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63-F-205-C

OTTAWA,

QUEENSWAY &

NICHOLAS ST.

INTERCHANGE

28-9.

H. Q. GOLDER & ASSOCIATES LTD.

CONSULTING CIVIL ENGINEERS

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REPORT

TO

DE LEUW, CATHER & COMPANY OF CANADA LIMITED

ON

PRELIMINARY SITE INVESTIGATION

PROPOSED QUEENSWAY - NICHOLAS STREET INTERCHANGE

BRIDGES 38, 39, 40 AND 41

OTTAWA

ONTARIO

Distribution:

10 copies - De Leuw, Cather & Company of Canada Limited,
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ABSTRACT

The results of a preliminary site investigation to determine the general subsoil conditions at the site of the proposed Queensway - Nicholas Street Interchange in Ottawa, Ontario, are reported.

It was found that the site is covered by fill up to about 23 feet in thickness. The fill in the north-west portion of the site is Leda clay obtained from excavation of the Rideau Canal. Elsewhere across the site the fill is essentially granular in nature. The fill in local areas is underlain by a thin layer of geologically recent loose sand, silt and peat followed by a stratum of generally stiff clayey silt to silty clay. The silty clay increases in thickness towards the west and was not encountered in the eastern extremity of the site. Compact silts and sands underlie the clay followed by dense to very dense till resting on shale bedrock some 50 to 60 feet below ground surface at the structure locations.

The significant deposit at the site which will control the stability of approach embankments and also the overall stability of the bridge structures is the fill. The problems which must be considered in the design of the interchange due to the presence of particularly the clay fill are briefly discussed in the report.

The piers and abutments for the proposed bridge structures may be founded on spread footings in the silty clay stratum beneath the fill or on piles driven to practical refusal in the underlying till or bedrock.

It is recommended that a detailed soil investigation be carried out at each structure location and in the approach embankment areas prior to final design of the interchange.

INTRODUCTION

H. Q. Golder & Associates Ltd. has been retained by De Leuw, Cather & Company of Canada Limited, Consulting Engineers, to carry out a preliminary soil investigation at the site of the proposed Queensway - Nicholas Street Interchange in Ottawa, Ontario. The interchange is to include 4 bridge structures, Bridges 38 and 39 for Nicholas Street northbound and southbound over the proposed Queensway, respectively, Bridge 40 for the Canal Road over the Queensway and Bridge 41 an underpass to the south of the Queensway for Lees Avenue. The purpose of this investigation was to determine the general subsoil conditions at the site and to provide preliminary information relating to possible foundation designs for the proposed structures and for embankments.

PROCEDURE

The field work for this investigation was carried out during the period May 22nd to June 15th, 1963 using mobile power auger and diamond drilling equipment. A pilot hole with an adjacent dynamic penetration test was put down at each of the 4 proposed structure locations. Each borehole was taken down to bedrock some 50 to 60 feet below ground surface and bedrock proved by core drilling for up to 13 feet in AXT size. In addition to the

pilot borings at the structure locations, eleven boreholes (numbered 5 to 15, inclusive) with accompanying dynamic penetration tests were put down to an average depth of about 40 feet along the proposed roadway approach network to the north of the Queensway location. These route borings were put down to determine the thickness of fill covering the site and also the thickness of the underlying clay deposit.

Detailed logs of each borehole are given on the Records of Boreholes at the end of this report. The locations of all the borings put down in this investigation are shown on Figure 1. Sections showing the inferred soil stratigraphy across the site are given on Figure 2.

The soil samples obtained during the investigation were brought to our laboratory for examination and testing. Laboratory testing was confined to samples from the pilot borings at the bridge locations. The results of the laboratory testing are shown on the Records of Boreholes and on the figures.

All elevations in this report were supplied by De Leuw, Cather & Company of Canada Limited, and are referred to Geodetic datum.

SITE TOPOGRAPHY AND GEOLOGY

The proposed interchange is located between the Rideau Canal and Rideau River some 1,500 feet east of Echo Drive in Ottawa, Ontario. The Queensway in this locality follows an abandoned railway right of way on an embankment up to 10 feet high. The area under consideration is approximately bounded by Lees Avenue to the south, Concord Street to the west, Montcalm Street to the north and the Ottawa Gas property to the east. The northern portion of the site is occupied by abandoned railway maintenance shops and the southern portion largely by a park. To the north of the Queensway centreline the site is used as a dump and is presently covered by numerous scattered debris and garbage piles. From local information it is known that the site was originally low lying and that fill has been placed over it. Further, the northern portion of the site in particular was covered by clay fill obtained from excavation of the Rideau Canal many years ago. The existing ground surface across the site, apart from the garbage piles, railway embankment and minor local depressions, slopes down from about elevation 210 to 195 in a general south-easterly direction.

Geological information indicates that bedrock at the site is an Ordovician shale of the Billings Formation. The bedrock

in this area is covered by glacial deposits laid down during the Wisconsin stage of glaciation. The glacial deposits consist of till chiefly in the form of ground moraine and fluvioglacial or stratified drift in the forms of kames, and outwash sheets of sand and gravel. Following the retreat of the ice sheet, the area in the Ottawa and Tributary Valleys was invaded by an arm of the ocean known as the Champlain Sea. During this period of submergence, sand, silts and clays were laid down over the glacial till. These marine deposits were then exposed by subsequent uplift which occurred after retreat of the glaciers. Geologically recent deposits of sand, silt and peat cover the Champlain soils in localized area.

SOIL CONDITIONS

Fill ranging in thickness from about 10 to 23 feet and commonly of the order of 15 feet thick was encountered by the borings put down across the site. The fill over most of the site is essentially granular in composition consisting of sand with silt and gravel but varies to a mixture of sand, peat, clayey silt and cobbles with chunks of clay, fragments of glass and pieces of wood. In the north-western portion of the site, to the north of the proposed Queensway centreline, the fill is clayey and is known from local information to have been obtained from excavation of the

Rideau Canal. The clay fill has a chunky structure and based on standard penetration tests and in situ vane shear test results given on the Records of Boreholes, it is soft to stiff. The stiff consistency indicated by a few of the vane shear test results is attributed to the presence of relatively undisturbed small chunks or blocks of clay. Considering the sensitivity of the Leda clay fill together with remoulding during excavation and replacing, its general overall consistency is probably between the soft and firm range. The granular fill, based on the recorded "N" values which ranged between about 1 and 25 blows per foot, is very loose to compact and generally in a very loose to loose state of packing. Grading curves for several samples of granular fill are shown on Figure 3.

The fill in the eastern portion of the site and in boreholes 13 and 14 at the western end of the site is underlain by a geologically recent deposit some 2 to 5 feet thick. The material comprising this deposit is variable in composition ranging from a sand with a trace of silt to organic silt and amorphous peat, and is generally loose.

A marine clay deposit (Leda Clay) underlies the major portion of the site below the fill or geologically recent deposits. The surface elevation of the clay is fairly constant between about

190 and 180. The clay stratum gradually decreases in thickness in a general north-easterly direction from about 25 to 30 feet at the western part of the site to zero in the eastern portion of the site, where at boreholes 10 and 11 it was not encountered.

The clay stratum is grey in colour and is generally oxidized to a grey-brown in the upper few feet. It is composed essentially of silty clay as shown by the grading curves on Figure 5 but varies to a clayey silt, particularly in the upper portion of the stratum. A grading curve from a sample near the surface of the stratum is given on Figure 4. The clay is characterized by thin stratifications of silt together with frequent thin layers of fine sand as well as shell fragments and organic matter in the form of a black mottling.

The variable silt content of the clay stratum is illustrated by the Atterberg limit results on samples from the pilot holes at the proposed structure locations. The liquid limit from the several tests carried out ranges from about 25 to 55 with the range in the plastic limit between about 7 and 35. The liquidity index of the clay ranges between about 0.6 and 1.5.

The undrained shear strength of the clay was measured by in situ vane tests and laboratory triaxial tests on relatively

undisturbed samples. The results obtained, which range from a value as low as 600 lb/sq.ft. to over 2,000 lb/sq.ft. are given on the Records of Boreholes. In general, however, the measured shear strength is between about 1,000 and 1,500 lb/sq.ft. This is in the stiff range of consistency. The sensitivity of the clay as determined by the field vane measurements is between about 5 and 10.

The results of 4 consolidation tests carried out on samples of the clay from the structure borings are given on Figures 8 to 11 inclusive. These show that the clay is over-consolidated by some 4 tons/sq.ft. above existing overburden pressure in the upper portion of the stratum decreasing with depth to about 2 tons/sq.ft.

The Leda clay where it was completely penetrated by the borings, and the geologically recent deposits in the eastern part of the site (boreholes 10 and 11) are underlain by a stratum of silt and sand. The composition of this deposit varies from a silt to silty fine sand and sand. At the proposed structure locations the silt and sand extends down to about elevation 150 and the surface of this deposit rises to about elevation 185 in a general north-easterly direction from about elevation 165 in the western part of the site. Several grading curves for samples of the silt

are given on Figure 6. Based on the standard penetration test results, the silt and sand is generally compact except in borehole 11 in the eastern portion of the site where it is very dense.

At the structure locations where the borings were taken down to bedrock, glacial till underlies the silt and sand deposit. The glacial till is some 10 to 20 feet thick and is comprised of a well graded composite of silt, sand and gravel with a trace of clay together with cobbles and boulders dispersed at random. Grading curves for 2 samples of glacial till obtained using a 1½ inch diameter sampler are given on Figure 7. The sandy silt till is generally dense to very dense.

Shale bedrock underlies the glacial till between about elevation 141 and 148 at the structure locations. The shale is sound, except in the upper portion where it was generally found to be fissured and fractured.

WATER CONDITIONS

Piezometers or water level observation pipes were installed in 10 of the boreholes put down during this investigation. Details of the installation are given on the Records of Boreholes. The latest available measured water levels in the borings are recorded on the Records of Boreholes and on the stratigraphy sections, Figure 2.

The readings showed that the water level across the site in June, 1963 was an average of about 10 to 15 feet below ground surface and generally in the lower portion of the fill deposit. Reference to Figure 2 indicates that there is a trend for the groundwater level across the site to slope down to the south-east generally following the slope of ground surface.

DISCUSSION

General

It is understood that as part of the Queensway construction to the east of the Rideau Canal an interchange with the Nicholas Street extension is to be provided in the area covered by this preliminary site investigation. The interchange is to eventually include 4 bridge structures referred to as bridges 38 to 41, inclusive. The tentative layout of the proposed interchange is shown on Figure 1. No details of the proposed structures or roadway grades are at present available, but it is understood that the bridges overpassing the Queensway will be of the open abutment type. The roadway approach fills will probably be up to about 20 to 25 feet in height.

Approach Embankments

The stability of the approach embankments at this site will control the overall stability of the bridge structures. For

the purpose of this discussion it is assumed that the roadway embankments in this interchange will be constructed with side and end slopes not steeper than 2 horizontal to 1 vertical. It is also assumed that all topsoil and recent garbage fill across the surface of the site will be removed prior to construction of the earthfill embankments.

The significant deposit at the site which will control the stability of the approach embankments is the clay fill covering the north-western section of the site. This fill, which is some 15 to 20 feet in thickness, was obtained from excavation in the Rideau Canal. It is sensitive Leda clay and has undoubtedly been remoulded to some extent during placing. The in situ shear strength of the clay fill has not been determined in detail in this preliminary investigation. It is however estimated, based on a limited number of vane shear tests together with the penetration test results and taking into account the chunky structure, that the overall shear strength could in places be of the order of 500 lb/sq.ft. or lower. Preliminary computations indicate that for a 500 lb/sq.ft. shear strength value in the fill the stability of embankments higher than about 20 to 25 feet above ground surface could be critical. It is therefore essential that the in situ shear strength of the clay fill, on which the stability of approach embankments is

dependent, should be determined in greater detail prior to final design.

A further point which must be considered in the case of approach embankments, is the probable settlement due to consolidation of the underlying clay fill. The settlement under a 20 foot high embankment resting on 15 feet of partially remoulded Leda clay fill, based on consolidation properties for the upper Leda clay obtained during a site investigation for the Queensway Crossing at the Rideau Canal, could be of the order of 1 to 2 feet over a period of some 10 years. In addition to settlement there will be some progressive lateral movement in the embankments and underlying clay fill.

For the remainder of the site, which is covered by fill of essentially a granular character, there should be no major problem with overall stability of roadway embankments 20 to 25 feet in height. There will however be some settlement and lateral movement of the roadway fills because of the generally loose nature of the granular fill and underlying recent deposits.

The problem of embankment stability together with settlement and lateral movements can largely be overcome at this site by removing the clay fill. This would however be an expensive solution

due to the thickness of this deposit. To minimize the problems resulting from the presence of the clay fill, the height of approach embankments should be kept to a minimum. Further, the embankments should be constructed as far in advance of the bridge structures as possible to permit a substantial portion of the consolidation settlement to take place. Surcharge could also be used to help take out some settlement prior to bridge construction.

In order to prevent lateral movements of approach embankments at the bridge abutments, which could possibly be detrimental to the bridge structure, the clayey fill should be removed under the complete end slope of the embankment and under the abutment area and replaced by granular fill, well compacted in place. This may also be necessary in the section of the site covered by essentially granular type fill, depending on the uniformity and density of the fill deposit across the bridge structure location. These properties would be determined during the final soil investigation at each bridge location.

The borings put down in this preliminary investigation show that the clay fill is confined to the north-west portion of the site. If it is possible to move the location of the interchange to the east, where granular fill mainly covers the site, the problems associated with constructing embankments on clay fill would be

eliminated.

