

#60-F-241-C

W.P. #303-60

Hwy. #97

PROP. CROSSING

HORNER CREEK

NEAR BRIGHT

BA 1146

Mr. A. M. Toye,
Bridge Engineer.
Materials & Research Section.

November 9, 1960.

FOUNDATION INVESTIGATION REPORT
by: H. Q. Golder & Associates, Ltd.

Attention: Mr. S. McCombie.

Re: Proposed Horner Creek Bridge,
Hwy. 97, Bright, Ontario,
W.P. 303-60 -- District No. 3.

We have reviewed the above mentioned report and are in full agreement with the discussion and recommendations contained therein.

We also believe that the recommendations are self-explanatory and sufficient for your future design work. However, should there be any questions that you would like to discuss, please feel free to call on our Office.

L. G. Soderman,
PRINCIPAL FOUNDATIONS ENGR.

Per:



(A. G. Stermac,
FOUNDATIONS OFFICE ENGR.)

AGS/MdeF

Attach.

cc: Messrs. A. M. Toye (2)

H. A. Tregaskes
D. G. Ramsay
A. Gater
L. D. Barrett
J. Roy
A. Watt

Foundations Office
Gen. Files.

H. Q. GOLDER & ASSOCIATES LTD.

CONSULTING CIVIL ENGINEERS

H. Q. GOLDER
V. MILLIGAN

2446A BLOOR ST. W.
TORONTO 9
RO. 7-9201

REPORT

TO

DEPARTMENT OF HIGHWAYS, ONTARIO

ON

SITE INVESTIGATION, PROPOSED HORNER CREEK BRIDGE

HIGHWAY 97

BRIGHT, ONTARIO

Distribution:

- 10 copies - Department of Highways, Ontario,
Toronto, Ontario.
- 2 copies - H. Q. Golder & Associates Ltd.,
Toronto, Ontario.

November, 1960

6019

ABSTRACT

The results of an investigation carried out at the site of the proposed Horner Creek crossing on Highway 97, just west of Bright, Ontario are reported. It was found the site is underlain by 7 to 8 feet of heterogeneous fill followed by 8 to 11 feet of loose to compact silty sand then hard silty clay.

Recommendations are made for founding the abutments of the proposed single span bridge on spread footings within the hard silty clay stratum with maximum design loads not to exceed 6,000 pounds per square foot. It is also recommended that construction of the footings take place in cofferdam and that the steel sheeting be left in place following construction as scour protection.

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INTRODUCTION

1.

H. Q. Golder & Associates Ltd. has been retained by the Department of Highways, Ontario under the terms of a letter of authorization dated September 29th, 1960 to carry out an investigation for a proposed new bridge at the re-alignment of Horner Creek, on Highway 97 about 1.2 miles west of Bright, Ontario. The purpose of the investigation was to determine the soil conditions at the site and to provide information for the foundation design of the proposed bridge.

PROCEDURE

The field work for the investigation was carried out on October 12th, and 13th, 1960. Two boreholes were put down in BX size to depths of 27 and 31 feet respectively using a standard skid-mounted machine drillrig. The locations of the boreholes together with the inferred soil stratigraphy are shown on Drawing 1. Detailed logs of each borehole are given on the Records of Boreholes.

The samples obtained during the investigation were returned to our laboratory for testing; and those remaining after testing will be stored until April 1st, 1961 at which time you will be notified regarding their disposal.

The results of the laboratory testing are plotted on the Records of Boreholes and on the enclosed figures.

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All elevations in the report are referred to geodetic datum and were determined by reference to a bench mark previously established at the site by the D.H.O. This bench mark is located on the north corner of the north-east wing wall of the existing bridge over Horner Creek some 300 feet east of the site and 18 feet right of Station 66+75. The elevation of this bench mark was given as 1004.14, Geodetic.

SITE TOPOGRAPHY AND GEOLOGY

The site of the proposed bridge is located in the Oxford Till Plain which is characterized by a gently rolling topography with the relief provided generally by glacial drumlins or broad shallow stream valleys. The area was over-ridden by the Wisconsin ice sheet and glacial drift, capped in some instances by recent alluvial deposits, forms the dominant soil type. The drift is underlain by Norfolk limestone.

SOIL CONDITIONS

The following soil strata were encountered at the site:

Heterogeneous Fill

Beneath a thin layer of topsoil in Boreholes 1 and 2, a stratum of heterogeneous fill was encountered. The thickness of fill was about 7 feet in Borehole 1 and 8 feet in Borehole 2. The fill stratum was erratic in composition and generally consisted of a brown fine to medium sand with

Heterogeneous Fill (continued)

irregular lenses of sandy clay and crushed stone or coarse gravel sizes.

