

#64-F-281m

WARK BRIDGE

LOT 1, CON 889

LoBo

Twp

BA 1978

MESSRS. A. M. SPRIET & ASSOCIATES LIMITED
CONSULTING ENGINEERS
264 WELLINGTON ROAD
LONDON ONTARIO

Report on
SOIL INVESTIGATION
for
WALK BRIDGE
LOT 1, CONCESSIONS 8 AND 9
TOWNSHIP OF LOBO

by
DOMINION SOIL INVESTIGATION LIMITED
363 Queens Avenue
LONDON ONTARIO
Reference No. 4-10-11
November 5th, 1964

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SUMMARY

The boreholes encountered silty fill to a depth of 10 feet, sand and silt with organics to 20 feet, clean loose to very dense sand to about 35 feet, and clay and silt strata of varying consistency to 88 feet. A hard clay till was encountered at this level, and explored to 96.5 feet.

The use of timber piles appears to offer the best solution, and it is estimated that 12-inch diameter piles driven to El. 67 will have a safe working load of 20 tons per pile. The use of conventional spread footings and steel tube piles is also discussed.

I INTRODUCTION

Verbal authorization was received from Mr. A. M. Spriet on the 1st of October, 1964 to carry out a soil investigation at the site of a proposed new road bridge in the Township of Lobo.

It is understood that the centre line of the proposed new structure will lie 60 feet to the east of the east abutment of the existing structure which has collapsed. The new bridge will replace both the collapsed structure and a 28 foot span overflow structure located 200 feet to the east. The new bridge may have a single 70 foot span or possibly a 30 - 40 - 30 foot span arrangement. The requirements of the project were discussed with Mr. A. M. Spriet who supplied the foregoing information.

The purpose of this investigation was to reveal the sub-surface 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 was done during the period 2nd to 6th of October, 1964 and consisted of two boreholes at the locations shown on enclosure 2. Dynamic cone penetration tests were performed adjacent to each borehole and at two additional locations as shown.

The holes were advanced by washboring and lined with Bx (3-inch) casing. Standard penetration tests were performed at frequent intervals of depth to evaluate the relative density or consistency of the soil and to recover representative samples. One undisturbed sample was recovered from a cohesive stratum in borehole 1.

Borehole 1 was terminated at a depth of 61.5 feet and did not encounter any very dense strata of appreciable thickness. When borehole 2 had reached a depth of 41.5 feet and encountered similar conditions at this level it was decided to wash ahead, recovering only wash samples, until a dense stratum was encountered. A stiffening was noted at a depth of 85 feet and split spoon samples were taken between depths of 90 and 96.5 feet where borehole 2 was terminated.

The results of the field tests are shown on geotechnical data sheets comprising enclosures 3 to 6. Elevations have been referred to a local temporary datum as shown on enclosure 2.

III SUBSURFACE CONDITIONS

Details of the stratification at each borehole are shown on enclosures 3 to 6 and a general picture of the soil stratigraphy is given in the form of a subsurface profile on enclosure 2. The principal strata are as follows:

a) Fill

Both boreholes penetrated the road embankment for depths of 9 to 10 feet. The fill consists of sandy and clayey silt in a compact or *stiff* condition.

b) Flood deposit

Below the fill a blackish-brown deposit of fine sand and silt extends for a further depth of 10 feet. This material contains organic matter, traces of white shells, and in places a trace of clay. Its density is termed *loose* to *compact*.

c) Fine sand

At 19.5 feet below the ground surface the flood deposit changes to a clean fine sand whose relative density varies from *loose* to *very dense*. The grain size is fairly uniform, lying mainly in the No. 50 to No. 100 mesh sieve range. This deposit is 15 feet deep in borehole 1 and 20 feet deep in borehole 2. In the latter borehole its density is noticeably higher.

A second deposit of very dense fine sand was encountered between depths of 47 and 49 feet in borehole 1.

d) Clay silt mixtures

The sand is underlain by deposits of clay and silt in which the proportions of these constituents vary quite widely. At some elevations the deposit consists of a slightly cohesive silt while at others there is a definite layered structure of alternating clay and silt seams. In general, the consistency is *stiff* to *very stiff*.

e) A deposit of *stiff* plastic clay relatively free from silt seams was encountered in borehole 1 between depths of 49 and 56 feet. Borehole 2 was terminated in a *hard* grey clay which was encountered at a depth of 88 feet. The latter material is a glacial till deposit containing traces of fine granular particles.

