67-F-233M

LOTS 15 & 16, CON. 7

MALAHIDE

B.H. 25 13
Site 5-100

FRED A. BELL AND ASSOCIATES LTD
CONSULTING ENGINEERS
ST. THOMAS ONTARIO

67-F-233M

Report on

SOIL INVESTIGATION

for

PROPOSED BRIDGE

LOTS 15 & 16, CONCESSION VII

TOWNSHIP OF MALAHIDE

by

DOMINION SOIL INVESTIGATION LIMITED
369 Queens Avenue
LONDON ONTARIO

Reference No 7-1-L11
February 8th, 1967

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ENCLOSURES

SUMMARY

The two boreholes revealed the following general ground succession:- loose silty fine sand (6'-0" to 11'-6" thick); overlying very stiff to hard silty clay till (maximum penetrated 20'-6").

It is recommended that the structure be supported on spread footing foundations at or below El. 36 using a maximum net soil pressure of 8000 p.s.f. Total settlement is estimated to be less than 1-inch.

Construction procedures are discussed in the report.

I INTRODUCTION

Verbal authorization was received from Fred A. Bell & Associates, Consulting Engineers, to carry out a soil investigation at a site in the Township of Malahide where it is proposed to replace an existing road bridge with a new structure.

It is understood that the new bridge will replace the two existing bridges which are located on the road allowance between Lots 15 and 16, Concession 7 of the Township. Also the proposed structure is a rigid frame with about a 60 foot span, and the centre line will be located 200 feet to the north of the centre line of the existing south structure. The requirements of the project were discussed with Mr. R. L. Lemon, 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 DESCRIPTION OF THE SITE AND GEOLOGY

The site is located on the northern edge of the physiographic region known as the Norfolk Sand Plain. The sands and silts of this region were deposited as a delta in glacial lakes Whittesey and Warren. Usually silt or clay strata, or beds of boulder clay underly the silts and sands, and when these occur close to the ground surface, poor vertical drainage results in a high water table.

III FIELD WORK

The field work, consisting of 2 boreholes, was carried out on February 2 and 3, 1967, at the locations shown on Enclosure 2. The holes 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 indicated by the client (top of southeast wing-wall of north bridge, El. 50.20 feet).

IV SUBSURFACE CONDITIONS

Detailed descriptions of the strata encountered in the boreholes 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	
		Borehole 1	Borehole 2
(a)	Loose brown silty fine sand, traces of decomposed wood.	4'- 0"	9'- 0"
(b)	Loose to dense grey silty fine sand.	2'- 0"	2'- 6"
(c)	Grey silty clay containing a trace of fine gravel (Glacial Till). The consistency of this stratum is described as 'very stiff' to 'hard' as indicated by standard penetration test results ranging from 36 to 97 blows per foot. Atterberg Limit tests carried out on two samples of this stratum gave values of Liquid Limit of 34%; Plastic Limit of 15% and 16% and Plasticity Index of 18 and 19, which classify the soil as a clay of low to medium plasticity and compressibility. The Liquidity Indices which relate the natural moisture content to the Atterberg Limits were 0.0 confirming the 'very stiff' consistency obtained from visual and tactile examination.	Penetrated 20'- 6"	15'- 0"

V GROUNDWATER CONDITIONS

The groundwater in the boreholes reached equilibrium at an average El. 45.8, which was about 4 feet above the water level in the adjacent northerly creek at the time the field work was carried out.

VI DISCUSSION AND RECOMMENDATIONS

The natural soil profile consists of generally loose silty fine sand strata overlying very stiff to hard silty clay till, which will be suitable for the support of spread footing foundations.

Bearing Capacity

The bed of the creek at the north bridge extends to El. 40.5, therefore, allowing 4 feet of cover for frost protection, it is recommended that footings should bear at or below El. 36. The footing depth will depend on the hydrology of the proposed new channel which is beyond the scope of this report. This level lies within the stratum of very stiff to hard silty clay till, and on the basis of the borehole results a maximum net soil pressure of 8000 p.s.f. is appropriate for the design of footings. Furthermore the footings will have a factor of safety of at least 3 against shear failure of the underlying soil.