A grain size distribution curve for a sample of the fill is shown on Figure 1.

Two standard resistances, or 'N' values, of 19 and 20 blows per foot were obtained in the stratum in Borehole 2 while an 'N' value of greater than 100 blows per foot was recorded in Borehole 1. From the pattern of dynamic penetration resistance in comparison with the 'N' values, it is considered that the fill is generally of compact relative density.

Silty Sand

Underlying the heterogeneous fill in both boreholes was a stratum of grey to brown silty medium sand with gravel up to $\frac{1}{2}$ inch size. The overall thickness ranged from 8.5 feet in Borehole 1 to 11.3 feet in Borehole 2.

The stratum contained occasional layers up to $\frac{3}{4}$ inch in thickness of coarse reddish-brown sand with some roots. A layer, 8 inches in thickness, of soft dark grey sandy clay with organic matter was encountered in Borehole 1 within the stratum. The liquid and plastic limits of this sandy clay were 32.4 and 20.0 per cent respectively and the natural water content was 23.6 per cent. One unconfined compression

Silty Sand (continued)

test gave a shear strength of 470 pounds per square foot. A water content of 52.0 per cent was obtained for a thin organic silt band immediately below the sandy clay layer.

Grain size distribution curves for typical samples of the stratum are shown on Figure 2.

In view of the general cohesionless character of the stratum, it is considered that the standard penetration resistances or 'N' values obtained in the boreholes accurately reflect the relative density. The 'N' values ranged from 2 to 25 blows per foot with an average value of 11 blows per foot. The relative density of the stratum is thus considered to be loose to compact.

Silty Clay

A stratum of grey silty clay containing small rounded gravel sizes was encountered beneath the silty sand stratum in both boreholes. Thin layers, 1/8 inch to 1/4 inch in thickness, of dark grey clay alternating with light grey clayey silt were encountered in the upper few feet of the stratum. The stratum was penetrated to a depth of 26.5 feet in Borehole 1 and 31.3 feet in Borehole 2.

The liquid limits of the material ranged from about 18 to 37 with an average of 29 per cent, and plastic limits ranged from about 12 to 20 with an average of 17 per cent.

SOIL CONDITIONS (continued)

5.

Silty Clay (continued)

Natural water contents were generally at or below the plastic limit.

One unit weight of 151 pounds per cubic foot was measured.

'Undisturbed' samples of the silty clay were difficult to obtain because of the difficulty in penetrating the stratum. Standard penetration resistances measured ranged from 37 to 77 blows per foot with an average value of 56 blows per foot, and one unconfined compression test gave an undrained shear strength in excess of 7,000 pounds per square foot. The consistency of the silty clay is therefore very stiff to hard.

Groundwater Conditions

Groundwater conditions in the boreholes at the time of the investigation were observed to be slightly above creek level at about elevation 993.

DISCUSSION

General

It is understood that Horner Creek, at its intersection with Highway 97, approximately 1.2 miles west of Bright, Ontario, is to be re-aligned, and that it is proposed to construct a 55 foot single span bridge across the creek diversion. The present profile grade will be raised approximately 5 feet

General (continued)

to elevation 1009. No other structural details are available at this time but it is assumed that the proposed bridge would be a simple reinforced concrete structure.

Foundation Design

It is recommended that the bridge be founded on spread footings in the hard silty clay stratum. Penetration to foundation grade should be at least 2 feet into the stratum. This will mean that the abutment footing at the west side of the creek diversion will be about elevation 986 and the footing for the east abutment will be at about elevation 983. From the results of the standard and dynamic penetration tests and the shear strength measured in the laboratory an allowable bearing capacity well in excess of 10,000 pounds per square foot is possible for footings founded in the stratum. However, to allow for possible softening of the silty clay during construction, it is recommended that the maximum design loads not exceed 6,000 pounds per square foot. Settlement of the proposed structure when founded as recommended should be negligible.

Construction Procedure

Construction of the proposed footings will necessitate excavation through the loose silty sand stratum. Normal river water level is about elevation 993, and high water

Construction Procedure (continued)

level for the creek diversion has been established at elevation 1002. Consequently, a hydrostatic head of about 10 feet will exist in the excavations. To prevent a possible blow in the silty sand during construction it is recommended that the excavations be sheeted. Steel sheeting should be driven to a penetration of at least 4 feet in the hard silty clay. To provide adequate scour protection it is further recommended that the sheeting be left in place following construction and cut off at the level of the top of the footings.

