

#68-F-227M

VAN CAMP

BRIDGE

MOUNTAIN

TOWNSHIP

H. Q. GOLDER & ASSOCIATES LTD.

SOIL AND FOUNDATION ENGINEERS

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July 17, 1968.

Graham, Berman and Associates Ltd.,
Consulting Engineers,
2277 Riverside Drive,
Ottawa 8, Ontario.

68-F-227 M

Attention: Mr. A. R. Sethna, P. Eng.

RE: Soil Investigation,
Proposed Van Camp Bridge,
Township of Mountain.

Dear Sirs:

This letter reports the results of an investigation carried out at the bridge crossing of the north branch of the South Nation River at Van Camp, some 5 miles west of Winchester, Ontario. The purpose of this investigation was to determine the subsoil and groundwater conditions at the site and, based on this information, to make recommendations for the foundation design of a proposed bridge replacement structure.

The field work for this investigation was carried out on June 25, 1968. A borehole was put down through the east approach embankment. The embankment fill contains numerous boulders and a dynamic penetration was attempted at several locations on the west approach embankment before the fill was penetrated. The dynamic penetration test was driven to practical refusal. The borehole and the dynamic penetration test was put down with a machine drill rig supplied and operated by the F. E. Johnston Drilling Co. Ltd., Ottawa. The field work was supervised by a

member of our engineering staff.

The location of the boring and the penetration test, together with a stratigraphic section along the centerline of the proposed bridge are shown on Figure 1. A detailed log of the borehole is given on the Record of Borehole sheet following the text of this report.

The soil samples were brought to our laboratory for detailed examination. The results of a laboratory test on a sample of the till overburden are shown on Figure 2.

The elevations given in this report are referred to a bench mark on the concrete stoop at the front of the house, west of the bridge. The elevation of this bench mark was given to us as 261.65, as referred to geodetic datum.

SITE AND GEOLOGY

The site is located, some 5 miles west of Winchester, at the crossing of the north branch of the South Nation River by the township road which runs west from Inkerman Station. The topography of the area is relatively flat. The stream has cut a valley some 10 to 15 feet deep. At a bridge crossing, about $\frac{1}{4}$ mile upstream, the stream channel has exposed bedrock.

From available geological information the stream flows through both clay and glacial till overburden in this area. The overburden is underlain generally by limestone bedrock of the Oxford formation, though interbedded sandstone and limestone bedrock of the March formation exists to the north of Van Camp.

SUBSURFACE CONDITIONS

The detailed soil stratigraphy encountered in the borehole is given on the Record of Borehole sheet. Following is a summarized account of the soil conditions.

Embankment Fill

From observation of the approach embankment side slopes, together with samples obtained from the borehole, the embankment fill consists of pit run sand and gravel material with numerous cobbles and boulders. The thickness of the embankment fill at

the borehole location was 14 feet. The coarse nature of the fill provided a variable resistance to driving of the casing and the sampler. It is considered, however, that the fill is in a compact state of packing.

Alluvium

About 2.5 feet of loose fine to coarse grey sand with some silt and a trace of clay size material was encountered immediately below the embankment fill. This layer is considered to be a stream deposit of recent geological origin.

Glacial Till

A 2 foot layer of dense glacial till of a sandy silt nature was encountered in the borehole below the alluvium. The results of a grading test on a sample of the till is given on Figure 2.

Limestone Bedrock

Limestone bedrock was encountered in the borehole at about elevation 243, that is, some 6 feet below river bottom. The bedrock was cored in the borehole for 5 feet in BX size. From the core recovered the limestone bedrock is considered to be sound. The upper 2.5 feet of the core consisted of thick beds of grey dolomitic limestone and the remaining core was dark grey shaly limestone.

A standpipe was installed in the borehole within the bedrock. The water level in the standpipe on July 12, 1968, 2 weeks after completion of boring was at elevation 250.4, that is, at about the water level in the stream.

