67-F-241 M

EAST OTTER CREEK

BRIDGE # C-1-10

SOMBRA TWP.

BH 2014
Site 14-248

E. M. PETO ASSOCIATES LTD.

SOILS INVESTIGATION REPORT

EAST OTTER CREEK BRIDGE NO.C-1-10

TOWNSHIP OF SOMBRA

FOR C-7-F-241 M

COUNTY OF LAMBTON

C/O TODGHAM AND CASE LTD.

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JOB NO. 67 F 3

FEBRUARY, 1967

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YOUR REFERENCE -

OUR REFERENCE - 67 P3

1287 caledonia road.
TORONTO 19. ONTARIO
Telephone: 789-1128

February 22, 1967.

County of Lambton,
c/o Todgham and Case Ltd.,
Consulting Civil Engineers,
151 Thames Street,
P. O. Box 386,
Chatham, Ontario.

Attention: Mr. H. H. Todgham, P.Eng.

Dear Sir:

Re: Soil Investigation: -
East Otter Creek Bridge No. C-1-10
in Township of Sombra.

We have pleasure in forwarding herewith our soil investigation report including our recommendations for the foundation design of the above bridge.

While we consider the report to be comprehensive within the terms of reference, we will be pleased to be of further assistance should you require any additional information in connection with this investigation.

Yours very truly,

E. M. PETO ASSOCIATES LTD.

KSS/jw

E. M. Peto, P. Eng.

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WATER LEVEL RECORD SHEET

TABLE I Unconfined Compression Test Results and Liquid Limit and Plastic Limit

FIGURE 1 Void Ratio -- Log Pressure Curve

FIGURE 2 Grain Size Distribution Curve

FIGURE 2a Compaction Test Results

FIGURE 3 Grain Size Distribution Curve

FIGURE 3a Compaction Test Results

BOREHOLE LOGS

SITE PLAN AND PROFILE

1. INTRODUCTION

1.1 Authority: The authorization for this investigation was given by Mr. H. H. Todgham of Todgham and Case Ltd. in a letter dated January 5, 1967.

1.2 Proposal: It is proposed to construct a bridge over the East Otter Creek where it crosses Lambton County Road #1 in the Township of Sombra. The creek and the road would be re-located and hence the new bridge is in a location where neither the creek nor the road exists at present. The detailed layout plan of the proposal is shown on the appended drawing. The bridge will be of a single 30 ft. clear span type with precast hollow deck and concrete topping and with cantilevered abutments and wings. The length of each abutment wall will be about 36 ft. The finished road grade elevation will be 598.5± and the existing grade along the approach roads will be raised by about 3 ft. to the proposed road elevation.

1.3 Object: The object of this investigation was to determine the soil and ground water conditions existing at this site, to evaluate their properties and to make recommendations for the foundation design of the proposed structure.

2. SITE AND GEOLOGY

This site is located at the crossing of East Otter Creek and Lambton County Road No. 1 in the Township of Sombra. The site is fairly flat except for the creek and the Approach Fill Embankment of the existing road. The existing creek is about 100 ft. wide at the top, 15 to 20 ft. wide at the bottom and the bed elevation is 589 ft. approximately. The grade of the creek bed is 0.11% approximately. The banks of the creek appear to be stable. The highest flood water elevation in this area is about 595± and the stream dries up in summer. Geologically this site overlies a Clay Plain formation.

3. FIELD WORK

The field work for this investigation was carried out during the middle part of January, 1967. Four boreholes were sunk using a standard boring rig. The locations of these holes are shown on the appended drawing. Borehole 1 was taken to refusal depth at 79 ft. 1 inch and borehole 2 was taken down to 26 ft. 6 inches. Boreholes 3 and 4 were taken down to 13 ft. 6 inches and 16 ft. 6 inches respectively in order to determine the soil conditions existing down to just below the proposed stream bed level and to determine the suitability of these soils as Fill material. Standard procedures of boring, sampling and carrying out field penetration tests were adopted. A dynamic cone penetration test was also carried out by the side of borehole 2 and the results are shown on the appended borehole log sheet. The holes were set out and their ground surface elevations were taken by us.

4. LABORATORY WORK

4.1 Moisture Contents: The natural moisture contents of all the standard penetration test samples were determined and the results are given in the appended borehole log sheets.

4.2 Shear Strength Tests: Unconfined compression tests were carried out on 3 representative undisturbed samples of the firm to stiff grey Silty CLAY which lies below the proposed foundation level of 582.0. The results of these tests are given in the appended Table I.

4.3 Consolidation Tests: A one-dimensional consolidation test was carried out on a representative sample of the firm to stiff grey Silty CLAY. The void ratio--log pressure curve obtained from this test, together with the theoretical field consolidation curve, and the coefficient of consolidation Cv is shown on the appended Figure I.

4. LABORATORY WORK - cont'd

4.4 Liquid Limit and Plastic Limit Tests: These tests were carried out on the consolidation test sample and on two of the shear strength test samples. The results of these tests are given in Table I.

4.5 Compaction Tests and Mechanical Analyses: A composite sample of the firm to stiff yellow grey brown mottled Silty CLAY stratum was made up by mixing the samples of this stratum from boreholes 3 and 4. Another composite sample of the very sitff grey brown Silty CLAY with Pebbles stratum was also made up by mixing samples from boreholes 3 and 4. Standard Proctor Compaction Tests and Mechanical Analyses were carried out on these two samples

The moisture content--dry unit weight curves are shown in Figure 2 and Figure 3, and the grain size distribution curves are shown in Figure 2a and 3a.

4.6 Chemical Tests: Tests were made on a water sample from borehole 1 and on another sample from the creek. The concentration of soluble sulphates, expressed as SO_3, was 250 p.p.m. for the former sample and 260 p.p.m. for the latter sample. The pH value of both the samples was 8.5.

5. SOIL CONDITIONS

Detailed descriptions of the soil strata are given in the appended borehole log sheets and a generalized soil profile is shown on the drawing. Underlying 0 ft. 9 inches to 1 ft. 3 inches of topsoil and about 3 ft. of firm clay FILL in the vicinity of borehole 1, are different strata of Silty CLAY varying in colour, shear strength and compressibility. The top 2 ft. 9 inches to 5 ft. 0 inches is firm to stiff and of yellow grey brown mottled colour. The next layer, 3 ft. 6 inches to 10 ft. 0 inches thick, is very stiff, grey brown in colour and contains pebbles in places. However in the vicinity of the proposed bridge, its thickness is only 3 ft. 6 inches to 4 ft. 6 inches. Underlying

5. SOIL CONDITIONS - cont'd

this layer is grey Silty CLAY, the top 4 ft. of which is very stiff; but this very stiff grey Silty CLAY was not encountered in borehole 1. Below this layer is grey Silty CLAY the strength of which gradually decreases with increasing depth. At a depth of 40 ft. in borehole 1; i.e. at the elevation of 556.75, a one ft. thick layer of SAND was also encountered. At 78 ft. 4 inches below ground surface there is a 0 ft. 9 inch layer of Gravelly CLAY TILL. Refusal occurred at 79 ft. 1 inch and it is assumed that SHALE Bedrock exists at this depth, as such bedrock has been encountered in previous investigations in the surrounding areas.

