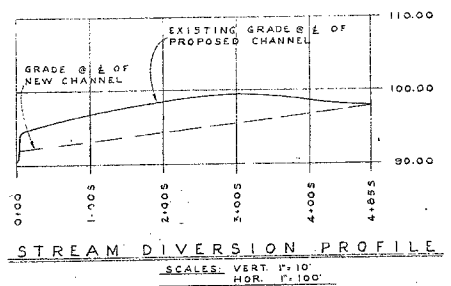
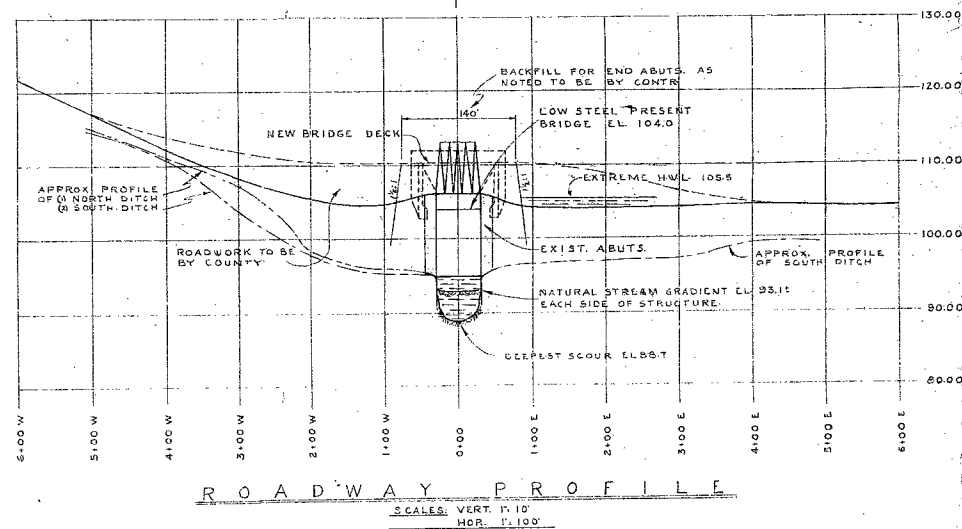
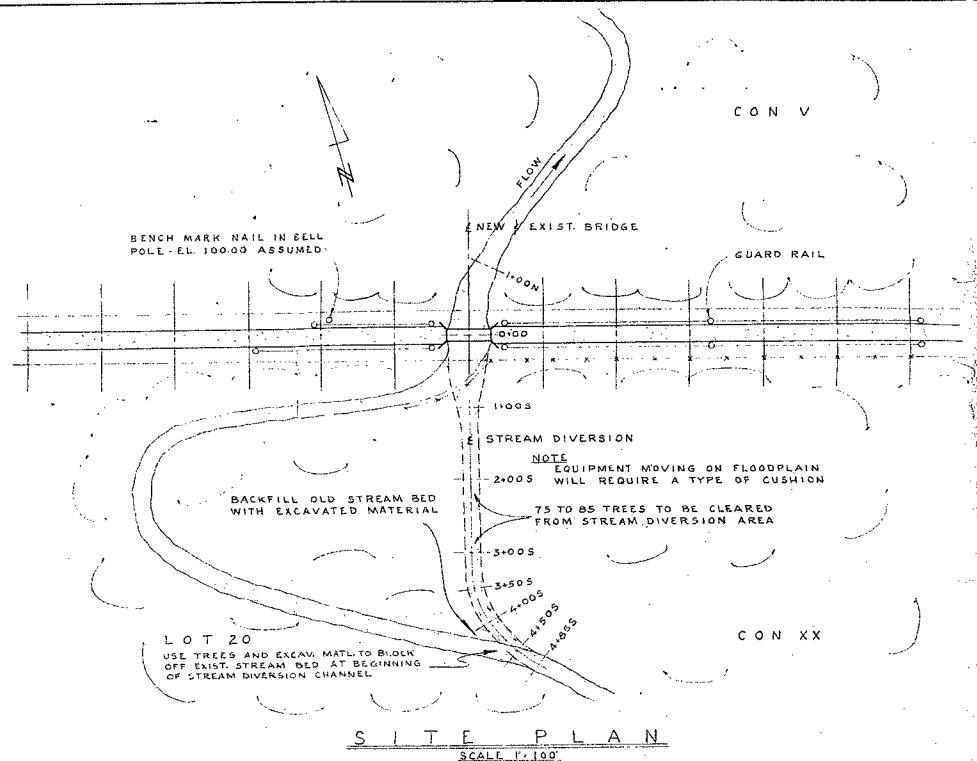
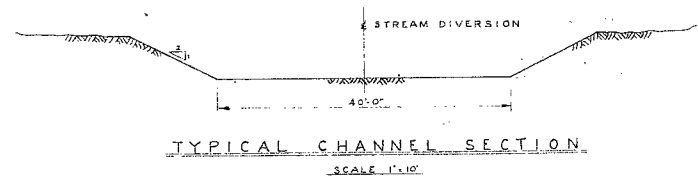
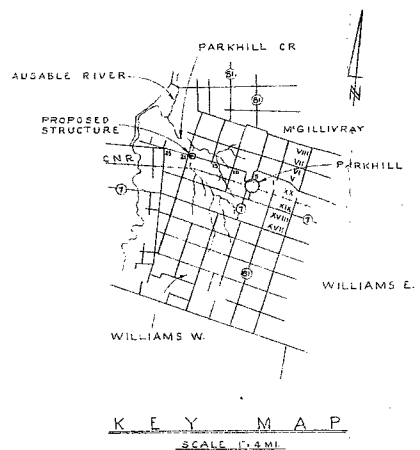
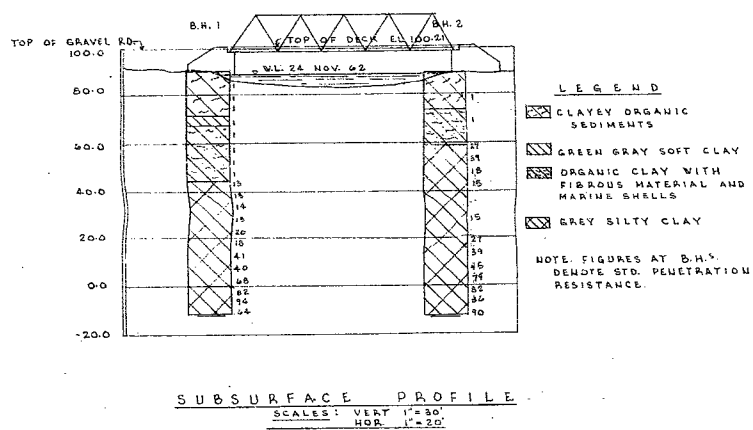
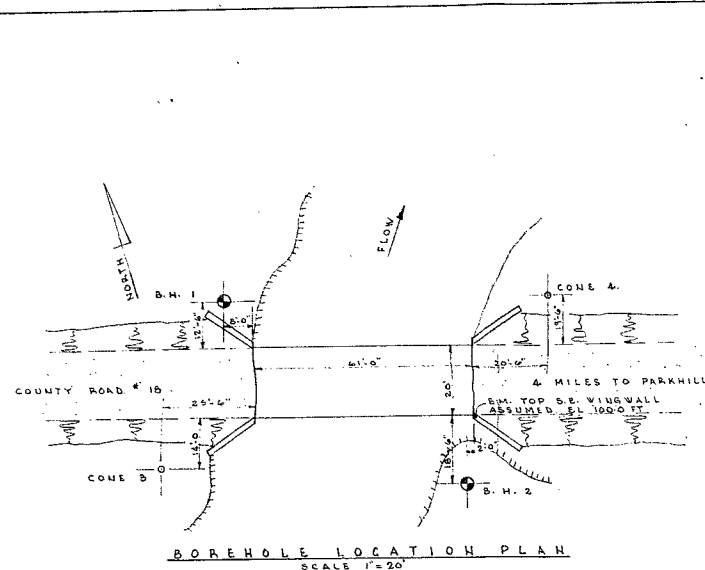


#62-F-290M

COUNTY RD#18

BRIDGE #104



1. Special Features: Waterfalls, Recreational Floods, Inc. Refinement, Office Notes, etc.
2. (a) Pasture and Pasture Bridges (Give Location, Length, Height, above M.H.L., Not Grassed-off Area at M.H.L. Estimated Area)
 - (1) 1 mile downstream: 8' span of 22' feet on steel beam, 11' from M.H.L. to 5/8" to 3/4" from M.H.L. to top of stream bed; 10' high; Area: 100 sq. ft.
 - (2) 1 mile upstream: 10' span; 11' high; 22' upon steel beam; 7-10' I beam; 2' from M.H.L. to 100' to 100' to top; 100 sq. ft.
 - (3) 1 mile upstream: 10' span; 11' high; 22' upon steel beam; 7-10' I beam; 2' from M.H.L. to 100' to 100' to top; 100 sq. ft.
 - (4) 1 mile upstream: 10' span; 11' high; 22' upon steel beam; 7-10' I beam; 2' from M.H.L. to 100' to 100' to top; 100 sq. ft.
 - (5) 1 mile upstream: 10' span; 11' high; 22' upon steel beam; 7-10' I beam; 2' from M.H.L. to 100' to 100' to top; 100 sq. ft.
- (b) Reasons why these bridges are, or are not, fair indications of size of proposed bridge:

These bridges are a fair indication of the size required. The older bridges do not provide enough clearance at M.H.L.
3. Reasons for Change in Height or Length from that of Old Bridge:

THE EXIST. BRIDGE, SPAN 15' 61" FT. THE PROPOSED BRIDGE IS A 3-SPAN STRUCTURE, 30', 40', 30' TO ELIMINATE THE HOR. THRUST OF THE APPROACH HILL. THE WATERWAY AREA IS COMPATIBLE TO A 66' SIMPLE SPAN STRUCTURE. THE ORGANIC SEDIMENTS UNDER THE BRIDGE ARE SUSCEPTIBLE TO SCOUR, AND PROTECTION IS PROPOSED.
4. Is Ditch, Stream or River Gradient liable to be lowered? Yes
5. Has Approval Been Obtained Under Navigable Water Protection Act? Yes
6. Is a Temporary Detour Required? Yes
- Who Will Build It? CONTRACTOR
- Who Will Maintain It? CONTRACTOR
7. Information and Evidence of Extreme Flooding was Obtained from Local Residents, and reflects Highest Water Elevation in the Area of this Construction to be 105.5, and the Lowest Water Elevation to be 93.5.
8. Road Design Information: Estimated A.D.T. 1000 vehicles.
Design Speed: 45 m.p.h.
Stopping Sight Distance: 600 feet.

STRUCTURE DATA	
1. Net Span Length and Type of Bridge:	3 SPANS 30', 40', 30', STEEL
COMPOSITE GIRDERS, ABUTMENTS & PIERS ON ST. TUBE PILES	
2. Roadway Width on Bridge:	30 FT
3. Number and Width of Sidewalks:	NONE
4. Skew Angle:	10.54° INTERLOCKING STEEL PILE BRIDGE
5. Total Length and Type of Piling:	124' 0.0" TUBE PILES - 214.5' UN. FT.
6. Approx. Volume of Concrete:	320.0 cu. yds
7. Approx. Weight of Str. Steel:	48.5 Tons
8. Approx. Weight of Reinforcements:	20.5 Tons
9. Approx. Volume of Approach Fill:	100' Each Side of structure
10. Drainage Area:	25.7 ac. MI.
Field Investigation Made NOV 17, 1963 By A. M. SPRIET Survey Engineer.	

