

GEOCRES No. 40P6-14DIST. 3 REGION \_\_\_\_\_

W.P. No. \_\_\_\_\_

CONT. No. \_\_\_\_\_

W. O. No. 73-F-210MSTR. SITE No. 12-335

HWY. No. \_\_\_\_\_

LOCATION PROPOSED NEW BRIDGEUSBORNE-TUCKERSMITH TOWNLINENo. of PAGES -       

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OVERSIZE DRAWINGS TO BE INCLUDED WITH THIS REPORT. \_\_\_\_\_

REMARKS: \_\_\_\_\_

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73-F-210 M



**DOMINION SOIL INVESTIGATION LIMITED**

**CONSULTING ENGINEERS**

**TORONTO**

**KITCHENER**

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**THUNDER BAY**



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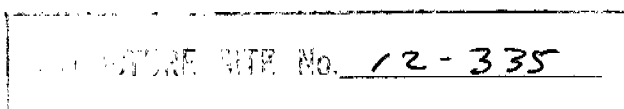
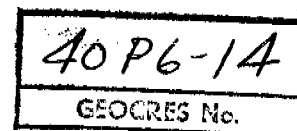
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B. M. ROSS AND ASSOCIATES LIMITED  
CONSULTING ENGINEERS  
GODERICH ONTARIO

73-F-210 M

DIST-3

Report On  
SOIL INVESTIGATION  
for  
PROPOSED NEW BRIDGE  
USBORNE-TUCKERSMITH TOWNLINE



by

Dominion Soil Investigation Limited  
1220 Trafalgar Street  
London Ontario

Ref: 73-3-L10

April 27, 1973



## KEY PLAN



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73-3-L10

I

## INTRODUCTION

In accordance with authorization from B. M. Ross and Associates Limited, Consulting Engineers, a soil investigation has been carried out on the Usborne-Tuckersmith Townline, where it is proposed to replace an existing road bridge with a new structure.

The existing structure is located  $1\frac{1}{4}$  miles south of Hensall and  $\frac{1}{4}$  mile to the east of Highway 4, where Black Creek crosses the Townline road.

It is understood that the proposed bridge is a 25 to 30 foot span reinforced concrete rigid frame structure, and that it will be centred on the existing bridge. The requirements of the project were discussed with Mr. K.G. Dunn, P. Eng., who supplied the foregoing information.

The purpose of the 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

FIELD WORK

The field work, consisting of two boreholes accompanied by two dynamic cone penetration tests, was carried out on April 4 & 5, 1973, at the locations shown on Enclosure 2. The holes were advanced to the sampling depths by a continuous flight power auger machine, which was equipped for soil sampling.

Standard penetration tests were performed at frequent intervals of depth, as detailed in Appendix 'A', and the results are recorded on the borehole logs as 'N' values. The split-spoon samples were stored in air-tight containers and transferred to our London laboratory for classification and testing.

The dynamic cone penetration tests were performed adjacent to the borehole locations to obtain an indication of soil density and strata changes with depth. The energy used to drive the cone was the same as was used for the standard penetration tests.

The field work was supervised by a soils engineer, who also determined the ground surface elevations. These were

referred to a nail in a hydro pole at Station 12+63, which was established by the client and given the assumed value, El. 100 feet.

## III

SUBSURFACE CONDITIONS

Detailed descriptions of the strata, which were encountered in each borehole, are given on the borehole logs comprising Enclosures 3 & 4, and a general picture of the soil stratigraphy is presented in the form of a Subsurface Profile on Enclosure 2. The following notes are intended only to amplify this data.

Both boreholes encountered a surface layer of sand and gravel overlying silty clay fill which is associated with the construction of the approaches to the existing bridge. The fill extends to depths of 10.5 and 6.7 feet in boreholes 1 and 2 respectively.

The natural soil profile consists predominantly of glacial silty clay till material in which a layer of fine sand was encountered at El. 87.5 and El. 85.9 in boreholes 1 and 2 respectively. The fine sand revealed a thickness of 1½ feet.





