

67 - F - 261 M

GREIG BRIDGE

CON. 6/7 , LOT 33

WEST MISSOURI TWP.

H. Q. GOLDER & ASSOCIATES LTD.

SOIL AND FOUNDATION ENGINEERS

HEAD OFFICE - TORONTO, ONTARIO

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747 HYDE PARK ROAD
LONDON, ONTARIO
471-9600

November 17, 1967.

R. C. Dunn & Associates Ltd.,
747 Hyde Park Road,
LONDON, Ontario.

Don G & S Lot 23

ATTENTION: Mr. N. W. Warner, P. Eng.

RE: Subsurface Investigation,
Greig Bridge, West Nissouri
Twp., Middlesex County, Ontario

Dear Sirs:

This letter reports the results of a subsurface investigation carried out at the site of the proposed reconstruction of Greig Bridge, located between Concession VI and VII at Lot 33 in the Township of West Nissouri, Middlesex County, Ontario. It is proposed to replace the existing structure with a reinforced concrete culvert.

Two boreholes were put down on October 23rd, 1967 at the locations shown on Figure 1, using a trailer mounted power auger. Standard penetration tests were carried out in both boreholes and the samples obtained brought to our London laboratory for detailed examination and representative testing. The ground-water level was observed in both boreholes during drilling and in a perforated standpipe installed in Borehole 1 on the completion of drilling.

The soil conditions encountered in the boreholes are shown in detail on the Record of Borehole sheets attached to this letter and an inferred soil stratigraphy across the site is shown with the Site Plan as Figure 1. The results of the laboratory testing are shown on the Records of Boreholes and on Figure 2.

..2

The elevations given in this letter are referred to a bench mark located as a red paint mark on the top of the northeast corner of the wingwall on the existing bridge. The elevation of this bench mark was given as 89.35 referred to a local datum.

The site is located within the physiographic region known as the Stratford Till Plain. The south branch of Gregory Creek over which the structure will be built flows west to join the Thames River through rolling agricultural land.

The borings put down at the side of the existing road show that there is about 6 feet of firm brown to dark brown clayey silt fill behind the existing abutments. Below the fill there was a very stiff to hard grey clayey silt till overlain by 1.5 feet of topsoil in Borehole 1. The till forms the predominant stratum at the site and has a natural water content of about 10 per cent with liquid and plastic limits of about 20 and 13 respectively. A typical grain size distribution curve for the till is shown as Figure 2. The ground-water level was measured about two weeks after completion of drilling to be at Elevation 87.1.

The proposed structure may be founded on spread footings in the till at Elevation 80 or deeper with a maximum allowable bearing pressure of 3 tons per square foot. If the foundations are lowered to Elevation 75, the design bearing pressure may be increased to 4 tons per square foot.

There should be only minor ground-water problems during construction providing the creek is properly diverted. Any seepage into the excavations can be easily handled with small sump pumps.

We trust that this letter provides sufficient information for the foundation design of the proposed structure. If there is any point that requires further explanation, please call our office.

Yours truly,
H. Q. GOLDER & ASSOCIATES LTD.,

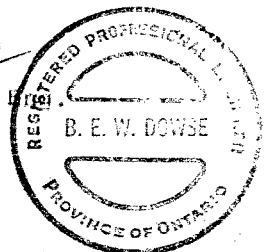
Brian E. W. Dowse

Brian E. W. Dowse, P. E.

BEWD:cmn
67581

Nov, 1967

GOLDER & ASSOCIATES



LIST OF ABBREVIATIONS

The abbreviations commonly employed on each "Record of Borehole," on the figures and in the text of the report, are as follows:

I. SAMPLE TYPES

<i>AS</i>	auger sample
<i>CS</i>	chunk sample
<i>DO</i>	drive open
<i>DS</i>	Denison type sample
<i>FS</i>	foil sample
<i>RC</i>	rock core
<i>ST</i>	slotted tube
<i>TO</i>	thin-walled, open
<i>TP</i>	thin-walled, piston
<i>WS</i>	wash sample

II. PENETRATION RESISTANCES

Dynamic Penetration Resistance: The number of blows by a 140-pound hammer dropped 30 inches required to drive a 2-inch diameter, 60 degree cone one foot, where the cone is attached to 'A' size drill rods and casing is not used.

Standard Penetration Resistance, *N*: The number of blows by a 140-pound hammer dropped 30 inches required to drive a 2-inch drive open sampler one foot.

