

64-F-259 M

McILQUHAM BRIDGE

DRUMMOND TWP

B.A. 1857
SITE 15-54

64-F-259M

REPORT

TO

C. C. PARKER AND ASSOCIATES LIMITED

ON

SITE INVESTIGATION

PROPOSED McILQUHAM BRIDGE

TOWNSHIP OF DRUMMOND

COUNTY OF LANARK

ONTARIO

Distribution:

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Toronto, Ontario

May, 1964

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GOLDER & ASSOCIATES

H. Q. GOLDER & ASSOCIATES LTD.

CONSULTING CIVIL ENGINEERS

H. Q. GOLDER
V. MILLIGAN
L. G. SODERMAN

2444 BLOOR STREET WEST
TORONTO 9, ONTARIO
767-9201
763-4103

May 7, 1964

C. C. Parker and Associates Limited,
Consulting Professional Engineers,
795 Main Street West,
Hamilton, Ontario.

Attention: Mr. D. C. Cramm, P. Eng.
Bridge Department Manager

RE: SITE INVESTIGATION
PROPOSED McILQUHAM BRIDGE
TOWNSHIP OF DRUMMOND
COUNTY OF LANARK, ONTARIO

Dear Sirs:

This letter reports the results of an investigation carried out at a bridge crossing over the Mississippi River on County Road 5B in Concession XI, Lot 7 in the Township of Drummond, County of Lanark, Ontario. The purpose of the investigation was to determine the subsoil conditions at the site and to provide information for the foundation design of a proposed bridge replacement structure.

PROCEDURE

The field work for this investigation was carried out during the period March 30, 1964 to April 4, 1964. A total of

seven boreholes were put down across the river from the existing bridge, along a line about 3 feet south of the north curb, using a trailer-mounted machine drillrig supplied and operated by the F. E. Johnston Drilling Co. Ltd. Each of the borings was taken to bedrock which was encountered at shallow depth and bedrock was proved by core drilling in AX size at boreholes 1 to 6, inclusive, and in BX size at borehole 7.

A detailed log for each borehole is given on the Records of Boreholes following the text of this report. The locations of the borings together with the approximate pier and abutment locations of the proposed bridge are shown on Figure 1. A section of the inferred soil and bedrock stratigraphy across the site is given on Figure 2.

All elevations in this report are referred to a local datum and were supplied by the County Surveyor.

SITE AND GEOLOGY

The site is located across the Mississippi River in an area underlain by highly metamorphosed rocks of Precambrian age. The general region is relatively flat and bears much evidence of Pleistocene glaciers which advanced into the area from the north-east and left the bedrock covered with a thin veneer of till and fluvial deposits of sand and gravel. Bedrock shows through the

glacial deposits in numerous places.

SUMMARIZED SOIL AND BEDROCK CONDITIONS

The borings put down during the field investigation show that the river bed, which is covered by random cobbles and boulders, is underlain by a 1 to 5 foot thick layer of essentially granular material. This layer is mainly comprised of silty sand with gravel and occasional cobbles and boulders but varies to an organic silt and silty sand, particularly in the upper portion of the deposit. Based on the standard penetration test results given on the Records of Boreholes, the silty sand and gravel deposit ranges between a loose and dense state of packing and is generally compact.

Highly metamorphosed bedrock of Precambrian age underlies the relatively thin river bed deposit. The bedrock was proved in each borehole by core drilling in generally AX size for a minimum depth of about 10 feet. A detailed description of the bedrock encountered in each borehole is given on the Records of Boreholes.

Several varieties of bedrock are present, including granite, granite gneiss, syenite, syenite gneiss and amphibolite. The predominant minerals in these rocks are feldspars, biotite, amphiboles, calcite and quartz. An examination of the rock core obtained shows that fractures are common throughout the bedrock, particularly in the upper few feet. Some of the fractures are

horizontal and probably represent a joint pattern, whereas other fractures are inclined parallel to the schistosity, which is inclined between about 45 and 80 degrees to the vertical, and represent a fracture cleavage. A few fractures are vertical and cut across the schistosity of the bedrock. Some of the fractures or joints are healed with calcium carbonate but the majority appear to be open and contain calcium carbonate and iron oxide on the fracture surfaces.

