#64-F-266M

COUNTY RD. #26

PLOVER MILLS

BRIDGE

THAMES RIVER

BA.1882
19-78

REPORT

TO

R. C. DUNN & ASSOCIATES LIMITED

ON

SITE INVESTIGATION

PROPOSED PLOVER MILLS BRIDGE

THAMES RIVER CROSSING COUNTY ROAD 26

NEAR BRYANSTON ONTARIO

64-F-2504

Distribution:

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June, 1964

64020

GOLDER & ASSOCIATES

H. Q. GOLDER & ASSOCIATES LTD.

CONSULTING CIVIL ENGINEERS

H. Q. GOLDER
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2444 BLOOR STREET WEST
TORONTO 9, ONTARIO
767-9201
763-4103

June 29, 1964

R. C. Dunn & Associates Limited,
Consulting Engineers,
747 Hyde Park Road,
London, Ontario.

Attention: Mr. N. M. Warner, P. Eng.

RE: SITE INVESTIGATION
PROPOSED PLOVER MILLS BRIDGE
NEAR BRYANSTON, ONTARIO

Dear Sirs:

This letter reports the results of an investigation carried out at the above proposed bridge crossing over the Thames River on County Road 26 in Concession 2 between Lots 25 and 26 in the Township of West Nissouri, County of Middlesex, Ontario. The purpose of the investigation was to determine the subsoil conditions at the site and to provide information for the design of foundations and approach embankments for the proposed bridge.

PROCEDURE

The field work for this investigation was carried out during the periods March 9 to March 13, 1964 and May 11 to May 15, 1964. A total of 5 boreholes with adjacent dynamic penetration tests and 5 additional dynamic penetration tests were put down at the proposed pier and abutment locations using a skid-mounted machine drillrig. The borings were put down in NX and BX casing size to an average depth of about 25 feet and bedrock was proven in 2 borings by core drilling for up to 9 feet in AXT size. Piezometers were installed in the borings at the abutment locations.

A detailed log for each borehole is given on the Records of Boreholes. The locations of the borings are shown on Figure 1 and a section of the inferred soil stratigraphy across the site is given on Figure 2.

The samples obtained during the investigation were brought to our laboratory for examination and testing. The results of the laboratory tests carried out are given on the Records of Boreholes and on Figures 3 to 6 inclusive.

All elevations are referred to Geodetic datum and were provided by R. C. Dunn & Associates Limited.

SUMMARIZED SOIL CONDITIONS

The borings put down in this investigation show that the river bed, which is covered by random cobbles and boulders, is underlain by a stratum of brown sand and gravel with cobbles, boulders and a trace of organic matter. This stratum is a recent fluvial deposit and is up to about 11 feet in thickness. Based on the penetration test results obtained and the resistance offered to drilling, the recent fluvial deposit is essentially in a loose to compact state of packing. Typical grading curves for samples from this deposit, obtained using 1½" I.D. sampling equipment, are shown on Figure 3.

Underlying the recent river deposit at the pier locations and at ground surface at the abutment locations is a stratum of glacial till. The glacial till at the pier locations is up to about 20 feet in thickness and was proved for a maximum depth of some 26 feet at the abutment locations. The upper 6 to 10 feet of the till stratum at the abutment locations has been weathered and is brown in colour. Below this depth the till is grey. At the pier locations the brown weathered zone was not encountered.

As shown by the grading curves on Figure 4 the till stratum is comprised of a well graded composite of silt, sand and gravel sizes with a trace to some clay binder. The above fine grained matrix contains pockets of cobbles and boulders throughout.

The glacial till has an average liquid limit of about 14, a plasticity index of about 4 and a natural in situ water content between about 8 and 10 percent.

Based on the penetration test results given on the Records of Boreholes the weathered portion of the till is generally loose; the non-weathered zone is dense to very dense. The dynamic penetration tests generally met practical refusal within a 10 foot penetration into the non-weathered till.

Sound grey fossiliferous limestone bedrock was encountered beneath the till at a depth of some 20 feet below the existing river bed at boreholes 8 and 10. This is the general Ordovician bedrock formation in this area.

Water level observations made in the boreholes at the abutment locations during the course of the field work indicate that the groundwater is at or slightly above river level. The river level during the time of the investigation was at about elevation 896. Local information indicates that the river high water level could be up to elevation 908.

DISCUSSION

It is understood that the proposed bridge is to replace an existing 2 lane structure presently downstream of the new location. The new bridge is to be a 4 span continuous structure. The approach embankments to the new structure are to be at about elevation 930, which is some 28 feet above existing ground surface at the abutment locations.

The non-weathered dense to very dense portion of the glacial till is a competent foundation stratum. We recommend that the bridge piers be founded on spread footings resting directly on this stratum using an allowable bearing pressure of 4 tons/sq.ft. Provided that the glacial till at and below foundation level is not softened or disturbed during construction, settlement resulting from the application of the above bearing pressure should not exceed 1/2 inches.

In order to found the pier footings on the till it is recommended that closed interlocking steel sheet piling be driven around the perimeter of the footings. The steel sheeting should penetrate at least 3 feet into the till below foundation level. Because of the presence of the cobbles and boulders in the river bed deposit it is recommended that a deep web pile section such as a ZP32 be used. It may be necessary to partially excavate boulders from below the pile tips during the pile driving operation. A Delmag 12 or equivalent hammer size should be used to drive these piles.

On completion of the driving operations the river bed deposit from within the sheet pile enclosure should be excavated and the sheeting adequately strutted and braced. The enclosure should then be dewatered, the bottom inspected for any local softened or loosened till and a working slab poured in the dry. The concrete for the main portion of the pier should also be poured in the dry.

It is recommended that the sheet piling be left in place to serve as scour protection to the pier footings.

The soil conditions at the abutment locations are such that the proposed approach fills may be placed directly on the weathered till stratum after removal of the topsoil or any surface organic deposits. Foundation preparation for the approach fill should include stripping under the complete base width of the embankment.

The glacial till, if taken from the proposed cut to the east of the crossing as proposed and compacted according to DHO specifications, will be adequate for 2 horizontal to 1 vertical side slope construction. A compaction test on a representative sample of the glacial till is shown on Figure 5. It should be noted that the optimum compaction water content is about 15 percent, whereas the in situ water content of the till is slightly below this value. This would indicate that the cut material can be taken directly, spread and compacted to form the embankments. The 2 horizontal to 1 vertical side slopes should be protected with rip-rap which should extend at least 5 feet above the river high water level.

It is recommended that the abutments be supported on "H" piles driven through the fill to penetrate a minimum distance of 10 feet into the dense to very dense non-weathered till stratum. Considering a 12 BP 53 section driven as discussed above, a load of 35 tons/pile may be used. A typical penetration value for the last foot of pile driving, consistent with the above capacity, is considered to be about 50 blows/foot using a driving energy of 15 foot kips.

The details of this report are in accordance with the interim discussions we have had with you. If we can be of any further assistance, please call us.

Yours faithfully,

H. Q. GOLDER & ASSOCIATES LTD.

J. L. Seychuk, P. Eng.,

for L. G. Soderman, P. Eng.

JLS:IMB
64020

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	*N, 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	c_u, *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 hydrometer[1]
Q	undrained triaxial[2]
R	consolidated undrained triaxial[2]
S	drained triaxial
U	unconfined compression
V	field vane test

NOTES:

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

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

LIST OF SYMBOLS

I. GENERAL

$\pi = 3.1416$

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_v	coefficient of consolidation
T_v	time factor $= c_v t/d^2$ (d, drainage path)
U	degree of consolidation

(e) *Shear strength*

τ_f	shear strength	
c'	effective cohesion intercept	in terms of effective stress $\tau_f = c' + \sigma' \tan \phi'$
ϕ'	effective angle of shearing resistance, or friction	
c_u	apparent cohesion*	in terms of total stress $\tau_f = c_u + \sigma \tan \phi_u$
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.