The adhesion between the footings and the silty clay may be taken as 2000 p.s.f. and the factor of safety against horizontal sliding of the abutments should be at least 1.5.

Settlement

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

Construction

The very stiff cohesive till will present no unusual construction problems. However excavations through the silty fine sand stratum below the water table will require lateral support, or construction of an impervious dyke to prevent a flow of soil and water in the excavation.

Yours very truly,

DOMINION SOIL INVESTIGATION LIMITED

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

CJWA: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

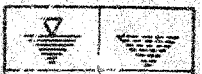
Enclosures

LIST OF SYMBOLS, ABBREVIATIONS AND NOMENCLATURE.

SOIL COMPONENTS AND GROUND WATER CONDITIONS.

BOULDER	COBBLE	GRAVEL		SAND			SILT	CLAY	ORGANICS	BEDROCK
		COARSE	FINE	COARSE	MEDIUM	FINE				
ø > 8"		3"	3/4"	4.76mm	2.0	0.42	0.074	0.002 >	NO SIZE LIMIT	

U.S. Standard Sieve Size : No.4 No.10 No.40 No.200



GROUND WATER LEVEL	DEPTH OF CAVE-IN

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.

SYMBOL :

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.

EXTRAPOLATED -N- VALUE 322

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 — UNCONFINED TEST — St

LABORATORY VANE TEST — St

FIELD VANE TEST — St

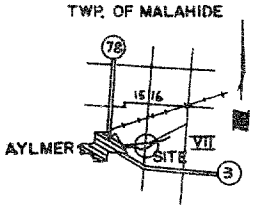
POCKET PENETROMETER TEST — St

Strain at failure is represented by direction of stem: 20%, 15%, 5%, 10%

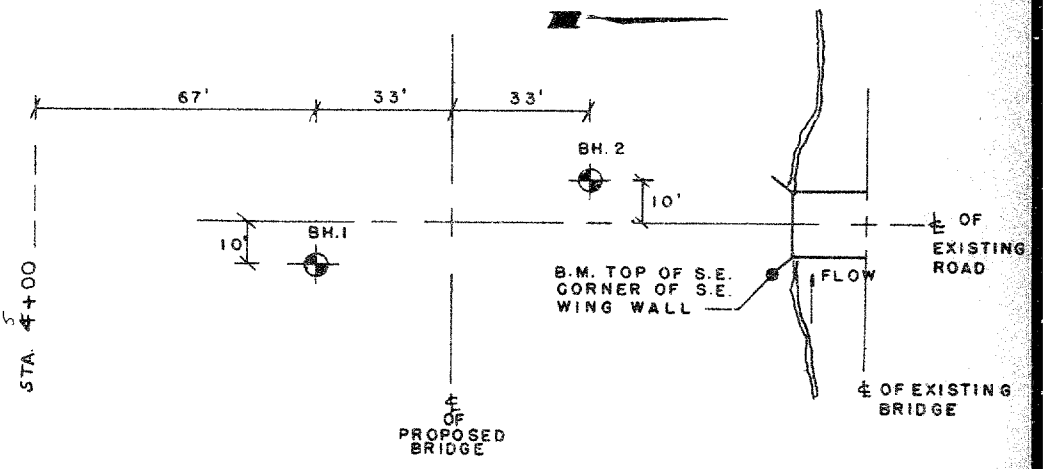
St : sensitivity = $\frac{\text{shear strength in undisturbed state}}{\text{shear strength in remoulded state}}$

