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58-F-262C

COUNTY RD. BRIDGE

OVER W. BRANCH

BLACK CREEK

BA 840

58-F-262

TROW, SODERMAN AND ASSOCIATES

SITE INVESTIGATIONS
AND
SOIL MECHANICS CONSULTATION

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Project: J305

November 24, 1958

Mr. A.M. Toye,
Bridge Engineer,
Department of Highways of Ontario,
280 Davenport Road,
Toronto, Ontario.

Attention: Mr. J. McAllister

Foundation Investigation
County Road Crossing of Black Creek West Branch,
Concessions 4 and 5, Enniskillen Township, County of Lambton.

Dear Sirs:

Enclosed herewith is our report on the soil conditions underlying the above noted bridge site.

As in Black Creek East Crossing support directly on the soil at a depth of 5 feet below creek bed level appears permissible. The safe bearing value on this level is 3800 psf. Seepage into the footing excavation through permeable sand seams above creek bed level can be anticipated. If this seepage can be sealed off by light sheeting the remainder of the excavation can be carried out in the dry. The alternative support at this site is end bearing piles driven to shale bedrock at elevation 590 feet.

We hope that the contents of this report assist you in the design of foundations for this structure.

Yours very truly,

W. A. Trow

William A. Trow (P. Eng.)

WAT/kb
ENC.

DEPARTMENT OF HIGHWAYS OF ONTARIO
280 Davenport Road,
Toronto, Ontario.

FOUNDATION INVESTIGATION
COUNTY ROAD CROSSING OF BLACK CREEK WEST BRANCH, CONCESSIONS 4 and 5, ENNISKILLEN TOWNSHIP, COUNTY OF LAMBTON

Project J305

November 24, 1958

Trow Soderman and Associates

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ENCLOSURES

Foundation Investigation
County Road Crossing of Black Creek, West Branch, Concessions 4 and 5, Enniskillen Township, County of Lambton.

This report presents the results of a subsoil investigation completed recently for the above noted creek crossing. Recommendations concerning permissible foundation pressures and bearing depths have been given.

Site Description

The existing county road bridge crosses Black Creek West at a widened pond-like portion of its course. The creek narrows about 200 feet to the north and to the south but at all locations the velocity of flow is essentially zero.

Residents have indicated that the present sluggish state of the creek is characteristic except during spring run-off when its flood plain may be covered with water. The presence of flattened shrubs beside the creek to the south of the bridge suggests that the flood rise is about 5 feet.

The flood plain of the creek is some 300 feet wide and is presently covered with grass and random mature oak and elm. It is terminated in the east and west by gentle slopes which rise about 20 feet to the general level of the countryside. Bedrock is reported to be about 55 to 60 feet below the level of this higher plain which places it about 40 feet below river level.

The existing bridge is a single span concrete structure which appears to be in excellent condition.

Field Sampling Methods

As in the investigation for the bridge site over the east branch of Black Creek, the boring work here was performed using diamond drill equipment adapted for soil sampling purposes. The boreholes were cased with 3-inch pipe although this casing was used only to a maximum depth of 15 feet and in holes 3 and 4 was limited to a depth of 5 feet. It was found that the borings remained open to full depth when washed out with a piece of AX flush joint pipe. In this way the field investigation was expedited. The clay at this site was much less resistant to wash water than was the case at the Black Creek East crossing and, as a result, work progressed more rapidly.

Samples were taken at 5 foot intervals of depth with holes 1, 3 and 4 taken to virtual refusal and assumed bedrock some 38 feet below the river surface. Most of the samples were obtained in the disturbed state using a 2-inch O.D. split spoon but representative undisturbed specimens of clay were recovered in holes 2 and 3. All samples were sealed to prevent moisture loss. Field vane tests were also attempted but with one exception the soil was found to have a strength in excess of 2000 psf, the capacity of this equipment.

The elevations of all boreholes were referenced to the river surface and to the bridge deck. The surface of the river was assumed to be 628 feet. The field work was supervised at all times by the author.

Subsoil Description

The soil types encountered in each of the four borings are indicated in drawings 2 to 5 and are summarized in the stratigraphical profile shown in drawing 1. A marked uniformity, as regards the arrangement of the various strata and the physical properties of the soil types composing them, was noted at all locations.

