

NEW BRIDGE

LOT 15 . CON. 4

LOBO TWP.

LOT 32 . CON 6

40P3 - 45

R.C. DUNN & ASSOCIATES LIMITED
CONSULTING ENGINEERS
747 HYDE PARK ROAD
LONDON ONTARIO

40 P3-45
GEOCRE No.

Report On
SOIL INVESTIGATION
for
PROPOSED NEW BRIDGE
LOT 15, CON. IV, LOBO TOWNSHIP
LOT 32, CON VI, LONDON TOWNSHIP

STRUCTURE SITE No. 74-8-120

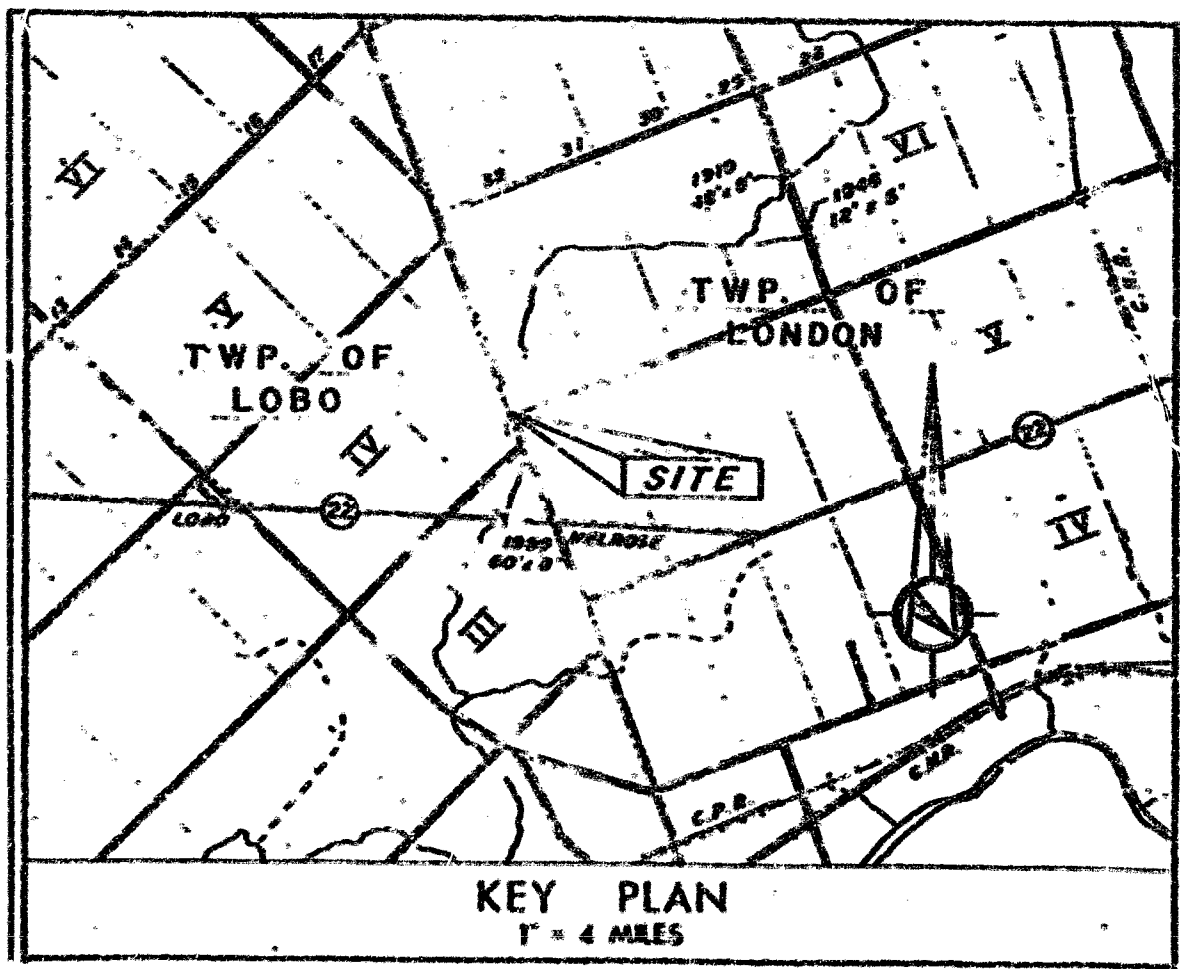
by

Dominion Soil Investigation Limited
1220 Trafalgar Street
London Ontario

Ref: 74-8-120
September 19, 1974

40 P3-45

GEOCRE No.



