

66-F-262 M

PATTERSON CREEK

CAMLACHIE

E. M. PETO ASSOCIATES LTD.

SOILS INVESTIGATION REPORT *No.*
PATTERSON CREEK BRIDGE *Plans*
CAMLACHIE, ONTARIO
FOR *66-F-262M*
COUNTY OF LAMBTON

c/o J.A. MONTIETH AND ASSOCIATES LTD.

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JOB NO. 66220

AUGUST, 1966

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YOUR REFERENCE..

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1237 caledonia road.

TORONTO 19, ONTARIO

Telephone: 789-1125

August 30th, 1966

County of Lambton,
c/o J.A. Montieth and Associates Ltd.,
4238 Petrolia Street,
P.O. Box 579,
Petrolia, Ontario.

Attention: Mr. G. Ingram

Dear Sir:

Re: Soils Investigation
Patterson Creek Bridge
Camlachie, Ontario.

We enclose herewith, our final report on the soils investigation carried out in connection with the above project.

Three testholes were put down at the positions shown on the appended site plan during the third week of August 1966. Testhole #1 was sampled to refusal on presumed bedrock at 61 ft. 6 inches; testhole #2 was sampled to 40 ft. 0 inches and a cone was driven to refusal at 61 ft. 0 inches; and testhole #3 was sampled to 21 ft. 6 inches.

Testholes 1 and 2 encountered a similar succession of strata consisting of a grey to light brown silty clay, which was firm but wet, underlying a thin layer of fill material. This stratum became softer and more moist below 20 ft. 0 inches.

In testhole #1 a stratum of darker grey sandy clayey till was encountered at 45 ft. 0 inches. This material was moist and dense, and the density increased with depth.

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Natural gas was encountered in the gravel or broken rock layer immediately above the refusal point. This gas was under pressure.

Testhole #3, which was, approximately, 130 ft. 0 inches north of the first two holes, encountered a stiff clay till underlying a layer, 2 ft. 6 inches thick, of topsoil and sand. *? SEE PAGE 2*

Although a reasonably stiff crust was encountered at the proposed bridge site the expected loads would overstress the softer layers beneath the crust and differential settlements would be possible.

It is recommended that the abutment walls be placed on a piled foundation, and the most suitable pile would appear to be an "H" section steel beam, which would be capable of penetrating the dense sandy clayey till. This type of pile would ensure that the bridge loads are transferred to the underlying bedrock, which is a hard bituminous shale.

We believe that this report is complete within our terms of reference, but we will be pleased to discuss any points you may wish to raise.

Yours very truly,

E. M. PETO ASSOCIATES LTD.,



E. M. Peto, P.Eng.

JH/hf

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1. INTRODUCTION

- 1.1 Authority: The work described in this report was authorized on behalf of the County of Lambton by Mr. G. Ingram, of J.A. Montieth and Associates Ltd., Consulting Engineers, Petrolia, Ontario on the 27th June, 1966.
- 1.2 Site and Proposal: The site of the investigation was at Patterson Creek on the new line of the proposed river crossing of the road from Camlachie to Aberarder. It is proposed to reline the road and the creek, and the investigation was carried out in an area southwest of the existing creek bridge.
- 1.3 Field Work: Three testholes were put down by a self-propelled, track mounted, 4½ inch diameter flight auger, at the area shown on the enclosed site plan. Of the three testholes, testhole 1 was sampled to refusal at a depth of 61 ft. 6 inches; testhole 2 was sampled to 28 ft. 6 inches, augered to 40 ft., and then dynamic cone probe driven to refusal at 61 ft. 6 inches; and testhole 3 was sampled to 21 ft. 6 inches. Standard penetration tests were carried out at intervals of 2 ft. 6 inches in the first 15 ft. and thereafter at 5 ft. intervals. A careful check was kept on water conditions within the testholes throughout the period of the investigation.
- 1.4 Report Preparation: The detailed soil conditions encountered in each testhole are given on the appended borehole logs, together with the results of the field tests carried out. The enclosed site plan shows the locations of the testholes, and in order to illustrate the inferred stratigraphy between testholes 1 and 2 a simplified soil profile has been included with the site plan.

The elevations, as given in the report and on the soil profile were supplied by the Consulting Engineers.

2. SOIL CONDITIONS

- 2.1 General: Testholes 1 and 2, which were on the centre line of the proposed road, encountered similar succession of strata, whereas testhole 3, which is approximately 120 ft. north of the first two holes, encountered different soil conditions.