The stratigraphical profile conforms with little variation to the following description, viewing a section through the soil from the surface down to bedrock.

Clayey Topsoil. This material ranged in thickness from 6 inches in hole 4 to 2 feet in hole 1 and it supported a vigorous cover of grass.

Alluvial Clay. This deposit occupied the depths between approx. elevations 629 and 627 and consisted of stiff fissured grey and brown clay. Because it contained lenses and pockets of medium water-bearing sand as well as tree roots and other organics it has been assumed to be the product of flood plain deposition. Water, from the creek, was found to pass through the medium sand when a small excavation was made adjacent to and below creek surface level.

Stiff Silty Clay. This material is an unstratified glacial till deposit which contains numerous small pebbles. It has been desiccated to a brown colour in the upper 5 to 9 feet but is grey below this depth. Shear strength measurements were remarkably uniform in this material as indicated in table No. 1 and drawing 6. According to laboratory tests its shear strength was of the order of 1500 psf; field vane tests showed a strength in excess of 2000 psf. Its natural moisture content was just above the plastic limit value of approximately 19% and its liquid limit was approximately 36 percent. The upper brown desiccated clay had higher liquid and plastic limit values, a condition often noted when soils have been dried out.

Medium Stiff Grey Clay. This stratum was encountered at elevation 607 at the lower limit of the overlying grey clay till and it continued to approximate elevation 596 feet. It exists in a medium stiff to stiff condition with a shear strength of about 900 psf as determined from laboratory tests. It is somewhat more plastic than the overlying till with a liquid limit of about 40 percent and a plastic limit of 21 percent. This material contained occasional thin seams of silt.

Very Stiff Dark Grey Clayey Silt. This stratum is also a glacial deposit and it contains numerous pebbles ranging up to about 1 inch in size. The gravel content increases with depth and is predominately of black shale particles from the underlying bedrock. Penetration resistance values in this material ranged from 30 to 70.

Dense Dark Grey Shale. The surface of this bedrock was encountered in holes 1 and 3 at elevation 590 feet and in hole 4 at elevation 589 feet where it was proved to be sound for a depth of 5 feet. It can be assumed therefore that bedrock is essentially at the same level under all parts of the site.

Foundation Considerations

In view of the stiff nature of the foundation soil and the probable light weight of the bridge, support directly upon abutment footings would appear permissible. Although the creek appears to be inactive, as regards scour, support at a depth of 5 feet below creek bed level or at approx. elevation 620 would appear desirable. The stiff clay glacial till above this level should be almost as resistant to scour as the soil underlying the Black Creek East bridge.

The soil at and for a depth of at least 12 feet below elevation 620 feet was found to have a shear strength of 1450 psf or more. The safe bearing value for a limiting settlement of 1 inch associated with this strength is 3800 psf. Although the soil becomes somewhat softer below a depth of 12 to 13 feet or elevation 607, the footing pressure of 3800 psf will be reduced to acceptable values at this level and no deep seated settlement therefore should be anticipated. Assuming a 2 to 1 load spread and footings 10 feet by 25 feet, the bearing stress at elevation 607 will be approximately 1100 psf. The safe capacity at this level is equal at least to 1750 psf. The assumption of a footing width of 10 feet appears to be somewhat conservative; lower stresses would result from the use of a narrower abutment footing.

Although the underlying silty clay till will be quite impermeable, some shoring will be required during excavation to prohibit the entry of water through the sand lenses between river surface and river bed level. Some type of light interlocking steel sheet piling would appear suitable for this purpose. After this upper permeable zone has been sealed off from the adjacent river the remaining depths can be dug in the dry. Concrete can be poured directly against the stiff clay face.

Conclusions and Recommendations

The foregoing comments regarding foundation conditions at this site can be summarized briefly as follows:

1) The soil underlying this bridge site consists essentially of stiff silty clay glacial till which has a shear strength of approx. 1500 psf and a natural moisture content just above the plastic limit. A 10 foot layer of softer soil exists below elevation 607 feet but this material should not be effected by footing loads applied at or above elevation 620 feet.