IV SITE AND GEOLOGY

The site is located on the upper reaches of the East Branch of the Sydenham River, and within the physiographic region known as the Caradoc Sand Plains. The river in flood has cut a wide U-shaped valley through the easily-eroded sand strata.

The underlying clay soils belong to the Ekfrid Clay Plain formation.

V GROUNDWATER CONDITIONS

Groundwater was observed in the two boreholes at an average level of El. 89.7 feet which is 1.0 foot above the level of water in the adjacent river at that time.

VI DISCUSSION

The upper sand and silt strata are highly susceptible to scour, a factor which is of primary importance in selecting the type of foundation. They are also quite loose above El. 75 in borehole 1, and this is the highest satisfactory bearing level common to both boreholes. The maximum recommended net soil pressure at this level is 6000 pounds per square foot for undisturbed soil conditions.

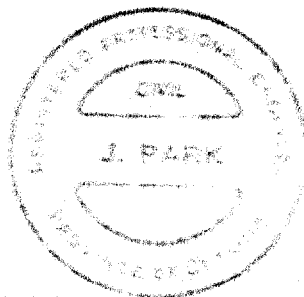
If spread footing foundations are used at El. 75, the dewatering of the excavation will be a major problem. It can be done by using sheet piling driven deep enough to prevent "boiling" or by using well points. The head of water above the suggested footing level was 13.7 feet at the time of the field work, and might be considerably higher during times of flood. Either of these methods might, therefore, be quite costly.

An alternative solution is to support the structure on timber piles driven into the sand stratum. The pile tips should be driven to about El. 67 to provide adequate protection against scour. For the conditions at borehole 2 where the sand is very dense, it will probably be necessary to use jetting to achieve the desired penetration without damaging the piles. The bearing capacity of the piles will be derived mainly from friction, and it is anticipated that nominal 12-inch diameter piles will reach a satisfactory set corresponding to a safe working load of 20 tons per pile at El. 67. The pile capacity should be determined in accordance with the Hiley formula and if the required set is not achieved at this level, the working load should be reduced and additional piles driven. The piles should not be driven below the recommended level or they may punch through into the looser silt strata below.

Consideration has been given to the use of steel pipe piles with a 60 ton working load. For the conditions at borehole 1, such piles would penetrate through the sand stratum into the underlying clay and silt. Experimental evidence and field measurements have indicated that the maximum friction or adhesion which can be generated on the sides of a pile is about 1.0 tons per square foot in sand and 0.5 tons per square foot in clay. On this basis the piles would only reach a satisfactory set in the deep till stratum at about El. 10. In practice it is believed that a wide variation in penetration would be experienced. Some piles would probably set on the thin dense sand layer at El. 50 while others would pass through it. For the conditions at borehole 2 where the main sand deposit is much denser, it is doubtful if the piles could be driven much below El. 65.

The settlement under spread footings bearing on undisturbed sand is unlikely to exceed 0.5 inch, and will occur immediately as the load is applied. No appreciable settlement would be expected in a piled structure provided that the piles are driven to a satisfactory set.

Dewatering of the excavation for the pile caps can probably be done by pumping from filtered sumps. If this proves to be inadequate, well-points or sheet pile cut-offs should be used. The sandy flood deposit has a slight cohesion due to the presence of clay and organics, and it is anticipated that the sides of the excavation will remain temporarily stable above the water level at a slope of 1 to 1.



DOMINION SOIL INVESTIGATION LIMITED

James Park

JP/mkf

James Park, M. Sc., P. Eng.

ENCLOSURES

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"	$\frac{3}{4}"$	4.75mm	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
 " pressure : p
 " tapping : t

OBSERVATIONS MADE WHILE CORING
 Steady pressure
 No pressure
 Intermittent pressure

Washwater returns
 Washwater lost

PENETRATION RESISTANCES.

DYNAMIC PENETRATION RESISTANCE : to drive a 2" ϕ , 100 lb cone attached to the end of the drilling rods into the ground, expressed in blows per foot.

STANDARD PENETRATION RESISTANCE, -N- : to drive a 1/2" 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:

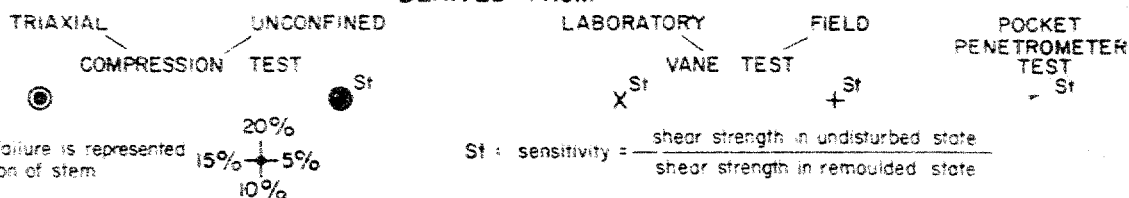
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SOIL PROPERTIES.

