#63-F-12

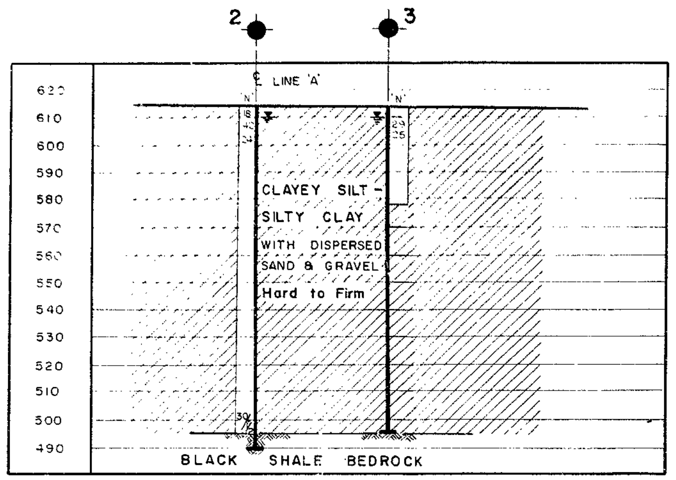
W.P. #53-63

Hwy #40A

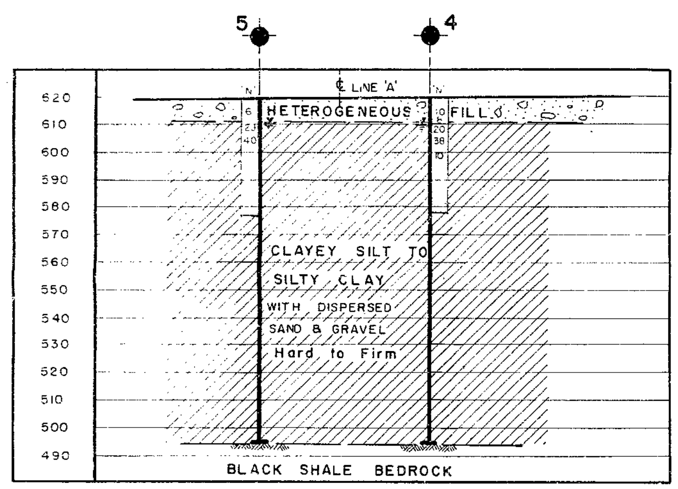
C.N.R

390250 E
4756500 N

40J16W