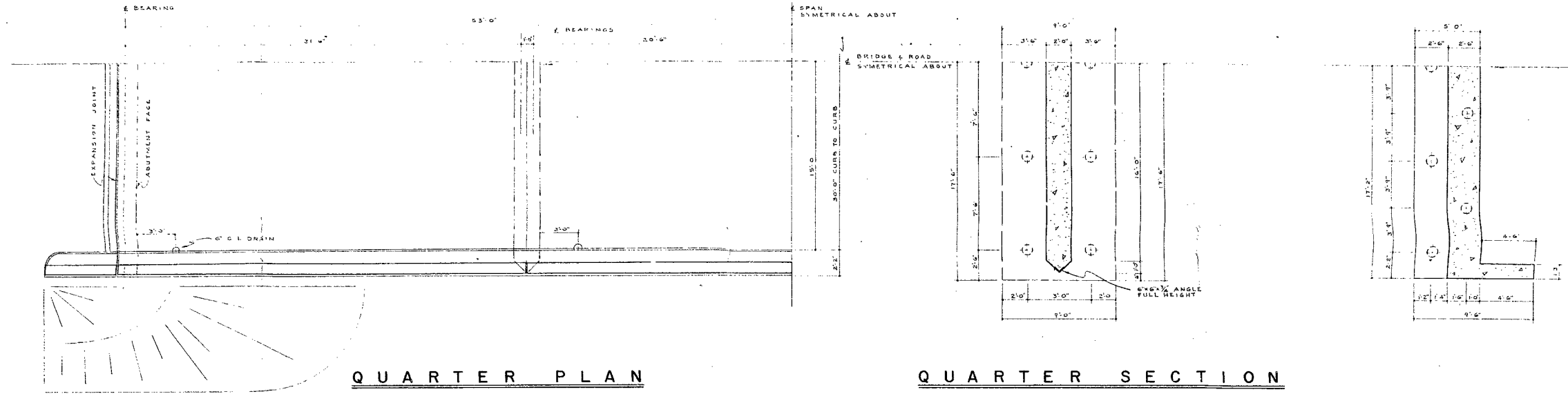
BRIDGE #104 COUNTY RD #18
COUNTY OF MIDDLESEX
STRUCTURE 20-29

BRIDGE #104 COUNTY RD #18
COUNTY OF MIDDLESEX
STRUCTURE 20-29

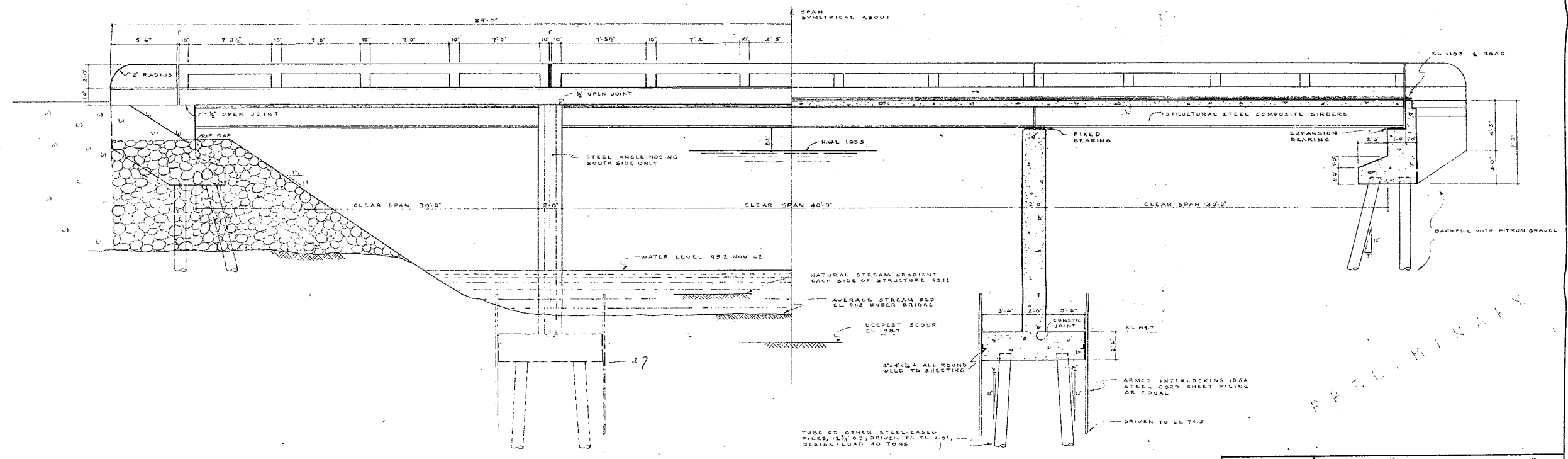
OWNER: COUNTY
COUNTY: MIDDLESEX
TOWNSHIP: MCGILLIVRAY
MUNICIPAL DISTRICT NO. 2
ROAD NO. 18
CONCESSION V XX

SITE PLAN

SCALE AS SHOWN
DATE: 31-1-63
APPROVED BY: A. J. DEVOE
JOB NO. 6233
DRAWN BY: A. J. DEVOE
F. B. D. ARNOLD, P. ENG.
COUNTY ENGINEER
A. M. SPRIET & ASSOCIATES
CONSULTING ENGINEERS
TORONTO & SINGAPORE

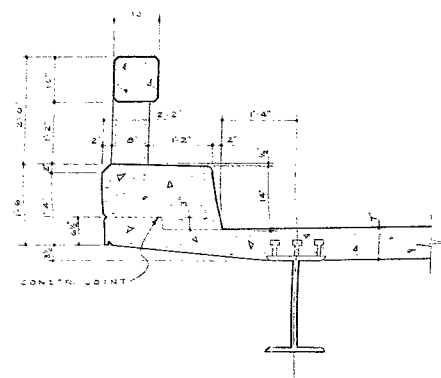


SCALE $\frac{1}{4}'' = 1'-0''$



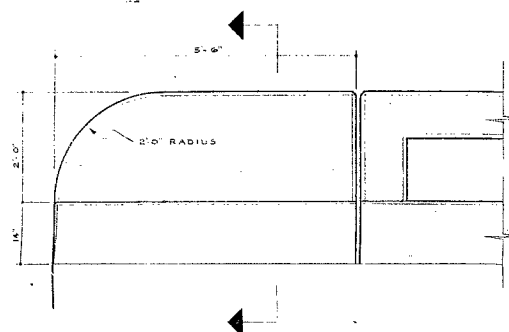
SCALE $\frac{1}{4}'' = 1'-0''$

BRIDGE #104 COUNTY RD#18			
COUNTY OF MIDDLESEX			
SCALE: AS SHOWN	APPROVED BY:	JOB NO. 6233	DRAWN BY: A.J.D.
DATE: 11-2-63			REUSED
PLAN, SECT. & ELEV.			
A. J. DEVOS & ASSOCIATES CONSULTING ENGINEERS LONDON & BRIDGE			DRAWING NUMBER 2



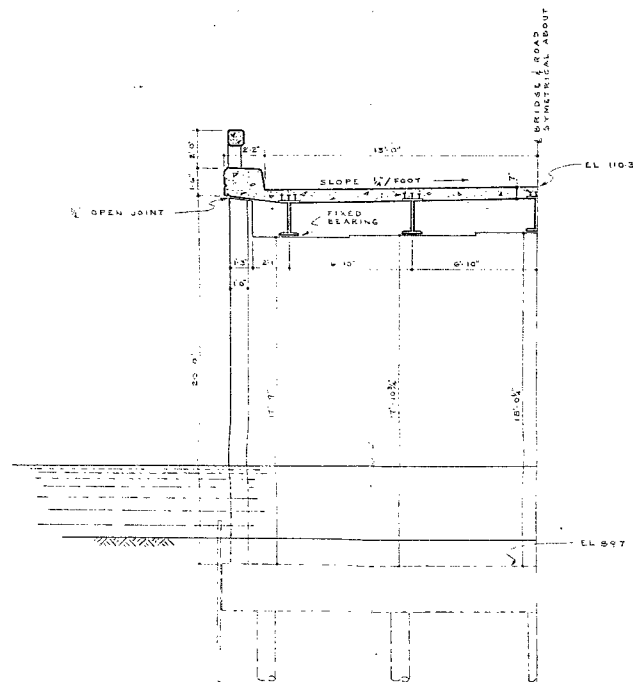
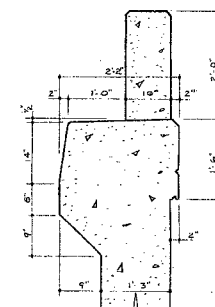
CURB & RAIL DETAIL