W % Water content	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

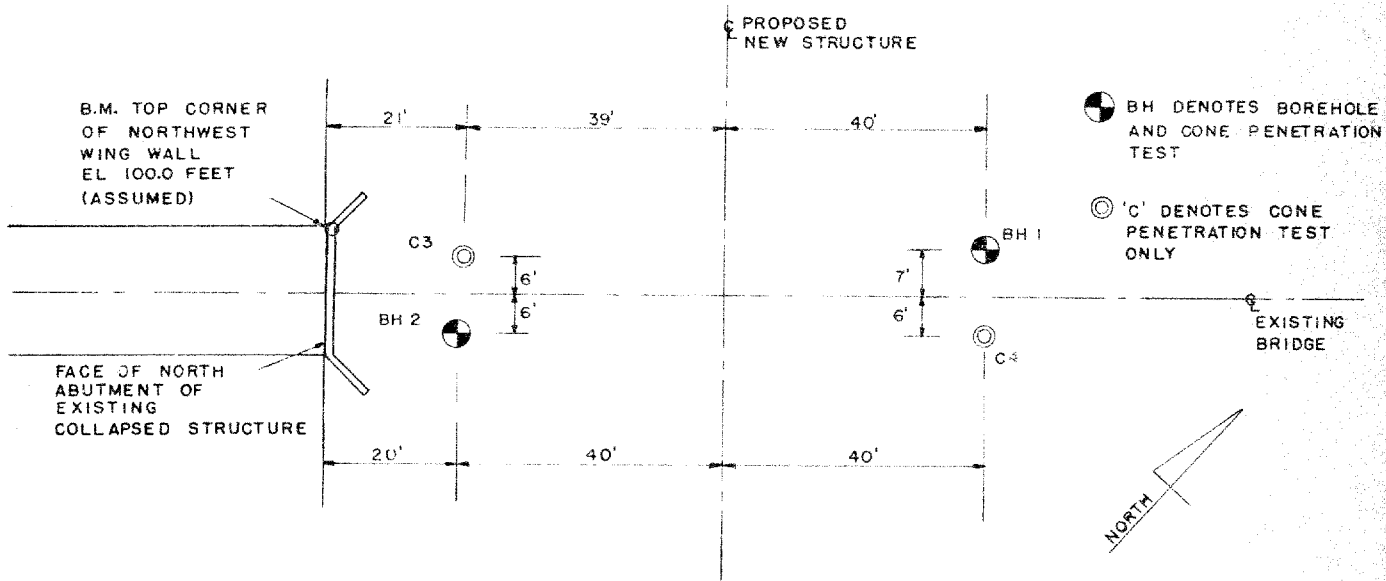
UNDRAINED SHEAR STRENGTH.