A - A



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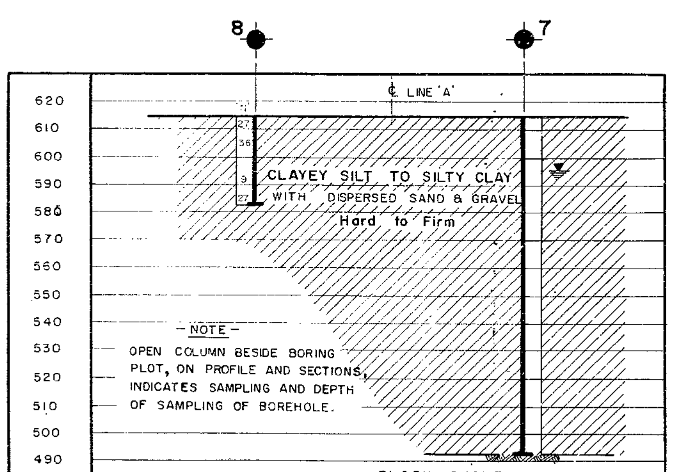
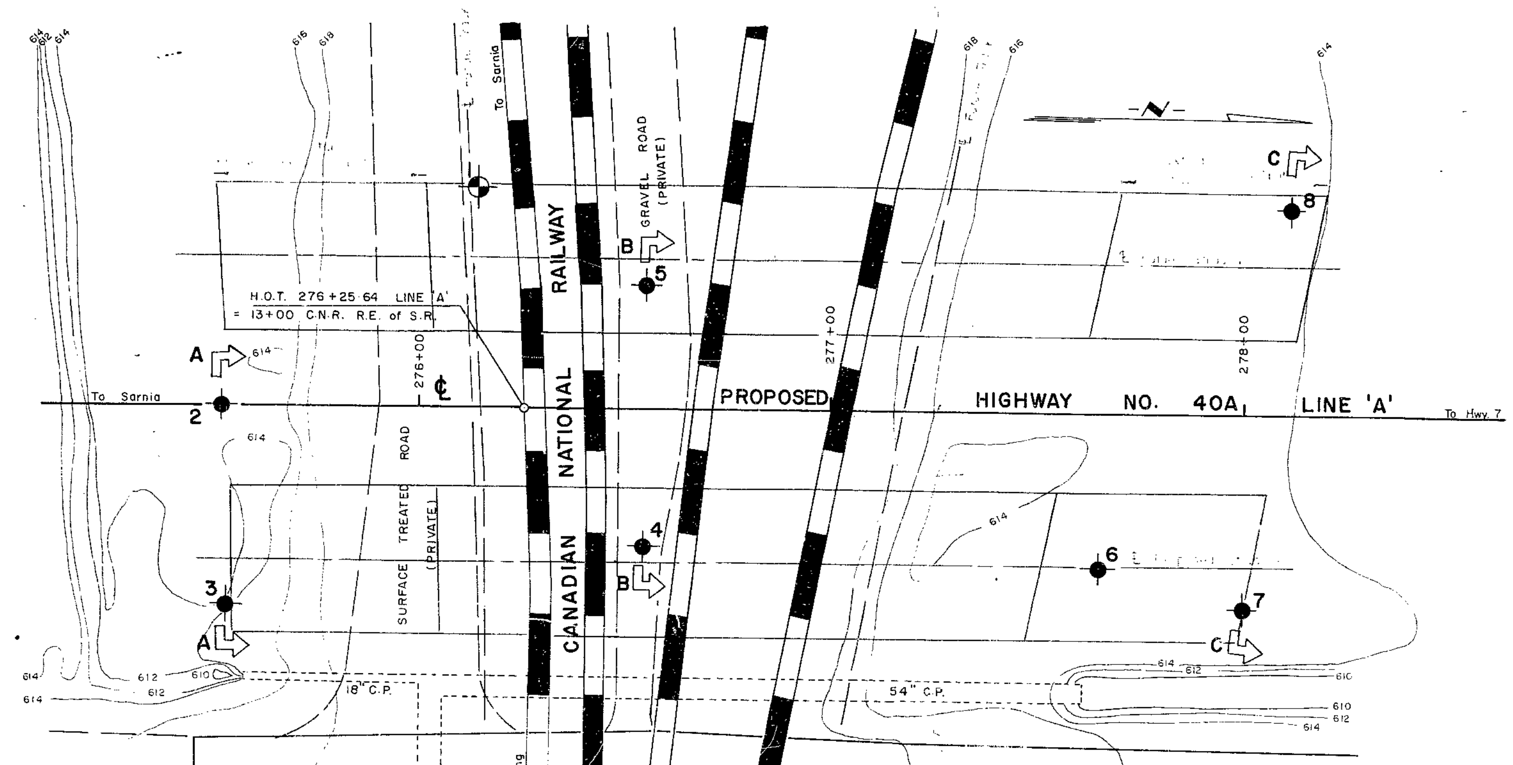