Bridge Foundations

The pilot boreholes put down at the proposed bridge locations show that an essentially granular fill overlies a clayey silt to silty clay stratum. The fill, which is some 15 to 20 feet thick at bridges 38, 39 and 40 and about 6 feet thick at bridge 41, is not a competent foundation stratum for the support of the structures because of its variable composition and low density. The bridge structures may be founded on spread footings in the underlying silty clay stratum. Based on the shear strength results obtained from the vane and compression tests, an allowable net bearing pressure of the order of 2,000 to 3,000 lb/sq.ft. may be used for preliminary design. Preliminary computations indicate that the total settlement of footings under this loading due to consolidation in the clay would be within about 2 inches and the possible differential settlement across a span of the order of 1 inch.

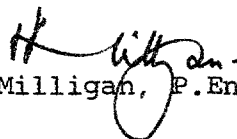
The use of a spread footing foundation at bridge 41 where the fill extends to a shallow depth should present no great construction problems. At the other bridge sites the fill is relatively thicker and the groundwater level was found to be generally above the base of the fill. Excavation through the fill to the underlying

clay would require the use of closed sheeting to control the seepage of groundwater into footing excavations. In addition a deep footing excavation in close proximity to approach embankments, if placed in advance of bridge construction, could present a stability problem.

To avoid deep sheeted excavation during construction and to limit consolidation settlement of the structures, the bridge piers and abutments can be founded on piles driven into the glacial till or bedrock. Steel 'H' piles are recommended in order to minimize displacement and consequent disturbance of the sensitive clay during driving. Assuming a 12 inch steel 'H' section driven to practical refusal in the shale bedrock underlying the site, an allowable load of about 70 tons per pile may be used for design. Pile load tests should be carried out prior to construction to confirm this design value.



J. L. Seychuk, P.Eng.



V. Milligan, P.Eng.

JLS:ab
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December, 1963

LIST OF STANDARD 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. - 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 4,200 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.

Sampler advanced by static weight	- weight, hammer	- Wh
Sampler advanced by pressure	- pressure, hydraulic	- Ph
Sampler advanced by pressure	- pressure, manual	- Pm

SOIL DESCRIPTION

The standard terminology for the descriptions of the relative density of cohesionless soils and the consistency of cohesive 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	Less than 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	Qc - 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 ($\frac{1}{2}$ Compressive Strength)
γ_b - Submerged Unit Weight	St - Sensitivity
L _L - Liquid Limit	ϕ' - Effective Angle of Shearing Resistance
P _L - Plastic Limit	c' - Effective Cohesion Intercept
W - Natural Water Content	Cc - Compression Index
G - Specific Gravity	Cv - Coefficient of Consolidation
e - Void Ratio	

RECORD OF BOREHOLE 1

LOCATION SEE FIGURE 1

BORING DATE MAY 22-30, 1963

DATUM

GEODETIC

BOREHOLE TYPE

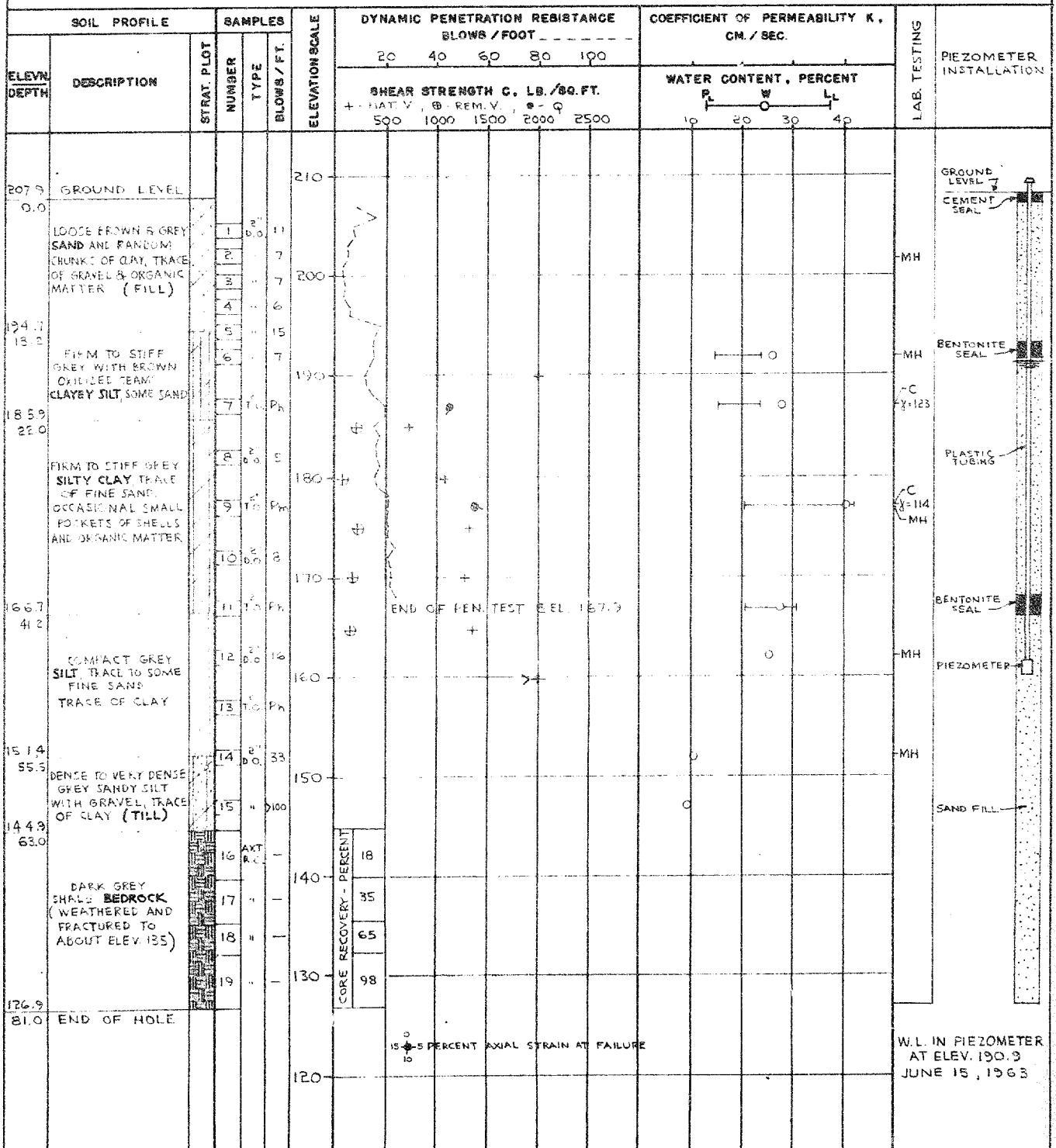
POWER AUGER & WASH BORING

BOREHOLE DIAMETER

4.5", BX & AX CASING

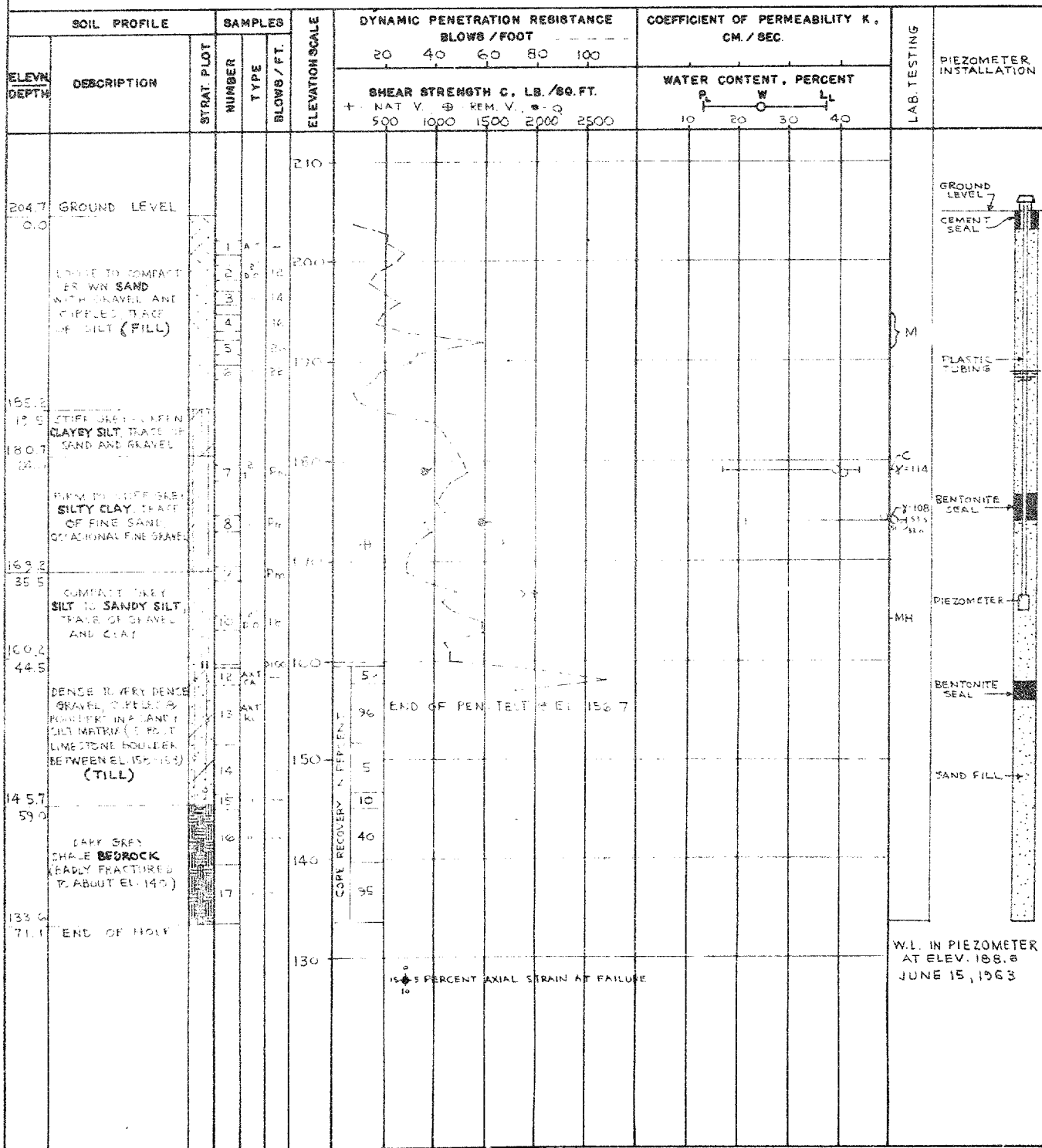
SAMPLER HAMMER WEIGHT 140 LB. DROP 30 INCHES

PEN. TEST HAMMER WEIGHT 140 LB. DROP 30 INCHES



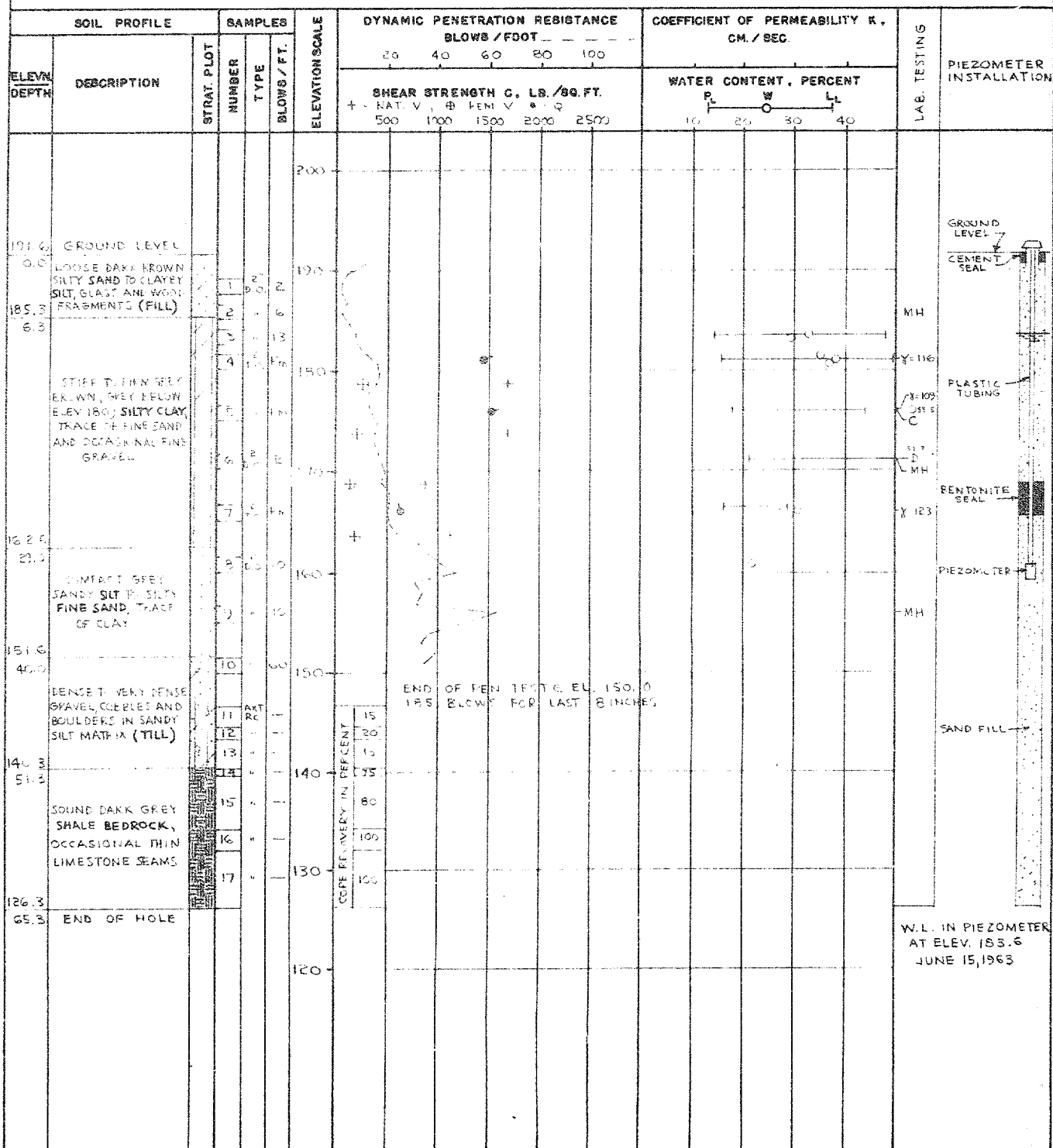
RECORD OF BOREHOLE 2

LOCATION SEE FIGURE 1 BORING DATE MAY 23 - JUNE 1, 1963 DATUM GEODETIC
 BOREHOLE TYPE POWER AUGER & WASH BORING BOREHOLE DIAMETER 4.5"
 SAMPLER HAMMER WEIGHT 140 LB. DROP 30 INCHES PEN. TEST HAMMER WEIGHT 140 LB. DROP 30 INCHES