- DERIVED FROM -



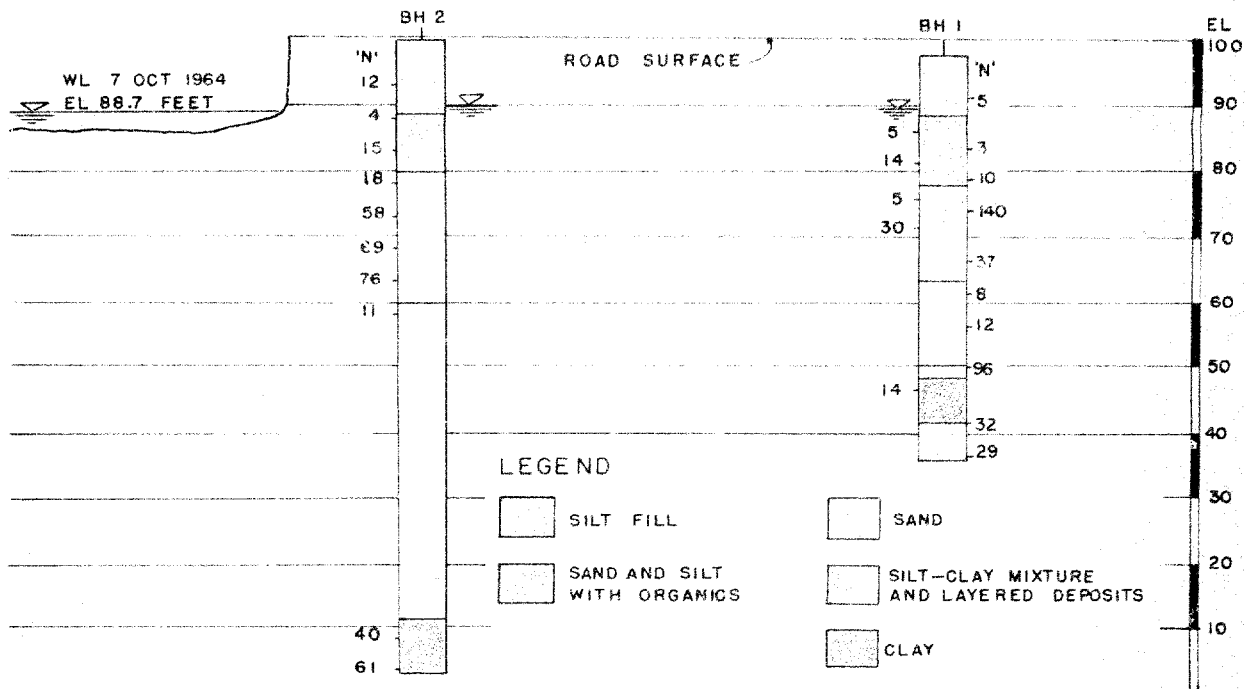
SOIL DESCRIPTION.