PROPOSED BRIDGE STRUCTURE

a) General

The existing bridge is a concrete structure of 42 foot span and about 15 foot width. The upstream wing walls are badly eroded at and below normal high water level and are beginning to separate from the abutments. The river side of the abutments also show signs of erosion. It is understood that it is planned to replace this bridge with a wider structure of the same span

length and at the same location. The roadway grade at the bridge will be raised by almost 3 feet.

b) Foundations

It is recommended that the abutments of the proposed bridge be founded on spread footings placed on the surface of the sound limestone bedrock which underlies the site at about 6 feet below river bed level. The abutment footings may be designed for an allowable bearing pressure of up to 10 tons/sq.ft. in the sound limestone bedrock.

The closed end abutments should be backfilled for a distance of at least 5 feet horizontally with a well compacted, free-draining and non-frost-susceptible granular material. Provision should be made for drainage from the backfill to prevent hydrostatic or ice pressure build up behind the walls. With full effective drainage of the backfill, a coefficient of lateral earth pressure at rest, K_0 , = 0.4 and a total unit weight of 135 lb/cu.ft. should be used for the compacted granular backfill in the design of the abutments of a rigid frame structure. For a simply supported structure in which some minor movement of the top of the wall could be tolerated, an active earth pressure coefficient, K_a , = 0.3 may be used.

c) Construction Procedures

No major construction problems are envisaged for the excavations for the bridge abutments to be founded on the limestone bedrock. It is recommended that the excavations on the stream side be surrounded with dykes of relatively impervious soil such as the glacial till which overlies the bedrock. The water level in the bedrock corresponds closely to river water level. The water inflow into the excavations through the jointed limestone bedrock should be readily handled by pumping from sumps.

d) Approach Embankments

It is understood that the grade of the approach embankments will be raised a maximum of about 5 feet above present roadway level and some 15 feet above the stream floodplain or alluvium level. The approach embankment will also be widened considerably. Due to the granular and competent nature of the subsoil, there should be no overall stability problem with roadway approach

embankments if raised to the height proposed, using $1\frac{1}{2}$ horizontal to 1 vertical side slopes, provided they are constructed of suitable fill material, properly compacted in place. The protection of the embankment slopes against erosion should be provided to some 2 feet above the maximum flood level. In this case, boulders graded from about 1 foot to 6 inch diameter and dumped on the side slopes should provide adequate protection. Prior to widening the embankments, it is recommended that all surficial topsoil and organic matter should be stripped from beneath the proposed construction area.

We trust that this report contains sufficient information for your design purposes. If we can be of any further service to you on this project, please call us.

Yours very truly,

H. Q. GOLDER & ASSOCIATES LTD.



F. J. Heffernan, P. Eng.

FJH/ml
68766A
July, 1968.



GOLDER & ASSOCIATES

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

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

<i>WH</i>	sampler advanced by static weight—weight, hammer
<i>PH</i>	sampler advanced by pressure—pressure, hydraulic
<i>PM</i>	sampler advanced by pressure—pressure, manual

III. SOIL DESCRIPTION

(a) *Cohesionless Soils*

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

(b) *Cohesive Soils*

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

<i>C</i>	consolidation test
<i>H</i>	hydrometer analysis
<i>M</i>	sieve analysis
<i>MH</i>	combined analysis, sieve and hydrometer ¹
<i>Q</i>	undrained triaxial ²
<i>R</i>	consolidated undrained triaxial ²
<i>S</i>	drained triaxial
<i>U</i>	unconfined compression
<i>V</i>	field vane test

NOTES:

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

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

LIST OF SYMBOLS

I. GENERAL

τ	= 3.1416
e	= base of natural logarithms 2.7183
$\log_e a$ or $\ln a$	natural logarithm of a
$\log_{10} a$ or $\log a$	logarithm of a to base 10
t	time
g	acceleration due to gravity
V	volume
W	weight
M	moment
F	factor of safety