It should be specified that the base of the abutment footing excavations shall be sealed with concrete immediately on exposure and that the abutments be backfilled with clean granular material placed in well-compacted layers not exceeding 6 inches in thickness. Because of the presence of organic matter and clay sizes, the silty sand at the site is not a suitable backfill material to abutments.

A. A. Gass, P. Eng.
A. A. Gass, P. Eng.

AAG:IMB
6019

November, 1960



ABBREVIATIONS

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

SAMPLE TYPES

A.S. - Auger Sample	R.C. - Rock Core
C.S. - Chunk Sample	S.T. - Slotted Tube
D.O. - Drive Open	T.O. - Thin-walled, Open
D.S. - Denison Type Sample	T.P. - Thin-walled, Piston
F.S. - Potl Sample	W.S. - Wash Sample

PENETRATION RESISTANCES

Dynamic Penetration Resistance - The energy required to drive a 2 inch diameter, 60 degree cone attached to the end of the drilling rods into the ground; expressed in blows per foot, where each blow represents 4200 inch-pounds of energy.

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 into the ground.

W_h - Sampler advanced by static weight of sampling hammer

P_h - Sampler advanced by an hydraulic pressure

P_e - Sampler advanced by levering on drill rods

SOIL DESCRIPTION

The standard terminology for the descriptions of the consistency of cohesive soils and the relative density of cohesionless soils is as follows:

Relative Density	N , Blows/ft.	Consistency	C , lb./sq.ft.
Very Loose	0 to 4	Very Soft	30 to 250
Loose	4 to 10	Soft	250 to 500
Compact	10 to 30	Firm	500 to 1,000
Dense	30 to 50	Stiff	1,000 to 2,000
Very Dense	over 50	Very Stiff	2,000 to 4,000
		Hard	over 4,000

SOIL TESTS

C - Consolidation Test	Q - Undrained Triaxial
H - Hydrometer Analysis	Q_c - Consolidated Undrained Triaxial
M - Sieve Analysis	S - Drained Triaxial
MH - Combined Analysis, Sieve and hydrometer	U - Unconfined Compression
	V - Field Vane Test

Note: Undrained triaxial tests in which pore pressures are measured are shown as Q' or Q'_c .

SOIL PROPERTIES

γ - Total Unit Weight	K - Coefficient of Permeability
γ_d - Dry Unit Weight	c - Undrained Shear Strength
γ_s - Submerged Unit Weight	(τ Compressive Strength)
L_l - Liquid Limit	S_t - Sensitivity
P_l - Plastic Limit	θ' - Effective Angle of Shearing
w - Natural Water Content	Resistance
G - Specific Gravity	c' - Effective Cohesion Intercept
e - Void Ratio	C_c - Compression Index
	c_v - Coefficient of Consolidation