6. GROUND WATER CONDITIONS

Free flowing ground water was encountered only in the SAND stratum at 40 ft. in borehole 1. This water rose rapidly to a standing water level of 11 ft. 4 inches below ground surface. The details of the rate of flow of water into the hole are given in the appended Water Level Record Sheet. There was also a very, very slow seepage of ground water from the grey Silty CLAY stratum in borehole 2. This hole was dry on completion, but after 3 days the water level was at 9 ft. 10 inches below ground surface. Boreholes 3 and 4 were dry on completion.

7. CONCLUSIONS AND RECOMMENDATIONS

7.1 Bearing Capacities of Bridge Abutment Foundations: It is recommended that the bridge abutments should be founded on continuous footings, the underside of which should be 4 to 5 ft. below the proposed stream bed elevation; i.e. ± elevation 581.0 subject to scour requirements. Such footings will bear in the firm to stiff grey Silty CLAY stratum. The allowable gross bearing capacity of such footings is 2.5 kips/sq.ft. for footing widths of up to 15 ft. For wider footings the allowable bearing capacity should be limited to 2.0 kips/sq.ft.

7.2 Settlements Under Abutment Foundations: The settlements which are likely to occur under the footing foundations recommended above would depend on the actual lengths and widths of footings. As these are not known at this stage, the settlements for a range of footing widths and 50 ft. length are given here.

Footing Width	Maximum Total Long Term Settlement	Period for 50% Settlement	Period for 90% Settlement
5'	2.0"	3 to 7 months after application of loads	15 to 36 months after application of loads.
10'	3.5"		
15'	5.5"		

If the lengths of the footings are less than 50 ft., the settlements would be smaller than those given above. For footing widths between those given, the approximate maximum settlement values could be obtained by interpolation. The actual settlements will also depend on the rate of application of the loads. As the settlements will occur fairly rapidly, a major part of the settlements will occur during the construction of the bridge, and may not seriously affect the completed bridge.

7.3 Foundations of Approach Fill Embankment: It is recommended that the topsoil should be stripped and the new Fill should be placed on the surface-rolled subgrade. Where the existing stream is to be filled under the proposed road, the soft and loose soil deposits on the banks and on the stream bed should also be stripped. The bearing capacity of the subgrade will be quite adequate to carry the proposed Fill and there should be no significant settlement in the subgrade.

7.4 Suitability of Excavated Soils as Fill Material: It is considered that the excavated Silty CLAY soils, except the topsoil, could be used for the Approach Fill provided it is compacted to 95% Standard Proctor maximum dry density. The appended compaction test results may be used for this purpose. If the excavation and construction are carried out during wet weather conditions, when the in situ moisture content of the firm to stiff yellow grey brown mottled Silty CLAY stratum is much higher than the optimum moisture content, some difficulty would be experienced in compacting this soil.

7.5 Stability of the Fill Embankment: As the new Approach Fill will be only 1 ft. 6 inches to 2 ft. 0 inches high it should be stable at the proposed slope of 1 vertical to 2 horizontal. Even the 8 to 9 ft. of Fill in the existing stream where the new road crosses it should be stable at the proposed slope of 1 vertical to 2 horizontal. If the whole of the diverted section of the existing creek is filled, then the stability consideration will not arise.

7.6 Stability of the Banks of the New Creek Diversion: The proposed slopes of 1 vertical to 2 horizontal for the new excavated section of the creek should be stable, and the proposed rip-rap bank on the bend should reduce erosion of the bank.

7.7 Chemical Attack: No special precautions are necessary to protect the concrete embedded in the ground from chemical attack.

E. M. PETO ASSOCIATES LTD.

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

KSS/jw

Report prepared by:

K. S. Senathirajah, P. Eng.
Senior Soils Engineer.

JOB NO. 67F3

WATER LEVEL RECORD SHEET

FEBRUARY, 1967

Borehole No. 1

Date	Time	Depth of Casing	Depth of Hole	Depth of Water From Surface	Water Bailed Yes	Water Bailed No	Depth of Water After Bailing	Remarks
Jan.17/67		Nil	3' 6"	Dry				
		Nil	6' 6"	Dry				
		5'	8' 6"	Dry				
		5'	11' 6"	Dry				
		5'	13' 6"	Dry				
		5'	16' 6"	Dry				
	5:00 pm	5'	20' 0"	Dry				
Jan.18/67	8:30 am	5'	20' 0"	17' 6"	Yes		20' 0"	
		5'	21' 6"	Dry				
		5'	26' 6"	Dry				
		5'	31' 6"	Dry				
		5'	36' 6"	Dry				
		5'	40' 0"					Water flowed in fast from sand layer while carrying out penetration test. At end of test sand rose in hole to 33'3"
	11:13 am	5'	33' 3"	25' 6"				
	11:18 am	5'	33' 3"	24' 6"				
	11:23 am	5'	33' 3"	24' 2"				
	1:30 pm	5'	30' 0"	17' 3"				Cont'd boring after this reading.
	6:00 pm	45'	79' 1"	19' 3"		No		Level of water after Completion
Jan.19/67	8:00 am	45'	79' 1"	11' 2"				
	5:00 pm			11' 4"				

JOB NO. 67 F 3

FEBRUARY, 1967

TABLE "I"

UNCONFINED COMPRESSION TEST RESULTS and LIQUID LIMITS AND PLASTIC LIMITS

B.H.#	SA.#	DEPTH	M.C. %	DENSITIES, P.C.F. WET	DRY	DEGREE OF SATURATION %	VOID RATIO	STRAIN AT FAILURE %	U/C SHEAR STRENGTH P.S.F.	L.L. %	P.L. %
1	7	18'0"-20'0"	22	129.7	106.0	100	.582	20	1030	37.6	19.9
1	11	33'0"-35'0"	21	130.2	107.7	100	.561	20	1180	-	-
1	15	65'0"	23	126.2	102.5	98	.642	20	1150	31.9	19.8
* 2	7	18'0"-20'0"	22	126.0	103.2	96	.633	-	-	37.6	19.5

* CONSOLIDATION TEST SAMPLE

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, 60 DEGREE CONE, FITTED TO THE END OF DRILL RODS, 12 INCHES INTO THE SUBSOIL. THE DRIVING ENERGY BEING 350 FOOT POUNDS PER BLOW.