Based on the rock core recovery given on the Records of Boreholes, the bedrock, although fractured and jointed, is generally fairly sound. The bedrock, however, is not impermeable and water will permeate along the open fractures.

The river water level during the period of the investigation was at about elevation 35.5, which is some 3 to 5 feet above the river bed. Local information indicates that the river fluctuates between a high and low level corresponding to about elevation 42 and 35.

DISCUSSION

It is understood that the existing bridge is to be replaced to accommodate a widening of the roadway at the crossing and an increase of some 4 feet in the grade level. The proposed

bridge is to be a five span simply supported structure with 65 foot central spans and 55 foot end spans. The bridge abutments are to be U shaped in plan and will retain about 15 feet of roadway approach fill above existing river bed level. It is planned to found the bridge piers and abutments on spread footings imposing a loading of the order of 3 tons/sq.ft.

The bedrock underlying the river bed beneath a thin cover of silty sand and gravel is a competent foundation stratum for the support of the proposed bridge structure and it is recommended that the pier and abutment footings be founded in it. Footings imposing a bearing pressure of up to 10 tons/sq.ft. on the bedrock should not experience any measurable settlement.

It is recommended that free-draining granular material, well compacted in lifts not exceeding 9 to 12 inches in loose thickness, be placed behind the abutments of the structure. The granular backfill should be placed in a zone extending from a point 5 feet in back of the base of the abutment wall upwards at an angle of 45 degrees to the roadway surface. Provision should be made for drainage of the backfill to prevent the buildup of hydrostatic or ice pressures behind the abutments.

Lateral pressures on the abutments for the simply supported structure may be computed using active earth pressure,

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as it is considered that sufficient movement of the abutments will take place to develop this condition in the granular backfill. For compact to dense free-draining granular material the coefficient of active earth pressure, K_a , is about 0.3.

In the computation of sliding resistance between a rough concrete footing base and the bedrock, a coefficient of friction of 0.3 may be used.

After removal of the pervious granular deposit overlying the bedrock, excavation for foundations in bedrock below the river water level could be made in the dry inside a relatively impervious earth dyke constructed around the perimeter of the proposed excavation area. However, it is considered that water seepage from the base of the rock excavation will take place due to the presence of fractures in the bedrock. The pouring of mass foundation concrete directly on bedrock, where this base condition exists, could result in poor quality concrete due to upward seepage of water washing out the fine cement sizes. To eliminate possible water seepage effects on the mass concrete, it is suggested that the forms for the footings be placed and the water level inside the excavation allowed to rise to river level. A tremie seal could then be placed over the base and after it has set up the water could be pumped out from inside the cofferdammed excavation. The remainder of the concrete may then be poured in the dry.

We trust that the above information is sufficient to enable you to carry out the foundation design of the proposed structure. If we can be of any further service please call us.

Yours faithfully,

H. Q. GOLDER & ASSOCIATES LTD.



J. L. Seychuk, P. Eng.

JLS:IMB
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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

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

WH sampler advanced by static weight—weight, hammer
 PH sampler advanced by pressure—pressure, hydraulic
 PM sampler advanced by pressure—pressure, manual

III. SOIL DESCRIPTION

(a) Cohesionless Soils

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

(b) Cohesive Soils

Consistency	<i>c_u</i> , lb./sq. ft.
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

C consolidation test
 H hydrometer analysis
 M sieve analysis
 MH combined analysis, sieve and hydrometer¹
 Q undrained triaxial²
 R consolidated undrained triaxial²
 S drained triaxial
 U unconfined compression
 V 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

τ	= 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_s	coefficient of consolidation
T_v	time factor = c_v / d^2 (d , drainage path)
U	degree of consolidation

(e) Shear strength

τ_f	shear strength
c'	effective cohesion
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_i	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.