SCALE $\frac{3}{4}'' = 1'-0''$



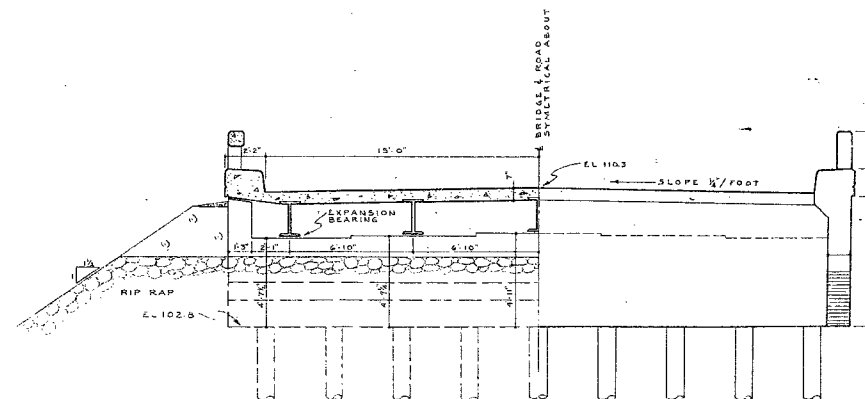
END POST DETAIL

SCALE $\frac{3}{4}'' = 1'-0''$



HALF CROSS SECTION - PIER

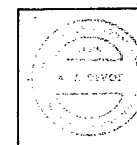
SCALE $\frac{1}{4}'' = 1'-0''$



HALF CROSS SECTION

HALF END VIEW

SCALE $\frac{1}{4}'' = 1'-0''$

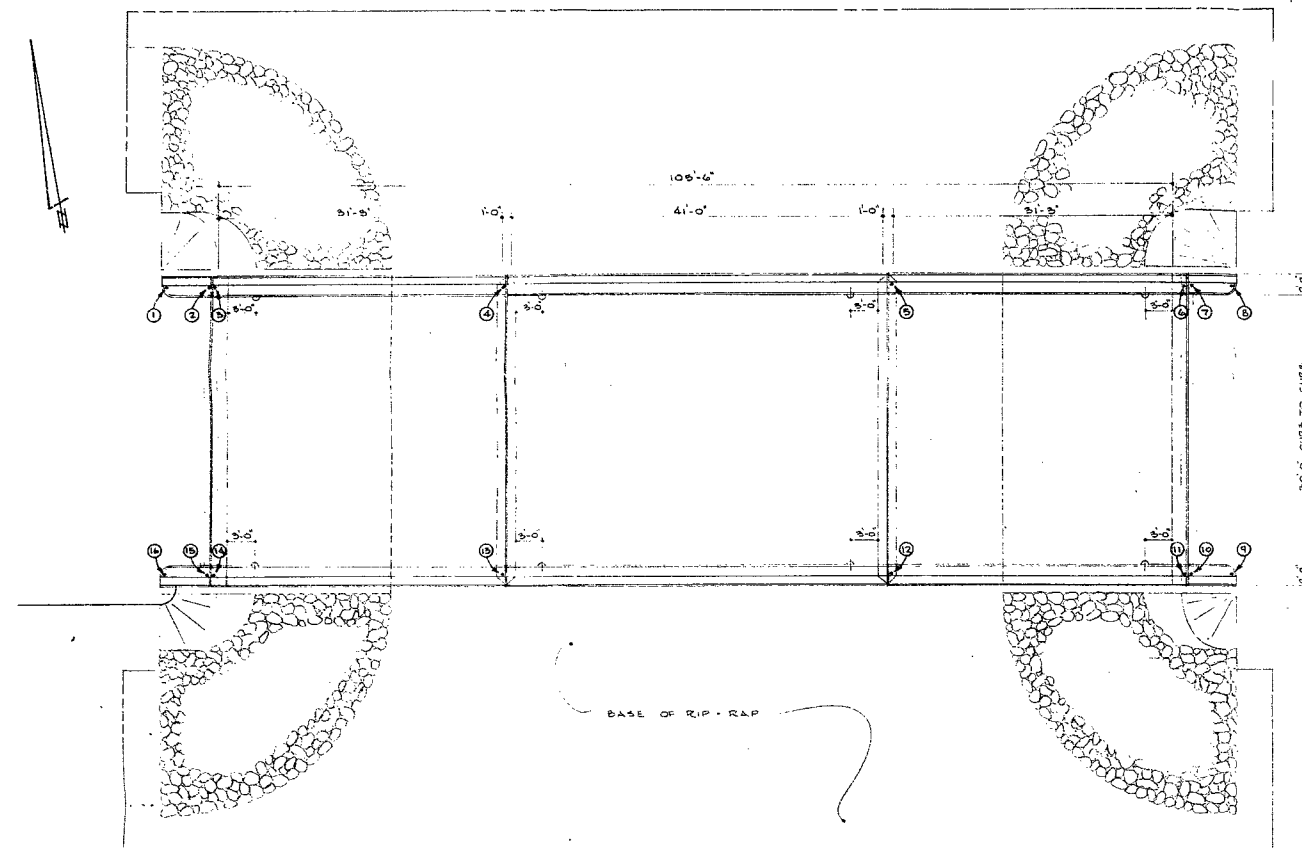


BRIDGE #104 COUNTY RD#18
COUNTY OF MIDDLESEX

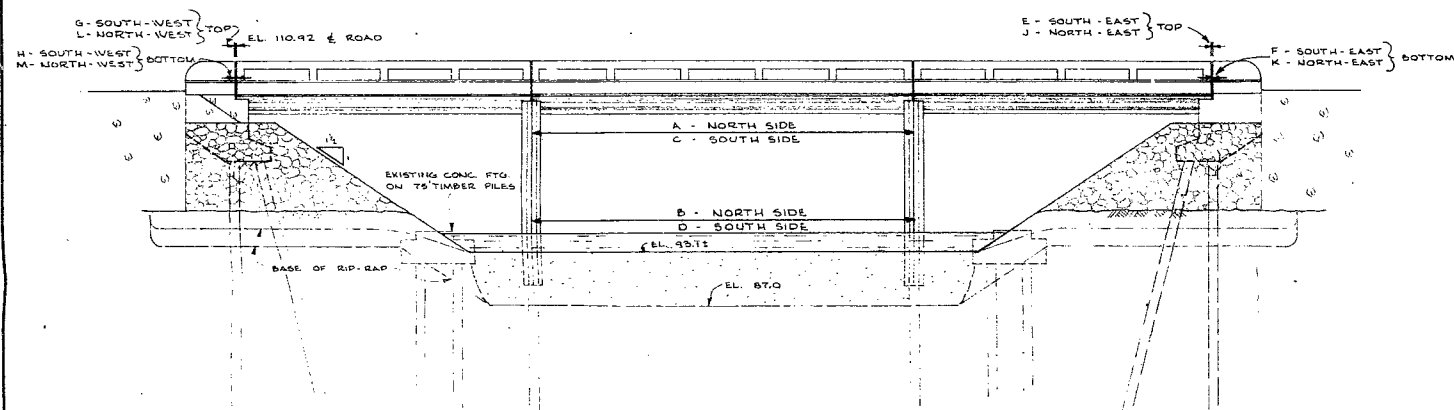
SCALE: AS SHOWN	APPROVED BY:	JOB NO.	DRAWN BY: A.J.D.
DATE: 11-2-63		6233	REVISED

ELEVATIONS & DETAILS

A. J. DEVOY & ASSOCIATES CONSULTING ENGINEERS LONGDON, N. Y.	DRAWING NUMBER 3
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PLAN SCALE $\frac{1}{8}'' = 1'-0''$



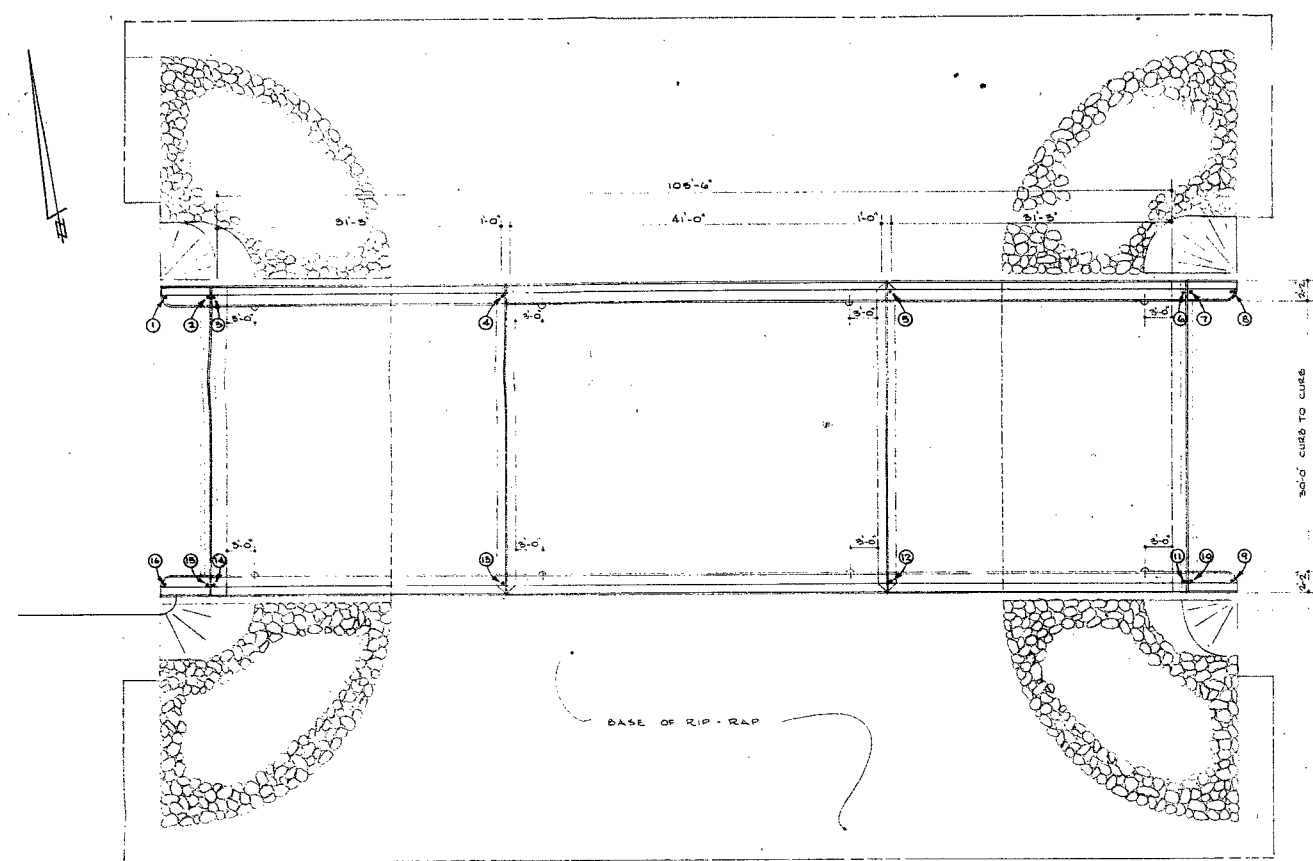
ELEVATION SCALE $\frac{1}{8}'' = 1'-0''$

NOTE
D.M. NAIL IN HYDRO POLE ON NORTH SIDE OF
COUNTY ROAD 110' WEST OF BRIDGE
ELEV. 50.00

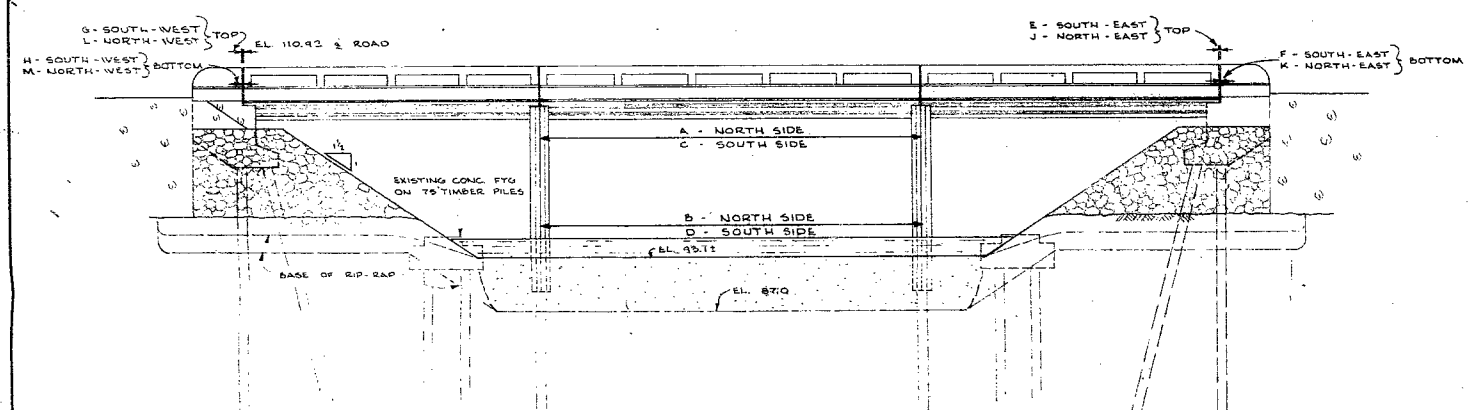
RECORDED ELEVATIONS & DIMENSIONS

DATE	ELEVATIONS																DIMENSIONS													REMARKS		
	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	A	B	C	D	E	F	G	H	I	J	K	L	M			
																	41.0	41.0	41.0	0.08	0.08	0.08	0.08	0.08	0.08	0.08	0.08	0.08	0.08	0.08	DIMENSIONS ACCORD TO PLANS.	
12-7-65	94.00	94.16	94.20	94.17	94.17	94.19	94.17	94.04	94.19	94.11	94.12	94.15	94.09	94.05	94.05	94.05	41.0	41.0	41.0	0.14	0.14	0.14	0.14	0.14	0.14	0.14	0.14	0.14	0.14	0.14	0.14	VARIATIONS IN SPACES A,B,C,D MAY NOT BE
5-6-65	94.01	94.18	94.21	94.16	94.17	94.19	94.16	94.04	94.19	94.12	94.12	94.14	94.10	94.05	94.05	94.05	41.0	41.0	41.0	0.14	0.14	0.14	0.14	0.14	0.14	0.14	0.14	0.14	0.14	0.14	0.14	ACCURATE - VERY DIFFICULT TO MEASURE