DESCRIPTION OF SOIL

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

CONSISTENCY	'N' BLOWS / FT.	c LB. / SQ FT	DENSENESS	'N' BLOWS / FT.
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

Qu	UNCONFINED COMPRESSION	L V	LABORATORY VANE
Q	UNDRAINED TRIAXIAL	F V	FIELD VANE
Qcu	CONSOLIDATED UNDRAINED TRIAXIAL	C	CONSOLIDATION
Qd	DRAINED TRIAXIAL		

ABBREVIATIONS USED IN THIS REPORT

SOIL PROPERTIES

γ	UNIT WEIGHT OF SOIL (BULK DENSITY)
γ_s	UNIT WEIGHT OF SOLID PARTICLES
γ_w	UNIT WEIGHT OF WATER
γ_d	UNIT DRY WEIGHT OF SOIL (DRY DENSITY)
γ'	UNIT WEIGHT OF SUBMERGED SOIL
G	SPECIFIC GRAVITY OF SOLID PARTICLES $G = \frac{\gamma_s}{\gamma_w}$
e	VOID RATIO
n	POROSITY
w	WATER CONTENT
S_r	DEGREE OF SATURATION
w_L	LIQUID LIMIT
w_p	PLASTIC LIMIT
I_p	PLASTICITY INDEX
s	SHRINKAGE LIMIT
I_L	LIQUIDITY INDEX $= \frac{w - w_p}{I_p}$
I_C	CONSISTENCY INDEX $= \frac{w_L - w}{I_p}$
e_{max}	VOID RATIO IN LOOSEST STATE
e_{min}	VOID RATIO IN DENSEST STATE
I_D	DENSITY INDEX $= \frac{e_{max} - e}{e_{max} - e_{min}}$
	RELATIVE DENSITY D_r IS ALSO USED
h	HYDRAULIC HEAD OR POTENTIAL
q	RATE OF DISCHARGE
v	VELOCITY OF FLOW
i	HYDRAULIC GRADIENT
k	COEFFICIENT OF PERMEABILITY
j	SEEPAGE FORCE PER UNIT VOLUME
m_v	COEFFICIENT OF VOLUME CHANGE $= \frac{-\Delta e}{(1+e)\Delta\sigma}$
c_v	COEFFICIENT OF CONSOLIDATION
C_c	COMPRESSION INDEX $= \frac{\Delta e}{\Delta \log_{10} \sigma}$
T_v	TIME FACTOR $= \frac{c_v t}{d^2}$ (d, DRAINAGE PATH)
U	DEGREE OF CONSOLIDATION
τ_f	SHEAR STRENGTH
c'	EFFECTIVE COHESION INTERCEPT
ϕ'	EFFECTIVE ANGLE OF SHEARING RESISTANCE, OR FRICTION
	IN TERMS OF EFFECTIVE STRESS $\tau_f = c' + \sigma' \tan \phi'$
c_u	APPARENT COHESION
ϕ_u	APPARENT ANGLE OF SHEARING RESISTANCE, OR FRICTION
	IN TERMS OF TOTAL STRESS $\tau_f = c_u + \sigma \tan \phi$
μ	COEFFICIENT OF FRICTION
S_t	SENSITIVITY

GENERAL

π	= 3.1416
e	BASE OF NATURAL LOGARITHMS 2.7183
$\log_e a$ OR $\ln a$	NATURAL LOGARITHM OF a
$\log_{10} a$ OR $\log a$	LOGARITHM OF a TO BASE 10
t	TIME
g	ACCELERATION DUE TO GRAVITY
V	VOLUME
W	WEIGHT
M	MOMENT
F	FACTOR OF SAFETY

STRESS AND STRAIN

u	PORE PRESSURE
σ	NORMAL STRESS
σ'	NORMAL EFFECTIVE STRESS ($\bar{\sigma}$ IS ALSO USED)
τ	SHEAR STRESS
ϵ	LINEAR STRAIN
γ	SHEAR STRAIN
ν	POISSON'S RATIO (μ IS ALSO USED)
E	MODULUS OF LINEAR DEFORMATION (YOUNGS MODULUS)
G	MODULUS OF SHEAR DEFORMATION
K	MODULUS OF COMPRESSIBILITY
η	COEFFICIENT OF VISCOSITY

EARTH PRESSURE

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

FOUNDATIONS

B	BREADTH OF FOUNDATION
L	LENGTH OF FOUNDATION
D	DEPTH OF FOUNDATION BENEATH GROUND
N	DIMENSIONLESS COEFFICIENT USED WITH A SUFFIX APPLYING TO SPECIFIC GRAVITY, DEPTH AND COHESION ETC IN THE FORMULA FOR BEARING CAPACITY
k_s	MODULUS OF SUBGRADE REACTION

SLOPES

H	VERTICAL HEIGHT OF SLOPE
D	DEPTH BELOW TOE OF SLOPE TO HARD STRATUM
β	ANGLE OF SLOPE TO HORIZONTAL

CONSOLIDATION TEST

BOREHOLE	1	2
DEPTH	18'	20'
INITIAL w_o	=	22.4 %
FINAL w_o	=	20.8 %
INITIAL γ_o	=	103.2 P.C.F.
FINAL γ_o	=	108.2 P.C.F.

P_o

P_c

RECONSTRUCTED CURVE

LABORATORY CURVE

REBOUND

VOID RATIO e

.640
.630
.620
.610
.600
.590
.580
.570
.560
.550
.540
.530
.520
.510
.500
.490
.480
.470
.460
.450
.440
.430
.420
.410

.060
.040
.020

Δe sq. in./lb.

