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MIDDLESEX CTY.

BRIDGE # 337

LOT 3 , CONC. D

DELAWARE TWP.

011 2312

A. M. SPRIET & ASSOCIATES
Consulting Engineers
264 Wellington Rd.
London Ontario

REPORT
ON
SOIL CONDITIONS AND FOUNDATIONS
FOR
MIDDLESEX COUNTY BRIDGE #337
LOT 3 CONCESSION D
TWP. OF DELAWARE

Submitted by

DOMINION SOIL INVESTIGATION LIMITED
77 Crockford Blvd., Scarborough, Ont.

OUR REF: 6-1-L2

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INTRODUCTION

At the request of Messrs. A. M. Spriet & Associates, Consulting Engineers, an investigation of the soil conditions was carried out at the site for the proposed new Middlesex County Bridge No. 337 in Lot 3, Concession D, Delaware Township.

The existing struction is to be replaced with a bridge of similar span and on the same alignment.

The purpose of the investigation was to determine the soil conditions at the site and to provide information relevant to the design and construction of the foundations for the bridge.

PROCEDURE

During the period 17th to 19th January, 1966, two boreholes were drilled on the site at the locations shown on the plan of Enclosure No. 2, to depths of 21 and 27 feet below the ground surface. The holes were lined with 8x size casing and advanced by washboring techniques.

The condition of the soil deposits was determined in-situ by means of the Standard Penetration Resistance test using a 2-inch O. D. split-spoon sampler driven with a 140 pound hammer falling 30 inches. The split-spoon sampler was driven through an initial seating penetration of 6 inches and the number of blows required to cause an additional penetration of 12 inches was recorded as the "N" value or Standard Penetration Resistance.

Adjacent to each borehole, dynamic cone penetration tests were carried out by driving, to practical refusal, a

2-inch O. D. 60-degree apex cone with the same amount of energy used in the Standard Penetration Resistance Test.

All samples which were recovered in the split-barrel sampler were examined and classified in the field, then shipped in sealed containers to the laboratory for further examination and any necessary testing.

The depth to the free water surface in each borehole was measured in order to determine the position of the ground water table.

The elevation of the ground surface at each borehole was determined and related to a bench mark on a spike in the root of a tree located at about 33 feet west of Station 1 + 20, north of the existing bridge. The elevation of the bench mark was assumed to be El. 100.0 ft.

In the laboratory, tests were carried out on representative samples to confirm the field classification. These tests consisted mainly of grain size analyses and Atterberg Limits Tests.

SOIL CONDITIONS

The details of the soil conditions encountered in the boreholes are shown on the Geotechnical Data Sheets of Enclosure No. 3. The laboratory test results are shown on this sheet and also on the grain size curves of Enclosures No. 4 to No. 6.

The soil profile as illustrated in section on Enclosure No. 2, is made up of three main deposits within

the depth explored:

- (i) A brown silty fine sand stratum about 10 feet thick.
- (ii) A brown to grey gravelly sand deposit with a trace of silt 4 to 7 feet thick.
- (iii) A grey silty clay till.

The deposits can be considered in more detail as follows:

(1) Silty Fine Sand:

The stratum of brown silty fine sand is encountered down to depths of 10 to 12 feet below the ground surface. The presence of organic matter or topsoil at around 6 feet depth suggests that the upper 5 or 6 feet of this deposit has been placed as fill while the remaining thickness covered the original ground surface to around El. 90±.

From the "N" values of 6 to 19 blows per foot in this stratum, it is inferred that the relative density of the soil is variable over a considerable range varying between loose and compact.

(ii) Gravelly Sand with a trace of Silt:

At around El. 90±, the stratum of gravelly sand with a trace of silt is encountered. The grain size distribution curves for this deposit are shown on Enclosures No. 4 to No. 6. From these curves, it can be seen that the soil consists of about 30% to 50% gravel, 40% to 50% sand and about 10% silt. The gravel component is mainly fine-grained, but the maximum particle size is about 1.5 inches.

The "N" values within this stratum range between 23 and 60 blows per foot, with a minimum average value of 35 blows per foot. From these values, it is inferred that the deposit is generally of dense relative density. The stream bed is founded at El. 91.5 in this stratum.

