

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

40P13-7
GEOCRES No.

73-F-212 M

# DOMINION SOIL INVESTIGATION LIMITED

CONSULTING ENGINEERS

TORONTO

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LONDON

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THUNDER BAY



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40P13-7

GEOCRE No.

Report On  
SOIL INVESTIGATION  
for  
PROPOSED NEW BRIDGE  
CANNING STREET  
VILLAGE OF LUCKNOW

*M.T.C. Set 2-331  
73-F-212 M DIST 3.*

by

Dominion Soil Investigation Limited  
1220 Trafalgar Street  
London Ontario

Ref: 73-4-L2

May 15, 1973

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73-4-L2

I

INTRODUCTION

In accordance with authorization from B. M. Ross & Associates Limited, Consulting Engineers, a soil investigation has been carried out on Canning Street in the Village of Lucknow, where it is proposed to replace an existing road bridge with a new structure.

It is understood that the new structure will be located to the west of the existing structure, and that the centre line will be 37 feet to the east of the centre line of the millrace which is located between the existing bridge and the County Road. The new bridge will have a span of about 50 feet, and the new location will allow for realignment of the river bed. 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 surface conditions at the proposed abutment locations, and to determine the relevant soil properties for the design of the foundations.



II

FIELD WORK

The field work, consisting of two boreholes accompanied by two dynamic cone penetration tests, was carried out on April 6, 1973, at the locations shown on Enclosure 2. The holes were advanced to the sampling depths 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 laboratory for classification and testing.

The dynamic cone penetration tests were performed 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 on the north side of the road at Station 9+82, which was established by the client and given a Geodetic El. 877.72 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 given 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 are associated with the construction of the existing road. The fill generally consists of sand and gravel, and it was found to extend to a depth of about 10 feet in both boreholes.

A layer of sand which contains seams of silty clay was encountered immediately below the fill material in borehole 1, and this was followed by sand and gravel to the limit of the borehole at a depth of 26½ feet. Borehole 2 encountered the sand and gravel stratum immediately below the fill, and also penetrated the sand and gravel to a depth of 26½ feet.

Grading analyses were performed on six samples of the sand and gravel and the results are shown as grain size distribution curves on Enclosure 5. The grading curves indicate that the sand and gravel contains 5% to 15% of silt, with the remaining part being evenly divided into sand and gravel fractions. The relative density of the sand and gravel stratum is described as 'compact' to 'dense' based on 'N' values ranging from 20 to 96 blows per foot.

IV

#### GROUNDWATER CONDITIONS

The groundwater in the boreholes reached an equilibrium level at El. 867.8, and the water level in the adjacent stream was observed at El.                      on April 6, 1973.

V

#### DISCUSSION AND RECOMMENDATIONS

The soil profile below the river bed consists of 'compact' to 'dense' sand and gravel, which is inherently capable of supporting normal spread footing foundations.

The river bed at the existing bridge site extends down to El. 864.6, therefore footings should be supported at or below El. 860 to provide sufficient protection against frost action. It is also recommended that a



hydrology study be made to determine the maximum depth of scour and insure that the footings will have sufficient protection against undermining due to scour.

On the basis of the borehole results a maximum allowable soil pressure of 6000 p.s.f. is appropriate for the design of footings at or below El. 860, and this soil pressure incorporates a factor of safety of at least 3 against shear failure of the underlying soil. Total settlement of the footings is estimated to be 1 inch or less.

The coefficient of friction between the footings and the sand and gravel stratum may be taken as 0.5, and the factor of safety against horizontal sliding of the abutments should be at least 1.5.

#### Construction

A major problem in constructing footings in the prevailing ground conditions will be to control the ground water and to prevent sloughing-in of the sides of the excavation and boiling in the bottom of the excavation due to an out-of-balance hydrostatic pressure.