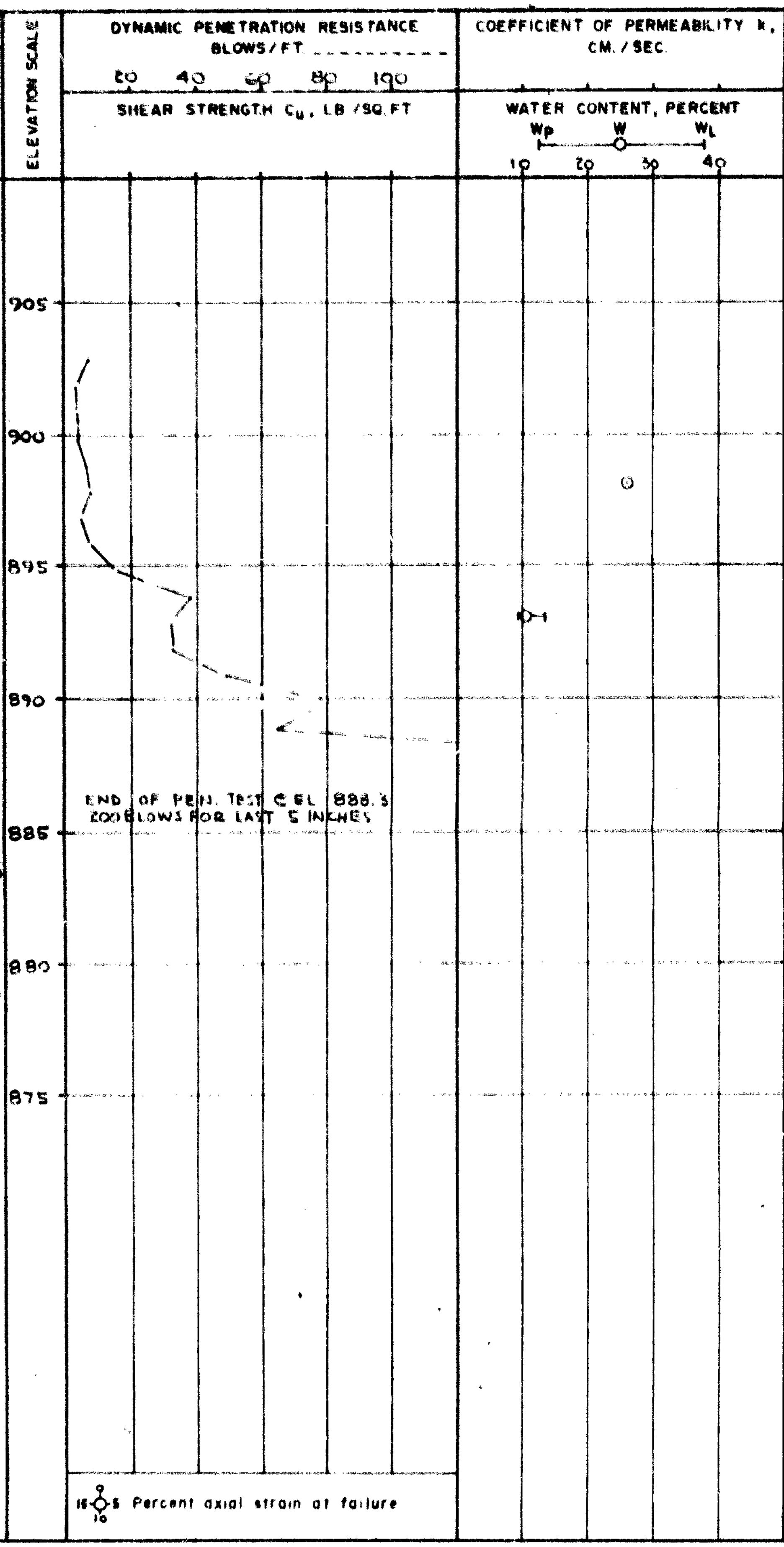
RECORD OF BOREHOLE 1

LOCATION: See Figure 1 — BORING DATE: MARCH 9 - 11, 1964 — DATUM: GEODETIC

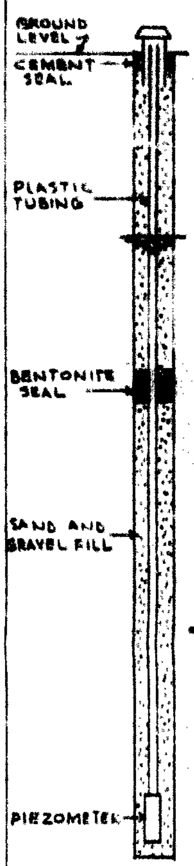
BOREHOLE TYPE: WASH BORING — BOREHOLE DIAMETER: NX & BX CASING

SAMPLER HAMMER WEIGHT 140 LB DROP 30 INCHES — PEN. TEST HAMMER WEIGHT 140 LB DROP 30 INCHES

ELEVN. / DEPTH	DESCRIPTION	SAMPLE NUMBER	TYPE	BLOWS / FT.	ADDITIONAL LAB. TESTING
903.7	GROUND LEVEL				
0.0	LOOSE BROWN SILTY SAND TO SANDY SILT WITH GRAVEL AND TRACE OF CLAY, OCCASIONAL COBBLES & BOULDERS THROUGHOUT (WEATHERED GLACIAL TILL)	1	2" D.O.	5	
		2	NX CA		
		3	D.O.	4	
		4	"	5	MH
		5	"	8	
893.9 / 9.8	VERY DENSE GREY SILTY SAND TO SANDY SILT WITH GRAVEL AND TRACE TO SOME CLAY. OCCASIONAL COBBLES AND BOULDERS. BOULDERS CORED 12.4' TO 15.4' (GLACIAL TILL)	6	"	>100	MH
		7	"	>100	
		8	AX CA		
		9	D.O.	54	
		10	"	>100	
		11	AX CA		
		12	D.O.	>100	
878.4 / 25.3	END OF HOLE				



PIEZOMETER OR STANDPIPE INSTALLATION



W.L. IN BOREHOLE @ EL. 897.8, MAY 11, 1964.

VERTICAL SCALE 1 INCH TO 5'-0"

GOLDER & ASSOCIATES

DRAWN J.A.

CHECKED [illegible]

PROJECT No. 64020

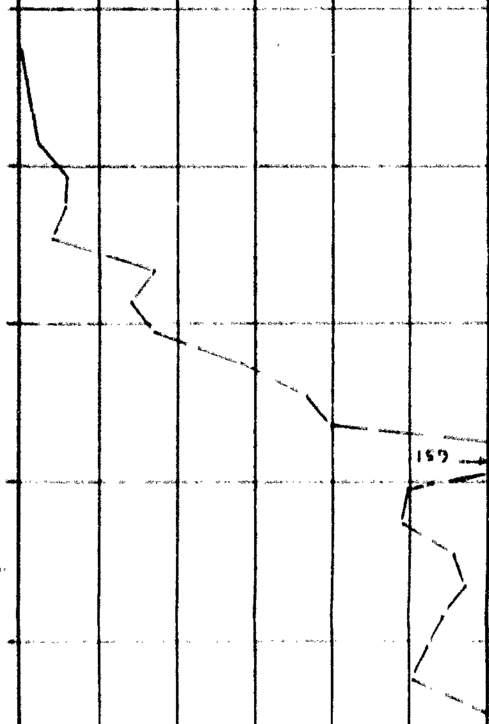
RECORD OF BOREHOLE 2

LOCATION See Figure BORING DATE MARCH 11, 1964 DATUM GEODETIC

BOREHOLE TYPE PENETRATION TEST BOREHOLE DIAMETER —

SAMPLER HAMMER WEIGHT — LB. DROP — INCHES PEN. TEST HAMMER WEIGHT 140 LB. DROP 30 INCHES

SOIL PROFILE			SAMPLES			ELEVATION SCALE	DYNAMIC PENETRATION RESISTANCE BLOWS/FT. (20, 40, 60, 80, 100) / SHEAR STRENGTH C_u, LB./SQ.FT.	COEFFICIENT OF PERMEABILITY k, CM./SEC. / WATER CONTENT, PERCENT W_P W W_L	ADDITIONAL LAB. TESTING	PIEZOMETER OR STANDPIPE INSTALLATION
ELEVN. / DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE	BLOWS/FT.					
904.6 / 0.0	GROUND LEVEL					905				
						900				
						895				
						890	159			
						885				
881.9 / 22.7	END OF PEN. TEST						165 BLOWS FOR LAST 9 INCHES			
						880				



15 -○- 5 (10) Percent axial strain at failure

VERTICAL SCALE
1 INCH TO 5'-0"

GOLDER & ASSOCIATES

DRAWN J.A.
CHECKED D.T.