RECORD OF BOREHOLE 3

LOCATION STA. 2+42-3.6' LEFT OF C
See Figure 1 BORING DATE MARCH 31, 1964 DATUM LOCAL
BOREHOLE TYPE WASH BORING BOREHOLE DIAMETER BX CASING
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
ELEVN. DEPTH	DESCRIPTION	STRAT. PLOT	NUMBER	TYPE	BLOWS/FT.		SHEAR STRENGTH C _u , LB./SQ. FT.				WATER CONTENT, PERCENT W _p W W _L					
44.6	EXISTING BRIDGE DECK					45										
0.0	CONCRETE															
0.6																
35.5	RIVER LEVEL					40										
9.1	WATER					35										
30.6	RIVER BOTTOM															
14.0						30										
14.6	COMPACT GREY SILTY SAND WITH SOME GRAVEL		1	D.O.	25											
27.8																
16.8			2	AXT R.C.	—	25										
	FAIRLY SOUND GEEYISH GREEN TO PINK GRANITE AND GRANITE GNEISS BEDROCK WITH SOME FRACTURES		3	"	—	20										
18.4			4	"	—	15										
26.2	END OF HOLE															

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16695

16710

16725

16740

16755

16770

16785

16800

16815

16830

16845

16860

16875

16890

16905

16920

16935

16950

16965

16980

16995

17010

17025

17040

17055

17070

17085

17100

17115

17130

17145

17160

17175

17190

17205

17220

17235

17250

17265

17280

17295

17310

17325

17340

17355

17370

17385

17400

17415

17430

17445

17460

17475

17490

17505

17520

17535

17550

17565

17580

17595

17610

17625

17640

1

15-0-5 Percent axial strain at failure

VERTICAL SCALE
1 INCH TO 5'-0"

COLDER & ASSOCIATES

DRAWN J.A.
CHECKED J.W.

RECORD OF BOREHOLE 4

LOCATION STA. 1+22-3.3 LEFT OF E
See Figure 1

BORING DATE

APRIL 1, 1964

DATUM

LOCAL

BOREHOLE TYPE

WASH BORING

BOREHOLE DIAMETER

BY CASING

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
ELEV. DEPTH	DESCRIPTION	STRAT. PLOT	NUMBER	TYPE	BLOWS/FT.		SHEAR STRENGTH C_u , LB /SQ.FT	WATER CONTENT, PERCENT				
								W_p	W_L			
44.7	EXISTING BRIDGE DECK					45						
0.0	CONCRETE											
0.6												
35.7	RIVER LEVEL					40						
9.0	WATER					35						
31.7	RIVER BOTTOM					30						
13.0	COMPACT TO DENSE BROWN SAND & GRAVEL WITH A FEW COBBLES		1	D.O.	21							
28.9			2	"	64							
15.8	FAIRLY SOUND PINK SYENITE BEDROCK SOME FRACTURES											
26.7			3	ANT R.C.	—							
18.0	HIGHLY WEATHERED AMPHIBOLITE BEDROCK					25						
22.9												
21.8	FAIRLY SOUND DARK GREEN AMPHIBOLITE BEDROCK, OCCASIONAL FRACTURES		4	"	—	20						
19.9												
24.8	SOUND PINK TO GREEN SYENITE GNEISS BEDROCK											
17.7												
27.0	END OF HOLE					15						

15

10

5

0

Percent axial strain at failure



Percent axial strain at failure

VERTICAL SCALE
1 INCH TO 5'-0"

COLDER & ASSOCIATES

DRAWN J.A.
CHECKED J.A.