+ 80

+ 60

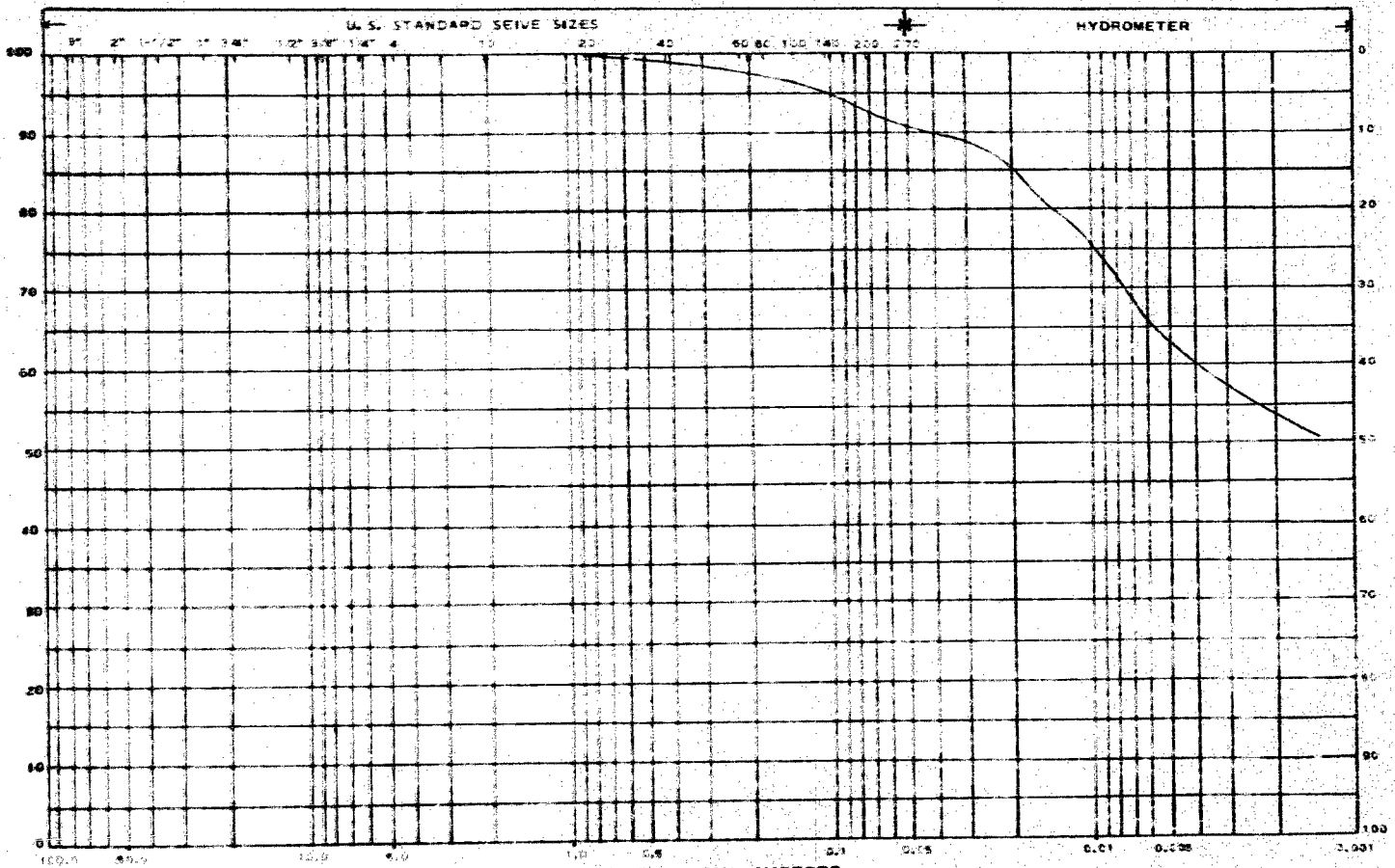
APPLIED PRESSURE K/FT²

1.0 10.0 100.0

JOB # 67-F3
E.M. DEVO ASSOCIATES INC.
FEB 1967

e. m. peto associates ltd.
Toronto 19, Ontario

DEFECTS IN NEGATIVE DUE TO CONDITION OF ORIGINAL DOCUMENT



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

MASS INST. OF TECH. CLASSIFICATION

JOB NAME East Otter Creek Bridge JOB NO. 67 P 3 HOLE NO. 4 SAMPLE NO. 1

DEPTH 2'-3'6" ELEVATION _____ REMARKS 3 2 and 3
2'-3'3" & 3'3"-4'

GRAIN SIZE DISTRIBUTION

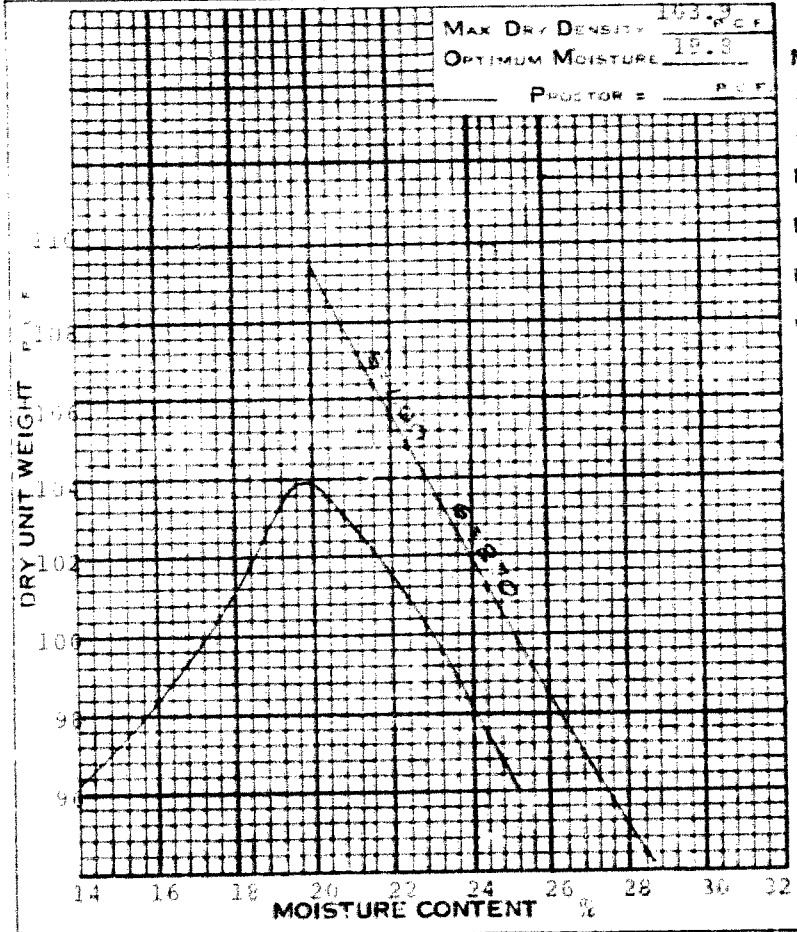
FIG 2

DEFECTS IN NEGATIVE DUE TO
CONDITION OF ORIGINAL DOCUMENT

COMPACTION TEST

FIG. 2A

	Trial Number	1	2	3	4	5	6
Unit Wt. Determination	Wt. Sample Wet + Mold	8.19	8.43	8.48	8.66	8.62	8.54
	Wt. Mold (lbs)	4.51	4.51	4.51	4.51	4.51	4.51
	Wt. Sample Wet	3.68	3.83	3.97	4.15	4.11	4.03
	Volume of Mold (cu. ft.)	1/30	1/30	1/30	1/30	1/30	1/30
	Wet Unit Weight (p.c.f.)	110.4	114.9	119.1	124.5	123.3	120.9
	Dry Unit Weight (p.c.f.)	96.5	99.0	100.7	104.0	101.0	97.2
Moisture Content	Tin No.	82	91	92	102	104	108
	Wt. Sample Wet + Tin	262.4	290.7	255.5	301.1	275.6	304.9
	Wt. Sample Dry + Tin	234.1	255.6	221.7	257.7	232.3	252.0
	Wt. Water (gms)	28.3	35.1	33.8	43.4	43.3	52.9
	Wt. Tin Empty	37.2	37.4	37.0	37.4	36.9	36.8
	Wt. Dry Soil	196.9	218.2	184.7	220.3	195.4	215.2
	Moisture Content	14.4	16.1	18.3	19.7	22.2	24.6



Max Dry Density 103.2 P.C.F.
Optimum Moisture 19.8
____ Proctor = ____ P.C.F.

