OFFICE LOCATION —
DOWNSVIEW AVE.
KEELE ST. — HIGHWAY 401
TORONTO, ONTARIO.

ONTARIO
DEPARTMENT OF HIGHWAYS

POSTAL ADDRESS:
DEPARTMENT OF HIGHWAYS
PARLIAMENT BUILDINGS
TORONTO 5, ONTARIO

January 16, 1962.

Memorandum to Mr. A. Stermac,
Principal Foundation Engineer,
Materials and Research Section,
Dept. of Highways,
Downsview.

Re: Township of Metcalfe
Rowe Bridge,
Lot 3, Con. XII/XIII.

We are enclosing herewith a copy of the Foundation Report, by Dominion Soils Investigation Limited, for your information.

We have given preliminary approval for a single 45 foot span prestressed "T" unit supported on concrete abutments having 11 foot wide footings. Footings are founded at elevation 85 approximately and we have recommended lowering them further to protect against scour.

K. L. KLEINSTEIBER
MUNICIPAL BRIDGE LIAISON ENGINEER.

Encl.
KLK*DW.

MR. A. M. SPRIET
CONSULTING ENGINEER
234 QUEENS AVENUE
LONDON ONTARIO

Report on

SOIL INVESTIGATION

for

TOWNSHIP ROAD BRIDGE
(Lot 2, 3, Concession XII, XIII)
TOWNSHIP OF METCALFE

by

DOMINION SOIL INVESTIGATION LIMITED
363 Queens Avenue
LONDON ONTARIO

Reference No. 1-8-L5

October, 1961

CONTENTS

ENCLOSURES

INTRODUCTION

In accordance with verbal authorization from Mr. A. M. Spriet, a soil investigation has been carried out at the site of an existing road bridge in Metcalfe Township, which is to be replaced with a new structure. The present bridge which carries a township road across Steer Creek (Government Drain No. 1) has a span of 44 feet and a width of 16 feet.

The purpose of the investigation was to reveal the subsurface conditions and determine the necessary soil properties for the design and construction of foundations.

I. DESCRIPTION OF SITE AND GEOLOGY

The site is located in a flat agricultural region about 6 miles south-west of Strathroy. It is on the border of the Ekfrid Clay Plain which extends to the west and south, and was apparently deposited by the early glacial Lake Whittlesey. The creek flows slowly north-west to join the east branch of the Sydenham River.

Drilling was carried out following a weekend of heavy rain, and the water level in the creek was as shown on Enclosure 1. Local reports, however, state that in times of flood it reaches as high as the underside of the steel-work on the bridge.

II. FIELD WORK

Field work was carried out during the period 28th to 30th of August, 1961 and consisted of 2 boreholes at the locations shown on enclosure 1. Dynamic cone penetration tests were made adjacent to each borehole. The holes were advanced by wash boring and lined with Bx casing, and Standard Penetration Tests were made at frequent intervals using a 2 inch O.D. split spoon. A constant driving energy was employed in the Standard Penetration and dynamic cone tests using a 140 pound hammer dropping 30 inches. The former test provided disturbed samples of the strata and the latter a continuous record of soil density.

Undisturbed samples were recovered in 2 inch diameter thin-walled Shelby tubes, and vane shear tests (2 inch vane) were made to determine the insitu and remoulded shear strength.

A record of the field test results is presented on data sheets comprising enclosures 2 and 3. Elevations have been referred to the top of a steel bearing plate on the north east abutment of the existing bridge which has been assigned the arbitrary elevation 100.00 feet.

III. SUBSURFACE CONDITIONS

A subsurface profile is shown on enclosure 1, and a more detailed description of the stratification on enclosures 2 and 3.

For a depth of 11 feet in borehole 1 and 9 feet 6 inches in borehole 2, there are layers of silt, fine sand and organics in a loose condition. Below these layers and throughout the remaining depth explored, the soil is a stiff grey clay containing seams and pockets of grey silt. The silt seams

were most prevalent in borehole 2 above a depth of 15 feet.

