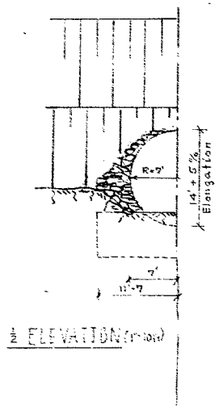
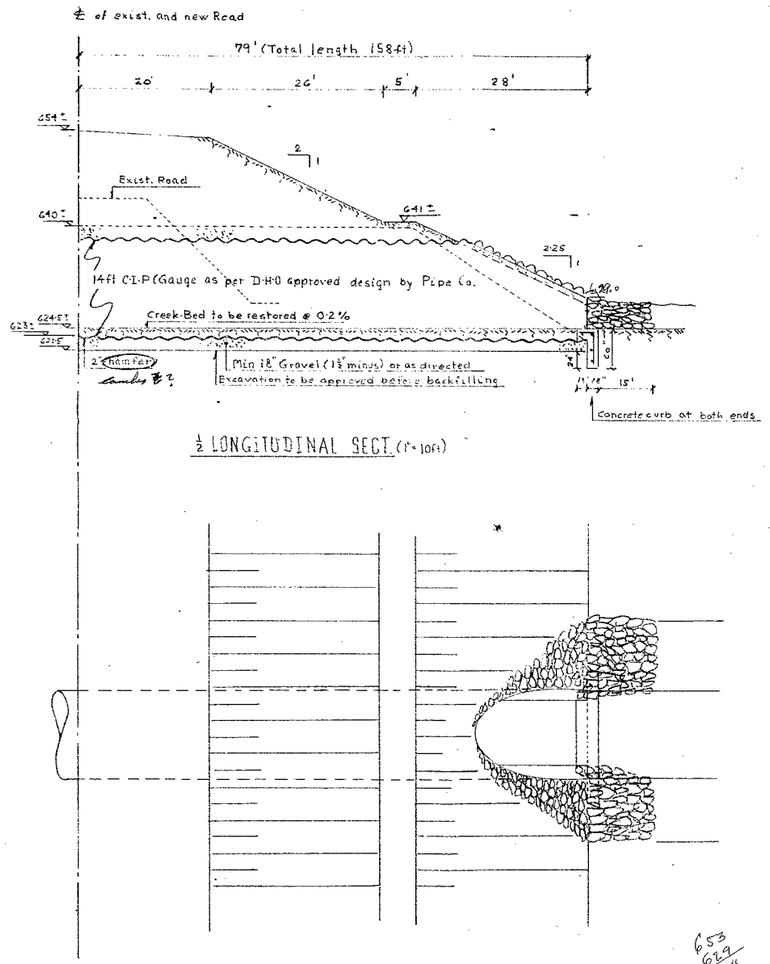
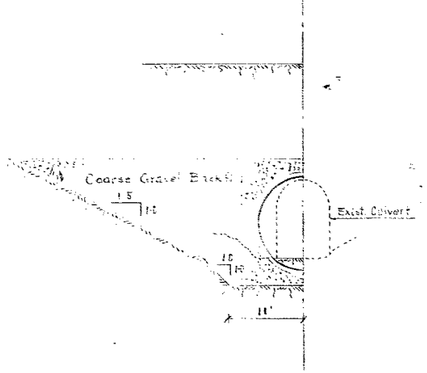
62-F-271M
LOT 67, ROAD
BETWEEN L.R.E.
+ L.R.W. CONS.
CULVERT C-12-16
BEITH CREEK
BOSANQUET



½ ELEVATION (1"=10ft)



½ LONGITUDINAL SECT. (1"=10ft)

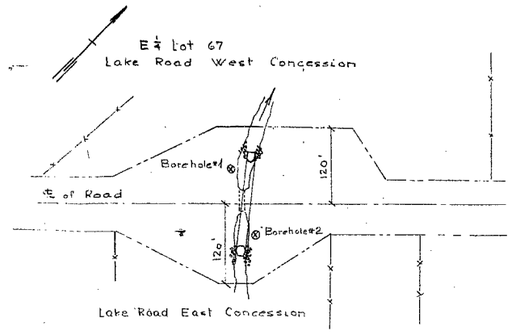


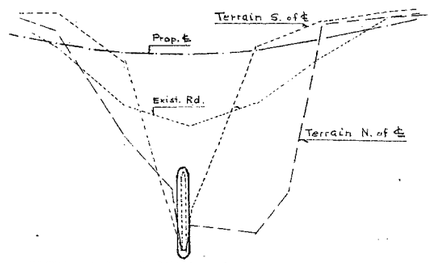
½ CROSS SECT. (1"=10ft)