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 AND CONES

SCALE: 1 INCH TO 20 FEET



NOTE: FIGURES AT BOREHOLES DENOTE STANDARD PENETRATION RESISTANCE

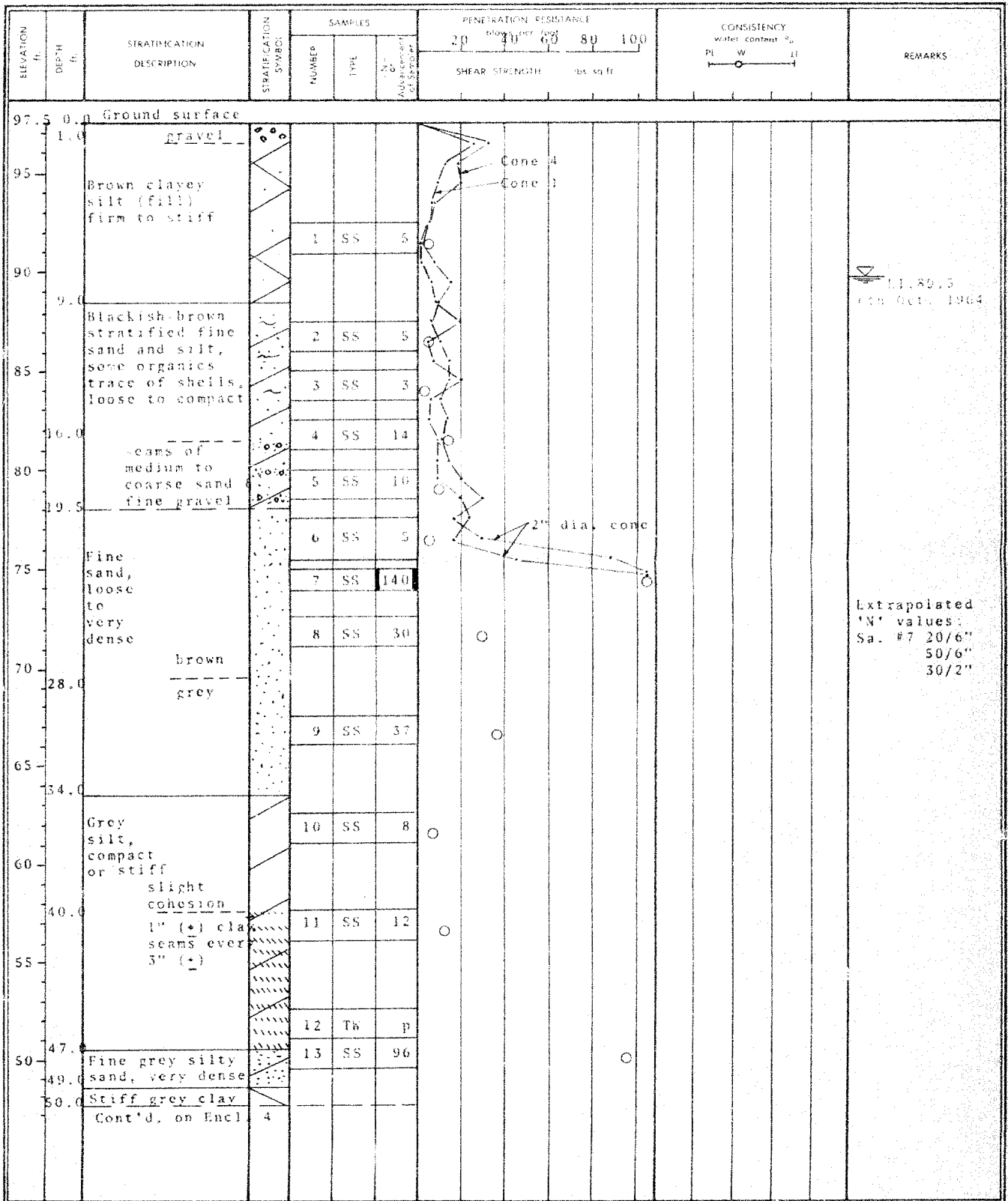
SUBSURFACE PROFILE

SCALE: 1 INCH TO 20 FEET

GEOTECHNICAL DATA SHEET FOR BOREHOLE 1.....

OUR REFERENCE NO. 4-10-11

CLIENT: Messrs. A.M. Spriet & Associates Ltd. METHOD OF BORING: Washboring
 PROJECT: Wark Bridge DIAMETER OF BOREHOLE: 8x (3-inch) ENCLOSURE NOS. 3
 LOCATION: Lobo Township DATE: October 2nd - 6th, 1964
 DATUM ELEVATION: 100.0' (Top of corner of N.W. wing wall of existing structure)



VERTICAL SCALE: 1 IN. TO 5 FT.

DOMINION SOIL INVESTIGATION LIMITED

MADE: MKF CHD: JP

GEOTECHNICAL DATA SHEET FOR BOREHOLE 1.

OUR REFERENCE NO. 4-10-L1

CLIENT: Messrs. A.M. Spriet & Associates Ltd. METHOD OF BORING: Washboring
 PROJECT: Wark Bridge DIAMETER OF BOREHOLE: 8x (3-inch) ENCLOSURE NO. 4
 LOCATION: Lobo Township DATE: October 2nd - 6th, 1964
 DATUM ELEVATION: 100.0' (Top of corner of N.W. wing wall of existing structure)