RECORD OF BOREHOLE 1

LOCATION SEE DRWG No. 1

BORING DATE

OCT. 12, 1960

DATUM

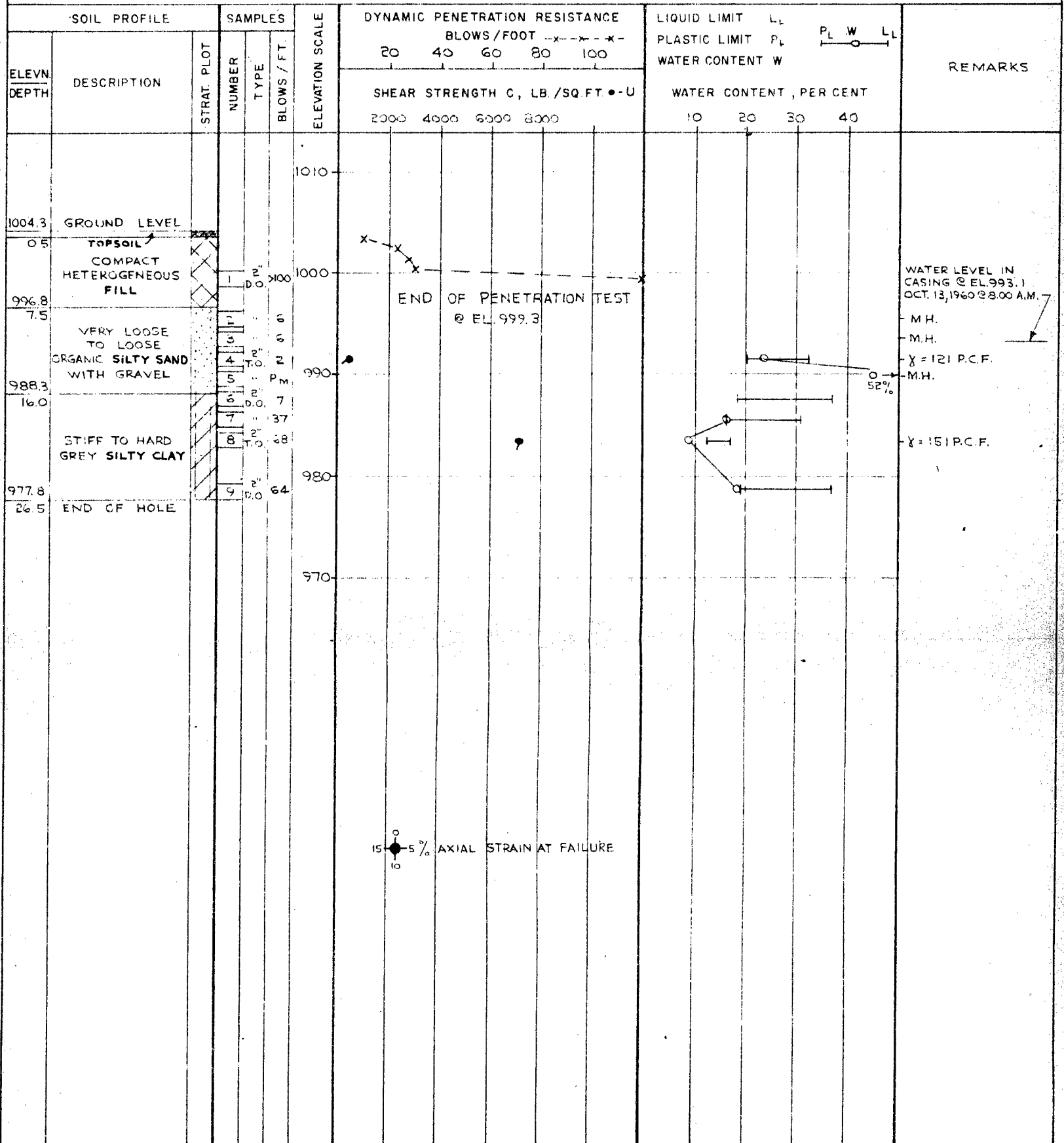
GEODETIC

BOREHOLE TYPE WASH BORING

BOREHOLE DIAMETER 8X CASING

SAMPLER HAMMER WEIGHT 140 LB. DROP 30 INCHES

PEN. TEST HAMMER WEIGHT 140 LB. DROP 30 INCHES



(a) Dynamic penetration resistance converted to 4200 inch lb. energy

