ONTARIO
DEPARTMENT OF HIGHWAYS

Memo to Mr. A. M. Toye, Bridge Engineer. *Date* August 17, 1961.

Subject RECOMMENDATIONS FOR FOOTINGS

From Materials & Research Section, (Foundations Office).

Attention: Mr. K. Bassi.

Re: Proposed Iona-Melbourne County Rd. Overpass over Hwy. 401, County of Elgin, District 2 -- W.P. 61-59.

In reply to the verbal request of Mr. K. Bassi, we herewith submit our recommendations for the footings of the above mentioned structure for your consideration:-

The pier footings should be founded at elevation 730.0 and a safe load of 3.0 T/sq.ft. should be used in the design.

The abutment footings should be founded on either 12-BP-53 H-piles or 12" steel tubular displacement piles driven down to elevation 700.0. The safe load per pile can be taken as 20 tons. A slightly greater factor of safety is obtained if steel H-piles are used, but both piles would serve the purpose and the economical factor should be decisive.

Also see letter dated 23rd Aug 1961 in file which suggests tube piles driven to El. 709 and 30 Ton capacity. Design based on El. 705 & 25 T capacity as a compromise

AGS/MdeF

A. G. Stermac,
PRINCIPAL FOUNDATION ENGINEER

cc: Mr. B. Davis
Foundations Office
Gen. Files.

ONTARIO
DEPARTMENT OF HIGHWAYS

Memo to Mr. S. McCombie, *Date* August 23, 1960.

Bridge Planning Engineer. *Subject*

From Materials & Research Section.

Attention: Mr. G. Scott:

RE: Dunwich Twp. Bridge #1
Hwy. 401 W.P. 61-59
District #2.

The preliminary Bridge drawing for the above site has been reviewed by the Foundation section. At your request we have investigated the possibility of raising the footings of the piers, and conclude that the elevations as recommended in the covering memo should be adhered to.

Concrete filled steel tube piles have been stipulated as support for the abutments. These piles should be driven to elevation 709.0 approximately. At this elevation the pile may be designed for a safe load of 30 tons/pile.

KP/gc
Attach.
cc: N. D. Smith
J. Roy
Foundation Office
General Files.

L. G. Soderman,
PRINCIPAL FOUNDATIONS ENGR.

Per: K Peaker

(K. Peaker,
PROJECT FOUNDATION ENGR.

Mr. A. M. Toye,

Bridge Engineer.

Materials & Research Section.

May 6, 1960.

FOUNDATION INVESTIGATION -- by

E.M. Peto Associates, Limited.

Attention: Mr. S. McCombie.

Re: Proposed Iona-Melbourne County Road
Overpass over Hwy. 401
W.P. 61-59 -- District 2

We have reviewed the above mentioned Report and, for your convenience, we have, below, summarized the foundation recommendations:-

1. Spread footings should be used for the structure.

2. The foundation elevation should be 728.0'. A minimum depth of 5 ft. below ground level is thus maintained. Because of the decrease of shear strength with depth, the foundation should not be lowered below the above given elevation.

3. An allowable nett bearing capacity of 3.5 T/sq.ft. can be taken for footing design.

4. Settlements will be within the permissible range.

5. No stability problems are foreseen for the approach embankments. Standard 2:1 slopes should be used.

If we can be of further assistance in connection with this project, please contact our Office.

AS/MdeF
Attach.
cc: Messrs. A. M. Toye (2)
H. A. Tregaskes
D. G. Ramsay
A. Gater
G. U. Howell
J. Roy
A. Watt
Foundations Office
Gen. Files.

L. G. Soderman,
PRINCIPAL SOILS & FOUNDATIONS ENGR.
Per:

(A. Stermac,
FOUNDATIONS OFFICE ENGR.)

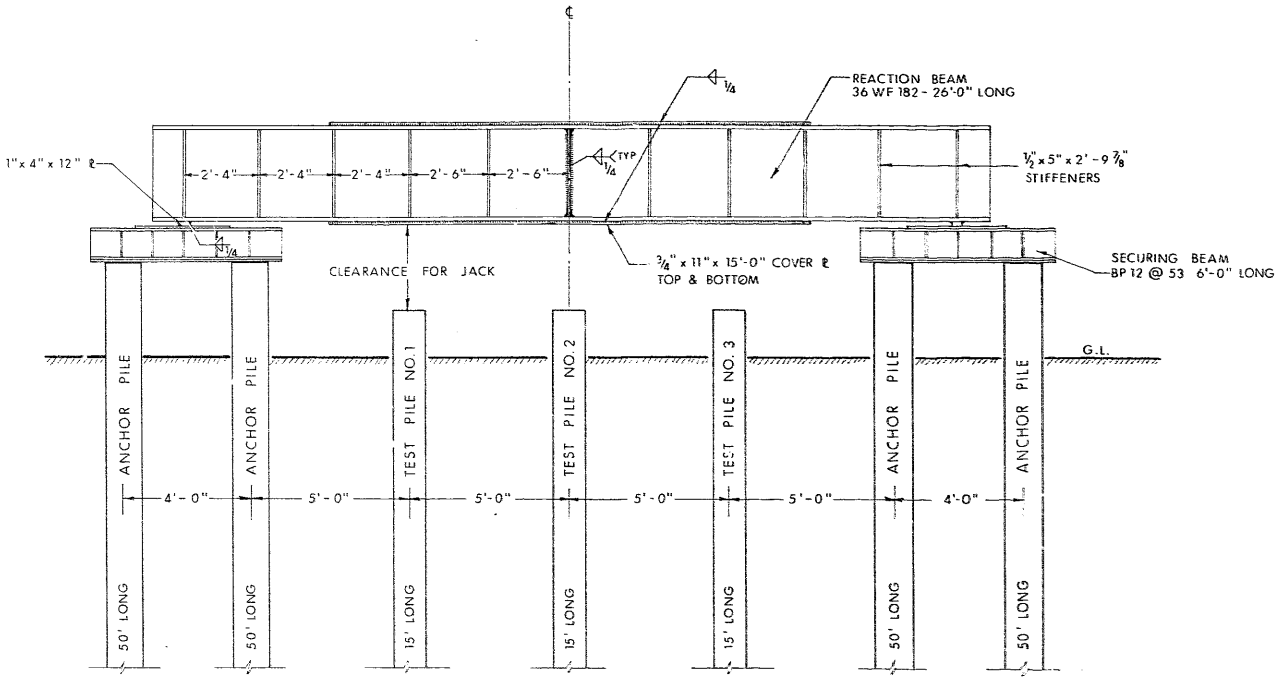
August

To: Mr. C. Grebski
Bridge Division

From: Mr. M. Devata
Foundation Section, D.H.O.

Re: Proposed Pile Loading Test
at Iona Sta. Rd. and Hwy. 401
in West of London, Ontario,
District 2 -
W.P. 61-59 -- W.J. 65-F-94

Please include attached
Drawings 65-F-94 A, B, and C,
with your copy of document
dated August 20/65.



ARRANGEMENT DETAILS

SCALE ⅜" = 1'-0"

PILE DETAILS

TEST PILE NO. 1 – TIMBER (NO. 14)
TEST PILE NO. 2 – TUBULAR (12¾" x 0·25")
TEST PILE NO. 3 – STEEL 'H' PILE (12 BP 74)
ANCHOR PILES – TIMBER (NO. 14)

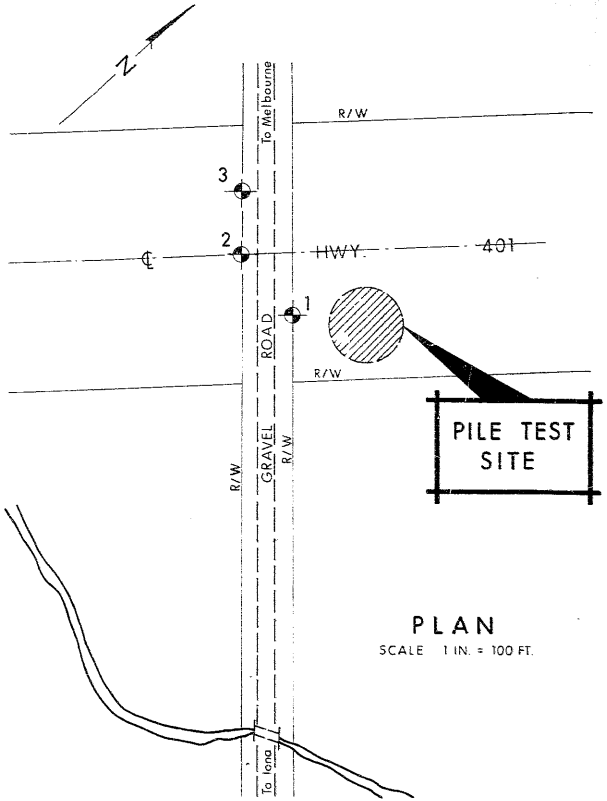
ONTARIO DEPARTMENT OF HIGHWAYS
MATERIALS and TESTING DIVISION