It is considered unlikely that the excavations can be dewatered by normal pumping procedures due to the high permeability of the sand and gravel, therefore it is recommended that the excavation be carried out under water and a tremie seal be poured to prevent disturbance of the footing grade. Thereafter the excavation could be dewatered by normal pumping procedures using wood or steel sheeting to prevent a lateral flow of soil and water into the excavation. Particular care should be taken to insure that the thickness of the tremie seal is sufficient to prevent uplift of the slab due to hydrostatic pressure when the excavation is dewatered.


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.



CJWA:eg

  
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-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
$\phi > 8"$	$3" - 3\frac{3}{4}"$	COARSE	FINE	COARSE	MEDIUM	FINE	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 :

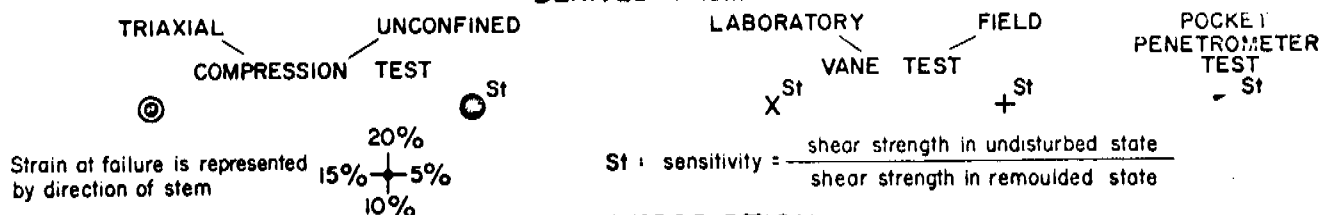
322

## SOIL PROPERTIES.

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

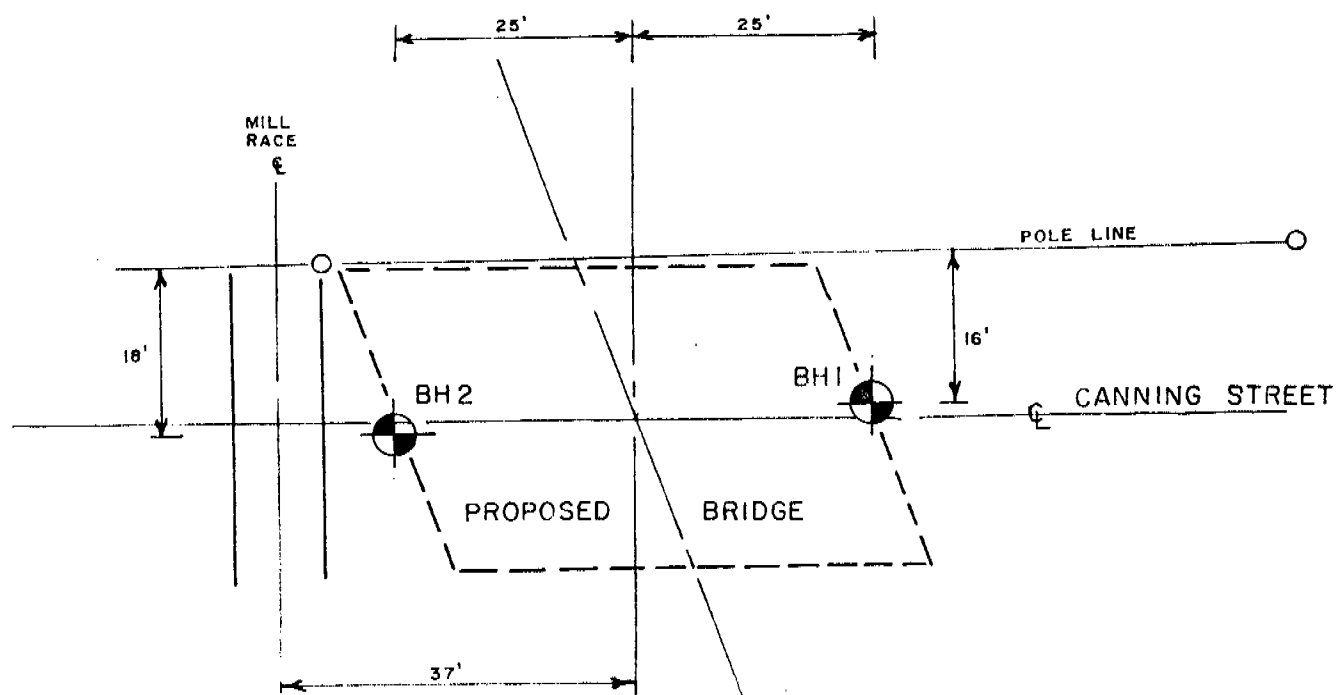
## UNDRAINED SHEAR STRENGTH.