½ PLAN (1"=10ft)

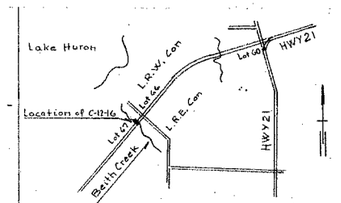
653
629
24

59/24 = 2·5



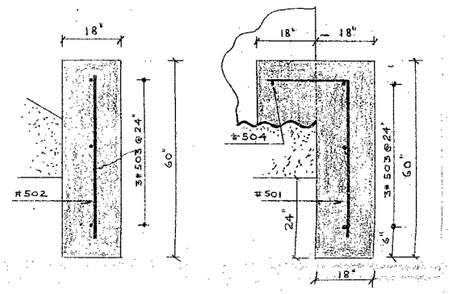


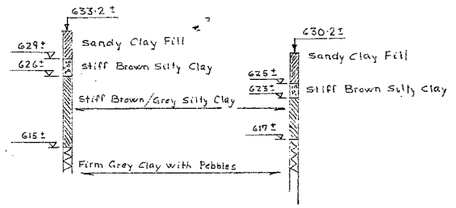
LOCATION & PROFILE (1"=100ft)



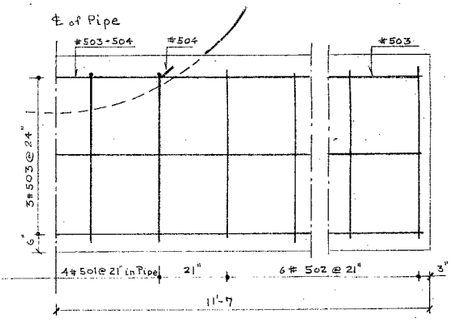
KEY PLAN (1·25"=1mile)

DRAINAGE AREA	3.300 acres
REQUIRED WATERWAY	147 ft²
EXIST. STRUCTURE	96 "
NEW "	154 "





BOREHOLES #1 and 2



DETAIL OF CONCRETE CURB (1"=20in.)

ROD #	DIA. (in.)	NO.	SHAPE	CUTTING LENGTH
501	⅝	8	24" L 54"	6'-6
502	"	24	54"	4'-6"
503	"	6	264"	22'-8
504	"	2	4" 63" 4"	6'-1

REV	DATE	BY	REMARKS

ROAD CULVERT C-12-16
BEITH CREEK
RD #12 ST. 112+00 PL.NO. R 24-4

Drawn: O.v.D.	Traced
COUNTY OF LAMBTON ENGINEERING DEPT.	Appr.
	Date: Sep. 25/62
	Scale: as noted
County Eng. O.van Deurs	PL.NO. B-41

Mr. K. L. Kleinsteiber,
Municipal Bridge Liaison Engr.,
Bridge Division.

Attn: Mr. C.C.J. Burkhardt.

Mr. A. C. Stermac,
Principal Foundation Engr.,
Foundation Section,
Materials & Research Division.
October 25, 1962.

Soils Report by E. M. Peto Assoc., Ltd.
County of Lambton,
Proposed Pipe Culvert,
Township of Bosanquet,
Lot 67, Rd. between L.R.E. & L.F.W. Cons.,
Bridge Office Ref. #BA 1517.

We have reviewed the above-mentioned report and hereby submit our comments for your consideration.

On the basis of presented information and data, no problems should be encountered and therefore the proposed design appears to be feasible.

In connection with the granular cushion, we would recommend that it be provided irrespective of whether the culvert is moved or remains at the proposed location.

It also appears to us that the embankment slopes could be steepened from 2.5:1 to 2:1 because the stability would still be adequate and some saving could be accomplished.

ACS/MDeF

A. C. Stermac,
PRINCIPAL FOUNDATION ENGINEER

cc: Foundations Office
Gen. Files.

