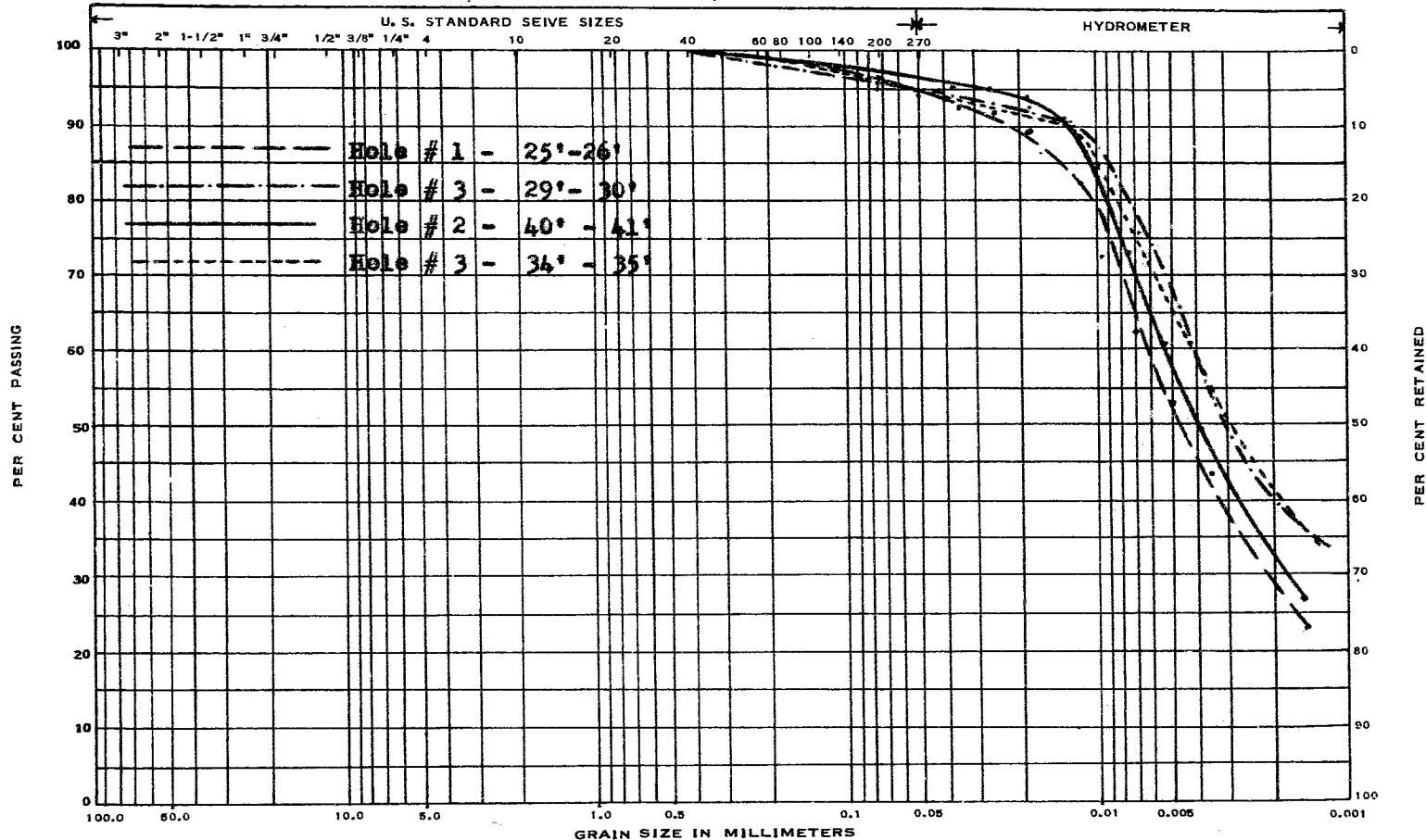
DEPTH 40' - 41'

DEPTH 45' - 46'



NO. OF BLOWS (LOG SCALE)

e. m. peto associates ltd.  
TORONTO, ONTARIO



STONES	GRAVEL	COARSE SAND	MED. SAND	FINE SAND	COARSE SILT	MED. SILT	FINE SILT	CLAY
--------	--------	-------------	-----------	-----------	-------------	-----------	-----------	------