In the first two holes, a grey laminated silty clay was encountered beneath a thin fill layer, and this grey clay became brown with depth. At approximately 43 ft., dark grey sandy clay till was encountered. Refusal on both holes was at a depth of 61 ft. below the existing grade, and gas was encountered at refusal depth in testhole 1. Testhole 3 encountered a mottled brown silty clay till, which became a grey till with depth, beneath a thin layer of topsoil and sand. The following paragraphs give a more detailed description of the soils encountered:

- 2.2 Fill: Testholes 1 and 2 encountered a layer of fill at grade elevation. The material was a mixed brown to mottled yellow brown silty clay with sand, grits and stones. This stratum was generally moist to wet and loose, with an N-value of 5 at a moisture content of 13% being recorded in one standard penetration test carried out in this material in testhole 2.
- 2.3 Sand: Testhole 2 encountered a stratum of wet sand and gravel, approximately 1 ft. 6 inches thick underlying the fill material. It is difficult to determine whether this stratum is part of the filled layer or the original creek bed at this location, however, it is most probably part of the original creek bed.
- 2.4 Grey Clay: A stratum of grey to dark greyish brown laminated silty clay was encountered in testholes 1 and 2, beneath the fill material. This layer, which was in a wetter than plastic condition, contained some sand seams and also grits and pebbles. The material was stiff to firm, and the average N-value was 13 blows/ft. at an average moisture content of 19%.

2. SOIL CONDITIONS - continued

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The geotechnical properties of this material are given in Table I appended to this report.

- 2.5 Light Brown Clay: At a depth of approximately 20 ft. below the existing grade, at testhole 1 the material became a light brown to grey silty clay with the odd grit and stone. This material, which was wetter than the plastic limit, was laminated with seams of silt, randomly, found throughout the depth. The thickness of the light brown clay stratum was 23 ft., and the material was very wet but firm, having an average N-value of 10 blows/ft. at an average moisture content of 29%.
- 2.6 Clay Till: In testhole 1, underlying the light brown clay, a stratum of dark grey sandy silty clay till with grits and stones, was encountered. This layer, which was 5 ft. thick, was moist and very stiff with an N-value of 19 blows/ft., at a moisture content of 16%, being recorded in the single standard penetration test carried out in the stratum.
- 2.7 Sand Till: Underlying the grey clay till was a layer of grey clayey fine sand till. This material which was lighter in colour than the above stratum had a much higher proportion of sand, but did contain some clay. The layer, which was 12 ft. 6 inches thick, was in a moist to dry condition, and, generally, dense to very dense, having an average N-value of 45 blows/ft., at an average moisture content of 15%. In the lower 12 ft. of this stratum the material was more a silty fine sand till with very little clay content.

2. SOIL CONDITIONS - continued

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- 2.8 Gravel: At a depth of 60 ft. 6 inches below the existing grade, testhole 1 encountered a layer of gravel or broken rock. Due to the presence of gas under a relatively high pressure it was impossible either to carry on the hole any further or to identify the material, which was being continually forced up the hole due to the pressure in the gas. However, it is thought from the knowledge of previous investigations at this site, and also confirmed by the cone penetration test carried out in testhole 2, that this gaseous condition in a sand or broken rock stratum is an indication of the elevation of the bedrock at this site.
- 2.9 Till (Testhole No. 3): Testhole No. 3, underlying a 1 ft. 10 inch thick layer of topsoil, and an 8 inch seam of sand, encountered a clay till, which for the first 5 ft. was a mottled brown silty clay till and at a depth of 7 ft. 8 inches became a greyish brown silty clay till. This stratum was moist and very stiff throughout the depth investigated, having an average N-value of 17 blows/ft., at an average moisture content of 17%. This till stratum was not encountered in testholes 1 and 2 although the grey laminated silty clay is probably a disturbed version of this material which has been deposited by the water action in the creek.
- 2.10 Water Conditions: Testhole No. 2 was the only hole which recorded a water table, and this was established at a depth of 7 ft. 1 inch below the existing grade. In testhole 1, wet seams were encountered during the sinking of the testhole, but due to the upthrust of the gas under pressure, at the termination of the hole, it was impossible to establish a final water table reading. In testhole 3 the till material was dense and dry, and no water was encountered in the depth investigated.

3. OBSERVATIONS AND RECOMMENDATIONS

3.1 Bearing Capacity: Testholes 1 and 2, which were put down at the site of the proposed bridge, reveal soil conditions indicating a desiccated crust of greyish brown silty clay to a depth of approximately 20 ft., and underlying the crust, the material is less dense and in a condition wetter than the plastic limit. Although the crust has a bearing capacity of 2.5 kips/sq.ft. for footing widths up to 8 ft., the underlying stratum is softer and not so strong. There is, therefore, the danger of either over-stressing the weaker material or of differential settlements occurring in the abutment walls. Because of this it is not thought feasible to place the abutment walls on the strip footings at shallow depths and it is recommended that a piled foundation be used.