Method of Compaction: Standard Proctor

No. of Layers: 3

Blows per Layer: 25

Ht. of Free Fall: 12 ins.

Wt. of Tamper: 5½ lbs.

Shape of Tamping Face: Circular

Description of Sample: brown silty clay

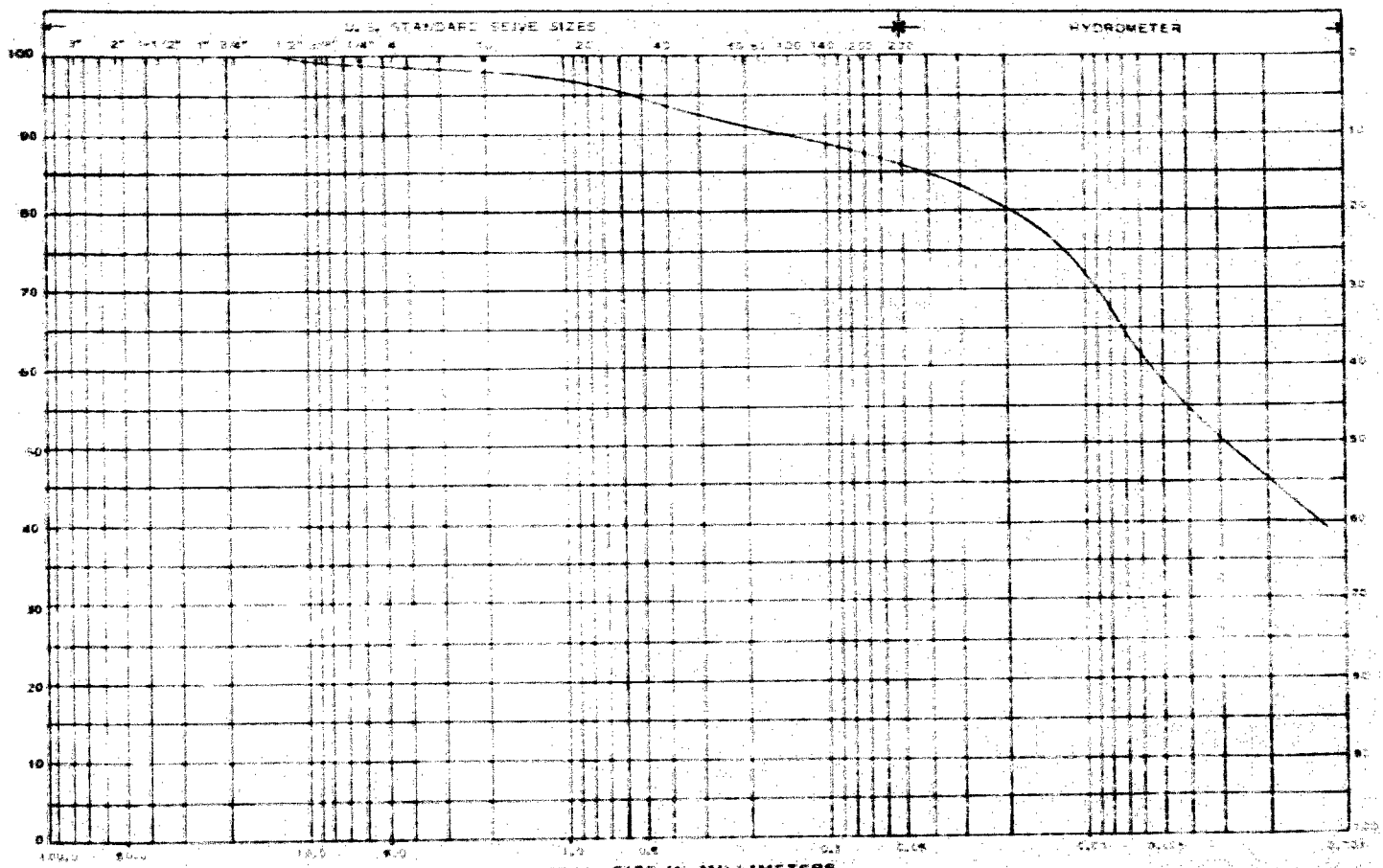
Remarks: Many air voids in trial #6

SOIL TESTING LABORATORY
e. m. peto associates ltd.
TORONTO, ONTARIO

Job Name: East Otter Creek Bridge
Job No.: 67 F 3
Hole No.: 3 and 4
Sample: 2 & 3 -1
Depth: 2'3"-3'3" & 4'-5'
Technician: BVD & LJ
Date: 10/2/67

e. m. peto associates ltd.