II. STRESS AND STRAIN

u	pore pressure
σ	normal stress
σ'	normal effective stress ($\bar{\sigma}$ is also used)
τ	shear stress
ϵ	linear strain
ϵ_{xy}	shear strain
ν	Poisson's ratio (μ is also used)
E	modulus of linear deformation (Young's modulus)
G	modulus of shear deformation
K	modulus of compressibility
η	coefficient of viscosity

III. SOIL PROPERTIES

(a) Unit weight

γ	unit weight of soil (bulk density)
γ_s	unit weight of solid particles
γ_w	unit weight of water
γ_d	unit dry weight of soil (dry density)
γ'	unit weight of submerged soil
G_s	specific gravity of solid particles $G_s = \gamma_s / \gamma_w$
e	void ratio
n	porosity
w	water content
S_r	degree of saturation

(b) Consistency

w_L	liquid limit
w_P	plastic limit
I_P	plasticity index
w_S	shrinkage limit
I_L	liquidity index = $(w - w_P) / I_P$
I_C	consistency index = $(w_L - w) / I_P$
e_{max}	void ratio in loosest state
e_{min}	void ratio in densest state
D_r	relative density = $(e_{max} - e) / (e_{max} - e_{min})$

(c) Permeability

h	hydraulic head or potential
q	rate of discharge
v	velocity of flow
i	hydraulic gradient
k	coefficient of permeability
j	seepage force per unit volume

(d) Consolidation (one-dimensional)

m_v	coefficient of volume change = $-\Delta e / (1+e) \Delta \sigma'$
C_c	compression index = $-\Delta e / \Delta \log_{10} \sigma'$
c_c	coefficient of consolidation
T_v	time factor = $c_c t / d^2$ (d , drainage path)
U	degree of consolidation

(e) Shear strength

τ_f	shear strength
c'	effective cohesion
ϕ'	effective angle of shearing resistance, or friction
c_u	apparent cohesion*
ϕ_u	apparent angle of shearing resistance, or friction
μ	coefficient of friction
S_i	sensitivity


$\left. \begin{array}{l} \text{in terms of effective stress} \\ \tau_f = c' + \sigma' \tan \phi' \end{array} \right\}$

$\left. \begin{array}{l} \text{in terms of total stress} \\ \tau_f = c_u + \sigma \tan \phi_u \end{array} \right\}$

*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** BORING DATE **JUNE 25, 1968** DATUM **GEODETIC**
BOREHOLE TYPE **WASH BORING** BOREHOLE DIAMETER **BA CASING**
SAMPLER HAMMER WEIGHT **140 LB.** DROP **30 INCHES** PEN. TEST HAMMER WEIGHT **LB** DROP **INCHES**

SOIL PROFILE			SAMPLES			ELEVATION SCALE	DYNAMIC PENETRATION RESISTANCE BLOWS/FT. -----					COEFFICIENT OF PERMEABILITY k , CM./SEC.					ADDITIONAL LAB. TESTING	PIEZOMETER OR STANDPIPE INSTALLATION
ELEV. DEPTH	DESCRIPTION	STRAT PLGT	NUMBER	TYPE	BLOWS/FT.		SHEAR STRENGTH C_u , LB./SQ.FT.					WATER CONTENT, PERCENT W_p — W — W_L						
261.6	GROUND LEVEL																	
0.0	COMPACT BROWN SAND AND GRAVEL, SOME COBBLES AND BOULDERS (EMBANKMENT FILL)		1	2	19													
			2		59													
247.6																		
14.0	LOOSE GREY SILTY SAND (ALLUVIUM)																	
245.1	DENSE GREY SANDY SILT, SOME GRAVEL TRACE OF CLAY (SANDY SILT TILL)		3		85													
16.5																		
242.7	SOUND GREY AND DARK GREY LIMESTONE BEDROCK		4	BR	RC													
18.9																		
237.5																		
24.1	END OF HOLE															WELL IN STANDPIPE AT ELEV. 250.4 ONLY 1.5' D.B.R.		