BA 1517

E. M. PETO ASSOCIATES LIMITED

1287 Caledonia Road,
Toronto 19, Ontario.

RUssell 9 - 1126.

Our Job Number 62134

September 18th, 1962.

Mr. O. vanDeurs, P. Eng.,
Lambton County Engineer,
County Buildings,
Sarnia, Ontario.

62-F-271M

Dear Sir,

Culvert C-12-16
Beith Creek
Soil Site Investigation

We have pleasure in presenting four copies of our Report Number 62134 on the above site investigation.

The two test holes have disclosed the presence of a stratum of silty clay till, of generally firm consistency. Assuming that the subsoil under the invert of the pipe will be equally firm as in the test holes, the proposed culvert will be stable and no major long-term settlement is anticipated.

In the report, we recommend that if the new culvert is to be located at the existing creek, any soft materials below the invert should be removed and replaced with a well compacted granular cushion, the purpose

of which would be to provide a uniform base for the pipe. However, you may wish to consider locating the new culvert some distance to the east of the existing stream; test hole 2 has indicated that, if thepipe is placed near the position of this borehole, it would be resting on a stiff, brown crust of the silty clay and there would probably be no need to provide a granular cushion below the pipe invert, if the bedding for the pipe is carefully prepared by shaping the clay to fit the pipe.

The stability of the proposed embankment was considered and no apparent danger of failure was noted. No major settlement is expected, but it is considered advisable to remove surficial layers of organic topsoil before placing the new fill.

We consider the report to be comprehensive within your terms of reference. However, we would be very pleased to provide further assistance should you wish to discuss any points connected with this work.

Yours very truly,

E. M. PETO ASSOCIATES LTD.

C. F. Freeman

for E. M. Peto, P. Eng.

RK/ap

THE COUNTY OF LAMBTON

SOIL SITE INVESTIGATION

C - 12 - 16 BEITH CREEK BRIDGE

E. M. PETO ASSOCIATES LTD.

1267 Caledonia Road,
Toronto 19, Ontario.

TABLE OF CONTENTS

A. INTRODUCTION

The work described in this report was authorized verbally by Mr. O. van Deurs, Lambton County Engineer, and confirmed by the return of our work order, signed.

In connection with the improvement of County Road 12, a larger culvert is to replace an existing one at Beith Creek. A site investigation was required to determine the subsoil conditions.

The new culvert is to be of corrugated metal, of 14 ft diameter, and the invert will be located at the elevation 623.0. The base is to consist of a compacted gravel cushion.

The culvert will be covered with embankment fill to an approximate height of 17.5 feet above the crown. The roadway is to be 40 ft wide at the crown inclusive of shoulders and the embankment is designed for side slopes of 2.5 to 1.

B. GENERAL INFORMATION

1. Two test holes were performed at the site, in the positions shown on the enclosed site plan. The positions were indicated in the field to our drilling foreman by the County Engineer, who later supplied a sketch showing the locations and ground elevations. However, the distance between the holes cannot be determined from the available data.

Test hole 1, located to the west of the existing bridge, (ground elevation 633.2) was taken down to a depth of 21.5 feet below the existing grade.

Test hole 2 (ground elevation 630.2) was terminated at a depth of 30 ft. Both holes encountered a generally firm or firm to stiff silty clay till, apart from some surficial layers of topsoil and fill. The borings were terminated in the stiff till.

2. The field work was performed between July 26th and 28th, 1962, by our drilling rig unit No. 6. Our standard drilling and sampling procedures were followed, as outlined in Appendix "A".

3. Details of soil conditions encountered in test holes are described on the appended borehole logs, which contain also results of in situ standard penetration tests, moisture content measurements and values of cohesive strength of clay.

C. SITE and GEOLOGY - Cont'd

The Beith Creek is approximately 20 ft wide, and the normal water level is believed to be near the elevation 628. The flow is in a northerly direction. The valley containing the creek is approximately 600 ft wide, with the invert about 35 ft below the level of the surrounding terrain.

County Road No. 12 is a gravel road. The existing bridge has the form of a concrete culvert with an 8 ft throat. The grade of the existing road at the centre of the crossing is at the elevation 643.3.

Geologically, the area is located within the St. Clair clay plain, where glacial processes have deposited a mantle of till over a shale bedrock. In the test holes, the clayey till was found to be overlain only by up to 4.5 ft of a sandy and clayey fill with organic matter.