Toronto 19, Ontario



JOB NAME East Otter Creek Bridge JOB NO. 67 F 3 HOLE NO. 3 SAMPLE NO. 4 and 6

DEPTH 4'-7' / 7'-10' ELEVATION _____ REMARKS 4 4 and 5

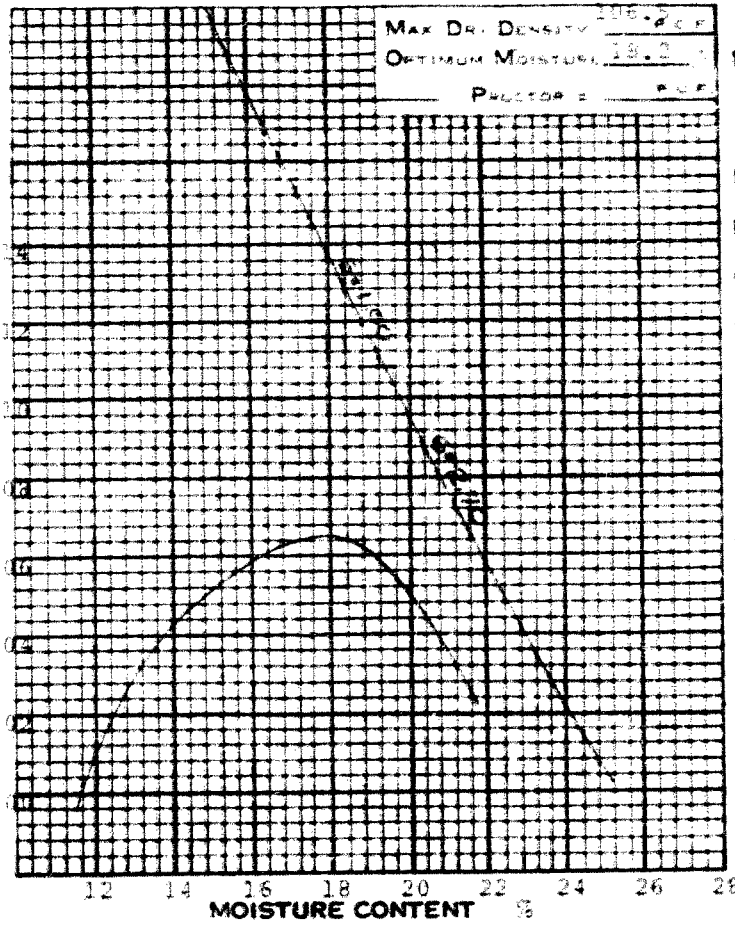
GRAIN SIZE DISTRIBUTION

DEFECTS IN NEGATIVE DUE TO CONDITION OF ORIGINAL DOCUMENT

COMPACTION TEST

FIG. 3A

	Trial Number	1	2	3	4	5	6
Unit Wt. Determination	Wt. Sample Wet + Mold	8.28	8.46	8.54	8.60	8.72	8.70
	Wt. Mold (lbs)	4.51	4.51	4.51	4.51	4.51	4.51
	Wt. Sample Wet	3.77	3.95	4.03	4.09	4.21	4.19
	Volume of Mold (cu. ft.)	1/30	1/30	1/30	1/30	1/30	1/30
	Wet Unit Weight (P.C.F.)	113.1	118.5	120.9	122.7	126.3	125.7
	Dry Unit Weight (P.C.F.)	101.0	104.3	105.2	105.2	106.8	106.1
Moisture Content	Tin No.	94	95	96	102	110	114
	Wt. Sample Wet + Tin	253.6	278.0	327.1	285.3	282.6	279.7
	Wt. Sample Dry + Tin	230.2	249.5	289.5	250.1	243.6	231.0
	Wt. Water (gms)	23.2	28.5	37.6	35.2	39.0	48.7
	Wt. Tin Empty	36.4	37.7	32.6	36.9	36.7	36.5
	Wt. Dry Soil	193.8	211.8	251.9	213.2	206.9	194.5
	Moisture Content %	12.0	13.5	14.9	16.5	18.8	25.0



Method of Compaction: Standard Proctor

No. of Layers: 3

Blows per Layer: 25

Ht. of Free Fall: 12 ins.

Wt. of Tamper: 5½ lbs.

Shape of Tamping Face: Circular

Description of Samples: brown sandy clay with mud stones and pebble

Remarks:

SOIL TESTING LABORATORY
e. m. peto associates ltd.
TORONTO, ONTARIO

Job Name: East Otter Creek Bridge
Job No.: 67 P 3 Hole No.: 3 and 4
Sample: 4 & 6-4 & 5 Depth: 4'5' & 5'7' 7'9' & 9'10'
Technician: Date: 9/2/67

e. m. peto associates ltd.

Consulting soil engineers

RECORD OF BOREHOLE NO. 1

JOB NO. 67 [illegible] 3 JOB NAME East Otter Creek Trunk TECHNICIAN [illegible]

BORING DATE 17-18 Jan. CLIENT County of Lambton ENGINEER KSS

GROUND ELEV 590.8 BOREHOLE TYPE 4" Standard TYPED BY HF

DEPTH ELEV	SOIL PROFILE DESCRIPTION	GRAPHIC LOG	SAMPLES NUMBER	SAMPLES TYPE	SAMPLES BLOWS/FOOT	DYNAMIC CONE PENETRATION BLOWS/FOOT / STANDARD PENETRATION TEST BLOWS/FOOT / SHEAR STRENGTH (LB/SQ FT)	LIQUID LIMIT W_L / PLASTIC LIMIT W_p / WATER CONTENT W / W_p W W_L WATER CONTENT %	REMARKS
0'0"								
1'0"	BLACK TOPSOIL							
	Firm yellow gr.brn. silty clay with pebbles APL., WTL		1	SS	7			
5'0"	Stiff gr. brown silty CLAY with pebbles APL		2	SS	14			
			3	SS				
10'0"	Very stiff grey brown silty clay with pebbles, APL to DTPL		4	SS	25			▼ 11'4"
	Firm to stiff grey silty CLAY with few pebbles in places		5	SS	16			Ground water from the sand seam at 40' rose to 11'4"
	APL to WTPL		6	SS	15			
			7	SS				Details of the rate of flow of water are given on the appended water level record sheet
			8	SS	12			
			9	SS	11			
			10	SS	10			
			11	2"TW				
20'0"			12	SS	10			
	Compact dk.gr.medium to coarse SAND, wet		13	SS	15			Fast flowing ground water in the sand layer
25'0"	Firm grey silty clay with pebbles Sandy in places		13A	SS				
			14	SS	12			
	WTPL							

40'0
41'0
to coarse SAND, wet
Firm grey silty clay
with pebbles
Sandy in places
WTPL
18'0
As above but no
pebbles
50'0
WT
78'4
Very silty grey
gravelly CLAY Till
Assumed bedrock
Hole terminated at
79'1" as refusal
occurred at this depth.
13 SS 13
13A SS
14 SS 12
15 SS 13
16 2"
17 SS 9
18 SS 6
19 2"
20 SS 8
21 SS 7
Fast flowing
ground wate
in the sand
layer
Lower water
content due to
fine sand
layers

e.m.peto associates ltd. — Consulting soil engineers

RECORD OF BOREHOLE NO. 2

JOB NO. 67-53 JOB NAME East Otter Creek Project TECHNICIAN J.L.

BORING DATE Jan. 16 & 17, 1967 CLIENT County of Lambton ENGINEER F. S.S.

GROUND ELEV. 595.4 BOREHOLE TYPE 4" Standard TYPED BY J. W.