(iii) Grey Silty Clay Till:

At around El. 85±, a grey silty clay containing traces of gravel is encountered. From the Standard Penetration Resistance ranging between 20 and 27 blows per foot and averaging 24 blows per foot, it is inferred that the deposit is of very stiff consistency. The natural moisture content of the soil varies between 13.1% and 27.2%, the Liquid Limit ranges between 26.4% and 32.6% and the Plastic Limit between 14.7% and 16.6%. Thus, the Liquidity Index varies between 0.064 to 0.81. These are associated with soils which have been preconsolidated and which, as a result, would have a relatively high strength and would be of low compressibility. The very stiff consistency of the soil is therefore further established. This stratum extends down at least to El. 75±, the maximum depth explored.

GROUND WATER CONDITIONS

The water surface in the boreholes was located at around El. 92.5± at approximately the same elevation as the surface of the water in the stream at the time of the exploration.

DISCUSSION

It is understood that the existing bridge is to be

replaced with a new structure of span of about 40 feet. The estimated loading on the abutments will thus be about 8 tons per linear foot.

The investigation has shown that the soil profile consists of about 10 feet of loose to compact silty fine sand underlain by a stratum of gravelly sand about 4 to 7 feet thick. Below this is a very stiff grey silty clay till. The stream bed is located at around El. 91.5 in the deposit of gravelly sand.

Because of the reasonably good soil conditions, normal spread footings can be used for the bridge foundations. However, the depth at which the foundations should be located will depend on the estimated depth to which scour will occur in the stream bed. The depth of scour is best determined from considerations of the hydraulics of the stream and this does not fall within the scope of this report. However, the soil contains only a small amount of coarse gravel of maximum size of about 1.5 inches and it is uncemented. The deposit is therefore considered to be moderately susceptible to scour.

The foundations should also be provided with a minimum of 4 feet of soil cover for protection against frost action. Thus, the foundations will be placed at or below El. 87.0. At El. 87.0, the soil under the foundations will consist of the dense gravelly sand stratum and from the "N" values of minimum average value of 35 blows per foot, the allowable bearing capacity is estimated to be 7,000 pounds per square foot.

sand stratum. It will, therefore, be desirable to use close sheeting to retain the sides of the pits and to reduce the quantity of flow into the excavations. Any seepage into the pits can then be removed by usual pumping methods. In order to prevent piping and heaving in the bottom of the pits, the sheeting should be carried into the silty clay stratum to provide an efficient cutoff. Since the gravelly sand deposit is generally dense, the use of steel sheeting is indicated.

CONCLUSIONS

1. The site is underlain by granular deposits of loose to compact silty fine sand and dense gravelly sand till to around El. 85±. Below El. 85, the soil consists of a very stiff grey silty clay till to El. 75±.
2. At El. 87±, the allowable soil pressure under normal spread footings will be 7,000 pounds per square foot. At El. 85, in the silty clay deposit, the allowable pressure will be 4,800 pounds per square foot. The location of the footings should be selected after the depth of scour in the stream bed is determined.
3. The total and differential settlements will be within tolerable limits for the proposed structure.
4. Close-sheeting should be used in the excavations and normal pumping methods can be adopted for removal of ground water. Steel sheeting may be necessary.

DOMINION SOIL INVESTIGATION LIMITED,

F. Debidin

F. Debidin, P. Eng.,
Soils Engineer.

Enclosures

LIST OF SYMBOLS, ABBREVIATIONS AND NOMENCLATURE.

SOIL COMPONENTS AND GROUND WATER CONDITIONS.

BOULDER	COBBLE	GRAVEL		SAND			SILT	CLAY	ORGANICS	BEDROCK	GROUND WATER LEVEL	DEPTH OF CAVE-IN
Ø	> 6"	3"	3/4"	4.76mm	2.0	0.42	0.074	0.002	>	NO SIZE LIMIT		
U.S. Standard Sieve Size:		No. 4		No. 10		No. 40		No. 200				

SAMPLE TYPES.