RECORD OF BOREHOLE 3

LOCATION	SEE FIGURE 1	BORING DATE	MAY 25 - 26, 1963	DATUM	GEODETIC
BOREHOLE TYPE	POWER AUGER & WASH BORING		BOREHOLE DIAMETER	4.5", BX & AX CASING	
SAMPLER HAMMER WEIGHT 140 LB.	DROP 30 INCHES		PEN. TEST HAMMER WEIGHT 140 LB.	DROP 30 INCHES	



VERTICAL SCALE
1 INCH TO 10'-0"

GOLDER & ASSOCIATES

DRAWN J. A.
CHECKED *[Signature]*

RECORD OF BOREHOLE 4

LOCATION SEE FIGURE 1

BORING DATE JUNE 3-5, 1963

DATUM GEODETIC

BOREHOLE TYPE

WASH BORING

BOREHOLE DIAMETER NX, BX, AX CASING

SAMPLER HAMMER WEIGHT 140 LB. DROP 30 INCHES

PEN. TEST HAMMER WEIGHT 140 LB. DROP 30 INCHES

SOIL PROFILE		SAMPLES		ELEVATION SCALE	DYNAMIC PENETRATION RESISTANCE BLOWS / FOOT					COEFFICIENT OF PERMEABILITY K, CM. / SEC.			LAB. TESTING	PIEZOMETER INSTALLATION		
ELEV. DEPTH	DESCRIPTION	STRAT. PLOT	NUMBER		TYPE	BLOWS / FT.						WATER CONTENT, PERCENT				
							SHEAR STRENGTH C, LB. / SQ. FT. + VANE, ϕ - REM. V. 500 1000 1500 2000 2500					P L W O L L				
													</			

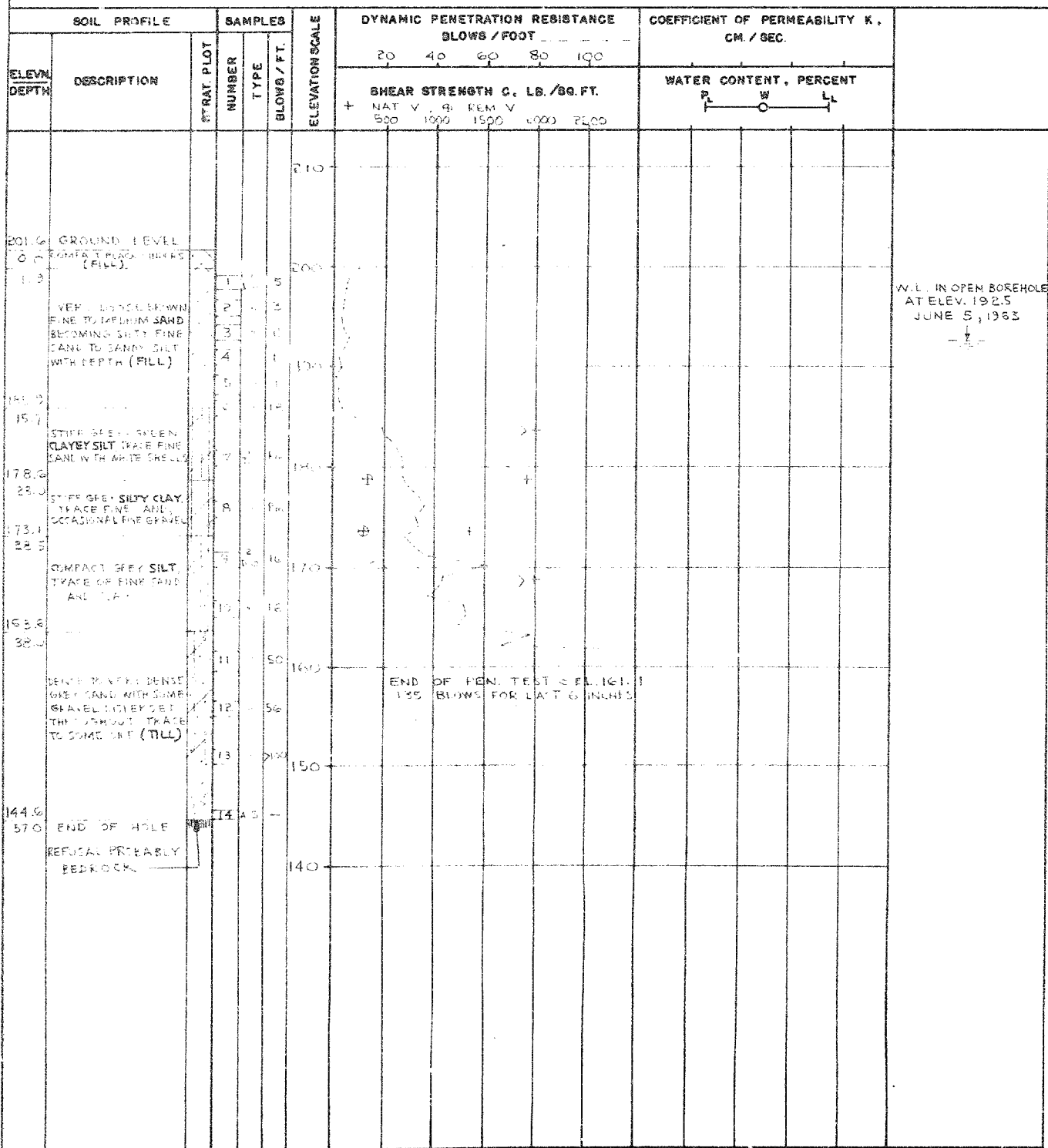
VERTICAL SCALE
1 INCH TO 10'-0"

GOLDER & ASSOCIATES

DRAWN J.A.
CHECKED RYW.L. IN PIEZOMETER
AT ELEV. 157.9
JUNE 15, 1963

RECORD OF BOREHOLE 5

LOCATION SEE FIGURE 1 BORING DATE JUNE 5 - 6, 1963 DATUM GEODETIC
 BOREHOLE TYPE POWER AUGER BORING BOREHOLE DIAMETER 4.5"
 SAMPLER HAMMER WEIGHT 140 LB. DROP 30 INCHES PEN. TEST HAMMER WEIGHT 140 LB. DROP 30 INCHES



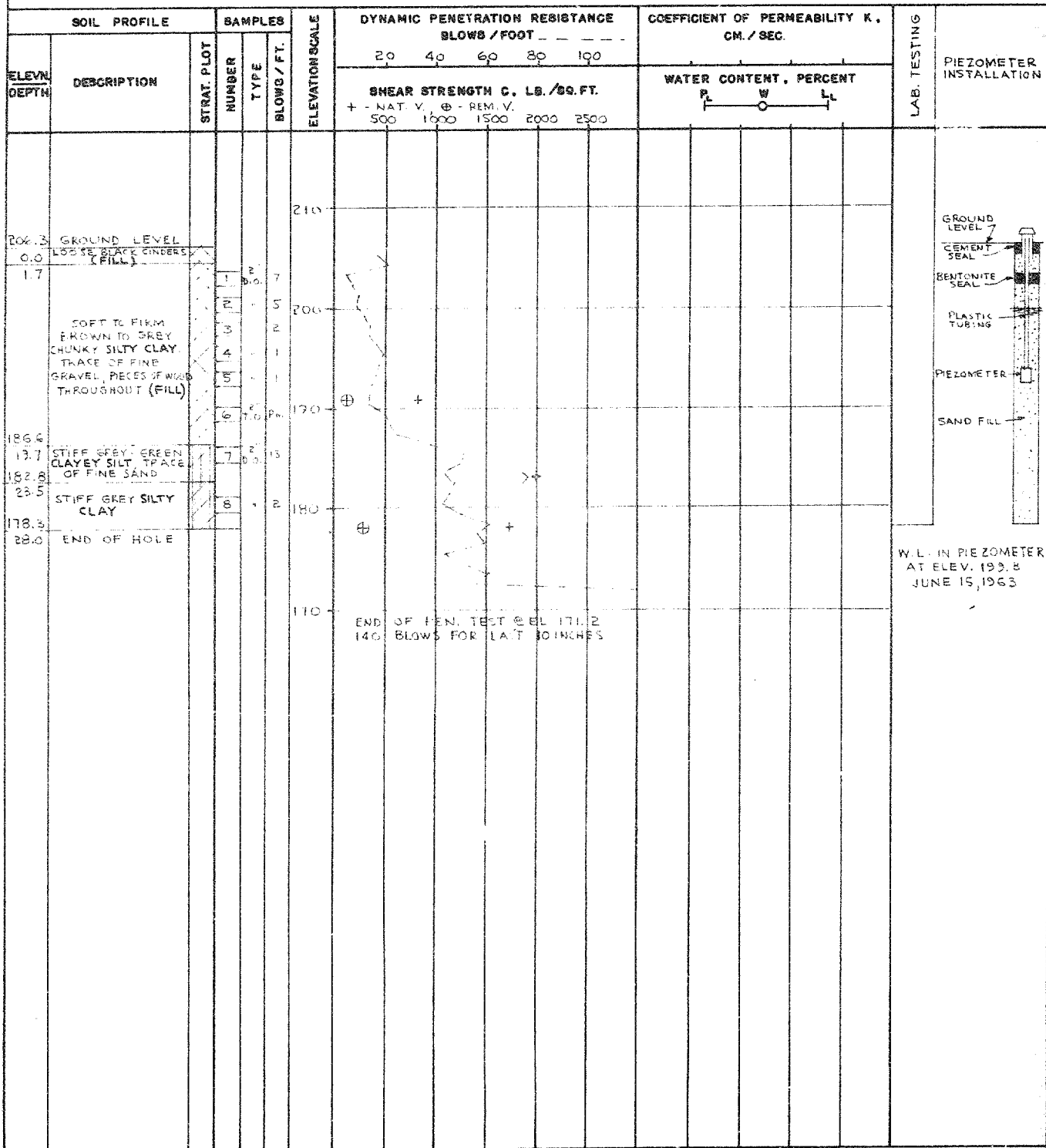
VERTICAL SCALE
1 INCH TO 1'-0"

GOLDER & ASSOCIATES

DRAWN J. A.
CHECKED JY

RECORD OF BOREHOLE 6

LOCATION SEE FIGURE 1 BORING DATE JUNE 6-7, 1963 DATUM GEODETIC
 BOREHOLE TYPE POWER AUGER BORING BOREHOLE DIAMETER 4.5"
 SAMPLER HAMMER WEIGHT 140 LB. DROP 30 INCHES PEN. TEST HAMMER WEIGHT 140 LB. DROP 30 INCHES



VERTICAL SCALE
1 INCH TO 10'-0"

GOLDER & ASSOCIATES

DRAWN J.A.
CHECKED [Signature]