A driven tube pile or "H" section pile would seem to be the most suitable in the circumstances encountered at this site and the depth of pile required will depend on the overall density of the sandy till encountered at approximately 50 ft. below the existing grade. The results, from both the standard penetration tests and the cone penetration test in testholes 1 and 2, indicate that the layer of sand till encountered above the bedrock is relatively dense, and has an increasing density with depth, therefore it is thought that refusal could be met in this material, especially if tube piles are used. However, as this material is dense and no softer layers exist between it and the bedrock, the bearing capacity of this material will be relatively high.

The bedrock, at this site, is a hard bituminous shale with a bearing capacity of between 55 and 65 tons/pile, if driven to refusal on the rock. Investigations in this site and the adjoining area show that the shale, and the weathered zone or gravel bed above it, contains gas under pressure, but this should not effect a driven pile.

3. OBSERVATIONS AND RECOMMENDATIONS - continued

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The elevation of the pile cut-off will depend on the scour protection required at the abutment walls, and the location of these walls relative to the new creek bed. However, if a scour depth of 6 ft. is required this would place the cut-off in the dark greyish brown silty clay in testhole 1 and in the wet sandy gravel in testhole 2.

In testhole 1, seepage should not be a major problem but as the fill material will be wet, and generally loose, it is recommended that the slopes of any excavation be set back at 1 horizontal to 1 vertical. If the material is very soft and water is seeping from the face, it will be necessary to employ some temporary timbering to prevent failure on the sides of the excavations.

In testhole 2, the wet sand and gravel strata, encountered between 5 ft. and 6 ft. 6 inches, is thought to be part of the old creek bed and could be a major source of seepage during the excavation. Some method of pre-draining either by over-excavating the footings and providing sumps inside the excavations, or by pre-digging deep pumping wells outside the footing area should be employed to keep the base of the excavations dry. In testhole 2, the overlying fill material is very soft and moist, and will require sloping back as recommended previously or the use of temporary timbering.

3.2 Proposed Borrow Area: We are informed that testhole 3 was located in an area from which material could be taken to be used as infilling. The results of this borehole indicate that the material, within the first 20 ft., is a clay till which, although strong, would be a difficult material in which to get the required compaction. It will also be difficult to control the moisture content to ensure proper compaction.

3. OBSERVATIONS AND RECOMMENDATIONS - continued

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However, it is recommended that the suitability of this material be reviewed at a later date when the full requirements as to the infilling are known and the correctness of the borehole as a representative sample of the soils in that area have been assessed.

No calculations have been carried out in respect of the stability of the slopes at the proposed bridge, as insufficient information is available on the proposed design. However, it would appear that the light brown silty clay, in which the new creek bed will be formed, should be dense enough to resist excessive scour.

Yours very truly,


E. M. PETO ASSOCIATES LTD.,



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

JH/hf

Prepared by:



J. Hunter,
Senior Soils Engineer.

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TABLE "I"

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GEOTECHNICAL PROPERTIES

LT. BROWN SILTY CLAY

AVERAGE VALUE OF PROPERTIES

N-Value	13 blows/ft.	
Moisture Content	18%	
Wet Density	112.0-130.0	119.5 p.c.f.
Dry Density	82.6-109.8	95.1 p.c.f.
Liquid Limit	32.6- 38.3	34.2 %
Plastic Limit	16.0- 20.4	24.1 %
Plasticity Index	15.7- 19.0	16.9
Degree of Saturation	92.5	
Void Ratio	.750-1.04	0.877
Shear Strength	655-922	820 p.s.f.

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TABLE "II"

UNDRAINED TRIAXIAL & UNCONFINED COMPRESSION TEST DATAQUICK UNGRAINED

B.H.*	Sample #	Depth Ft.	M.C. %	Densities p.c.f. Wet	Dry	Degree of Saturation %	Void Ratio	% Strain at Failure	Shear Strength	Lateral Pressure σ_3 , p.s.i.
1	7	18'-20'	25.6	120.8	96.3	92	0.750	18.5	922	15
2	10	28'-30'	35.6	112.0	82.6	93	1.04	19.5	655	20
2	13	38'-40'	28.4	117.5	91.5	69	0.841	19.5	886	30
2	6	15'-18'	18.2	130.0	109.8	93	0.533	20	1295	15

UNCONFINED COMPRESSION

									U/C Compression Strength
1	3	7'-8'6"	18.6	134.0	113.0	100	0.491	20	2,100
2	4	10'-11'6"	15.9	133.0	114.6	91	0.471	20	2,680
2	7	20'-21'6"	19.4	131.2	109.7	98	0.535	20	2,350

LIST OF ABBREVIATIONS

PENETRATION RESISTANCE

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

DYNAMIC PENETRATION RESISTANCE -- THE NUMBER OF BLOWS REQUIRED TO ADVANCE A 2 INCH, 90 DEGREE CONE, FITTED TO THE END OF DRILL RODS, 12 INCHES INTO THE SUBSOIL, THE DRIVING ENERGY BEING 350 FOOT POUNDS PER BLOW.