AS Auger sample
CS Sample from casing
ChS Chunk sample

RC Rock core
% Recovery
SS Split spoon sample

TP Piston, thin walled tube sample
TW Open, thin walled tube sample
WS Wash sample

SAMPLER ADVANCED BY static weight : w
" pressure : p
" tapping : t

OBSERVATIONS MADE WHILE CORING
Steady pressure
No pressure
Intermittent pressure

Washwater returns
Washwater lost

PENETRATION RESISTANCES.

DYNAMIC PENETRATION RESISTANCE : to drive a 2" dia, 60° cone attached to the end of the drilling rods into the ground, expressed in blows per foot

STANDARD PENETRATION RESISTANCE, -N- : to drive a 2" outside dia, split spoon sampler 1 foot into the ground, expressed in blows per foot.

EXTRAPOLATED -N- VALUE

The energy for the penetration resistances is supplied by a 140 lb hammer falling 30 inches

SYMBOL :

322

SOIL PROPERTIES.

W % Water content
LL % Liquid limit
PL % Plastic limit
PI % Plasticity index
LI Liquidity index

γ Natural bulk density (unit weight)
e Void ratio
RD Relative density
C_v Coeff of consolidation
m_v Coeff of volume compressibility

k Coeff. of permeability
C Shear strength — in terms of total stress
φ Angle of int friction —
c' Cohesion — in terms of effective stress
φ' Angle of int friction —

UNDRAINED SHEAR STRENGTH.

— DERIVED FROM —

TRIAXIAL COMPRESSION TEST
UNCONFINED TEST

LABORATORY VANE TEST
FIELD

POCKET PENETROMETER TEST

Strain at failure is represented by direction of stem

20%
15% + 5%
10%

S_t : sensitivity = $\frac{\text{shear strength in undisturbed state}}{\text{shear strength in remoulded state}}$

SOIL DESCRIPTION.

COHESIONLESS SOILS :

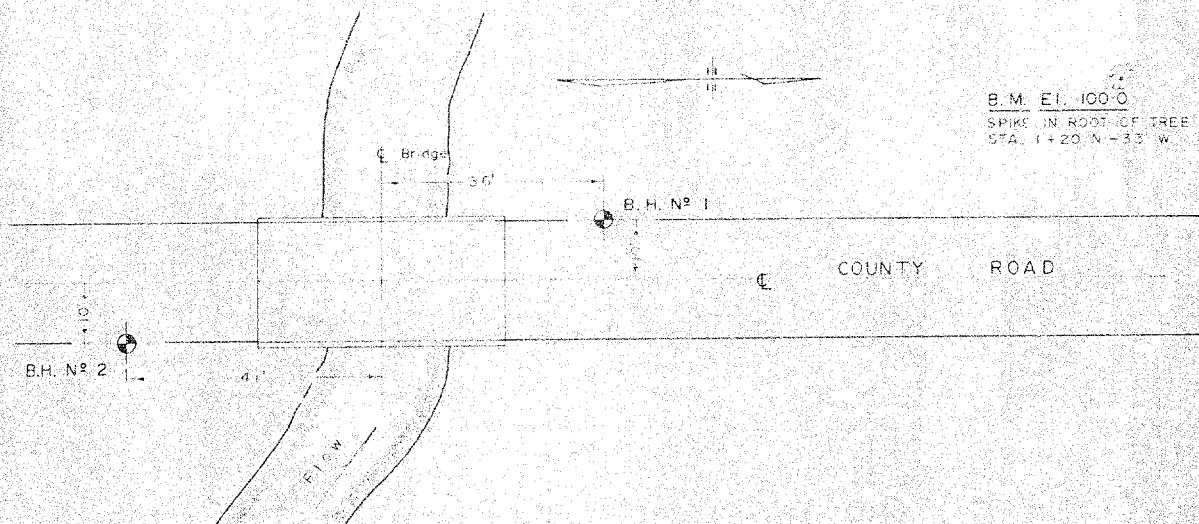
RD :

COHESIVE SOILS :