COUNTY BRIDGE #104
COUNTY OF MIDDLESEX
SCALE(S) SHOWN APPROVED BY JOB NO. DRAWN BY W.R.
DATE: 12-7-65 Misc. REVISED
RECORDED ELEVATIONS & DIMENSIONS
FOR STABILITY OBSERVATIONS
A.M. SPIRIET & ASSOCIATES LTD.
CONSULTING ENGINEERS



PLAN SCALE $\frac{1}{8}'' = 1'-0''$



ELEVATION SCALE $\frac{1}{8}'' = 1'-0''$

NOTE
B.M. NAIL IN HYDRO POLE ON NORTH SIDE OF
COUNTY ROAD 110' WEST OF BRIDGE
ELEV. 50.00

RECORDED ELEVATIONS & DIMENSIONS

DATE	ELEVATIONS																DIMENSIONS												REMARKS																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																					
	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	A	B	C	D	E	F	G	H	I	J	K	L		M																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																				
12-7-65	59.00	59.16	59.20	59.17	59.17	59.19	59.17	59.04	58.89	59.11	59.12	59.13	59.09	59.08	59.05	58.88	41.04	41.67	41.03	41.13	41.03	41.03	41.03	41.03	41.03	41.03	41.03	41.03	41.03	41.03	41.03	41.03	41.03	41.03	41.03	41.03	41.03	41.03	41.03	41.03	41.03	41.03	41.03	41.03	41.03	41.03	41.03	41.03	41.03	41.03	41.03	41.03	41.03	41.03	41.03	41.03	41.03	41.03	41.03	41.03	41.03	41.03	41.03	41.03	41.03	41.03	41.03	41.03	41.03	41.03	41.03	41.03	41.03	41.03	41.03	41.03	41.03	41.03	41.03	41.03	41.03	41.03	41.03	41.03	41.03	41.03	41.03	41.03	41.03	41.03	41.03	41.03	41.03	41.03	41.03	41.03	41.03	41.03	41.03	41.03	41.03	41.03	41.03	41.03	41.03	41.03	41.03	41.03	41.03	41.03	41.03	41.03	41.03	41.03	41.03	41.03	41.03	41.03	41.03	41.03	41.03	41.03	41.03	41.03	41.03	41.03	41.03	41.03	41.03	41.03	41.03	41.03	41.03	41.03	41.03	41.03	41.03	41.03	41.03	41.03	41.03	41.03	41.03	41.03	41.03	41.03	41.03	41.03	41.03	41.03	41.03	41.03	41.03	41.03	41.03	41.03	41.03	41.03	41.03	41.03	41.03	41.03	41.03	41.03	41.03	41.03	41.03	41.03	41.03	41.03	41.03	41.03	41.03	41.03	41.03	41.03	41.03	41.03	41.03	41.03	41.03	41.03	41.03	41.03	41.03	41.03	41.03	41.03	41.03	41.03	41.03	41.03	41.03	41.03	41.03	41.03	41.03	41.03	41.03	41.03	41.03	41.03	41.03	41.03	41.03	41.03	41.03	41.03	41.03	41.03	41.03	41.03	41.03	41.03	41.03	41.03	41.03	41.03	41.03	41.03	41.03	41.03	41.03	41.03	41.03	41.03	41.03	41.03	41.03	41.03	41.03	41.03	41.03	41.03	41.03	41.03	41.03	41.03	41.03	41.03	41.03	41.03	41.03	41.03	41.03	41.03	41.03	41.03	41.03	41.03	41.03	41.03	41.03	41.03	41.03	41.03	41.03	41.03	41.03	41.03	41.03	41.03	41.03	41.03	41.03	41.03	41.03	41.03	41.03	41.03	41.03	41.03	41.03	41.03	41.03	41.03	41.03	41.03	41.03	41.03	41.03	41.03	41.03	41.03	41.03	41.03	41.03	41.03	41.03	41.03	41.03	41.03	41.03	41.03	41.03	41.03	41.03	41.03	41.03	41.03	41.03	41.03	41.03	41.03	41.03	41.03	41.03	41.03	41.03	41.03	41.03	41.03	41.03	41.03	41.03	41.03	41.03	41.03	41.03	41.03	41.03	41.03	41.03	41.03	41.03	41.03	41.03	41.03	41.03	41.03	41.03	41.03	41.03	41.03	41.03	41.03	41.03	41.03	41.03	41.03	41.03	41.03	41.03	41.03	41.03	41.03	41.03	41.03	41.03	41.03	41.03	41.03	41.03	41.03	41.03	41.03	41.03	41.03	41.03	41.03	41.03	41.03	41.03	41.03	41.03	41.03	41.03	41.03	41.03	41.03	41.03	41.03	41.03	41.03	41.03	41.03	41.03	41.03	41.03	41.03	41.03	41.03	41.03	41.03	41.03	41.03	41.03	41.03	41.03	41.03	41.03	41.03	41.03	41.03	41.03	41.03	41.03	41.03	41.03	41.03	41.03	41.03	41.03	41.03	41.03	41.03	41.03	41.03	41.03	41.03	41.03	41.03	41.03	41.03	41.03	41.03	41.03	41.03	41.03	41.03	41.03	41.03	41.03	41.03	41.03	41.03	41.03	41.03	41.03	41.03	41.03	41.03	41.03	41.03	41.03	41.03	41.03	41.03	41.03	41.03	41.03	41.03	41.03	41.03	41.03	41.03	41.03	41.03	41.03	41.03	41.03	41.03	41.03	41.03	41.03	41.03	41.03	41.03	41.03	41.03	41.03	41.03	41.03	41.03	41.03	41.03	41.03	41.03	41.03	41.03	41.03	41.03	41.03	41.03	41.03	41.03	41.03	41.03	41.03	41.03	41.03	41.03	41.03	41.03	41.03	41.03	41.03	41.03	41.03	41.03	41.03	41.03	41.03	41.03	41.03	41.03	41.03	41.03	41.03	41.03	41.03	41.03	41.03	41.03	41.03	41.03	41.03	41.03	41.03	41.03	41.03	41.03	41.03	41.03	41.03	41.03	41.03	41.03	41.03	41.03	41.03	41.03	41.03	41.03	41.03	41.03	41.03	41.03	41.03	41.03	41.03	41.03	41.03	41.03	41.03	41.03	41.03	41.03	41.03	41.03	41.03	41.03	41.03	41.03	41.03	41.03	41.03	41.03	41.03	41.03	41.03	41.03	41.03	41.03	41.03	41.03	41.03	41.03	41.03	41.03	41.03	41.03	41.03	41.03	41.03	41.03	41.03	41.03	41.03	41.03	41.03	41.03	41.03	41.03	41.03	41.03	41.03	41.03	41.03	41.03	41.03	41.03	41.03	41.03	41.03	41.03	41.03	41.03	41.03	41.03	41.03	41.03	41.03	41.03	41.03	41.03	41.03	41.03	41.03	41.03	41.03	41.03	41.03	41.03	41.03	41.03	41.03	41.03	41.03	41.03	41.03	41.03	41.03	41.03	41.03	41.03	41.03	41.03	41.03	41.03	41.03	41.03	41.03	41.03	41.03	41.03	41.03	41.03	41.03	41.03	41.03	41.03	41.03	41.03	41.03	41.03	41.03	41.03	41.03	41.03	41.03	41.03	41.03	41.03	41.03	41.03	41.03	41.03	41.03	41.03	41.03	41.03	41.03	41.03	41.03	41.03	41.03	41.03	41.03	41.03	41.03	41.03	41.03	41.03	41.03	41.03	41.03	41.03	41.03	41.03	41.03	41.03	41.03	41.03	41.03	41.03	41.03	41.03	41.03	41.03	41.03	41.03	41.03	41.03	41.03	41.03	41.03	41.03	41.03	41.03	41.03	41.03	41.03	41.03	41.03	41.03	41.03	41.03	41.03	41.03	41.03	41.03	41.03	41.03	41.03	41.03	41.03	41.03	41.03	41.03	41.03	41.03	41.03	41.03	41.03	41.03	41.03	41.03	41.03	41.03	41.03	41.03	41.03	41.03	41.03	41.03	41.03	41.03	41.03	41.03	41.03	41.03	41.03	41.03	41.03	41.03	41.03	41.03	41.03	41.03	41.03	41.03	41.03	41.03	41.03	41.03	41.03	41.03	41.03	41.03	41.03	41.03	41.03	41.03	41.03	41.03	41.03	41.03	41.03	41.03	41.03	41.03	41.03	41.03	41.03	41.03	41.03	41.03	41.03	41.03	41.03	41.03	41.03	41.03	41.03	41.03	41.03	41.03	41.03	41.03	41.03	41.03	41.03	41.03	41.03	41.03	41.03	41.03	41.03	41.03	41.03	41.03	41.03	41.03	41.03	41.03	41.03	41.03	41.03	41.03	41.03	41.03	41.03	41.03	41.03	41.03	41.03	41.03	41.03	41.03	41.03	41.03	41.03	41.03	41.03	41.03	41.03	41.03	41.03	41.03	41.03	41.03	41.03	41.03	41.03	41.03	41.03	41.03	41.03	41.03	41.03	41.03	41.03	41.03	41.03	41.03	41.03	41.03	41.03	41.03	41.03	41.03	41.03	41.03	41.03	41.03	41.03	41.03	41.03	41.03	41.03	41.03	41.03	41.03	41.03	41.03	41.03	41.03	41.03	41.03	41.03	41.03	41.03	41.03	41.03	41.03	41.03	41.03	41.03	41.03	41.03	41.03	41.03	41.03	41.03	41.03	41.03	41.03	41.03	41.03	41.03	41.03	41.03	41.03	41.03	41.03	41.03	41.03	41.03	41.03	41.03	41.03	41.03	41.03	41.03	41.03	41.03	41.03	41.03	41.03	41.03	41.03	41.03	41.03	41.03	41.03	41.03	41.03	41.03	41.03	41.03	41.03	41.03	41.03	41.03	41.03	41.03	41.03	41.03	41.03	41.03	41.03	41.03	41.03	41.03	41.03	41.03	41.03	41.03	

DOMINION SOIL INVESTIGATION LTD
DID THE SOIL INVESTIGATION.