C - C

SECTIONS

SCALE IN FEET

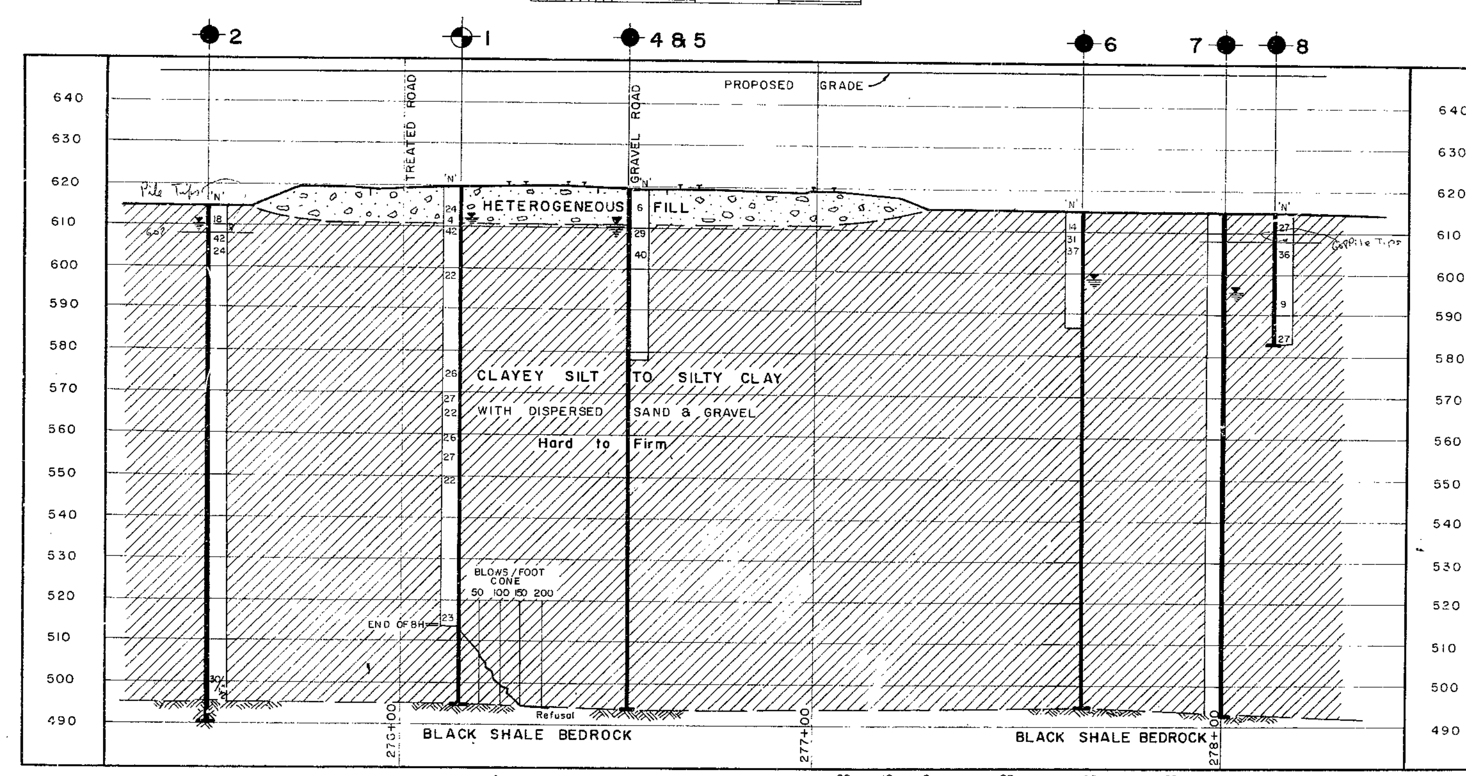


PLAN

SCALE IN FEET

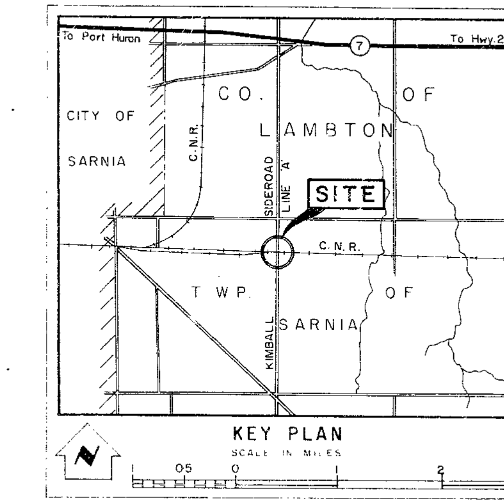
- NOTE -

The complete soil investigation report for this structure may be examined at the Bridge Office and Foundation Office, Downsview, and at the CHATHAM District Office. The Department does not guarantee the accuracy of this report or the abridged version shown on these plans.



℄ PROFILE

SCALE IN FEET



KEY PLAN

SCALE IN MILES

LEGEND

Bore Hole

Cone Penetration Hole

Bore & Cone Penetration Hole

Water Levels established at time of field investigation . . Feb. 1963

NO.	ELEVATION	STATION	OFFSET
1	619 5	276+14	53'LT
2	614·0	275+52	℄
3	614·0	275+52	48'RT.
4	620·0	276+55	33'RT.
5	619·5	276+55	29'LT.
6	615 0	277+65	38'RT.
7	615·0	278+00	49'PT.
8	615·0	278+12	50'LT.