DEPTH ELEV	DESCRIPTION	LEGEND	SAMPLES NUMBER	SAMPLES TYPE	BLOWS/FOOT
1'0"	Black topsoil				
2'0"	Dark brown silty clay				
	Firm to stiff yellow grey brown mottled silty clay W.T.".L.		1	S.S.	9
5'1"					
	Very stiff grey brown very silty CLAY with pebbles fissured, A.P.L.		2	S.S.	15
			3	2"tw	
9'5"					
	Very stiff grey very silty CLAY with pebbles A.P.L.		4	S.S.	14
			5	S.S.	16
13'6"					
	Stiff grey very silty CLAY A.P.L. to W.T.".L.		6	S.S.	12
			7	2"tw	
			8	S.S.	11
			9	S.S.	12
26'6"	Hole terminated at 26'6"				

DYNAMIC CONE PENETRATION BLOWS/FOOT ——×——
STANDARD PENETRATION TEST BLOWS/FOOT ——·——
10 20 30 40 50
SHEAR STRENGTH C_u LB/SQ FT

LIQUID LIMIT ——— W_L
PLASTIC LIMIT ——— W_P
WATER CONTENT ——— W
W_P W W_L
WATER CONTENT %
10 20 30

60
62
65
72
80
95
115
135
150

REMARKS

▼ 9'10"

Hole was dry on completion Ground water seeped very, very slowly and rose to 9'10" after 3 days.

e.m. peto associates ltd. — Consulting soil engineers

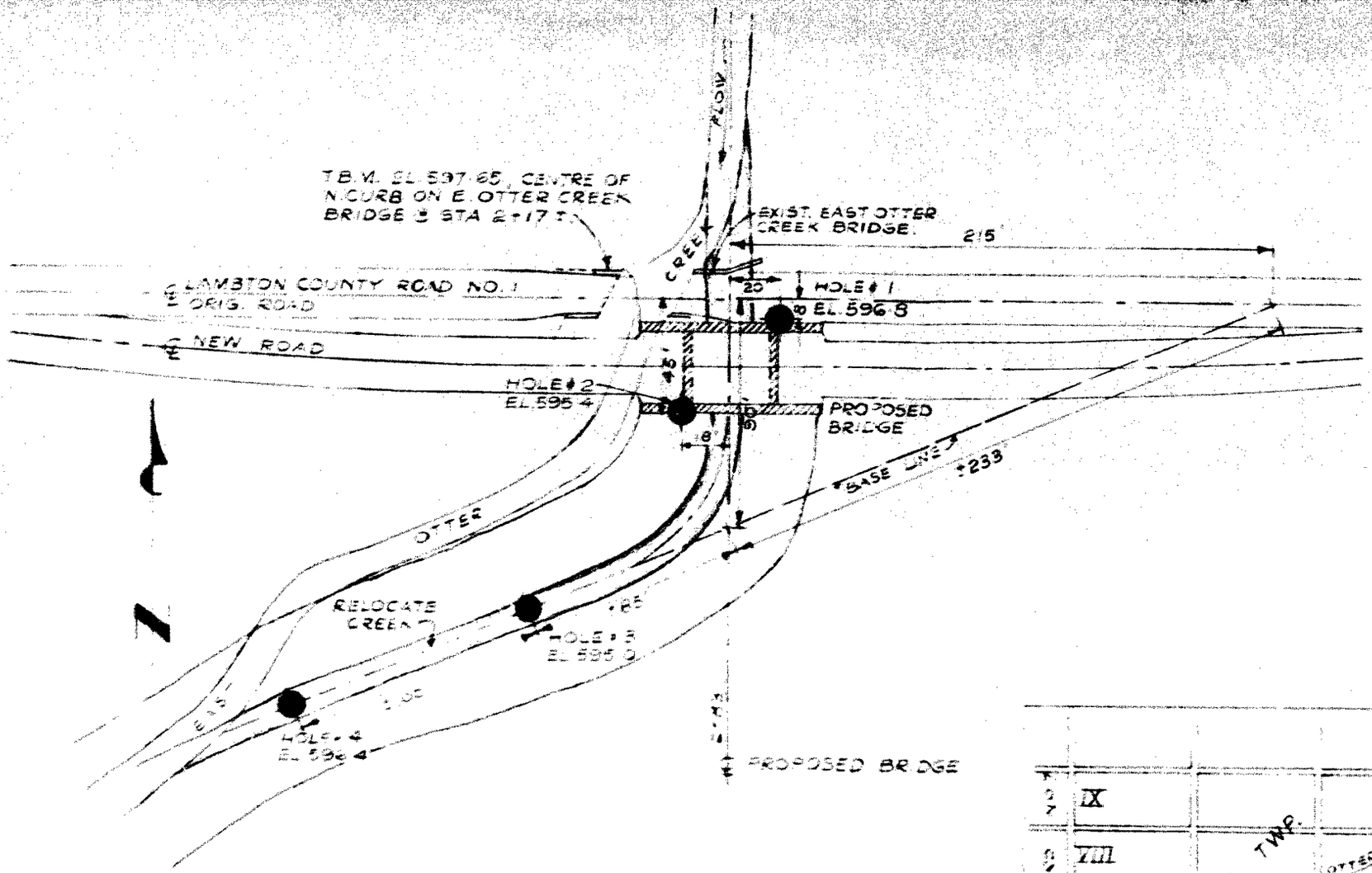
RECORD OF BOREHOLE NO. 3 and 4

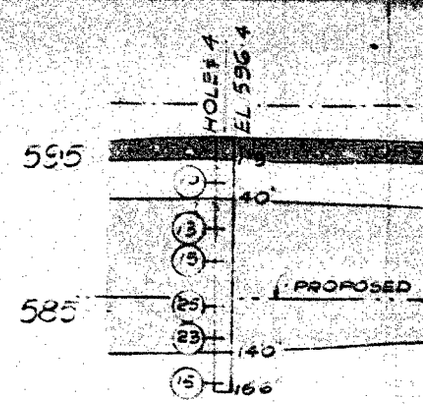
JOB NO. 67 3 3 — JOB NAME Last Otter Creek Bridge — TECHNICIAN JL