<i>WH</i>	sampler advanced by static weight—weight, hammer
<i>PH</i>	sampler advanced by pressure—pressure, hydraulic
<i>PM</i>	sampler advanced by pressure—pressure, manual

III. SOIL DESCRIPTION

(a) *Cohesionless Soils*

<i>Relative Density</i>	<i>N, blows/ft.</i>
Very loose	0 to 4
Loose	4 to 10
Compact	10 to 30
Dense	30 to 50
Very dense	over 50

(b) *Cohesive Soils*

<i>Consistency</i>	<i>c_u, lb./sq. ft.</i>
Very soft	Less than 250
Soft	250 to 500
Firm	500 to 1,000
Stiff	1,000 to 2,000
Very stiff	2,000 to 4,000
Hard	over 4,000

IV. SOIL TESTS

<i>C</i>	consolidation test
<i>H</i>	hydrometer analysis
<i>M</i>	sieve analysis
<i>MH</i>	combined analysis, sieve and hydrometer ¹
<i>Q</i>	undrained triaxial ²
<i>R</i>	consolidated undrained triaxial ²
<i>S</i>	drained triaxial
<i>U</i>	unconfined compression
<i>V</i>	field vane test

NOTES:

¹Combined analyses when 5 to 95 per cent of the material passes the No. 200 sieve.

²Undrained triaxial tests in which pore pressures are measured are shown as \bar{Q} or \bar{R} .

LIST OF SYMBOLS

I. GENERAL

π	= 3.1416
e	= base of natural logarithms 2.7183
$\log_e a$ or $\ln a$	natural logarithm of a
$\log_{10} a$ or $\log a$	logarithm of a to base 10
t	time
g	acceleration due to gravity
V	volume
W	weight
M	moment
F	factor of safety

II. STRESS AND STRAIN

u	pore pressure
σ	normal stress
σ'	normal effective stress ($\bar{\sigma}$ is also used)
τ	shear stress
ϵ	linear strain
ϵ_{xy}	shear strain
ν	Poisson's ratio (μ is also used)
E	modulus of linear deformation (Young's modulus)
G	modulus of shear deformation
K	modulus of compressibility
η	coefficient of viscosity

III. SOIL PROPERTIES

(a) Unit weight

γ	unit weight of soil (bulk density)
γ_s	unit weight of solid particles
γ_w	unit weight of water
γ_d	unit dry weight of soil (dry density)
γ'	unit weight of submerged soil
G_s	specific gravity of solid particles $G_s = \gamma_s / \gamma_w$
e	void ratio
n	porosity
w	water content
S_r	degree of saturation

(b) Consistency

w_L	liquid limit
w_P	plastic limit
I_P	plasticity index
w_S	shrinkage limit
I_L	liquidity index = $(w - w_P) / I_P$
I_C	consistency index = $(w_L - w) / I_P$
e_{max}	void ratio in loosest state
e_{min}	void ratio in densest state
D_r	relative density = $(e_{max} - e) / (e_{max} - e_{min})$

(c) Permeability

h	hydraulic head or potential
q	rate of discharge
v	velocity of flow
i	hydraulic gradient
k	coefficient of permeability
j	seepage force per unit volume

(d) Consolidation (one-dimensional)

m_v	coefficient of volume change = $-\Delta e / (1+e) \Delta \sigma'$
C_c	compression index = $-\Delta e / \Delta \log_{10} \sigma'$
c_c	coefficient of consolidation
T_v	time factor = $c_c d^2 / d^2$ (d , drainage path)
U	degree of consolidation

(e) Shear strength

τ_f	shear strength
c'	effective cohesion intercept
ϕ'	effective angle of shearing resistance, or friction
c_u	apparent cohesion*
ϕ_u	apparent angle of shearing resistance, or friction
μ	coefficient of friction
S_t	sensitivity

*For the case of a saturated cohesive soil, $\phi_u = 0$ and the undrained shear strength $\tau_f = c_u$ is taken as half the undrained compressive strength.