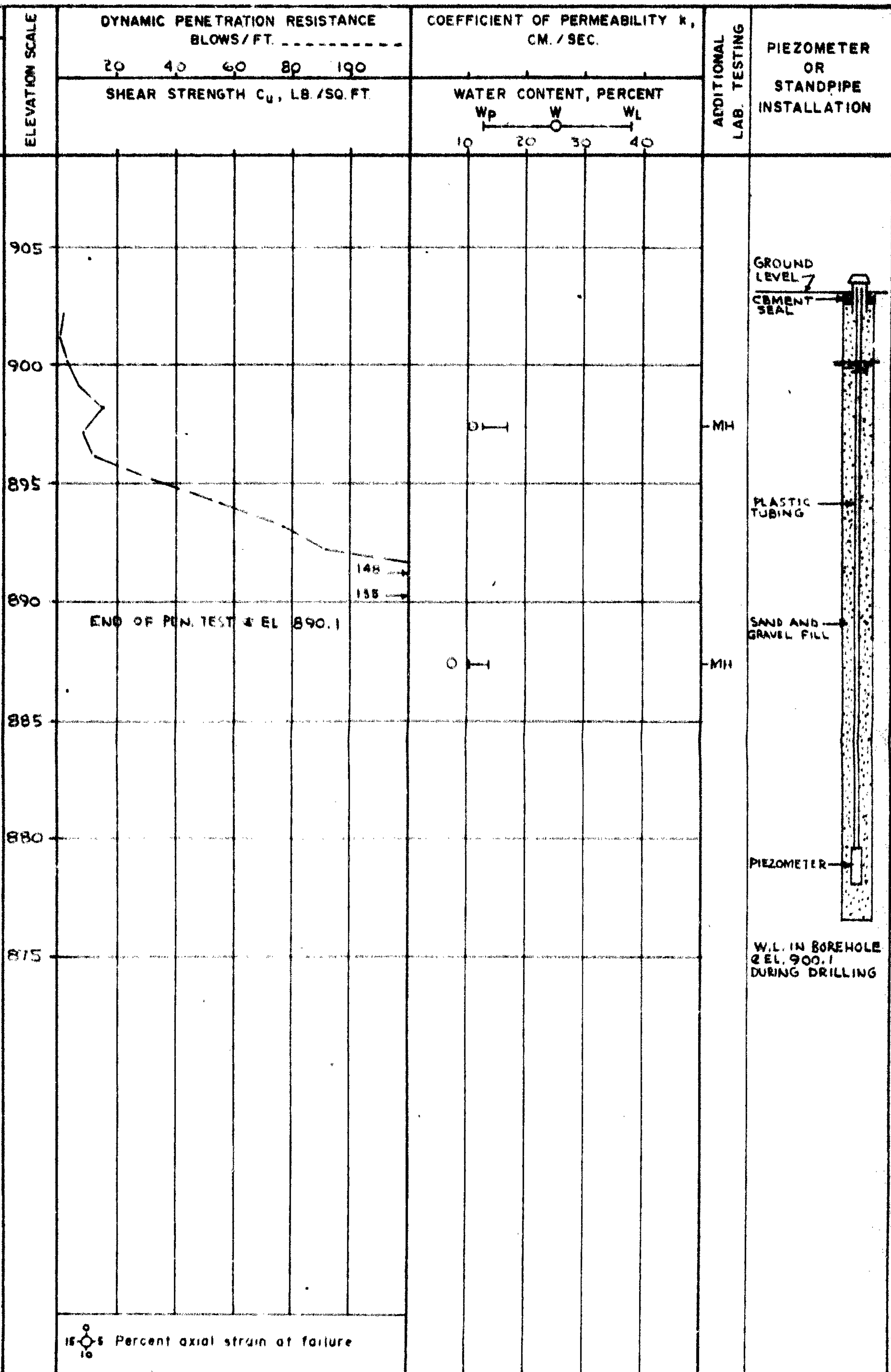
RECORD OF BOREHOLE 3

LOCATION See Figure 1 — BORING DATE MARCH 11-13, 1964 — DATUM GEODETIC

BOREHOLE TYPE WASH BORING — BOREHOLE DIAMETER NX CASING

SAMPLER HAMMER WEIGHT 140 LB. DROP 30 INCHES — PEN. TEST HAMMER WEIGHT 140 LB. DROP 30 INCHES

ELEVN / DEPTH	DESCRIPTION	SAMPLE NUMBER	TYPE	BLOWS/FT.
903.1	GROUND LEVEL			
0.0	LOOSE BROWN SANDY SILT TO SILTY SAND WITH TRACE OF GRAVEL AND TRACE TO SOME CLAY. (WEATHERED GLACIAL TILL)	1	2" D.O.	6
		2	"	9
		3	"	11
896.1 / 7.0		4	NX CA.	—
	DENSE TO VERY DENSE BROWN (GREY BELOW EL. 894.5) SILTY SAND TO SANDY SILT WITH GRAVEL, TRACE TO SOME CLAY. OCCASIONAL COBBLES AND BOULDERS THROUGHOUT (GLACIAL TILL)	5	D.O.	49
		6	"	53
		7	"	83
		8	"	95
		9	AX CA.	—
		10	D.O.	55
		11	"	>100
		12	AX CA.	—
		13	D.O.	73
876.6 / 26.5	END OF HOLE			



VERTICAL SCALE
1 INCH TO 5'-0"

GOLDER & ASSOCIATES

DRAWN J.A.
CHECKED

PROJECT No. 64020

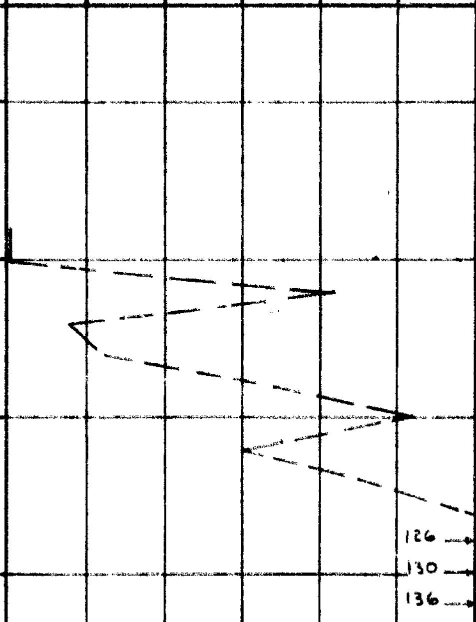
RECORD OF BOREHOLE 4

LOCATION: See Figure 1 | BORING DATE: MARCH 13, 1964 | DATUM: GEODETIC

BOREHOLE TYPE: PENETRATION TEST | BOREHOLE DIAMETER: —

SAMPLER HAMMER WEIGHT — LB. DROP — INCHES | PEN. TEST HAMMER WEIGHT 140 LB. DROP 30 INCHES

SOIL PROFILE			SAMPLES			ELEVATION SCALE	DYNAMIC PENETRATION RESISTANCE BLOWS/FT. (20, 40, 60, 80, 100) / SHEAR STRENGTH C_u, LB./SQ.FT.	COEFFICIENT OF PERMEABILITY k, CM./SEC. / WATER CONTENT, PERCENT W_P W W_L	ADDITIONAL LAB. TESTING	PIEZOMETER OR STANDPIPE INSTALLATION
ELEVN. / DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE	BLOWS/FT.					
						905				
901.9 / 0.0	GROUND LEVEL									
						900				
						895				
						890	126, 130, 136			
888.9 / 13.0	END OF PEN. TEST									
						885				



15 0 5 / 10 Percent axial strain at failure

VERTICAL SCALE
1 INCH TO 5'-0"

GOLDER & ASSOCIATES

DRAWN J.A.
CHECKED [illegible]

PROJECT No. 64023

RECORD OF BOREHOLE 5

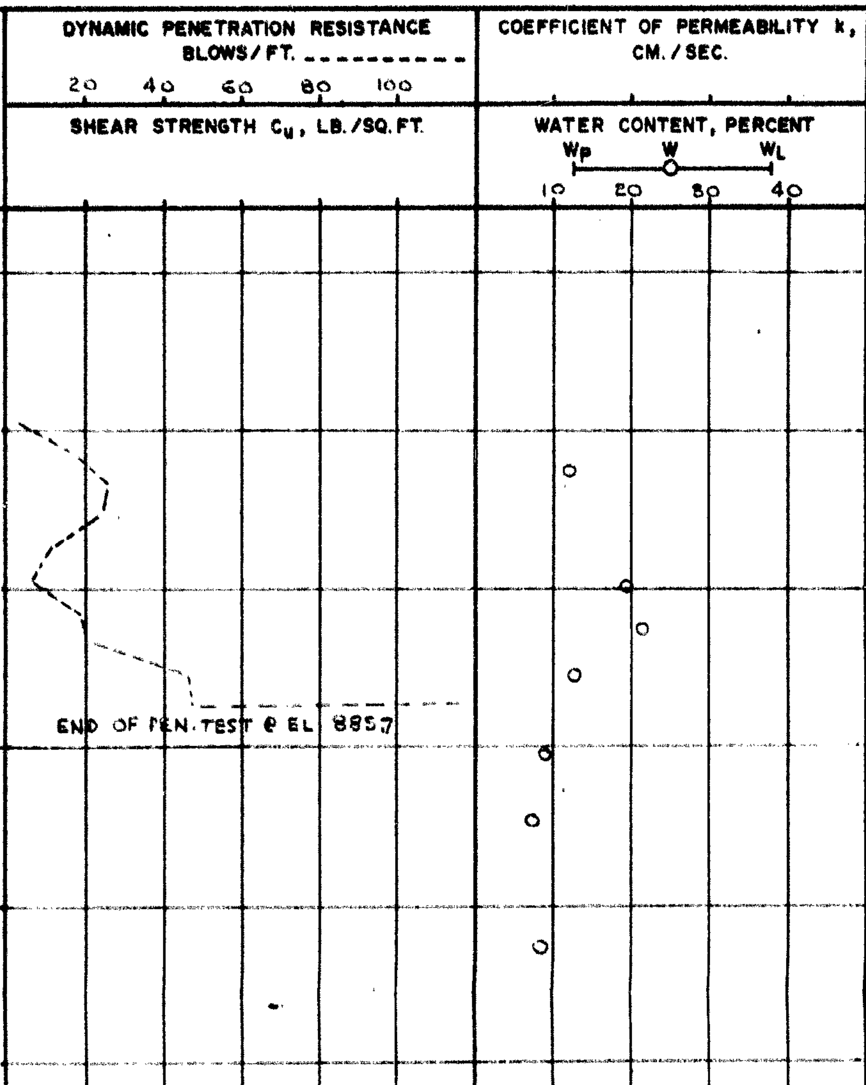
LOCATION See Figure 1 **BORING DATE** MAY 11-12, 1964 **DATUM** GEODETIC

BOREHOLE TYPE WASH BORING **BOREHOLE DIAMETER** BX CASING

SAMPLER HAMMER WEIGHT 140 LB. **DROP** 30 INCHES **PEN. TEST HAMMER WEIGHT** 140 LB. **DROP** 30 INCHES

ELEVN. / DEPTH	SOIL PROFILE – DESCRIPTION	SAMPLE NUMBER	TYPE	BLOWS/FT.	ADDITIONAL LAB. TESTING	PIEZOMETER OR STANDPIPE INSTALLATION
896.2	GROUND LEVEL					RIVER WATER LEVEL AT GROUND LEVEL MAY 11, 1964
0.0	LOOSE TO COMPACT BROWN SAND AND GRAVEL, TRACE OF SILT WITH COBBLES AND BOULDERS. DECAYED WOOD AT 6.6' TO 6.8'	1	2" D.O.	27		
		2	"	10		
		3	"	6	M	
		4	"	26		
		5	"	23		
885.2		6	ART CORE	—		
11.0	DENSE TO VERY DENSE GREY SILTY SAND TO SANDY SILT WITH GRAVEL AND TRACE OF CLAY, OCCASIONAL COBBLES AND BOULDERS (GLACIAL TILL)	7	D.O.	51		
		8	"	81	MH	
877.7		9	"	85		
18.5	END OF HOLE					

ELEVATION SCALE: 900, 895, 890, 885, 880, 875



Percent axial strain at failure

VERTICAL SCALE 1 INCH TO 5'-0"

GOLDER & ASSOCIATES

DRAWN G.W.