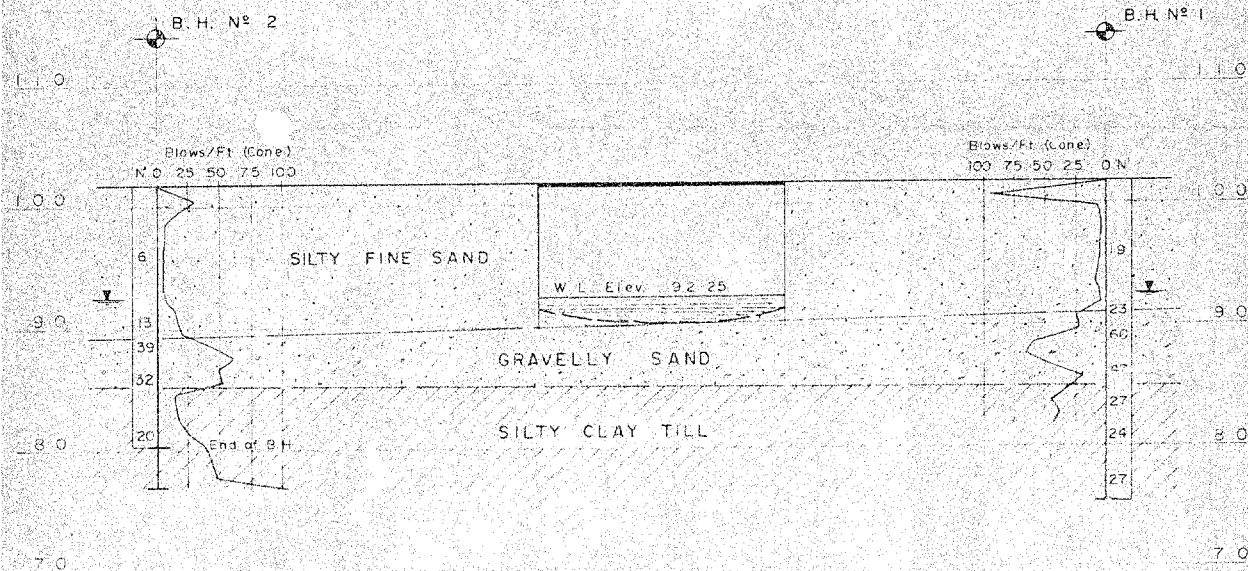
c lbs/sq ft

Very loose 0 - 15 %
Loose 15 - 35 %
Compact 35 - 65 %
Dense 65 - 85 %
Very dense 85 - 100 %

Very soft less than 250
Soft 250 - 500
Firm 500 - 1000
Stiff 1000 - 2000
Very stiff 2000 - 4000
Hard over 4000