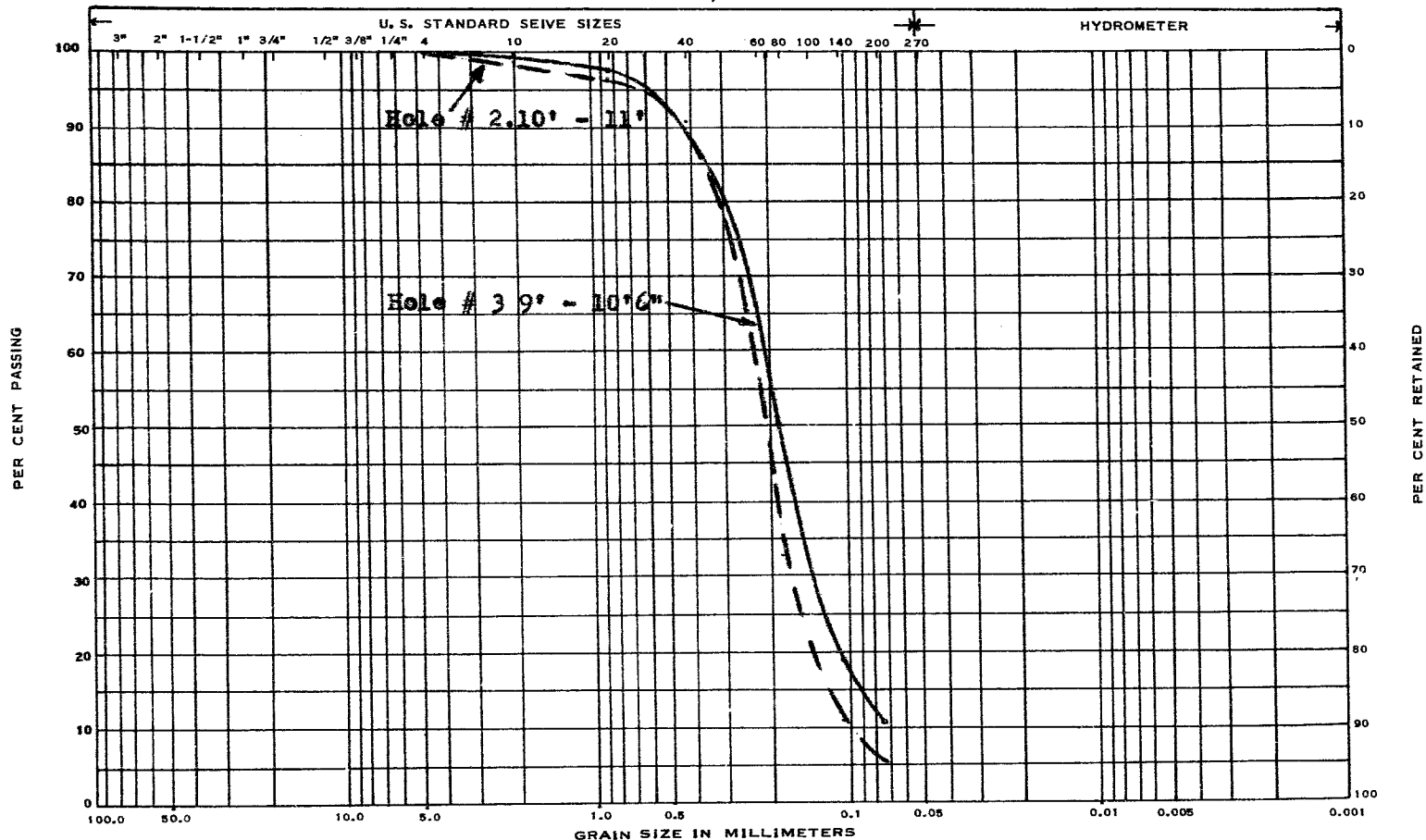
MASS. INST. OF TECH. CLASSIFICATION

JOB NAME Blenheim Twp. Bridge # 5. JOB NO. 58103 HOLE NO. # 1, 2 & 3 SAMPLE NO. \_\_\_\_\_