- NOTE -

The boundaries between soil strata have been established only at Bore Hole locations. Between Bore Holes the boundaries are assumed from geological evidence and may be subject to considerable error.

PRINT RECORD

NO	FOR	DATE

REVISIONS

DATE	BY	DESCRIPTION

DEPARTMENT OF HIGHWAYS - ONTARIO

MATERIALS & RESEARCH DIVISION - FOUNDATION SECTION

CANADIAN NATIONAL RAILWAY

KING'S HIGHWAY NO. 40A LINE 'A' REVISION DIST. NO. 1

CO. LAMBTON

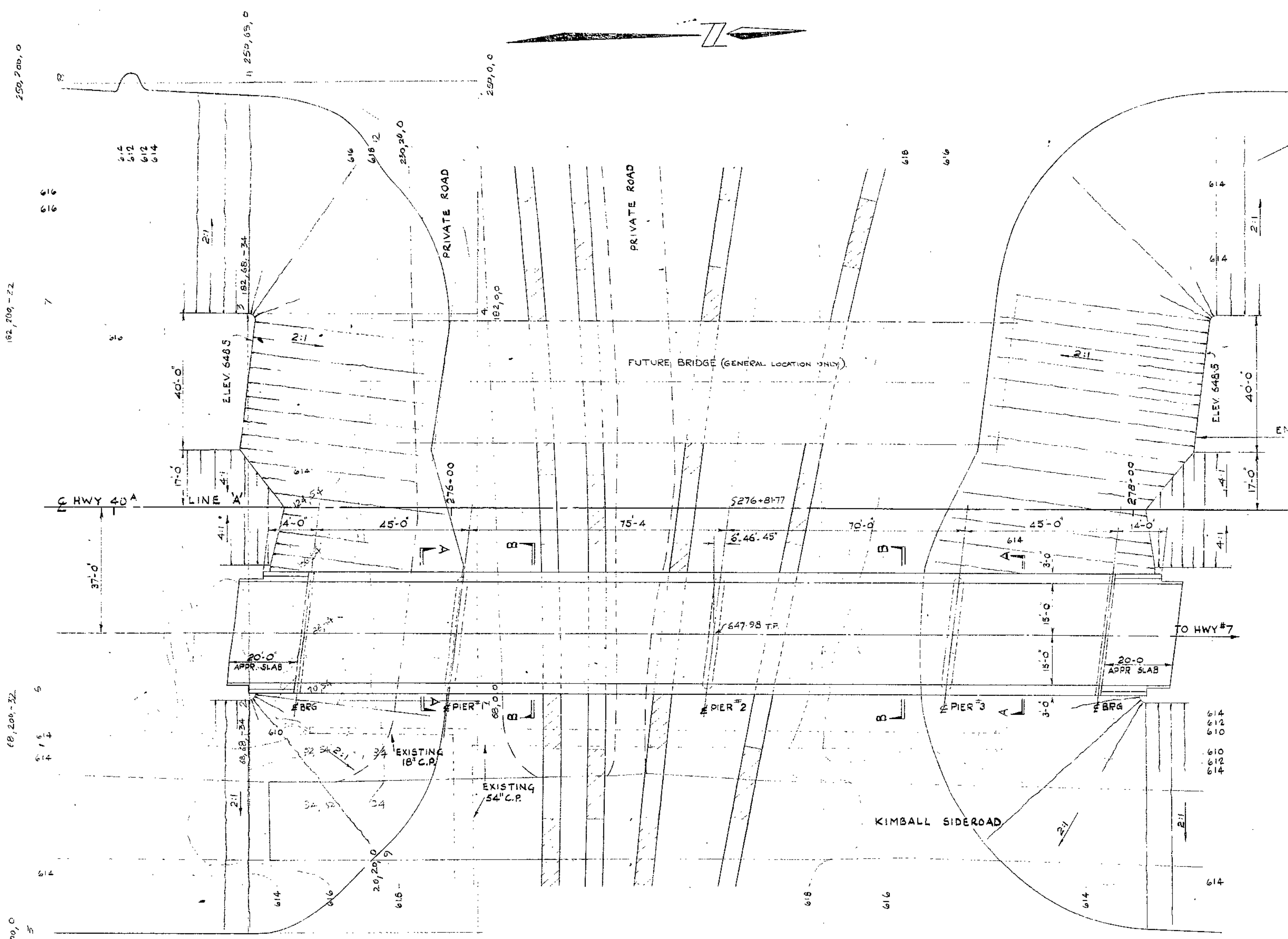
TWP. SARNIA LOT 15 & 16 CON. IV

