

NEW BRIDGE

FRANK STREET

TOWN OF

MITCHELL

40P6-15



# DOMINION SOIL INVESTIGATION LIMITED

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40 P 6 - 15
GEOCRE5 No.

Report On  
SOIL INVESTIGATION  
for  
PROPOSED NEW BRIDGE  
FRANK STREET  
TOWN OF MITCHELL

by

Dominion Soil Investigation Limited  
1220 Trafalgar Street  
London Ontario

Ref: 74-2-L10  
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I

INTRODUCTION

In accordance with a letter of authorization dated February 22, 1974, from R.M. Dawson, P.Eng., Consulting Engineer, a soil investigation has been carried out on Frank Street in the Town of Mitchell, where it is proposed to construct a new bridge across the Thames River.

It is understood that the proposed structure will have three spans, and that an 18-foot embankment will be constructed on the west side of the river to raise the profile to the required level. The requirements of the project were discussed with Mr. D.G. Johnson, P.Eng., who supplied a site plan and 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 proposed bridge foundations.

II FIELD WORK

The field work, consisting of two boreholes, was carried out on March 21, 1974, at the locations shown on Enclosure 2. The holes were advanced by a self-propelled drilling machine, which was equipped with hollow-stem augers 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, testing and storage.

The field work was supervised by a soils engineer, and the ground surface elevations at the borehole locations were provided by the client.

III SUBSURFACE CONDITIONS

Detailed descriptions of the strata, which were encountered in each borehole, are given on the borehole logs comprising Enclosures 3 and 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 surface layers of fill which extend to depths of 12 and 10½ feet in boreholes 1 and 2 respectively. The fill consists predominantly of silty clay at borehole 1 location and silty sand at borehole 2 location.

The natural soil profile consists of sand strata, which extend down to El. 1071.3 in borehole 1 and El. 1066.3 in borehole 2, overlying clayey silt in which both boreholes were terminated. The relative density of the sand varies from 'compact' to 'very dense' as indicated by 'N' values ranging from 11 to 104 blows per foot, and grading analyses of four representative samples of the sand strata are shown as grain size distribution curves on Enclosure 5.

The consistency of the clayey silt is described as 'hard' based on 'N' values ranging from 74 to 104 blows per foot. Atterberg Limit tests were performed on a sample of the clayey silt giving values of Liquid Limit of 29%, Plastic Limit of 19%, and Plasticity Index of 10%. The natural moisture content

of the clayey silt was found to range from 12.5% to 12.9%, which is lower than the plastic limit of the soil and confirms the 'hard' consistency obtained from visual and tactile examination.

#### IV GROUNDWATER CONDITIONS

An equilibrium water level was observed at El. 1084.3 in borehole 2, and insufficient time was available for the water level in borehole 1 to reach an equilibrium state. Due to the permeable nature of the sand strata, it may be assumed that the prevailing groundwater table is closely related to the water level in the river at any particular time.

#### V DISCUSSION AND RECOMMENDATIONS

##### Spread Footing Foundations

The existing river bed extends down to El. 1082±, therefore to provide a 4 foot depth of soil cover for protection against frost action, the footing grade would require to be established at or below El. 1078. This level lies within the 'very dense' sand at borehole 1 location, and an allowable soil pressure of 5 tons per square foot would be appropriate

for the design of footings for the east abutment. At borehole 2 location the layer of 'compact' fine sand extends down to El. 1075±, and an allowable soil pressure of 7000 p.s.f. would be appropriate for the design of footings at or below this elevation.

Both the recommended soil pressures are based on placing the footings on the undisturbed subgrade, and this would require special dewatering or construction techniques to prevent 'sloughing-in' of the sides of the excavation or 'boiling' in the bottom of the excavation due to an out-of-balance hydrostatic pressure. The excavations could be carried out inside closed sheeting which should be driven into the impervious clayey silt to seal the bottom of the excavation, or alternatively a well-point system may be employed to lower the groundwater table during the construction period.

#### Piled Foundations

In view of the difficulties in maintaining a stable excavation for the spread footing type of foundation, consideration should be given to a piled foundation which would be more practical to install and possibly more economical. Any type of driven pile or



'expanded-base' type of pile would be suitable, however steel tube piles would be preferable to H-piles because of their greater base area and higher end-bearing capacity. Working loads of 50 and 65 tons per pile may be used for 10.75 and 12.75 inch diameter tube piles respectively. The pile should be driven to refusal, which is considered to be reached when 5 blows of an adequate hammer produce a total penetration of  $\frac{1}{4}$  inch.