IONA - MELBOURNE RD. & HWY. 401 OVERPASS

TEST PILES, ANCHOR PILES & REACTION BEAM ARRANGEMENT

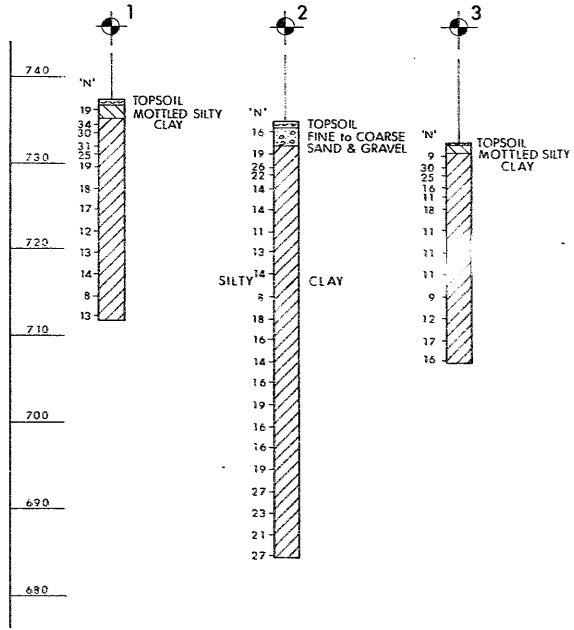
DATE 24 AUG. 1965 | APPROVED W. L. Acres | DRAWING NO. 65-F-94 B

File

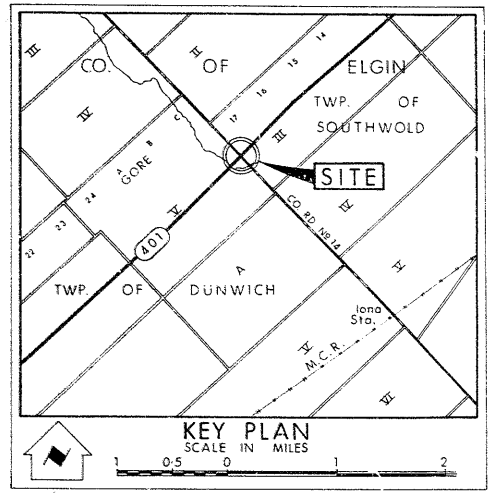


PLAN

SCALE 1 IN. = 100 FT.



BORE HOLE DETAILS



LEGEND

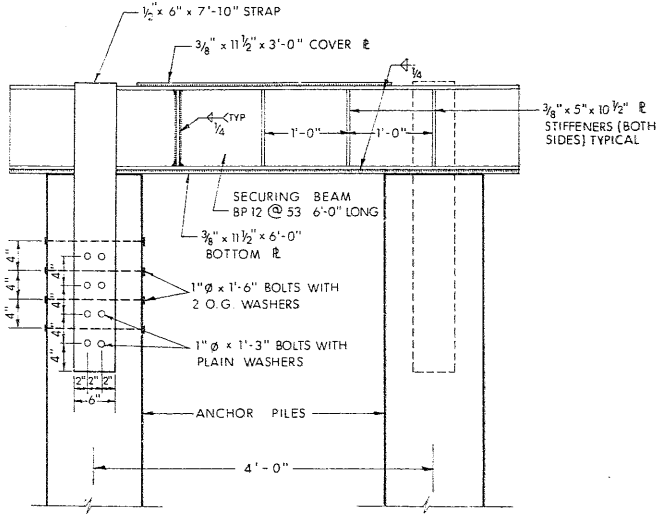
Bore Hole

DEPARTMENT OF HIGHWAYS
ONTARIO
MATERIALS and TESTING DIVISION

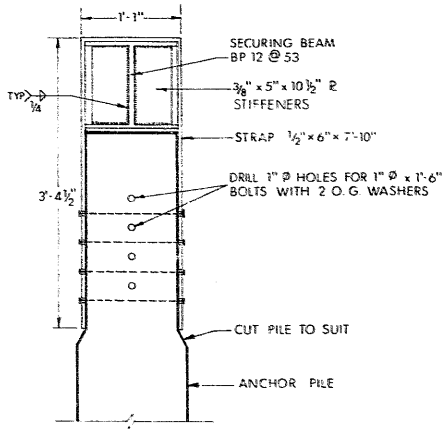
IONA - MELBOURNE RD. & HWY. 401 OVERPASS

PILE TEST LOCATION & SOIL STRATA

DATE 24 AUG. 1965 | APPROVED [signature] | DRAWING NO. 65-F-94 A



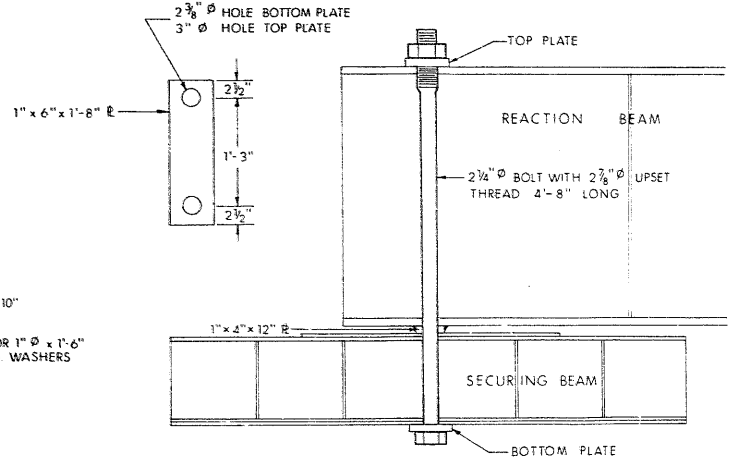
FRONT VIEW



END VIEW

SECURING BEAM & STRAP DETAILS

SCALE 1" = 1'-0"



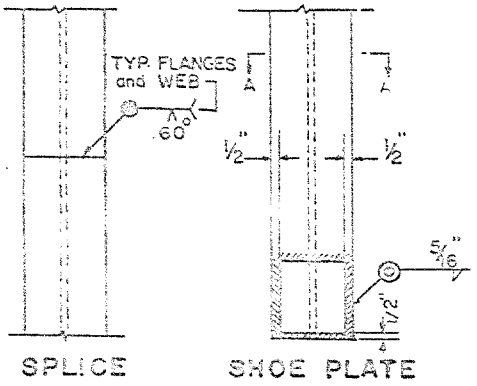
BOLT & PLATE DETAILS

SCALE 1" = 1'-0"

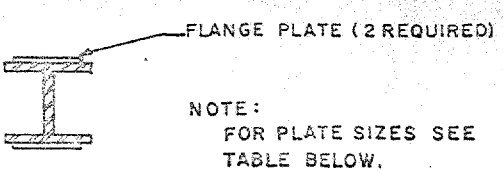
DEPARTMENT OF HIGHWAYS ONTARIO — MATERIALS and TESTING DIVISION	IONA-MELBOURNE RD. & HWY. 401 OVERPASS REACTION BEAM ATTACHMENT DETAILS	
DATE 24 AUG. 1965	APPROVED	DRAWING NO. 65-F-94 C

PILE SPLICES AND SHOES

STEEL H PILES



SPLICE SHOE PLATE

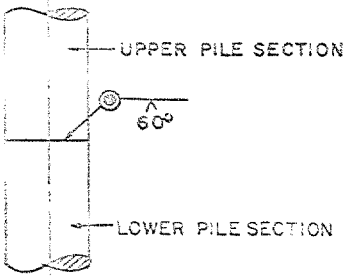


SECTION A-A

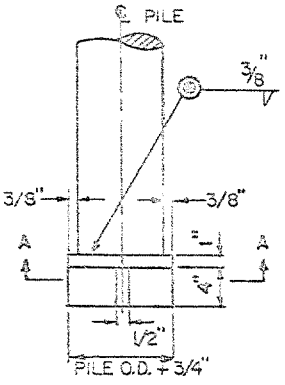
NOTE:
FOR PLATE SIZES SEE TABLE BELOW.

PILE	10 B.P. 42	12 B.P. 53	14 B.P. 73
FLANGE PLATES	9"X1/2"X12"	11"X1/2"X12"	13"X1/2"X12"

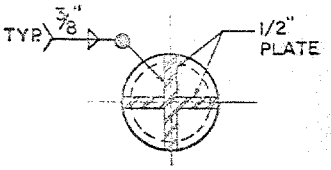
TUBE PILE



SPLICE



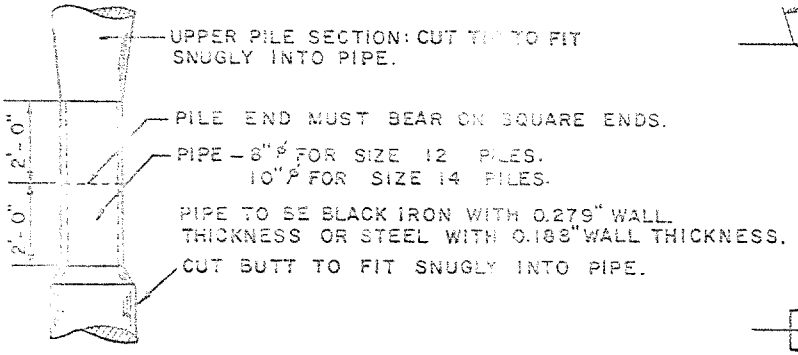
SHOE

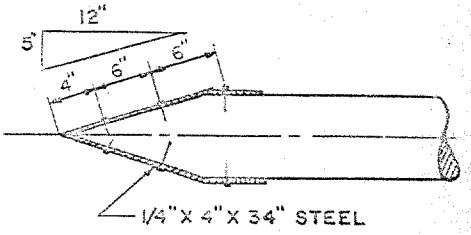


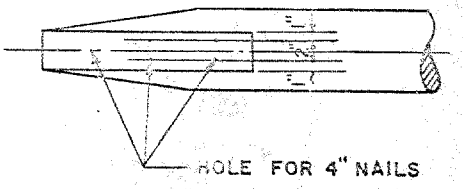
SECTION A-A

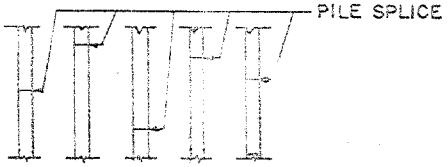
THIS SHOE FOR ANY DIAMETER TUBE PILE.