BORE HOLE LOCATIONS & SOIL STRATA

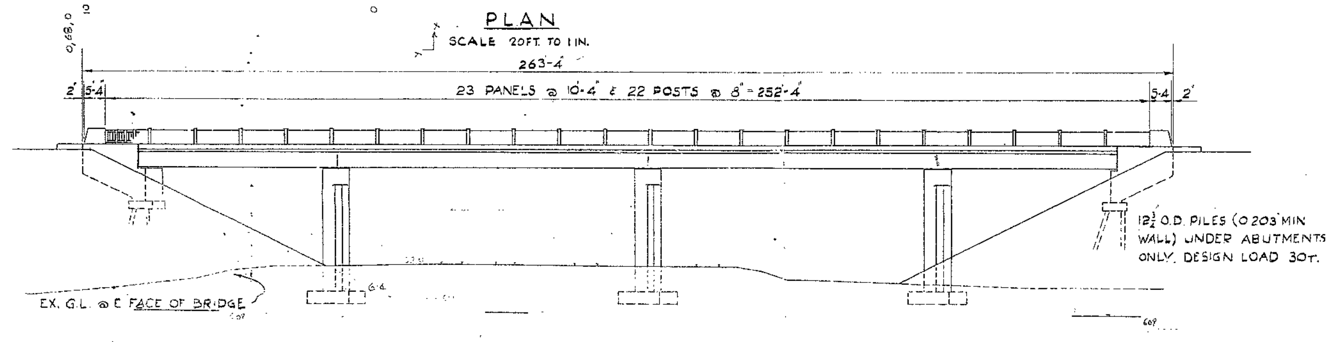
SUBM'D T.W.	CHECKED	W.P. NO 53 - 63	M&R DRAWING NO. 63-F-12A
DRAWN F.C.	CHECKED	JOB NO. 63-F-12	
DATE FEB. 18, 1963		SITE NO.	BRIDGE DRAWING NO.
APPROVED PRINCIPAL FOUNDATION ENGINEER		CONT. NO	

SOME DEFECTS IN NEGATIVE DUE TO CONDITION OF ORIGINAL DOCUMENTS

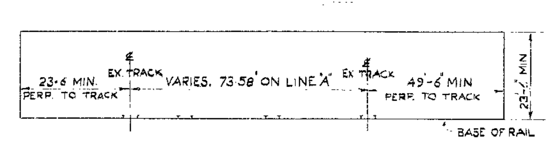
PRINT RECORD		
No.	FOR	DATE



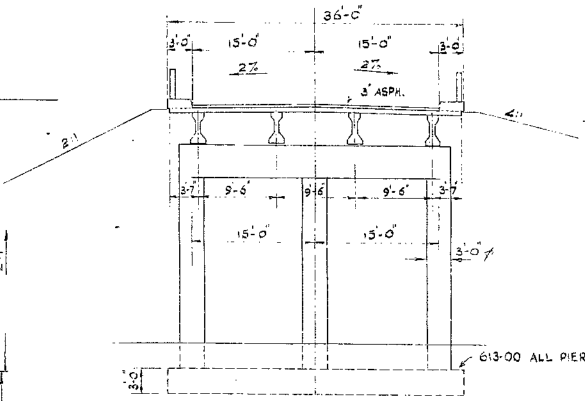
PLAN
SCALE 20FT. TO 1 IN.



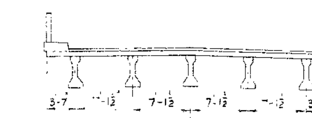
ELEVATION
SCALE 20FT. TO 1 IN.