Ground water was encountered in both holes at a level corresponding to that in the creek. i.e. el. 93.75 ft.

IV. LABORATORY TESTS

Laboratory tests have been performed on samples of the clay stratum as follows:

(a) Atterberg limits to assess behaviour and for precise classifications.

(b) Unconfined Compression tests to determine shear strength.

(c) Consolidation tests to provide data for settlement calculations.

The test results are summarized below:

Atterberg Limits

Borehole No.	1	1	2	2
Sample No.	6	8	4	7
Liquid limit (%)	31	35	31	38
Plastic limit (%)	28	24	22	25
Natural Moisture (%)	22	27	24	23
Plasticity index	3	11	9	13
Liquidity index	-2.0	0.3	0.2	-0.9

The presence of silt pockets has created some scatter in the above results but the soil can be described as a silty clay of low plasticity.

Unconfined Compression Tests

Borehole No.	1	1	2	2
Sample No.	6	8	4	7
Depth (feet)	16	21	17	27
El. (feet)	80	75	80	70
Unit weight (p.c.f.)	121	122	126	123
Void Ratio	0.66	0.67	0.63	0.67
Natural moisture (%)	22	23	22	22
Unconfined compression strength (T.S.F.)	1.58	1.68	1.80	1.77

The results of consolidation tests on borehole 1 sample 6 and borehole 2 sample 4 are shown on enclosures 4 and 5.

The pressure-void ratio curves for these two tests show similar shapes and preconsolidation loads, but the range of void ratio covered, and the values obtained for coefficient of consolidation are substantially different. Because the initial void ratio e_o for borehole 2 sample 4 corresponds more closely to the values measured for the unconfined compression test specimens, and because the curve for coefficient of consolidation is of a more conventional shape, it is concluded that the results from this test are more reliable than those for borehole 1 sample 6. (The use of test results from the latter sample would lead to an increase of approximately 30% in the calculated consolidation settlement.

V. BEARING CAPACITY AND SETTLEMENT

The clay layer in boreholes 1 and 2 was encountered at elevations 85.0 and 87.5 feet respectively. The footings for the bridge should be located just below the top of this layer, and for the purpose of calculation it is assumed that the footing elevation will be 85.0 feet.

The dead load to be carried by the footings will be in the range of 15,000 pounds per lineal foot and the total length of the footing is assumed to be 28 feet. The ultimate bearing capacity of the clay has been calculated according to Meverhof, and assuming a value for cohesion c = 1600 p.s.f. This gives

Width of footing	Ultimate bearing capacity g_d (p.s.f.)	Maximum Allowable Soil pressure $\frac{g_d}{3}$ (p.s.f.)
4 feet	13,900	4,633
5 feet	13,300	4,433

To limit settlements to a tolerable amount a width of 5 feet is recommended giving an average soil pressure of 3000 p.s.f. which is well within the above values.

Settlement will be made up of two parts; immediate settlement due to the elastic deflection of the soil when the load is applied, and consolidation settlement resulting from the gradual expulsion of pore water. A value for the modulus of elasticity E of 168 tons per square foot has been deduced from measurements made during the consolidation tests. The resulting immediate settlement according to different theories (Steinbrenner and Timoshenko) is expected to be in the range 0.5 to 1.0 inches.

The distribution of vertical stress below the characteristic point (as defined by Kany viz. 0.74 a/2, 0.74 b/2 from

centre of rectangle with sides a and b) has been calculated by Steinbrenner's method and the resulting consolidation settlement calculated from the test result on borehole 2 sample 4. A value of 1.62 inches is obtained. Applying to this the Skempton-Bierrum correction factor modified by Wood, the estimated total settlement is expected to be in the region of 0.5 inches. * (consolidation settlement)

The calculated time periods for 50% and 90% consolidation are

	Days
50%	120
90%	840

In view of the uniform subsurface conditions and the relatively small values of calculated total settlement, no appreciable differential settlement is envisaged.

VI. CONSTRUCTION

No unusual construction problems are envisaged. It is suggested that the creek might be carried through a temporary culvert. The soft soil overlying the clay will require bracing, and probably the most effective procedure will be to surround the excavation with sheet piles driven into the clay.