TIMBER PILES









DIAGRAMMATIC SKETCH SHOWING SPLICE STAGGERING.

5-48
SP1040

Fice

cc: Mr. C. Grebski

Hwy. 401 & Keele St.,
Downsview, Ontario.

Materials and Testing Division

August 20, 1965

Frankl of Canada Ltd.,
214 Merton Street,
Toronto, Ontario.

Attention: Mr. A. Prior

Dear Sir:

Please supply us with a firm quotation for carrying out the work outlined on the attached sheets.

The work described will be carried out under the technical supervision of the Department of Highways Foundation Section, and will be subject to the conditions contained herein and to the current Department Specifications.

The prices quoted should be exclusive of Federal Sales Tax, but should include Ontario Provincial Sales Tax.

It is intended that the work be commenced about the latter part of September 1965.

Please include your proposed time schedule.

AGS/MdeF
Attach.
cc: Messrs. H. C. Dernier
C. Grebski
Foundations Office
Gen. Files

Yours very truly,

A. G. Stermac,
Principal Foundation Engineer

Identical letters also sent to the following:

Bermingham Construction Ltd. - Toronto, Ont.
Western Caissons Ltd. - Toronto, Ont.
Graham and Graham Ltd. - London, Ont.

PROPOSED PILE LOADING TESTS
AT IONA STA. RD. & HWY. 401
IN WEST OF LONDON, ONTARIO.
DISTRICT No. 2
W.P. 6[illegible]9 - W.J. 65-F-94

GENERAL DESCRIPTION OF WORK:

The work consists of the following:

1) Driving 4 timber piles (#14) ..... each 50 ft. long
Driving 1 timber pile (#14) ..... some 15 ft. long
Driving 1 tubular pile (12¾" x 0.25") some 15 ft. long
Driving 1 steel H-pile (12 BP 74) .. some 15 ft. long

2) Supplying and fixing in position a suitable reaction beam and attaching it to 4 anchor piles, then load testing on three test piles. The beam should be capable of withstanding a vertical load of 150 tons. Details of the reaction beam are shown on Dwg. #65-F-94C.

3) Placing concrete in tube pile, splicing and cutting off piles as required.

4) Welding end plate on steel tube pile.

5) Carrying out one load test on each of three piles, as directed by the Department, and in general, according to the National Building Code of Canada.

6) Supplying and fixing in position, all materials and equipment necessary to:

a) carry out the load tests.

b) install reference beams, gauge brackets and bearing plates for the load tests as directed by the Department.

7) Clearing site at completion of work to the satisfaction of the Department.

NOTE: If any material or equipment supplied by the Contractor proves to be inadequate or defective, it must be replaced or modified to the satisfaction of the Department at the Contractor's expense.

cont'd. /2 ...

MATERIALS:

The following materials and equipment will be supplied by the Department and made available at the designated points:

1) Piles: Steel Tube Pile 12¾" O.D. x 0.25 Wall - 15'

Steel H-Pile (12 BP 73) ..... - 15'

Timber Pile #14 - 4 pieces at 50'

Timber Pile #14 - 1 piece ..... - 15'

All piles will be available at the pile load test site.

2) One 200-ton hydraulic jack and 4 deflection gauges.

Available at Department Lab. Bldg., Downsview, Ont.

All other materials necessary to carry out the above work must be supplied by the Contractor.

DRAWINGS:

The site location and subsoil stratigraphy is shown on Dwg.#65-F-94A. Arrangements of test piles, anchor piles and reaction beam are shown on Dwg. #65-F-94B. Details of reaction beam attachments are shown on Dwg. #65-F-94C.

In the event that the Contractor wishes to use an alternative scheme, he must include with his quotation, a sketch showing details of the following:

1) Reaction beam.

2) Anchorage or loading system (principle and details)

In any event, the scheme has to be approved by the Department.

QUOTATION:

The Contractor should submit a quotation for carrying out the work as outlined above, such quotation to include the provision of all personnel, equipment, materials necessary, except as provided by the Department (materials supplied to the Contractor). The quotation should be itemized as follows and the quantities will be minimum pay quantities:

cont'd. /3 ...

LOCATION: (cont'd.) ...

1) Supply all equipment and materials for pile driving and load tests. - Lump Sum

2) Supply and weld drive shoes to tube pile ..... - One

3) Drive Steel tube pile ..... - 15 Lin. ft.

4) Drive Steel H-pile ..... - 15 Lin. ft.

5) Drive timber piles ..... - 415 Lin. ft.

6) Place concrete in tube pile ..... - 0.5 cu.ft.

7) Carry out load test ..... - 3 ea.

SITE:

The site is located some 18 miles west of London, Ontario, on Hwy. 401. The test area is within the Right-of-Way of Hwy. 401, and is generally flat and easily accessible.

M. Devata -
Senior Foundation Engr.

e. m. peto associates ltd.

YOUR REFERENCE:- W.P. 81-59

OUR REFERENCE:- 6052

1287 caledonia road,
TORONTO 19, ONTARIO.
RUssell 9-1126

April 22, 1960.

The Department of Highways of Ontario,
Soil and Foundation Engineering Branch,
Parliament Buildings,
Toronto, Ontario.

Attention: Mr. K. Peaker, P. Eng.

re: Foundation Investigation
Proposed Iona Melbourne County Road
Overpass over Hwy. 401 - W.P. 81-59

Dear Sirs:

We have pleasure in submitting herewith ten (10) copies of our foundation investigation report carried out at the above location.

In the report you will find a detailed description of the soil conditions encountered and its characteristics. Our observations and conclusions regarding the proposed overpass are given in the rear of the report.

We believe we have covered all the points in connection with the proposed overpass from the soil-mechanics aspect; however, should you have some questions relating to this report, we will be glad to be of further service.

Yours very truly,
E. M. PETO ASSOCIATES LTD.

E. M. Peto, P. Eng.

EMP/vs
Encls.

THE DEPARTMENT OF HIGHWAYS OF ONTARIO

SOILS REPORT
for
PROPOSED IONA - MELBOURNE COUNTY ROAD

OVERPASS OVER HWY 401

April, 1960.

e. m. peto associates ltd.

e. m. peto associates ltd., 1287 caledonia road, Toronto 19, Ontario

Job No. 6052 Client's Ref. No. Date April 22, 1960.

Report on

FOUNDATION INVESTIGATION
PROPOSED IONA - MELBOURNE COUNTY ROAD
OVERPASS OVER HWY 401

for

THE DEPARTMENT OF HIGHWAYS OF ONTARIO

INTRODUCTION:

We were asked verbally by Mr. K. Peaker, P. Eng., to carry out a soil investigation at the proposed location of Iona-Melbourne County Road Overpass over Hwy. 401, W.P.61 59,

The purpose of the investigation was to determine the soil conditions (i.e. the stratification, the properties of the individual strata) and the water conditions.

The site investigation was carried out during the period March 25 to April 2, 1960.

The investigation consisted of drilling 3 test holes and 2 probeholes (Dutch cone penetration tests). As the soil conditions were found to be uniform no additional test holes were put down.

GENERAL INFORMATION:

(a) The test holes were put down in accordance with our standard procedure as outlined in Appendix III.

(b) The details of the test holes (the elevation at the existing grade, the terminal depth and the diameter of the casing) were as follows:

Test hole	Elevation	Terminal Depth	Diameter of Casing
1	737.64	51'0"	BA (2-1/2")
2	734.92	101'0"	BX(2-1/2")
3	733.22	51'0"	4" pipe

(bb) Allowable bearing value calculations and details are given in Appendix 4.

GENERAL INFORMATION: Cont'd.

(c) The elevations as given above, in the following report (site plan, graphs, etc.) are with reference to elevation 735.55 denoted for the B.M. which was taken to be nail and washer in South root of 1.8 feet diameter elm 93 feet left of sta. 0 + 32.

(d) The details of the soil stratification as encountered at each test hole, the results of the standard penetration test and the natural moisture contents are given on the borehole logs.

(e) The laboratory test results (Atterberg Limits, Mechanical analysis and the Unconfined Compressive Shear Tests) are given in Appendix I.

(f) Graphical representation of the results of standard penetration tests, the natural moisture contents and the shear strength versus elevation are given in Appendix II.

SITE AND GEOLOGY:

The site for the proposed intersection is located on the county road between the townships of Dunwich and Southwold in the county of Elgin, approximately 4.5 miles North of Iona. The site is surrounded by agricultural land with a gently rolling topography. Generally, the elevations decrease to the North West. There is a small creek approximately 900 feet to the South of the site; at the time of the investigation this creek was carrying a considerable amount of water, and minor flooding was observed at several places. Trees, 0.5 to 3 feet in diameter, occur along the fence lines at the site.

Geologically, the site is located on a clay plain. However, the silty clay with grits and pebbles was overlain by a layer of sand at most of the boreholes. The silty clay has a glacial origin (clay till) whereas the sand has a lacustrine origin, being deposited in one of the early proglacial lakes.

SOIL CONDITIONS:

The investigation disclosed the presence of the following soil types:

(a) Topsoil
(b) Fine to medium sand and gravel
(c) Mottled yellowish-brown and grey silty clay
(d) Brown silty clay, and
(e) Grey-brown silty clay

According to the results of the investigation and the laboratory tests, the following detailed description of each soil type is given:

(a) Topsoil

The topsoil was dark brown in colour and was classified as a sandy loam soil. The depth of this uppermost layer was as follows:

Test hole 1 - 1'6" deep
Test hole 2 - 1'6" deep, and
Test hole 3 - 3" deep

At the time of this investigation, the topsoil was found to be frozen throughout nearly the whole depth.