2) The recommended safe bearing value for this soil is 3800 psf which pressure incorporates a factor of safety of three. For the soil condition and footing sizes applicable here settlement under this unit load should be less than 1 inch.

3) Support of the abutment footings 5 feet below river bed level or at elevation 620 feet is recommended.

4) The alternative to the use of spread footings is end-bearing piles to shale bedrock located some 38 feet below river surface level or at elevation 590 feet.

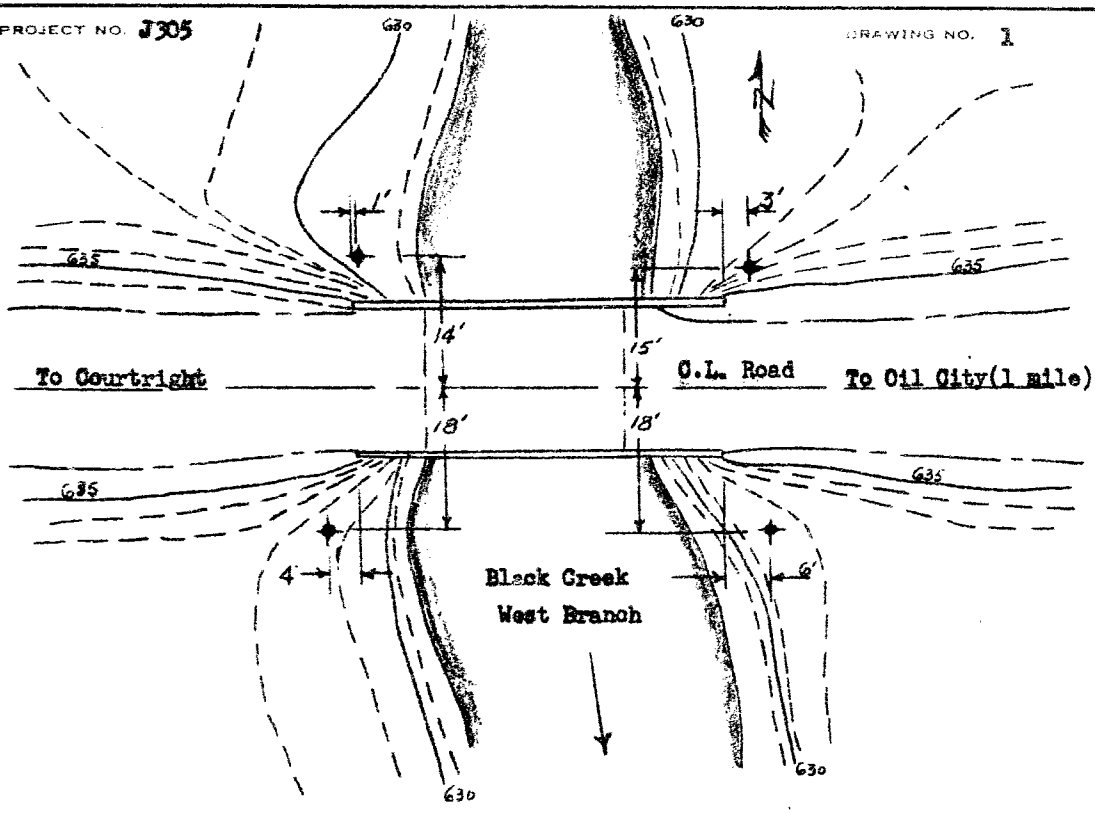
5) Seepage from the creek through the soil above elevation 627 should be anticipated. If this can be cut off by light sheeting the remainder of the excavation for footings can be done in the dry.