Attention should be given to the presence of silt seams, especially under the east abutment. The borings indicated that these might only be 1 or 2 inches thick, and may be pockets rather than continuous strata. Whatever the condition, the footing grade must not include areas of non-cohesive silt. Such material must be cut out and if necessary the excavation taken deeper.

VII. SUMMARY

1. The strata consist of a loose deposit of sand, silt and organics approximately 10 feet deep, overlying a stiff grey clay.

2. Laboratory tests have shown that the latter material

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* The clay has an overconsolidation ratio of 7 or 8. Accordingly it has been assumed that the pore pressure coefficient "A" is not greater than zero. See reference 7.

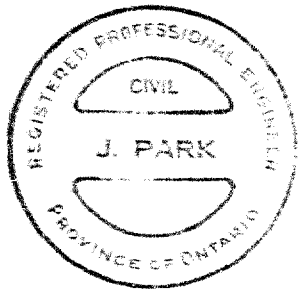
is a silty clay of low plasticity, with an unconfined compressive strength in the region of 1.6 to 1.8 T.S.F.

3. It is recommended that the structure be carried on spread footings 5 feet wide, causing a soil pressure of approximately 3000 p.s.f. and resulting in a safety factor in excess of 3 against shear failure.

4. It is estimated that under the above loading the immediate settlement will be approximately 0.5 inch and the consolidation settlement a similar amount. No appreciable differential settlement is expected. The calculated time periods for 50% and 90% consolidation are 120 days and 840 days respectively.

5. No unusual construction problems are envisaged.

DOMINION SOIL INVESTIGATION LTD.,



James Park, M.Sc., P. Eng.

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2. Procedures for Testing Soils. ASTM. April, 1958. p.p. 186 to 198. (Unified Soil Classification System - by A. A. Wagner)

3. Terzaghi and Peck: Soil Mechanics in Engineering Practice. John Wiley and Sons, New York 1948

4. Karl Terzaghi: Theoretical Soil Mechanics. John Wiley and Sons, New York, 1943.

5. The Ultimate Bearing Capacity of Foundations by G.G. Meyerhof Geotechnique, Vol. II. 1950 and 1951.

6. A Contribution to The Settlement Analysis of Foundations on Clay by A. W. Skempton and L. Byerrum - Geotechnique VII. (1957) and Amendment thereto by A. M. Muir Wood (Correspondence. Geotechnique Vol. IX)

7. The Measurement of Soil Properties in the Triaxial Test. By Bishop and Henkel. London. 1957.

8. Theory of Elasticity. By S. Timoshenko and J.N. Goodier. McGraw-Hill Book Co. 1951.

OUR REFERENCE NO. 1-8-L5

GEOTECHNICAL DATA SHEET FOR BOREHOLE 1

CLIENT: MR. A.M. SPRIET
PROJECT: ROAD BRIDGE
LOCATION: SEE ENCLOSURE N° 1
DATUM ELEVATION: STEEL PLATE TOP OF N.E. ABUTMENT EL 100-0'

METHOD OF BORING: HAND AUGER 12'0" & WASH BORING
DIAMETER OF BOREHOLE: Bx (2 7/8 INCH.)
DATE: 28/29 AUG. 1961

ENCLOSURE NO. 2

ELEVATION ft.	DEPTH ft.	STRATIFICATION DESCRIPTION	STRATIFICATION SYMBOL	SAMPLES NUMBER	SAMPLES TYPE	SAMPLES Penetration of Sampler	PENETRATION RESISTANCE blows per foot	SHEAR STRENGTH (UNCONFINED) lbs/sq ft	CONSISTENCY water content % PL W LL	REMARKS
96.9	0	SANDY ORGANIC SILT		1	SS	2				▽ W.L. EL 93.75' 29 AUG 61
				2	SS	6				
90	5	FINE BROWN SILTY SAND		3	SS	2				
		FINE BLUE-GREY SILTY SAND ORGANICS WOOD FRAGMENTS		4	SS	3				
	10			5	SS	11				
					VANE					
80	15			6	TW					CONSOLIDATION TEST ON SAMPLE 6
				7	SS	15				
					VANE					
	20			8	TW					
				9	SS	13				
		GREY SILTY CLAY			VANE					
	25			10	TW					
70				11	SS	17				
					VANE					
	30			12	TW					
				13	SS	15				
					VANE					
	35			14	TW					
60				15	SS	17				
					VANE					
	40			16	SS	16				
		END OF BOREHOLE								