(b) Fine to medium sand and gravel

Underlying topsoil at test hole 2, a layer of saturated fine to coarse sand and gravel was encountered. The general colour of this layer was very pale-brown. The lower limit was established at 5'6" below the existing grade. The fine to medium sand and gravel layer, according to the results of standard penetration test, was compact with an N value of 16 at the 2 to 3 feet depth. The natural moisture content at this depth was 18.9%, indicating a saturated condition of the layer. During the sampling operation at the 5 feet depth, the sand was found to be backing up the casing. This layer was not found at the remainder of the test holes.

(c) Mottled yellowish-brown and grey silty clay

The uppermost crust of the clay strata was formed by a mottled yellowish-brown and grey silty clay layer. This layer was encountered in the area of test holes 1 and 2. At the corresponding depth at test hole 3, the sand and gravel layer was present. At test hole 1, the stratum was found to cease at a depth of 5'0", and at test hole 3 at a depth of 3'3".

One standard penetration test result is available, i.e. at a depth of 3-5 feet at test hole 1. The N value at this depth was 19 and the moisture content here was 16.3%.

(d) Brown silty clay

Underlying the mottled yellowish-brown and grey clay stratum at test hole 1, a 3 feet thick layer of brown silty clay was present. The N values were in excess of 30, denoting the very stiff to hard density of the layer. The natural moisture content was found to increase with depth from 18.5% to 21.3%.

SOIL CONDITIONS: Cont'd.

(d) Brown silty clay: Cont'd.

The unconfined compression test results gave the shear strength of this layer as 6050 p.s.f. and 48[illegible] p.s.f. with an average value of about 5600 p.s.f. The average value of the remaining soil characteristics may be assumed to be:

Wet Density:	w = 130 lbs. per cu. ft.
Dry Density:	d = 107 " " " "
Void Ratio:	e = 0.58

(e) Grey brown silty clay

The upper limit of the grey-brown silty clay layer was encountered at the following depths below the existing grade:

Test hole 1 at 10'0"
2 at 5'6"
3 at 2'3"

Thus, as may be seen, the upper boundary of the grey-brown silty clay layer rises from the vicinity of test hole 1, towards test hole 3.

The extent of the depth of this layer could not be established. Test hole 2, which reached a depth of 101 feet below the existing grade was still in the stratum of grey-brown silty clay.

The silty clay layer was found to contain numerous grits and pebbles. The results of the mechanical analyses was as follows:

Test hole	Depth Feet	Elevation	Per cent Sand	Silt	Clay	Textural Classification
1	10-11	727.1	9	43	48	Silty clay
1	30-31	707.1	9	41	50	Silty clay
2	45-46	686.7	12	34	54	Clay

According to these results, the soil is a silty clay in its upper portion changing gradually into a clay. The clay fraction of the soil increases gradually from 48% to 54% with the corresponding decrease in the silt fraction.

The results of the standard penetration test clearly indicate the presence of the stiff crust. The N values at the top of the grey-brown silty clay layer were found to be at about 30, decreasing first fairly rapidly to elevation 720; from here a less marked decrease to elevation 700 was observed.

SOIL CONDITIONS:

(c) Grey-brown silty clay: Cont'd.

At this elevation, N values of about 11 were recorded. From about elevation 700, an indication of stiffening of the clay stratum was seen, with the N values increasing from about 10 (minimum N value of 8 was obtained at test hole 1, and 2) to over 30 below elevation 655.

The correlation between the results of the standard penetration test and the unconfined compression test may also be seen.

The shear strength profile also indicated the presence of the stiff crust. This crust may be assumed to extend to elevation 700. The distribution of the shear strength versus elevation showed that the grey brown silty clay layer was a normally-loaded clay with a dessicated upper portion. The increase in shear strength with depth from the elevation of 700 is characteristic for normally-loaded clays, thus the observation may be made that the soil as encountered during this investigation was never subjected to loads greater than the present. The ratio of the shear strength over the effective overburden pressure (S_u/p_o) was found to vary between 0.36 and 0.37, which further substantiates the observation made above. The shear strength of the stiff crust decreased from about 7000 p.s.f. at the upper portion to 1300 p.s.f. at its lower limit, (elevation 700) which may be taken as the minimum undrained shear strength of the grey-brown silty clay layer. From and below elevation 700, a gradual increase in shear strength was evident.

The uniformity of the deposit could also be seen from the results of the Atterberg Limits. The Atterberg Limit tests gave the following results.

Test hole	Depth Feet	Elevation	Per Cent L.L.	P.L.	P.I.	Casagrande's Classification
2	7-8	727.4	37.6	15.4	125	CL
2	12-13	722.4	41.0	21.7	19.3	CI
2	20-21	714.4	40.8	20.1	20.4	CI
2	30-31	704.4	40.6	20.8	19.8	CI
2	40-41	694.4	37.3	20.4	16.9	CI
2	55-56	678.4	41.8	22.3	19.5	CI
2	70-71	664.4	41.0	21.1	19.8	CI
2	90-91	644.4	38.4	20.2	18.2	CI

As may be seen, the Atterberg limits apart from the results at 7-8 feet depth, and again at 40-41 feet depth are nearly constant with depth. Thus, the average value for the whole layer may be taken as follows:

Liquid Limit: 40.1%
Plastic Limit: 20.8%
Plasticity Index: 19.2%

SOIL CONDITIONS:

(e) Grey-brown silty clay: Cont'd.

According to the Casagrande's Classification system, the above values represent a CI soil, i.e. inorganic clay of medium plasticity.

The natural moisture contents were mostly at the Plastic Limit in the upper layer, i.e. the dessicated portion of the grey brown silty clay. From about a depth of 12 feet, the moisture contents only slightly exceeded the Plastic Limit of the soil and were, although increasing very slightly with depth, at about 23 to 24%. From elevation 710 nearly constant moisture contents with depth could be seen in all the test holes.

The average values for the other soil characteristics of the grey-brown silty clay layer may be assumed as follows:

Wet Density w = 132.0 lbs. per cu. ft.
Dry Density d = 107.7 lbs. per cu. ft.
Void ratio, e = 0.580

WATER CONDITIONS:

Apart from the perched water table in the stratum of fine to medium sand and gravel no water was encountered in any of the test holes. The perched water table in the permeable layer may vary depending on the climatic and seasonal changes.

OBSERVATIONS AND CONCLUSIONS:

1. The stratification at this site appears to be uniform and homogeneous. The grey-brown silty clay layer is a normally-loaded clay with a dessicated crust.

2. A perched water table may exist in the layer of fine to medium sand and gravel, depending on seasonal and climatic changes.

3. We understand that a bridge structure is proposed which will overpass the proposed Highway 401.

The foundation of the bridge may be placed on the upper portion of the grey-brown silty clay layer.

The proposed foundation elevation and the allowable bearing values are as follows:

(a) Continuous footing:
from elevation 730 - 724 q_a = 7800 p.s.f.
(b) Isolated footing:
from elevation 730-724 q_a = 9400 p.s.f.

OBSERVATIONS AND CONCLUSIONS: Cont'd.

The above given values have a Factor of Safety of 3 against shear failure.

Due to decrease of shear strength in the upper crust of the grey-brown silty clay stratum, maximum permissible footing sizes are stipulated. They are:

(a) Continuous footing

Foundation elevation	Max B =
- 730	12.4 feet
- 728	11.4 feet
726	10.4 feet
724	9.4 feet

(b) Isolated Footings

Foundation elevation	Max B =
730	24.8 feet
728	20.8 feet
726	16.8 feet
724	14.8 feet

If larger footing sizes are required, the allowable bearing values should be decreased correspondingly. (See Appendix IV for calculation details)

Due to the character of the grey-brown silty clay layer, primarily due to its low void ratio and the moisture content slightly above the Plastic Limit, it is felt that the settlements will be within the amounts normally tolerated.

4. The analytical analysis of the approach embankment gave the following Factor of Safeties for different side slopes and heights of the embankment.

(a) Side slope: 1 vertical to 1 horizontal

Height of the proposed embankment	F.S. =
H = 20 feet	F.S. = 2.65
H = 25 feet	F.S. = 2.15
H = 30 feet	F.S. = 1.80
H = 35 feet	F.S. = 1.50

(b) Side slope: 1 vertical to 2 horizontal

Height of the proposed embankment	F.S. =
H = 20 feet	F.S. = 2.77
H = 30 feet	F.S. = 1.60
H = 40 feet	F.S. = 1.40

OBSERVATIONS AND CONCLUSIONS: Cont'd.

5. No difficulty is foreseen in excavating to the required foundation depths for the bridge structure.

6. The approach embankment may be constructed in one operation, placing the fill in 6" thick layers, compact to the required standard.

The removal of the organic topsoil and drainage rather than removal of the fine to medium sand layer is recommended to ensure adequate stability of the embankment.

Yours very truly,
E. M. PETO ASSOCIATES LTD.

C. F. Freeman

C. F. Freeman, P. Eng.
Chief Engineer.

BL/vs

e. m. peto associates ltd.