RECORD OF BOREHOLE 5

LOCATION STA. 1+82-33' LEFT OF &
See Figure 1

BORING DATE

APRIL 2, 1964

DATUM

LOCAL

BOREHOLE TYPE


WASH BORING

BOREHOLE DIAMETER

BX CASING

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	
ELEV. DEPTH	DESCRIPTION	STRAT. PLOT	NUMBER	TYPE		BLOWS/FT.	SHEAR STRENGTH C_u , LB./SQ. FT.					WATER CONTENT, PERCENT W_p W W_L
44.6	EXISTING BRIDGE DECK					45						
0.0	CONCRETE											
0.6												
35.5	RIVER LEVEL					40						
9.1	WATER					35						
31.8	RIVER BOTTOM					30						
12.8			1	2" D.C.	3							
30.1												
14.5			2	AT R.C.		25						
	FAIRLY SOUND PINK TO GREYISH - GREEN SYENITE AND SYENITE GNEISS BEDROCK WITH SOME FRACTURES		3	"	1							
			4	"	1							
16.0						20						
28.6	END OF HOLE					15						

53
89
100

PERCENT CORE RECOVERY

LOOSE DARK BROWN SILTY SAND WITH TRACE
TO SOME GRAVEL, ORGANIC MATTER AND
SHELLS, OCCASIONAL BOULDERS

15-10-5 Percent axial strain at failure

15-10 Percent axial strain at failure

VERTICAL SCALE

1 INCH TO 5'-0"

GOLDER & ASSOCIATES

DRAWN L.A.

CHECKED DY

RECORD OF BOREHOLE 6

LOCATION STA. 3+02 - 3.5' LEFT OF C
See Figure 1

BORING DATE APRIL 3, 1964

DATUM

LOCAL

BOREHOLE TYPE

WASH BORING

BOREHOLE DIAMETER

BY CASING

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
ELEV. DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE	BLOWS/FT.		SHEAR STRENGTH C_u , LB./SQ. FT.				WATER CONTENT, PERCENT W_p — W — W_L					
44.6	EXISTING BRIDGE DECK					45										
0.8	CONCRETE															
0.6						40										
35.6	RIVER LEVEL					35										
9.0	WATER					30										
30.2	RIVER BOTTOM					25										
14.4	COMPACT GREY SILTY SAND WITH GRAVEL		1	DO.	30											
29.0																
15.6	FAIRLY SOUND MOTTLED GREY-GREEN TO PINK SYENITE GNEISS AND BIOTITE GNEISS BEDROCK WITH A FEW FRACTURES		2	AXT R.C.												
20.0																
24.6	END OF HOLE					20										
						10										

15

10

5

Percent axial strain at failure

15 0 5 Percent axial strain at failure

VERTICAL SCALE
1 INCH TO 5'-0"

GOLDER & ASSOCIATES

DRAWN J.A.
CHECKED *en*

RECORD OF BOREHOLE 7

 LOCATION STA. 1+12-3.5' LEFT OF $\frac{1}{4}$
See Figure 1

BORING DATE APRIL 3, 1964

DATUM

LOCAL

BOREHOLE TYPE

WASH BORING

BOREHOLE DIAMETER

BX CASING

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
ELEV. DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE	BLOWS/FT.		SHEAR STRENGTH C_u , LB./SQ. FT.	WATER CONTENT, PERCENT				
								W_p	W_L			
44.7	EXISTING BRIDGE DECK					45						
0.0	CONCRETE											
0.6												
35.6	RIVER LEVEL					40						
9.1	WATER					35						
32.1	RIVER BOTTOM					30						
12.6	LOOSE BROWN ORGANIC SILTY SAND WITH SOME GRAVEL AND SHELLS		1	2" D.O.	9							
30.7			2	"	11							
14.0	COMPACT REDDISH- BROWN SILTY SAND AND GRAVEL, TRACE OF CLAY		3	"								
28.2			4	BY R.C.								
16.5			5	"	25							
	FAIRLY SOUND PINK AND RED TO GREYISH- GREEN SYENITE GNEISS BEDROCK WITH SOME FRACTURES		6	"								
			7	"	20							
			8	ANT R.C.								
16.2												
28.5	END OF HOLE					15						

PERCENT CORE RECOVERY

75

97

100

100

75

0

10

15

Percent axial strain at failure

15 0 5 Percent axial strain of failure

 VERTICAL SCALE
1 INCH TO 5'-0"