CHECKED

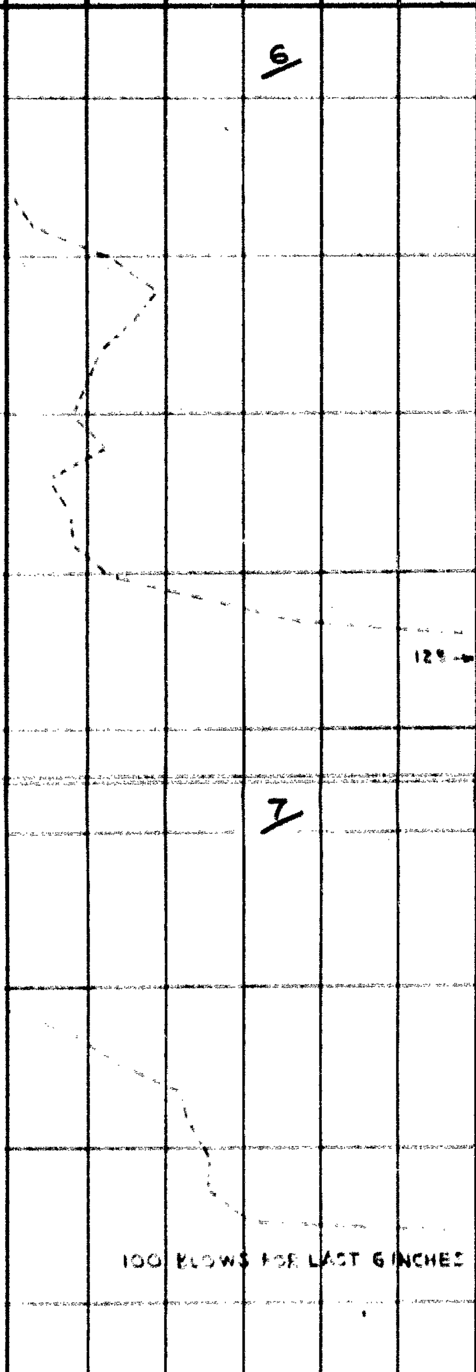
RECORD OF BOREHOLES 6, 7

LOCATION See Figure 1 — BORING DATE MAY 13, 1964 — DATUM GEODETIC

BOREHOLE TYPE PENETRATION TESTS — BOREHOLE DIAMETER —

SAMPLER HAMMER WEIGHT — LB. DROP — INCHES — PEN. TEST HAMMER WEIGHT 140 LB. DROP 30 INCHES

SOIL PROFILE			SAMPLES				ELEVATION SCALE	DYNAMIC PENETRATION RESISTANCE BLOWS/FT. (20, 40, 60, 80, 100) / SHEAR STRENGTH C_u, LB./SQ.FT.	COEFFICIENT OF PERMEABILITY k, CM./SEC. / WATER CONTENT, PERCENT W_p W W_L	ADDITIONAL LAB. TESTING	PIEZOMETER OR STANDPIPE INSTALLATION
ELEVN. / DEPTH	DESCRIPTION	STRAT. PLOT	NUMBER	TYPE	BLOWS/FT.						
	Borehole 6						900				
897.8 / 0.0	GROUND LEVEL						895				
							890				
							885				
881.8 / 16.0	END OF PEN. TEST						880				
	Borehole 7						900				
895.6 / 0.0	RIVER LEVEL										
1.0	RIVER BOTTOM						895				
							890				
886.1 / 9.5	END OF PEN. TEST						885				



15 ⌖ 5 Percent axial strain at failure (10)

VERTICAL SCALE
1 INCH TO 5'-0"

GOLDER & ASSOCIATES

DRAWN ..MWL..
CHECKED ....

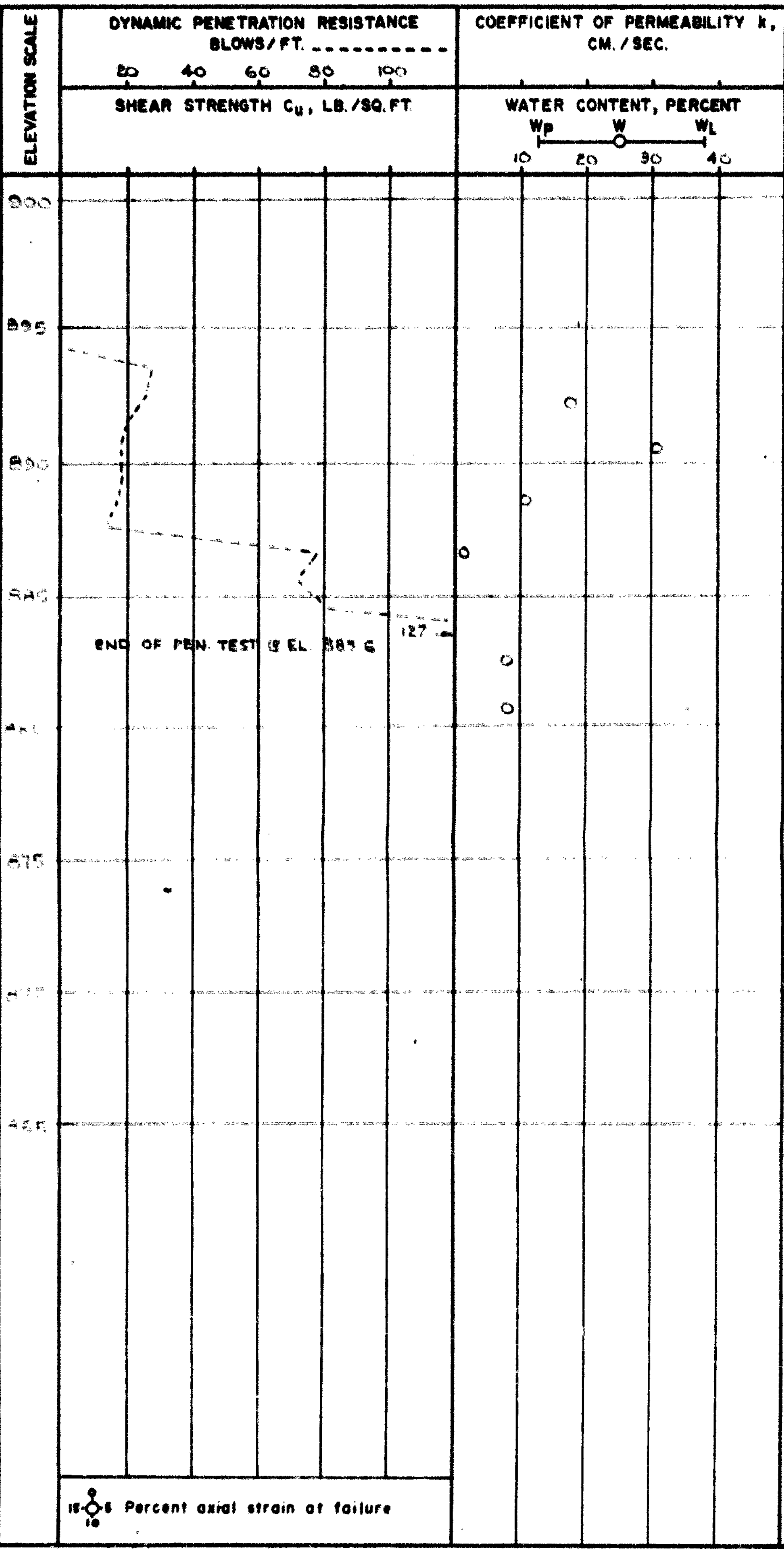
RECORD OF BOREHOLE 8

LOCATION See Figure 1 BORING DATE MAY 13-14, 1964 DATUM GEODETIC

BOREHOLE TYPE WASH BORING BOREHOLE DIAMETER BX CASING

SAMPLER HAMMER WEIGHT 140 LB. DROP 30 INCHES PEN. TEST HAMMER WEIGHT 140 LB. DROP 30 INCHES

ELEVN. / DEPTH	DESCRIPTION	SAMPLE NUMBER	TYPE	BLOWS/FT.	ADDITIONAL LAB. TESTING
895.6	RIVER LEVEL				
0.0	RIVER BOTTOM				
0.7	LOOSE TO COMPACT BROWN SAND & GRAVEL TRACE OF SILT COBBLES AND BOULDERS THROUGHOUT. OCCASIONAL WOOD FRAGMENTS AND SHELLS	1	A/T DRE	–	
		2	2" D.O.	15	
		3	"	8	M
		4	"	29	M
		5	"	57	
885.8 / 9.8	VERY DENSE GREY SILTY SAND TO SANDY SILT WITH GRAVEL TRACE CLAY OCCASIONAL COBBLES AND BOULDERS (GLACIAL TILL)	6	A/T DRE	–	
		7	2" D.O.	>100	
		8		81	
		9	"	>100	
875.6 / 20.0	[illegible] LIMESTONE BEDROCK (100% [illegible] RECOVERY)	10	A/T E.C.	–	
		11		–	
		12	"	–	
[illegible] / 29.3	END OF HOLE				



PIEZOMETER OR STANDPIPE INSTALLATION

VERTICAL SCALE 1 INCH TO 5'0"

GOLDER & ASSOCIATES

DRAWN ..A.W.....

CHECKED ..O.D.....