COUNTY BRIDGE #104			
COUNTY OF MIDDLESEX			
SCALE: AS SHOWN	APPROVED BY:	JOB NO.	DRAWN BY: W.R.
DATE:	Misc.	REVISED	
RECORDED ELEVATIONS & DIMENSIONS FOR STABILITY OBSERVATIONS			
A.M. SPRIET & ASSOCIATES LTD.		CONSULTING ENGINEERS	

BA 1601

MESSRS. A.M. SPRIET AND COMPANY
CONSULTING ENGINEERS
234 Queens Avenue
LONDON ONTARIO

Report on
SOIL INVESTIGATION
for
ROAD BRIDGE NO. 104, ROAD 18
COUNTY OF MIDDLESEX

by
DOMINION SOIL INVESTIGATION LIMITED
363 Queens Avenue
LONDON ONTARIO

Reference No. 2-11-L2
November
1962

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INTRODUCTION

Verbal authorization was received from Mr. A.M. Spriet to carry out a soil investigation at a site on Road No. 18 in the County of Middlesex where it is proposed to replace an existing road bridge with a new structure. It is understood that the new bridge will be of approximately the same span (i.e. about 60 feet) and in the same position as the present one.

The purpose of this investigation was to reveal the subsurface conditions and to determine the necessary soil properties for the design and construction of foundations.

Ia FIELD WORK

Field work was carried out during the period 19th to 25th November 1962, and consisted of 2 boreholes and 4 dynamic cone penetration tests at the locations shown on enclosure 2. The holes were advanced by washboring and lined with Bx casing. Standard Penetration tests were made at frequent intervals using a 2-inch O.D. split spoon. For a considerable depth in both boreholes the Standard Penetration resistance is recorded as "less than one". In these cases the split-spoon penetrated the required distance under the weight of the drill rods or was pushed in manually, or alternatively a penetration of approximately 2 feet was recorded with one hammer blow.

Insitu vane shear tests were performed using a 2-inch diameter 4-bladed vane, with a vane length of 4 inches. One undisturbed sample of cohesive soil was recovered from borehole 2, using a 2-inch diameter thin-walled sampling tube.

The results of the field tests are recorded on geotechnical data sheets comprising enclosures 3, 4 and 5. Elevations have been referred to a temporary benchmark shown on enclosure 2.

I DESCRIPTION OF SITE AND GEOLOGY

The site lies in the extreme northwest of the county of Middlesex, where Road No. 18 crosses a tributary stream of the Ausable River. The valley drained by the stream is approximately half a mile wide and in earlier times was much deeper than at present. It has been filled by organic deposits and the flat shallow bottom created in this way is virtually a marsh. The site was most likely an extension of the lagoon which was formed behind the dunes of the Huron shoreline and has created extensive marshlands in the Smith Lake region, a few miles to the northwest.

The tops of timber piles which presumably carried an earlier bridge can be seen below the surface of the creek. It can reasonably be assumed that the existing bridge is also carried on piles because the subsoil offers negligible bearing capacity for a considerable depth.

II SUBSURFACE CONDITIONS

Details of the stratification at each borehole are shown on the data sheets and a general picture is provided by the subsurface profile shown on enclosure 2.

The most notable differences between the two boreholes are (a) that the depth of unconsolidated organic material differs by 15 feet (45 feet at borehole 1 and 30 feet at borehole 2) and, (b) that a hard crust exists on the clay deposit at borehole 2. This latter feature suggests that the location may have been a local high point before the upper organic sediments were deposited, and that preconsolidation of the clay has taken place due to dessication. The dynamic penetration results for cones 3 and 4 suggest that the stratification in these locations is more similar to that at borehole 1 than at borehole 2.

The upper organic sediments are of very low density. The proportion of organic material may be as high as 70 to 80% near the ground surface, and this decreases with depth until an abrupt change occurs at the surface of the grey silty clay stratum.

The clay stratum showed a progressive increase in stiffness at both boreholes below a depth of 70 feet (except for the final sample in borehole 1). Traces of small gravel particles were found at all elevations. The material is not a "till", however, but rather a heavily preconsolidated silty clay.

III FOUNDATIONS

The prevailing soil conditions necessitate the use of piles to support the weight of the bridge and other applied loads. Factors affecting the choice of pile to be used are:

- (i) the resistance to driving will be negligible for 45 or more feet, therefore the piles will be long, and timber piles are not suitable.
- (ii) the soft conditions in the upper strata exclude the use of any type of uncased, cast-in-situ pile.
- (iii) the inaccuracy inherent in predicting the length of piles in soils where the stiffening is progressive, rather than abrupt, requires that the length should be readily adjustable on the site.

The choice of pile is thus narrowed to a steel-cased pile, such as a simple tube pile driven with a shoe, or the Raymond cast-in-place type. In the latter case it would probably be necessary for the lowest sections of the pile to be heavy-gauge tube to resist the hard driving conditions below El. 20.0. For piles of the length required here, it will be more economical to drive until a relatively high working load can be used, rather than to stop the piles at a higher level (say between Els. 40 and 20) where the working load would be small and settlement would be an important factor.

In estimating the length and bearing capacity of the piles it has been necessary to make certain assumptions as to the physical properties of the clay layer. The assumed values are summarised on enclosure 6. Where the consistency of the clay is *stiff* to *very stiff*, the vane shear test results provide values for cohesion. Where the clay is *very stiff* to *hard*, the assumed cohesion values are estimated from the Standard Penetration test results.

The adhesion of the soil to the pile (expressed as a percentage of the cohesion value) has been estimated from the figures published by Tomlinson* for tube piles.

Based on the foregoing values and the soil conditions at borehole 1, it is estimated that a 12-3/4 inch O.D. pile driven to El. 0.0 (or 90 feet below the floodplain) will have an ultimate resistance in excess of 80 tons, and can be safely used for a working load of 40 tons. The settlement under load is not expected to be significantly more than the elastic deflection of the pile.

* See reference No. 4.

It has already been mentioned that predictions of this type contain inherent inaccuracies, so that the piles should be driven until a satisfactory set is achieved in accordance with accepted pile-driving formulae, at whatever depth this may occur.

The resistance of the piles to buckling in the soft upper strata has been considered. Cummings* and others have analysed this problem and have concluded that in the worst soil conditions (other than a liquid) the buckling strength of the pile is appreciably increased by the surrounding soil. Model tests in Sweden and elsewhere have supported these results. In examples discussed by Cummings it is concluded that for conditions far more severe than those experienced in the present project, the buckling strength of the pile is increased by a factor of 10 or more by a soil which would be "little better than a swamp". By comparison, buckling is not considered to be a significant factor in the soil conditions found in this project.

IV

APPROACH FILL

The approach embankments may be expected to settle if the road is widened or raised. The magnitude of the settlement is not a predictable quantity, and it can be said only that periodic maintenance will probably be required for some time after construction. The problem will be lessened if the existing embankments which have already consolidated the subsoil are disturbed as little as possible, and are included in the new construction.

V

CONSTRUCTION

It will be necessary to provide some depth of compacted fill for the movement of construction equipment around the site, other than on the existing road. Otherwise, heavy vehicles will sink immediately into the floodplain which has no ability to withstand concentrated loads.

The timber piles of the earlier bridge should not interfere with present piling operations. If steel or concrete piles have been used to support the existing bridge there will be some risk of damage to the new piles unless the existing piles are first withdrawn. This possible problem can only be dealt with once the type, pattern and alignment of the existing piles is known.

** See reference No. 5.

VI SUMMARY

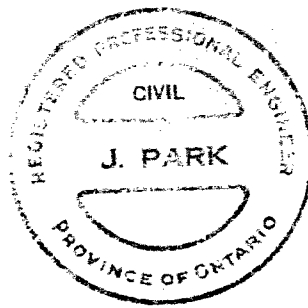
1. The strata consist of up to 45 feet of unconsolidated clayey organic material, overlying a stiff to hard clay.
2. The new bridge should be supported on piles, which should either be tube piles or some other steel-cased type.
3. It is estimated that 12-3/4 inch O.D. piles driven to El. 0.0 (or 90 feet below the floodplain) will allow a safe working load of 40 tons per pile. The piles should be driven to a satisfactory set, irrespective of depth.
4. Settlement of the approach embankments should be expected for some time after construction.
5. Construction equipment moving on the floodplain will require a cushion of compacted fill.
6. Attention should be given to the possibility of new piles being damaged by existing piling.

VII REFERENCES

1. The Physiography of Southern Ontario by L.J. Chapman and D.F. Putman of the Ontario Research Foundation, University of Toronto Press, 1951.
2. Procedures for Testing Soils, ASTM, April 1958, pp. 186 to 198 (Unified Soil Classification System, by A.A. Wagner) London.
3. Terzaghi and Peck: Soil Mechanics in Engineering Practice, John Wiley and Sons, New York, 1948.
4. M.J. Tomlinson, The Adhesion of Piles Driven in Clay Soils, Proceedings of the Fourth International Conference on Soil Mechanics and Foundation Engineering 1957.

5. A.E. Cummings, Proceedings of the Highway Research Board, U.S.A., December 1938.

Encl.
JP/mc






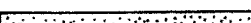
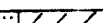


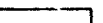


DOMINION SOIL INVESTIGATION LIMITED

A handwritten signature in cursive script, appearing to read "James Park", followed by a large, stylized flourish.

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

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"	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
 " 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 , 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 :



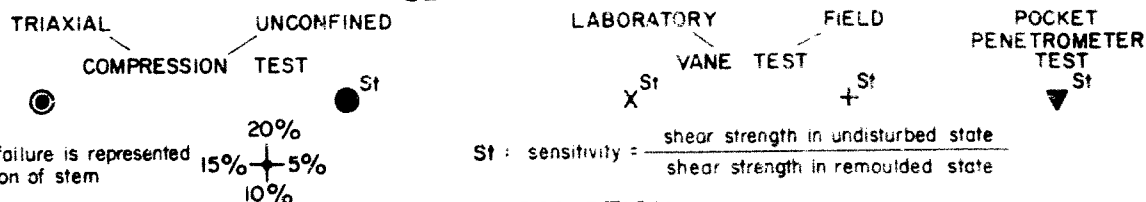
322

SOIL PROPERTIES.

W % Water content	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 effective stress
PI % Plasticity index	C _v Coeff. of consolidation	C' Cohesion
LI Liquidity index	m _v Coeff. of volume compression	ϕ' Angle of int friction

UNDRAINED SHEAR STRENGTH.