B. GENERAL INFORMATION - Cont'd

A simplified subsoil profile, in the form of a section through the test holes, is included on the enclosed drawing.

4. Laboratory testing of soil samples, apart from moisture content determinations, was limited to Atterberg Limits and unconfined compression tests with volumetric analyses.

Results of the tests are included in Appendix "B".

C. SITE and GEOLOGY

The site of the proposed new culvert C-12-16 is located in the Bousanquet Township, on County Road No. 12 at the Beith Creek, and approximately 2 miles west of the junction of this road with Highway 21. It is approximately 1.5 miles along County Road No.12 in a south-westerly direction from the Shashawandah Creek; a site investigation for a new culvert at this creek was recently described in our Report No. 62131, of September 11th, 1962.

D. SOIL CONDITIONS

Details of the soil conditions found in the test holes are described on the enclosed borehole logs. A simplified subsoil profile, in the form of a section through the two test holes is included on the enclosed drawing.

Only two types of subsoil were found in the test holes, viz:

a) Clayey and sandy fill

b) Silty clay with pebbles (clay till)

a) The thickness of fill was 4 ft 2 in. in test hole 1 and 4 ft 6 in. in test hole 2. It consisted mainly of a clayey sand and included organic matter. It was dark brown in colour and of firm consistency, as indicated by standard penetration test results of 6 and 14 blows per foot at a depth of 3 ft below the existing grade in test holes 2 and 1 respectively. The moisture contents ranged from 14.6% to 18.8%.

b) Apart from the above described fill, the silty clay till was the only stratum encountered at this site, and both test holes were terminated in this material. It is known to form the main overburden over bedrock in the area, but the depth to bedrock was not determined.

The silty clay till can be subdivided into :

D. SOIL CONDITIONS - Cont'd

(i) a brown, desiccated and stiff crust,

(ii) a grey-brown, firm to stiff transition zone,

(iii) a grey, firm , main portion of the stratum .

The stiff clay, brown and brown-grey, extended between the depths of 4.2 ft below the existing grade to approximately 17.5 ft in test hole 1, while in test hole 2 it occurred between the depth of 4.5 ft and approximately 13 ft below the existing grade.

The brown and brown-grey till had a natural moisture content in the range of 17.3% to 21.3%. Standard penetration tests in this zone were in the range of 8 to 16 blows per foot with an average of 14 blows per foot.

In the greyclay the moisture content was in the range of 24.6% to 31.6% with an average of 28.6%. Standard penetration tests in the grey clay were in the range of 7 to 13 blows per foot.

Unconfined compression tests were performed only on four samples of the softer, grey portion of the clay till. The undrained shear strength, taken as one half of unconfined compressive strength, ranged from 660 to 730 lb/sq.ft. For the purposes of calculating bearing capacity of culvert and stability of embankment, it is considered permissible to assume that the minimum strength of the subsoil is 700 lb/sq.ft.

D. SOIL CONDITIONS - Cont'd

In test hole 2, the clayey till again became stiffer at a depth of 27.5 ft below existing grade, and standard penetration test results at a depth of 29 ft gave 15 blows per foot; moisture contents at this depth were 21.4% and 23.3%. This may serve as an indication that the silty clay till is becoming stiffer with depth.

E. WATER CONDITIONS

No free water was encountered in either of the test holes. The silty clay till is of very low permeability, so that the phreatic surface could not be established during the short duration of a test hole. However, the ground water table can be assumed as controlled by the normal water level in the creek, which is believed to be near the elevation 626 or 627. This corresponds roughly to the change from brown to grey colour in the clay till, which normally occurs below the phreatic surface.

F. CONCLUSIONS and RECOMMENDATIONS

a) Culvert Foundation

1. The invert of the proposed 14 ft diameter, corrugated metal culvert, is to be located at the elevation 622.0.

Judging from the stratigraphy of test holes 1 and 2, at this level the culvert would be resting 3 to 6 ft below the top of the brown or grey-brown, stiff silty clay till. This material is very strong at this level, and will safely support the culvert and the superimposed fill.