Based on the borehole results it is estimated that a suitable set would be achieved within the 'hard' clayey silt material at El. 1065± at the east abutment location, and at El. 1055± at the west abutment location. Piles supporting the centre piers would penetrate slightly deeper, and providing the soil profile is similar to the abutment locations the piles would penetrate to El. 1050±. The rating of the pile driving equipment should not be less than 10,000 foot pounds per blow for 50 ton capacity piles and not less than 13,000 foot pounds per blow for 65 ton capacity piles.

The above working loads and sets are based on theoretical estimates, and in practice the assumed working loads should be checked by the use of an approved dynamic pile driving formula. If the desired working load is not achieved with the anticipated depths of penetration, the piles should be extended or additional piles driven to provide the required support for the structure.

Yours very truly,

DOMINION SOIL INVESTIGATION LIMITED



CJWA:eg

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

## 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 inches. 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 inches 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						
> 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							

## 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		Steady pressure		Washwater returns
"	"	pressure : p	MADE WHILE CORING		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 :



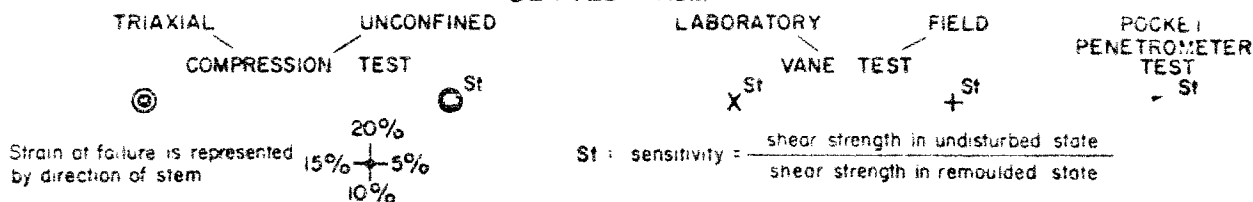
322

## SOIL PROPERTIES.

W %	Water content	$\gamma$	Natural bulk density (unit weight)	k	Coeff. of permeability
LL %	Liquid limit	e	Void ratio	C	Shear strength
PL %	Plastic limit	RD	Relative density	$\phi$	Angle of int. friction
PI %	Plasticity index	C <sub>v</sub>	Coeff. of consolidation	C'	Cohesion
LI	Liquidity index	m <sub>v</sub>	Coeff. of volume compressibility	$\phi'$	Angle of int. friction

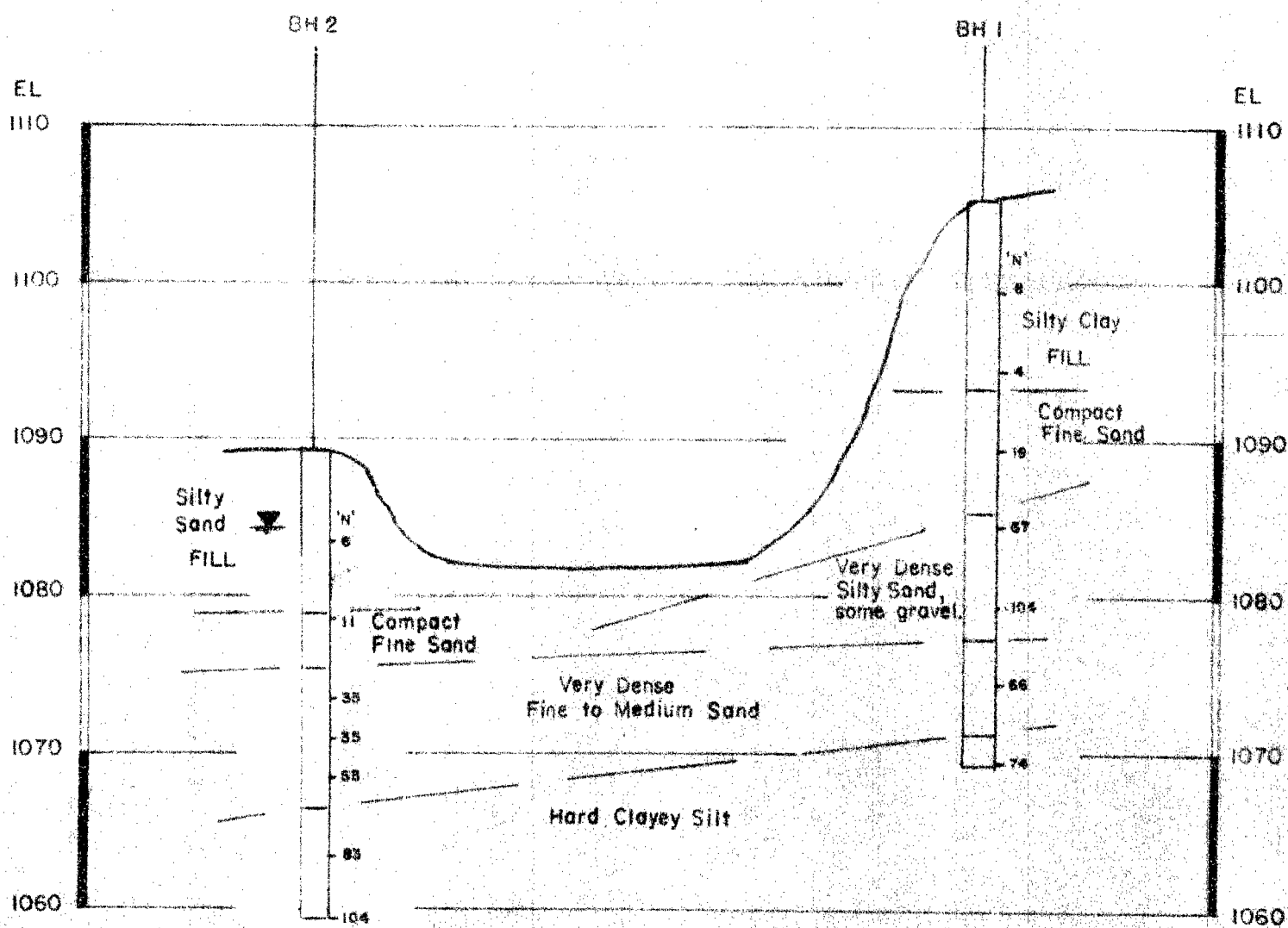
## UNDRAINED SHEAR STRENGTH.