CLEARANCE DIAGRAM
N.T.S.

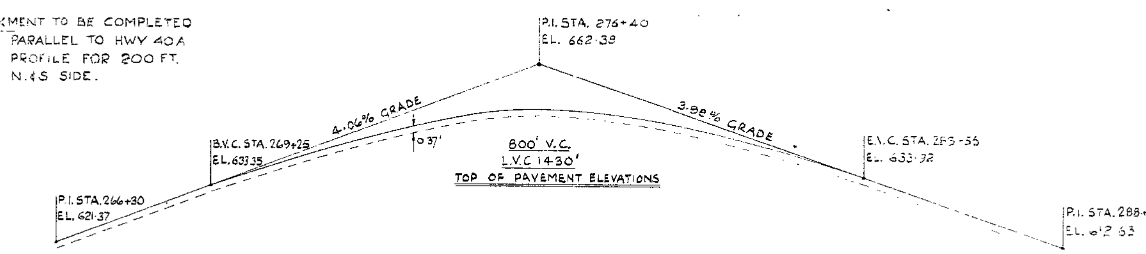


A-A



B-B

CROSS SECTIONS
SCALE 10FT TO 1 IN.



PROFILE OF HWY #40A
LINE 'A'
N.T.S.

GEODETIC DATUM

B.M. Elev. 614.79 N.&W. in W. root of 1'-0" maple 180'-0" rt. of Sta. 275+77

REFERENCE PLANS

C-2889
E-4168-1
C-179-11
B-179-15
BA-1617

DRAWING LIST

NOTES

TO CONTRACTOR

Structure to be built in accordance with Form Nº 9 and the special provisions, extra copies of which may be obtained from the engineer.

CONCRETE MIX

	MIN. STRENGTH AT 28 DAYS	MAX. SIZE AGGREGATE
Footings	3000 P.S.I.	¾"
Elsewhere	5000 P.S.I.	¾"

CLEAR COVER ON REINFORCING STEEL (Unless otherwise stated.)

Footings 3", Abutments 2", Piers 2", Deck 1½", End Posts 1½", Approach Slabs 1½".

CONSTRUCTION NOTES

All exposed edges to be chamfered 1"×1" except as noted.

All construction joints must be approved by the engineer.

Ballast walls shall not be poured until the Deck has been constructed.

REVISIONS		
DATE	BY	DESCRIPTION

DEPARTMENT OF HIGHWAYS ONTARIO
BRIDGE DIVISION

C.N.R. O'HEAD ON HWY 40A
2 MILES SOUTH OF HIGHWAY 402

KING'S HIGHWAY No. 40A — DIST. No. 1
CO. LAMBTON
TWP. SARNIA — LOT 15 & 16 — CON. IV

PRELIMINARY GENERAL PLAN

APPROVED ______ BRIDGE ENGINEER				SITE No.	W.P. No. 53-63
DESIGN		CHECK		CONTRACT Nos.	
DRAWING		CHECK			
DATE	AUG 63	LOADING	H20-S16	DRAWING No.	D-5312-P1

cc: Gen. Files 23-64-307

Mr. A. M. Toye,
Bridge Engineer,
Bridge Division.

Attention: Mr. S. McCombie

Mr. A. G. Stermac,
Principal Foundation Engr.,
Foundation Section,
Materials & Research Division
March 25, 1963

D.H.O. FOUNDATION INVESTIGATION REPORT -
Proposed Overhead where the Proposed
Extension of Hwy. 40-A, Line 'A',
Crosses C.N.R. Tracks in Sarnia Twp.
District No. 1
W.J. 63-F-12 -- W. P. 53-63.

Attached, we are forwarding to you, our detailed foundation investigation report dealing with the subsoil conditions existing at the above structure location.

We believe you will find the factual data and recommendations adequate for your future design work.

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

KYL/MdeF
Attach.

K. Y. Lo,
SUPERVISING FOUNDATION ENGR.
For:
A. G. Stermac,
PRINCIPAL FOUNDATION ENGR.

cc: Messrs. A. M. Toye (2)
H. A. Tregaskes
H. D. McMillan
A. Gater
G. U. Howell
J. Roy
A. Watt

Foundations Office
Gen. Files.