RECORD OF BOREHOLE 7

LOCATION SEE FIGURE 1

BORING DATE JUNE 7-8, 1963

DATUM

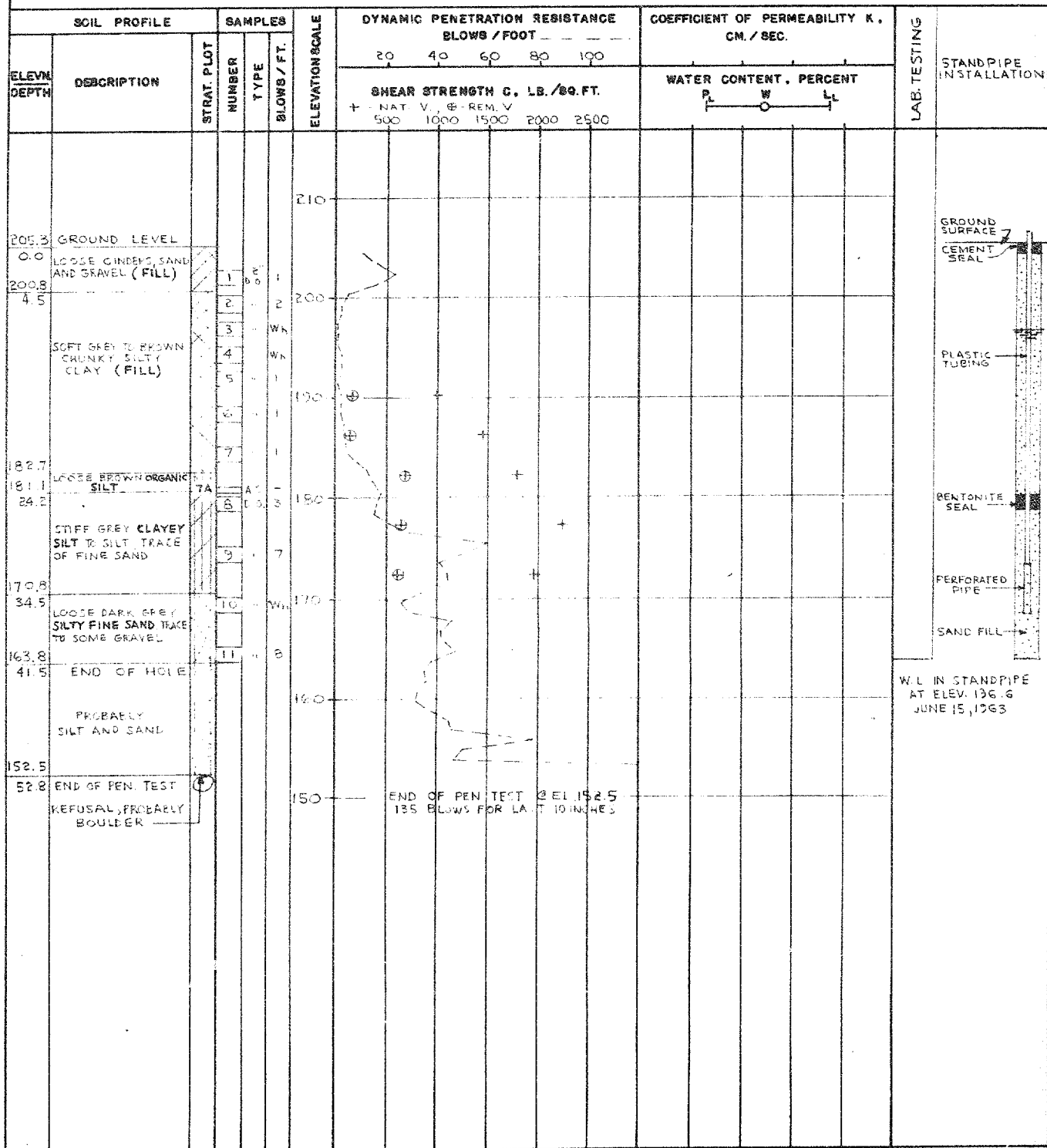
GEODETIC

BOREHOLE TYPE POWER AUGER BORING

BOREHOLE DIAMETER 4.5"

SAMPLER HAMMER WEIGHT 140 LB. DROP 30 INCHES

PEN. TEST HAMMER WEIGHT 140 LB. DROP 30 INCHES

VERTICAL SCALE
1 INCH TO 10'-0"

GOLDER & ASSOCIATES

DRAWN J.A.
CHECKED *W*

RECORD OF BOREHOLE 8

LOCATION SEE FIGURE 1 BORING DATE JUNE 10-11, 1962 DATUM GEODETIC
 BOREHOLE TYPE POWER AUGER BORING BOREHOLE DIAMETER 4.5"
 SAMPLER HAMMER WEIGHT 140 LB. DROP 30 INCHES PEN. TEST HAMMER WEIGHT 140 LB. DROP 30 INCHES

SOIL PROFILE			SAMPLES		ELEVATION SCALE	DYNAMIC PENETRATION RESISTANCE BLOWS / FOOT					COEFFICIENT OF PERMEABILITY K, CM. / SEC.					LAB. TESTING	STANDPIPE INSTALLATION	
ELEV. DEPTH	DESCRIPTION	STRAT. PLOT	NUMBER	TYPE		BLOWS / FT.	20	40	60	80	100	WATER CONTENT, PERCENT						
							SHEAR STRENGTH C, LB./SQ. FT. + - NAT. V. 500 1000 1500 2000 2500					P	W	L				
202.2	GROUND LEVEL																	
0.0			1	D.O.	2													
	VERY LOOSE TO LOOSE BLACK CINDEKS WITH SAND, TRACE TO SOME GRAVEL (FILL)		2	"	2													
			3	"	5													
			4	"	5													
84.4			5	A.S.	-													
17.8	LOOSE BLACK ORGANIC SILT, TRACE OF SAND AND GRAVEL		6	A.S.	-													
180.8																		
22.0	FIRM GREY SILTY CLAY		7	D.O.	4													
17.9																		
26.1	LOOSE TO COMPACT GRAY SILT, TRACE OF CLAY AND FINE SAND		8	"	9													
169.2																		
33.0	END OF HOLE																	
	FEEDABLY SILT AND SAND																	
160.2																		
42.0	END OF PEN. TEST																	

GROUND LEVEL

CEMENT SEAL

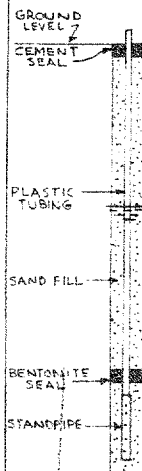
PLASTIC TUBING

SAND FILL

BENTONITE SEAL

STANDPIPE

W.L. IN STANDPIPE
AT ELEV. 130.0
JUNE 15, 1963



VERTICAL SCALE
1 INCH TO 10'-0"

GOLDER & ASSOCIATES

DRAWN J.A.
CHECKED JAY

RECORD OF BOREHOLE 9

LOCATION SEE FIGURE 1 BORING DATE JUNE 10, 1963 DATUM GEODETIC
 BOREHOLE TYPE POWER AUGER BORING BOREHOLE DIAMETER 4.5"
 SAMPLER HAMMER WEIGHT 140 LB. DROP 30 INCHES PEN. TEST HAMMER WEIGHT 140 LB. DROP 30 INCHES

SOIL PROFILE			SAMPLES		BLOWS / FT.	ELEVATION SCALE	DYNAMIC PENETRATION RESISTANCE BLOWS / FOOT					COEFFICIENT OF PERMEABILITY K, CM. / SEC.			
ELEV. DEPTH	DESCRIPTION	STRAT. PLT.	NUMBER	TYPE			20	40	60	80	100	WATER CONTENT, PERCENT			
							SHEAR STRENGTH C, LB. / SQ. FT.					P W LL			
							+ NAT. V								
							500 1000 1500 2000 2500								
205.3	GROUND LEVEL					210									
0.0	LOOSE BLACK CLAY (FILL)														
1.5			1	D.C.	11										
			2	"	11										
	LOOSE TO COMPACT BROWN SAND, TRACE OF SILT AND GRAVEL (FILL)		3	"	12										
			4	"	10										
			5	"	10										
188.8			6	"	4										
16.5	COMPACT TO LOOSE GREY SAND, A FEW SILT LAYERS, TRACE OF ORGANIC MATTER		7	"	47										
188.8															
21.5	FIRM GREY SILTY CLAY		8	"	10										
179.3			9	"	1										
26.0	LOOSE TO COMPACT GREY SILT, TRACE OF CLAY TO SILTY SAND														
173.9															
31.5	END OF HOLE														
	PROBABLY SILT AND SAND														
	PROBABLY TILL														
157.6															
47.7	END OF PEN. TEST REFUSAL, PROBABLY BOULDER														

W.L. IN OPEN BOREHOLE AT ELEV. 189.0 JUNE 10, 1963

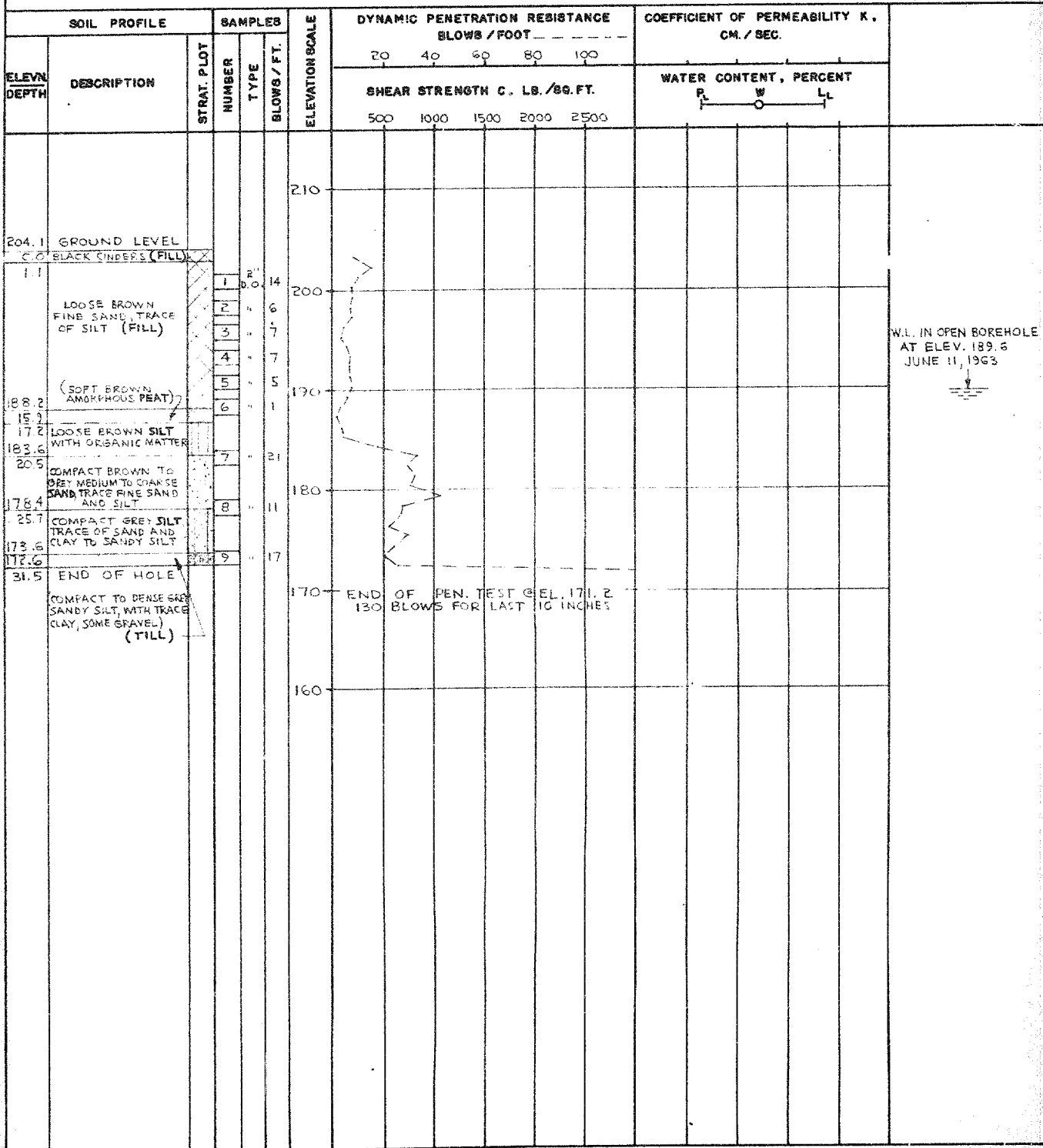
VERTICAL SCALE
1 INCH TO 10'-0"

GOLDER & ASSOCIATES

DRAWN J.A.
CHECKED JY

RECORD OF BOREHOLE 10

LOCATION SEE FIGURE 1 BORING DATE JUNE 11, 1963 DATUM GEODETIC
BOREHOLE TYPE POWER AUGER BORING BOREHOLE DIAMETER 4.5"
SAMPLER HAMMER WEIGHT 140 LB. DROP 30 INCHES PEN. TEST HAMMER WEIGHT 140 LB. DROP 30 INCHES



VERTICAL SCALE
1 INCH TO 10'-0"

GOLDER & ASSOCIATES

DRAWN J.A.
CHECKED JBY

PROCESSED BY _____

DATUM GEODETIC

BOREHOLE DIAMETER 4.5"

PEN. TEST HAMMER WEIGHT 140 LB. DROP 30 INCHES

A vertical cross-section diagram of a well casing. From top to bottom, the components are labeled: 'GROUND LEVEL' with an arrow pointing to the top surface; 'BENTONITE SEAL' with an arrow pointing to a shaded layer just below the ground level; 'PLASTIC TUBING' with an arrow pointing to the main vertical pipe; 'PERFORATED PIPE' with an arrow pointing to a section of the pipe with small holes near the bottom; and 'SAND FILL' with an arrow pointing to the area at the very bottom of the casing.