The consistency of the glacial silty clay is described as 'stiff' to 'very stiff' based on undrained shear strengths ranging from 2230 to 4400 p.s.f., which were confirmed by 'N' values ranging from 17 to 100 blows per foot. Atterberg Limit tests were performed on two samples of the silty clay giving values of Liquid Limit of 20% and 22%, Plastic Limit of 13% and 14%, and Plasticity Index of 6% and 9%. The Liquidity Indices, which relate the natural moisture content to the Atterberg Limits, were 0.11 and -0.17, which confirms the 'very stiff' consistency obtained from visual and tactile examination. The moisture content within the silty clay stratum was found to range from 12% to 17%.

## IV

GROUNDWATER CONDITIONS

Equilibrium water levels were observed in boreholes 1 and 2 at El. 92.0 and El. 92.9 respectively. The water level in the adjacent creek was observed at El. 91.0 on April 4, 1973.

## V

DISCUSSION AND RECOMMENDATIONSFoundations

The creek bed at the existing bridge location extends down to El. 89<sup>+</sup>, therefore normal spread footing foundations would be constructed at or below El. 85 to provide sufficient

protection against frost action. The proposed footing grade level lies within the fine sand layer at the east abutment location, therefore it is recommended that the footing grade be lowered to El. 83 to obtain a more suitable subgrade. On the basis of the borehole results a maximum allowable soil pressure of 5000 p.s.f. is appropriate for the design of footings at or below El. 83, and this soil pressure incorporates a factor of safety of 3 against shear failure of the underlying soil. Total settlement of footings up to 10 feet in width is estimated to be 0.5 inch or less, and in view of the uniform soil conditions below the proposed footing grade, differential settlement is expected to be negligible.

The adhesion between the footings and the clay till may be taken as the lower value of 1250 p.s.f. or 35% of the vertical load, and the factor of safety against horizontal sliding of the abutments must be at least 1.5. Additional sliding resistance may be generated by using a lateral passive pressure of 8000 p.s.f. for the part of the footing located below the maximum depth of scour.

#### Construction

The footing grade will be located within the impervious silty clay till stratum, and seepage into the excavation will be limited to lateral flow from the fine sand layer.

It is anticipated that the volume of water will be controlled by normal pumping procedures using sumps dug below the footing grade.

All backfill behind retaining walls should be free-draining granular material to prevent an out-of-balance hydrostatic pressure being exerted on the wall by entrapped water. The backfill must also be compacted to at least 95% of the standard Proctor dry density to preclude settlement of the fill and damage to the finished road surface.



Yours very truly,

DOMINION SOIL INVESTIGATION LTD.

A handwritten signature in cursive script, appearing to read 'C.J.W. Atkinson', written over the printed name.

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

CJWA:eg

## APPENDIX 'A'

### THE STANDARD PENETRATION TEST.

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-ins. The tube is first driven an initial 6-inches 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 is one originally developed by 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

# LIST OF SYMBOLS, ABBREVIATIONS AND NOMENCLATURE.

## SOIL COMPONENTS AND GROUND WATER CONDITIONS.

BOULDER	COBBLE	GRAVEL		SAND			SILT	CLAY	ORGANICS	BEDROCK	GROUND WATER LEVEL	DEPTH OF CAVE-IN
		COARSE	FINE	COARSE	MEDIUM	FINE						
Ø	> 8"	3"	¾"	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					

## 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	OBSERVATIONS MADE WHILE CORING	Steady pressure	Washwater returns
" pressure : p		No pressure	Washwater lost
" tapping : t		Intermittent pressure	

## PENETRATION RESISTANCES.

**DYNAMIC PENETRATION RESISTANCE :** to drive a 2"  $\phi$ , 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

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

SYMBOL :