PROJECT No. [illegible]

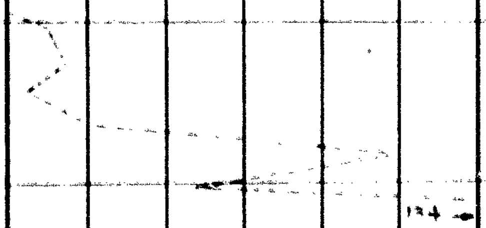
RECORD OF BOREHOLE 9

LOCATION See Figure 1 — BORING DATE MAY 11 1964 — DATUM GEODETIC

BOREHOLE TYPE PENETRATION TEST — BOREHOLE DIAMETER —

SAMPLER HAMMER WEIGHT — LB. DROP — INCHES — PEN. TEST HAMMER WEIGHT 140 LB. DROP 30 INCHES

SOIL PROFILE			SAMPLES			ELEVATION SCALE	DYNAMIC PENETRATION RESISTANCE BLOWS/FT. (20, 40, 60, 80, 100) / SHEAR STRENGTH C_u, LB./SQ.FT.	COEFFICIENT OF PERMEABILITY k, CM./SEC. / WATER CONTENT, PERCENT W_p W W_L	ADDITIONAL LAB. TESTING	PIEZOMETER OR STANDPIPE INSTALLATION
ELEVN. / DEPTH	DESCRIPTION	STRAT. PLOT	NUMBER	TYPE	BLOWS/FT.					
						900				
896.0 / 0.2	RIVER LEVEL		RIVER BOTTOM							
						895				
						890				
888.8 / 7.2	END OF PEN TEST						134			
						885				



H-O-S Percent axial strain at failure

VERTICAL SCALE 1 INCH TO 5'-0"

GOLDER & ASSOCIATES

DRAWN [illegible]

CHECKED [illegible]

PROJECT No. [illegible]

RECORD OF BOREHOLE 10

LOCATION See Figure 1 BORING DATE MAY 15, 1964 DATUM GEODETIC

BOREHOLE TYPE WASH BORING BOREHOLE DIAMETER BX CASING

SAMPLER HAMMER WEIGHT 140 LB. DROP 30 INCHES PEN. TEST HAMMER WEIGHT – LB. DROP – INCHES

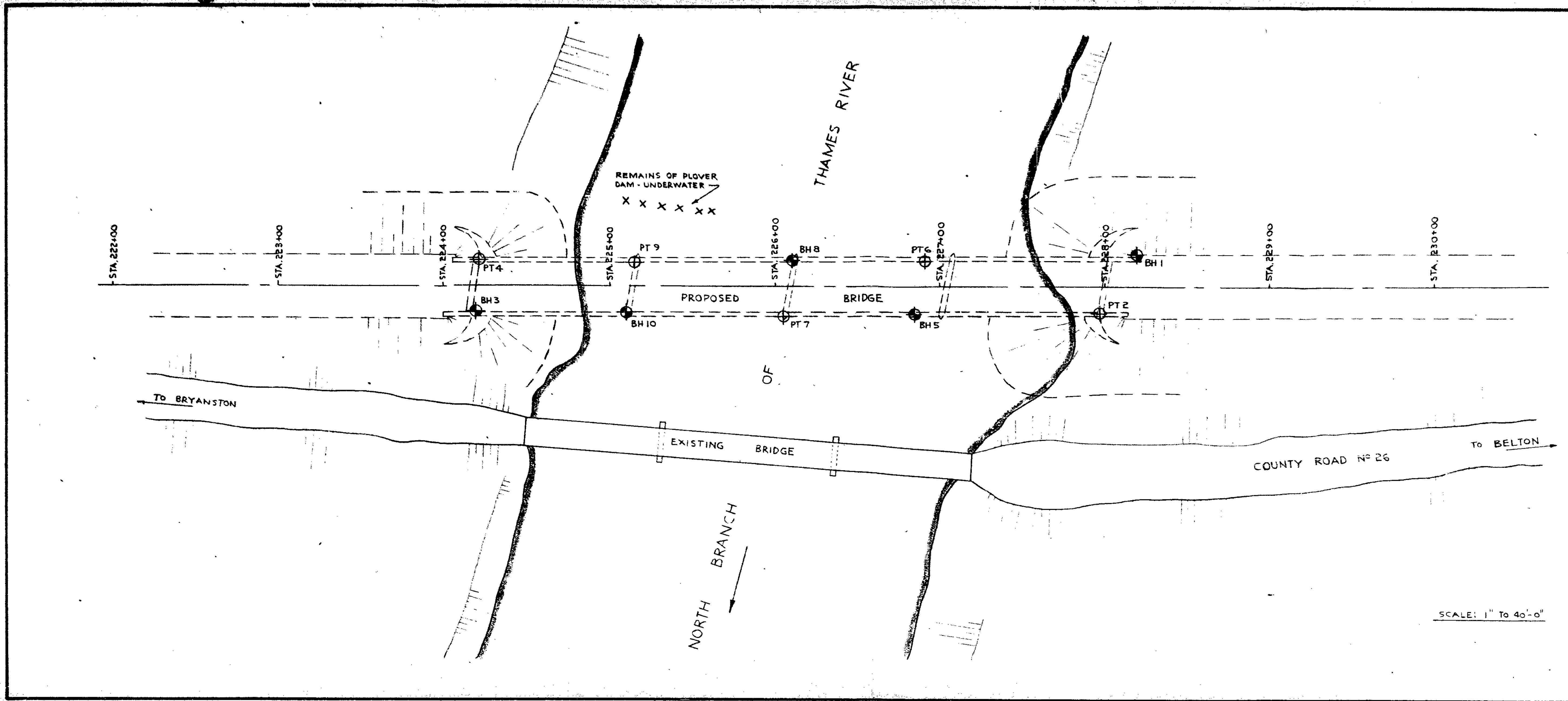
SOIL PROFILE: ELEVN. / DEPTH	SOIL PROFILE: DESCRIPTION	STRAT. PLOT	SAMPLES: NUMBER	SAMPLES: TYPE	SAMPLES: BLOWS/FT.	ELEVATION SCALE	DYNAMIC PENETRATION RESISTANCE BLOWS/FT. / SHEAR STRENGTH C_u, LB./SQ.FT.	COEFFICIENT OF PERMEABILITY k, CM./SEC. / WATER CONTENT, PERCENT W_p W W_L (10 20 30 40)	ADDITIONAL LAB. TESTING	PIEZOMETER OR STANDPIPE INSTALLATION
						900				
896.0	RIVER LEVEL		RIVER BOTTOM							
0.1	LOOSE BROWN SILTY SAND AND GRAVEL WITH COBBLES AND BOULDERS		1	AR CORE	–	895				
893.3 / 2.7	DENSE TO VERY DENSE GREY SILTY SAND TO SANDY SILT WITH GRAVEL TRACE OF CLAY, OCCASIONAL COBBLES AND BOULDERS (GLACIAL TILL)		2	2" D.O.	32			o		
			3	"	37			o		
			4	"	57	890		o		
			5	"	50					
						885				
			6	"	59			o		
						880				
			7	"	43	875				
874.7 / 21.3	SOUND GREY FOSSILIFEROUS LIMESTONE BEDROCK (100% CORE RECOVERY)		8	A-T R.C.	–					
869.6 / 26.4	END OF HOLE					870				
						865				

15 ◇ 5 / 10 Percent axial strain at failure

VERTICAL SCALE
1 INCH TO 5'-0"

GOLDER & ASSOCIATES

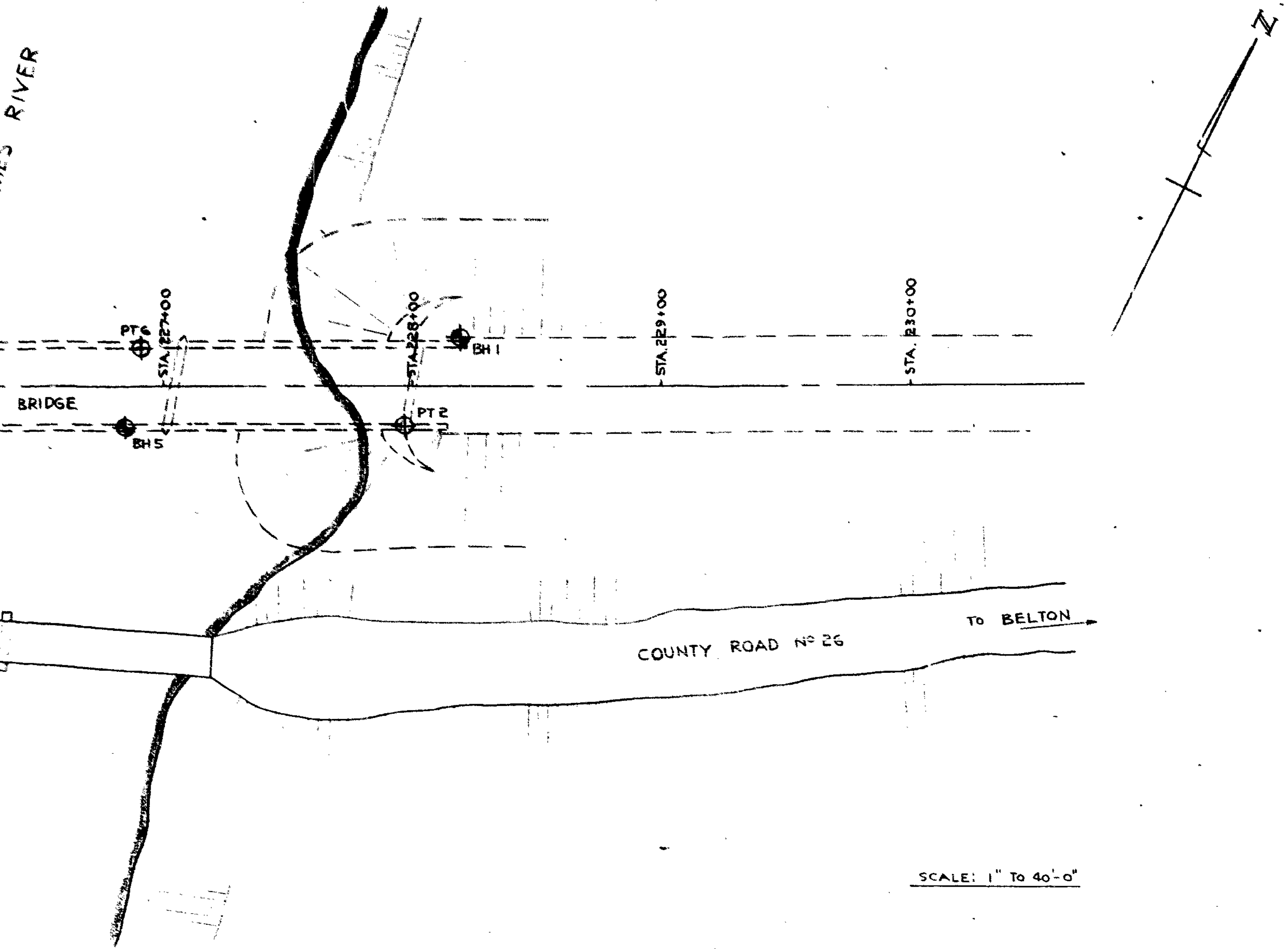
DRAWN M.W.
CHECKED D.M.