15 0 5 Percent axial strain at failure

VERTICAL SCALE
1 INCH TO 5'

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DRAWN **RAH**
CHECKED **FSH**

PEN. TEST RECORD OF BOREHOLE A

LOCATION

See Figure

BORING DATE JUNE 20, 1958

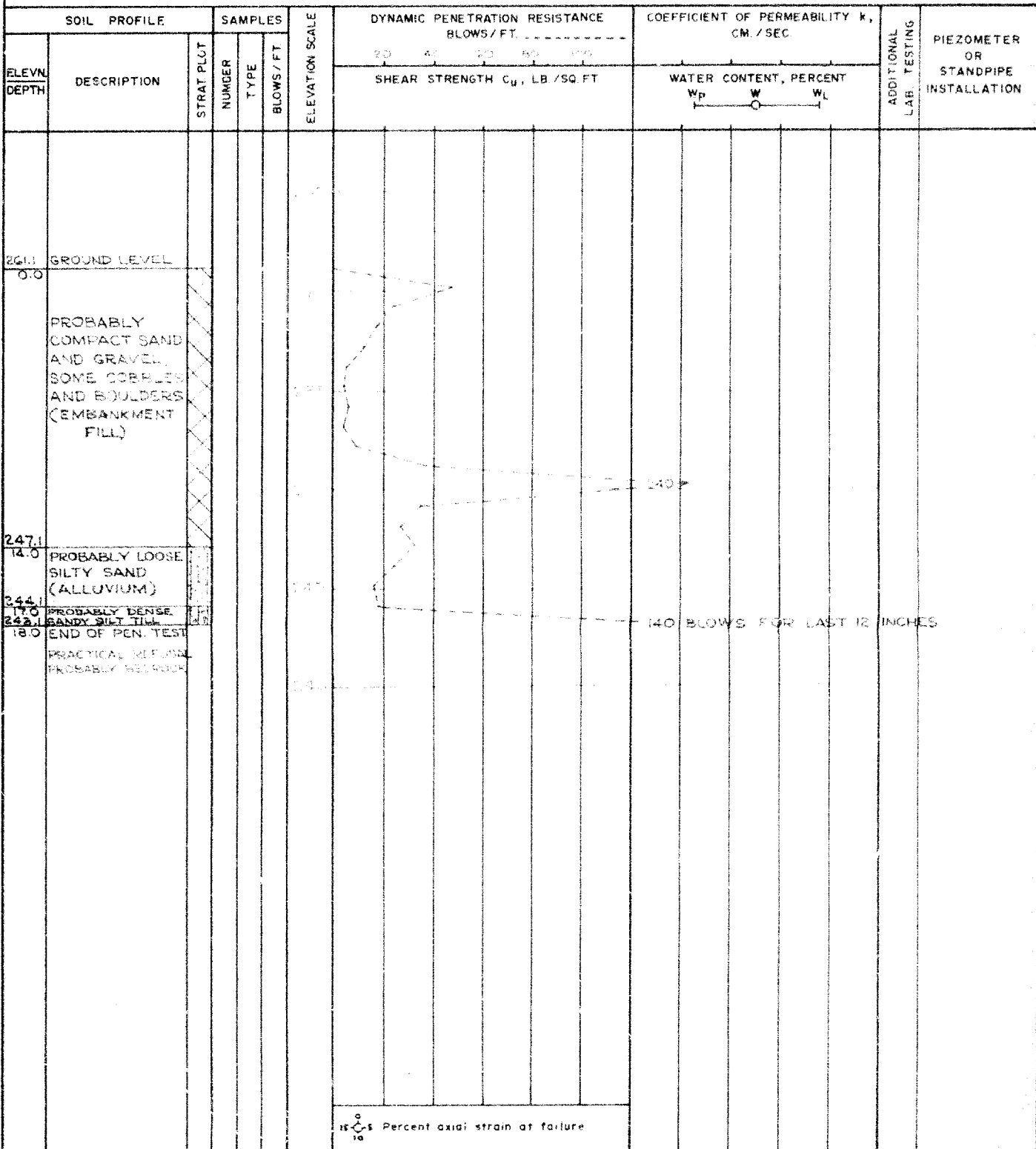
DATUM GEOD. NG

BOREHOLE TYPE PENETRATION TEST

BOREHOLE DIAMETER ---

SAMPLER HAMMER WEIGHT --- LB. DROP --- INCHES

PEN. TEST HAMMER WEIGHT 140 LB. DROP 30 INCHES



VERTICAL SCALE
1 INCH TO 5'

GOLDER & ASSOCIATES

DRAWN D.M.
CHECKED E.S.

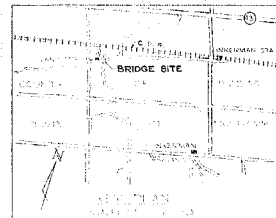


FIGURE 1
SITE PLAN

- LEGEND
- LOOSE SAND, GRAVEL, COBBLES, AND BOULDERS (EMBANKMENT FILL)