W.L. IN STANPIPE
AT ELEV. 188.9
JUNE 15, 1963

DRAWN J. A.
CHECKED *[Signature]*

RECORD OF BOREHOLE 12

LOCATION SEE FIGURE 1 BORING DATE JUNE 12-13, 1963 DATUM GEODETIC
 BOREHOLE TYPE POWER AUGER BORING BOREHOLE DIAMETER 4.5"
 SAMPLER HAMMER WEIGHT 140 LB. DROP 30 INCHES PEN. TEST HAMMER WEIGHT 140 LB. DROP 30 INCHES

SOIL PROFILE		SAMPLES		ELEVATION SCALE	DYNAMIC PENETRATION RESISTANCE BLOWS / FOOT					COEFFICIENT OF PERMEABILITY K, CM. / SEC.			
ELEV. DEPTH	DESCRIPTION	STRAT. PLOT	NUMBER	TYPE						WATER CONTENT, PERCENT			
206.1	GROUND LEVEL												
0.0	LOOSE BLACK SANDS WITH BROWN SAND (FILL)		1	6									
199.3	LOOSE BROWN TO GREY SANDY TO CLAYEY SILT (FILL)		2	3									
6.8			3	3									
94.2			4	11									
11.3	SOFT GREY SILTY CLAY WITH TRACE AND AND GRAVEL (FILL)		5	4									
188.1			6	2									
19.0	FIRM TO SOFT BROWN TO GREY CLAYEY SILT, TRACE OF FINE SAND		7	6									
181.0			8	3									
25.1	FIRM TO STIFF BROWN SILTY CLAY		9	11									
170.8			10	7									
169.6	COMPACT GREY SILTY CLAY AND FINE SAND		11	11									
37.5	END OF HOLE												
	MODERATELY SILTY AND SAND												
159.1													
47.0	END OF PEN. TEST												

W.L. IN OPEN BOREHOLE
AT ELEV. 196.0
JUNE 12, 1963



VERTICAL SCALE
1 INCH TO 10'-0"

GOLDER & ASSOCIATES

DRAWN J.A.
CHECKED *mm*

RECORD OF BOREHOLE 13

LOCATION SEE FIGURE 1

BORING DATE JUNE 13-14, 1963

DATUM

GEODETIC

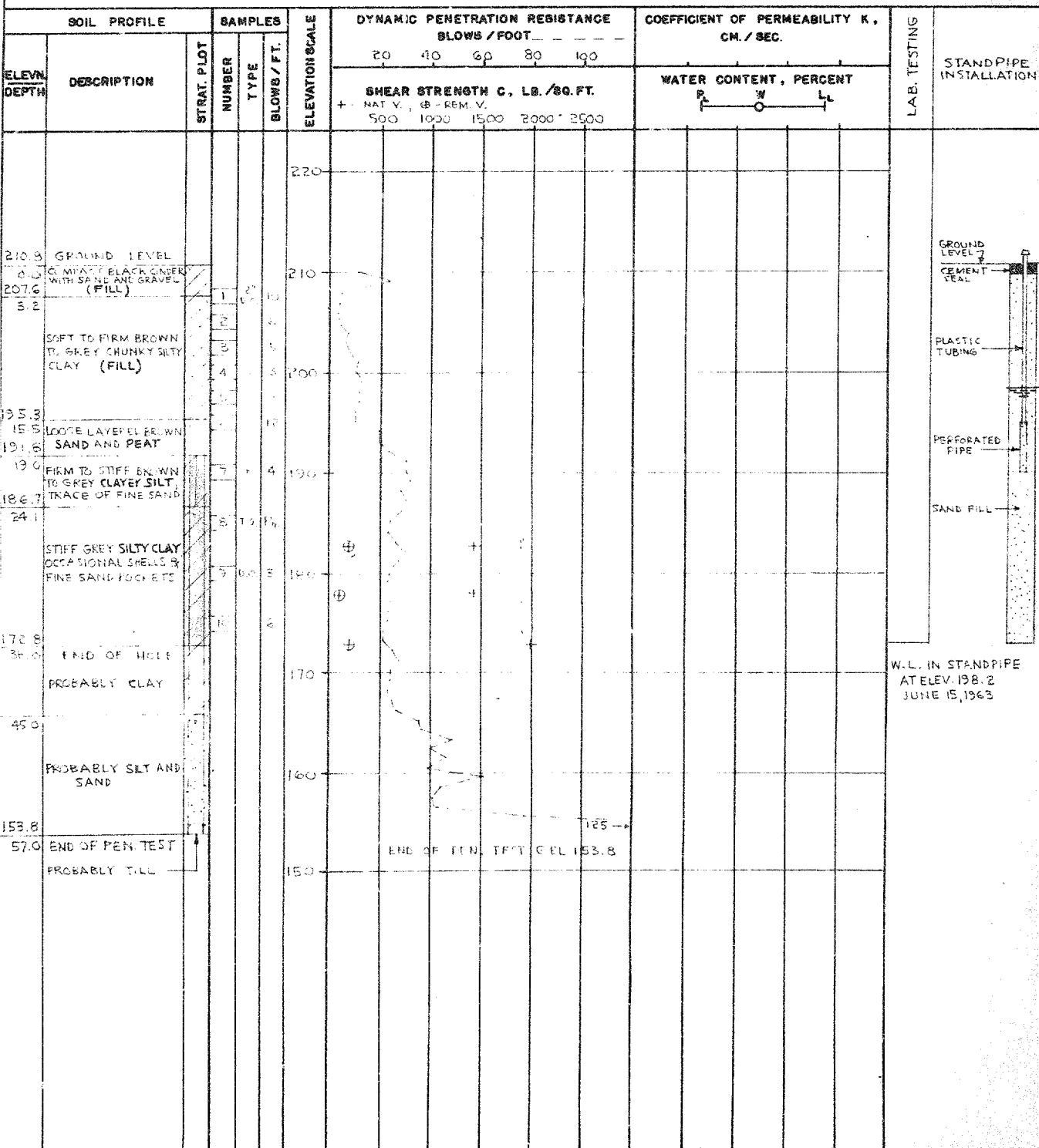
BOREHOLE TYPE POWER AUGER BORING

BOREHOLE DIAMETER

4.5"

SAMPLER HAMMER WEIGHT 140 LB. DROP 30 INCHES

PEN. TEST HAMMER WEIGHT 140 LB. DROP 30 INCHES



W.L. IN STANDPIPE
AT ELEV. 198.2
JUNE 15, 1963

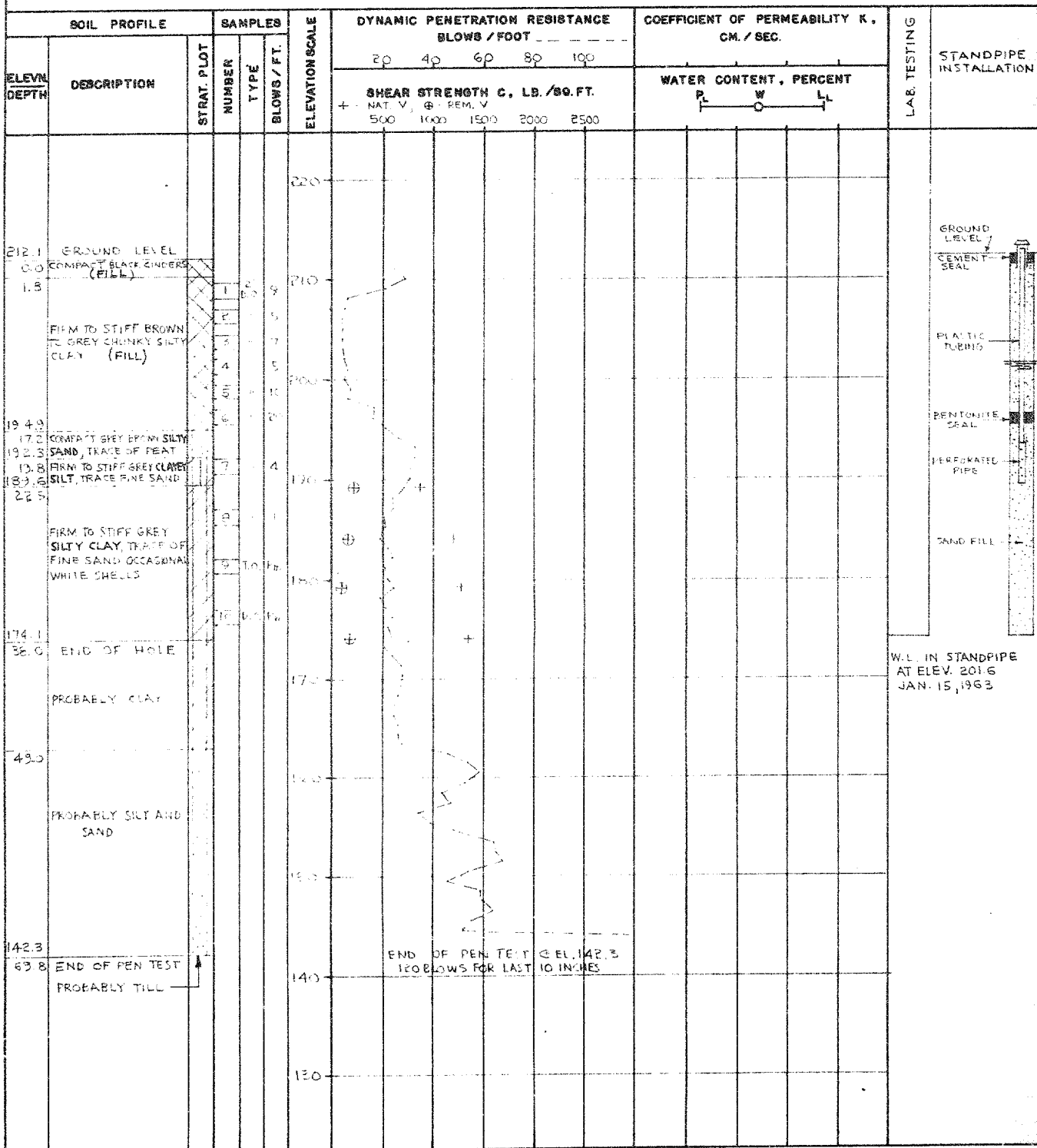
VERTICAL SCALE
1 INCH TO 10'-0"

GOLDER & ASSOCIATES

DRAWN J.A.
CHECKED *[Signature]*

RECORD OF BOREHOLE 14

LOCATION SEE FIGURE 1 BORING DATE JUNE 14, 1963 DATUM GEODETIC
 BOREHOLE TYPE POWER AUGER BORING BOREHOLE DIAMETER 4.5"
 SAMPLER HAMMER WEIGHT 140 LB. DROP 30 INCHES PEN. TEST HAMMER WEIGHT 140 LB. DROP 30 INCHES



VERTICAL SCALE
1 INCH TO 10'-0"

GOLDER & ASSOCIATES

DRAWN J.A.
CHECKED JY

RECORD OF BOREHOLE 15

LOCATION SEE FIGURE 1

BORING DATE

JUNE 15, 1963

DATUM

GEODETIC

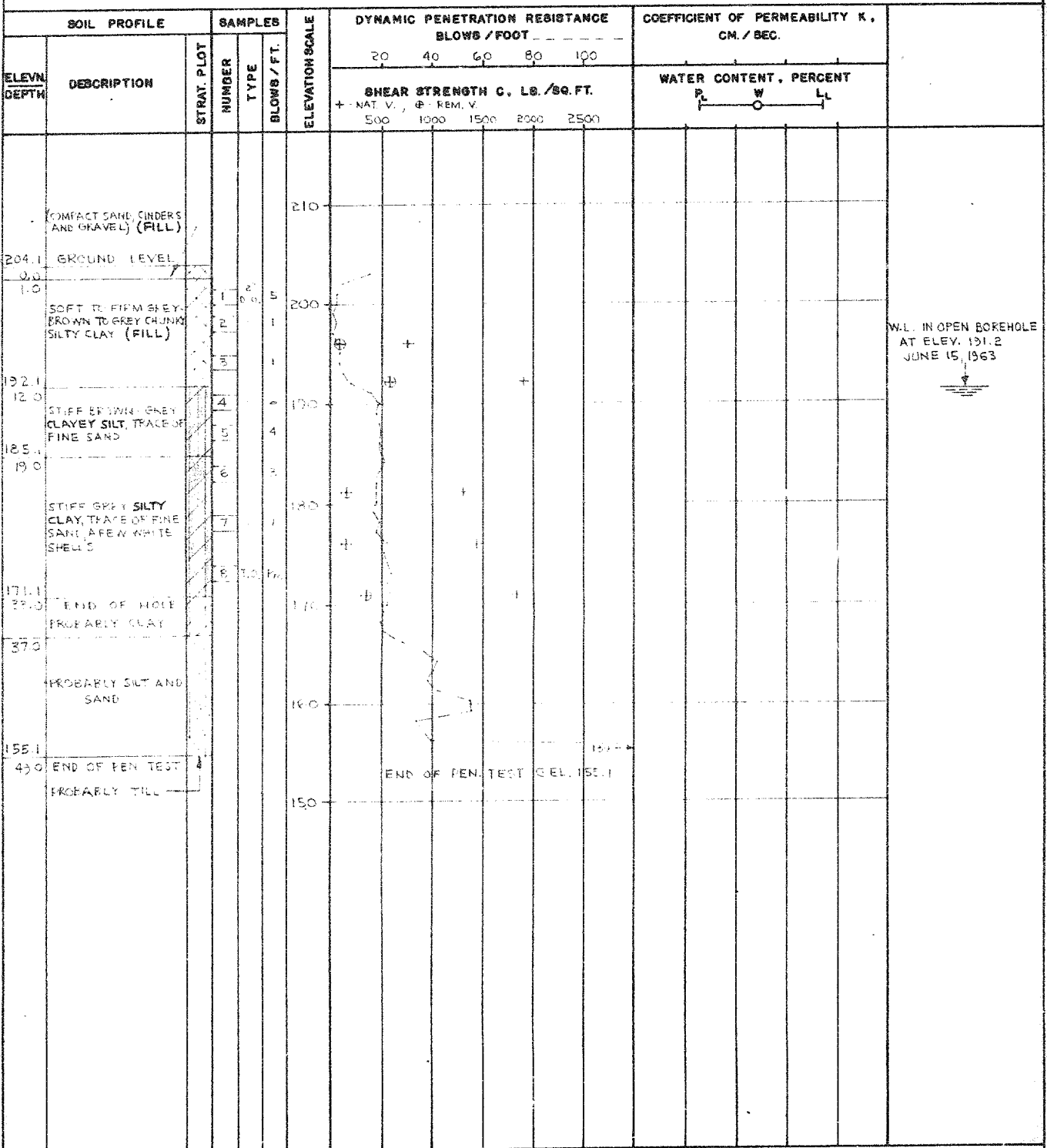
BOREHOLE TYPE POWER AUGER BORING

BOREHOLE DIAMETER

4.5"