However, according to Client's Drawing No. R-24-4, the bottom of the creek is near the elevation 624.5, while the invert of the valley at a distance of 43 ft north of the centre line is near the elevation 627.5 to 628.5. It is therefore possible that the subsoil below the bed of the existing creek does not consist of the stiff clay immediately, but that some unknown depth of river-deposited material is present at the creek bottom, while the top layers of the silty clay have been eroded by scouring. However, on account of the general firm to stiff consistency of the upper layers of the clayey till, it does not appear likely that the thickness of the stream-deposited materials is large and the clay probably begins a short distance below the creek invert, though this could only be proved by probes put down at the creek bed itself.

F. CONCLUSIONS and RECOMMENDATIONS - Cont'd

2. Assuming that the shear strength of the clay below the proposed culvert invert is not considerably lower than the average of 700 lb/sq ft established in the softest layers in the two test holes, it can be concluded that the bearing capacity of the subsoil under the culvert will be entirely adequate.

3. The culvert should be laid on a cushion of well compacted granular material. The purpose of the cushion is to ensure a good uniform bearing medium so that any settlement would be as uniform as possible.

The thickness of the granular cushion under the culvert invert will depend on the material which exists at the present stream bed. From results of test holes located at some distance from the stream it is not possible to judge what materials are present and this information can only be obtained by additional probes or by visual examination of excavation below the pipe.

It is recommended that the bedding for the culvert be prepared by excavating any variable stream deposits under the pipe invert until the clay till stratum is reached. The depth of excavation below the culvert invert should preferably be uniform throughout the length of the culvert. It is particularly important to remove all organic material or soft mud, and also it is advisable to remove any boulders.

F. CONCLUSIONS and RECOMMENDATIONS - Cont'd

The excavated trench should then be filled up to the required level of pipe invert with well compacted granular material, placed in layers 4 to 6 inches thick. Judging by the consistency of the clay till as found inthe test holes, the subgrade below the culvert, once the surficial variable and wet layers have been removed, should be firm and relatively dry, forming a good base for placing the compacted fill. Should, however, excavation reveal the presence of soft layers of clay till below the pipe invert, which were not encountered in the test holes located some distance from the creek, compaction of the granular cushion material should only begin after an initial layer at least one foot thick has been laid on top of the soft clay; this precaution is intended to ensure against the disturbance of the soft clay by the compacting operation.

4. The formation grade on the clay below the granular cushion should not be disturbed during excavation and construction and should not be allowed to soften by absorbing free water. All machinery should operate from outside the trench and the excavated grade should be protected against the inflow of water. The flow in the creek should be diverted or cut off from the excavation by sheeting in order to ensure a dry bottom.

F. CONCLUSIONS and RECOMMENDATIONS - Cont'd

Should the excavation reveal soft subsoil below the existing creek bed, consideration could be given to moving the culvert in an easterly direction, towards the position of test hole 2. Indications are that if this is done, the culvert would be resting in the stiff brown silty clay till, and it may be unnecessary to use a granular blanket below the invert. The bedding for the metal should, however, be carefully prepared, preferably by shaping the surface of the clay to fit the profile of the culvert.

6. The preparationof a base for the pipe and the compaction of the fill around the pipe should be performed in accordance with the customary requirements of good practice, which are briefly outlined on pages 15 and 16 of our Report No. 62131 for the culvert C-12-17 at the Shashawandah Creek.

7. Because of the generally firm or stiff consistency of the clay, consolidation settlement of the culvert and embankment was not considered quantitatively but is unlikely to exceed a total of 2 to 3 inches. This, however, assumes that any soft pockets or organic materials have been removed prior to placement of the culvert and replaced by a well compacted granular cushion. Retention of soft or organic matter might result in additional settlements.

F. CONCLUSIONS and RECOMMENDATIONS - Cont'd

b) Stability and Settlement of Embankment

Judging by the firm to stiff consistency of the subsoil, there appears to be no danger of a slip failure of the new embankment, the top of which at the critical section is to be near the elevation 654.5. The proposed side slopes of 2.5 to 1 should be stable.

The total settlement of the embankment was not considered analytically but is unlikely to exceed 2 or 3 inches, judging by the consistency of the clayey till in the two test holes. However, it is advisable to remove the fill material, which may containorganic matter, from below the new embankment. Scraping should proceed until visual examination of excavated grade reveals a firm subsoil, which does not contain considerable quantity of organic matter. If organic topsoil is retained under the membankments, it may result in some additional long-term settlements.