- DERIVED FROM -

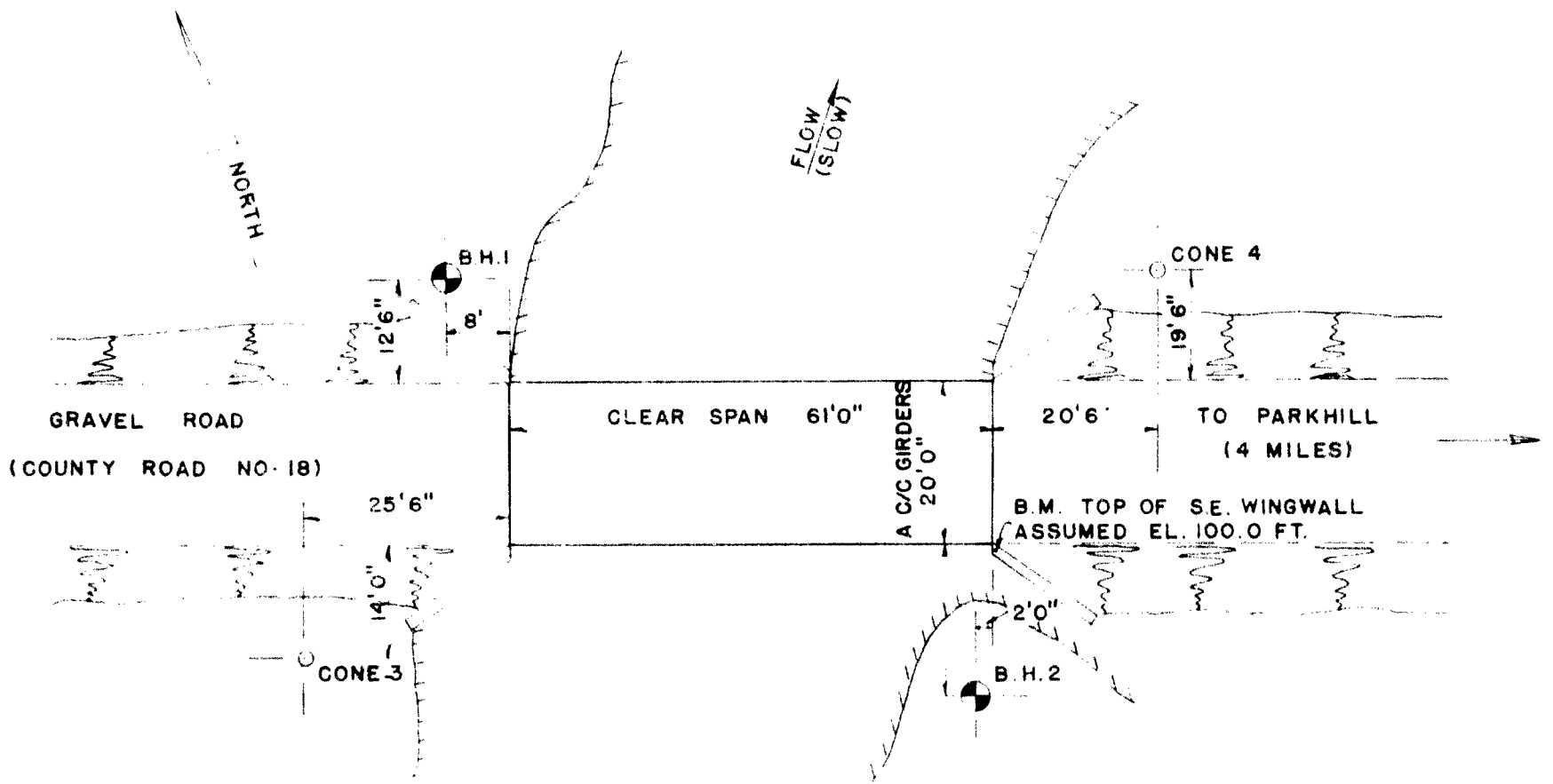


SOIL DESCRIPTION.

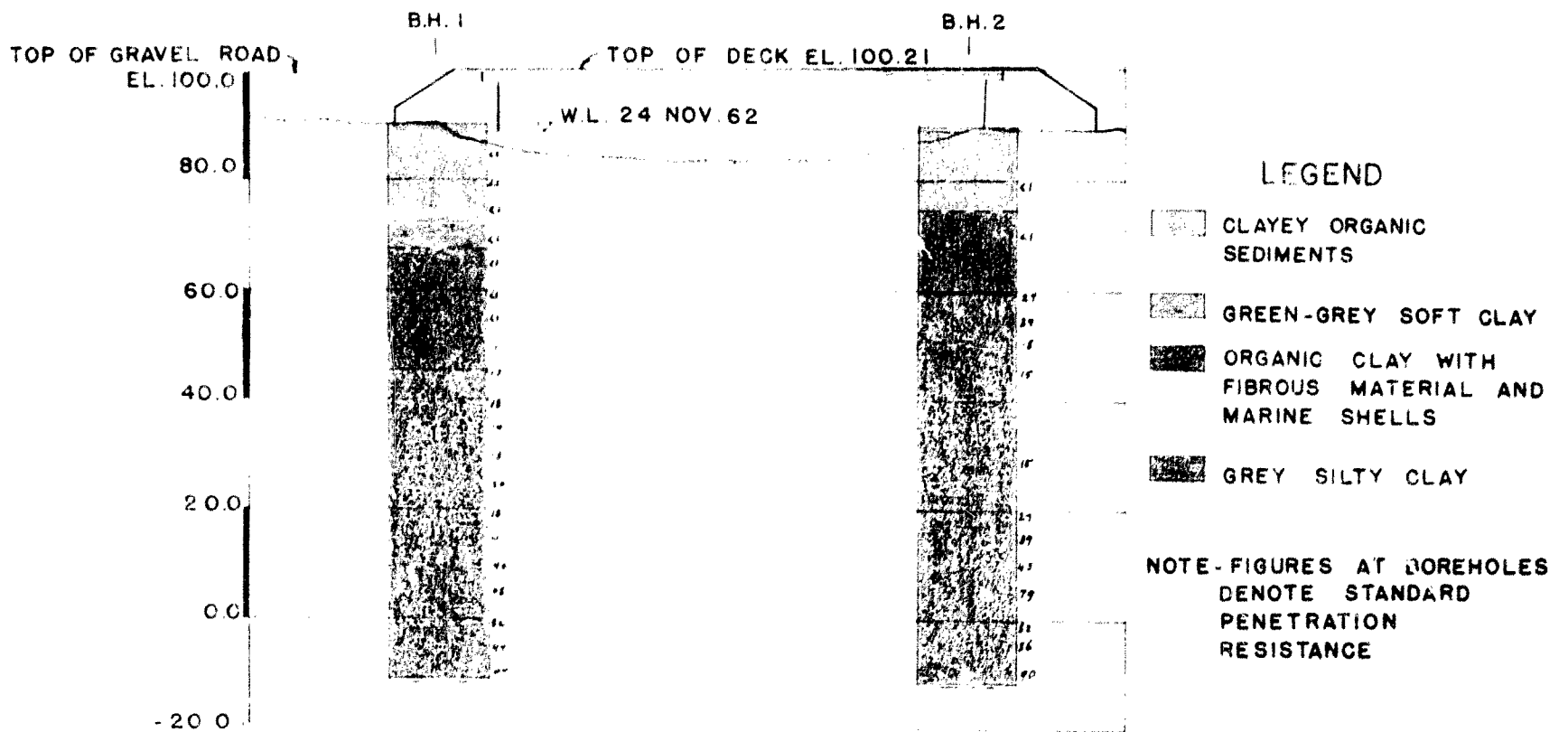
COHESIONLESS SOILS :	RD :	COHESIVE SOILS :	C lbs/sq ft
Very loose	0 - 15 %	Very soft	less than 250
Loose	15 - 35 %	Soft	250 - 500
Compact	35 - 65 %	Firm	500 - 1000
Dense	65 - 85 %	Stiff	1000 - 2000
Very dense	85 - 100 %	Very stiff	2000 - 4000
		Hard	over 4000

JOB NO. 2-II-L2
PREP. BY M.C.

ENCLOSURE 2



LOCATION OF BOREHOLES
SCALE - 1 INCH TO 20 FEET



SUBSURFACE PROFILE (LOOKING NORTH)
SCALES - HORIZ. 1 INCH TO 20 FEET
VERT. 1 INCH TO 30 FEET

GEOTECHNICAL DATA SHEET FOR BOREHOLE ...

OUR REFERENCE NO. 2-11-12

CLIENT: Mr. A.M. Sriet, Consulting Engineer
PROJECT: Bridge near Parkhill
LOCATION: See enclosure 2
DATUM ELEVATION

METHOD OF BORING Washboring
DIAMETER OF BOREHOLE 12" (2-7/8")
DATE 20th to 22nd November 1962

ENCLOSURE NO. 3

ELEVATION ft.	DEPTH ft.	STRATIFICATION DESCRIPTION	STRATIFICATION SYMBOL	SAMPLES			PENETRATION RESISTANCE blows per foot				CONSISTENCY water content %				REMARKS
				NUMBER	TYPE	No. of Advancement of Sampler	20	40	60	80	100	PL	W	LI	
90.7	0	Ground surface													
	10	Soft black clayey organic sediments		1	SS	< 1									
				2	SS	< 1									
				3	SS	< 1									
71.7	20	green-grey soft clay sandy		4	SS	< 1									
67.7				5	SS	< 1									
	30	Soft grey-brown organic clay, containing much fibrous material and traces of white marine shells sandy		6	SS	< 1									
				7	SS	< 1									
	40			8	SS	1									
47.7				9	SS	13									
	50			10	SS	13									
				11	SS	14									
30.7	60	stiff		12	SS	13									
				13	SS	20									
	70	Grey silty clay very stiff hard		14	SS	18									
				15	SS	41									
10.7	80			16	SS	40									
				17	SS	65									
	90			18	SS	82									
				19	SS	94									
	100			20	SS	64									
19.7		End of borehole													

VERTICAL SCALE: 1 IN. TO 10 FT.

DOMINION SOIL INVESTIGATION LIMITED

MADE: MC

CH'D: JP

GEOTECHNICAL DATA SHEET FOR BOREHOLE ...2...

OUR REFERENCE NO. 2-11-1.2

CLIENT: Mr. A.M. Spriet, Consulting Engineer
PROJECT: Bridge near Parkhill
LOCATION: See enclosure 2
DATUM ELEVATION:

METHOD OF BORING: Washboring
DIAMETER OF BOREHOLE: Bx (2-7/8")
DATE: 23rd to 25th November 1962

ENCLOSURE NO. 4

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	
							SHEAR STRENGTH lbs/sq ft								
							1000	2000	3000	4000	5000				
80.8	0	Ground surface													
	10	Soft black clayey organic sediments		1	SS	< 1									
74.8	20	Soft grey-brown organic clay, containing much fibrous material and traces of white marine shells		2	SS	< 1									
60.8	30			3	SS	27									
	40	sandy, hard gravel		4	SS	39									
	45	very stiff		5	SS	18									
	50			6	SS	15									
39.8	55			7	FW										
	60	stiff to very stiff		8	FW										
	65			9	SS	15									
	70	Grey silty clay		10	SS	27									
19.8	75	hard		11	SS	39									
	80			12	SS	45									
	85			13	SS	79									
	90			14	SS	82									
	95			15	SS	83									
	100			16	SS	90									
-11.7	107	End of borehole													

Sample 8 not recovered

GEOTECHNICAL DATA SHEET FOR BOREHOLE Cones 3 and 4

OUR REFERENCE NO 2-11-12

CLIENT: Mr. A.M. Spriet, Consulting Engineer
PROJECT: Bridge near Parkhill
LOCATION: See enclosure 2
DATUM ELEVATION:

METHOD OF BORING:
DIAMETER OF BOREHOLE

DATE: 23rd November 1962

ENCLOSURE NO. 5

[illegible]

Enclosure 6

Assumed shear strength and adhesion values for calculation
of pile bearing capacity

Depth (feet)	Elevation (feet)	Cohesion (p.s.f.)	Adhesion (%)	Adhesion (p.s.f.)
0 to 45	90 to 45	0	-	0
45 to 74	45 to 16	1500	50	750
74 to 85	16 to 5	5000	15	750
below 85	below 5	8500	5 to 10	750

Mr. John Roy,
Regional Materials Engr.,
London Regional Office.