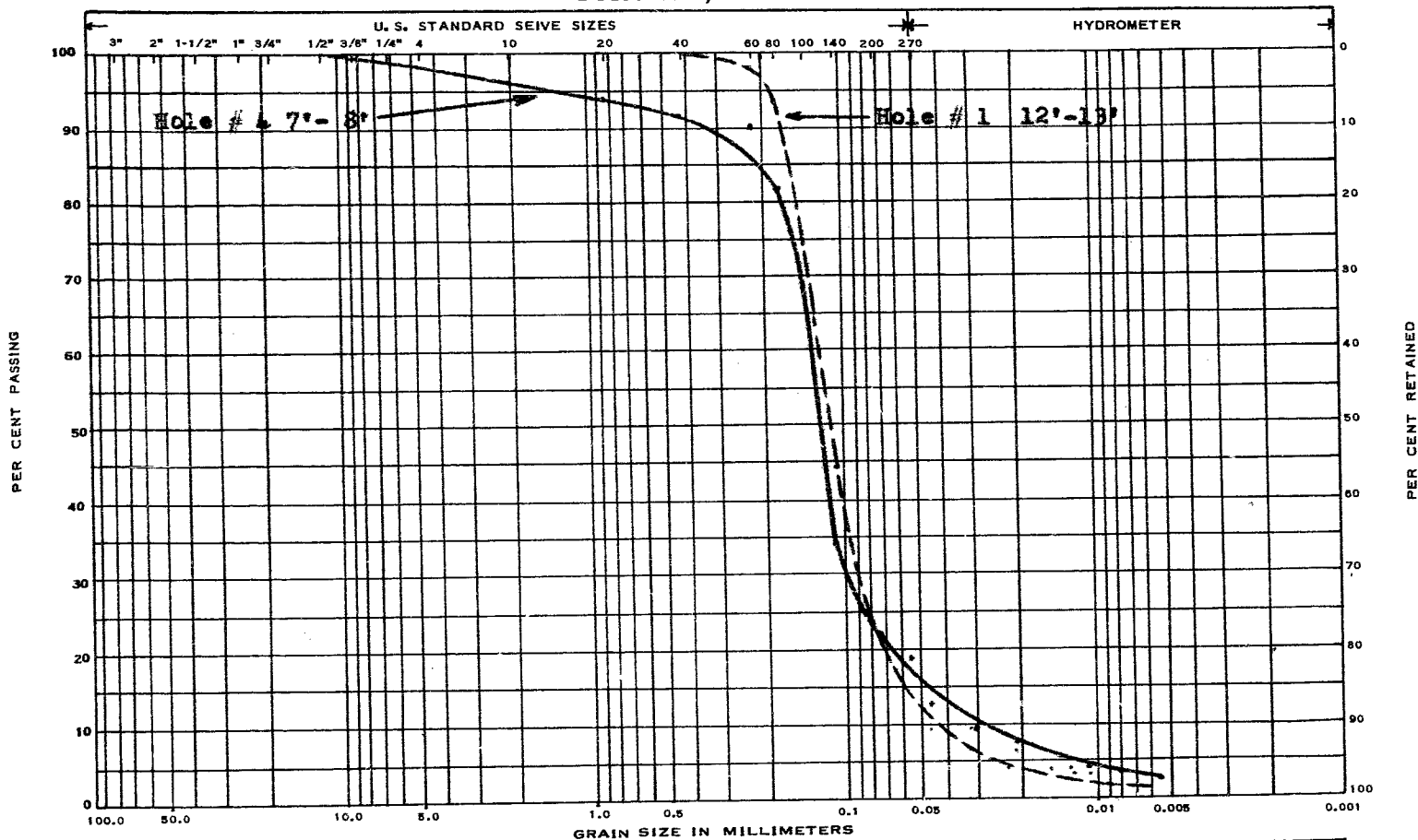
DEPTH See above ELEVATION \_\_\_\_\_ REMARKS \_\_\_\_\_

GRAIN SIZE DISTRIBUTION

e. m. peto associates ltd.  
TORONTO, ONTARIO



e. m. peto associates ltd.  
TORONTO, ONTARIO



STONES	GRAVEL	COARSE SAND	MED. SAND	FINE SAND	COARSE SILT	MED. SILT	FINE SILT	CLAY
--------	--------	-------------	-----------	-----------	-------------	-----------	-----------	------

MASS. INST. OF TECH. CLASSIFICATION

JOB NAME Blenheim Twp. Bridge # 5 . JOB NO. 58103 HOLE NO. 1 & 4 SAMPLE NO. \_\_\_\_\_

DEPTH See above ELEVATION \_\_\_\_\_ REMARKS \_\_\_\_\_

GRAIN SIZE DISTRIBUTION

APPENDIX II

METHOD OF OPERATION-



## METHOD OF OPERATION

The field investigation work is carried out by means of a skid-mounted diamond drill rig.

Standard sampling procedures are followed. Casing is driven and cleaned, either by tubes or by wash water.

Samples are recovered ahead of the casing at frequent intervals, with either a 2 inch or 3 inch O.D. split barrel sampling tube, Shelby tube, or split barrel sampling tube fitted with brass liners and special sharp cutting nose.

The standard penetration test results are recorded when sampling with the regular 2 inch O.D. split barrel sampler, these being the number of blows of a 140 pound hammer falling 30 inches, required to drive the sampling tube a distance of one foot into undisturbed soil.

The Dutch cone probe test is made by driving the drill rods into the ground with a 2-1/4" - 90° cone tip. The number of 4200 inch pound blows per foot of penetration are recorded, as in the standard penetration test.

Where required, "in situ" shear strength tests are made ahead of the casing, using modified Acker vane test equipment.

Disturbed samples are visually classified in the field, sealed in sample jars, and are re-examined, and tested as necessary, in the soils laboratory. Undisturbed samples are returned to the laboratory for later examination and testing, as required.

The test holes are bailed at the end of the day and on completion. Subsequent water level readings are taken for the duration of the field work. Water pressure readings are recorded when Artesian water conditions are encountered. Moisture content samples are recovered at frequent intervals to assist in the soil classification and the interpretation of water table results.