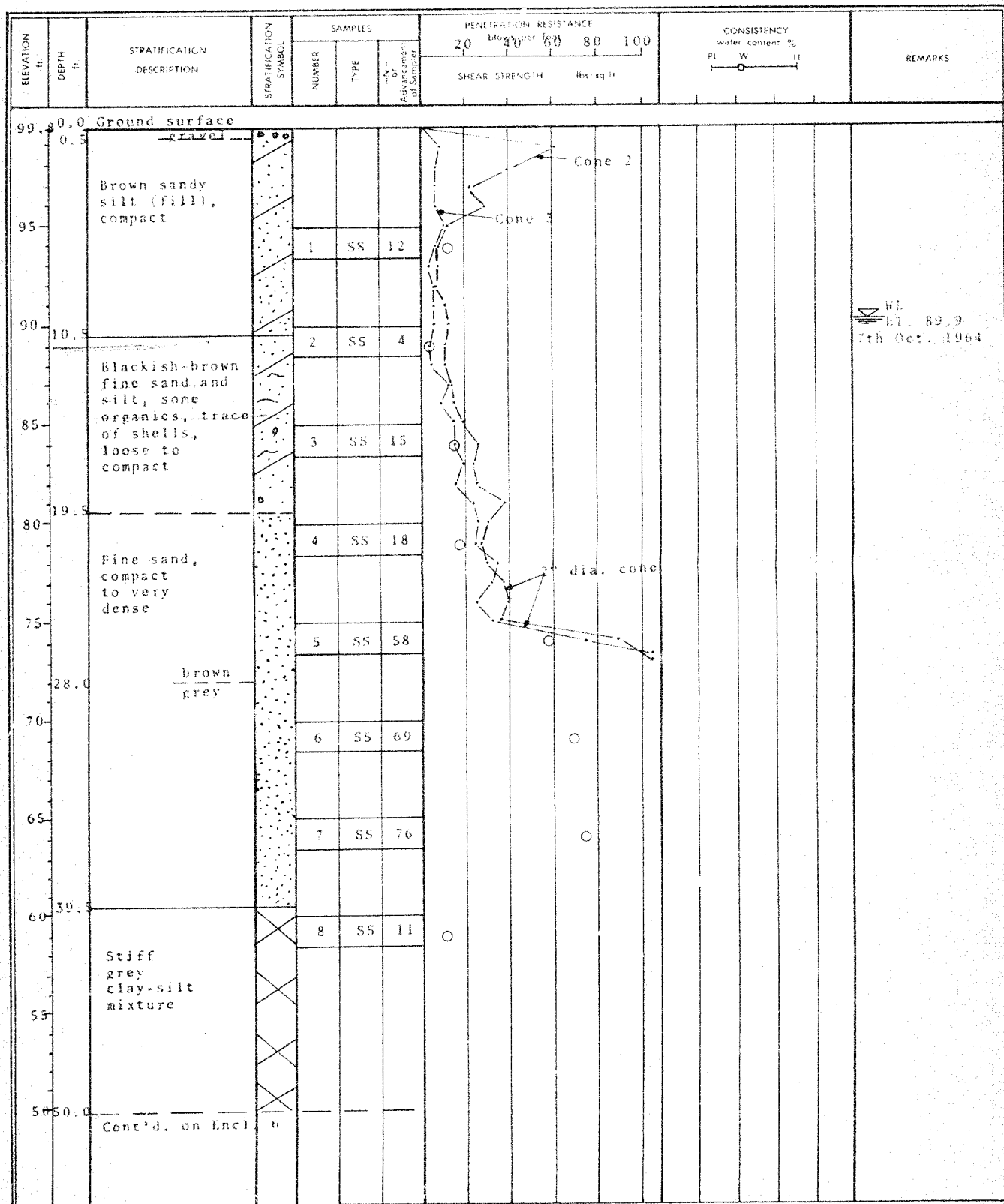
ELEVATION ft.	DEPTH ft.	STRATIFICATION DESCRIPTION	STRATIFICATION SYMBOL	SAMPLES			PENETRATION RESISTANCE				CONSISTENCY				REMARKS
				NUMBER	TYPE	N. of Advance of Sampler	20	40	60	80	100	PL	W	LI	
47.5	50.0	Stiff grey clay		14	SS	14									
45															
50.0		Grey silt slight stiff cohesion		15	SS	32									
40		to 1" (+) clay very seams every													
61.5		stiff 3' to 4'		16	SS	29									
		End of borehole													

OUR REFERENCE NO. 4-10-11

GEOTECHNICAL DATA SHEET FOR BOREHOLE

CLIENT: Messrs. A. M. Spriet & Associates Ltd. METHOD OF BORING: Washboring
 PROJECT: Wark Bridge, DIAMETER OF BOREHOLE: Bx (3-inch)
 LOCATION: Lobo Township, DATE: October 6th and 7th, 1964
 DATUM ELEVATION: 100.0' (Top of corner of N.W. win wall of existing structure)

ENCLOSURE NO. 5



VERTICAL SCALE: 1 IN. TO 5 FT.

DOMINION SOIL INVESTIGATION LIMITED

MADE MKP CHD: JP

OUR REFERENCE NO. 4-10-L1

GEOTECHNICAL DATA SHEET FOR BOREHOLE 2

CLIENT: Messrs. A.M. Spriet & Associates Ltd.
 PROJECT: Wark Bridge
 LOCATION: Lobo Township
 DATUM ELEVATION: 100.0' (Top of corner of N.W. wing wall of existing structure)

METHOD OF BORING: Washboring
 DIAMETER OF BOREHOLE: 8x (3-inch)

ENCLOSURE NO. 6

DATE: October 6th and 7th, 1964

ELEVATION ft.	DEPTH ft.	STRATIFICATION DESCRIPTION	STRATIFICATION SYMBOL	SAMPLES			PENETRATION RESISTANCE blows per foot					CONSISTENCY water content %			REMARKS			
				NUMBER	TYPE	N or Advancement of Sampler	20	40	60	80	100	PL	W	LI				
49.8	50.0	Stiff grey clay-silt mixture			W A S H S A M P L E S O N L Y													
45																		
40																		
35																		
30																		
25																		
20																		
15																		
10	88.0			Hard grey silty clay			9	SS	40									
5	10						SS	61										
	96.8	End of borehole																

VERTICAL SCALE: 1 IN. TO 5 FT.

DOMINION SOIL INVESTIGATION LIMITED

MADE: MKF

CH'D: JP