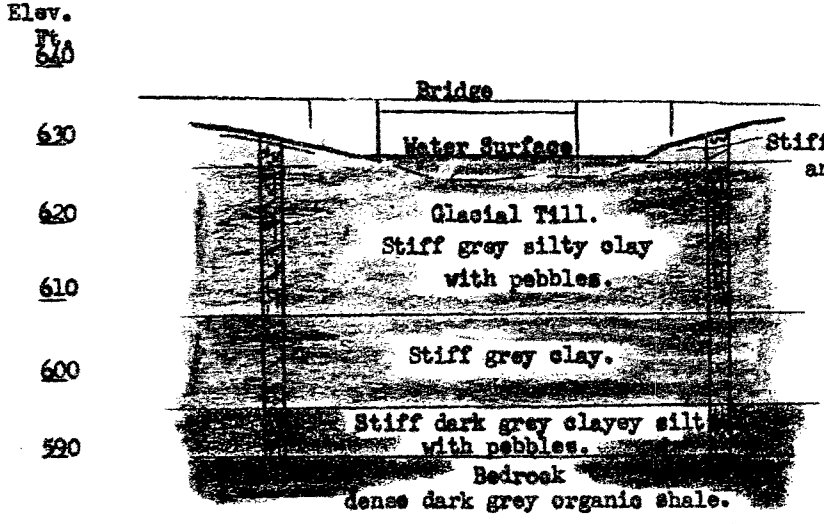
W.A. Trow

WAT/kb

William A. Trow (P. Eng.)

PROJECT NO. J305 DRAWING NO. 1





Sketch of Site Showing Borehole Locations and Subsoil Stratigraphy (Scale 1" = 20')

PROJECT NO. J305

DRAWING NO. 2

TROW SODERMAN AND ASSOCIATES

SITE INVESTIGATIONS AND SOIL MECHANICS CONSULTATION

PROJECT County Road Bridge, Black Creek West Branch BOREHOLE NO. 1

LOCATION Concession 4 and 5, Lot 13, Enniskillen Twp. FIELD SUPERVISOR W.T.

HOLE LOCATION See dwg. 1 DRILLER E.A.

HOLE ELEVATION AND DATUM 631 PREP. W.T.

LEGEND

- 2" DIA. SPLIT TUBE
- 2" SHELBY TUBE
- 2" SPLIT TUBE
- 2" DIA. CONE
- CASING
- 2" SHELBY
- 1.2 UNCONFINED COMPRESSION (Qu)
- VANE TEST (C) AND SENSITIVITY (S)
- NATURAL MOISTURE AND LIQUIDITY INDEX
- LIQUID LIMIT
- PLASTIC LIMIT

DESCRIPTION	ELEV. FEET	DEPTH FEET
Ground surface.	631	0
Medium stiff clayey topsoil.	629	2
Stiff fissured grey and brown clay with intrusions of sand.	627	4
Glacial Till. Stiff brown silty clay with pebbles, changing to very stiff to stiff grey silty clay with small pebbles below about 5 feet.		
	608	23
Stiff grey very cohesive clay (layer of silty fine sand noted at 27½ feet).		
Stiff dark grey clayey silt with pebbles and interbeds of stiff dark grey clay.	596	35
Gravel content increasing with depth		
Assumed bedrock.	590	41

STRENGTH AND PENETRATION RESISTANCE

Shear strength 1000 2000 P.S.F.

BLOWS/FT. 0 20 40 60 80

Vane +>2000 psf

Vane +>2000 p.s.f.

CONSISTENCY

MOIST. CONTENT - % DRY WT. 20 30 40

SAMPLE

SS1 SS2 SS3 SS4 SS5 SS6

NATURAL UNIT WT. P.C.F.

Note: Boring cased to 15 ft., sampled ahead of casing to 37 ft. Cone penetration test began from 38½ ft. Cone blows 40' 10" to 41' 0" = 64. Hammer bouncing.

PROJECT NO. J305

DRAWING NO. 3

TROW SODERMAN AND ASSOCIATES

SITE INVESTIGATIONS AND SOIL MECHANICS CONSULTATION

PROJECT: County Road Bridge, Black Creek West Branch
LOCATION: Conc. 4 and 5, Lot 13, Enniskillen Twp.
BOREHOLE LOCATION: See dwg. 1
ELEVATION: 631
BOREHOLE NO. 2
FIELD SUPERVISOR W.T.
DRILLER E.A.
PREP. W.T.