Report prepared by:

R. Kulesza

R. Kulesza, P. Eng.

E. M. PETO ASSOCIATES LTD.

C. F. Freeman

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

RK/ap

APPENDIX "A"

STANDARD PROCEDURE

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 augers, 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 inch dia. x 60° 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 or pumped out during the work as necessary, 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.

Borehole logs are prepared giving details of the soil description and condition as recorded in the field. These logs form the basis of the soil profile, which indicates the general stratigraphy assumed to exist between the boreholes as represented by the borehole logs.

The boreholes are normally set out by the Field Engineer, who also records the ground elevations referred to a temporary bench mark or known reference point. If the client has been responsible for setting out the boreholes and recording their ground elevations this is stated in the preamble to the report.

A plan is drawn up from drawings supplied by the Client or his representatives showing the locations of the boreholes and the T. B. M where applicable.

Normally, the standard penetration forms and the natural moisture contents are plotted against elevation as a graph, and these graphs form a part of the appendices. Boreholes with laboratory test result details, ground water readings and other soil characteristics which can be best illustrated in graphical form.

APPENDIX "B"

SOIL TEST RESULTS

Job No. 62134

ATTERBERG LIMIT TEST RESULTS

BH/SA. No.	Depth Ft.	Liquid Limit %	Plastic Limit %	Plasticity Index	Natural Water Content %
1/4	8	30.7	15.8	14.9	19.1
1/8	21	34.8	16.5	18.3	24.6
2/8	16	34.6	16.7	17.9	29.2

E. M. PETO ASSOCIATION LTD.

UNCONFINED COMPRESSION TEST DATA SHEET

Job No. 62134

Borehole Number	Sample Number	Depth feet	Nat. M. C.	Wet Density p.c.f.	Dry Density p.c.f.	Void Ratio, e	u/c Shear Strength p.s.f.
2	7	14'0"	28.7	125	97	0.77	680
2	7A	15'0"	30.0	125	96	0.79	660
2	10	22'0"	30.3	125	96	0.80	680
2	10A	23'0"	29.0	121	94	0.84	730

e. m. peto associates ltd.

SOIL ENGINEERING SERVICE – TORONTO, ONTARIO

BOREHOLE LOG

Job Name Culvert C-12-10 Job No. 2213 Borehole No. 4

Client The County of Lambton Casing 4" & BX Boring Date July 26-27/62

Elevation 933.2 Compiled By HEG Checked By MF

SAMPLE CONDITION

- UNDISTURBED
- FAIR
- DISTURBED
- LOST

SAMPLE TYPE

- A.S. AUGER SAMPLE
- C.S. CASING SAMPLE
- 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
- M. MOIST
- W.L. WATER LEVEL IN CASING
- W.T. GROUND WATER TABLE IN SOIL
- W.T.P.L. WETTER THAN PLASTIC LIMIT
- D.T.P.L. DRIER THAN PLASTIC LIMIT
- A.P.L. ABOUT PLASTIC LIMIT

SOIL DESCRIPTION	COLOUR	Density or Consistency	Depth Elevation	Legend	Sample No and Condition	Sample Type	No. of Blows per Ft	Natural Moisture Content	WATER LEVELS & REMARKS
	Ground Surface		0'						
Clayey Sand fill organic	DK.-Brown		2'7"		1	CS			Very Moist
As above		Compact	4'2"		2	SS	14	17.0 14.0	" "
Silty clay till - some sand	Brown	Stiff			3	SS	10	18.5	WTPL
As above	Grey Brown	"	10'0		4	SS	15	19.9	WTPL
As above	" "	"			5	SS	14	17.8	"
As above	" "	"	15'		6	SS	14	21.3	"
As above	Brown - Grey	"			7	SS	10	19.9	WTPL
			20'0						
Silty clay-few pebbles (till)	Grey	Firm	21'0"		8	SS	13	24.0	WTPL
			Boring Terminated at 21'0"						

e. in. peto associates ltd.

SOIL ENGINEERING SERVICE – TORONTO, ONTARIO

BOREHOLE LOG

Job Name: Calvert Co Site | Job No.: 9434 | Borehole No.: #2

Client: The County of Lambton | Casing: 4" HX | Boring Date: July 27 & 28/62

Elevation: 938.2 | Compiled By: J.F.G. | Checked By: Y.F.