(b) Abbreviations listed on page 8

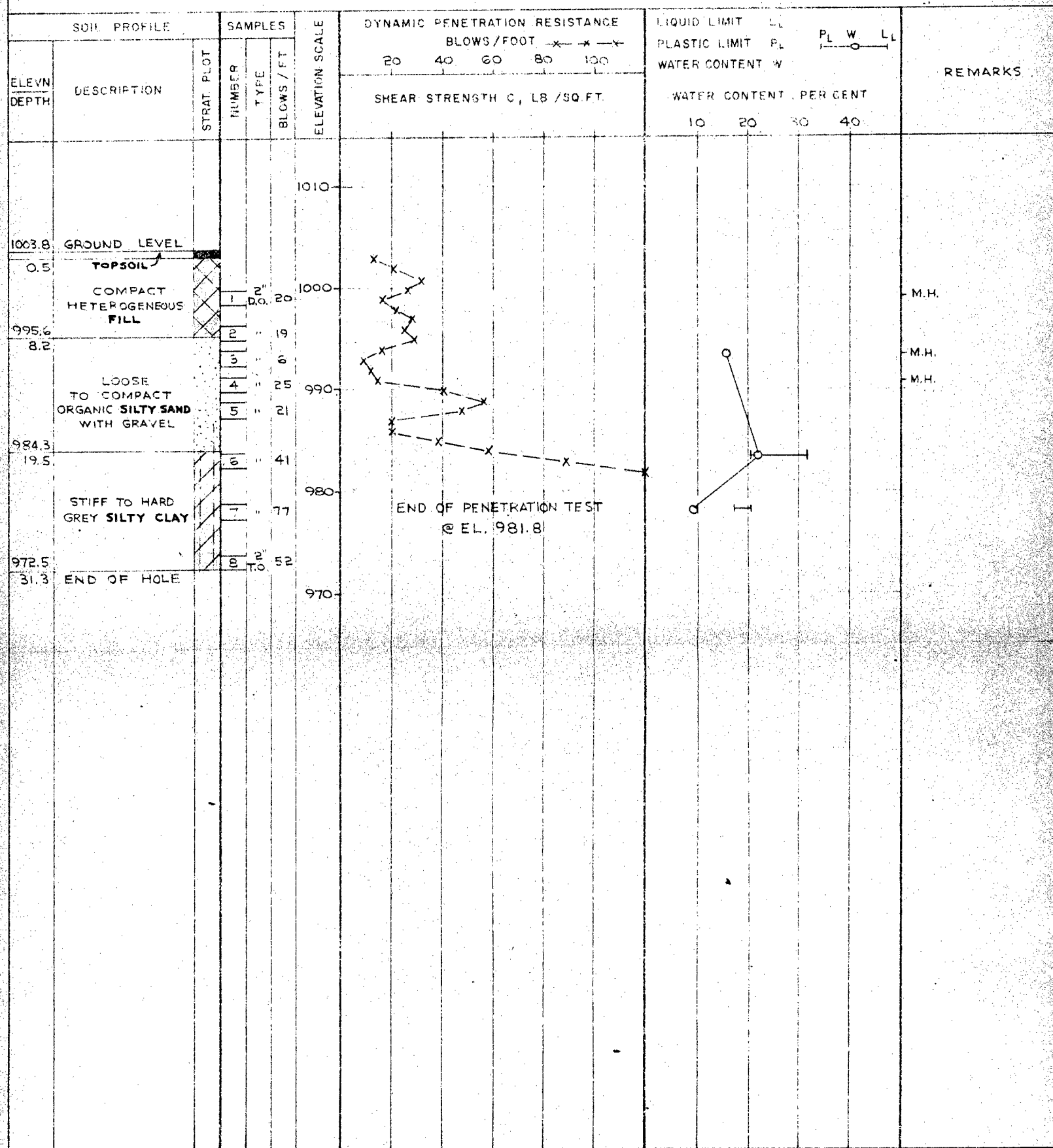
VERTICAL SCALE
1 INCH TO 10 FEET

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DRAWN J.A.
CHECKED 276

RECORD OF BOREHOLE 2

LOCATION SEE DRWG. NO 1 BORING DATE OCT. 13, 1960 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



