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BRIDGE #12

LOT 1, CONS. 3/4

METCALFE TWP.

A. M. SPRIET AND ASSOCIATES LTD
CONSULTING ENGINEERS
264 WELLINGTON STREET
LONDON ONTARIO

67 A-265 K

Report on

SOIL INVESTIGATION

for

BRIDGE NO 12

LOT 1, CONCESSIONS 3 & 4

TOWNSHIP OF METCALFE

by

DOMINION SOIL INVESTIGATION LIMITED
369 Queens Avenue
LONDON ONTARIO

Reference No. 7-2-L3
February 28th, 1967.

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ENCLOSURES

SUMMARY

The two boreholes revealed the following general ground succession:- topsoil or road ballast (6 to 9 inches thick); stiff silty clay fill (6'-9" to 7'-0" thick); compact silty sandy gravel (2'-0" to 3'-0" thick); and very stiff to hard silty clay till (maximum penetrated 17'-0").

It is recommended that the structure be supported on spread footing foundations at or below El. 89, using a maximum net soil pressure of 5000 p.s.f. Total settlement is estimated to be less than 1-inch.

Construction problems are discussed.

I INTRODUCTION

Verbal authorization was received from A. M. Spriet & Associates Limited, Consulting Engineers, on February 7, 1967, to carry out a soil investigation at a site in the Township of Metcalfe where it is proposed to replace an existing road bridge with a new structure.

The existing concrete structure is located on Lot I, Concessions 3 and 4 of the Township, where the road crosses a creek which eventually flows into the Sydenham River.

It is understood that the proposed structure is a concrete rigid frame with about a 40 foot span and that the longitudinal centre line will be the same as the existing bridge. Also, the transverse centre line of the proposed bridge will be moved about 100 feet to the east of the transverse centre line of the existing bridge. The requirements of the project were discussed with Mr. A. M. Spriet, P. Eng., who supplied the foregoing information.

The purpose of this investigation was to reveal the subsurface conditions at the site and to determine the relevant soil properties for the design and construction of the new foundations.

II THE GEOLOGY OF THE SITE

The site lies in the physiographic region known as the Ekfrid Clay Plain which lies west and south of the Caradoc Sand Plain. The soil profile generally consists of pale greyish-brown clay

which is strongly calcareous, due largely to limestone from the Norfolk formation. Occasionally knolls or low smooth ridges of sand and gravel are superimposed on the clay.

III FIELD WORK

The field work, consisting of 2 boreholes, was carried out on February 13 and 14, 1967, at the locations shown on Enclosure 2. The boreholes were advanced to the sampling depths by washboring methods and were lined with Bx size casing.

Standard penetration tests were carried out at frequent intervals of depth, as detailed on Appendix 'A', and the results are recorded on the Geotechnical Data Sheets as 'N' values.

Dynamic cone penetration tests were performed adjacent to each borehole location to obtain an indication of soil density changes with depth. The same source of energy was used to drive the cone as was used for the standard penetration test.

Elevations were referred to a benchmark which was established at the time to field work was carried out (Spike in 6-inch diameter tree, indicated on Enclosure 2, El. 100 feet).

IV SUBUSRFACE CONDITIONS

Detailed descriptions of the strata encountered in each borehole are given on the Geotechnical Data Sheets, comprising Enclosures 3 and 4, and a general picture of the soil stratigraphy is given in the form of a Subsurface Profile on Enclosure 2.

The boreholes revealed the following general ground succession:-

		Thickness
(a)	Topsoil or Road Ballast	0'- 6" to 0'- 9"
(b)	Brown weathered silty clay fill associated with the construction of the approaches to the existing bridge. The consistency of the clay is described as 'stiff' as indicated by 'N' values ranging from 5 to 9 blows per foot.	6'- 9" to 7'- 0"
(c)	Brown silty sandy gravel. Based on the dynamic cone penetration test results of about 20 blows per foot through this stratum, it is estimated that the relative density may be described as 'compact'.	2'- 0" to 3'- 0"
(d)	Grey silty clay. Below El. 84 the stratum is stratified and contains thin layers of fine sand. The consistency of the clay is described as 'very stiff' to 'hard' as indicated by 'N' values ranging from 16 to 35 blows per foot.	Maximum penetrated 17'- 0"