LEGEND

SS DENOTES SPLIT SPOON (DISTURBED) SAMPLE

TW DENOTES THIN WALLED SHELBY TUBE UNDISTURBED SAMPLE

VANE ⊕ DENOTES INSITU VANE SHEAR TEST

● DENOTES UNCONFINED COMPRESSION TEST RESULT

VERTICAL SCALE: 1 IN. TO 5 FT.

DOMINION SOIL INVESTIGATION LIMITED

MADE: J.T. CHD: J.B.

GEOTECHNICAL DATA SHEET FOR BOREHOLE 2

OUR REFERENCE NO. 1-B-65

CLIENT: MR. D.M. SPRIET
PROJECT: ROAD BRIDGE
LOCATION: SEE ENCLOSURE #1
DATUM ELEVATION: STEEL PLATE TOP OF N.E. ABUTMENT EL 100.0'

METHODE OF BORING & WASH BORING: HAND AUGER 3.5"
DIAMETER OF BOREHOLE: BX 2 7/8" O.D.
DATE: 29-30 AUG. 1965

ENCLOSURE NO. 3

ELEVATION ft.	DEPTH ft.	STRATIFICATION DESCRIPTION	STRATIFICATION SYMBOL	SAMPLES: NUMBER	SAMPLES: TYPE	SAMPLES: No. BLOWS/FT. OR RECOVERY % OF SAMPLE	PENETRATION RESISTANCE: Blows per foot (20, 40, 60, 80, 100+)	SHEAR STRENGTH (COHESION) lbs/sq.ft. (0, 1000, 2000, 3000, 4000)	CONSISTENCY: water content % (PL, W, LL; 10, 20, 30, 40)	REMARKS
96.5	0	FINE BROWN SAND SILT & ORGANICS								
90	5	FINE BLUE-GREY SAND SILT & ORGANICS		1	SS	5				
	10			2	SS	9				
					VANE					
	15	SILT SEAMS		3	SS	9				
					VANE					
80				4	TW					CONSOLIDATION TEST ON SAMPLE 4
	20			5	SS	11				
					VANE					
		GREY SILTY CLAY		6	SS	12				
	25				VANE					
70				7	TW					
				8	SS	10				
	30				VANE					
				9	SS	13				
	35				VANE					
60				10	SS	15				
	40	END OF BOREHOLE								

LEGEND

SEE ENCLOSURE #2

VERTICAL SCALE: 1 IN. TO 5 FT.