Mr. A. G. Stermac,
Principal Foundation Engr.,
Foundation Section,
Materials & Research Division.
November 29, 1963

-- Site Visit --
Bridge No. 104, County Road 18
County of Middlesex
District No. 2

(Wed., November 27, 1963)

This is to summarize the verbal recommendations given by the undersigned during the visit to the construction site of the above-mentioned structure.

Because of the very low strength of the subsoil, the placing of the fill to raise the grade of the old approach embankment and the fill placed to widen it, has caused the ground to settle considerably. The movements under the fill widening can hardly be regarded any more as settlements, but rather, as a base failure. The fact that no bulging or deformation of the adjacent natural ground and the fill slopes can be observed, could be explained by the highly organic character of the subsoil in which all the present movements have been absorbed.

In order to prevent further failures that could be very costly, it is suggested to berm the approach fills. A rational analysis to define the height and width of berm is impractical because the determining of shear strength parameters of the highly organic soil is not reliable. It is therefore, suggested that a berm of approx. half the fill height and having a width of some 40 ft., be built. The presence of such a berm will not stop further fill movements, but it is believed that it will prevent any sudden failures. Settlements of the fill will continue for a long time to come, again because of the highly organic character of the subsoil,

It should be noted that presently the subsoil conditions are rather favourable because of the prolonged dry season during which the soil has dried out and a sort of a mat was formed. However, when the ground water table rises, the strength of the soil will again decrease and more problems could be expected. It is therefore, essential that the berm be built as soon as possible.

On the Southwest side, some material from the new creek bed excavation had been already placed against the fill. With some additional placement, this side would satisfy the requirements.

cont'd. /2 ...

Mr. John Roy,
Reg. Mat'ls. Engr.

- 2 -

November 29, 1963

It was already emphasized at the site that the material around the cracks on the East approach fill has to be removed so as to enable the establishment of the size of the movements and also to enable the completion of effective backfilling.

It is believed that the above will be sufficient for you to initiate the necessary work. However, should there be any additional clarification that you would require, please feel free to contact this office.

AGS/KdeF

Afternoon
A. G. Sternac,
PRINCIPAL FOUNDATION ENGINEER

cc: Messrs. K. L. Kleinsteinber
L. F. Eadie
T. S. Caldwell
Foundations Office ✓
Gen. Files

Mr. K. L. Kleinsteinber,
Municipal Bridge Liaison Engr.,
Bridge Division.

Attn: Mr. G.C.E. Burkhardt.

Mr. A. G. Stermac,
Principal Foundation Engr.,
Foundation Section,
Materials & Research Division.

March 11, 1963.

Your Memo - Mar. 8/63.

County of Middlesex,
Bridge #104, County Rd. #18,
Twp. McGillivray, Lot 20, Con. V,
Twp. West Williams, Lot 20, Con. XX,
Structure Site No. 20-29,
Your File No. BA 1601.

The Foundation Report on the above site by Dominion Soils has been reviewed, and we would like to draw your attention to the following:

(a) Due to the increase in stiffness of the silty clay, it is probable that the piles will not penetrate to the specified elevation of +6.00 feet. However, the design load of 40 T will be achieved as long as the pile meets practical refusal.

(b) The soils investigation shows that the organic sediments have little or practically no shear strength. Therefore, a raising of 5 feet of grade at the approach embankments will likely result in instability.

(c) For the same reason, construction of the 10-foot deep channel through the organic material will encounter construction difficulties.

If there are any other queries in connection with this project, please do not hesitate to call on our Office.

HYL/Md eF

cc: Foundations Office
Gen. Files.

K. Y. Lo,
SUPERVISING FOUNDATION ENGR.
For:
A. G. Stermac,
PRINCIPAL FOUNDATION ENGR.

[illegible]

MEMORANDUM

To: Mr. A. Stermac
Principal Foundation Engineer
Room 107 Lab. Bldg.

FROM: G. C. E. Burkhardt

DATE: March 8, 1963.

OUR FILE REF.

IN REPLY TO

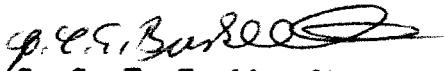
SUBJECT:

County of Middlesex
Bridge #104, County Rd. #18,
Twp. McGillivray, Lot 20, Con. V,
Twp. West Williams, Lot 20, Con. XX,
Structure Site No. 20-29,
Our File No. BA 1601.

Attached please find one copy of the Foundation Report, by Dominion Soil Investigation Limited, and one copy of the Preliminary Plans for your comment.

We would like to approve the plans as soon as possible and would appreciate it very much, if we could have your comments at your earliest convenience.

GCEB:go


G. C. E. Burkhardt,
for K. L. Kleinsteinber,
Municipal Bridge Liaison Engineer.

Hwy. 401 & Keele St.,
Downsview, Ontario.

Materials and Testing Division

August 19, 1965

Mr. F. B. D. Arnold, County Engineer,
County of Middlesex,
County Buildings,
London, Ontario.

Re: County Bridge No. 104

Dear Mr. Arnold:

We are now in receipt of two readings of movements of the above-mentioned bridge, as recorded by the designer, A. M. Spriet & Associates Ltd.

It is our opinion that these readings should be continued on a monthly basis in order to provide a reliable record of bridge movements. There seems to be no doubt that movements have occurred. However, they may have stopped by now, or there might be a decreasing tendency. The monthly readings should provide an answer to this question.

We would also suggest that the reliability of the bench mark (nail in hydro pole) be checked and that efforts be made to have a more permanent bench mark established. It is our experience that due to the doubtful reliability of the bench mark, many observations and readings had questionable value.

Yours very truly,

A. G. Stermac

A. G. Stermac,
Principal Foundation Engineer

ACS/MdeF

cc: Mr. J. Roy

Foundations Office ✓
Gen. Files

August 17, 1965

Mr. F. B. D. Arnold, County Engineer,
County of Middlesex,
County Buildings,
London, Ontario

Dear Mr. Arnold:

Re: County Bridge No. 104

Enclosed you will find one (1) copy of the plan showing the latest elevations and dimensions for stability observations on the above structure.

There are very slight variations in the span dimensions between piers top and bottom (dimensions A, B, C and D on plan). The very soft bottom makes it a little difficult to obtain a precise span dimension at the bottom while the overhand of the deck, curb, and handrail makes it quite difficult to obtain an accurate plumb alignment for taking the top span dimensions.

It is our pleasure to be of service.

Yours truly,

A. M. SPRIET & ASSOCIATES LTD.,



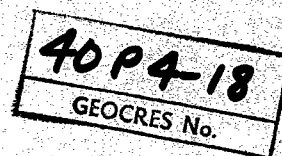
A. J. DeVos, P. Eng.

AJD/mc
Encs.

Copies to: Mr. A. G. Stermac, D.H.O.
Mr. C. J. W. Atkinson, Dominion Soils Investigation Ltd.

INCLUDE WITH 40P4-18

MESSRS. A.M. SPRIET AND COMPANY
CONSULTING ENGINEERS
234 Queens Avenue
LONDON ONTARIO



Report on
SOIL INVESTIGATION
for
EMBANKMENT STABILITY
BRIDGE NO. 104, COUNTY ROAD 18
COUNTY OF MIDDLESEX

by
DOMINION SOIL INVESTIGATION LIMITED
363 Queens Avenue
LONDON ONTARIO

Reference No. 3-3-L11
March 1963

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SUMMARY

One additional borehole has been made through the existing road embankment into the substrata, to augment the information obtained in the previous soil investigation at this site (reference 2-11-L2).

It is found that the shear strength of the natural soil has been increased considerably by consolidation under the weight of the embankment. The analysis presented here leads to the conclusion that the stability of the piles supporting the bridge will not be affected by slipping or bulging of the soil. There is a possibility, however, that future erosion of the bed of the creek could lead to instability of the slope below the bridge abutment, and a method to prevent or diminish this danger is proposed.

The road embankment remote from the bridge, considered as a long footing, has a sufficient factor of safety. Slips and settlement of the shoulders of the road where it is widened should be expected for some time after construction.

I INTRODUCTION

A soil investigation was carried out at the site of a proposed new bridge on County Road #18 in November 1962 (reference No. 2-11-L2). Following completion of a tentative design arrangement, it appeared that a problem of stability might exist when fill is added to raise the roadway. The possible development of several adverse conditions was envisaged; viz.:

- (1) The weight of the road embankment resting on a soft organic deposit might cause a slip in the direction of the stream bed, which would affect the longitudinal stability of the pile group supporting the bridge.
- (2) A horizontal bulging of the substrata under the weight of the additional embankment fill might have the same effect as in (1) above.
- (3) The road embankment at points remote from the bridge might become unstable in itself, as a result of the additional weight and the low shear strength of the subsoil.

The purpose of this investigation has been to examine the probability of the development of such conditions, and to assess the factor of safety against their occurrence.

II FIELD WORK

Field work was carried out on the 30th of March 1963, and consisted of one borehole (borehole 3) at the location shown on enclosure 2. The hole was advanced by washboring from the top of the existing road embankment. Standard Penetration tests were performed using a 2-inch O.D. split spoon and one undisturbed sample was recovered in a 2-inch diameter thin-walled tube from the organic clay deposit below the embankment. An attempt to recover an undisturbed sample from a layer of fibrous organic sediments was not successful, apparently because of the fibrous nature of the deposit.

Insitu vane shear tests were performed using a 4-bladed vane with a length of 4 inches and diameter of 2 inches.

The results of the field tests are recorded on enclosure 3. Elevations have been referred to the same datum as in the earlier

investigation, with the difference that this is now assumed to be El. 106.0 feet to comply with the client's system of elevations.