B.M. El. 100.0
SPIKE IN ROOT OF TREE
STA. 1+20 N-33 W



DEFECTS IN NEGATIVE DUE TO
CONDITION OF ORIGINAL DOCUMENT

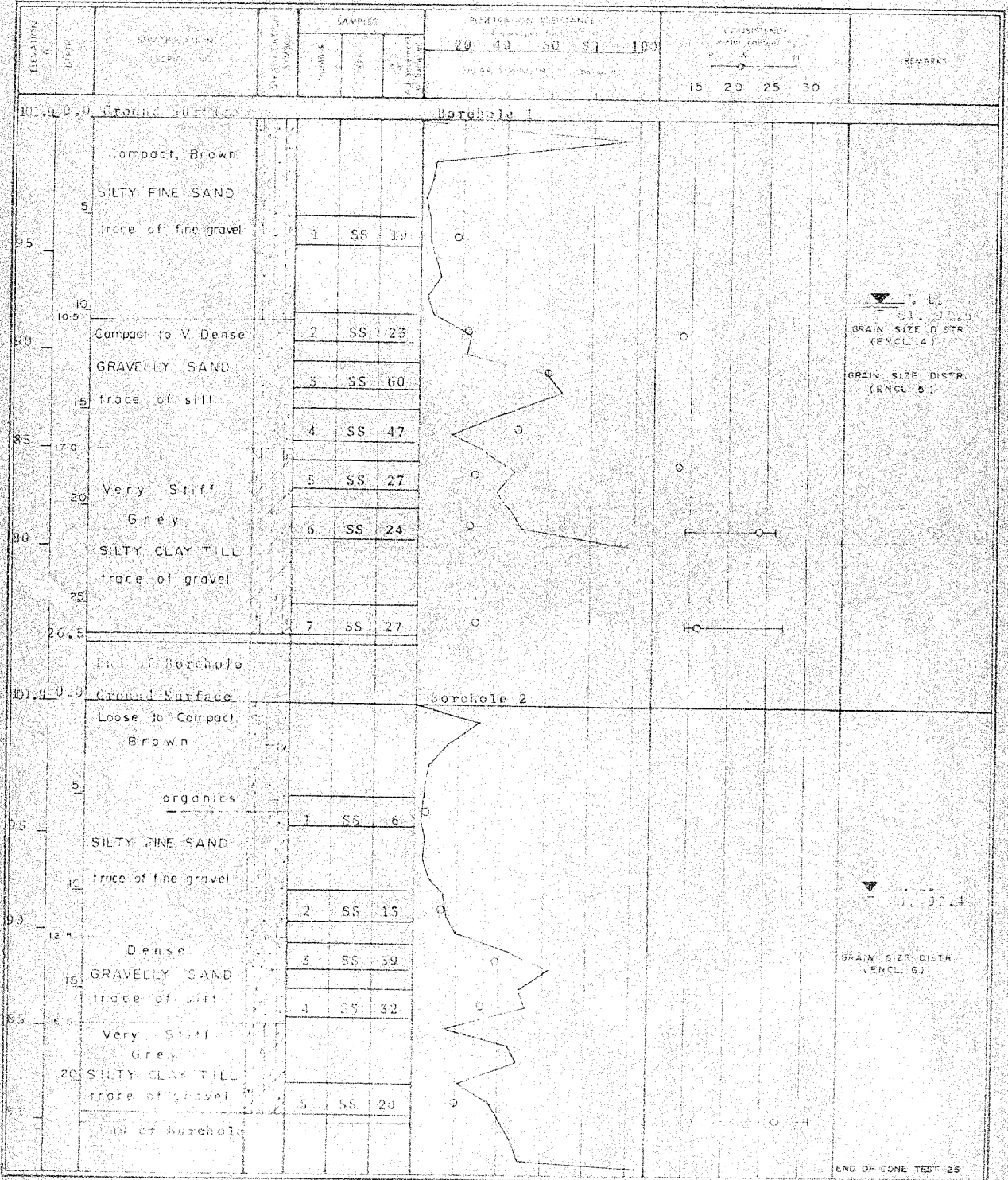
GEOTECHNICAL DATA SHEET FOR BOREHOLES 1 & 2.

OUR REFERENCE NO. 6-1-67

CLIENT: A. M. Sprist & Assoc.
PROJECT: Middlesex County Bridge #337
LOCATION: Lat. 3, Conc. B, Top. of Delaware
DATUM ELEVATION: 100 feet

WETLAND BY BUREAU: Washington
SAMPLE NO. BOREHOLE 1: 1-1000
DATE: January 17 - 19, 1966

ENCLOSURE NO. 3



VERTICAL SCALE: 1" = 5'