DEFECTS IN NEGATIVE DUE TO
CONDITION OF ORIGINAL DOCUMENT

RECORD OF BOREHOLE 1

LOCATION

See Figure 1

BORING DATE

DATUM

BOREHOLE TYPE

BOREHOLE DIAMETER

SAMPLER HAMMER WEIGHT 140 LB. DROP 30 INCHES

PEN. TEST HAMMER WEIGHT - LB. DROP - INCHES

SOIL PROFILE			SAMPLES			ELEVATION SCALE	DYNAMIC PENETRATION RESISTANCE BLOWS / FT. -----					COEFFICIENT OF PERMEABILITY k, CM. / SEC.				ADDITIONAL LAB. TESTING	PIEZOMETER OR STANDPIPE INSTALLATION
ELEVATION DEPTH	DESCRIPTION	STRAT. PLOT	NUMBER	TYPE	BLOWS / FT.		SHEAR STRENGTH C_u , LB. / SQ. FT.					WATER CONTENT, PERCENT					
												W_p	W	W_L	10		
89.5	GROUND SURFACE																
88.0	FIRM BROWN TO DARK BROWN CLAYEY SILT WITH SOME SAND AND GRAVEL (FILL)		1	ST	87.5												
			2	ST	87.0												
83.5			3	ST	83.0												
82.0	LOOSE BLACK SILTY TOPSOIL		4	ST	81.5												
77.5			5	ST	77.0												
	VERY STIFF TO HARD GREY CLAYEY SILT TILL OCCASIONAL SAND AND GRAVEL		6	ST	76.5												
			7	ST	76.0												
			8	ST	75.5												
			9	ST	75.0												
			10	ST	74.5												
66.5					66.0												
23.0	END OF HOLE				22.5												

PROTECTIVE PIPE

WATER LEVEL IN STANDPIPE AT ELEVATION 87.1 NOV. 8, 1967

Percent axial strain at failure

15-10-5 Percent axial strain at failure

PROTECTIVE PIPE

CABLE

PNEUMATIC
FLUID LINE

-MH

WATER LEVEL IN
STANDPIPE AT
ELEVATION 87.1
NOV. 8, 1967VERTICAL SCALE
1/2 INCH TO 5'-0"

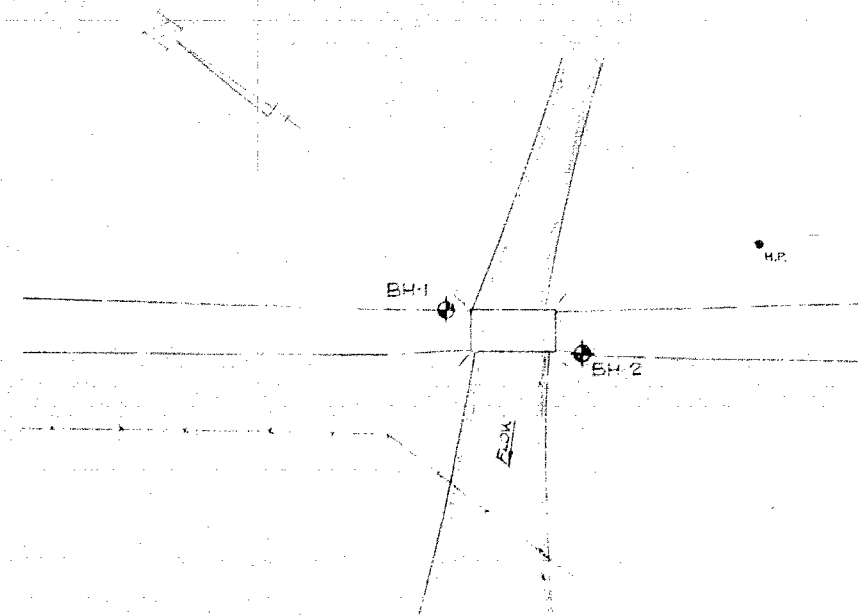
GOLDER & ASSOCIATES

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CHECKED HL

LOCATION	See Figure 1	BORING DATE	001 23 1960	DATUM	LOCAL
BOREHOLE TYPE	POWER AUGER BOREHOLE	BOREHOLE DIAMETER	4.5"		
SAMPLER HAMMER WEIGHT 140 LB.	DROP 30 INCHES	PEN. TEST HAMMER WEIGHT - LB.	DROP - INCHES		