— 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



Hor. Scale 1" = 50'  
Vert. Scale 1" = 10'

ENCLOSURE No. 2

# LOG OF BOREHOLE 1

Our Reference No. 74-2-110

Enclosure No. 3

CLIENT: R.M. Dawson P.Eng.,  
PROJECT: Frank Street Bridge,  
LOCATION: Mitchell, Ontario.  
DATUM ELEVATION: Geodetic

## DRILLING DATA

Method: Auger  
Diameter: Hollow-stem.  
Date: March 21, 1974.

SUBSURFACE		PROFILE		SAMPLES			PENETRATION RESISTANCE					WATER CONTENT			REMARKS		
ELEVATION Ft.	DEPTH Ft.	DESCRIPTION	SYMBOL	GROUND WATER	NUMBER	TYPE	'N' Blows/Ft.	Blows/Ft.					%				
								20	40	60	80	100	PLASTIC LIMIT	NATURAL		LIQUID LIMIT	
								UNDRAINED SHEAR STRENGTH 100 p.s.f.					W <sub>p</sub>	W		W <sub>L</sub>	
								+ FIELD VANE TEST    • COMPRESSION TEST									
								20	40	60	80	100	10	20	30	40	50
11053	0.0	Ground Surface															
		Brown silty clay, some gravel.			1	SS	8	•									
1095		(FILL)			2	SS	4	•									
120																	
1090		Compact brown fine sand, trace of silt.			3	SS	19	•									
1085	200				4	SS	67	•									
1080		Very dense brown silty sand, some gravel.			5	SS	104	•									
280		(Till)															
1075		Very dense brown fine to medium sand, trace of silt.			6	SS	66	•									
1070	340																
	360	Hard grey clayey silt.			7	SS	74	•									
		End of Borehole															

VERTICAL SCALE: 1 inch to 5 ft.

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DRAWN:

CHECKED:

# LOG OF BOREHOLE.....2.....

Our Reference No. 74-2-110

Enclosure No. 4

CLIENT: R.M. Dawson P. Eng.,  
PROJECT: Frank Street Bridge,  
LOCATION: Mitchell, Ontario.  
DATUM ELEVATION: Geodetic.

## DRILLING DATA

Method: Auger  
Diameter: Hollow-stem  
Date: March 21, 1974.