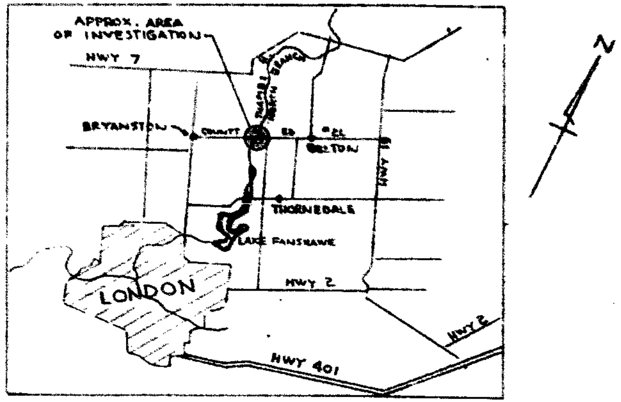


THAMES RIVER
REMAINS OF PLOVER DAM - UNDERWATER
STA. 222+00
STA. 223+00
STA. 224+00
STA. 225+00
STA. 226+00
STA. 227+00
STA. 228+00
STA. 229+00
STA. 230+00
PT 4
PT 9
BH 8
PT 6
BH 1
BH 3
BH 10
PT 7
BH 5
PT 2
PROPOSED BRIDGE
OF
TO BRYANSTON
EXISTING BRIDGE
COUNTY ROAD No 26
TO BELTON
NORTH BRANCH
SCALE: 1" TO 40'-0"

BORING PLAN

FIGURE 1





KEY PLAN

SCALE: 1" TO 8 MILES (APPROX.)

REFERENCE

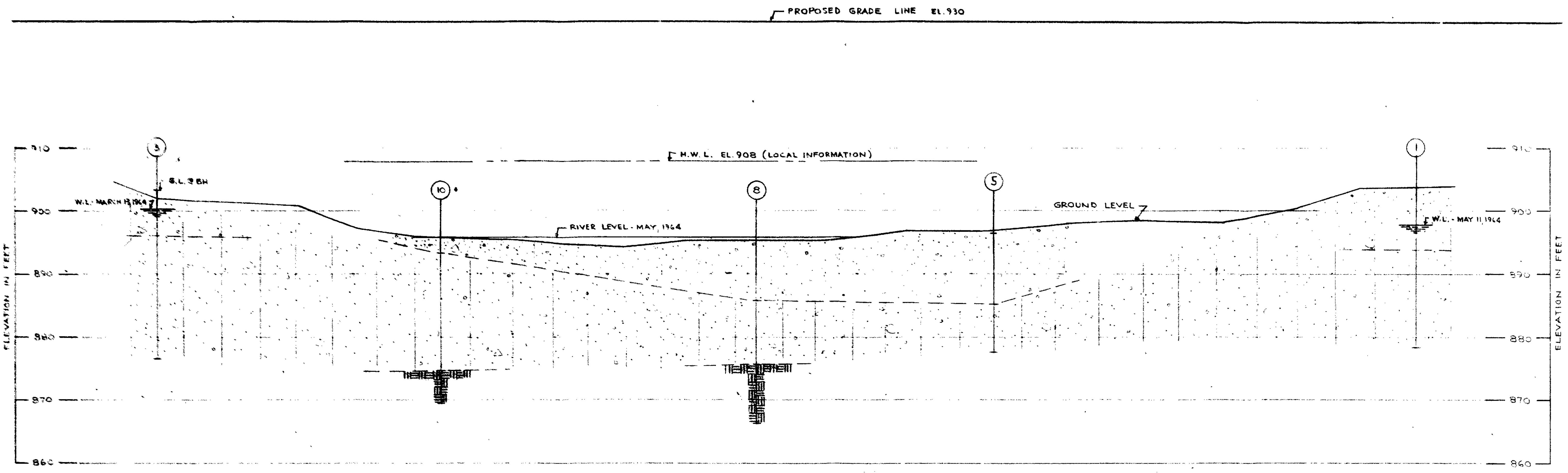
DRWG. R. C. DUNN & ASSOCIATES LTD. - PLOVER MILLS BRIDGE #78, LOCATED ON COUNTY ROAD #26 BETWEEN LOTS 25 & 26 IN CONC. II TWP. OF WEST NISSOURI - SITE PLAN SHOWING THAMES RIVER CHANNEL DATED FEB. 20, 1964.

LEGEND

- BOREHOLE IN PLAN
- PENETRATION TEST IN PLAN

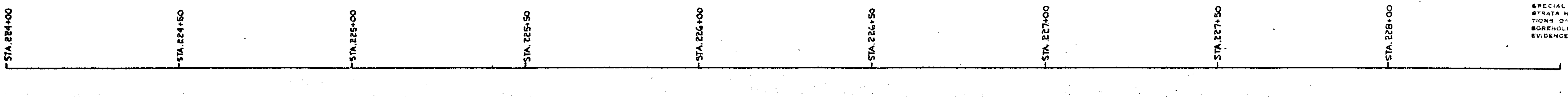
GOLDER & ASSOCIATES

Made J.A.
Chkd.
Appd.



SCHEMATIC SECTION ALONG CENTRELINE OF PROPOSED BRIDGE

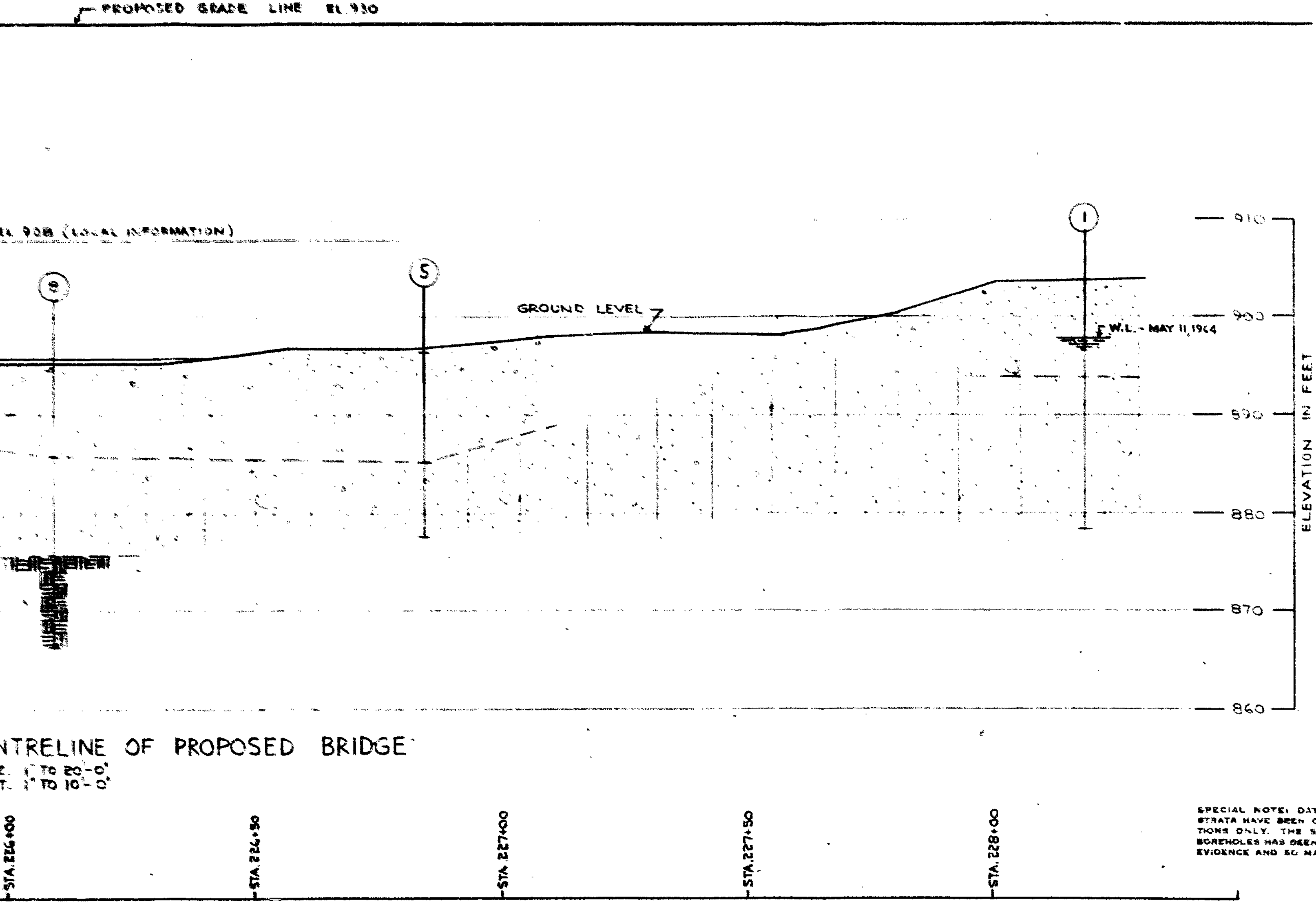
SCALE: HORIZ. 1" TO 20'-0"
VERT. 1" TO 10'-0"