BORING DATE 19 Jan 67 — CLIENT County of Haldimand — ENGINEER KBS

GROUND ELEV as shown — BOREHOLE TYPE 4" Standard — TYPED BY HF

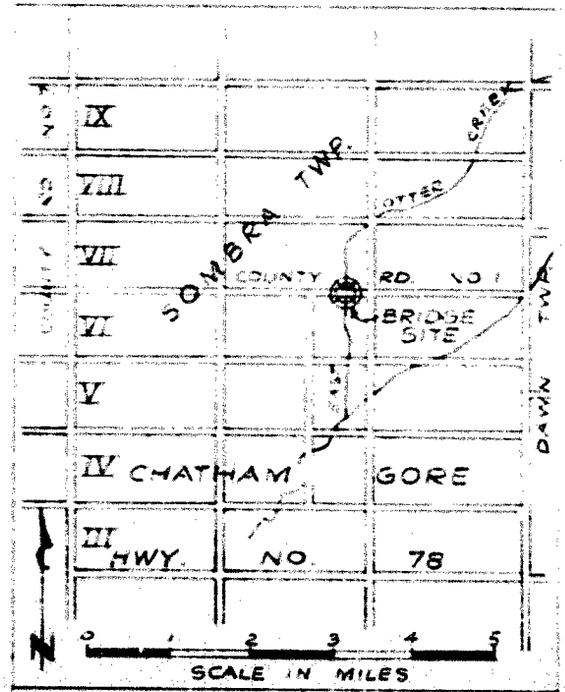
DEPTH ELEV	DESCRIPTION	LEGEND	SAMPLES NUMBER	SAMPLES TYPE	SAMPLES BLOWS/FOOT	DYNAMIC CONE PENETRATION BLOWS/FOOT STANDARD PENETRATION TEST BLOWS/FOOT (10 20 30 40 50) SHEAR STRENGTH C_u LB/SQ FT	LIQUID LIMIT W_L, PLASTIC LIMIT W_p, WATER CONTENT W — W_p W W_L WATER CONTENT % (10 20 30)	REMARKS
0'0"	B.H.#3, EL. 595.9							
0'2"	TOPSOIL							
	Firm to stiff yellow grey brown mottled silty CLAY, WTPL		1 & 2	SS	10			
3'0"			3	1"CS				
			5	SS	18			
	Very stiff grey brown silty CLAY APL		6	CT				
			7	SS	23			
10'0"								
	Very stiff grey silty CLAY, APL		8	SS	26			
13'6"			9	SS	22			
	Hole terminated at 13'6" Hole was dry and open on completion							
	B.H.#4, EL. 596.4							
0'0"								
1'3"	Organic TOPSOIL							
	Firm to stiff yellow gr.brn.mottled silty CLAY with pebbles, WTPL		1	SS	10			
4'0"								
	Very stiff grey brown silty CLAY.APL to DTPL		2	SS	13			
			3	SS	15			
			4	BX				
			6	SS	25			
	Few wet clay seams		7	BX				
			8	SS	23			
			9	BX				
14'0"			10	BX				
	Stiff grey silty CLAY, APL to WTPL		11	SS	15			No wash water was used for boring.
16'6"								
	Hole terminated at 16'6" On completion hole was dry and open							



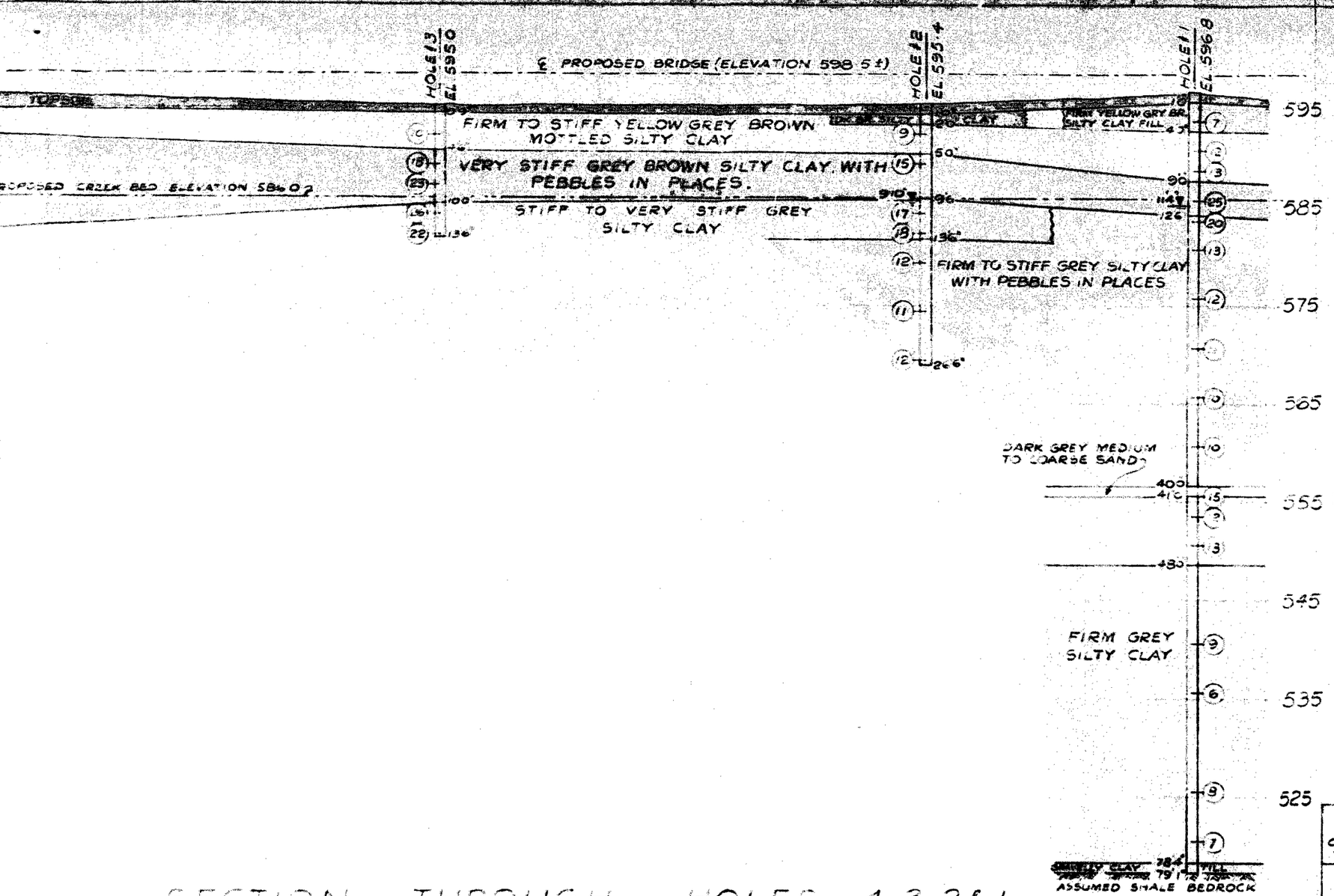


SITE PLAN

SCALE 50' TO 1"



KEY PLAN



LEGEND

- BOREHOLE
- (10)– BLOWS. FT.
- GROUND WATER LEVEL

NOTE: SEE BOREHOLE LOGS FOR COMPLETE SOIL DETAILS

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

SECTION THROUGH HOLES 4.3.2&1

SCALES : HOR. 20'TO 1", VERT. 10'TO 1"

DEFECTS IN NEGATIVE DUE TO CONDITION OF ORIGINAL DOCUMENT

COUNTY OF LAMBTON
℅ TODGHAM & CASE LTD., CONSULTING CIVIL ENGINEER

EAST OTTER CREEK BRIDGE

PREPARED BY:
e.m.peto associates ltd.

JOB NO	DATE	DWN. BY:	CHECKED BY:
67-F3	FEBRUARY 1967	K	K.S.S.