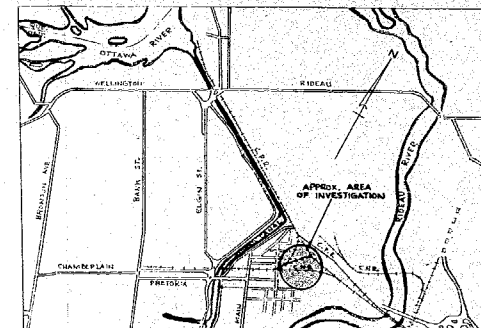
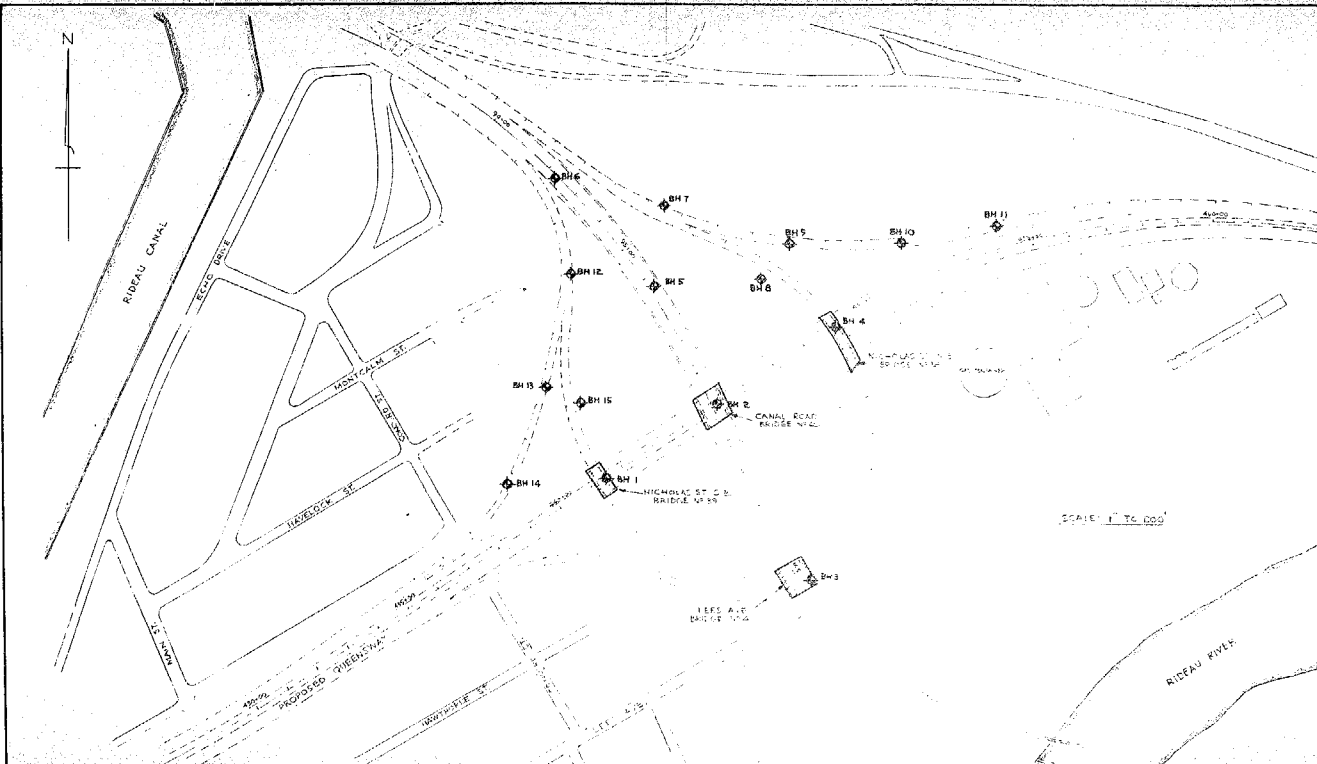
SAMPLER HAMMER WEIGHT 140 LB. DROP 30 INCHES

PEN. TEST HAMMER WEIGHT 140 LB. DROP 30 INCHES

VERTICAL SCALE
1 INCH TO 10'-0"

GOLDER & ASSOCIATES

DRAWN J.A.
CHECKED *[Signature]*



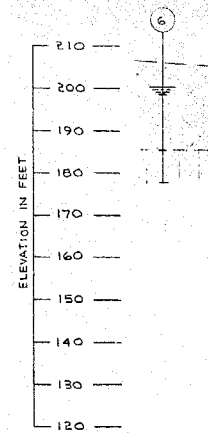
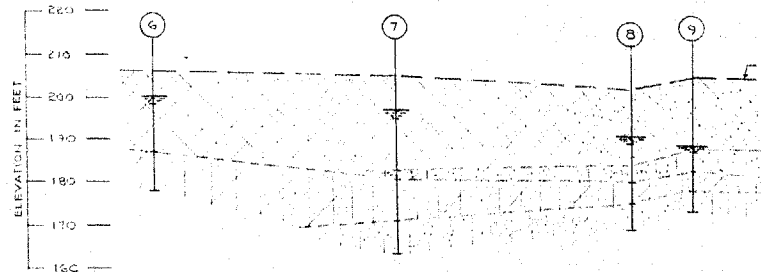
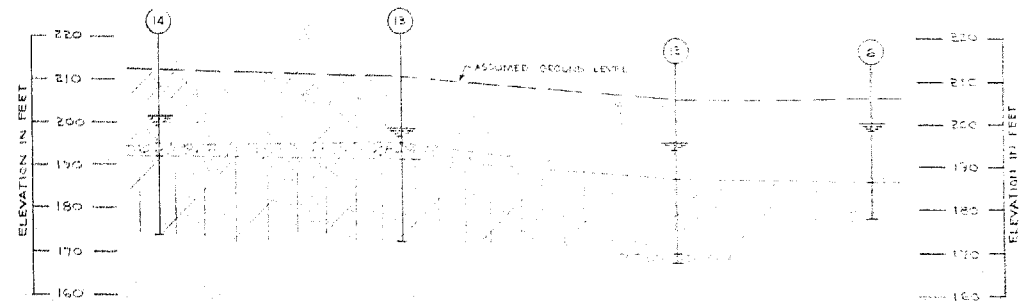
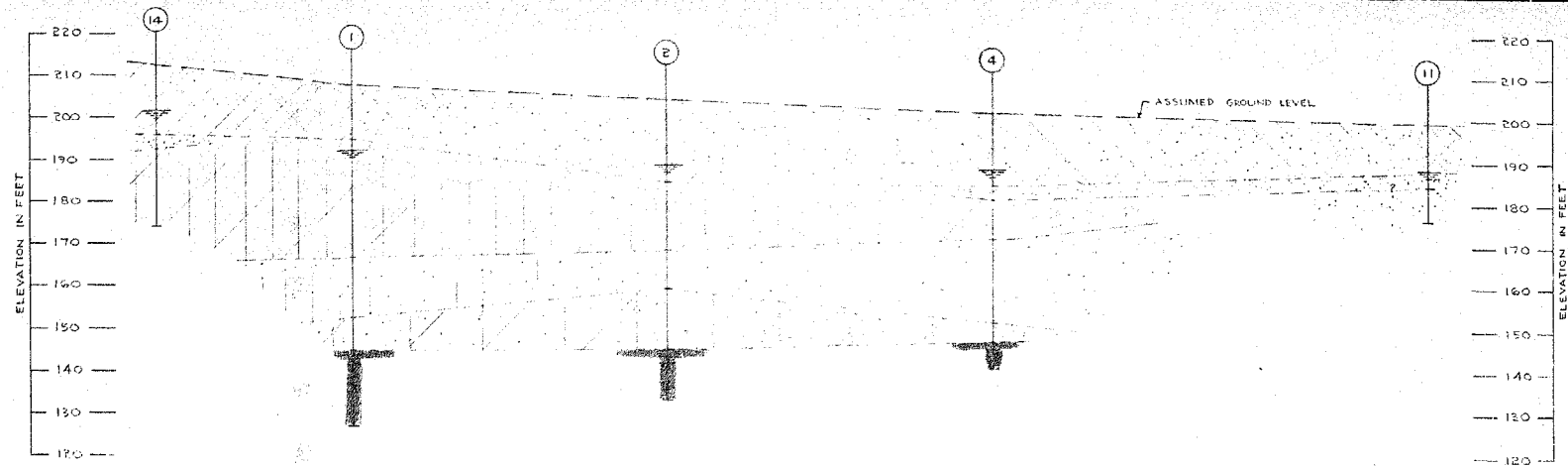
KEY PLAN
SCALE: 1" TO 2,000' (APPROX.)

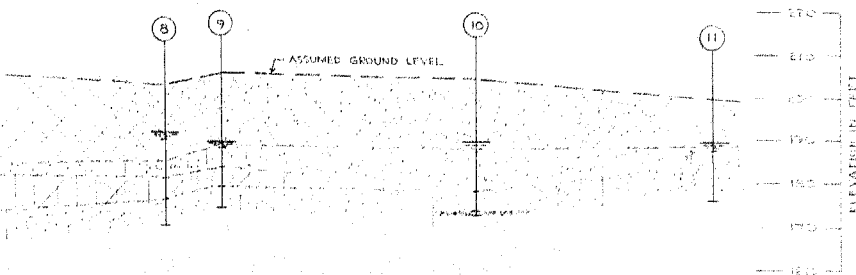
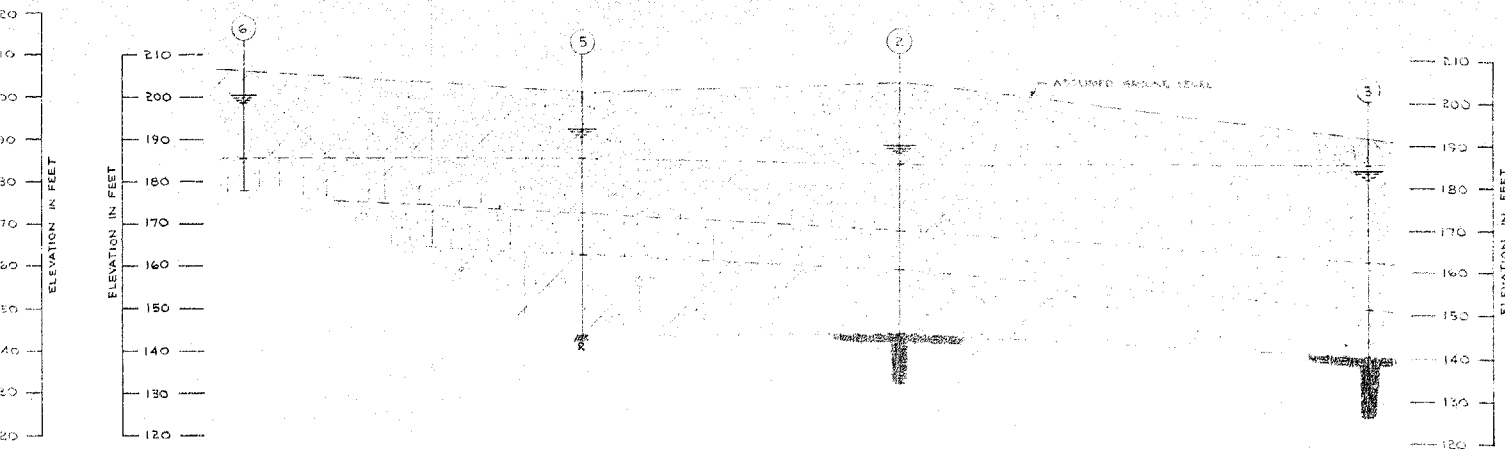
LEGEND

◆ BOREHOLE IN PLAN

REFERENCE

DE LEUW, CATHIER & CO. DRWS. NO. C45H-5
PLAN SHOWING STAGE IV NICHOLAS ST. INTERCHANGE
AT QUEENWAY, SCHEME "B" DATED MAY 29, 1965
SCALE: 1" TO 100'



LEGEND

BOREHOLE IN ELEVATION



WATER LEVEL IN BOREHOLE, JUNE, 1963

STRATIGRAPHY

MAINLY VERY LOOSE TO COMPACT GRANULAR FILL



MAINLY SOFT TO FIRM CLAY FILL



COMPACT BROWN TO GREY SILTY SAND, LOOSE DARK ORGANIC SILT AND SOFT AMORPHOUS PEAT (RECENT DEPOSITS)



FIRM TO STIFF GREY-BROWN TO GREY CLAYEY SILT TO SILTY CLAY, TRACE OF FINE SAND, OCCASIONAL SHELLS AND ORGANIC POCKETS



COMPACT TO VERY DENSE GREY SILT WITH FINE SAND AND CLAY TO SILTY FINE SAND, TRACE TO SOME GRAVEL



DENSE TO VERY DENSE SILTY SAND TO SANDY SILT WITH GRAVEL, COBBLES AND BOULDERS (TILL)