LEGEND
- 2" DIA. SPLIT TUBE
- 2" SHELBY TUBE
- 2" SPLIT TUBE
- 2" DIA. CONE
- CASING
- 2" SHELBY
- 1 2 UNCONFINED COMPRESSION (Qu)
- VANE TEST (C) AND SENSITIVITY (S)
- NATURAL MOISTURE AND LIQUIDITY INDEX
- LIQUID LIMIT
- PLASTIC LIMIT

SOIL	DESCRIPTION	ELEV.	DEPTH FEET	STRENGTH AND PENETRATION RESISTANCE P.S.F. Shear strength 1000 2000 BLOWS/FT.	CONSISTENCY MOIST. CONTENT - % DRY WT.	SAMPLE	NATURAL UNIT WT. P.C.F.
	Ground surface.	631	0	0 20 40 60 80	20 30 40		
	Approx. 1' clayey topsoil. Stiff fissured grey and brown clay (probably flood plain deposits)	627	10	Vane > 2000 psf.		SS1	
	Glacial Till. Very stiff brown silty clay with pebbles becoming grey below about 10 feet.					TW2	140
			20			TW3	129
						TW4	130
	Stiff grey clear clay (very adhesive).	607	30	Vane > 2000 psf.		SS5	
	End of bore.	602					

PROJECT NO. J305

DRAWING NO. 4

TROW SODERMAN AND ASSOCIATES

SOIL INVESTIGATIONS AND SOIL MECHANICS CONSULTATION

PROJECT County Road Bridge, Black Creek West Branch
LOCATION Conc. 4 & 5, Lot 13, Enniskillen Twp.
ELEVATION See dwg. 1
DATUM 630.7

BOREHOLE NO. 3
FIELD SUPERVISOR W.T.
DRILLER E.A.
PREP W.T.

LEGEND
- 2" DIA. SPLIT TUBE
- 2" SHELBY TUBE
- 2" SPLIT TUBE
- 2" DIA. CONE
- CASING
- 2" SHELBY
- 1-2 UNCONFINED COMPRESSION (Qu)
- VANE TEST (C) AND SENSITIVITY (S)
- NATURAL MOISTURE AND LIQUIDITY INDEX
- LIQUID LIMIT
- PLASTIC LIMIT

SYMBOL	DESCRIPTION	ELEV. FEET	DEPTH FEET
	Ground surface.		
	Approx. 1' grass topsoil.	630.7	
	Stiff fissured grey and brown clay with intrusions of fine sand (probably flood plain deposition).	627	
	Glacial Till. Very stiff brown silty clay with fine gravel becoming stiff grey clay below approximately 9' depth.		
		608	
	Stiff grey clear clay with occasional thin seam of silt.		
		596	
	Very stiff dark grey clayey silt with pebbles becoming more numerous and larger with depth. Pieces of black shale recovered below 39½'. Virtual refusal at 41'.		
	Presume bedrock at 40' 10".	590	

STRENGTH AND PENETRATION RESISTANCE

Shear strength P.S.F. 1000 2000

BLOWS/FT. 20 40 60 80

0 10 20 30 40

Vane +>2000 psf.

S= 2.4

CONSISTENCY

MOIST. CONTENT - % DRY WT. 20 30 40

SAMPLE	NATURAL UNIT WT. P.C.F.
SS1	
TW2	127
TW3	131
TW4	134
TW5	131
SS6	
SS7	

PROJECT NO. J305

DRAWING NO. 5

TROW SODERMAN AND ASSOCIATES

SITE INVESTIGATIONS AND SOIL MECHANICS CONSULTATION

PROJECT County Road Bridge, Black Creek West Branch
LOCATION Conc. 4 & 5, Lot 13, Enniskillen Twp.
HOLE LOCATION See dwg. 1
HOLE ELEVATION AND DATUM 629.7

BOREHOLE NO. 4
FIELD SUPERVISOR W.T.
DRILLER E.A.
PREP. W.T.