- DERIVED FROM -

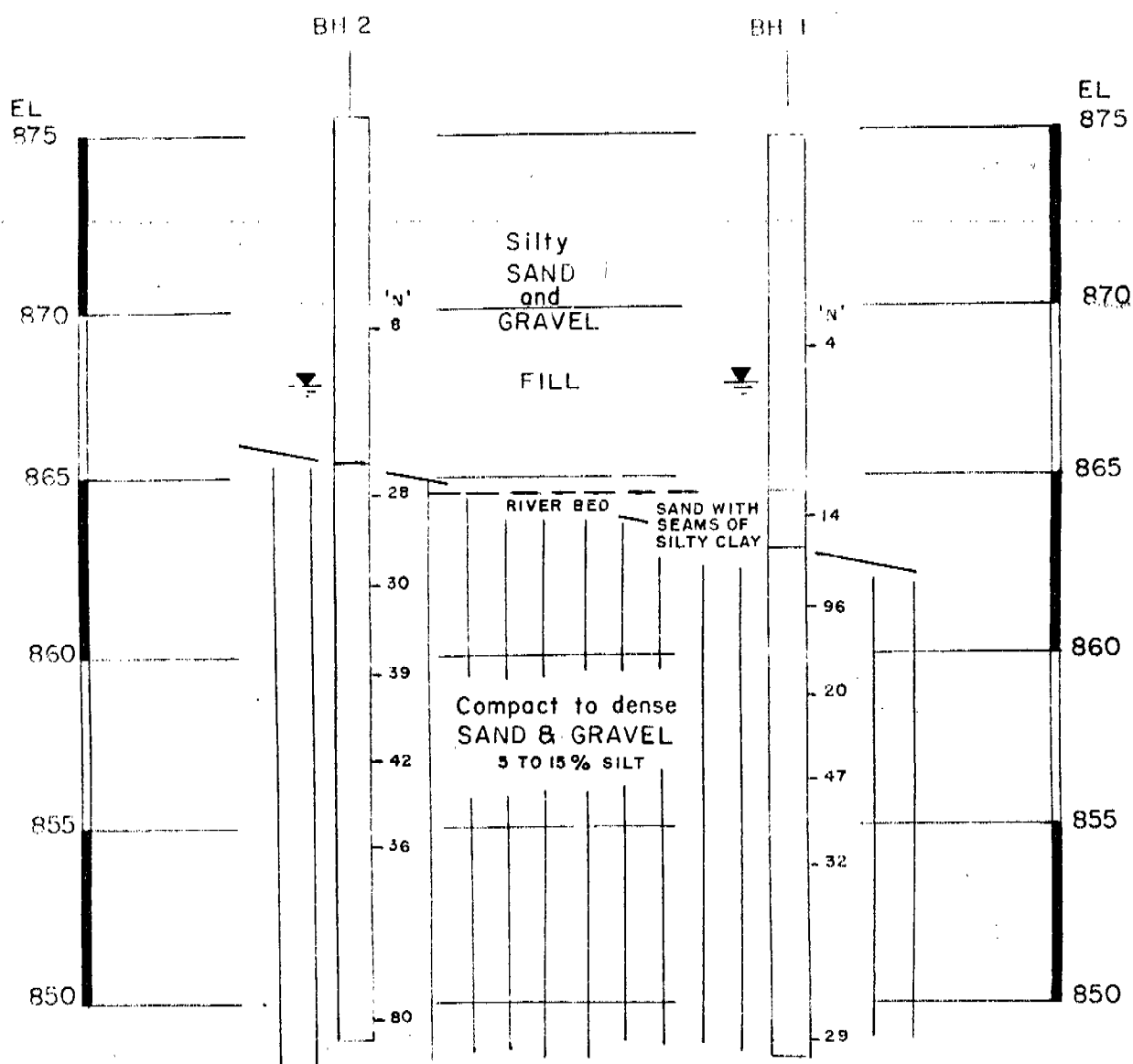


## SOIL DESCRIPTION.

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



LOCATION OF BOREHOLES  
Scale 1" = 20'



SUBSURFACE PROFILE  
Vert Scale 1" = 5'

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

Our Reference No. 73-4-L2.....

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

CLIENT: B.M. Ross & Associates Ltd.,  
PROJECT: Canning Street Bridge,  
LOCATION: Lucknow, Ontario.  
DATUM ELEVATION:

## DRILLING DATA

Method: Hollow-stem auger.  
Diameter: 8-inch.  
Date: April 6, 1973.

SUBSURFACE PROFILE					SAMPLES			PENETRATION RESISTANCE      Blows / Foot					WATER CONTENT %			REMARKS						
ELEVATION Ft.	DEPTH Ft.	DESCRIPTION	SYMBOL	GROUND WATER	NUMBER	TYPE	'N' Blows / Foot	20	40	60	80	100	PLASTIC LIMIT	NATURAL	LIQUID LIMIT							
								UNDRAINED SHEAR STRENGTH      lbs./sq.ft.					W <sub>p</sub> W      W <sub>L</sub>									
								+ FIELD VANE TEST      • COMPRESSION TEST														
874.8	0.0	Ground Surface																				
		1½" Asphalt																				
		Brown silty sand & gravel.																				
870					1	SS	4															
		FILL																				
865																						
	10.3	Sand with seams of silty clay.			2	SS	14															
	12.0																					
860		Compact to dense brown sand and gravel, trace of silt.			3	SS	96															
					4	SS	20															
					5	SS	47															
855					6	SS	32															
850																						
					7	SS	29															
845																						

2-inch diameter dynamic cone.

# LOG OF BOREHOLE.....2

Our Reference No. 73-4-L2

Enclosure No. 4

CLIENT: B.M. Ross & Associates Ltd.,  
PROJECT: Canning Street Bridge,  
LOCATION: Lucknow, Ontario  
DATUM ELEVATION:

## DRILLING DATA

Method: Hollow-stem.  
Diameter: 8-inch  
Date: April 6, 1973.

