

#60-F-246C

W.P. # 34-61

Hwy #97

PROPOSED

WASHINGTON

CREEK BRIDGE



ONTARIO
DEPARTMENT OF HIGHWAYS

Memo to Mr. A. M. Toye, **Date** November 25, 1960.
Bridge Engineer. **Subject** FOUNDATION INVESTIGATION REPORT
From Materials & Research Section. **by:** H.Q. Golder & Associates, Ltd.
Attention: Mr. S. McCombie.

Re: Proposed Washington Creek Bridge,
Washington, Ontario, - Hwy. #97,
District #3.

Attached, we are sending you the above-mentioned report submitted by the Consultant, H. Q. Golder & Associates.

We have reviewed the presented factual data and are in agreement with the recommendations contained in the report, which we believe, will be adequate for your future design work.

Should there be any queries in connection with this project that you would like to discuss, please do not hesitate to contact our Office.

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.

L. G. Soderman,
PRINCIPAL FOUNDATIONS ENGR.
Per:

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

Bridge Division,
December 9, 1960.

MEMORANDUM TO:

Mr. L. A. Soderman,
Principal Soils and
Foundation Engineer,
Department of Highways,
Laboratory Building,
Downsview, Ontario.

RE: Proposed Washington Cr. Br.,
W.P. 34-61,
Mty. #97, Dist. #3,
Soil Report No. 1154.

With reference to the above mentioned Soil Report we would like to load the timber piles to a capacity of 20 tons and would appreciate if you would advise us to the depth to which the piles will have to be driven and the set and hammer energy required to achieve this. The report at present allows us to load the timber piles to only 15 tons each with a set of 3 blows per inch.

LF:go
c.c. G. Scott

L. Francis,
for G. Griebel,
Sr. Engineer,
Bridge Design Office.

H. Q. GOLDER & ASSOCIATES LTD.

CONSULTING CIVIL ENGINEERS

**H. Q. GOLDER
V. MULLAGAN**

**2466 BLOOR ST. W.
TORONTO 9
NO. 74281**

**REPORT
TO
DEPARTMENT OF HIGHWAYS, ONTARIO
ON
SITE INVESTIGATION, PROPOSED WASHINGTON CREEK BRIDGE
HIGHWAY 97
WASHINGTON, ONTARIO**

Distribution:

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

November, 1960

6024

ABSTRACT

The results of an investigation carried out at the site of the proposed Washington Creek crossing on Highway 97 in the village of Washington, Ontario are reported. It was found that the site is underlain by a thin stratum of soft to firm silty clay overlying loose to compact silt then very dense silty sand at a depth of about 24 to 30 feet.

Recommendations are made for founding the abutments of the proposed 30 foot span bridge structure on timber piles driven to practical refusal in the very dense silty sand stratum. If the final set and driving energy requirements discussed in the report are met, then an allowable pile load of 15 tons may be used in design.

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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 October 19th, 1960 to carry out an investigation for a proposed new bridge at Washington Creek on Highway 97 in the village of Washington, Ontario. The purpose of the investigation was to determine the soil conditions at the site and to provide the information required for the design of the foundations for the proposed bridge.

PROCEDURE

The field work for the investigation was carried out on October 14th, 15th, 17th and 18th, 1960. Two boreholes were put down in BX size to depths of 46 and 41 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 30th, 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 figures.

All elevations in the report are referred to Geodetic datum and were determined by reference to a bench mark cut in the

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North end of the East head wall of an existing concrete bridge 14 feet right of Station 241+63. The elevation of this bench mark was given as 999.46 geodetic.

SITE TOPOGRAPHY AND GEOLOGY

The site of the proposed bridge is located at the edge of the Oxford Till Plain which is characterized by a gently rolling topography with the relief provided 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 or meltwater deposits, forms the dominant soil type.

The major river close to the site is the Nith which flows in one of the sandy gravel spillways by which glacial drainage escaped from the Grand basin into the Thames. Washington Creek flows into the Nith River.