III SUBSURFACE CONDITIONS

Details of the stratification are shown on enclosure 3, and a comparison of borehole 3 with the original borehole 1 is made on enclosure 4. The following strata were encountered:

- 0' - 11' Stiff clay fill comprising the road embankment. The upper 3 feet contains approximately 30% of sand and gravel.
- 11' - 20' A firm to stiff grey clay containing traces of fibrous organic matter, wood fragments, etc. This layer has the appearance of a natural deposit, although its origin is not apparent unless it is part of the embankment.
- 20' - 27' Black clayey fibrous organic sediments in a firm (or compressed) condition. It is significant to compare the thickness of this layer (7 feet) with that of the corresponding layer at borehole 1 (19 feet) and the respective "N" values (6 v. less than 1).
- 27' - 41.5' Soft to firm grey organic clay. The "N" value in this stratum is 2 compared with less than 1 at borehole 1, suggesting an increase in strength due to consolidation. However, the top of the layer corresponds identically with that at borehole 1, indicating that appreciable compression of the strata under the weight of the road embankment is restricted to the fibrous organic layer above.

IV STABILITY CALCULATIONS

(a) Stability of slope below proposed abutment.

Three potential slip surfaces have been considered as shown on enclosure 4. The assumptions made concerning the water level

and soil parameters are shown together with the calculated factor of safety in each case. The assumed shear strength values are probably conservative, and the doweling effect of the existing and new piles has been ignored. The resulting minimum safety factor of 1.4 is adequate for the present configuration, and no danger to the new piling arises from this source.

The effect of future erosion of the stream bed, however, will be to diminish the calculated factor of safety. If hydrological data shows that appreciable erosion is possible, then some measure should be taken to maintain the stability of the slope. For this purpose it is suggested that a layer of gravel or crushed stone should be placed on the bed of the stream to a depth of 4 or 5 feet. The particle size should be large (say, more than one inch) to resist erosion. This will have the effect of (i) increasing stability by adding mass, (ii) compressing the fibrous organic material thus increasing its shear strength, and (iii) possibly reducing erosion by giving the bed a more durable surface. If the foregoing suggested procedure is carried out, it should be done before the pile groups for the piers are driven, in order to avoid creating lateral pressure on the piles.

(b) Lateral bulging of compressible strata against pile groups.

The only stratum likely to be appreciably affected by the added weight of fill is the layer of fibrous organic matter between Els. 84.7 and 77.7. This has already been compressed apparently from a thickness of 19 feet to 7 feet, and is now quite firm as demonstrated by the Standard Penetration test and vane shear strength values. The addition of 4 feet of fill weighing approximately 450 pounds per square foot of area will increase the surcharge on the organic material by approximately 20%. It is difficult to conceive that the resulting lateral spread which will be largely confined between Els. 84.7 and 77.7 will seriously affect the stability of the piles.

(c) Stability of road embankment remote from bridge.

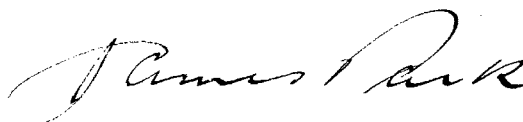
The embankment can be considered as a long footing with its underside on top of the fibrous stratum at El. 84.7. The effective pressure of material at this level will be 2500 p.s.f.

Neglecting the shear strength of the material above this level, and taking a conservative figure of 500 p.s.f. for the soil below it, the factor of safety against failure of the "footing" is 1.3 which, in the circumstances, is sufficient.

At the edges of the road where the embankment will be widened by 5 feet on each side, the height of new fill above the present flood plain will be approximately 14 feet. Large settlements and frequent slips should be expected in these border strips, until the soft organic deposits become compressed and stable under the weight of fill. The only economic solution which can be suggested for this condition is to frequently build up the shoulders with new fill until equilibrium is reached, a process which may take months or years.

Possible beneficial factors which have not been taken into account in the foregoing analyses are the "doweling" effect of the pile groups supporting the existing bridge and some earlier bridge, the possibility that the embankment is deeper and the substrata stronger below the centre of the road than at the edge where borehole 3 was made, and the probable fibrous strength of the organic deposit at the sides of the embankment where there is considerable surface vegetation.

DOMINION SOIL INVESTIGATION LIMITED



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

Encl.
JP/mc



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"	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
"	pressure : p	MADE WHILE CORING	No pressure
"	tapping : t		Intermittent pressure

	Washwater returns
	Washwater lost

PENETRATION RESISTANCES.

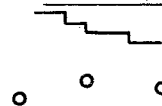
DYNAMIC PENETRATION RESISTANCE : to drive a 2"Ø, 60° cone attached to the end of the drilling rods into the ground, expressed in blows per foot.

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 :



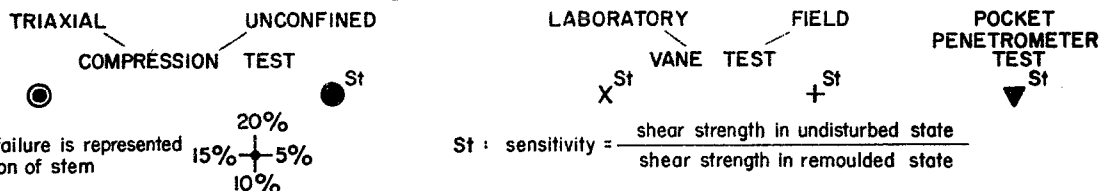
322

SOIL PROPERTIES.

W % Water content	γ _n Natural bulk density (unit weight)	k Coeff. of permeability
LL % Liquid limit	e Void ratio	C Shear strength
PL % Plastic limit	RD Relative density	φ Angle of int. friction
PI % Plasticity index	C _v Coeff. of consolidation	C' Cohesion
LI Liquidity index	m _v Coeff. of volume compressibility	φ' Angle of int. friction

UNDRAINED SHEAR STRENGTH.

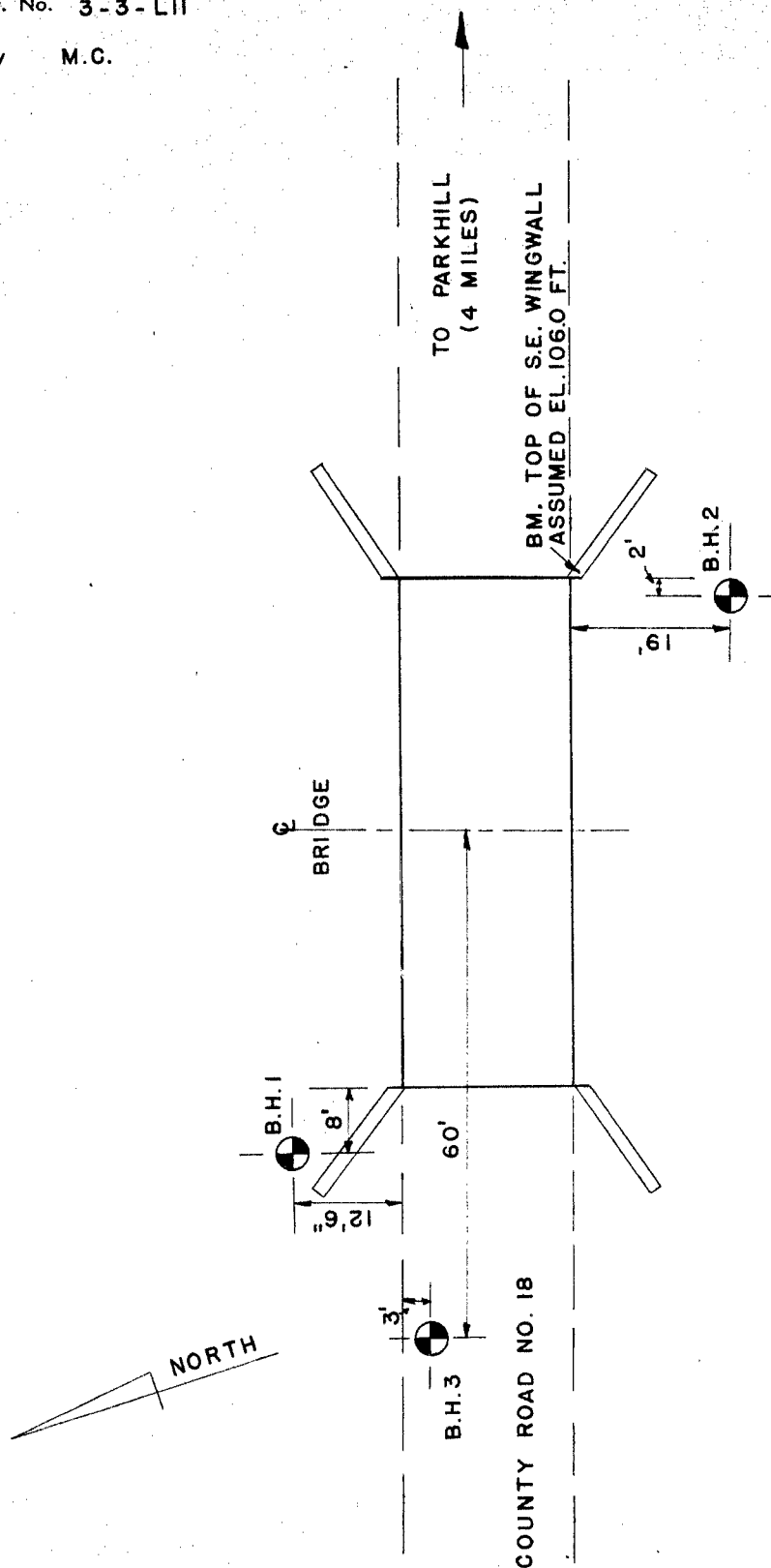
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SOIL DESCRIPTION.

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

Prep. By M.C.



LOCATION OF BOREHOLES
SCALE - 1 INCH TO 20 FEET

OUR REFERENCE NO. 3-3-L11

GEOTECHNICAL DATA SHEET FOR BOREHOLE 3

40P4-18

GEOCRETS No.

CLIENT: Mr. A.M. Spriet

PROJECT: Road Embankment Stability

METHOD OF BORING: Washboring

DIAMETER OF BOREHOLE: Bx (3-inch)

ENCLOSURE NO. 3

Borehole LOCATION: See enclosure 2

DATE: 30 Mar 63

DATUM ELEVATION: 110 feet - see enclosure 2

ELEVATION ft.	DEPTH ft.	STRATIFICATION DESCRIPTION	STRATIFICATION SYMBOL	SAMPLES			PENETRATION RESISTANCE blows per foot					CONSISTENCY water content % PL W LI	REMARKS
				NUMBER	TYPE	N or Adj. comp. of sampler	20	40	60	80	100		
							SHEAR STRENGTH lbs./sq. ft.						
							500	1000	1500	2000	2500		
104.70	0	Ground surface											
		gravelly		1	WS								
	5	Road embankment (clay fill)		2	WS								
93.7	10			3	SS	3							
				3a	SS	4							
	15	Firm grey clay, traces of fibrous organics		4	WS								
				5	vane SS	4							
					vane								
84.720	25	Firm black clayey fibrous organic sedi- ments		6	TW								
				7	vane SS	6							
77.7	30			8	TW								
					vane								
	35	Soft to firm grey organic clay		9	SS	2							
					vane								
	40												
63.2		End of borehole											

Cone

WL E1.96.0
30 Mar 63Details of
Extrapolated
N-value

Sa, #3a 2/6"

+ St=3.2

+ St=3.6

+ St=3.6

+ St=1.8

+ St=2.4

+ St=1.7

JOB NO. 3-3-LII
PREP. BY J.P.

ENCLOSURE 4