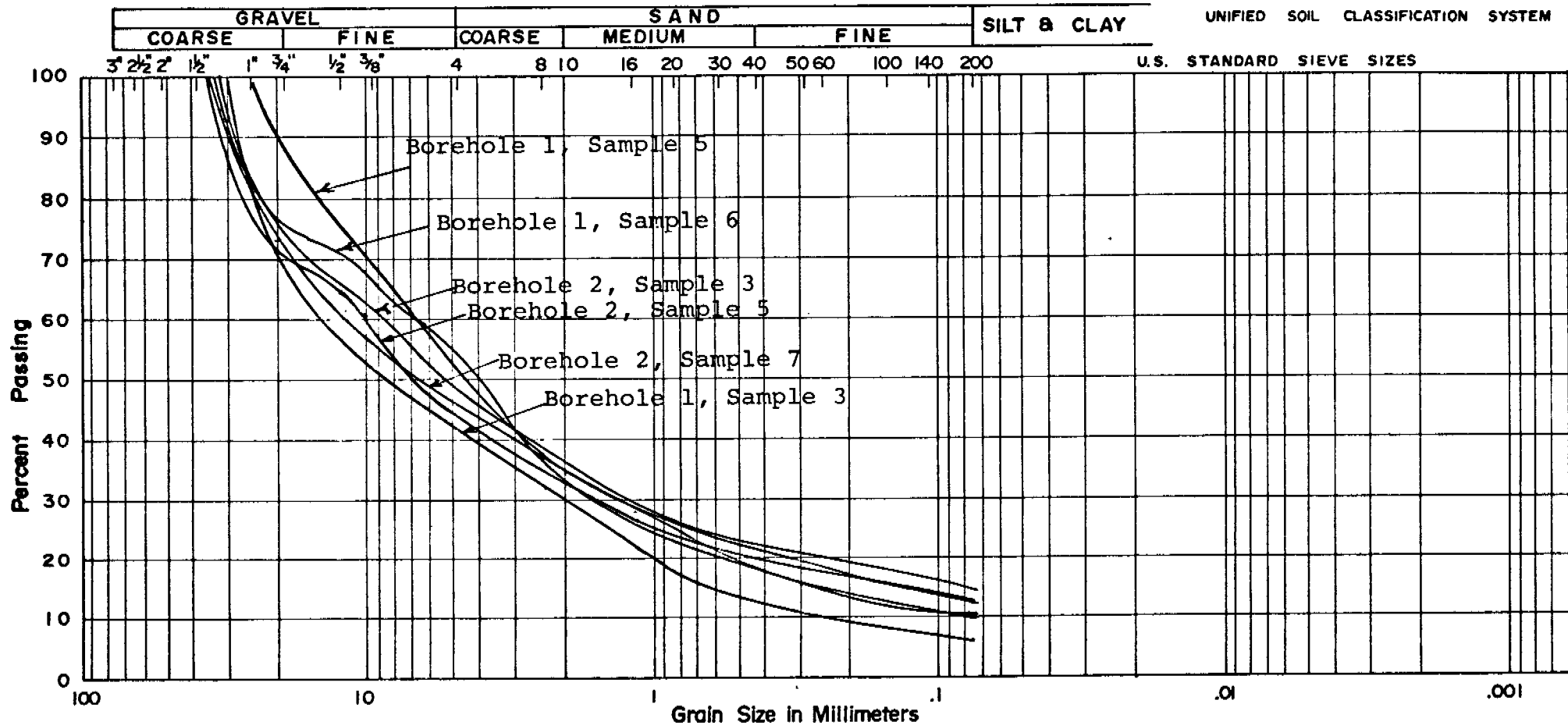
SUBSURFACE PROFILE				SAMPLES			PENETRATION RESISTANCE					WATER CONTENT %					REMARKS
ELEVATION Ft.	DEPTH Ft.	DESCRIPTION	SYMBOL	GROUND WATER	NUMBER	TYPE	'N' Blows / Foot	Blows / Foot					PLASTIC LIMIT W <sub>p</sub>	NATURAL W	LIQUID LIMIT W <sub>L</sub>		
								20	40	60	80	100					
								UNDRAINED SHEAR STRENGTH + FIELD VANE TEST								COMPRESSION TEST ●	
875.5	0.0	Ground Surface															
		2" Asphalt															
		Brown silty sand and gravel.															
870					1	SS	8										
		FILL															
865	10.0				2	SS	28										
					3	SS	30										
860		Compact to dense brown sand and gravel, some silt.			4	SS	39										
					5	SS	42										
855					6	SS	36										
850					7	SS	80										

2" diameter dynamic cone.

# DOMINION SOIL INVESTIGATION LIMITED

## GRAIN SIZE DISTRIBUTION

OUR REFERENCE № 73-4-L2



PROJECT: Canning Street Bridge,  
 LOCATION: Lucknow, Ontario.  
 BOREHOLE №:  
 SAMPLE №:  
 DEPTH:  
 ELEVATION:

COEFFICIENT OF UNIFORMITY:  
 COEFFICIENT OF CURVATURE:

### Classification of Sample and Group Symbol:

Sand and Gravel with  
5% to 15% silt.

### PLASTIC PROPERTIES

LIQUID LIMIT           % =  
 PLASTIC LIMIT       % =  
 PLASTICITY INDEX    % =  
 MOISTURE CONTENT    % =

ENCLOSURE № 5