SOIL CONDITIONS

The following soil strata were encountered at the site:

Silty Clay

Beneath a thin layer of topsoil in Boreholes 1 and 2 there was a stratum of yellow to grey silty clay containing erratic lenses of light brown fine sand and occasional pieces of wood and black organic matter. Chunks of yellow brittle clay were also observed in some samples. The thickness ranged from 9 feet in Borehole 1 to 7 feet in Borehole 2.

Silty Clay (continued)

The standard penetration resistance obtained in the stratum ranged from 'manual push' to 16 blows per foot. It is considered that the higher 'N' values were obtained by the sampler striking wood pieces. From examination of samples it is estimated that the consistency varies erratically from soft to firm.

Silt

The silty clay was underlain by a stratum of grey silt. The thickness was about 22 feet in Borehole 1 and about 17 feet in Borehole 2.

Occasional thin bands of clayey silt were encountered within the stratum. The maximum liquid limit measured for a clayey silt band was 24 per cent and the plastic limit 16 per cent at a natural water content of 22 per cent. Generally the samples were non-plastic at a natural water content of about 20 per cent.

The results of four hydrometer analyses are plotted on Figure 1. The distribution curves indicate the general uniformity of grain sizes.

The wet unit weight of silt samples ranged between 123 and 136 pounds per cubic foot with an average value of 128 pounds per cubic foot. These values are higher than one would expect; it is suggested that possibly there was some increase in density in sampling.

Silt (continued)

The standard penetration resistances obtained in Borehole 1 ranged from 'manual push' to 11 blows per foot, but in Borehole 2 all samples were taken using 'manual push'. The stratum is estimated to be of loose to compact relative density.

Sand

A stratum of brown to grey silty sand was encountered in both boreholes below the silt. It was penetrated to a maximum depth of 46 feet in Borehole 1 and 41 feet in Borehole 2. The stratum contained angular gravel up to 1 inch in size dispersed throughout. Occasional thin wet layers, less than $\frac{1}{2}$ inch in thickness, of coarse sand, silt and clayey silt were occasionally encountered.

Three grain size analyses carried out on samples from this stratum are shown on Figure 2.

The standard penetration resistances ranged from 26 to greater than 100 blows per foot. The majority of 'N' values were greater than 100 blows per foot. The relative density of the stratum is estimated to be compact to very dense but generally very dense.

Groundwater Conditions

Observations of wash water in the boreholes during

Groundwater Conditions (continued)

boring and sampling indicated no excess water; however, on completion of the investigation the water level in Borehole 1 rose to 2 feet 4 inches above ground level and in Borehole 2 rose to 2 feet 11 inches above ground level over a period of about 2 days. It is considered that water in the lower sand stratum is under a slight artesian head.

DISCUSSIONGeneral

It is understood that the existing bridge over Washington Creek on Highway 97 is to be replaced by a 30 foot single span bridge located approximately as shown on Drawing 1. The present profile grade is to be raised about 5 feet to elevation 1004 or some 4 feet above maximum recorded high water level in Washington Creek. 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

In view of the loose relative density of the silt stratum at the site it is recommended that the proposed bridge be founded on timber piles driven to practical refusal in the very dense silty sand stratum. Thus piles about 40 feet in length will be required. It is considered that timber piles about 8 inches in diameter at the tip and about 10 to 12 inches diameter at the butt could be used.

Foundation Design (continued)

The piles should be driven to a set of about 3 blows to the inch, but not exceeding 5 blows to the inch, in the very dense silty sand stratum using a hammer developing an energy of at least 7,500 foot pounds per blow. If this is done, an allowable pile load of 15 tons may be used.

It is recommended that the base of piled concrete footings be placed at elevation 992 which is 1 foot below minimum creek water level. In this way protection of the timber piles against rot by creosoting should not be required and sufficient cover will be provided to prevent frost action and possible uplift on the piles and footings. If this is not done, provision should be made to prevent deterioration of the upper part of the piles by pressure creosoting or jacketing above minimum creek water level.

Total settlement of the bridge, when founded as recommended, should be minor and well within tolerable limits for the bridge structure.