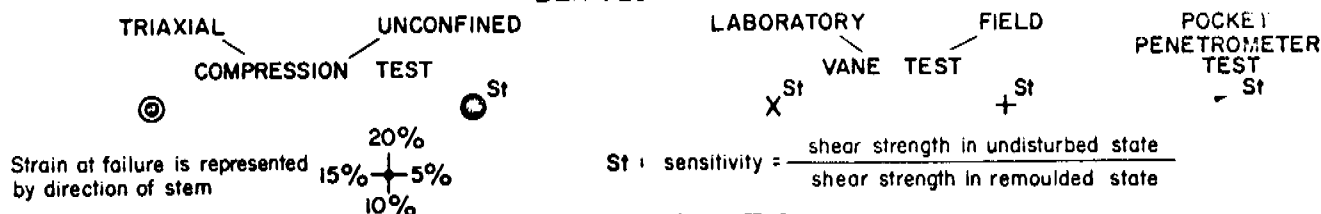
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## SOIL PROPERTIES.

W % Water content	$\gamma^*$ 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	$\phi$ Angle of int. friction
PI % Plasticity index	$C_v$ Coeff. of consolidation	C' Cohesion in terms of effective stress
LI Liquidity index	$m_v$ Coeff. of volume compressibility	$\phi'$ Angle of int. friction