DOMINION SOIL INVESTIGATION LIMITED

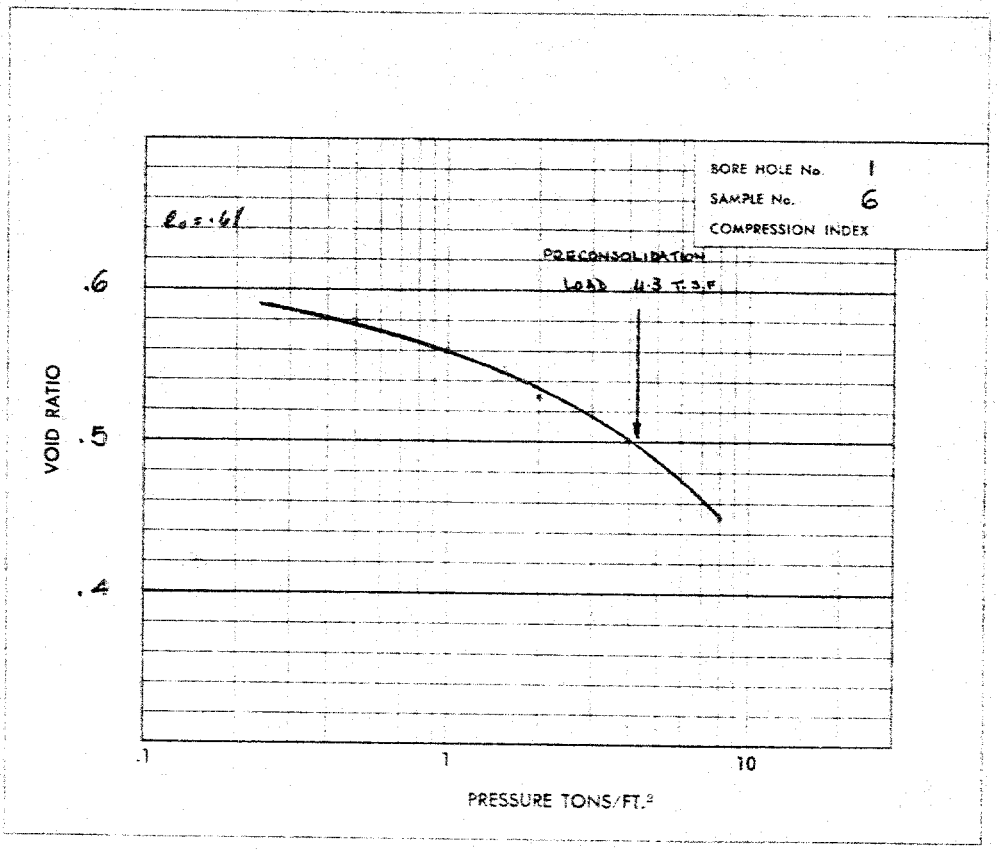
MADE J.T. CH'D. J.P.

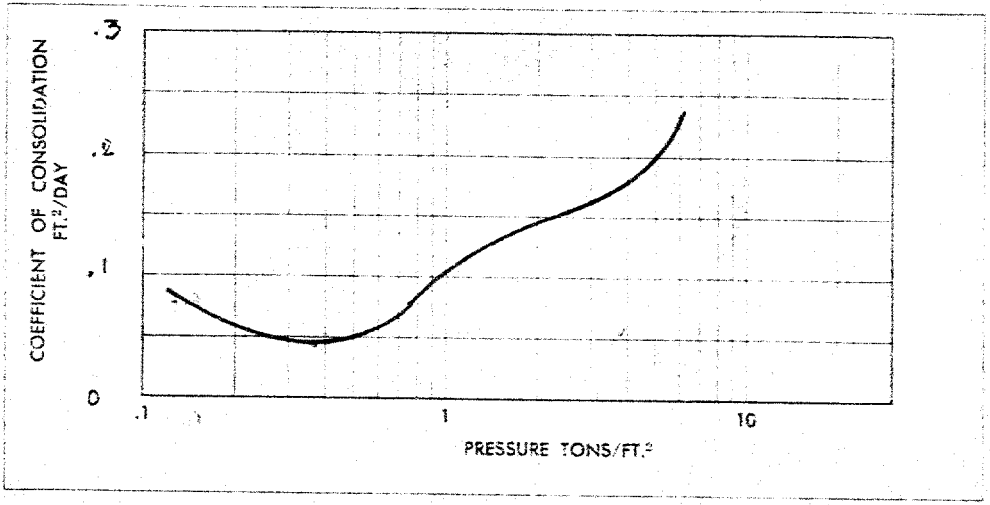
Order No. 1-8-L 5

Enclosure No. 4

Dominion Soil Investigation Ltd.