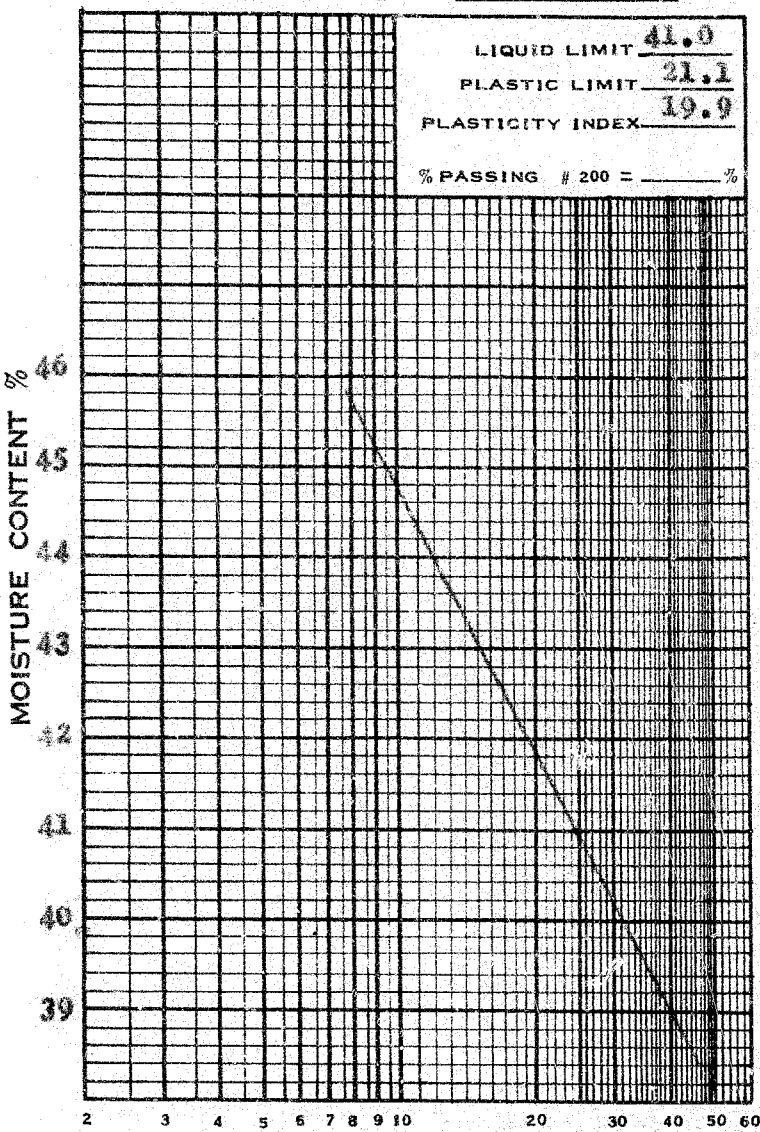
SOIL TESTING LABORATORY

LIQUID LIMIT TEST — FLOW LINE CHARTS

Job No. 6052 Project Iona Melbourne County Rd. Overpass W.P. 61-69

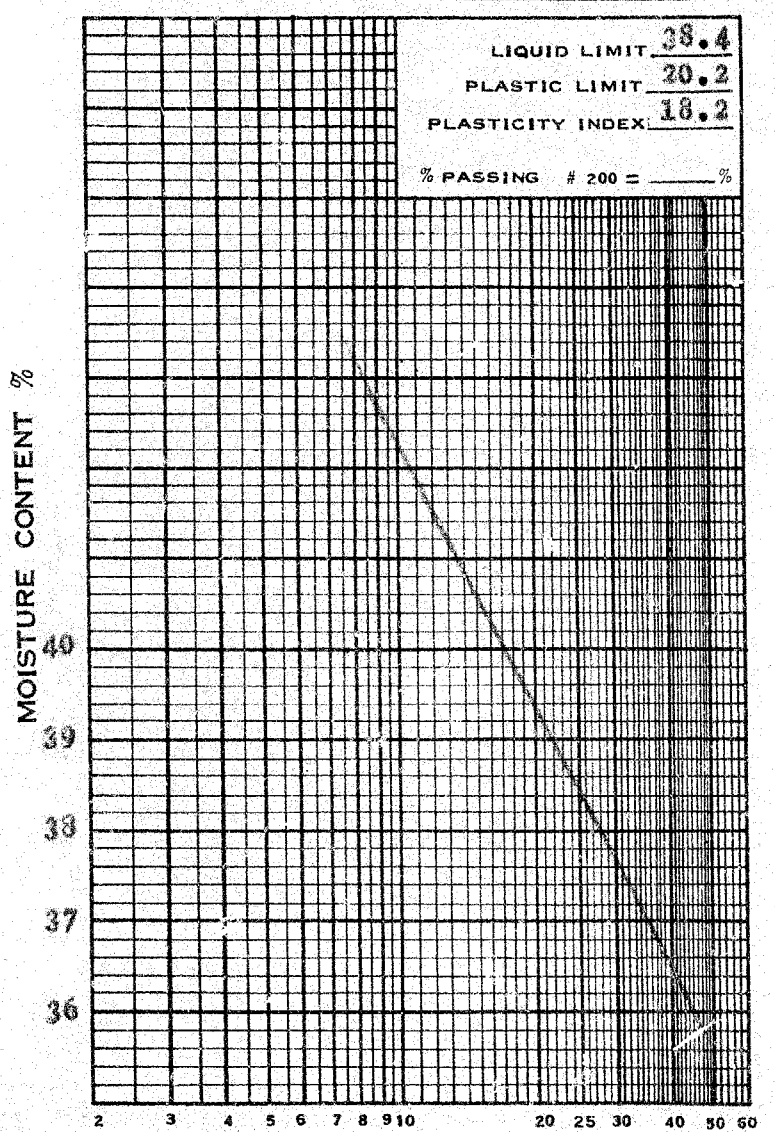
Sample From BH 2 SA 22
Depth 70'-71'

LIQUID LIMIT 41.0
PLASTIC LIMIT 21.1
PLASTICITY INDEX 19.9
% PASSING # 200 = _____ %



Sample From BH 2 SA 27
Depth 90'-91'

LIQUID LIMIT 38.4
PLASTIC LIMIT 20.2
PLASTICITY INDEX 18.2
% PASSING # 200 = _____ %



NO. OF BLOWS (Log Scale)

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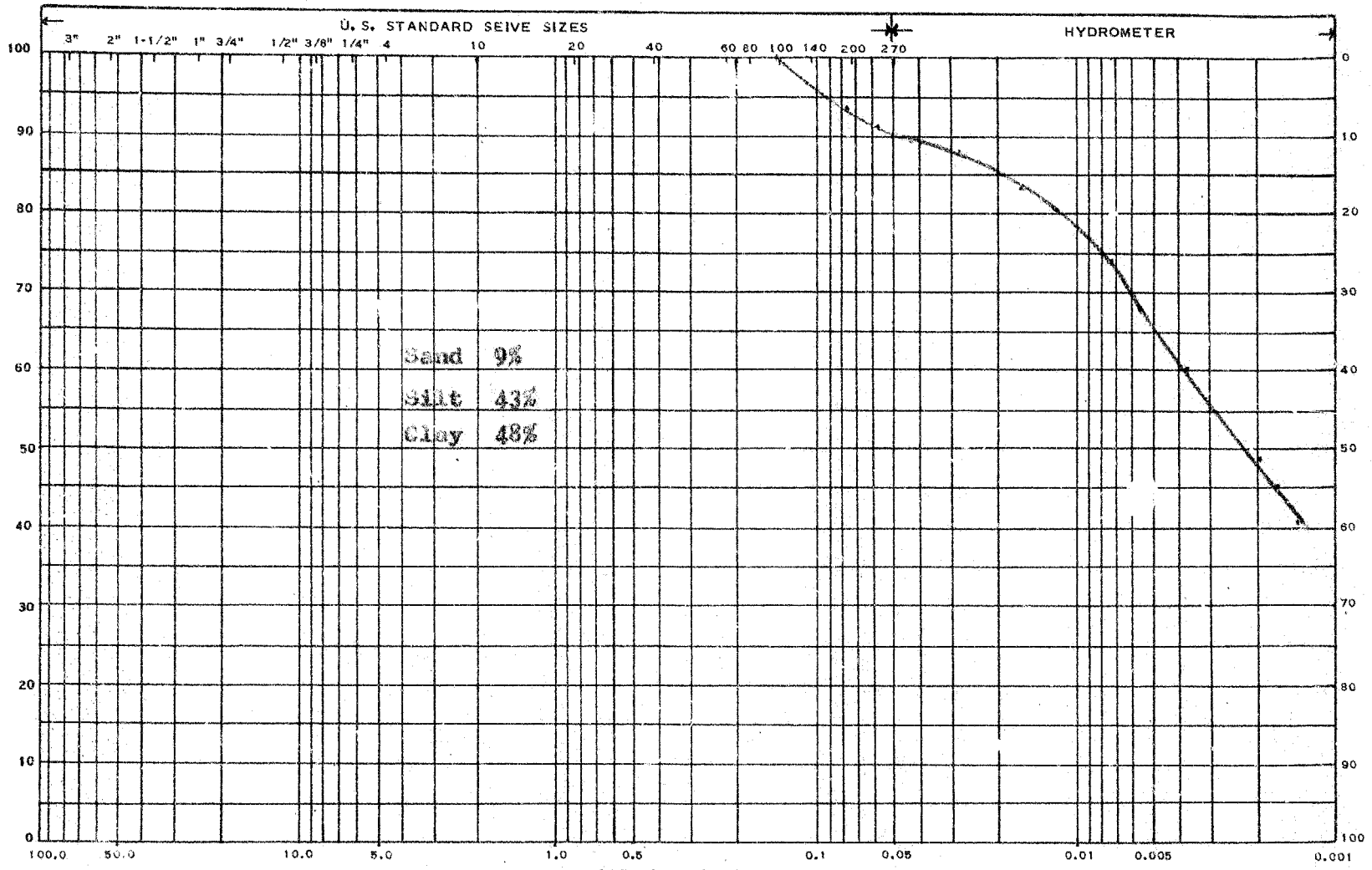
Toronto 19, Ontario