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



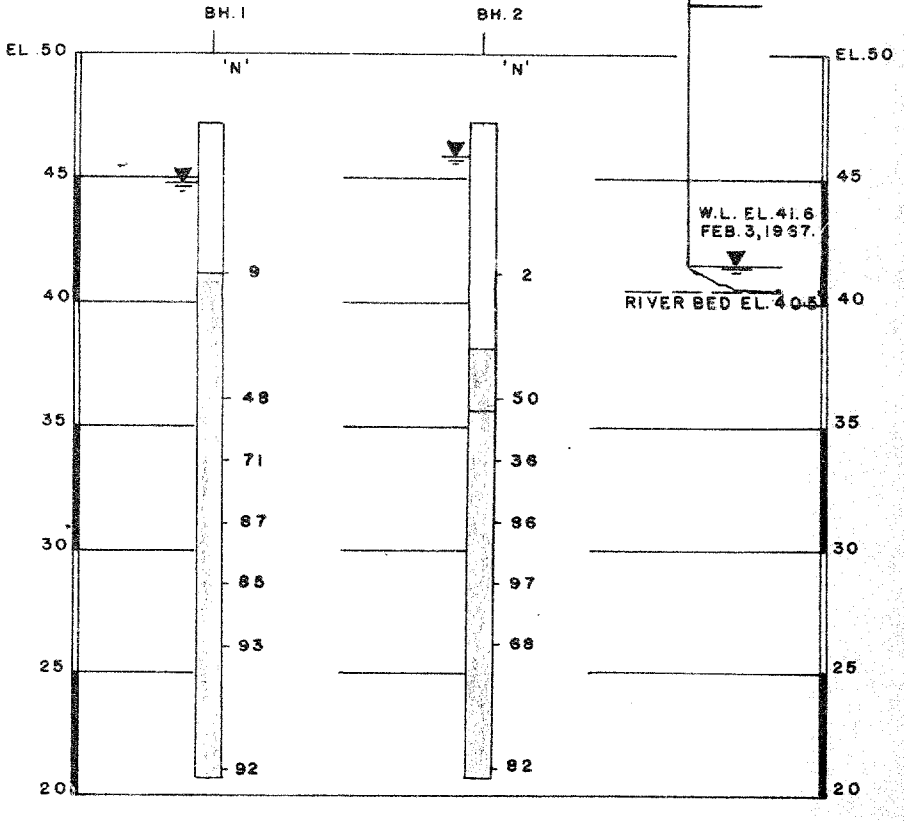
KEY PLAN



LOCATION OF BOREHOLES
SCALE 1"–30'

LEGEND

- LOOSE SILTY FINE SAND
- DENSE SILTY FINE SAND
- VERY STIFF TO HARD SILTY CLAY TILL



SUBSURFACE PROFILE
VERT. SCALE 1"–5'

GEOTECHNICAL DATA SHEET FOR BOREHOLE 1

OUR REFERENCE NO 7-1-111

CLIENT Fred A. Bell & Associates
PROJECT Bridge
LOCATION Township of Malahide
DATUM ELEVATION 50.2feet (See enclosure 2)

METHOD OF BORING Washboring
DIAMETER OF BOREHOLE Bx (3-7/8ch)
DATE February 2, 1967

ENCLOSURE NO 3

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 w_n PL W LL 10 20 30 40	REMARKS
47.2	0.0	Ground Surface							
		Loose brown silty fine sand							W. L. El. 45.7
	4.0	Loose grey silty fine sand							
	6.0	Very stiff to hard grey silty clay, trace of fine gravel		1	SS	9			
				2	SS	48			
				3	SS	71			
				4	SS	87			
				5	SS	85			
				6	SS	93			
				7	SS	92			
	26.5	End of Borehole							

2" diameter cone

VERTICAL SCALE: 1 IN. TO 5 FT.