LEGEND
- 2" DIA. SPLIT TUBE
- 2" SHELBY TUBE
- 2" SPLIT TUBE
- 2" DIA. CONE
- CASING
- 2" SHELBY
- 1/2 UNCONFINED COMPRESSION (Qu)
- VANE TEST (C) AND SENSITIVITY (S)
- NATURAL MOISTURE AND LIQUIDITY INDEX
- LIQUID LIMIT
- PLASTIC LIMIT

SYMBOL	DESCRIPTION	ELEV. FEET	DEPTH FEET
	Ground surface.	629.7	0
	Approx. 6" grassy topsoil mantle over fissured brown clay (possibly ripple deposit).	~627	2
	Glacial Till. Very stiff brown silty clay with tiny pebbles throughout stiff and grey below about 7 feet.		
		~606	23
	Stiff grey clear clay.		
	Stiff to very stiff grey clayey silt with gravel content increasing with depth.	594.2	35
	Bedrock. Dense dark grey organic shale (carried pressure for 5'2"; recover 2'3", remainder lost in hole - 1" seam at 45').	589	40

STRENGTH AND PENETRATION RESISTANCE

Shear strength P.S.F. 2000 4000

BLOWS/FT. 20 40 60 80

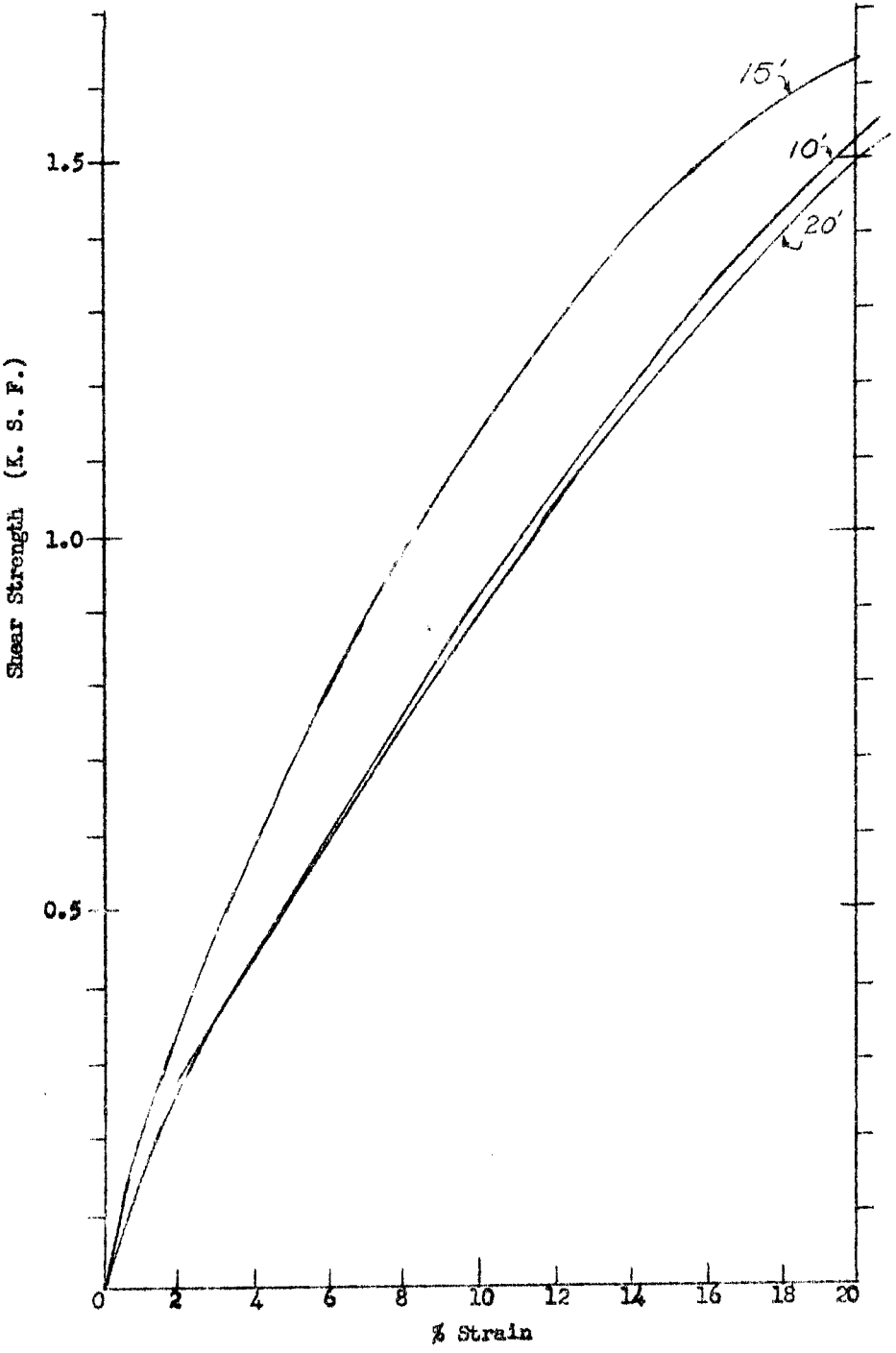
Vane +>2000psf

Vane +>2000psf

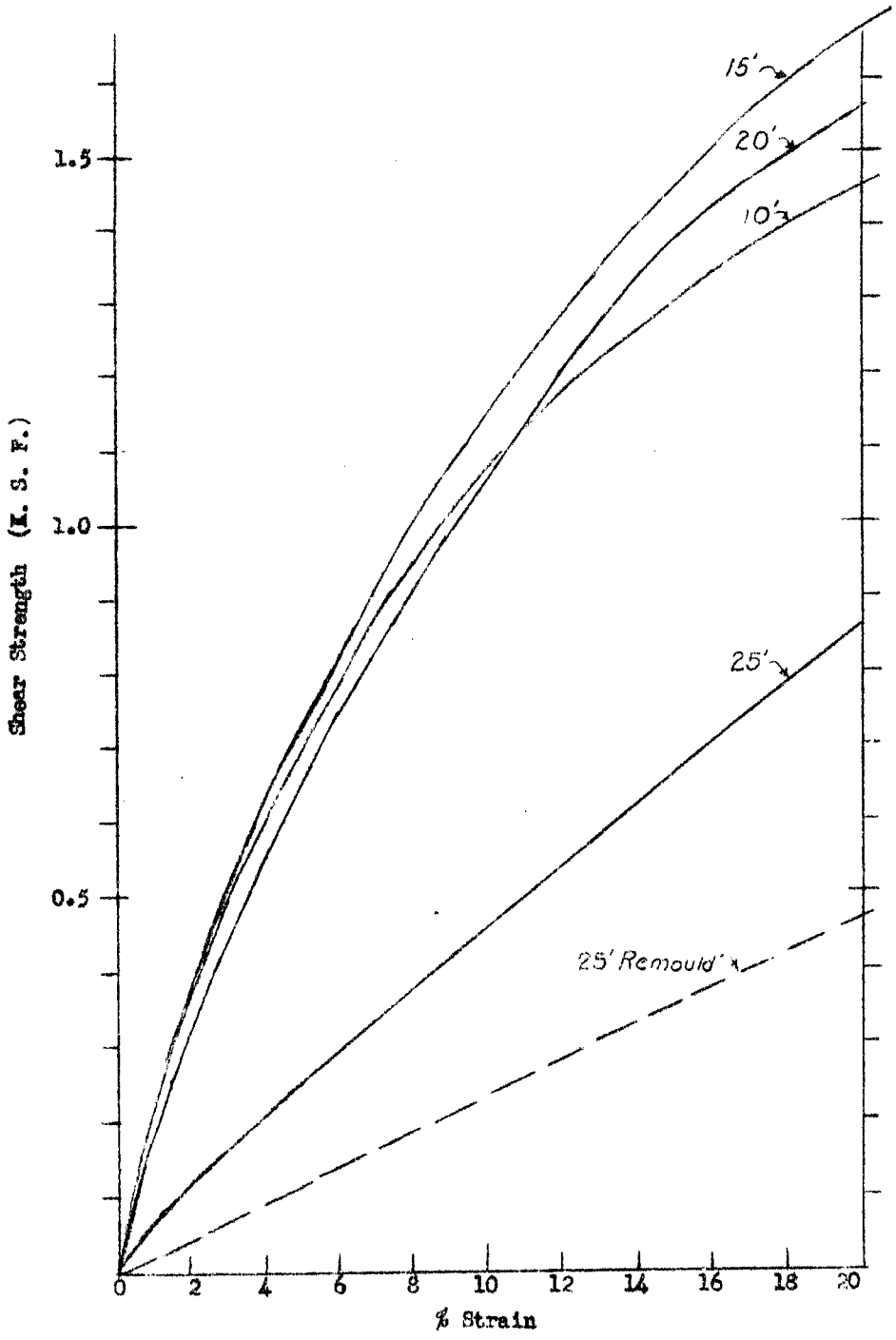
CONSISTENCY

MOIST. CONTENT - % DRY WT. 20 30 40

SAMPLE	NATURAL UNIT WT. P.C.F.
SS1	
SS2	
SS3	
SS4	
SS5	
SS6	
SS7	



Stress Strain Curves of Clay samples from Hole 2



Stress Strain Curves of Clay Samples from Hole 3

TABLE No. 1

SUMMARY OF LABORATORY TEST MEASUREMENTS

Elev. Ft.	Shear Strength (psf)*				Consistency % dry wt. W_n				L.L.	P.L.	Natural Unit Weight pcf			
	Hole 1	Hole 2	Hole 3	Hole 4	Hole 1	Hole 2	Hole 3	Hole 4			Hole 1	Hole 2	Hole 3	Hole 4
627														
625					13.6	23.0	24.3	25.4	45.5	22.7(H3)				
623														
621														
619		1545	1450		22.9	22.7	21.6	24.1		19.2(H3) 20.3(H2)		140	127	
617														
615		1620	1690		23.3	21.2	21.2	21.8	36.1	19.3(H3)		129	131	
613									36.1	18.8(H2)				