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INTRODUCTION

In accordance with authorization from R.C. Dunn & Associates Limited, Consulting Engineers, a soil investigation has been carried out on the Lobo-London Town line, where it is proposed to replace an existing road bridge with a new structure.

The existing 48-foot span steel truss structure is located on Lot 15, Concession IV of Lobo Township, and Lot 32 Concession VI of London Township. The site is located on the northern limit of the Hamlet of Melrose.

It is understood that the proposed structure will have a minimum span of 50 feet, and that it will be centred on the existing bridge. The requirements of the project were discussed with Mr. N.M. Warner, 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 September 5, 1974, 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 airtight containers and transferred to our London laboratory for classification, testing and storage.

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 related the ground surface elevations to a local benchmark. The benchmark was taken as the northwest bridge seat of the existing bridge, and it was given an 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 2 and 3, and a general picture of the soil stratigraphy is presented in the form of a Subsurface Profile on Enclosure 1. 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 approaches to the existing bridge. The fill generally consists of cohesive clayey silt, and it was found to extend to a depth of about 8 feet in both holes. The fill is underlain by a topsoil layer which is assumed to be the original ground surface.

The natural subsoil consists of granular materials which range in gradation from silt and fine sand, to sand and gravel, and borehole 1 was terminated in the granular material at a depth of 25½ feet. The granular strata have a stratified structure and at the horizon of the existing creek bed a sand and gravel layer was encountered. Below the sand and gravel the subsoil

consists of silt and fine sand. Grading analyses of representative samples of the granular materials are shown as grain size distribution curves on Enclosure 5.

Borehole 2 encountered a cohesive glacial silty clay stratum at El. 83±, and the borehole was terminated in the silty clay at El. 77. The silty clay has a 'hard' consistency as indicated by 'N' values of 100 and 103 blows per foot.

IV

GROUNDWATER CONDITIONS

The water level in the existing creek was observed at El. 92.8, and it may be assumed that the groundwater table coincides with the creek level at the proposed abutment locations.

V

DISCUSSION AND RECOMMENDATIONS

The natural soil profile consists of 'very dense' granular strata overlying 'hard' silty clay, and it may be assumed that the granular materials are

inherently suitable for the support of normal spread footing foundations. A driven pile foundation may be considered as an alternative.

Spread Footing Foundations

The creek bed extends down to El. 92± and it is understood that spread footings will be located between El. 87 and 86 to provide sufficient protection against frost action and erosion by scour. On the basis of the borehole results a maximum allowable soil pressure of 5 tons per square foot is appropriate for the design of footings at or below El. 87. This soil pressure incorporates a factor of safety of at least 3 against shear failure of the underlying soil and total settlement of footings up to 10 feet in width is estimated to be 0.5 inch or less.

The coefficient of friction between the footings and the underlying soil may be taken as 0.45, and the factor of safety against horizontal sliding of the abutments must be at least 1.5.

The major problem in construction of footings below the water table will be to control the groundwater, and prevent sloughing-in of the sides and boiling occurring in the bottom of the excavations. This can be achieved by carrying out the excavation inside continuous sheeting which should be driven into the impervious silty clay, or in the sand to a depth below the footing grade equal to the height of the groundwater table above the footing grade. After construction the sheeting may be left in place as a positive means of scour protection. Alternatively the groundwater table may be lowered below the footing grade during the construction period by the use of a well-point system.

Piled Foundations

An alternative to the use of spread footings with the associated groundwater problems would be the use of a driven pile foundation which could take the form of timber or concrete filled steel tubes. The length of the piles will be relatively short, therefore the use of timber piles is recommended. It is estimated that nominal 12-inch diameter timber piles will develop a working load of 20 tons if driven to El. 75.

The foregoing estimates of length and bearing capacity of piles are only theoretical predictions based on the soil data. In practice, the piles should be driven to a satisfactory set in accordance with an accepted pile driving formula, irrespective of the elevation at which such a set is achieved.

Mine 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	REDROCK	GROUND WATER LEVEL	DEPTH OF CAVE-IN
> 6"	5"	4"	4.75mm	2.0	0.42	0.075	0.002	>	NO. 2-10 LUST			

U. S. Standard Sieve Size

No. 4

No. 10

No. 40

No. 200

SAMPLE TYPES.

AS Auger sample

CS Sample from casing

CAS Chuck sample

RC Rock core

% Recovery

SS Split spoon sample

TP Piston, thin walled tube sample

Tn Open, thin walled tube sample

WS Wash sample

SAMPLER ADVANCED BY static weight

+ pressure

+ tapping

w

p

t

OBSERVATIONS

MADE WHILE

CORING

Steady pressure

No pressure

intermittent pressure

Steady pressure

No pressure

intermittent pressure

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PENETRATION RESISTANCES.