Construction Procedure

Construction of the piled concrete abutment footings will necessitate excavations approximately 7 feet below existing grade and about 2 feet below normal creek water level. It is considered that water in such excavations can readily be controlled by pumping from a sump provided that the lower silt

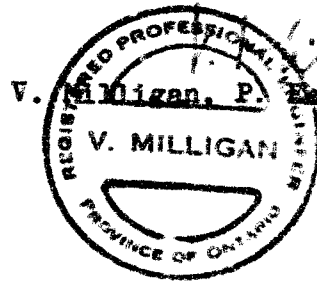
Construction Procedure (continued)

stratum is not exposed at the base of the excavations. If it is exposed the base of the excavation should be sealed with a mat of lean concrete.

It should be specified that backfill to the abutments consist of a clean granular material well-compacted in lifts not exceeding 6 inches in thickness. The local materials at the site are not suitable backfill material.

VM:IMB
6024

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	H.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. - Foil 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 on hydraulic pressure

P_m - 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:

<u>Relative Density</u>	<u>N, Blows/ft.</u>	<u>Consistency</u>	<u>C, lb./sq.ft.</u>
Very Loose	0 to 4	Very Soft	50 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	C - 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

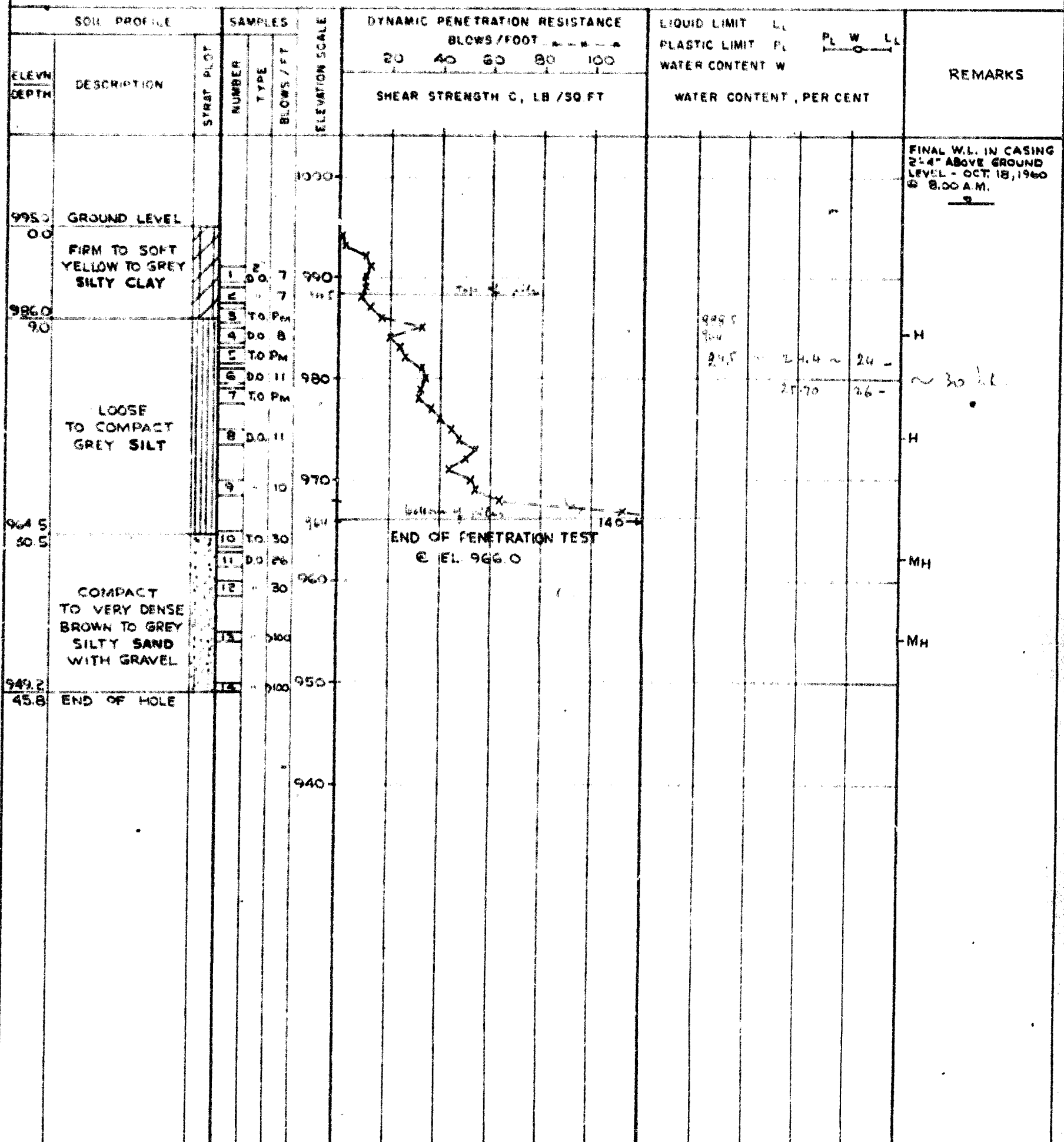
Note: Undrained triaxial tests in which pore pressures are measured are shown as Q' or Q'_c .