SPECIAL NOTE: DATA
STRATA HAVE BEEN
TIONS ONLY. THE
BOREHOLES HAS BEEN
EVIDENCE AND SO MAY

SOIL STRATIGRAPHY

FIGURE 2



...NTRELINE OF PROPOSED BRIDGE
...Z. 1" TO 20'-0"
...T. 1" TO 10'-0"

STRATIGRAPHY

- LOOSE BROWN SILTY SAND TO SANDY SILT WITH GRAVEL AND TRACE OF CLAY, OCCASIONAL COBBLES AND BOULDERS (**WEATHERED GLACIAL TILL**)
- DENSE TO VERY DENSE GREY SILTY SAND TO SANDY SILT WITH GRAVEL AND TRACE OF CLAY, OCCASIONAL COBBLES AND BOULDERS (**GLACIAL TILL**)
- LOOSE TO COMPACT BROWN **SAND AND GRAVEL**, TRACE OF SILT, COBBLES AND BOULDERS. OCCASIONAL WOOD FRAGMENTS AND SHELLS
- SOUND GREY FOSSILIFEROUS LIMESTONE **BEDROCK**

LEGEND

BOREHOLE IN ELEVATION

WATER LEVEL IN BOREHOLE

REFERENCE

1. CONSTRUCTION PLAN AND PROFILE, COUNTY RD. No 26 SUPPLIED BY COUNTY OF MIDDLESEX - JOB. No 30/63, FILE No 12/26/I/R, DATED MARCH 5, 1963, SCALE 1" TO 200'.
2. R.C. DUNN & ASSOCIATES LTD., PLOVER MILLS BRIDGE No 78, SITE PLAN SHOWING THAMES RIVER CHANNEL, DATED FEB. 20, 1964 UNNUMBERED.
3. R.C. DUNN & ASSOCIATES LTD. DRWG. No P2 SHOWING PROFILES ALONG EXISTING & PROPOSED BRIDGE CENTRELINES, DATED JUNE 3, 1964.

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.

GOLDER & ASSOCIATES

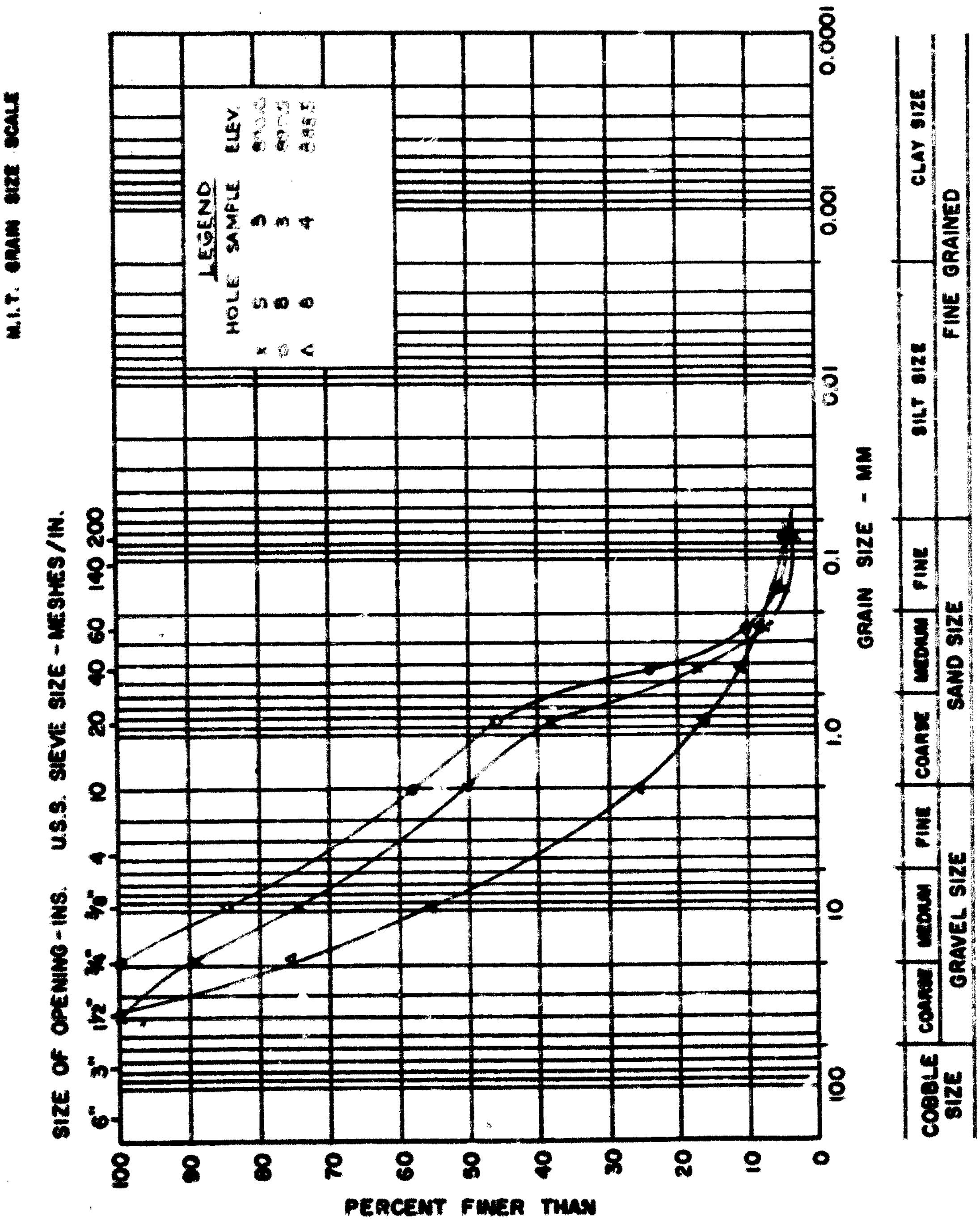
Made L.A.
Chkd. [illegible]
Appd. [illegible]