DYNAMIC PENETRATION RESISTANCE. - N - is to drive a 2" dia. 60° cone attached to the end of the driving rods into the ground, expressed in blows per foot.

STANDARD PENETRATION RESISTANCE. - N - is 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

SOIL PROPERTIES.

W % Water content

LL % Liquid limit

PL % Plastic limit

PI % Plasticity index

LI % Liquidity index

G

e

RD

C_vm_v

Natural bulk density (unit weight)

Void ratio

Relative density

Coeff. of consolidation

Coeff. of volume compressibility

k Coeff. of permeability

C Shear strength

Angle of internal friction

C' Cohesion

Angle of internal friction

UNDRAINED SHEAR STRENGTH.

- DERIVED FROM -

TRIAXIAL

COMPRESSION TEST

UNCONFINED

TEST

LABORATORY

VANE TEST

FIELD

PENETROMETER TEST

Strain at failure is represented by direction of stem

20%

15%

10%

5%

σ_u = sensitivity = $\frac{\text{shear strength in undrained state}}{\text{shear strength in remoulded state}}$

SOIL DESCRIPTION.

COHESIONLESS SOILS

RD:

Very loose

Loose

Compact

Dense

Very dense

0 - 15 %

15 - 35 %

35 - 65 %

65 - 85 %

85 - 100 %

COHESIVE SOILS

C lbs./sq. ft.