CONSOLIDATION TEST



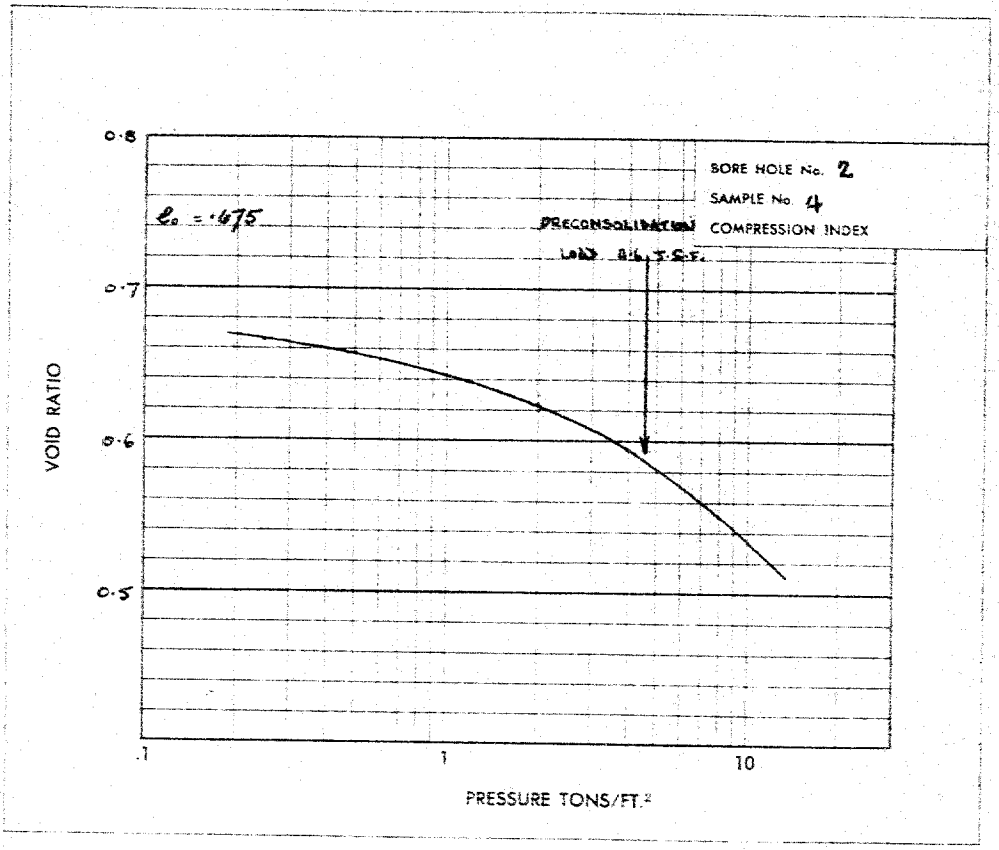


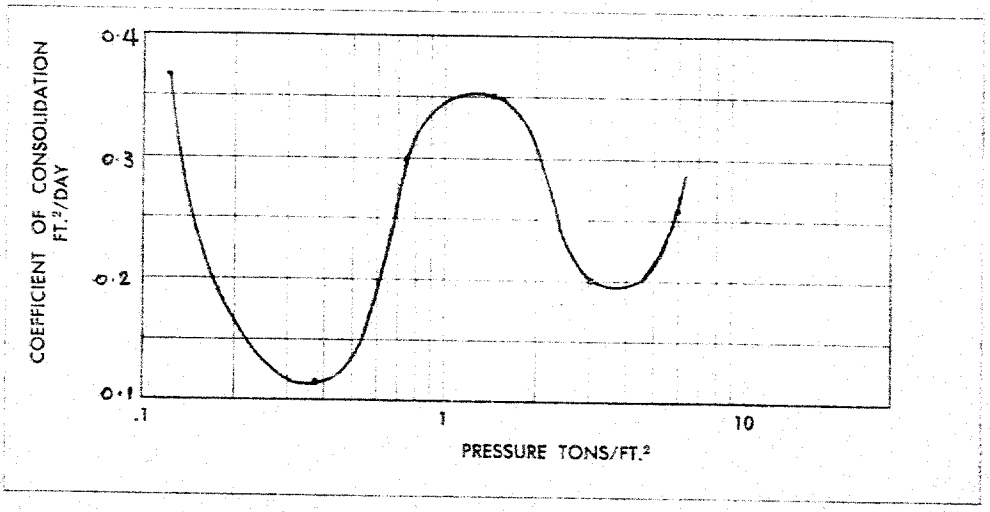
Order No. 1-8-L5

Enclosure No. 5

Dominion Soil Investigation Ltd.