SOIL PROFILE		SAMPLES			ELEVATION SCALE	DYNAMIC PENETRATION RESISTANCE BLOWS / FT.	COEFFICIENT OF PERMEABILITY k , CM. / SEC.				ADDITIONAL LAB. TESTING	PIEZOMETER OR STANDPIPE INSTALLATION
ELEVATION DEPTH	DESCRIPTION	STRAT. PLOT	NUMBER	TYPE		BLOWS / FT.	SHEAR STRENGTH c_u , LB. / SQ. FT.	WATER CONTENT, PERCENT <div style="display: flex; justify-content: space-between; width: 100%;"> w_p w w_L </div> <div style="display: flex; justify-content: space-between; width: 100%;"> 10 20 30 40 </div>				
	LOOSE SAND AND GRAVEL ROADBASE											
89.4	GROUND SURFACE											
88.4			1	CL	6							
87.4			2	CL	8							
86.4	FIRM BROWN TO DARK BROWN CLAYEY SILT SANDY AND GRAVEL (FILL)		3	CL	10							
85.4			4	CL	12							
84.4			5	CL	14							
83.4			6	CL	16							
82.4			7	CL	18							
81.4			8	CL	20							
80.4			9	CL	22							
79.4			10	CL	24							
78.4	VERY STIFF TO HARD GREY CLAYEY SILT TILL OCCASIONAL SAND AND GRAVEL		11	CL	26							
77.4			12	CL	28							
76.4			13	CL	30							
75.4			14	CL	32							
74.4			15	CL	34							
73.4			16	CL	36							
72.4			17	CL	38							
71.4			18	CL	40							
70.4			19	CL	42							
69.4			20	CL	44							
68.4			21	CL	46							
67.4			22	CL	48							
66.4			23	CL	50							
65.4			24	CL	52							
64.4			25	CL	54							
63.4			26	CL	56							
62.4			27	CL	58							
61.4			28	CL	60							
60.4			29	CL	62							
59.4			30	CL	64							
58.4			31	CL	66							
57.4			32	CL	68							
56.4			33	CL	70							
55.4			34	CL	72							
54.4			35	CL	74							
53.4			36	CL	76							
52.4			37	CL	78							
51.4			38	CL	80							
50.4			39	CL	82							
49.4			40	CL	84							
48.4			41	CL	86							
47.4			42	CL	88							

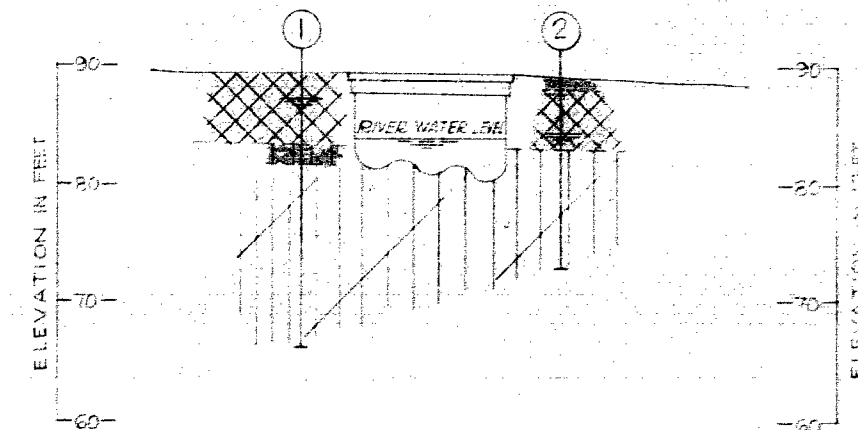
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SCALE: 1"=40'

REFERENCE

TOWNSHIP OF WEST NISSOUR
 R.C. DINN AND ASSOCIATES
 GREIG BRIDGE
 LOCATED ON ROAD BETWEEN CON
 VI AND VII LOT 33, TOWNSHIP OF
 WEST NISSOUR

SECTION ALONG CENTRELINE OF ROAD

HORIZONTAL: 1"=20'
 VERTICAL: 1"=10'

STRATIGRAPHY

- LOOSE SAND AND GRAVEL (ROADBASE)
- FIRM BROWN TO DARK BROWN CLAYEY SILT WITH SOME SAND AND GRAVEL (FILL)
- LOOSE BLACK SILTY TOPSOIL
- VERY STIFF TO HARD GREY CLAYEY SILT TILL OCCASIONAL SAND AND GRAVEL

LEGEND

- BOREHOLE IN PLAN
- BOREHOLE IN ELEVATION
- WATER LEVEL IN BOREHOLE NOV. 8, 1967

SPECIAL NOTE: DATA CONCERNING THE VARIOUS STRATA HAVE BEEN OBTAINED AT BOREHOLE LOCATIONS ONLY. THE SOIL STRATIGRAPHY BETWEEN BOREHOLES HAS BEEN INFERRED FROM GEOLOGICAL EVIDENCE AND SO MAY VARY FROM THAT SHOWN.

DEFECTS IN NEGATIVE DUE TO
 CONDITION OF ORIGINAL DOCUMENT

Drawn NOV 9, 1967

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