SOIL PROPERTIES

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

RECORD OF BOREHOLE I

LOCATION SEE DRWG No. BORING DATE OCT. 14-15, 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



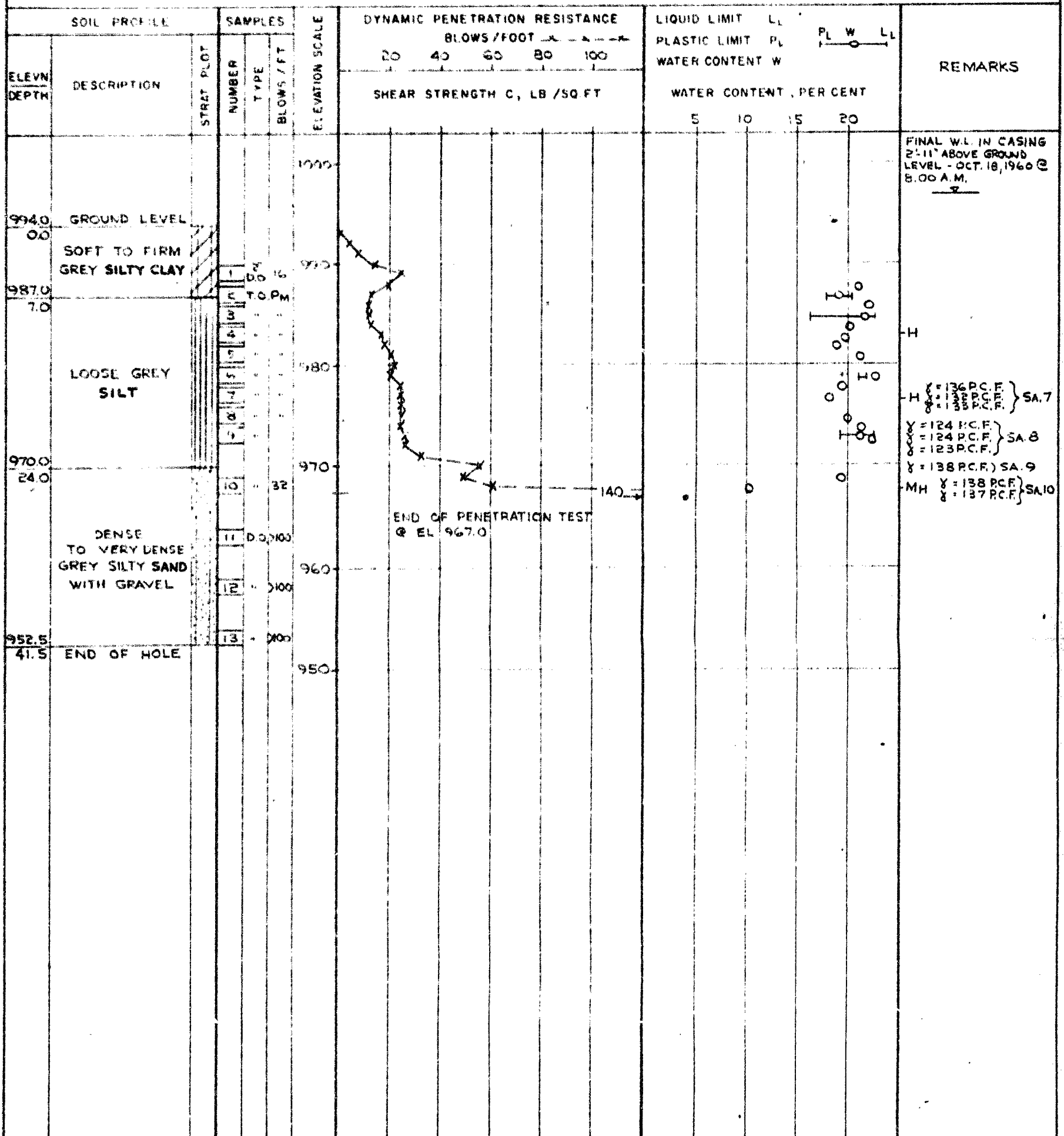
VERTICAL SCALE
1 INCH TO 10 FEET

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DRAWN J.A.
CHECKED V.M.

RECORD OF BOREHOLE 2

LOCATION SEE DRWG. NO. 1 BORING DATE OCT. 17-18, 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



Dynamic penetration resistance converted to 4200 inch lb. energy

VERTICAL SCALE
 1 INCH TO 10 FEET

GOLDER & ASSOCIATES

DRAWN J.A.
 CHECKED V.M.