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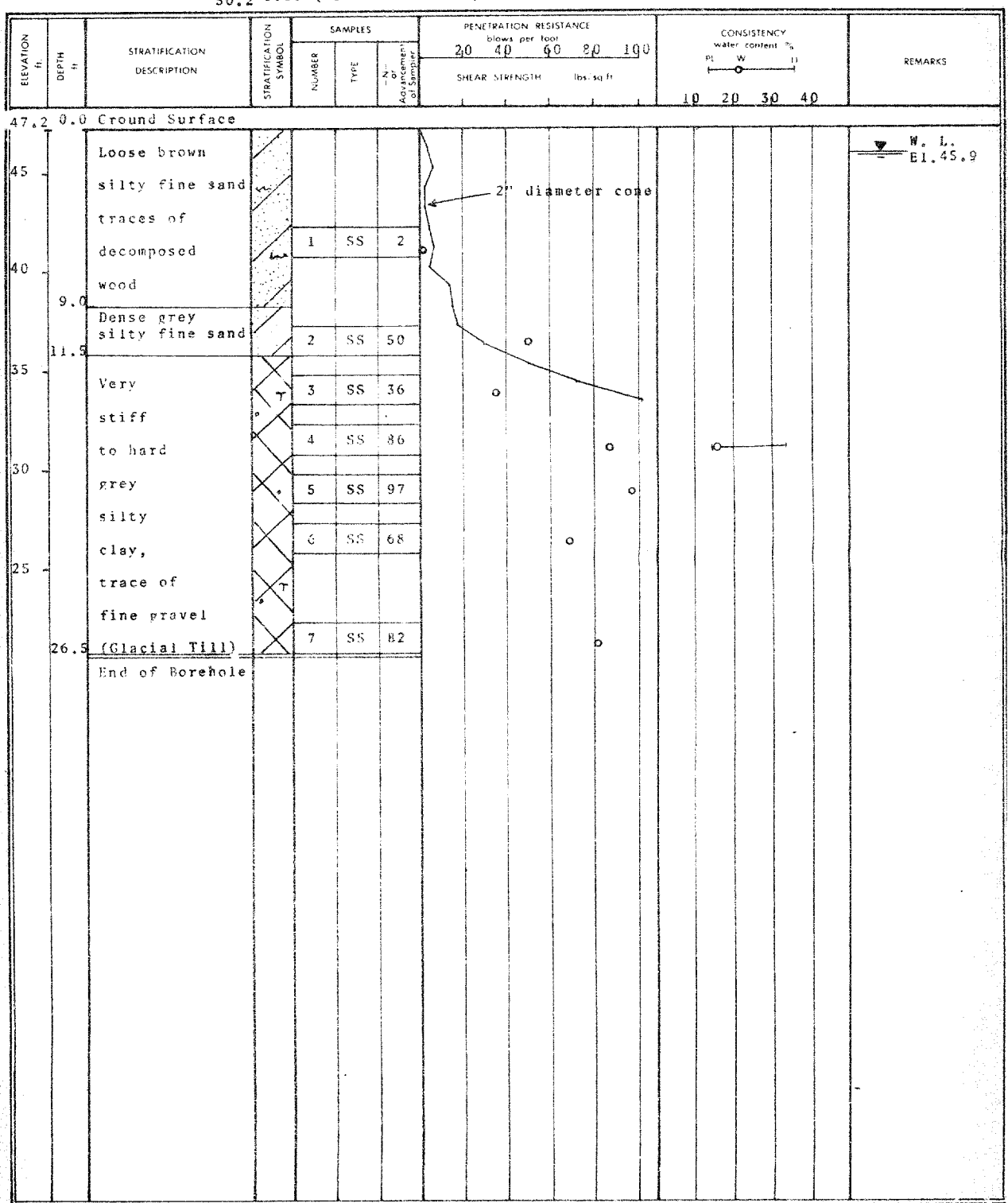
GEOTECHNICAL DATA SHEET FOR BOREHOLE . . 2 . . .

OUR REFERENCE NO. 7-1-L11

CLIENT: Fred A. Bell & Associates
PROJECT: Bridge
LOCATION: Township of Malahide
DATUM ELEVATION: 50.2 feet (see Enclosure 2)

METHOD OF BORING: Washboring
DIAMETER OF BOREHOLE: Bx (3-inch)
DATE: February 3, 1967

ENCLOSURE NO. 4



VERTICAL SCALE: 1 IN. TO 5 FT.

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