(a) Dynamic penetration resistance converted to 4200 inch lb energy

(b) Abbreviations listed on page 8

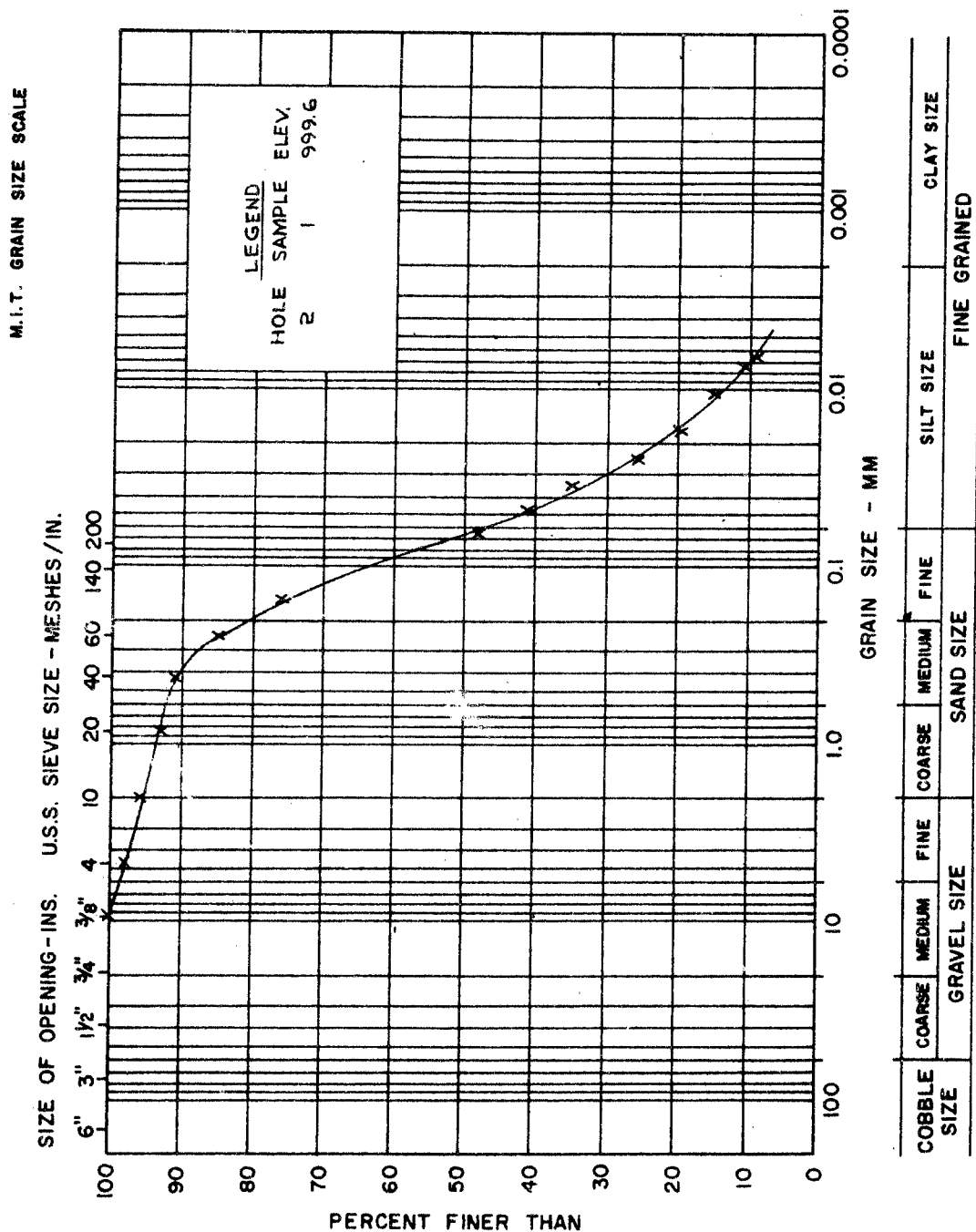
VERTICAL SCALE