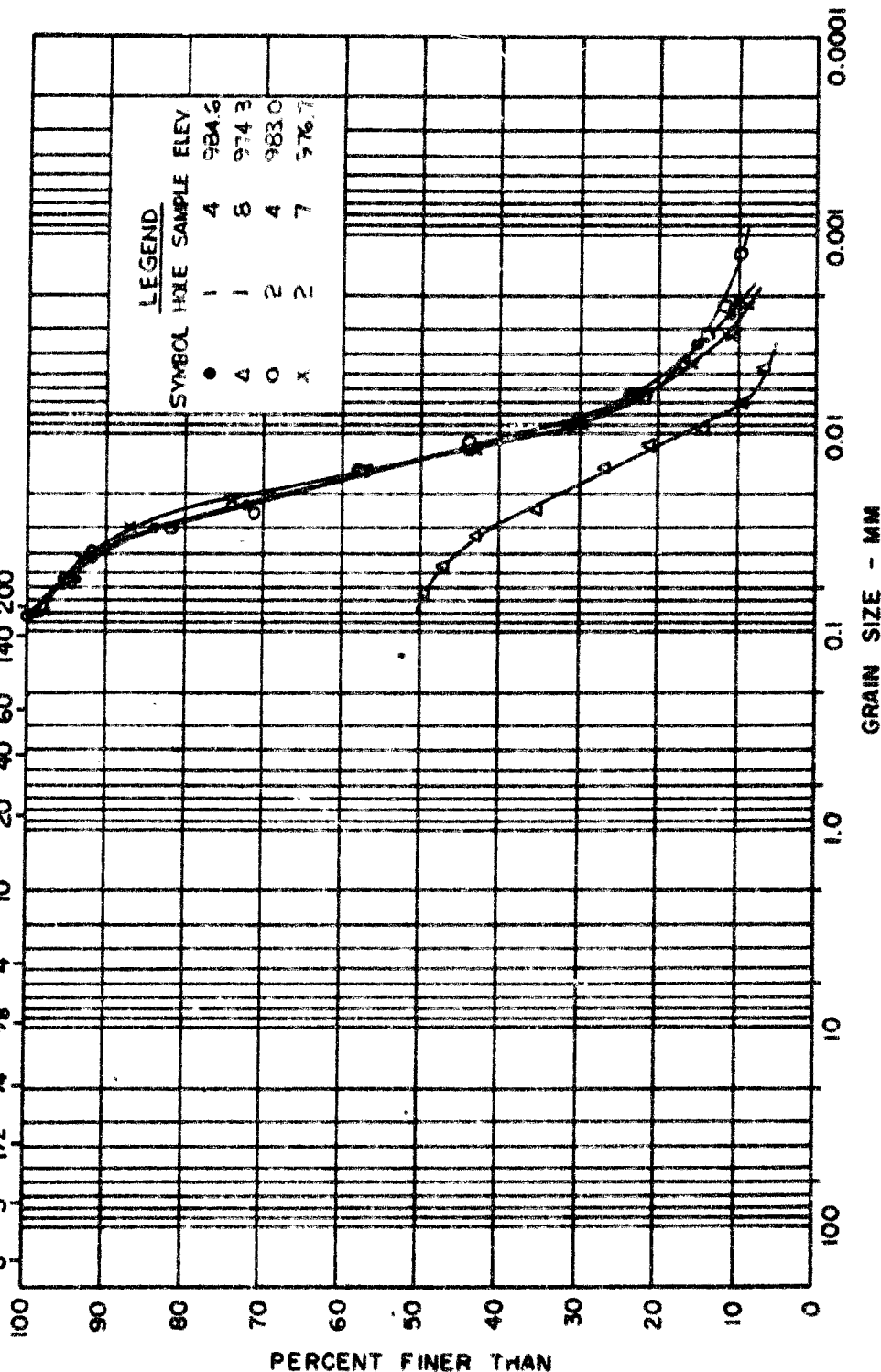
GRAIN SIZE DISTRIBUTION GREY SILT

FIGURE 1

M.I.T. GRAIN SIZE SCALE

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

6" 3" 1 1/2" 3/4" 3/8" 4 10 20 40 60 140 200



COBBLE SIZE	GRAVEL SIZE			SAND SIZE			SILT SIZE		CLAY SIZE	
	COARSE	MEDIUM	FINE	COARSE	MEDIUM	FINE				
									FINE GRAINED	