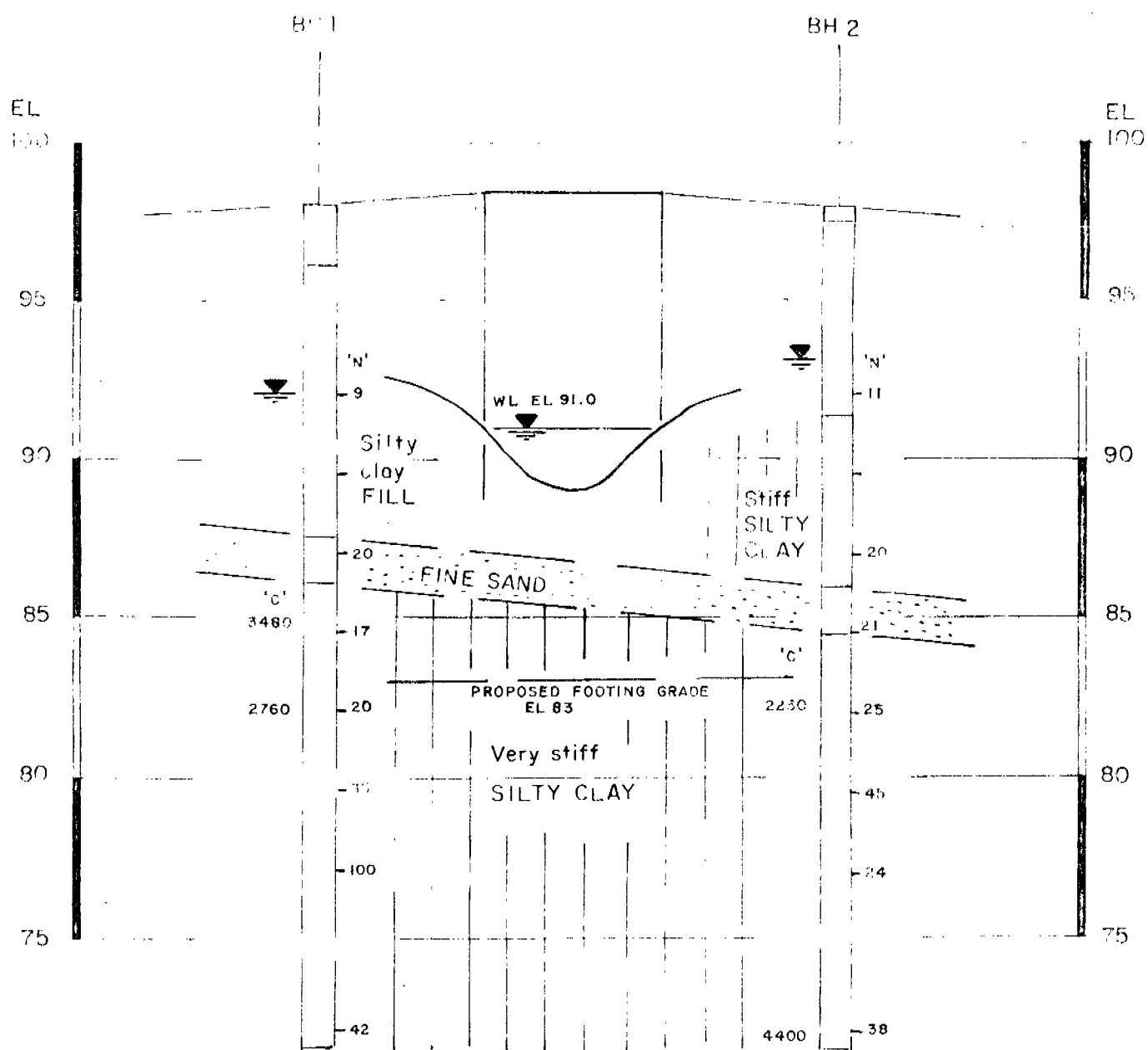
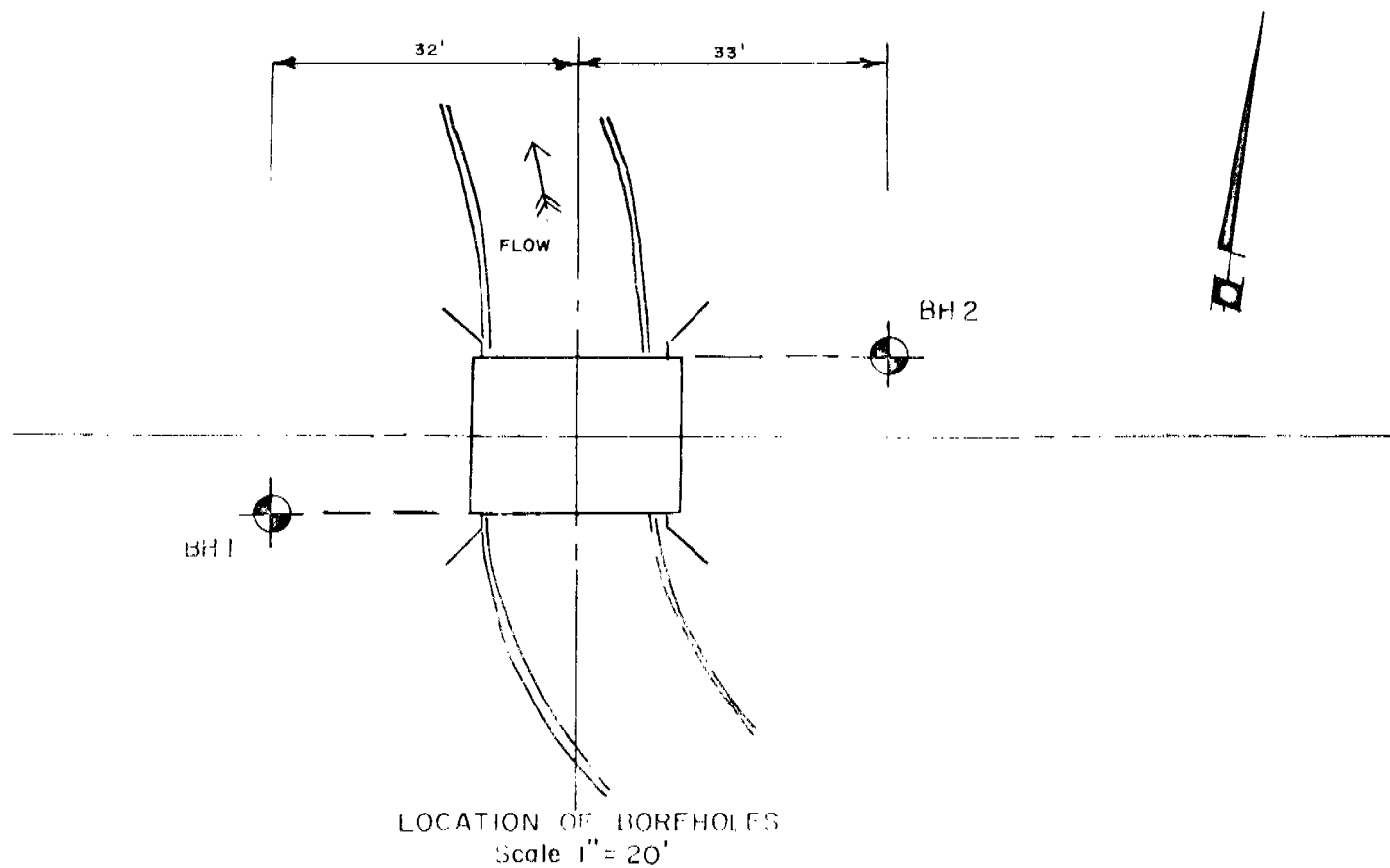
## UNDRAINED SHEAR STRENGTH.