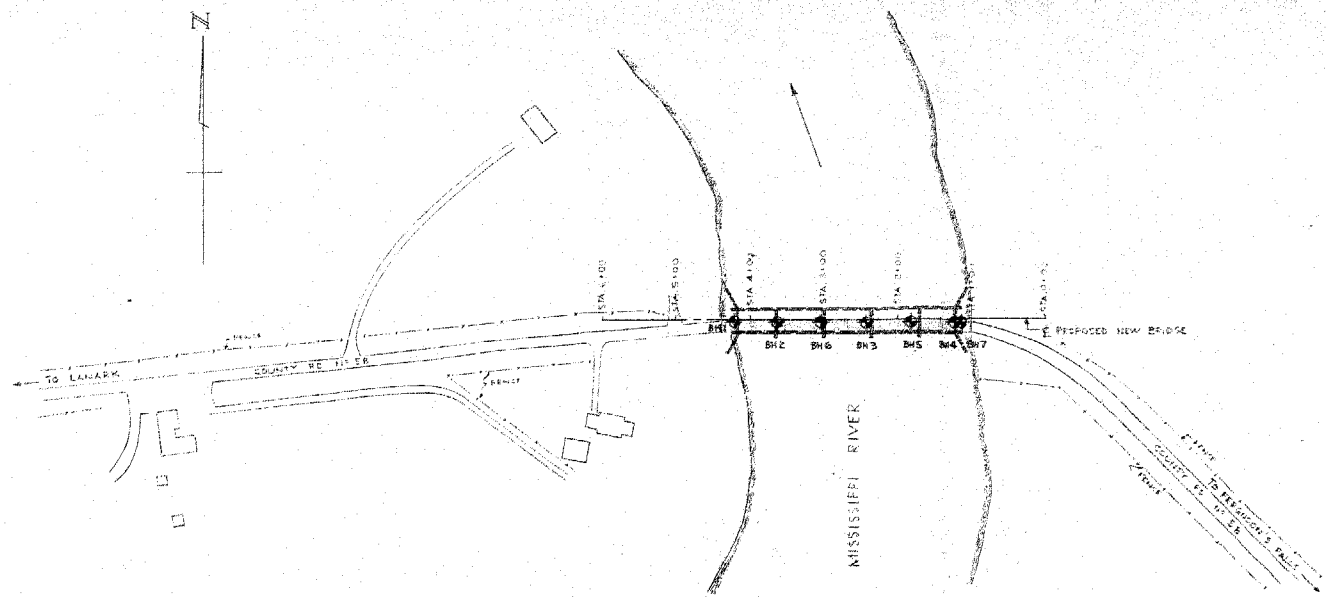
GOLDER & ASSOCIATES

 DRAWN J.A.
CHECKED *an*

64010

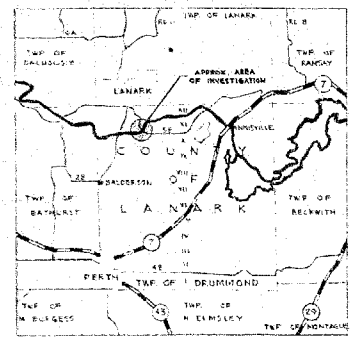
BORING PLAN

FIGURE 1



PLAN
SCALE: 1" = 100'-0"

- LEGEND**
- ◆ BORING LOCATION
 - EXISTING BRIDGE STRUCTURE
 - - - - - PROPOSED BRIDGE STRUCTURE



KEY PLAN

REFERENCE

DRAWG. NO. 2127-P1 - C. C. PARKER & ASSOCIATES LTD.
BRIDGE OVER MISSISSIPPI RIVER - COUNTY ROAD NO. 115,
LOT 7, CON. 14 - COUNTY OF LANARK, TOWNSHIP OF
DEERFIELD - SITE PLAN AND PROFILE, DATED APR. 8, 1964.

GOLDER & ASSOCIATES

Made by
Chkd. by
Appd. by