SAMPLE CONDITION

- UNDISTURBED
- FAIR
- DISTURBED
- LOST

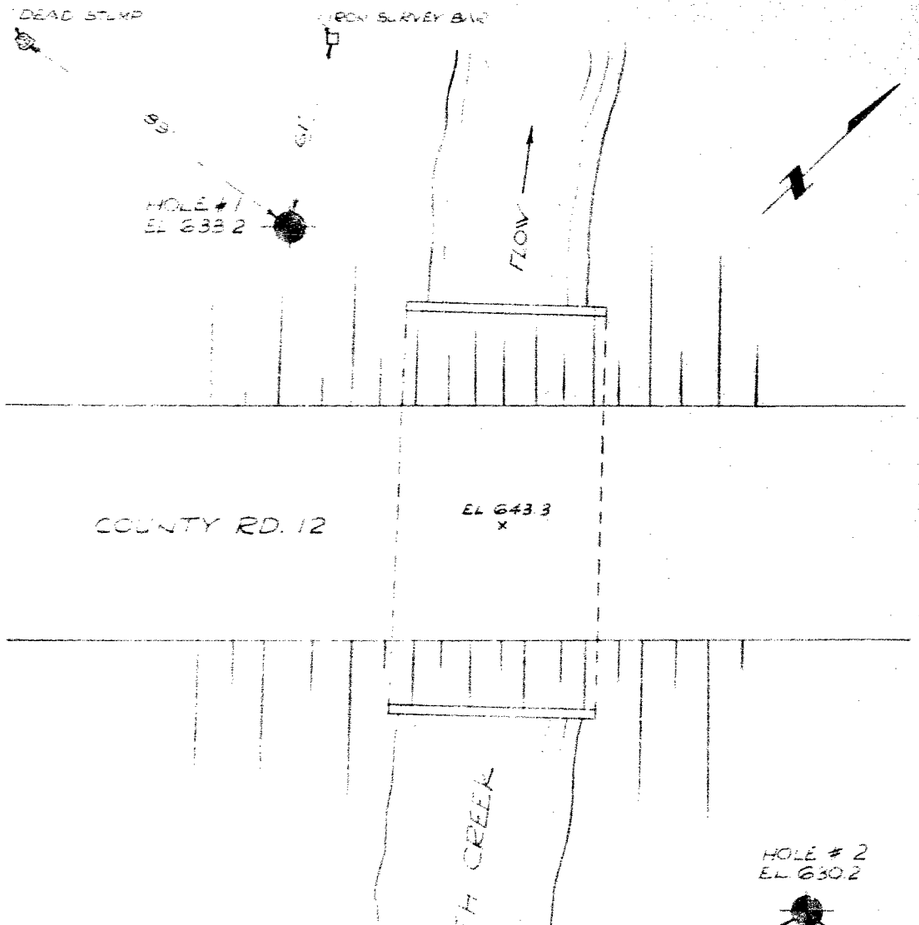
SAMPLE TYPE

- A.S. AUGER SAMPLE
- C.S. CASING SAMPLE
- 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
- M. MOIST
- W.L. WATER LEVEL IN CASING
- W.T. GROUND WATER TABLE IN SOIL
- W.T.P.L. WETTER THAN PLASTIC LIMIT
- D.T.P.L. DRIER THAN PLASTIC LIMIT
- A.P.L. ABOUT PLASTIC LIMIT