GOLDER & ASSOCIATES

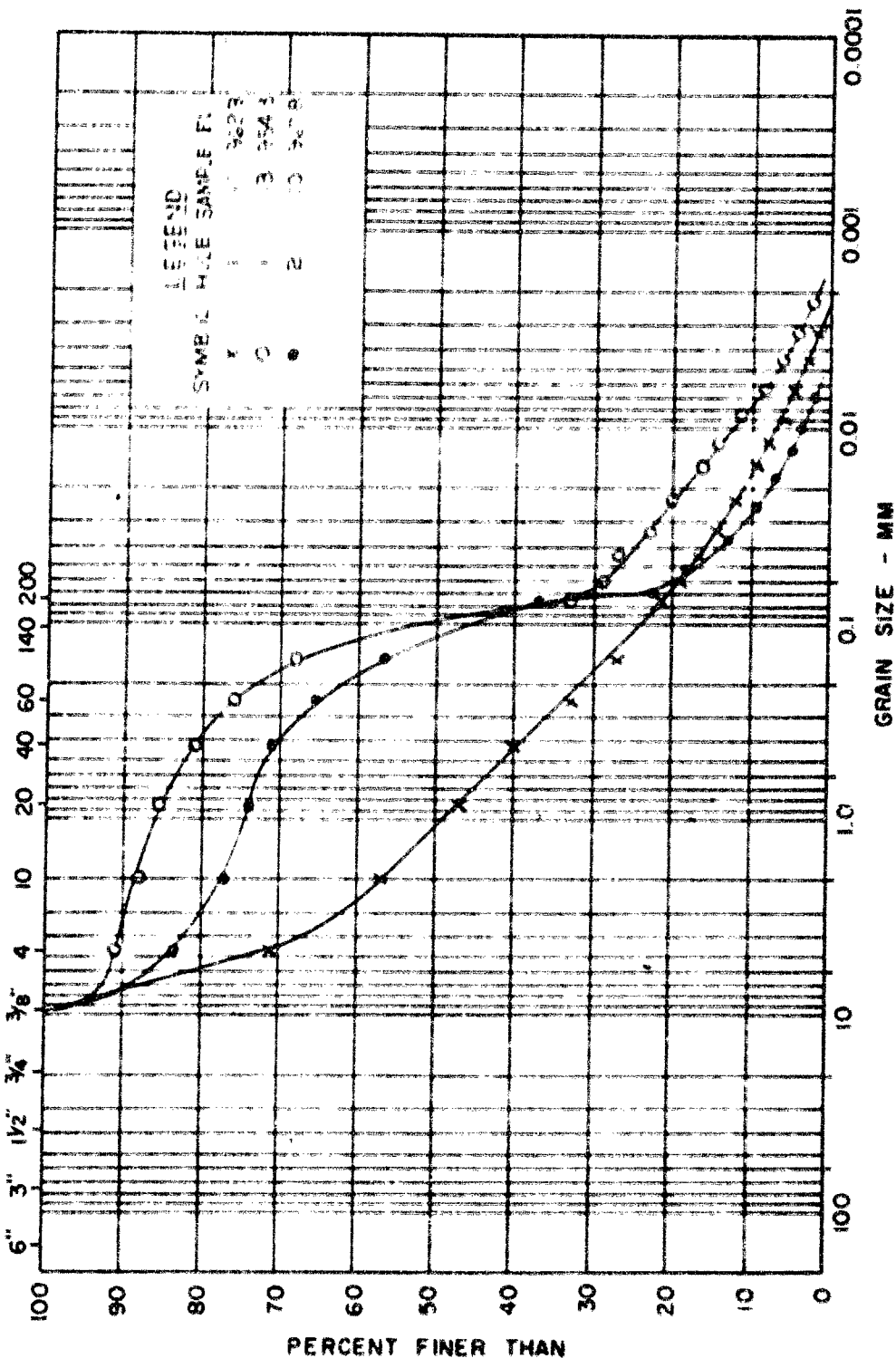
GRAIN SIZE DISTRIBUTION

GREY SILTY SAND

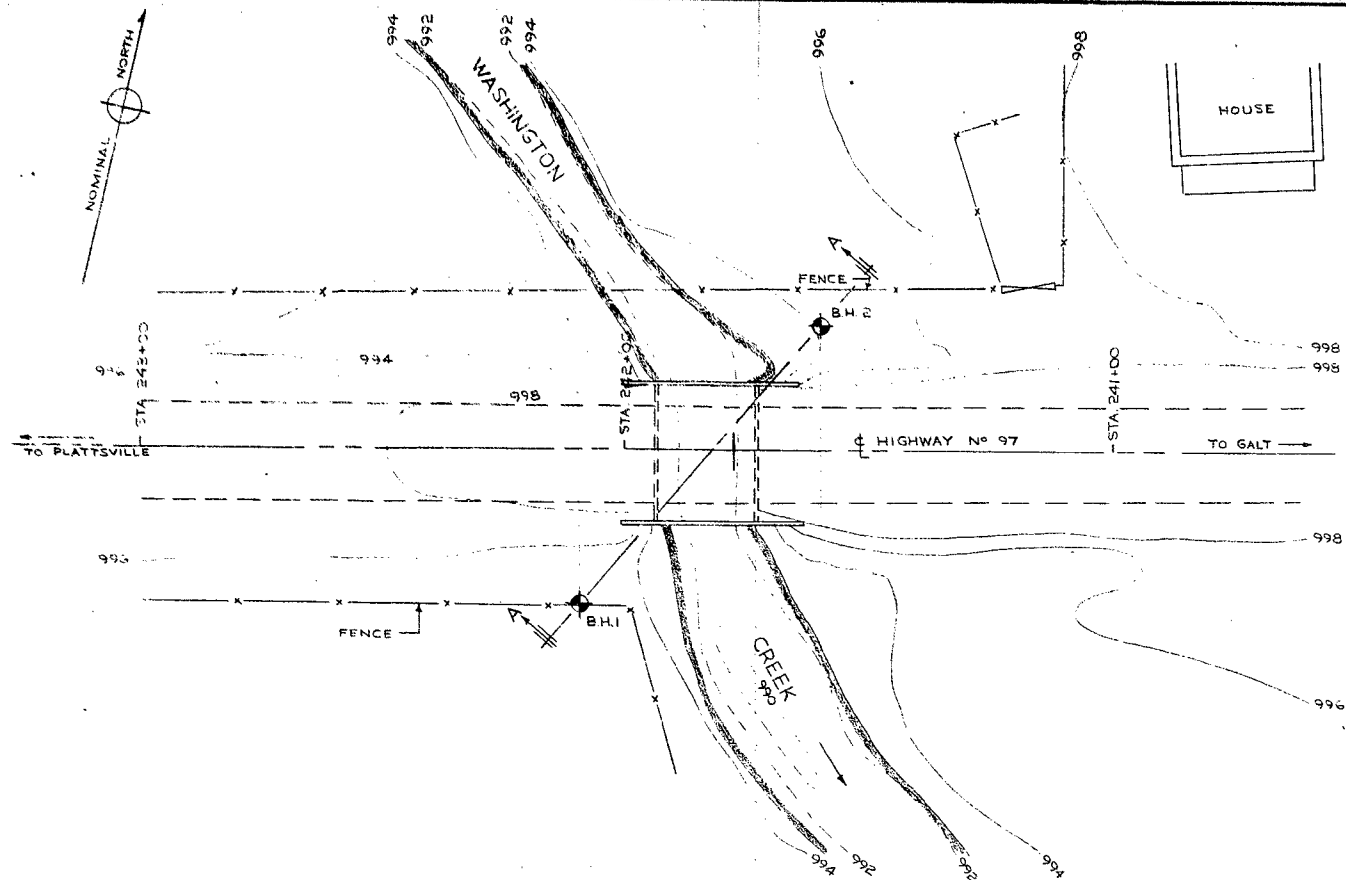
FIGURE 2

M.I.T. GRAIN SIZE SCALE

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

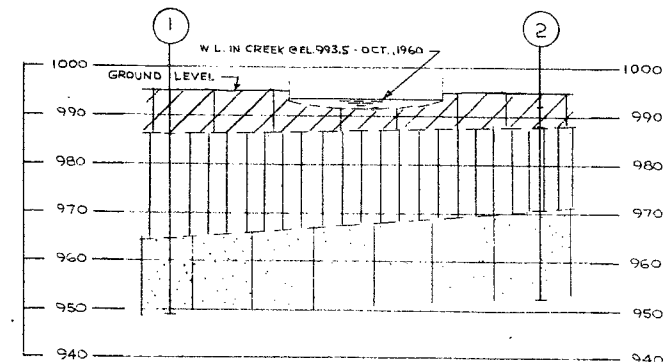


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PLAN
SCALE: 1" TO 20'-0"

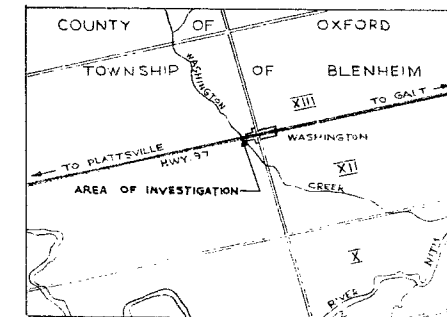