CONSOLIDATION TEST





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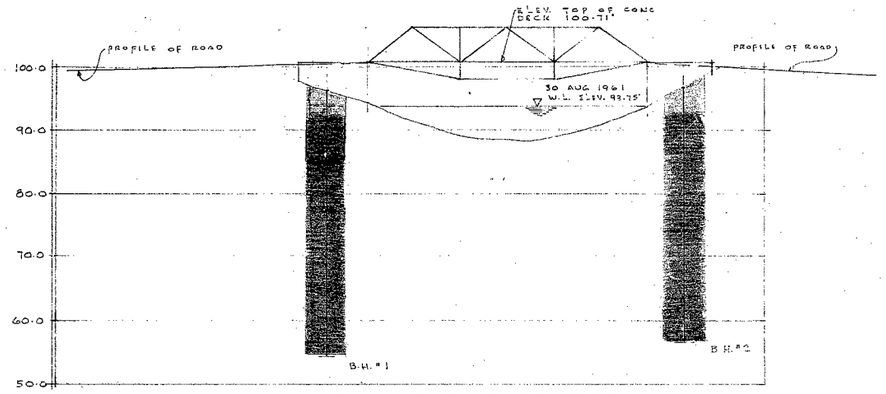
ROWE BRIDGE

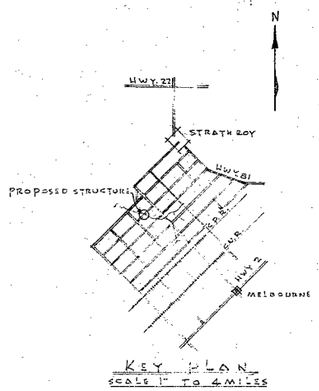
LOT 3. CON. XII/XIII

METCALFE

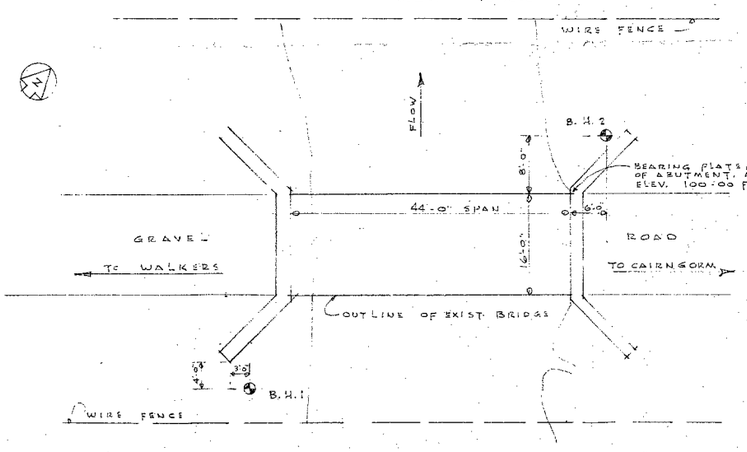
TWP.



SUB SURFACE PROFILE
SCALE 1" TO 10'-0"



KEY PLAN
SCALE 1" TO 4 MILES



LOCATION PLAN
SCALE 1" TO 10'-0"

LEGEND

- FINE BROWN SAND, SILT & ORGANICS
- FINE BLUE-GREY SAND, SILT & ORGANICS
- GREY SILTY CLAY

ENCLOSURE NO. 1	MR. A. M. SPRIET - CONSULTING ENGINEER LONDON ONTARIO
REF. 1-B.L5	SOIL INVESTIGATION
AUG. 1961	FOR TOWNSHIP ROAD BRIDGE TOWNSHIP OF METCALFE
DRAWN BY J.T.	DOMINION SOIL INVESTIGATION LIMITED
CHECKED BY J.R.	LONDON 363 QUEENS AVE ONTARIO