 - LIGHT GRAY SILTY SAND (ALLUVIUM)
 - LIGHT GRAY SILTY SAND (SANDY SILT TILL)
 - SOUND GREEN AND DARK GREEN Limestone BEDROCK
 - R PRACTICAL REFUSAL, PROBABLY BEDROCK

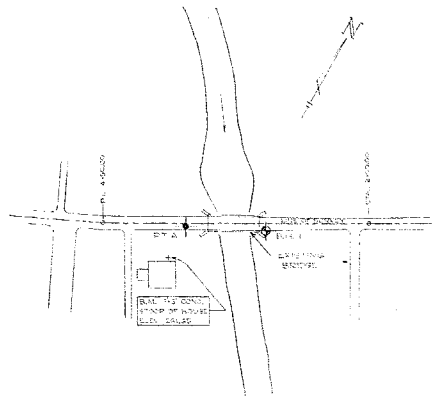
REFERENCE: DRAWING SUPPLIED BY
GRAHAM, BERMAN AND ASSOCIATES LTD.
J25 No 1842, DATED JULY 17, 1968.

SPECIAL NOTE: DATA CONTAINED ON THIS DRAWING
STRATA HAVE BEEN OBTAINED AT BOREHOLE LOCATIONS ONLY. THE SOIL STRATIGRAPHY BEHIND
BORING LOGS HAS BEEN DETERMINED FROM LOGICAL
EVIDENCE AND DO NOT VARY FROM THAT SHOWN.

Drawn: JULY 17, 1968.

GOLDER & ASSOCIATES

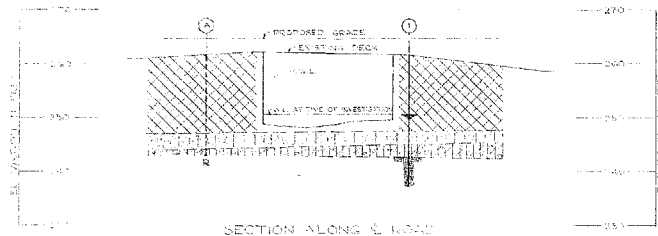
Scale
Date
Appr.



PLAN

SCALE: 1" TO 50'