Very soft

Soft

Firm

Stiff

Very stiff

Hard

less than 250

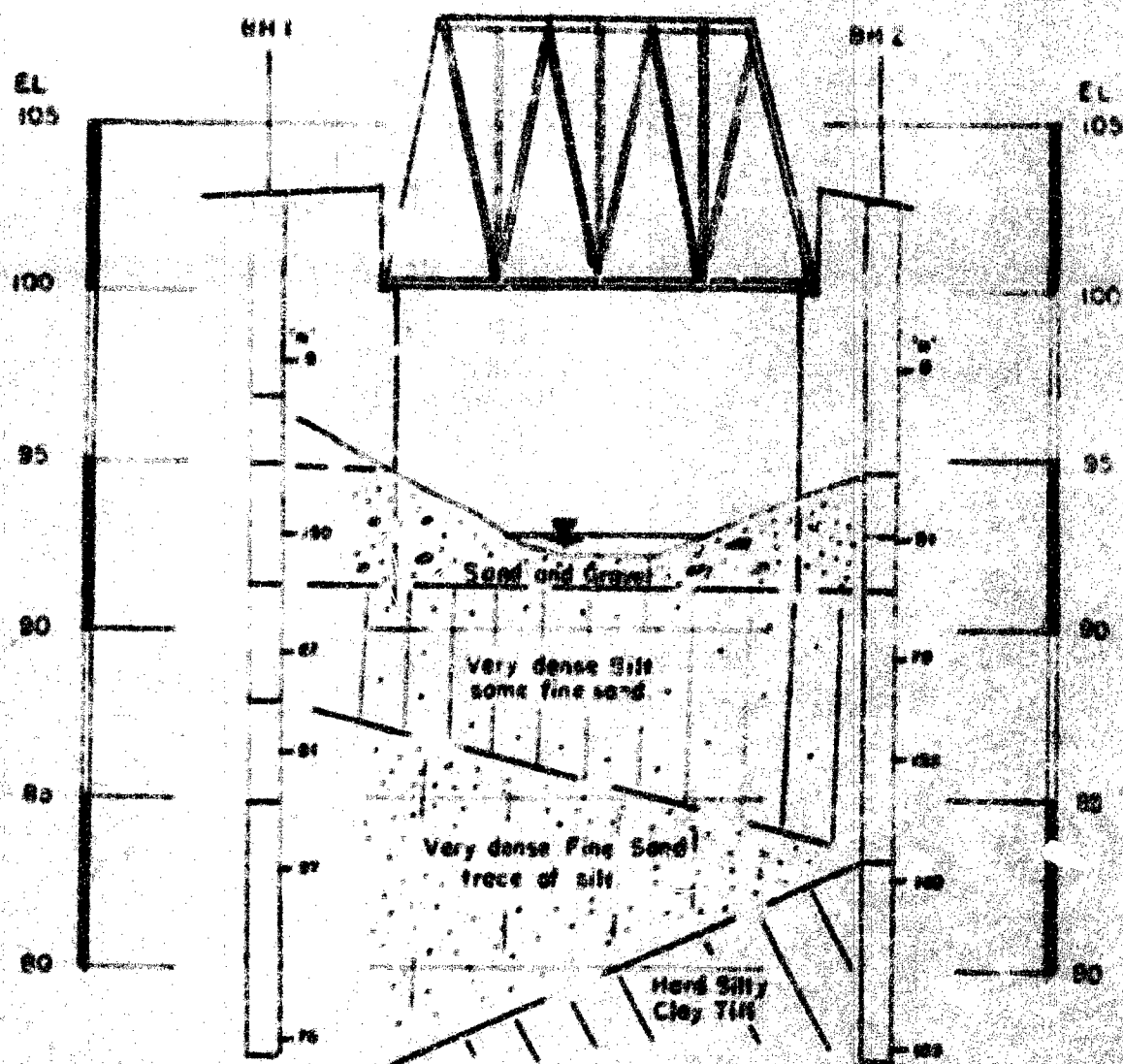
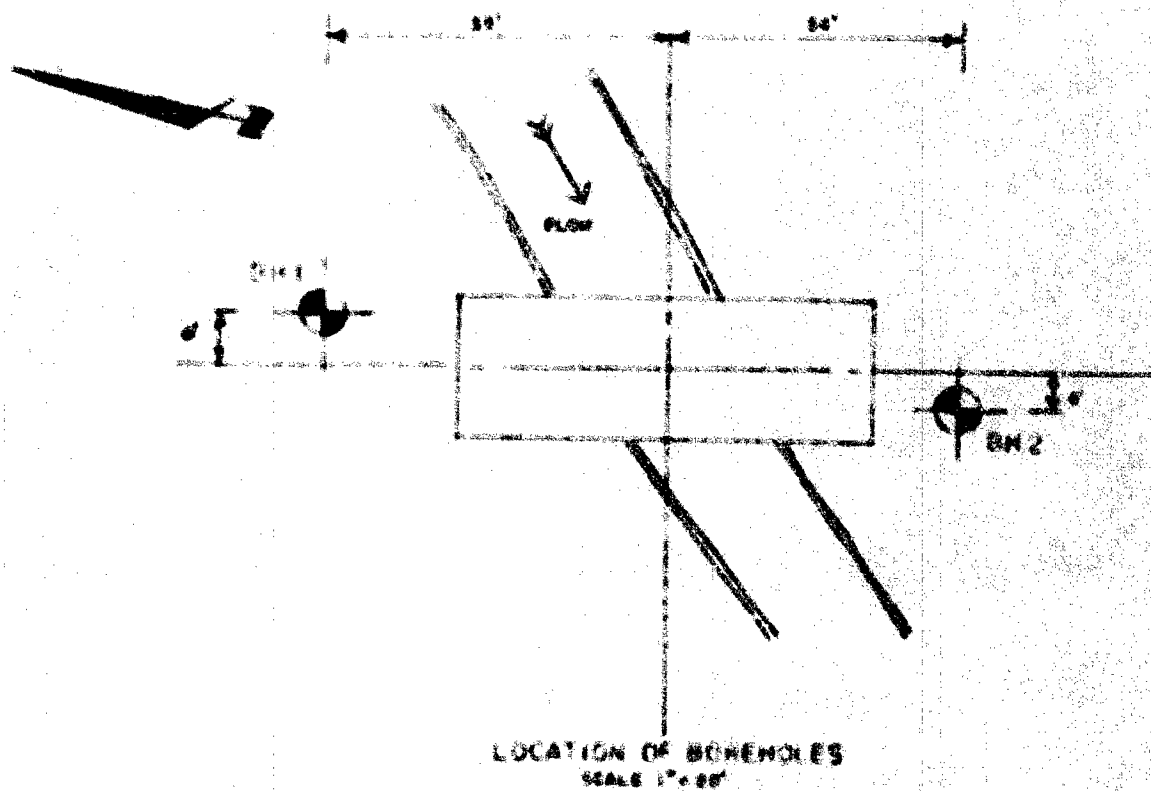
250 - 500

500 - 1000

1000 - 2000

2000 - 4000

over 4000



SUBSURFACE PROFILE
HORIZ SCALE 1" = 20'
VERT SCALE 1" = 5'

40P3-45
CHECKED No.

CLIENT: R.C. Dunn & Associates Ltd.,
 PROJECT: Bridge M.T.C.-231
 LOCATION: County of Middlesex
 DATUM ELEVATION: bridge seat, El. 100 feet

DRILLING DATA

Method: Auger
 Diameter: 4½ inch
 Date: Sept. 5, 1974.