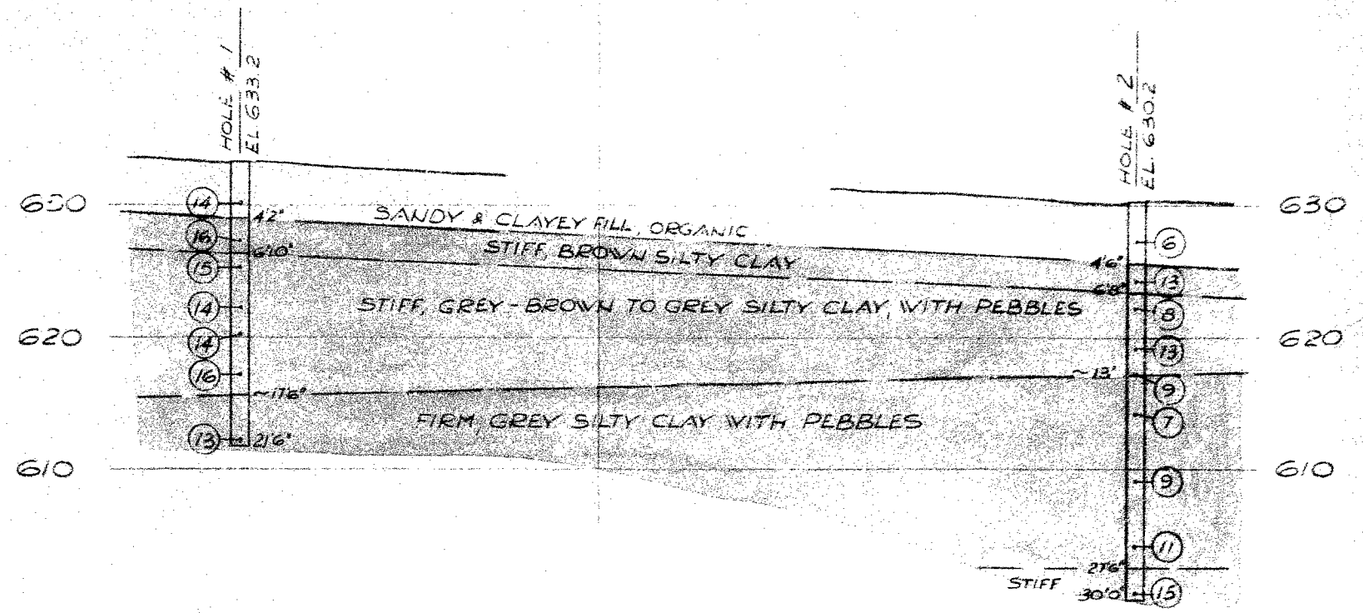
SOIL DESCRIPTION	COLOUR	Density or Consistency	Depth Elevation	Legend	Sample No. and Condition	Sample Type	No. of Blows per Ft.	Natural Moisture Content	WATER LEVELS & REMARKS
	Ground Surface		0'						
Clayey, organic sand	D.K. Brown				1	CS			About PL
			2'0"						
Sandy clay organic	Brown	Firm			2	SS	0	15.9	- about PL
			4'0"						
Silty clay till	Grey-Brown	Firm to stiff			3	SS	13	17.2	WTPL
Silty clay till	Brown-Grey	- " -			4	SS	8	19.8	WTPL
			10'0						
Silty clay till	Grey-Brown	- " -			5	SS	13	18.3	WTPL
As above- less grits & pebbles	"	- " -	13'		6	SS	9	19.3	WTPL C_u = 680 / 660
			15'0		7	2"SL	Tapped	20.8	
As above - " -	Grey	Firm			8	SS	7	20.2	WTPL
			20'0						
As above	"	-"-			9	SS	9	28.3	WTPL
					10	2"SL	Tapped	31.6	C_u = 680 / 730
			25'						
As above - stones & pebbles	"	-"-			11	SS	11	31.4	WTPL
			27'6"						
Silty Clay till	"	Firm to stiff	30'0"		12	SS	15	23.9 / 21.4	WTPL
		Boring Terminated at 30'0"							



SITE PLAN
(NOT TO SCALE.)

NOTE

THE SITE PLAN IS A REPRODUCTION OF CLIENT'S SKETCH.



SECTION THROUGH HOLES 1 & 2

HOR. NOT TO SCALE

SCALES:

VERT: 10' TO 1"

LEGEND

BOREHOLE

(16) BLOWS/FOOT S.P.T

NOTE

SEE BOREHOLE LOGS FOR COMPLETE SOIL DATA.

NOTE: **The actual soil stratification has been verified from data obtained at the borehole locations only. The inferred contacts shown are based on geological evidence and these may vary from those shown between borings.**

REGISTERED PROFESSIONAL ENGINEER
E. M. PETO
PROVINCE OF ONTARIO

THE COUNTY OF LAMBTON

BEITH CREEK BRIDGE
C-12-16

PREPARED BY
e m. peto associates ltd.

JOB No. 62134	SEPT. 1962	K.K.