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

MASS. INST. OF TECH. CLASSIFICATION

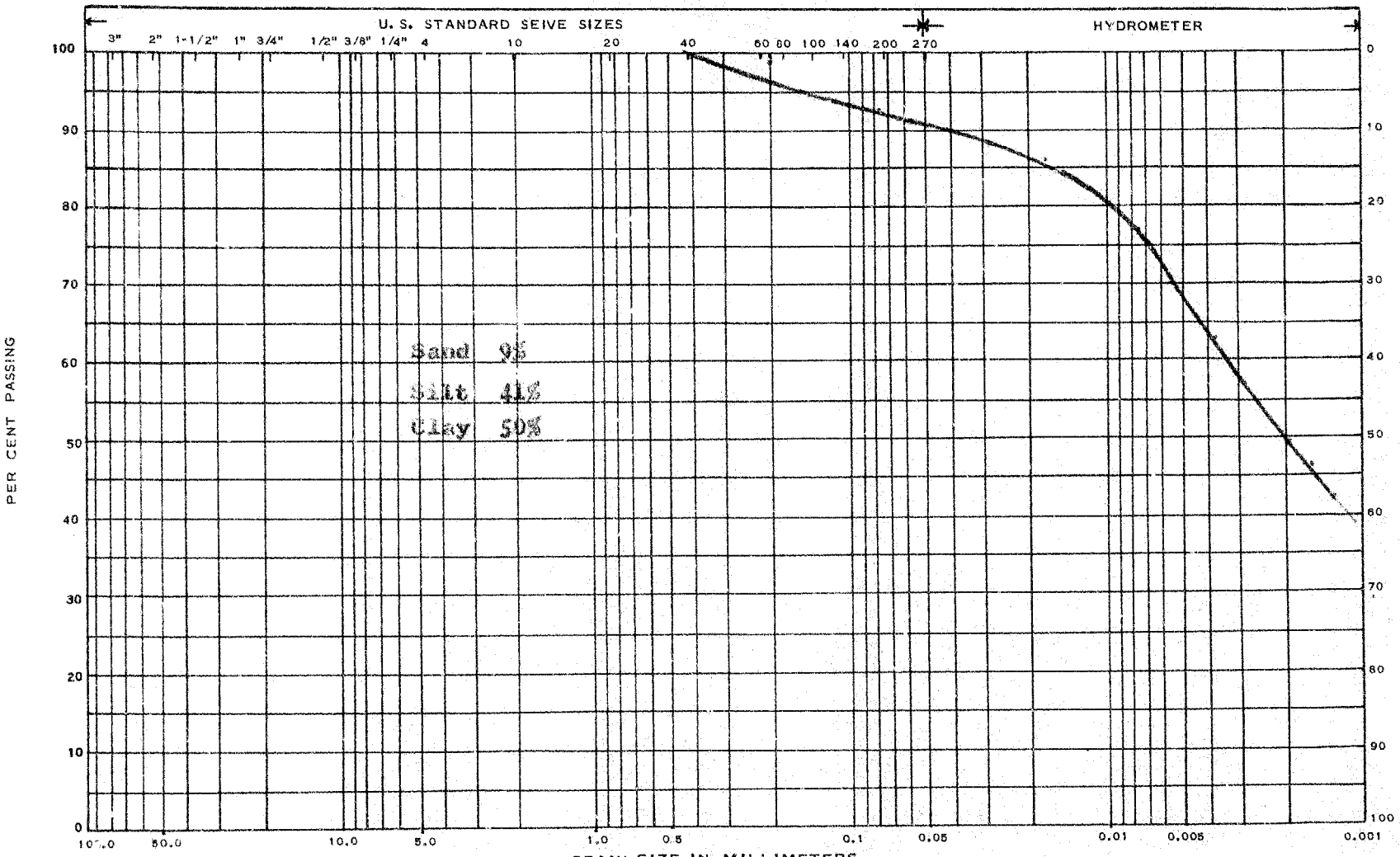
JOB NAME Tona Melbourne County Rd. Overpass W.P. 61-59 JOB NO. 6052 HOLE NO. 1 SAMPLE NO. 5

DEPTH 10'-11' ELEVATION _____ REMARKS Silty Clay

GRAIN SIZE DISTRIBUTION

e. m. peto associates ltd.

Toronto 19. Ontario



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

MASS. INST. OF TECH. CLASSIFICATION

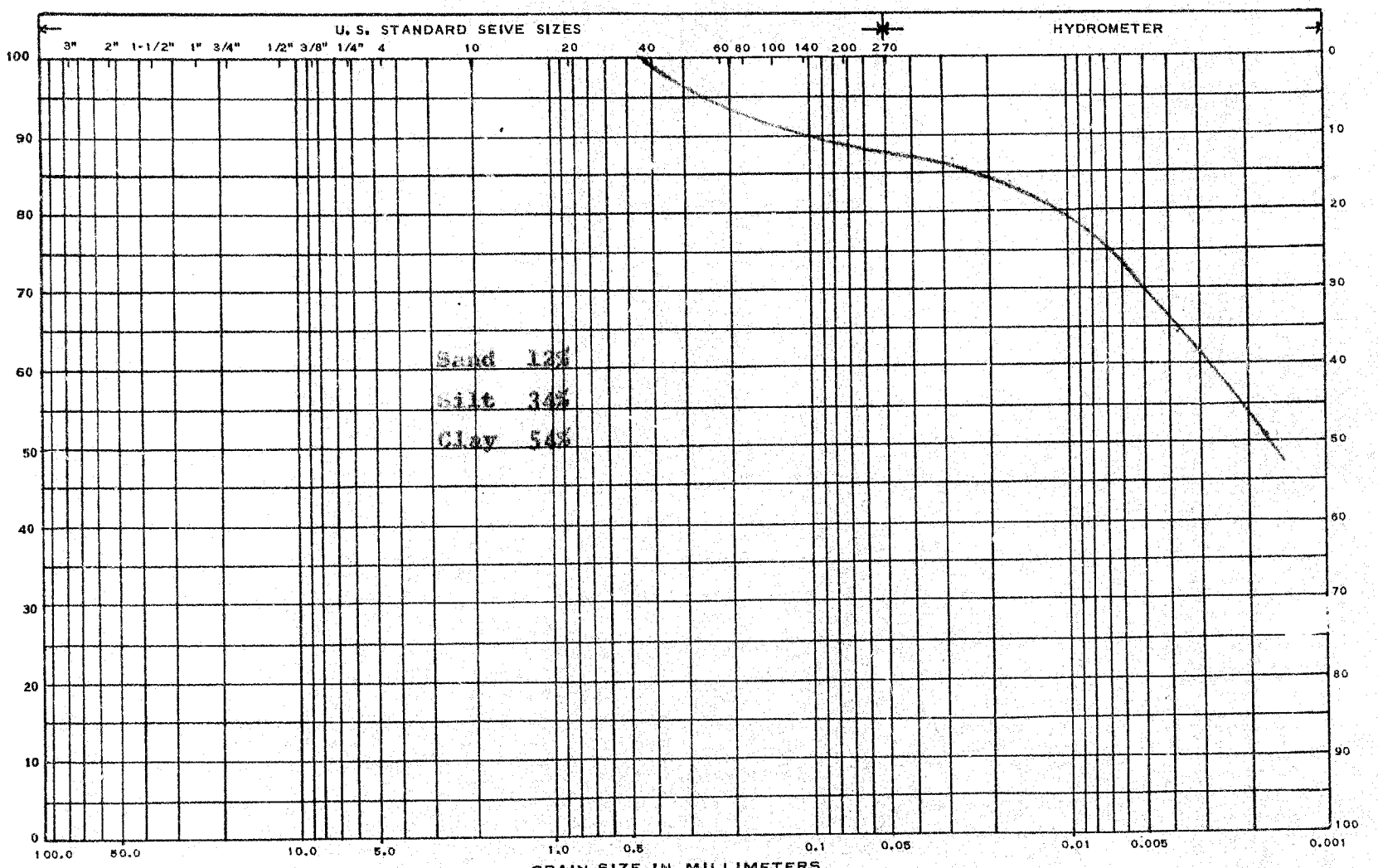
JOB NAME Iona Melbourne County Rd. Overpass W.P. 61-59 JOB NO. 6052 HOLE NO. 1 SAMPLE NO. 11

DEPTH 30'-31' ELEVATION _____ REMARKS Silty clay

GRAIN SIZE DISTRIBUTION

e. m. peto associates ltd.

Toronto 19, Ontario



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

MASS. INST. OF TECH. CLASSIFICATION

Iona Melbourne County Rd.