V LABORATORY TESTS

Atterberg Limit and moisture content tests were carried out on 2 samples of the silty clay stratum as a means of classification and as a guide to the probable behaviour of the soil. These tests gave values of Liquid Limit of 32% and 36%; Plastic Limit of 15% and 16% and Plasticity Index of 17 and 20, indicating that the

soil is a clay of low to medium plasticity and compressibility. The Liquidity Indices which relate the natural moisture content of the clay to the Atterberg Limits were 0.20 and 0.29, indicating a 'stiff' consistency.

VI GROUNDWATER CONDITIONS

The average water level observed in the boreholes after completion of the field work was El. 97.6, which was 2'-6" above the ice level in the adjacent creek at the time the field work was carried out.

VII DISCUSSION AND RECOMMENDATIONS

The natural subsoil below El. 91 consists of very stiff silty clay till which will be suitable for the use of spread footing foundations.

The bed of the creek extends to El. 93, therefore allowing 4 feet of soil cover for frost protection it is recommended that the footings should bear at or below El. 89. The footing depth should be decided after a hydrological study has been made to determine the maximum depth of scour. This level lies within the stratum of very stiff silty clay till, and on the basis of the borehole results a maximum net soil pressure of 5000 pounds per square foot is appropriate for the design of footings. A safety factor of 3 against general shear failure of the underlying soil is incorporated in the recommended soil pressure.

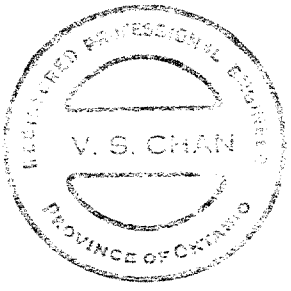
It is estimated that the total settlement will not exceed 1-inch, and in view of the similar conditions encountered in the two boreholes, no appreciable differential settlement is anticipated.

The adhesion between the footings and the silty clay may be taken as 1500 p.s.f. and the factor of safety against horizontal sliding of the abutments should be at least 1.5.

The very stiff silty clay stratum will present no unusual construction problems. However, excavations through the silty sandy gravel stratum below the water table will require lateral support, or alternatively, construction of an impervious dyke to prevent a flow of soil and water into the excavation.

Yours very truly,

DOMINION SOIL INVESTIGATION LIMITED



Victor S. Chan, P. Eng.,
Project Engineer

C.O.W. Atkinson, M.Sc., P. Eng.,
Branch Manager

VSC:jms

APPENDIX A

STANDARD PENETRATION TESTS

In order to determine the relative density of non-cohesive soils, such as sands and gravels, the standard penetration test has been adopted. The test also gives an indication of the consistency of cohesive soils.

A two-inch external diameter thick-walled sample tube is driven into the ground at the bottom of the borehole by means of a 140 lb. hammer falling freely through 30 in. The tube is first driven an initial 6 in. to allow for the presence of disturbed material at the bottom of the borehole. The number of standard blows (N) required to drive the sampler a further 12 in. is recorded. The sample tube used is one originally developed by the Raymond Concrete Pile Company in the United States, where a sufficient number of tests have been made in conjunction with field investigations to show that the results, although essentially empirical, may be applied to foundation design.

For sands:

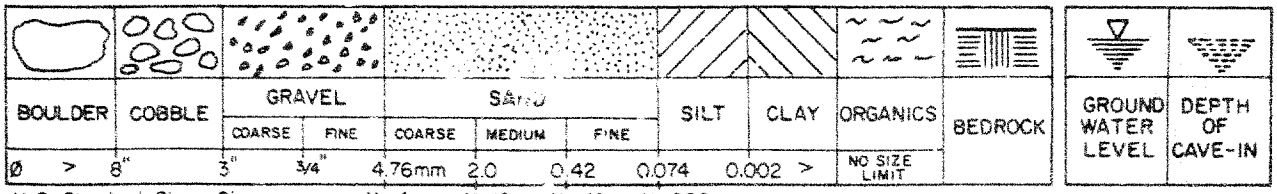
Values of N	Density
Less than 10	Loose
Between 10 and 30	Compact
Between 30 and 50	Dense
Greater than 50	Very dense

Enclosures

Enclosure No. 1.