SPECIAL NOTE: DATA CONCERNING THE VARIOUS STRATA HAVE BEEN OBTAINED AT BOREHOLE LOCATIONS ONLY. THE SOIL STRATIGRAPHY BETWEEN BOREHOLES HAS BEEN INFERRED FROM GEOLOGICAL EVIDENCE AND SO MAY VARY FROM THAT SHOWN.



SECTION A-A
SCALE: 1" TO 20'-0"

LEGEND

- BOREHOLE WITH PENETRATION TEST IN PLAN
- BOREHOLE IN ELEVATION



KEY PLAN
SCALE: 1" TO 0.5 MILES

STRATIGRAPHY

- SOFT TO FIRM YELLOW TO GREY SILTY CLAY
- LOOSE TO COMPACT GREY SILT
- COMPACT TO VERY DENSE BROWN AND GREY SILTY SAND

REFERENCE	
DRWG. No.	DESCRIPTION
E 3912	DEPARTMENT OF HIGHWAYS, ONTARIO PRESENT CROSSING AT WASHINGTON CREEK AND HIGHWAY No 97 - DATED AUG. 1960

DEPARTMENT OF HIGHWAYS, ONTARIO
TORONTO
PROPOSED WASHINGTON CREEK BRIDGE
WASHINGTON
BORING PLAN AND SOIL STRATIGRAPHY

GOLDER & ASSOCIATES CONSULTING CIVIL ENGINEERS	
DATE: OCT. 27, 1960 SCALE: AS SHOWN	
MADE J.A.	CHKD. J.A.
APPD. J.A.	DRWG. No. 1