DESCRIPTION OF SOIL

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

<u>CONSISTENCY</u>	<u>'N' BLOWS / FT.</u>	<u>c LB. / SQ. FT.</u>	<u>DENSENESS</u>	<u>'N' BLOWS / FT.</u>
VERY SOFT	0 - 2	0 - 250	VERY LOOSE	0 - 4
SOFT	2 - 4	250 - 500	LOOSE	4 - 10
FIRM	4 - 8	500 - 1000	COMPACT	10 - 30
STIFF	8 - 15	1000 - 2000	DENSE	30 - 50
VERY STIFF	15 - 30	2000 - 4000	VERY DENSE	> 50
HARD	> 30	> 4000		
W.T.P.L. WETTER THAN PLASTIC LIMIT		D.T.P.L. DRIER THAN PLASTIC LIMIT		
A.P.L. ABOUT PLASTIC LIMIT				

TYPE OF SAMPLE

S.S.	SPLIT SPOON	T.W.	THINWALL OPEN
W.S.	WASHED SAMPLE	T.P.	THINWALL PISTON
S.B.	SCRAPER BUCKET SAMPLE	O.S.	OESTERBERG SAMPLE
A.S.	AUGER SAMPLE	F.S.	FOIL SAMPLE
C.S.	CHUNK SAMPLE	R.C.	ROCK CORE
S.T.	SLOTTED TUBE SAMPLE		
	P.H. SAMPLE ADVANCED HYDRAULICALLY		
	P.M. SAMPLE ADVANCED MANUALLY		

SOIL TESTS

Q _u	UNCONFINED COMPRESSION	L.V.	LABORATORY VANE
Q	UNDRAINED TRIAXIAL	F.V.	FIELD VANE
Q _{cu}	CONSOLIDATED UNDRAINED TRIAXIAL	C	CONSOLIDATION
Q _d	DRAINED TRIAXIAL		

TECHNICIAN D.N.

ENGINEER J. H.

TYPED BY D.C.

Hole terminated at 61'6"
Because of Gas, stones
and water being blown up hole

TECHNICIAN D.N.

ENGINEER J. H.

TYPED BY D.C.

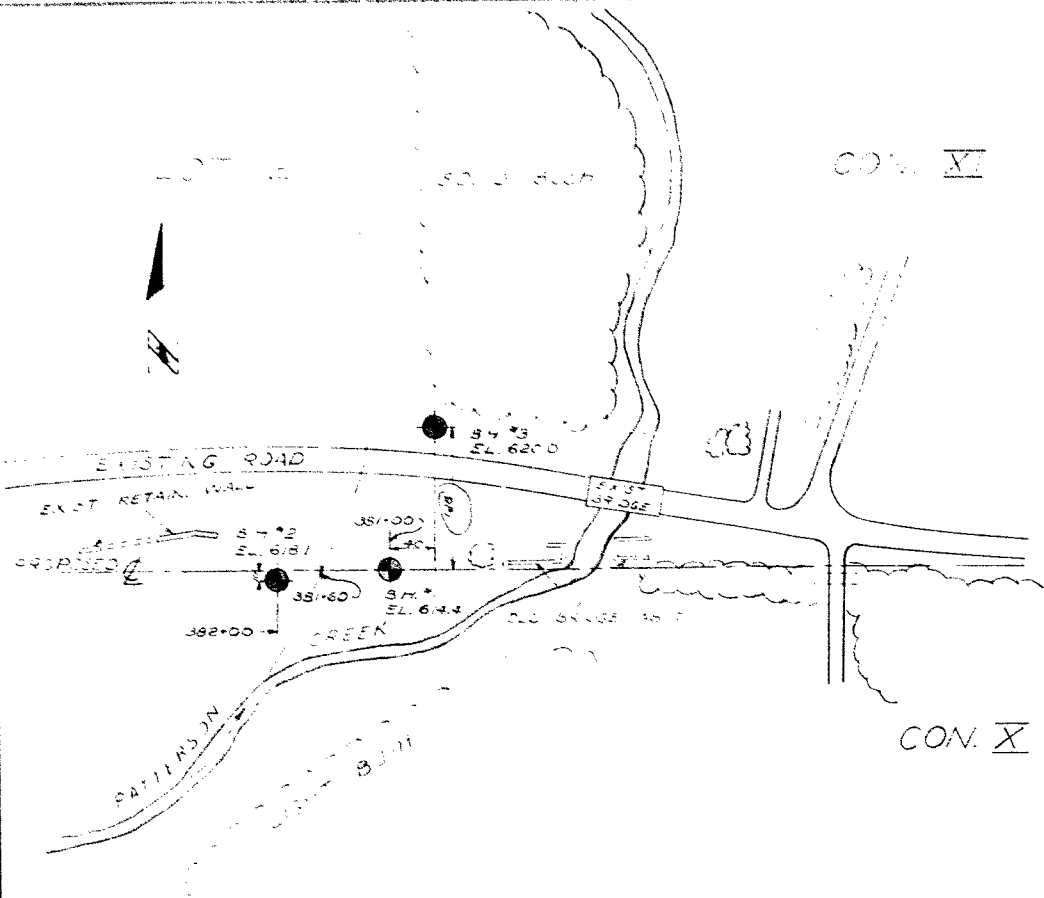
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TECHNICIAN D. N.