LIST OF SYMBOLS, ABBREVIATIONS AND NOMENCLATURE.

SOIL COMPONENTS AND GROUND WATER CONDITIONS.



SAMPLE TYPES.

AS	Auger sample	RC	Rock core	TP	Piston, thin walled tube sample
CS	Sample from casing	%	Recovery	TW	Open, thin walled tube sample
ChS	Chunk sample	SS	Split spoon sample	WS	Wash sample

SAMPLER ADVANCED BY static weight : w
" pressure : p
" tapping : t

OBSERVATIONS MADE WHILE CORING — Steady pressure; No pressure; Intermittent pressure

Washwater returns; Washwater lost

PENETRATION RESISTANCES.

DYNAMIC PENETRATION RESISTANCE : to drive a 2"ø, 60° cone attached to the end of the drilling rods into the ground, expressed in blows per foot

STANDARD PENETRATION RESISTANCE, -N- : to drive a 2" outside dia, split spoon sampler 1 foot into the ground, expressed in blows per foot.

SYMBOL :

EXTRAPOLATED -N- VALUE

The energy for the penetration resistances is supplied by a 140 lb. hammer falling 30 inches

SOIL PROPERTIES.

W %	Water content	γ	Natural bulk density (unit weight)	k	Coeff. of permeability
LL %	Liquid limit	e	Void ratio	C	Shear strength — in terms of total stress
PL %	Plastic limit	RD	Relative density	ϕ	Angle of int. friction — in terms of total stress
PI %	Plasticity index	C_v	Coeff. of consolidation	C'	Cohesion — in terms of effective stress
LI	Liquidity index	m_v	Coeff. of volume compressibility	ϕ'	Angle of int. friction — in terms of effective stress

UNDRAINED SHEAR STRENGTH.

— DERIVED FROM —

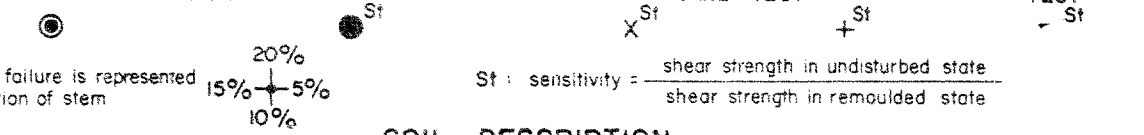
TRIAXIAL COMPRESSION TEST

UNCONFINED TEST

LABORATORY VANE TEST

FIELD VANE TEST

POCKET PENETROMETER TEST



Strain at failure is represented by direction of stem

St : sensitivity = $\frac{\text{shear strength in undisturbed state}}{\text{shear strength in remoulded state}}$

SOIL DESCRIPTION.

COHESIONLESS SOILS :	RD :	COHESIVE SOILS :	C lbs/sq ft.
Very loose	0 – 15 %	Very soft	less than 250
Loose	15 – 35 %	Soft	250 – 500
Compact	35 – 65 %	Firm	500 – 1000
Dense	65 – 85 %	Stiff	1000 – 2000
Very dense	85 – 100 %	Very stiff	2000 – 4000
		Hard	over 4000