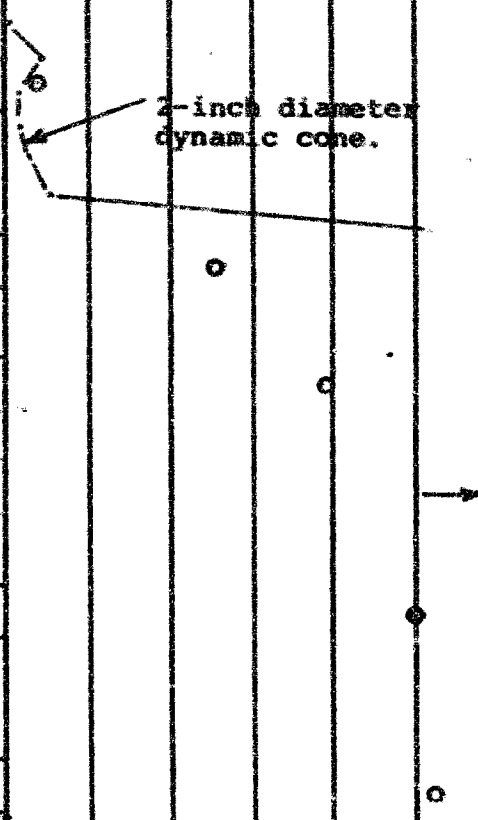
SUBSURFACE PROFILE			SAMPLES			PENETRATION RESISTANCE					Blows/ft.					PLASTIC LIMIT %	NATURAL WATER %	LIQUID LIMIT %
ELEVATION Ft.	DEPTH Ft.	DESCRIPTION	SYMBOL	GROUND WATER	NUMBER	TYPE	'N'	Blows/ft.	20	40	60	80	100					
									Undrained Shear Strength + Field cone test	p.s.f.				or Compression test				
102.9	0.0	Ground Surface																
		1" Asphalt																
		Sand and gravel.																
100		Brown clayey silt																
		trace of topsoil.																
		Fill.			1	SS	8											
60		Dark brown																
95	80	clayey silt.																
		Very dense			2	SS	150											
		brown sand																
		and gravel.																
115		Very dense			3	SS	67											
90		silt, some																
		fine sand.																
150		Very dense			4	SS	51											
		fine sand																
		trace of silt.																
85	180	Very dense			5	SS	97											
		fine sand,																
		traces of																
		silt and																
80		fine gravel.			6	SS	76											
255		End of Borehole																
75																		

2-inch diameter
dynamic cone.

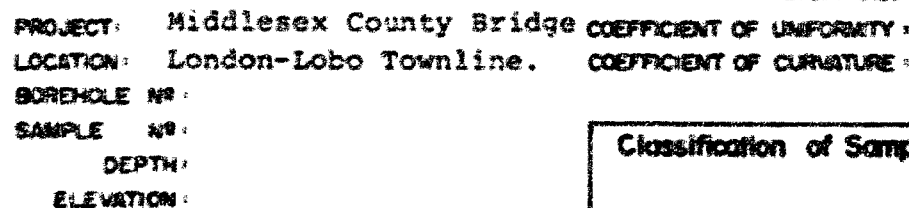
CLIENT: R.C. Dunn & Associates Ltd.,
 PROJECT: Bridge M.T.C.-231
 LOCATION: County of Middlesex
 DATUM ELEVATION: bridge seat, El. 100 feet

DRILLING DATA
 Method: Auger
 Diameter: 4 1/2 inch
 Date: Sept. 5, 1974

SUBSURFACE PROFILE				SAMPLES			PENETRATION RESISTANCE					Blows/ft.			
ELEVATION Ft.	DEPTH Ft.	DESCRIPTION	SYMBOL	GROUND WATER	NUMBER	TYPE	'N' Blows/Foot	20	40	60	80	100	PLASTIC LIMIT %	NATURAL WATER %	LIQUID LIMIT %
102.7	0.0	Ground Surface													
100		Brown clayey silt.			1	SS	8								
95	8.0	Fill. Topsoil.													
98		Very dense brown sand & gravel.			2	SS	51								
90	11.5	Very dense silt, some fine sand.			3	SS	79								
85					4	SS	132								
80	19.5	Hard grey silty clay, trace of sandy gravel.			5	SS	100								
75	25.0	End of Borehole			6	SS	103								



OUR REFERENCE #74-8-L2



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