TABLE OF CONTENTS

FOUNDATION INVESTIGATION

For

Proposed Overhead where the Proposed
Extension of Hwy. 40-A, Line 'A',
Crosses C.N.R. Tracks in Sarnia Twp.
District No. 1
W.J. 63-F-12 -- W. P. 53-63.

1. INTRODUCTION:

A request dated January 18, 1963, for a foundation investigation at the site where the proposed extension of Hwy. 40-A, Line 'A' is to cross the Canadian National Railway tracks by means of an overhead, was received from the Bridge Location Section.

A field investigation was carried out by this Section during February, 1963, to determine the subsoil conditions at the site of the proposed structure. Presented in this report, are the results of this investigation, together with the recommendations pertaining to the design of the bridge foundations and approach embankments.

2. DESCRIPTION OF THE SITE AND GEOLOGY:

The site of the proposed overhead lies within the physiographic area known as the St. Clair Clay Plain. The subsoil at the site is a clay till deposited during the Wisconsin glacial stage of the Pleistocene Epoch. The bedrock underlying the glacial till is a black shale of Devonian and Missippian Age.

cont'd. /2 ...

3. FIELD AND LABORATORY INVESTIGATION:

The field work consisted of eight sampled boreholes put down to bedrock using a 5" diameter flight auger. In boreholes 1, 2 and 7, the subsoil was sampled down to bedrock, whereas in boreholes 3, 4, 5, 6 and 8, sampling was discontinued after 40 feet. Disturbed samples were obtained using a 2" O.D. split-spoon sampler, of which the energy used for driving conformed to the Standard Penetration Test. Undisturbed samples were obtained by means of 2" I.D. Shelby tubes. In situ vane shear measurements were carried out where possible, between the sampling depths. Bedrock was proved in B.H.'s 2 and 7 using AXT core barrel.

All samples were visually identified in the field and then returned to the laboratory where further tests were carried out to determine Atterberg limits and moisture content, density, particle size distribution, and unconfined shear strength. In addition, undrained triaxial tests with pore pressure measurements and standard consolidation tests, were carried out.

4. SUBSOIL CONDITIONS:

4.1) General:

The subsoil at the site consists of a stratum of clayey silt to silty clay till, some 119.0 feet thick, lying on top of the black shale bedrock. In the past, the Canadian National Railways have built a small embankment some 5.0 feet above the

cont'd. /3 ...

4. <u>SUBSOIL CONDITIONS</u>: (cont'd.) ...

4.1) <u>General</u>: (cont'd.) ...

original ground level using a heterogeneous fill material of clayey silt, sand, gravel, boulders and cinders.

4.2) <u>Heterogeneous Railway Embankment Fill</u>:

This fill extends across the site between chainages 275+65 and 277+32, and was proved to a depth of 9.0 feet below the surface in B.H.'s 4 and 5. This fill material consists of silty clay with sand, gravel, boulders and cinders. An average 'N' value for this material is 8, indicating it to have a consistency which is stiff.

4.3) <u>Clayey Silt to Silty Clay Till</u>:

A stratum of clayey silt to silty clay till extends from beneath the railway embankment in B.H.'s 4 and 5, and from the ground surface in the remaining boreholes, to the black shale bedrock. The top 12 feet of this material is brown in colour, being desiccated by weathering.

Grain size distribution tests have been run on samples of this material, indicating it to contain on an average, 45% clay sizes, 40% silt sizes, 12% sand sizes, and 3% gravel sizes.

Atterberg limit determinations were carried out on samples of this material and these values, together with the natural moisture contents, are plotted on the Record of the Borelogs. When the Plasticity Index is plotted against the liquid limit on the Casagrande Plasticity Chart, they indicate the material to be

cont'd. /4 ...

4. SUBSOIL CONDITIONS: (cont'd.) ...

4.3) Clayey Silt to Silty Clay Till: (cont'd.) ...

clayey silt above elevation 574 in B.H.s 1 and 2, and 566 in B.H. 7. Beneath these elevations, the material is silty clay.