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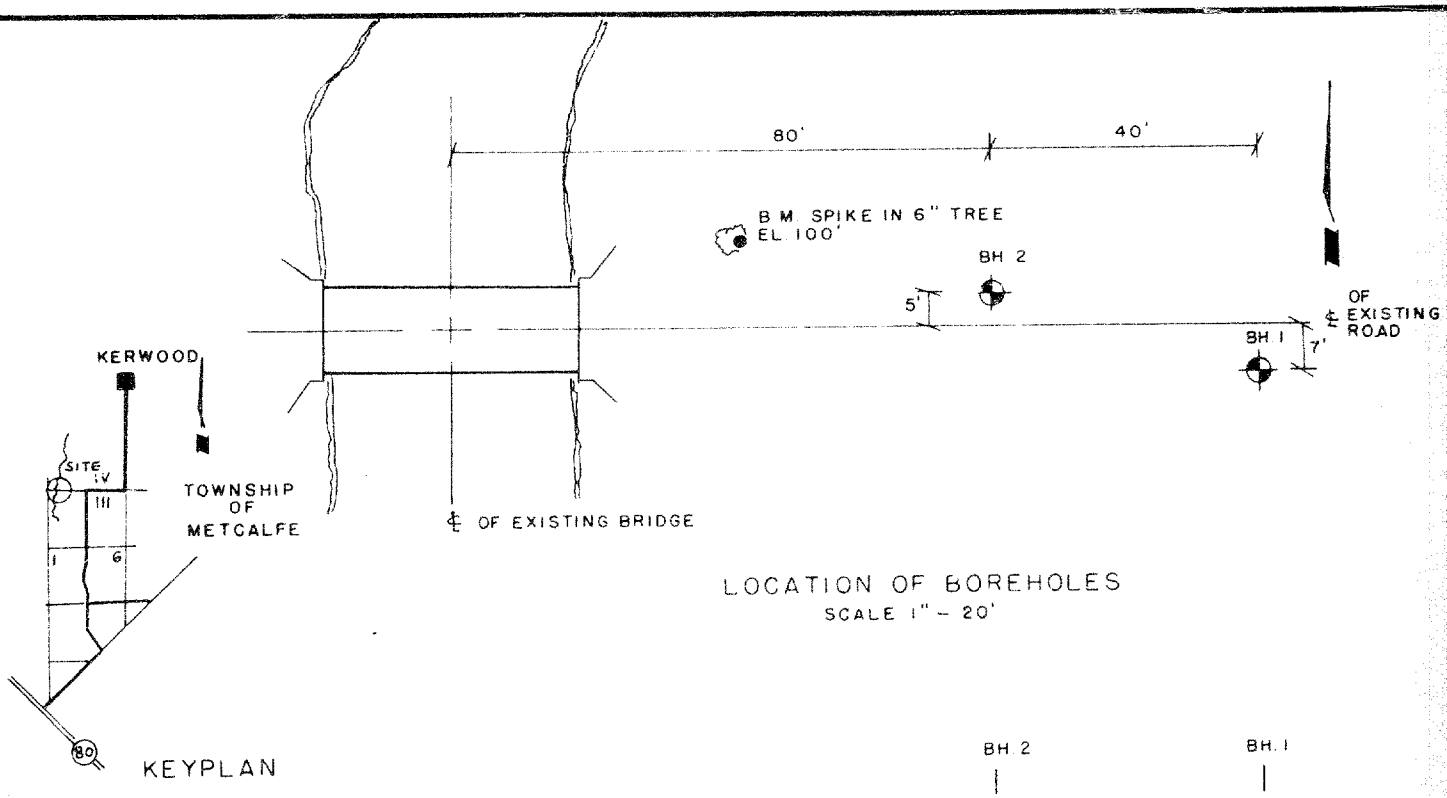
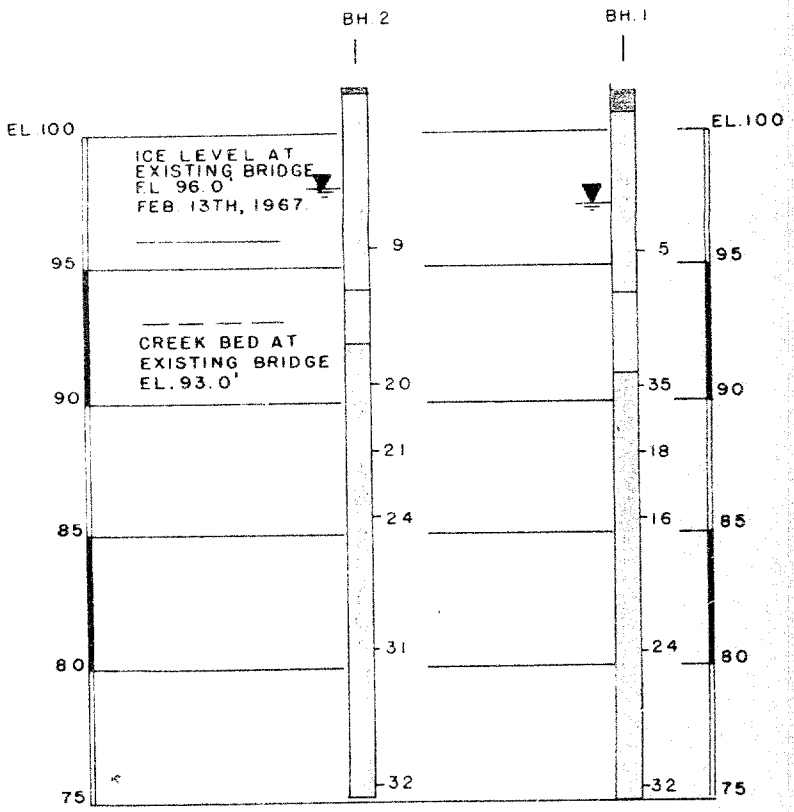