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WASH

END

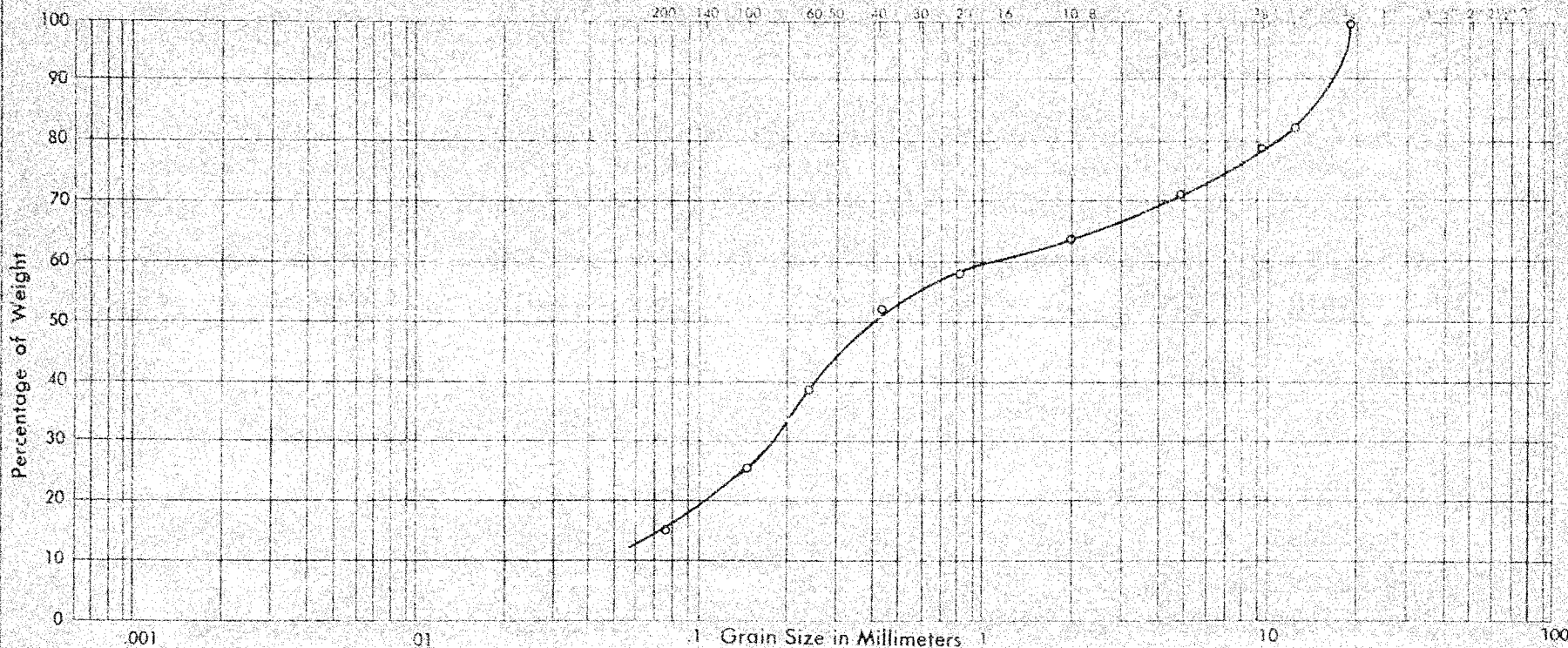
DOMINION SOIL INVESTIGATION LIMITED

GRAIN SIZE DISTRIBUTION

OUR REFERENCE NO. 6-1-L2

UNIFIED SOIL CLASSIFICATION
SYSTEM

SILT AND CLAY	SAND			GRAVEL	
	FINE	MEDIUM	COARSE	FINE	COARSE



PROJECT MIDDLESEX CO. RD. BRIDGE NO 337

LOCATION TWP. OF DELAWARE

BORHOLE NO. 1

SAMPLE NO. 2

DEPTH OF SAMPLE 11'

ELEVATION OF SAMPLE 90.9 ft.

COEFFICIENT OF UNIFORMITY

COEFFICIENT OF CURVATURE

PLASTIC PROPERTIES

LIQUID LIMIT % =

PLASTIC LIMIT % =

PLASTICITY INDEX % =

MOISTURE CONTENT % =

ACTIVITY =

Classification of Sample and Group Symbol:

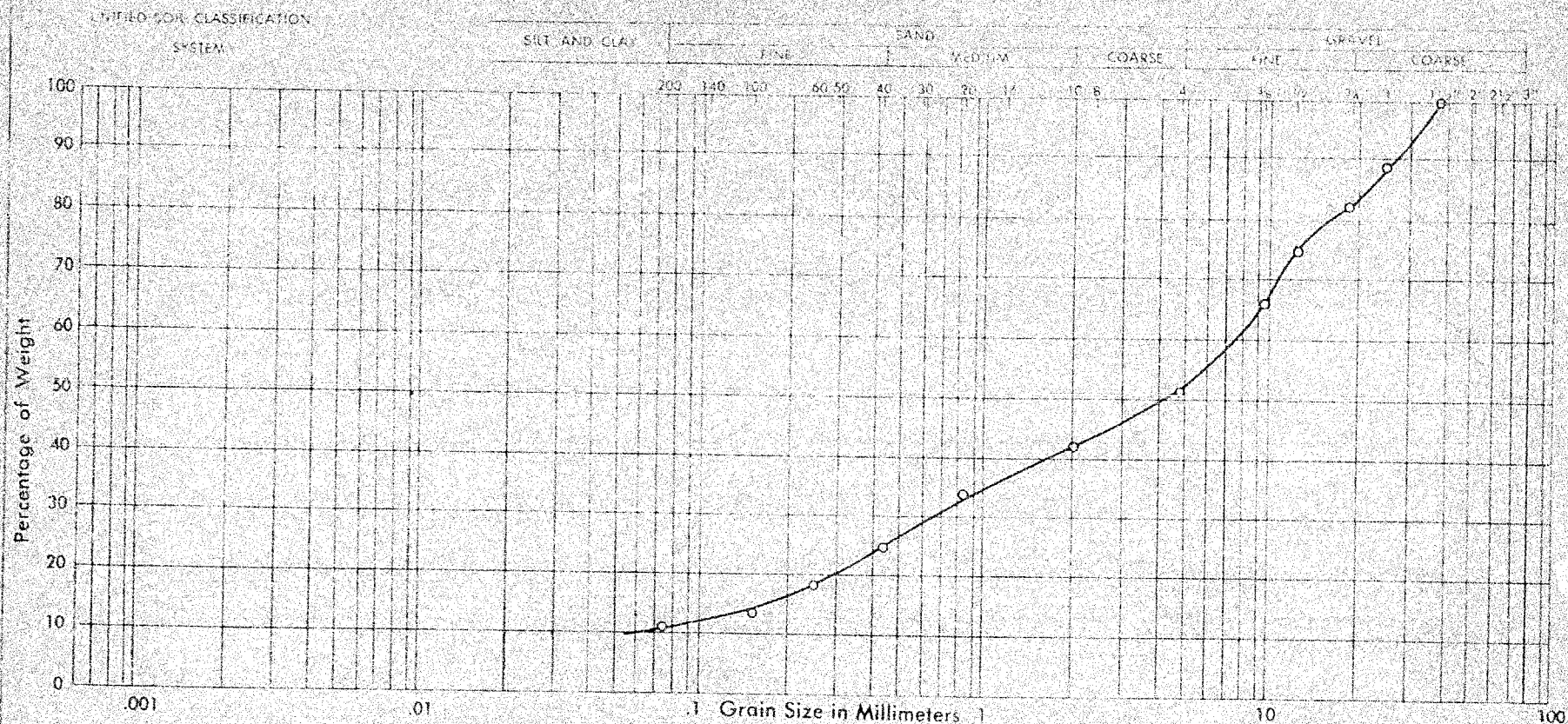
GRAVELLY SAND with a trace of silt

DEFECTS IN NEGATIVE DUE TO
CONDITION OF ORIGINAL DOCUMENT

DOMINION SOIL INVESTIGATION LIMITED

GRAIN SIZE DISTRIBUTION

OUR REFERENCE NO. 6-1-L 2



PROJECT MIDDLESEX CO. RD. BRIDGE No 337
 LOCATION T.W.P. OF DELAWARE
 BOREHOLE NO. 1
 SAMPLE NO. 3
 DEPTH OF SAMPLE 13'
 ELEVATION OF SAMPLE 88.9 ft.

COEFFICIENT OF UNIFORMITY

COEFFICIENT OF CURVATURE

Classification of Sample and Group Symbol:

SAND & GRAVEL with a trace of silt

PLASTIC PROPERTIES:

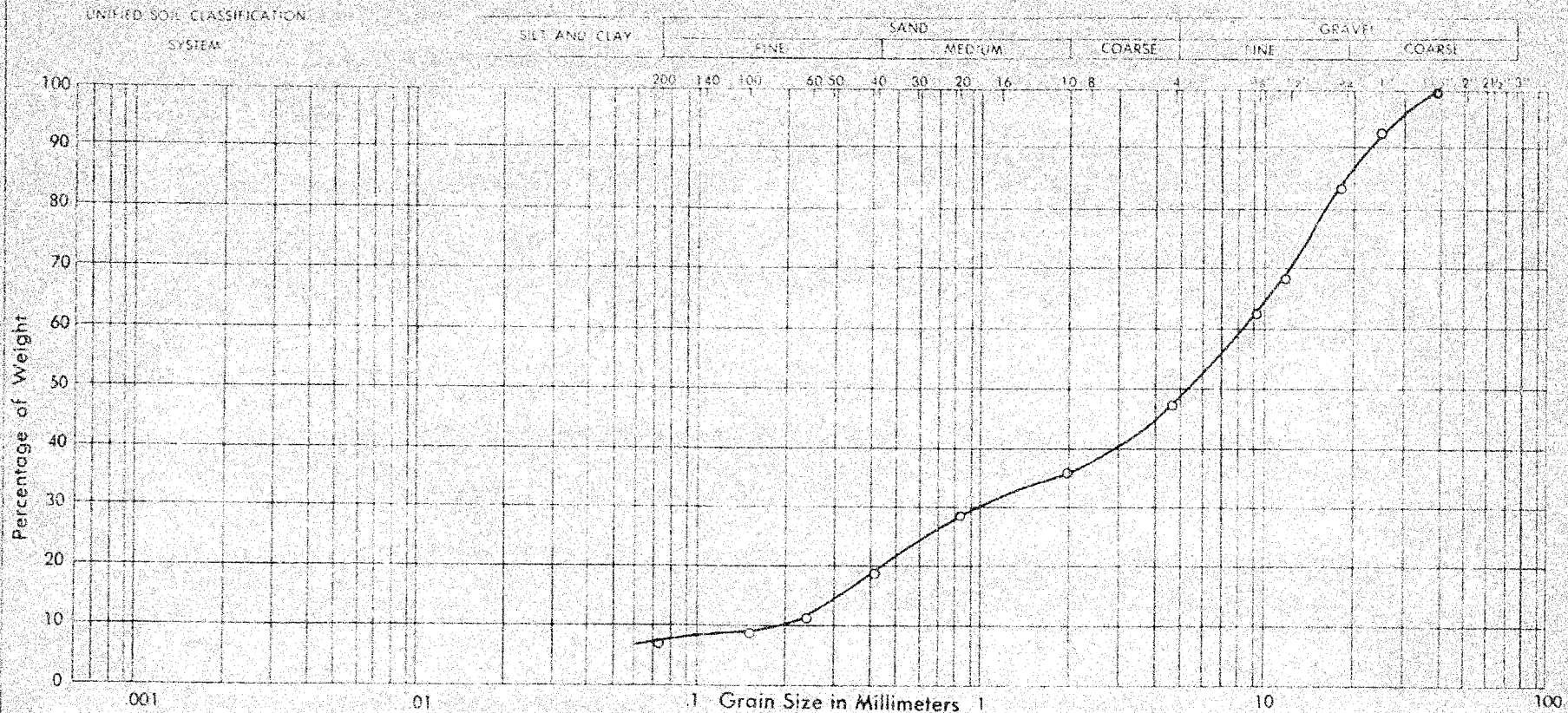
LIQUID LIMIT	%	11
PLASTIC LIMIT	%	11
PLASTICITY INDEX	%	0
MOISTURE CONTENT	%	11
ACTIVITY		

Enclosure No. 5

DOMINION SOIL INVESTIGATION LIMITED

GRAIN SIZE DISTRIBUTION

OUR REFERENCE NO. 6-1-L2



PROJECT MIDDLESEX CO. RD. BRIDGE NO 337
 LOCATION TWP. OF DELAWARE
 BOREHOLE NO. 2
 SAMPLE NO. 3
 DEPTH OF SAMPLE: 13'
 ELEVATION OF SAMPLE: 88.9 ft.

COEFFICIENT OF UNIFORMITY
 COEFFICIENT OF CURVATURE

Classification of Sample and Group Symbol:

SAND & GRAVEL with a trace of silt

PLASTIC PROPERTIES:

LIQUID LIMIT % —
 PLASTIC LIMIT % —
 PLASTICITY INDEX % —
 MOISTURE CONTENT % —
 ACTIVITY —

Enclosure No. 6