PROJECT No. 69020

GRAIN SIZE DISTRIBUTION

SAND & GRAVEL

FIGURE 3



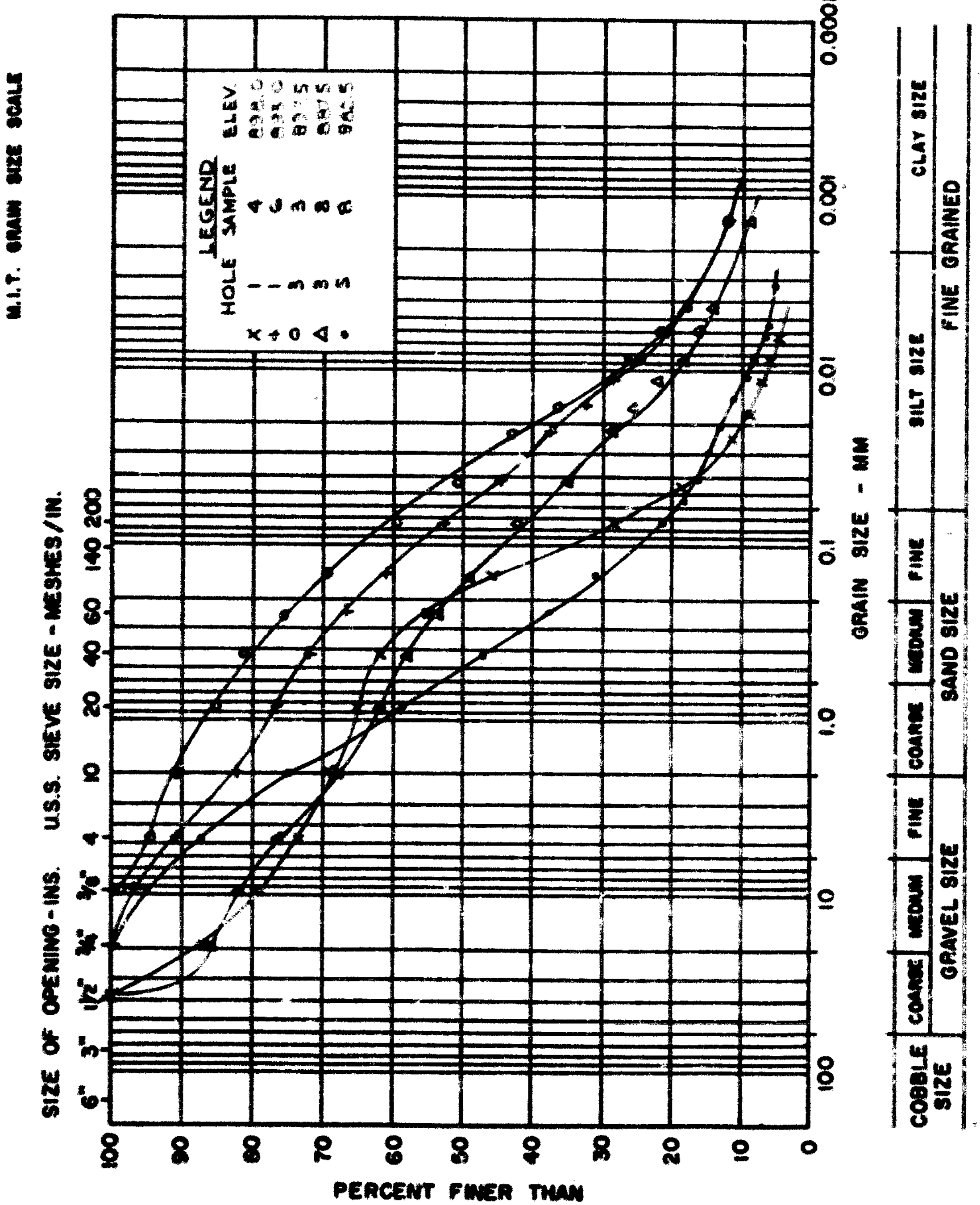
GOLDER & ASSOCIATES

PROJECT No. 64959

GRAIN SIZE DISTRIBUTION

GLACIAL TILL

FIGURE 4



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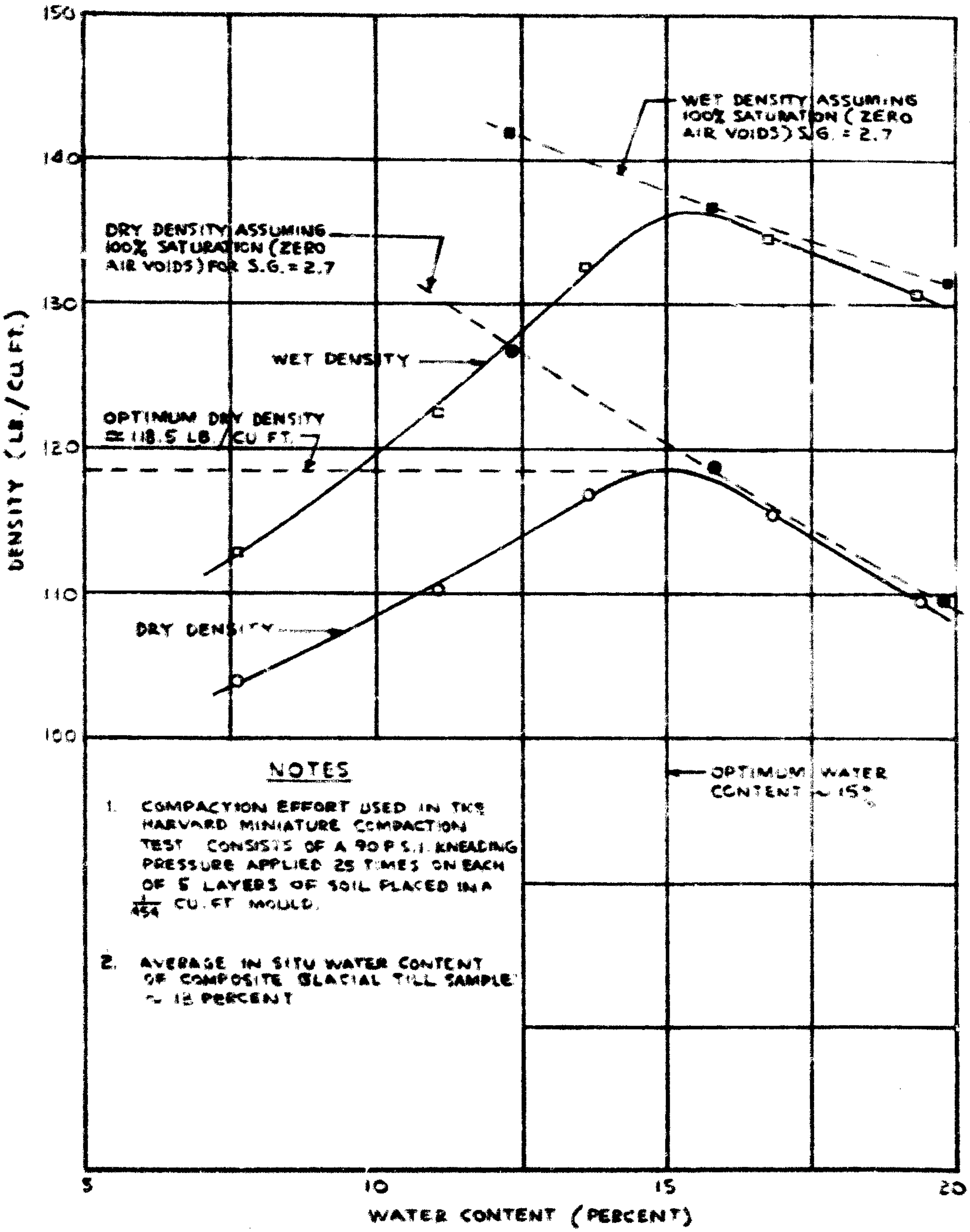
HARVARD MINIATURE COMPACTION TEST RESULTS

COMPOSITE GLACIAL TILL SAMPLE OBTAINED FROM OPEN CUT IN EXISTING ROADWAY BETWEEN STATIONS 214+00 AND 216+65

FIGURE 5

* FOR GRAIN SIZE DISTRIBUTION SEE FIGURE 6



NOTES

1. COMPACTION EFFORT USED IN THE HARVARD MINIATURE COMPACTION TEST CONSISTS OF A 90 P.S.I. KNEADING PRESSURE APPLIED 25 TIMES ON EACH OF 5 LAYERS OF SOIL PLACED IN A $\frac{1}{454}$ CU. FT. MOULD.

2. AVERAGE IN SITU WATER CONTENT OF COMPOSITE GLACIAL TILL SAMPLE ≈ 12 PERCENT

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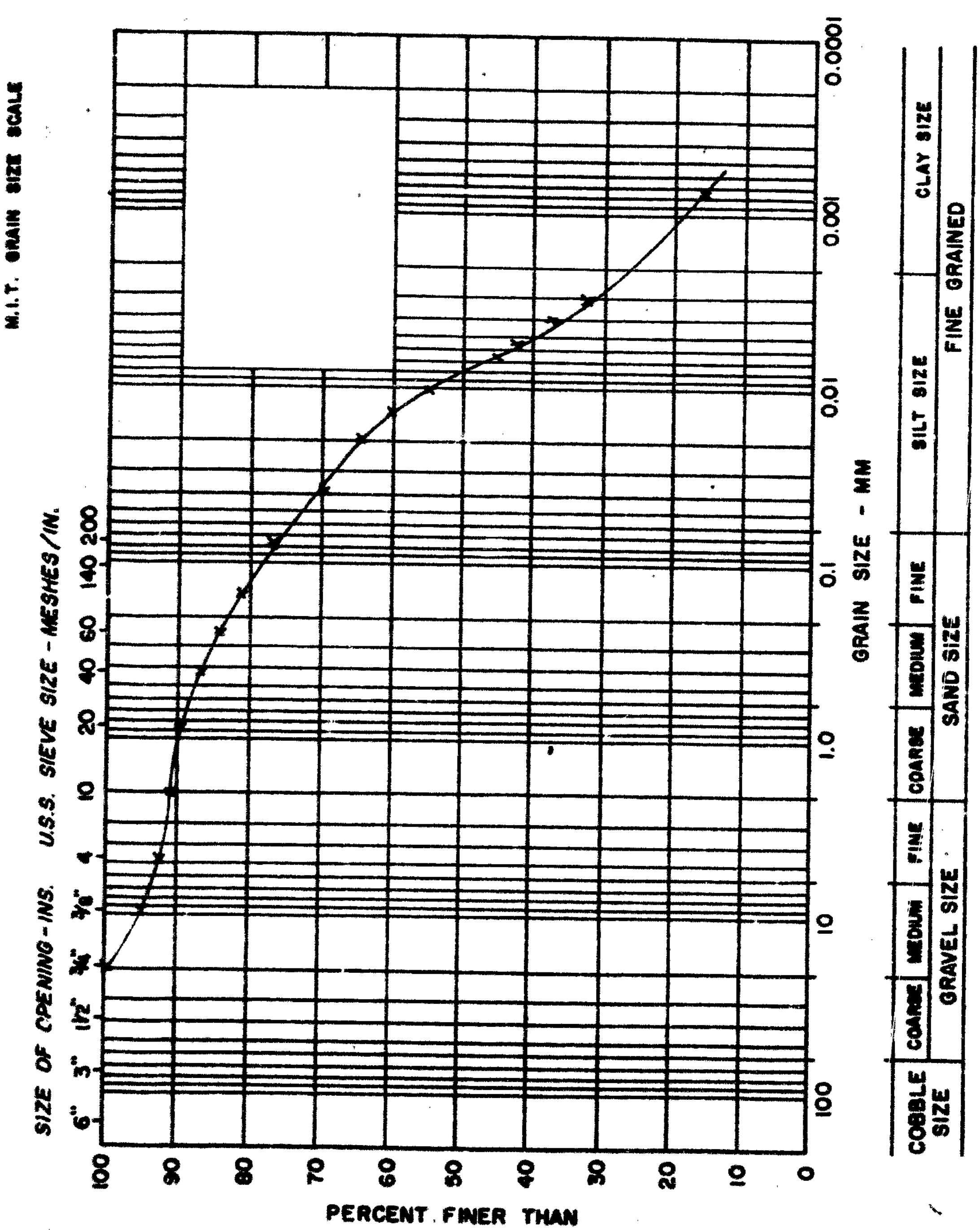
GRAIN SIZE DISTRIBUTION

COMPOSITE GLACIAL TILL SAMPLE
USED IN HARVARD MINIATURE COMPACTION TEST

FIGURE 6



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