LOCATION OF BOREHOLES
SCALE 1" – 20'

KEYPLAN

LEGEND

- TOPSOIL OR ROAD BALLAST
- COMPACT SILTY SANDY GRAVEL
- VERY STIFF TO HARD SILTY CLAY
- SILTY CLAY, FILL



SUBSURFACE PROFILE
VERT SCALE 1"–5'

GEOTECHNICAL DATA SHEET FOR BOREHOLE . 1 . . .

OUR REFERENCE NO. 7-2-13

CLIENT A. M. Soriet & Associates
PROJ. Proposed Bridge
LOCATION Lot 1, Cons 3 & 4, Twp. of Metcalfe
DATUM ELEVATION 100 feet Spike in Tree (See enclosure 2)

METHOD OF BORING Sonic Boring
DIAMETER OF BOREHOLE 3x (4-inch)
DATE February 15, 1967

ENCLOSURE NO. 3

ELEVATION ft	DEPTH ft	STRATIFICATION DESCRIPTION	STRATIFICATION SYMBOL	SAMPLES NUMBER	SAMPLES TYPE	SAMPLES N VALUE OR RQD %	REMARKS
101.5	0.0	Ground Surface					
	0.8	Topsoil					
100		Stiff brown weathered silty clay		1	SS	5	2" diameter cone
95	7.5	Compact brown silty sandy gravel		2	SS	35	W. L. El. 97.3' Feb 14/67
	10.5			3	SS	18	
90		Very stiff to hard grey fine sand layers silty clay		4	SS	10	
85				5	SS	24	
80							
75	26.5			6	SS	32	
		End of Borehole					

VERTICAL SCALE: 1 IN TO 5 FT

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GEOTECHNICAL DATA SHEET FOR BOREHOLE . 2 . . . .

OUR REFERENCE NO. 7-2-63

CLIENT A. M. Sprict & Associates
PROJECT Proposed Bridge
LOCATION Lot 1, Cones 3 & 4, Twp. of Metcalfe
DATUM ELEVATION 100 feet Spike in Tree (See enclosure 2)

METHOD OF BORING Washboring
DIAMETER OF BOREHOLE 8x (3-inch)
DATE February 14, 1967

ENCLOSURE NO. 4

ELEVATION ft	DEPTH ft	STRATIFICATION DESCRIPTION	STRATIFICATION SYMBOL	SAMPLES NUMBER	SAMPLES TYPE	SAMPLES No. of Advancement of Sampler	PENETRATION RESISTANCE Blows per foot 20 40 60 80 100	SHEAR STRENGTH lbs/sq ft	CONSISTENCY Water content % P W L 10 20 30 40	REMARKS
101.7	0.0	Ground Surface								
	0.5	Road Ballast								
100		Stiff brown weathered silty clay		1	SS	9				W. L. El. 97.9 Feb. 14/67
95	7.5	Compact brown silty sand gravel								
	9.5	Very stiff to hard grey silty clay fine sand layers		2	SS	20				
90				3	SS	21				
				4	SS	24				
85				5	SS	31				
80				6	SS	32				
	26.5	End of Borehole								
75										

2" diameter cone

VERTICAL SCALE 1 IN TO 5 ft

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