DARK GREY SHALE BEDROCK



REFUSAL, BOULDER OR BEDROCK

SCALES

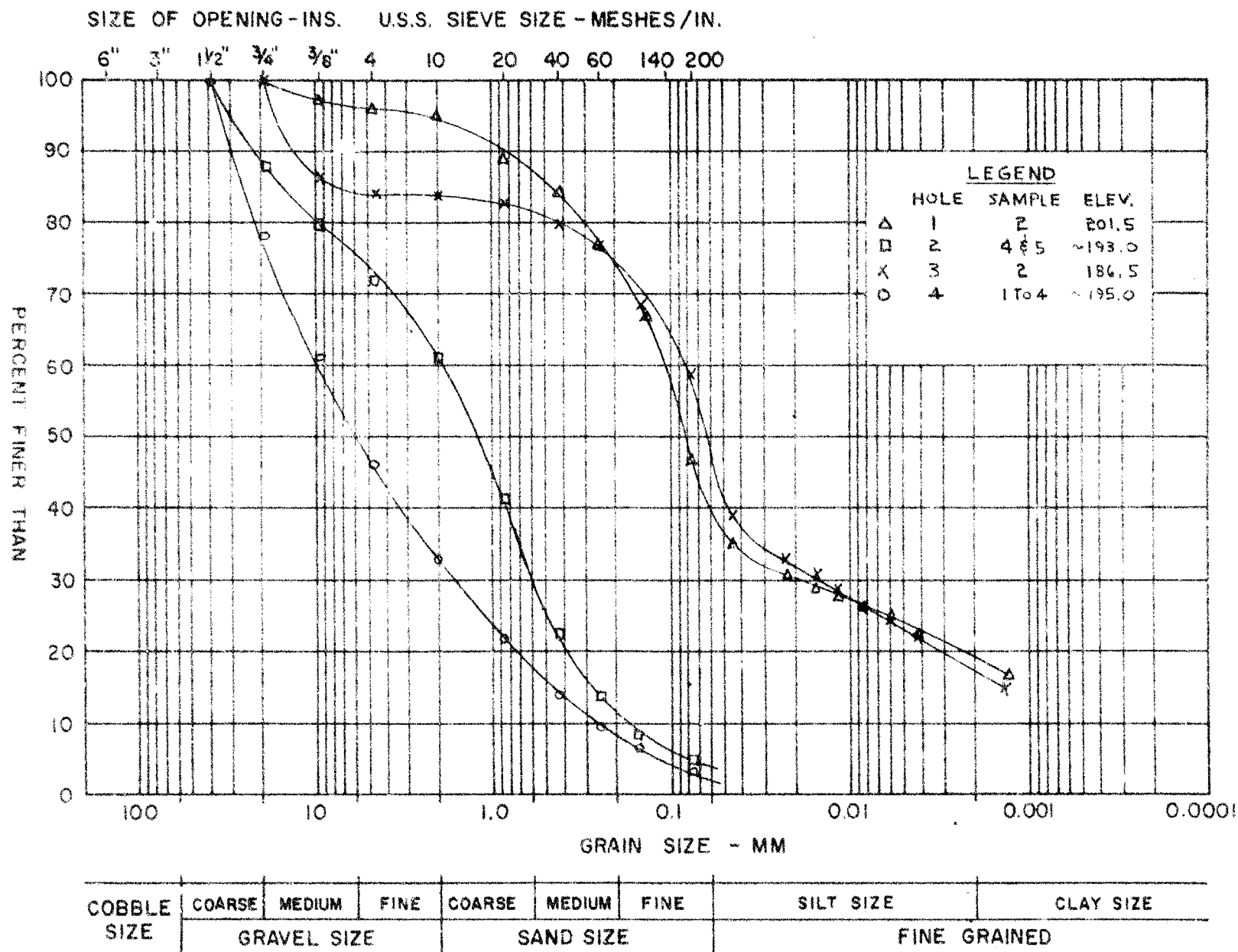
HORIZONTAL SCALE 1" TO 100' 0"

VERTICAL SCALE 1" TO 20' 0"

GRAIN SIZE DISTRIBUTION (FILL)

FIGURE

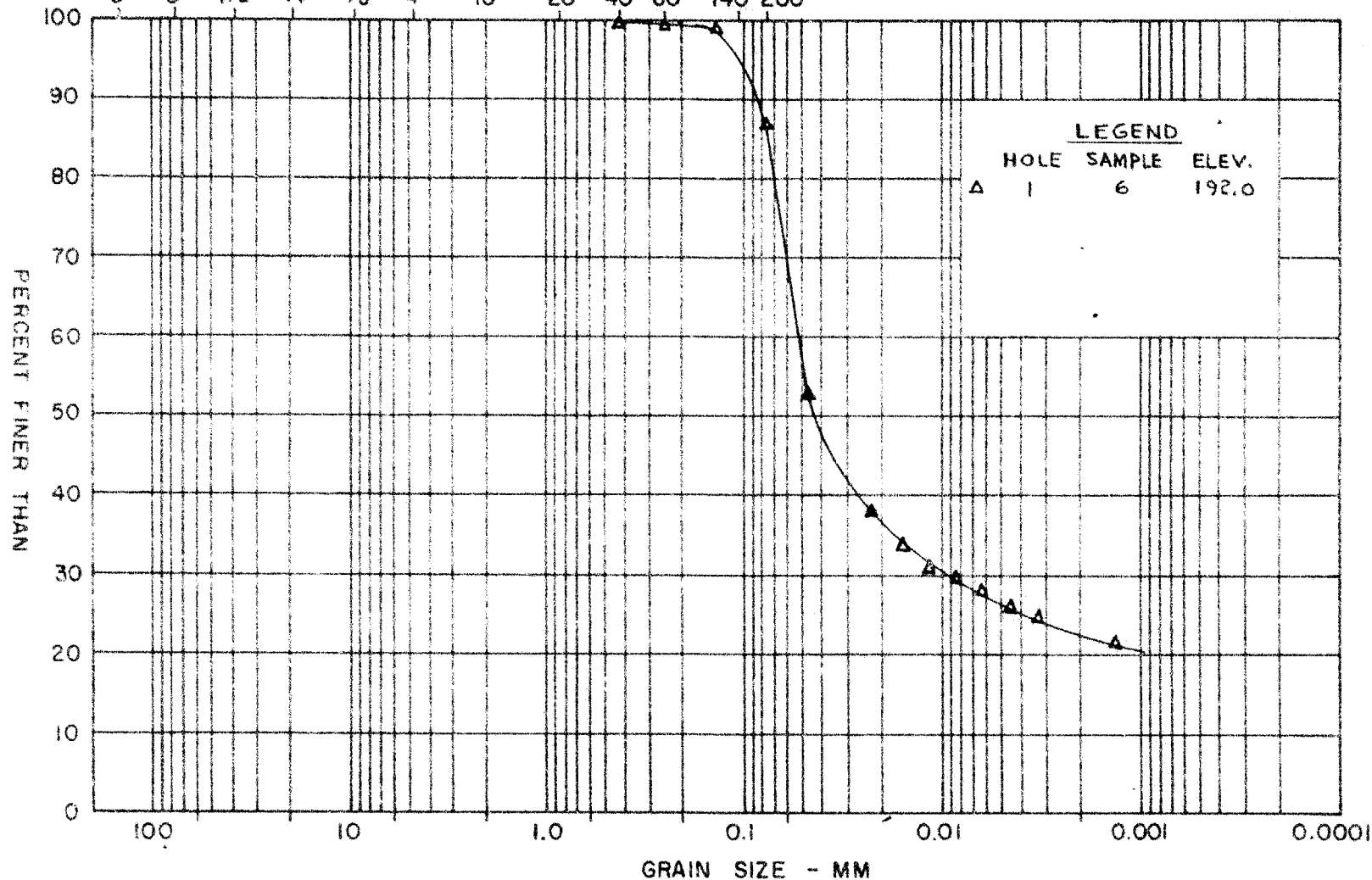
3



GOLDER & ASSOCIATES

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

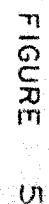
6" 3" 1 1/2" 3/4" 3/8" 4 10 20 40 60 140 200



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

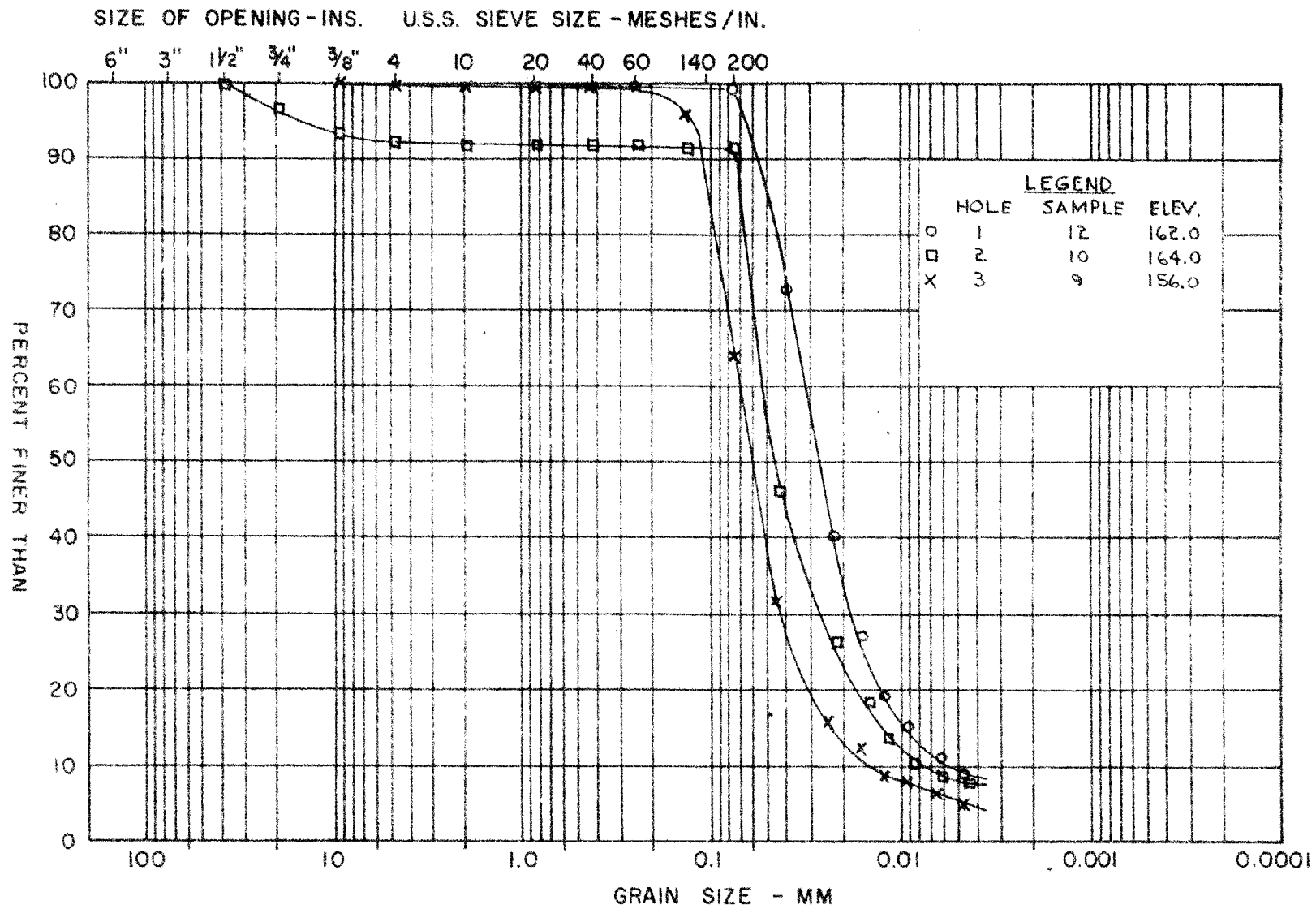
GRAIN SIZE DISTRIBUTION
CLAYEY SILT

FIGURE



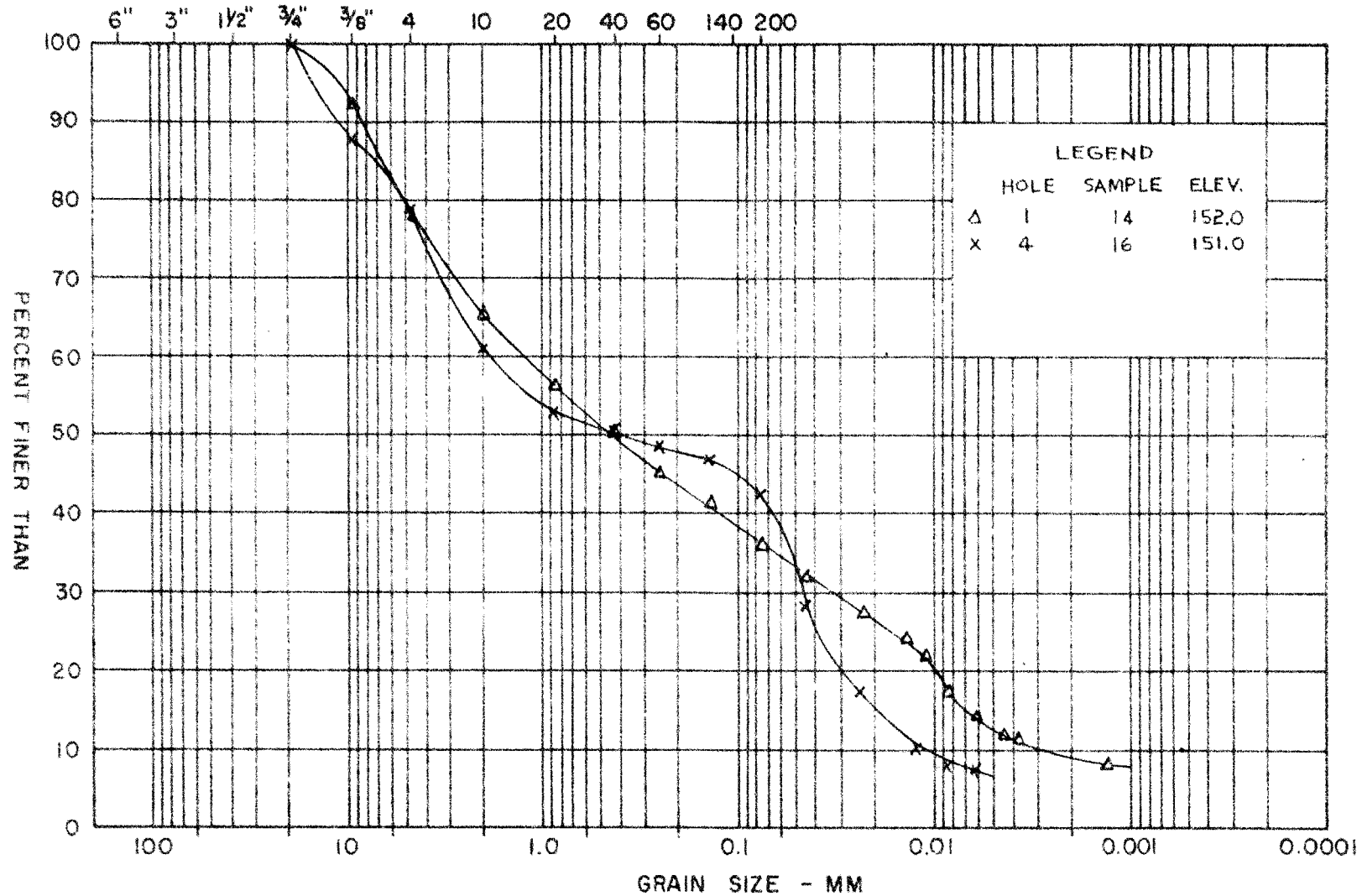
COBBLE SIZE	COARSE	MEDIUM	FINE	COARSE	MEDIUM	FINE	SILT SIZE	CLAY SIZE
	GRAVEL SIZE			SAND SIZE			FINE GRAINED	