— DERIVED FROM —



## 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



# LOG OF BOREHOLE .....1.....

Our Reference No 73-3-L10.....

Enclosure No.....3.....

CLIENT: B.M. Ross and Associates Limited

PROJECT: Bridge BR-322

LOCATION: County of Huron

DATUM ELEVATION: nail in hydro pole, Sta 12+63, El. 100 ft.

## DRILLING DATA

Method: Hollow-stem Auger

Diameter: 8-inch

Date: April 4, 1973.

SUBSURFACE PROFILE				SAMPLES			PENETRATION RESISTANCE					WATER CONTENT %					REMARKS
ELEVATION Ft.	DEPTH Ft.	DESCRIPTION	SYMBOL	GROUND WATER	NUMBER	TYPE	'N' Blows / Foot	Blows / Foot					PLASTIC LIMIT	NATURAL	LIQUID LIMIT		
								20	40	60	80	100	W <sub>p</sub>	W	W <sub>L</sub>		
								UNDRAINED SHEAR STRENGTH 100 lbs/sq.ft. + FIELD VANE TEST      • COMPRESSION TEST									
								20	40	60	80	100	10 20 30 40 50				
98.0	0.0	Ground Surface															
	20	Sand and gravel. FILL.															
95		Brown silty clay, with pockets of topsoil.			1	SS	9										
		FILL.															
90																	
	10.5	Fine sand, trace of gravel			2	SS	20										
85	12.0																
		Very stiff grey silty clay, traces of embedded sand and gravel.			3	SS	17										
					4	SS	20										
80					5	SS	35										
					6	SS	100										
75																	
		silt and fine sand seams.			7	SS	42										
70																	

2-inch diameter dynamic cone.

# LOG OF BOREHOLE.....

Our Reference No. 73-3-L10

Enclosure No. 4

CLIENT: B.M. Ross and Associates Limited

PROJECT: Bridge BR-322

LOCATION: County of Huron

DATUM ELEVATION: nail in hydro pole, Sta 12+63, El. 100ft.

## DRILLING DATA

Method: Hollow-stem Auger

Diameter: 8-inch

Date: April 4 & 5, 1973

SUBSURFACE PROFILE				SAMPLES			PENETRATION RESISTANCE					WATER CONTENT %			REMARKS	
ELEVATION Ft.	DEPTH Ft.	DESCRIPTION	SYMBOL	GROUND WATER	NUMBER	TYPE	'N' Blows / Foot	Blows / Foot					PLASTIC LIMIT W <sub>p</sub>	NATURAL W		LIQUID LIMIT W <sub>L</sub>
								20	40	60	80	100				
								UNDRAINED SHEAR STRENGTH 100 + FIELD VANE TEST      • COMPRESSION TEST								
								20	40	60	80	100				

97.9	0.0	Ground Surface														
97.5	0.5	Sand & gravel														
95.0	2.5	Brown silty clay, with pockets of topsoil.														
		FILL			1	SS	11									
90.0	7.5	Stiff brown silty clay, seams of silt and fine sand.			2	SS	20									
85.0	12.0	Fine sand.			3	SS	21									
80.0	17.5	Very stiff grey silty clay, traces of embedded sand and gravel.			4	SS	25									
					5	SS	45									
					6	SS	24									
75.0	22.5															
					7	SS	38									
70.5	27.5	End of Borehole														

2-inch diameter dynamic cone.

2-inch diameter dynamic cone.