611														
609		1520	1550		20.5	21.2	21.2	20.4		18.8(H2) 18.5(H3)		130	134	
607														
605														
603			867		30.7	27.1	25.7	28.6	40.5	21.1(H3)			131	
601			S=2.2											
599								30.2						
597														
595					19.4		20.0	13.8						

Legend * = ½ unconfined compression

W_n = natural moisture content

L.L. = liquid limit

P.L. = plastic limit.

S = sensitivity.

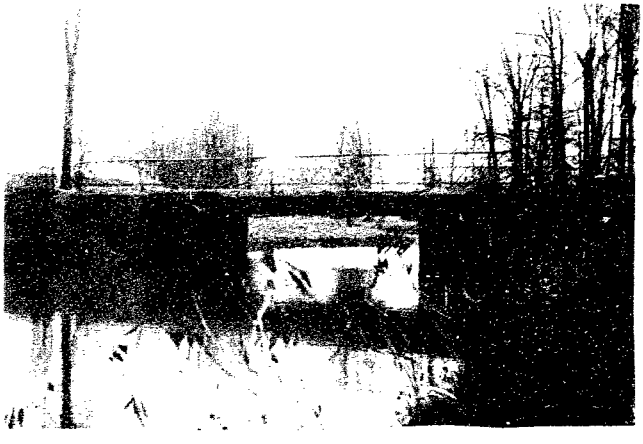
TABLE No. 2

View Looking Downstream Toward Bridge
Drill Over Hole No. 1

View of Bridge Looking Upstream

TABLE No. 2

Week Log at a Drumstead Toward Bridge
Drill Over Hole No. 2



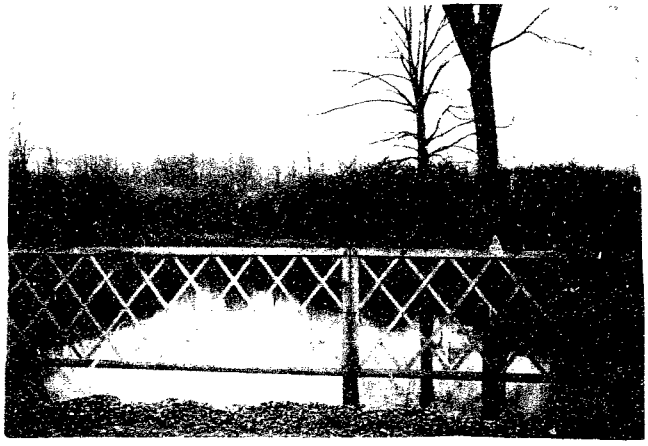
Week Log Looking Upstream

TABLE No. 2a

View Looking Downstream from Bridge

View Looking Upstream from Bridge

TABLE No. 2a



View Looking Downstream from Bridge

View Looking Upstream from Bridge