1 INCH TO 10 FEET

GOLDER & ASSOCIATES

DRAWN J.A.
CHECKED

GRAIN SIZE DISTRIBUTION

FIGURE 1



GOLDER & ASSOCIATES

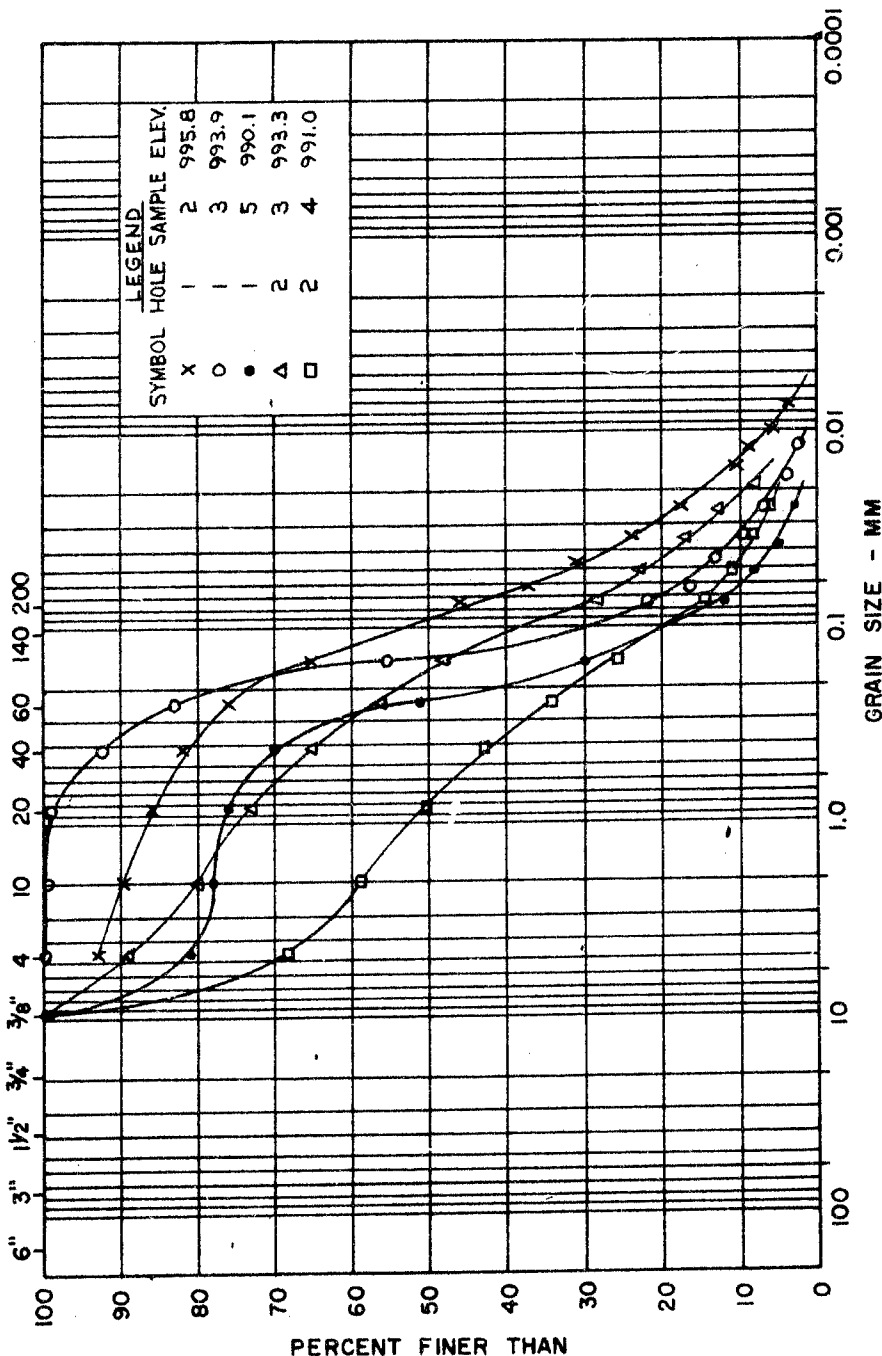
J.A.