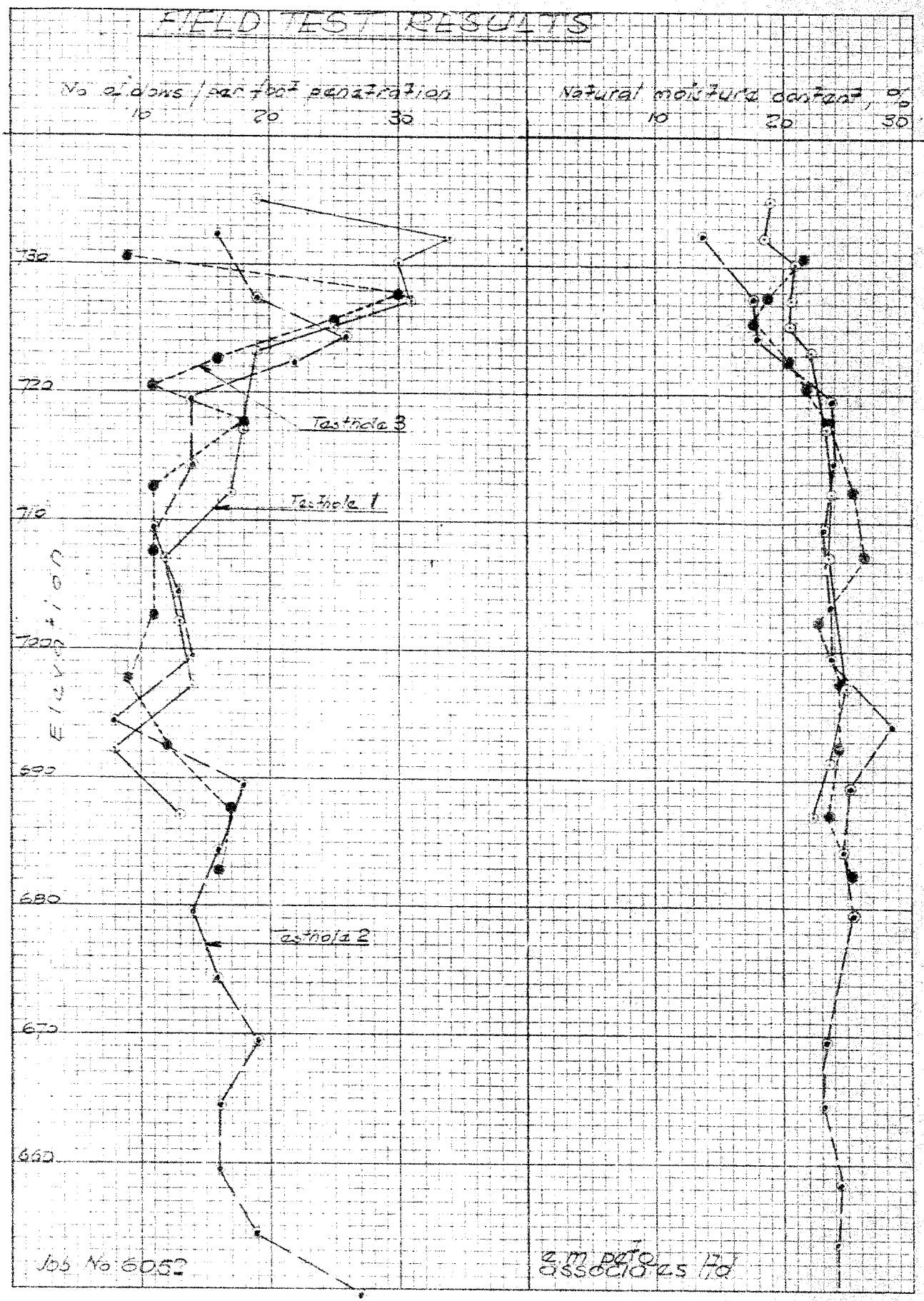
JOB NAME Crampton W.P. 61-59 JOB NO. 6052 HOLE NO. 3 SAMPLE NO. 19

DEPTH 45-46 ELEVATION ____ REMARKS Clay

GRAIN SIZE DISTRIBUTION

APPENDIX II

GRAPHS



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DRILLER'S DAILY FIELD RECORD SHEET

Name of job **Iona-Melbourne Road** Date **April 2, 1960.**

Probehole no. **P.H. 1 (D.C. 1)** Order No. **6052**

Location **A.C.S.P. but 3 ft. E.**
Elevation 738.78

Drill Rig No. **4**

CONE PENETRATION TEST

Depth from to	No. of blows	Depth from to	No. of blows	Depth from to	No. of blows	Depth from to	No. of blows
0 - 1	12 X	25 - 26	161	50 - 51		75 - 76	
1 - 2	7 X	26 - 27	151	51 - 52		76 - 77	
2 - 3	6 X	27 - 28	163	52 - 53		77 - 78	
3 - 4	11 X	28 - 29	150	53 - 54		78 - 79	
4 - 5	17 X	29 - 30	138	54 - 55		79 - 80	
5 - 6		30 - 31	156	55 - 56		80 - 81	
6 - 7	Washing hole out to 10 feet	31 - 32	155	56 - 57		81 - 82	
7 - 8		32 - 33	148	57 - 58		82 - 83	
8 - 9		33 - 34	130	58 - 59		83 - 84	
9 - 10		34 - 35	125	59 - 60		84 - 85	
10 - 11	12	35 - 36	130	60 - 61		85 - 86	
11 - 12	18	36 - 37	128	61 - 62		86 - 87	
12 - 13	34	37 - 38	125	62 - 63		87 - 88	
13 - 14	55	38 - 39	135	63 - 64		88 - 89	
14 - 15	87	39 - 40	120	64 - 65		89 - 90	
15 - 16	105	40 - 41	133	65 - 66		90 - 91	
16 - 17	120	41 - 42	148	66 - 67		91 - 92	
17 - 18	140	42 - 43	160	67 - 68		92 - 93	
18 - 19	148	43 - 44	163	68 - 69		93 - 94	
19 - 20	143	44 -	Test terminated at 44 feet			94 - 95	
20 - 21	140	45 - 46		70 - 71		95 - 96	
21 - 22	147	46 - 47		71 - 72		96 - 97	
22 - 23	136	47 - 48		73 - 73		97 - 98	
23 - 24	158	48 - 49		73 - 74		98 - 99	
24 - 25	135	49 - 50		74 - 75		99 - 100	

0-4' - sandy loam and sand
from 4' - silty clay

e. m. peto associates ltd

DRILLER'S DAILY FIELD RECORD SHEET

Name of job. **Iona - Melbourne Road** Date. **April 1, 1960**

Probehole no. **2(Elevation 733.69)** Order No. **6052**

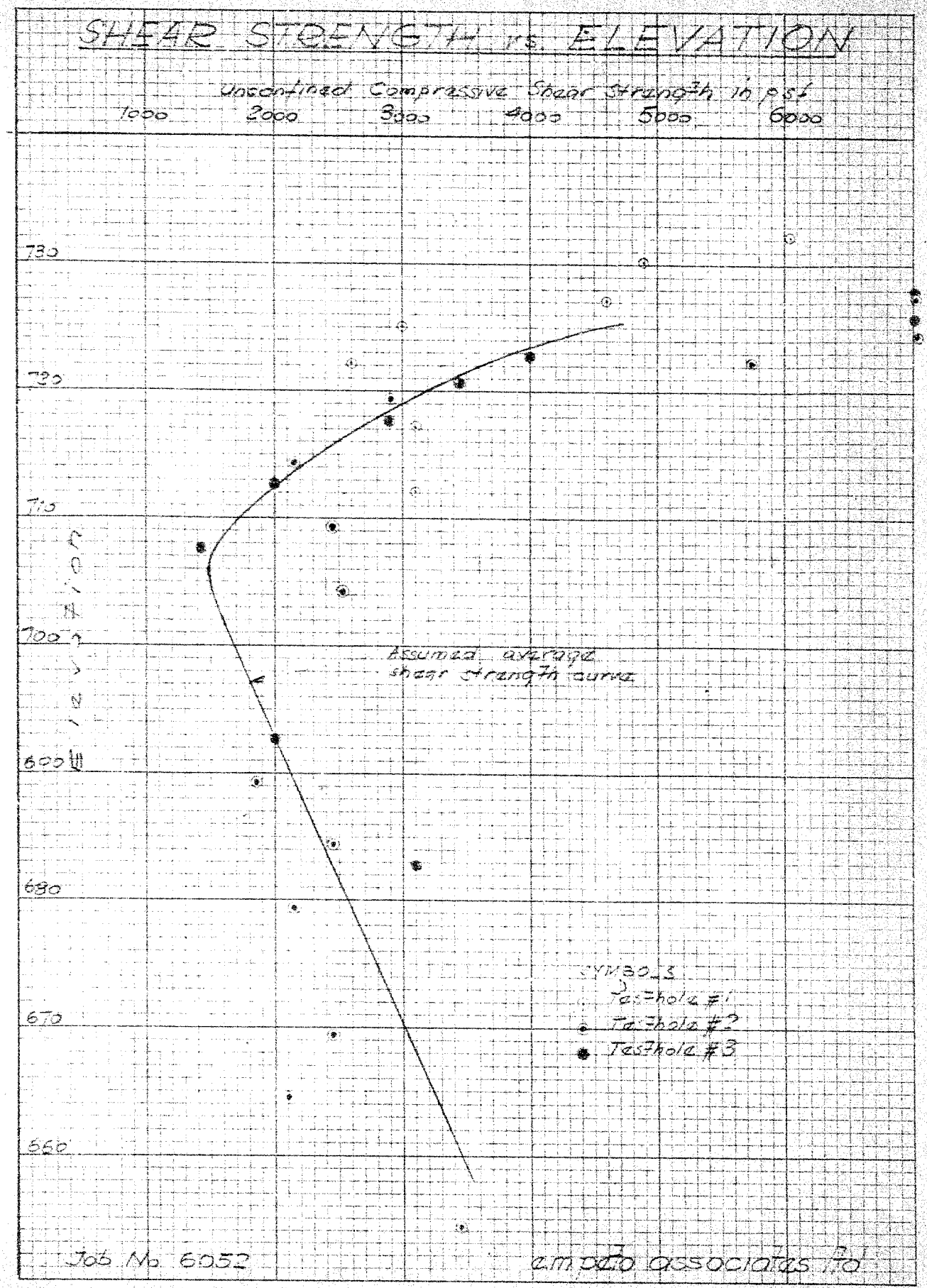
Location **A.O.S.P. but 3' W** Drill Rig No. **4**