NOTES IN NEGATIVE DUE TO
REPRODUCTION OF ORIGINAL DOCUMENT



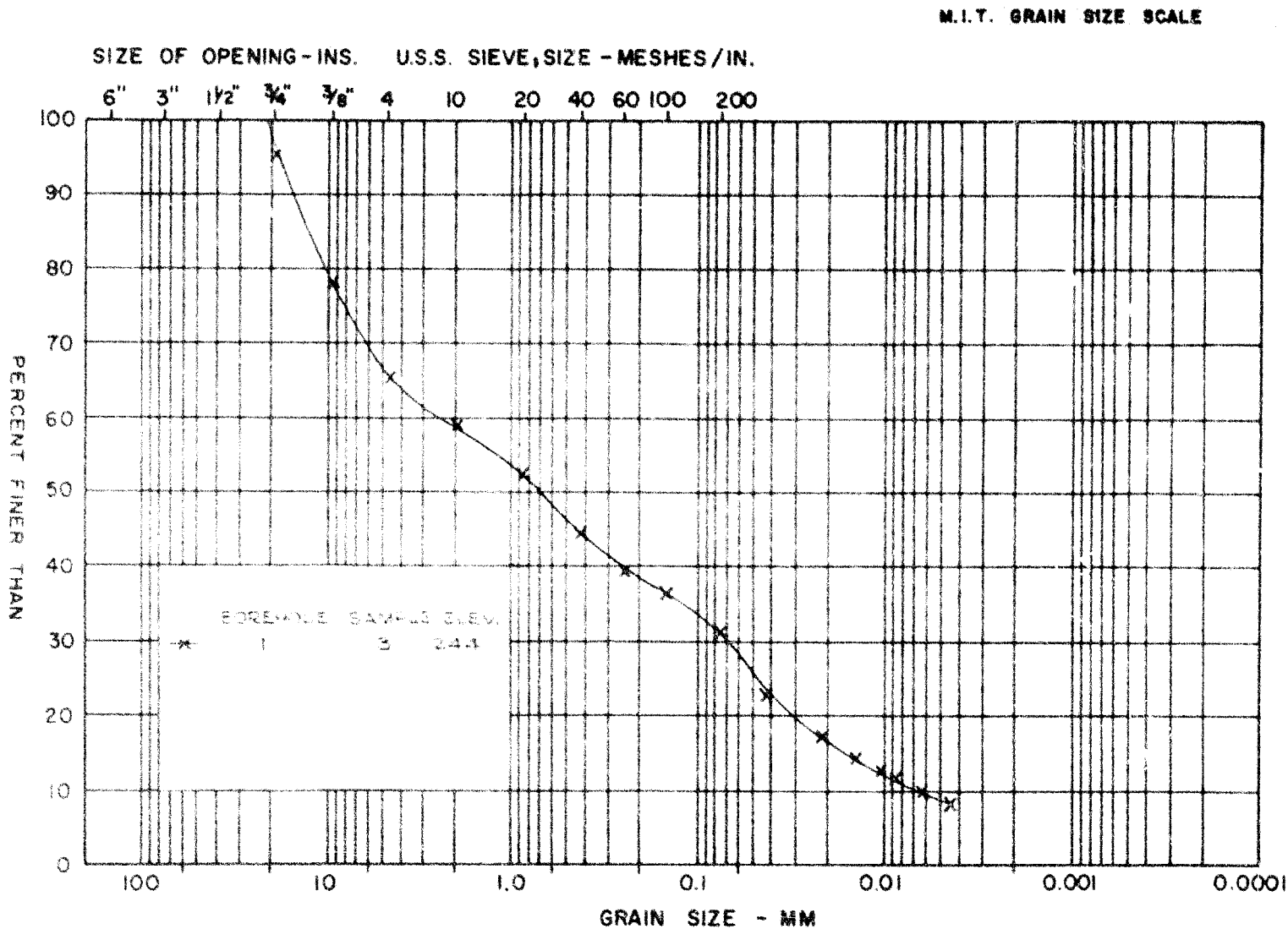
SECTION ALONG SLOPE

HOR. 1" TO 20'
VER. 1" TO 10'

LEGEND

- BOREHOLE IN PLAN
- PENETRATION TEST IN PLAN
- BOREHOLE IN ELEVATION
- PENETRATION TEST IN ELEVATION
- WATER LEVEL IN ELEVATION

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SANDY SILT TILL

GRAIN SIZE DISTRIBUTION

FIGURE 2

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