GRAIN SIZE DISTRIBUTION

FIGURE 2

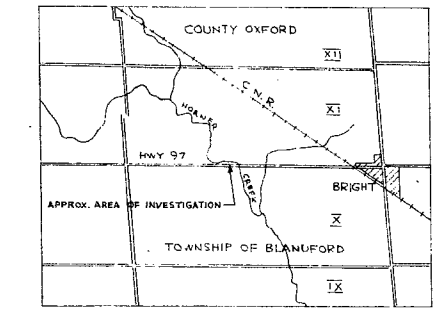
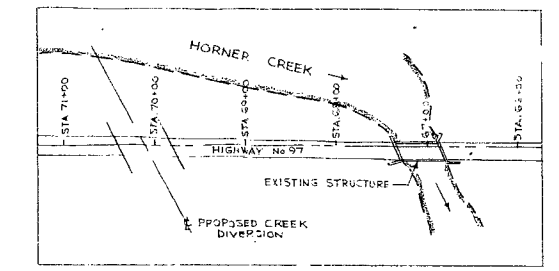
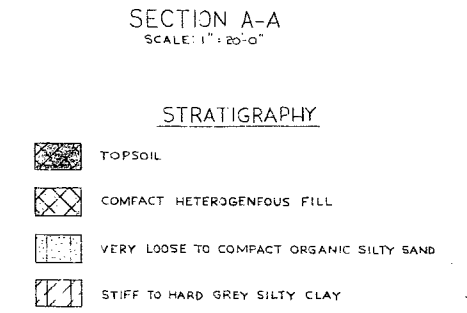
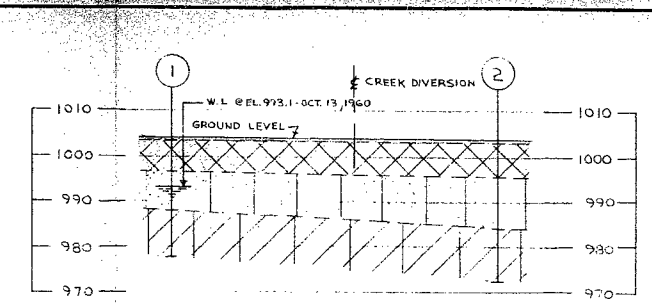
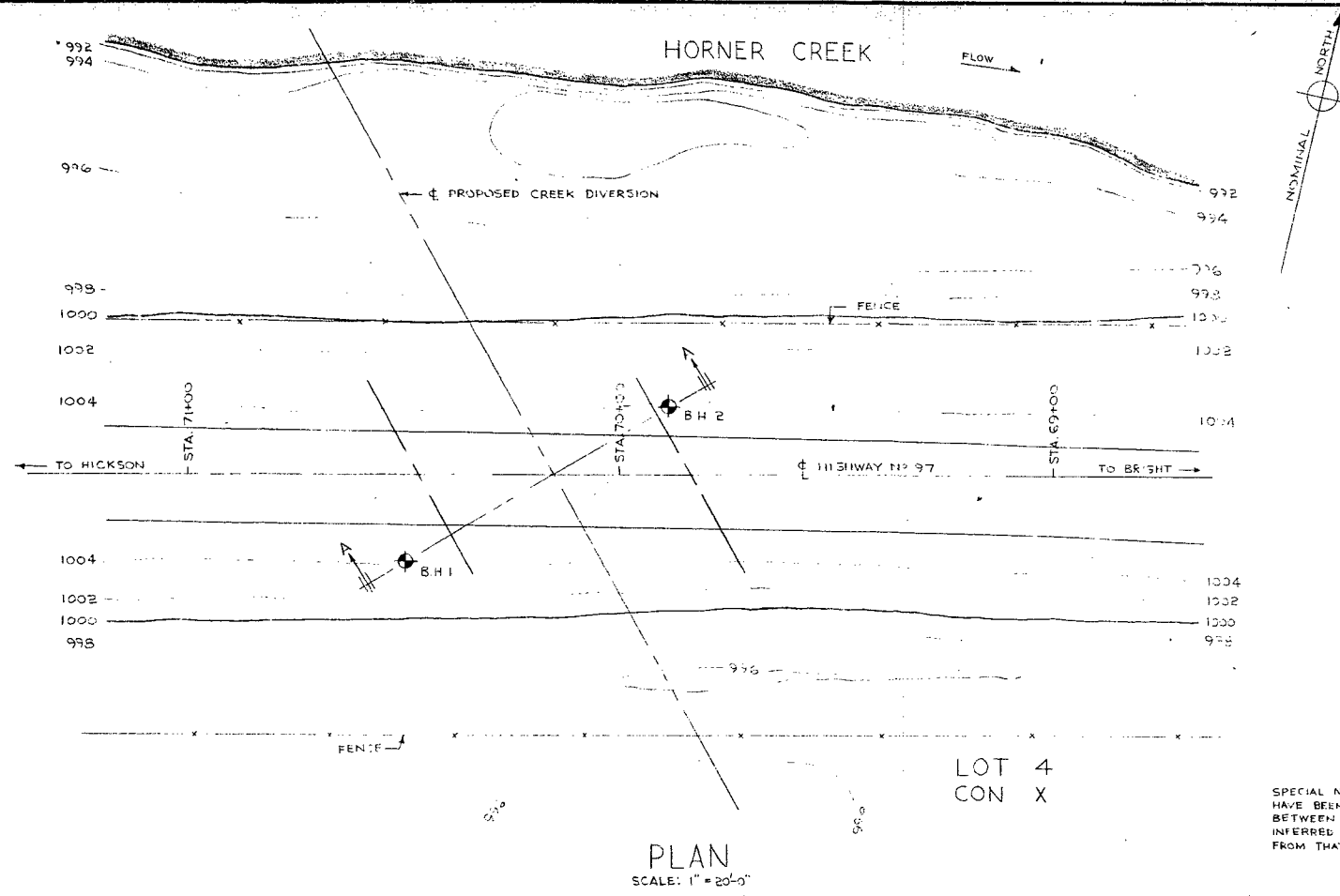
M.I.T. GRAIN SIZE SCALE

SIZE OF OPENING - INS. U.S.S. SIEVE SIZE - MESHES / IN.



GOLDER & ASSOCIATES

J.A.



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

REFERENCE	
DRWG. No.	DESCRIPTION
E-3897	DEPARTMENT OF HIGHWAYS, ONTARIO PRESENT CROSSING AT HORNER CREEK AND HIGHWAY 97 - DATED JULY, 1960

DEPARTMENT OF HIGHWAYS, ONTARIO
TORONTO
PROPOSED HORNER CREEK BRIDGE
NEAR BRIGHT, ONTARIO
BORING PLAN AND SOIL STRATIGRAPHY

GOLDER & ASSOCIATES CONSULTING CIVIL ENGINEERS	
DATE: OCT. 19, 1960 SCALE: AS SHOWN	
MADE J.A.	CHKD. J.A.
APPD. J.A.	DRWG No. 1