CONE PENETRATION TEST

Depth from to	No of blows	Depth from to	No. of blows	Depth from to	No. of blows	Depth from to	No. of blows
0 - 1	4X	25 - 26	75	50 - 51		75 - 76	
1 - 2	6X	26 - 27	76	51 - 52		76 - 77	
2 - 3	7X	27 - 28	81	52 - 53		77 - 78	
3 - 4	10X	28 - 29	79	53 - 54		78 - 79	
4 - 5	15X	29 - 30	86	54 - 55		79 - 80	
Washing out to 10'		30 - 31	88	55 - 56		80 - 81	
6 - 7		31 - 32	80	56 - 57		81 - 82	
7 - 8		32 - 33	76	57 - 58		82 - 83	
8 - 9		33 - 34	88	58 - 59		83 - 84	
9 - 10		34 - 35	90	59 - 60		84 - 85	
10 - 11	8	35 - 36	92	60 - 61		85 - 86	
11 - 12	15	36 - 37	94	61 - 62		86 - 87	
12 - 13	32	37 - 38	102	62 - 63		87 - 88	
13 - 14	48	38 - 39	102	63 - 64		88 - 89	
14 - 15	56	39 - 40	123	64 - 65		89 - 90	
15 - 16	72	40 - 41	110	65 - 66		90 - 91	
16 - 17	80	41 - 42	112	66 - 67		91 - 92	
17 - 18	80	42 - 43	114	67 - 68		92 - 93	
18 - 19	74	43 - 44	Test terminated at 43 feet	68 - 69		93 - 94	
19 - 20	92	44 - 45		69 - 70		94 - 95	
20 - 21	72	45 - 46		70 - 71		95 - 96	
21 - 22	57	46 - 47		71 - 72		96 - 97	
22 - 23	62	47 - 48		72 - 73		97 - 98	
23 - 24	67	48 - 49		73 - 74		98 - 99	
24 - 25	70	49 - 50		74 - 75		99 - 100	

0'-3'6" sandy loam
3'6" change to clayey silt

SHEAR STRENGTH vs. ELEVATION



Job No. 6052

empire associates, inc.

APPENDIX III

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.

APPENDIX IV

Calculation of the allowable bearing values

The allowable bearing values, q_a, were calculated using the following equation:

$$q_a = \frac{Su \times Nc}{F.S.}$$

where: Su - the undrained shear strength of the soil
Nc - Parameter, calculated according to Skempton's empirical relation

$$Nc = 5\left(1 + \frac{D}{5B}\right)\left(1 + \frac{B}{5L}\right)$$

where D - depth of foundation
B - Width of foundation
L - Length of foundation

F.S. - Factor of Safety (In the following table F.S. = 3)

Proposed foundation elevation	Footing Size Cont.	Square	D	D/B	Nc Cont.	Square	Su p.s.f.	q_a p.s.f Cont.	Square
730.0	2		5	2.5	7.5		4000	10000	
	4	4		1.25	6.3	7.5	"	8800	10000
	6	6		0.835	6.8	7.0	"	7750	9350
	8	8		0.625	5.6	6.7	"	7500	8950
	10	10		0.500	5.5	6.6	"	7350	8800
	15	15		0.333	5.3	6.4	"	7050	8550
	20	20		0.250	5.2	6.3	"	6950	8400

Note: The q_a is limited by maximum permissible footing sizes as calculated below

Calculation of the permissible footing sizes

As the shear strength of the soil decreases with depth, the maximum permissible footing size is controlled by the induced shear stress at depth, which at all points should be less than the shear strength of the soil. To determine the maximum permissible footing size, the following table is thus constructed:

(a) Continuous footings:

Elevation	Su p.s.f.	$\frac{Su_n + 1}{Su_n} = I\sigma$	m	Proposed foundation elevation 730 z	b	728 z	b	726 z	b	724 z	b
1	2	3	4	5	6	7	8	9	10	11	12
730	4000	1.0	∞	0							
728	4000	1.0	∞			0					
726	4000	1.0	∞					0			
724	4000	1.0	∞							0	

(a) Continuous footings (cont'd.)

Elevation	Su p.s.f.	$\frac{Su_{n+1}}{Su_n} = I_\sigma$	m	Proposed foundation elevation 730		723		726		724	
				z	b	z	b	z	b	z	b
1	2	3	4	5	6	7	8	9	10	11	12
720	3100	0.775	0.55	10	8.6	8	6.8	8	5.15		
715	2150	0.538	0.48	15	7.2	13	6.3	11	5.30	9	4.30
710	1850	0.462	0.40	20	8.0	18	7.2	16	6.40	14	5.60
706	1250	0.313	0.26	24	6,2	22	5.7	20	5.20	18	4.70

Column 1 - Elevation considered

Column 2 - the undrained shear strength, Su, as read off the attached graph of Su versus elevation

Column 3 - $\frac{Su_{n+1}}{Su_n} = I_\sigma$ influenced factor as found in Boussinesq equation

Column 4 - $m = \frac{B}{z}$ where B - width of the footing = 2b
z - depth of point considered below the footing elevation

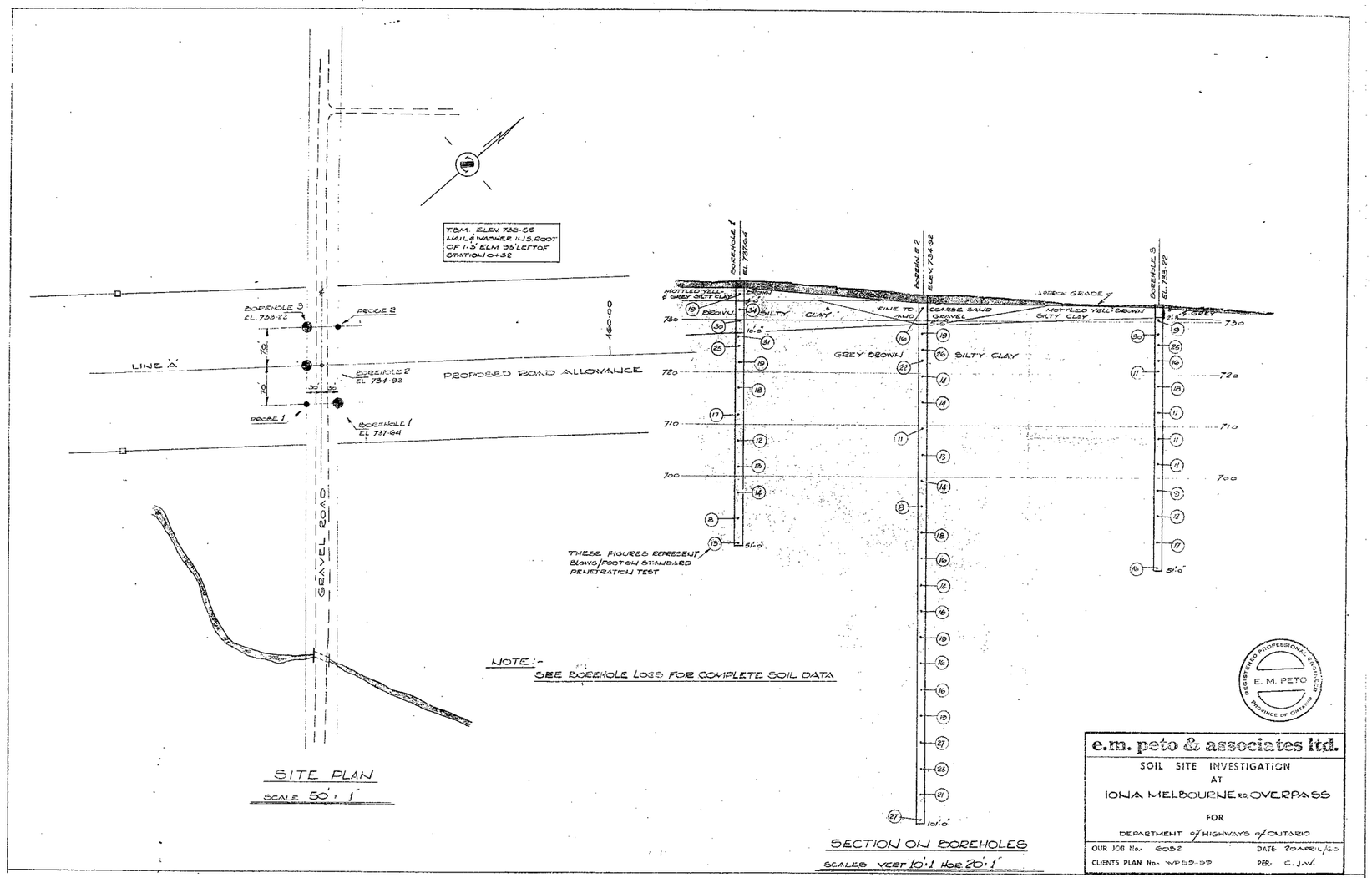
m is found, according to the Boussinesq stress equation

Columns 5, 7, 9 and 11 - z for different proposed foundation elevations

Columns 6, 8, 10 and 12 - b - half width of the continuous footing obtained according to the following relation
$b = mz$

Similar calculation was carried out for square footings, and the results are given in the recommendations of the report.

#60-F-263C
W.P.#61-59
Hwy#401
OVERPASS
PROPOSED IONA-
MELBOURNE COUNTY
RD.



NOTE:-
SEE BOREHOLE LOGS FOR COMPLETE SOIL DATA

REG'D PROFESSIONAL ENGINEER E. M. PETO PROVINCE OF ONTARIO

e.m. peto & associates ltd.

SOIL SITE INVESTIGATION
AT
IONA MELBOURNE RD. OVERPASS
FOR
DEPARTMENT OF HIGHWAYS OF ONTARIO

OUR JOB No. 6052	DATE 20 APRIL/65
CLIENTS PLAN No. W59-55	PER. C.J.W.