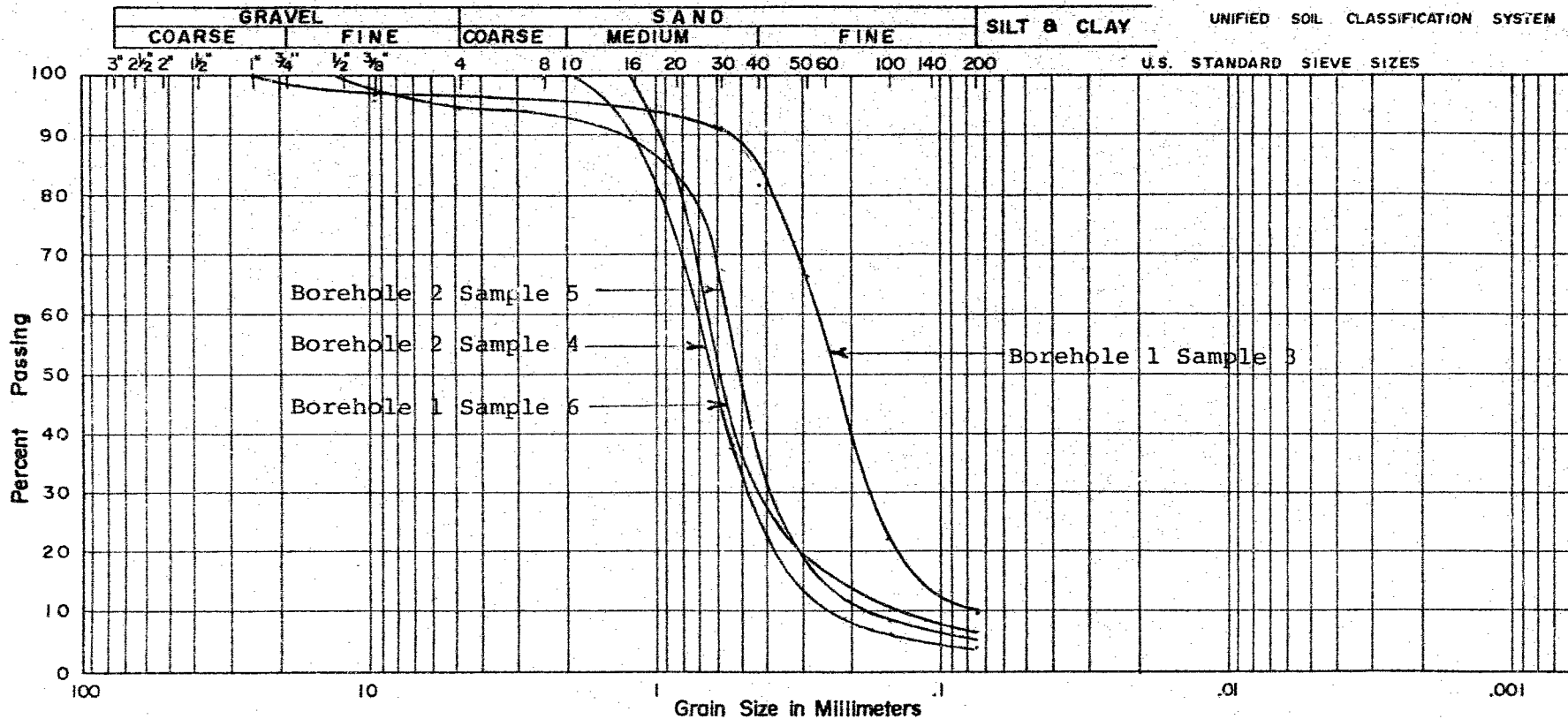
SUBSURFACE PROFILE		SAMPLES			PENETRATION RESISTANCE					WATER CONTENT %					REMARKS		
ELEVATION Ft.	DEPTH Ft.	DESCRIPTION	SYMBOL	GROUND WATER	NUMBER	TYPE	'N' Blows/Ft.	Blows/Ft.									
								20	40	60	80	100	PLASTIC LIMIT	NATURAL		LIQUID LIMIT	
								UNDRAINED SHEAR STRENGTH 100 p.s.f.					W <sub>p</sub>	W		W <sub>L</sub>	
								+ FIELD VANE TEST    • COMPRESSION TEST									
								20	40	60	80	100	10	20	30	40	50

1089.3	0.0	Ground Surface																	
		Brown																	
		silty																	
1085		sand,																	
		some																	
		gravel.																	
1080		(FILL)																	
	10.5	Compact brown			2	SS	11												
		fine sand.																	
1075	14.0	Dense grey																	
		fine to				3	SS	33											
		medium																	
1070		sand.				4	SS	35											
		trace																	
		of			5	SS	55												
		gravel																	
	23.0																		
1065		Hard grey																	
		clayey				6	SS	83											
		silt.																	
1060																			
						7	SS	104											
	31.0	End of Borehole																	

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## GRAIN SIZE DISTRIBUTION

OUR REFERENCE No 74-2-L10



PROJECT: Frank Street Bridge

LOCATION: Mitchell

BOREHOLE No: 1 1 2 2

SAMPLE No: 3 6 4 5

DEPTH: 15' 30' 17 1/2' 20'

ELEVATION 1090 1075 1072 1069

COEFFICIENT OF UNIFORMITY:

COEFFICIENT OF CURVATURE:

### Classification of Sample and Group Symbol:

1/6, 2/4, 2/5 Fine to medium sand, trace of silt.

1/3 Fine sand, traces of silt.

### PLASTIC PROPERTIES

LIQUID LIMIT % =

PLASTIC LIMIT % =

PLASTICITY INDEX % =

MOISTURE CONTENT % =

ENCLOSURE No 5