GRAIN SIZE DISTRIBUTION SILT



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

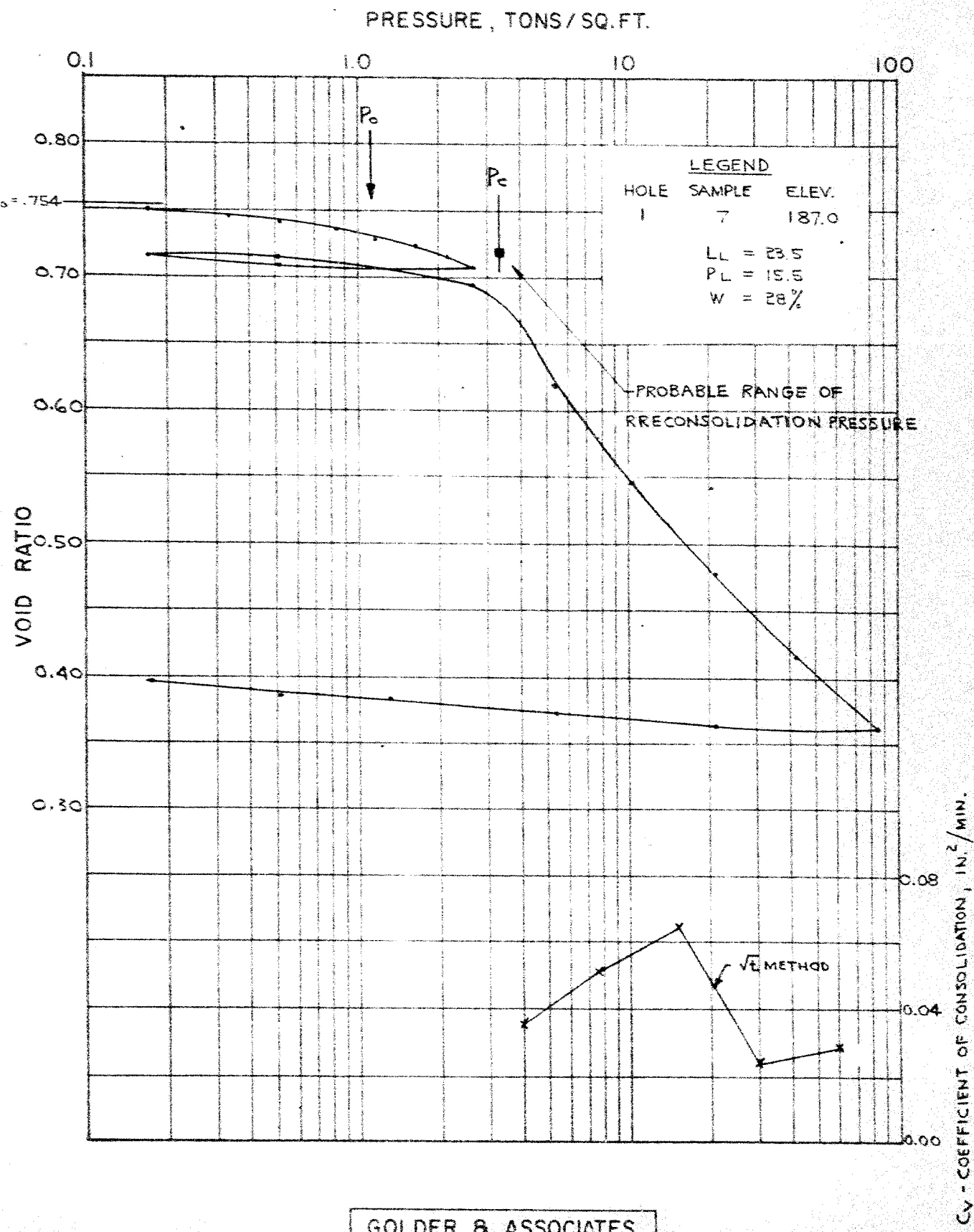
SIZE OF OPENING - INS. U.S.S. SIEVE SIZE - MESHES / IN.



GRAIN SIZE DISTRIBUTION
(TILL)

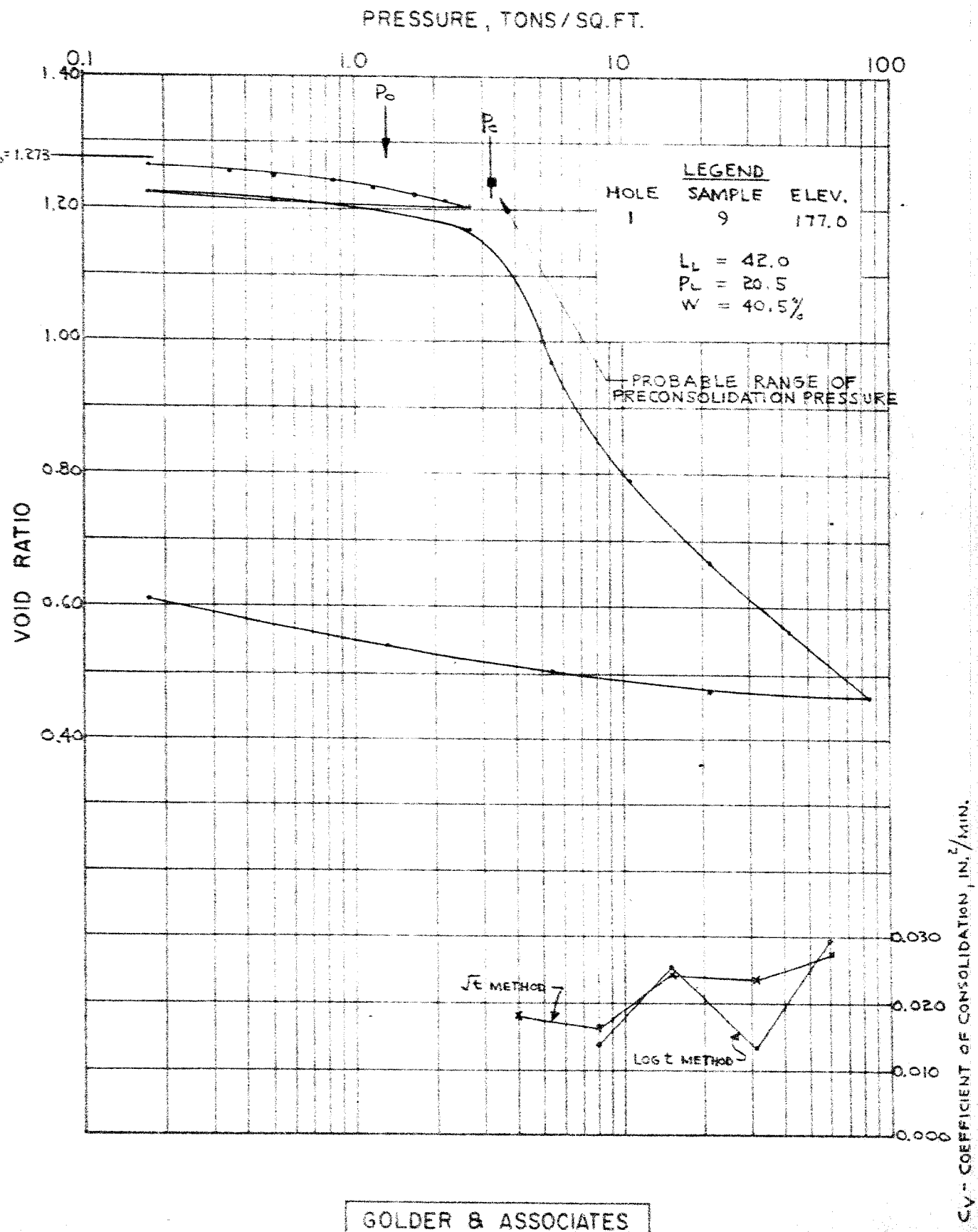
VOID RATIO - PRESSURE CURVES CONSOLIDATION TEST

FIGURE 8



VOID RATIO - PRESSURE CURVES CONSOLIDATION TEST

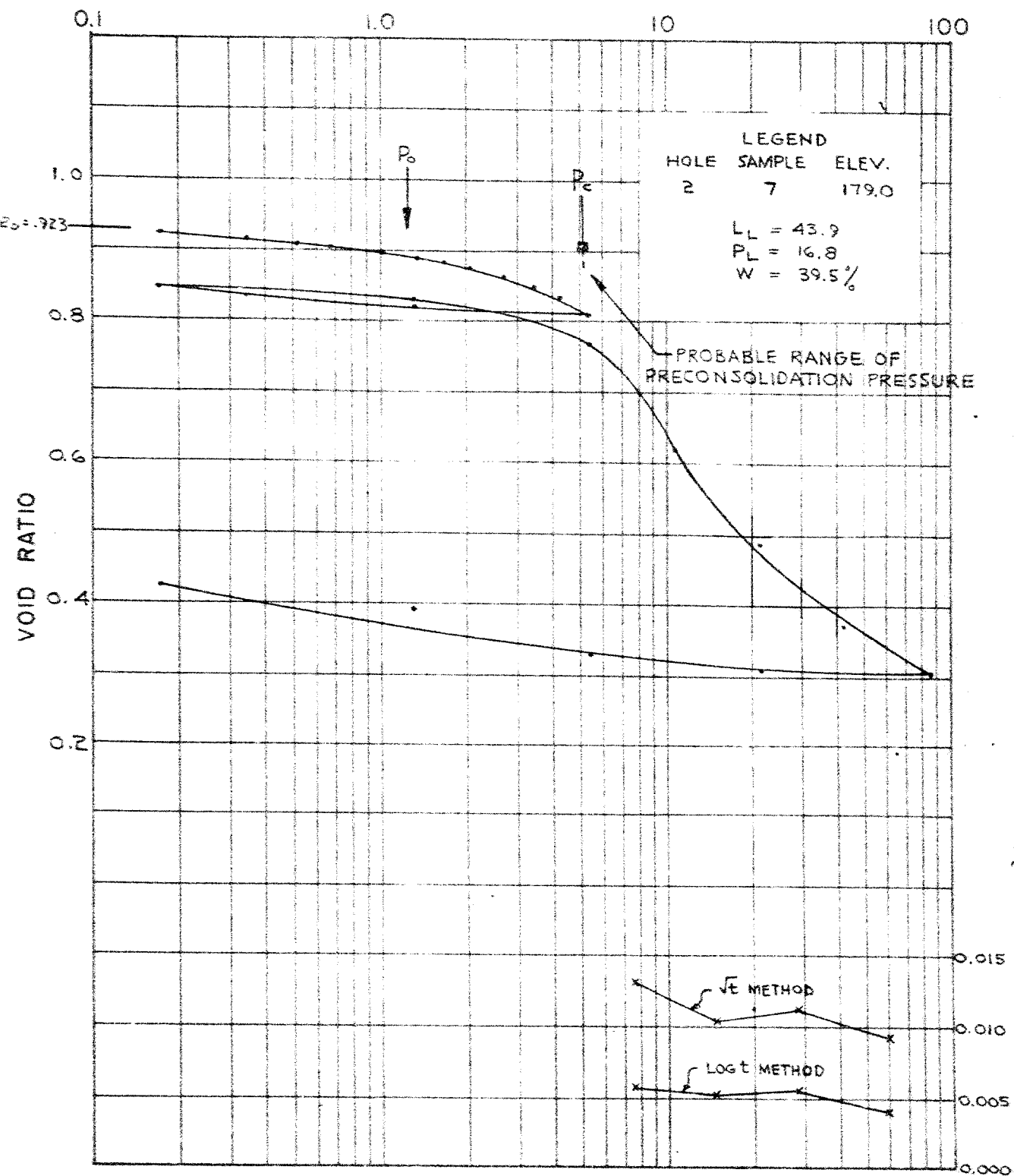
FIGURE 9



VOID RATIO - PRESSURE CURVES CONSOLIDATION TEST

FIGURE 10

PRESSURE, TONS/SQ.FT.



GOLDER & ASSOCIATES

C_v - COEFFICIENT OF CONSOLIDATION, $\text{IN.}^2/\text{MIN.}$

VOID RATIO - PRESSURE CURVES CONSOLIDATION TEST

FIGURE 11