ENGINEER C. H.

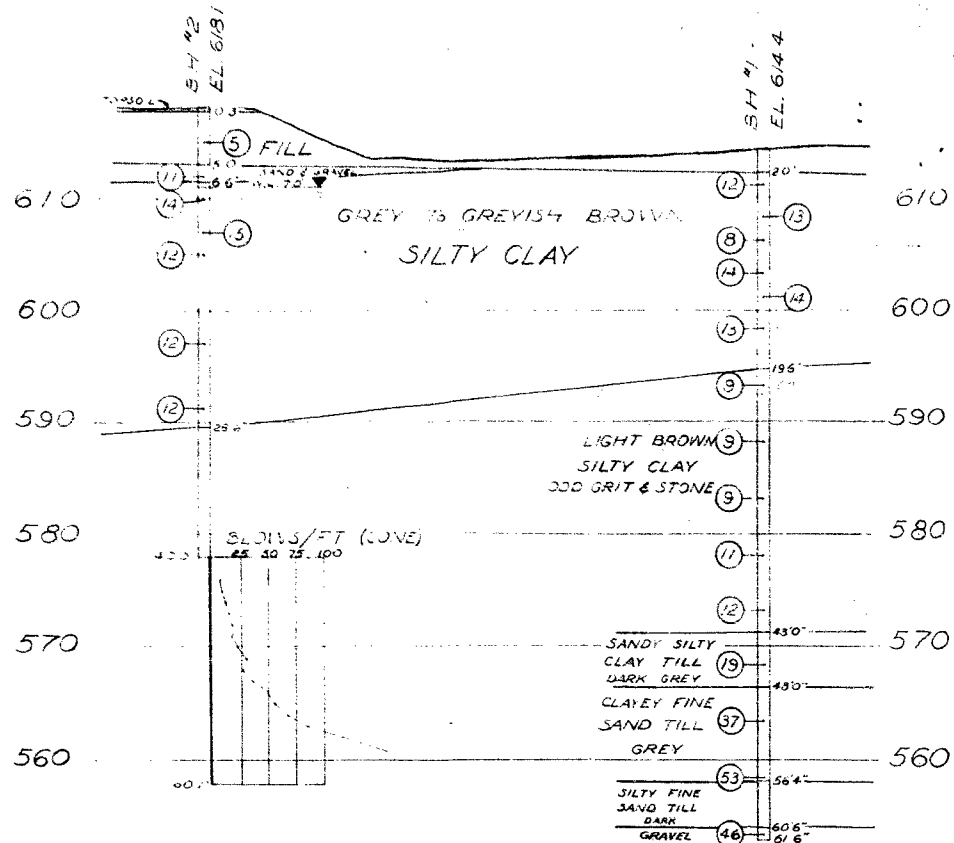
TYPED BY D.C.

[illegible]



SCALE PLAN

SCALE: 100' TO 1"



SECTION THROUGH HOLES 2 & 1

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.

COUNTY OF LAMBTON % J.A. MONTIETH AND ASSOCIATES LIMITED			
PATTERSON CREEK BRIDGE			
PREPARED BY e.m. peto associates ltd.			
JOB. NO. 66220	DATE AUG 1966	DRAWN BY D.N.	CHECKED BY J.H.