The average properties are summarized below:

	Clayey Silt	Average	Silty Clay	Average
Liquid Limit % --	25 to 35	31	37 to 43	38
Plastic Limit % --	13 to 19	16	19 to 26	21
Moisture Content %--	8 to 23	19	21 to 26	23
Density P.C.F. --	125 to 139	131	123 to 133	127

The undrained shear strength of the material was measured by in situ vane testing in the field and by unconfined compression tests in the laboratory. The results of these tests are recorded on the Records of the Borelogs. A plot of the unconfined shear strength with depth is shown on Fig. 3. The shear strength varies from in excess of 5000 P.S.F. in the crust, to a minimum of 540 P.S.F. at an elevation of 594.00 feet. For design purposes, a shear strength of 2000 P.S.F. in the crust, and 1000 P.S.F. beneath the crust, has been assumed as representative.

The sensitivity of the material, as measured by the field vane, is 2.

A series of consolidated undrained triaxial compression tests with pore pressure measurements, was carried out to determine the effective stress parameters of the material. The results gave an effective angle of shearing resistance of 28 degrees with a

cont'd. /5 ...

4. SUBSOIL CONDITIONS: (cont'd.) ...

4.3) Clayey Silt to Silty Clay Till: (cont'd.) ...

cohesion intercept of 140 P.S.F. The pore pressure parameter A, determined by using the equation $\Delta u = B \left[\Delta \sigma_3 \; 2 \; A(\Delta \sigma_1 - \Delta \sigma_3)\right]$ and the results of the triaxial tests, have been plotted against strain in Fig. 6. Six consolidation tests were carried out which have been plotted on Fig's. 7, 8, 9, 10, 11 and 12. The results indicate the material to be slightly overconsolidated.

4.4) Black Shale Bedrock:

Bedrock was proved in boreholes 2 and 7 by coring with an AXT core barrel, and was found to be a black shale. No evidence of surface weathering was observed in the recovered core.

5. GROUND WATER CONDITIONS:

The water levels as recorded in the boreholes at the time of the field investigation, are presented in the Records of the Boreholes. No artesian water was observed at the site.

Natural gas was observed in all the boreholes when contact was made with the bedrock.

6. DISCUSSION AND RECOMMENDATIONS:

6.1) General:

It is proposed to build an overhead where the proposed extension of Hwy. 40-A is to cross the Canadian National Railway tracks in the Twp. of Sarnia. Planning indicates that a dual highway is being considered with a 50-ft. median and two parallel bridges. The present proposal requires construction of only the

cont'd. /6 ...

6. DISCUSSION AND RECOMMENDATIONS: (cont'd.) ...

6.1) General: (cont'd.) ...

east bridge, with the other structure to follow at a later, unspecified date. At the time of writing this report, neither the type of structure nor the location of the centre pier had been decided. The proposed centre line profile grade is to be 27 feet above the railroad tracks.

6.2) Approach Embankments:

The approach embankments should be constructed of well compacted acceptable fill. The shear strength of the subsoil is such so as to be able to support the required height of fill with an adequate factor of safety. The settlement due to consolidation of the subsoil caused by embankment loading directly beneath the abutment location, has been estimated by conventional methods to be 8.3 inches. The approach embankments for both structures should be built in one operation, for a distance of about 200 ft. behind the abutments, as this will remove the danger of additional differential settlements which would result if the embankment was extended after completion of the first structure.

6.3) Foundations:

Three alternatives for the support of the structure have been considered:

cont'd. 7/ ...

6. DISCUSSION AND RECOMMENDATIONS: (cont'd.) ...

6.3) Foundations: (cont'd.) ...

6.3.1) Spread Footings -

The structure can be supported on spread footings placed in the desiccated crust at elevation 610.00 with a safe design load of 2 tons per sq. ft. The maximum settlements, as estimated by conventional methods for a footing 10 feet by 36 feet with a loading of 2 tons/sq.ft., will be 1.6 inches beneath the centre and 1.0" beneath the edge of the footing. When the footings and the embankments are constructed at the same time, the maximum estimated settlements will be 5.6 inches for a footing placed at the toe of the embankment, and 8.3 inches for a footing placed within the fill. If spread footings are adopted, a simply supported structure with allowance for jacking, is recommended. The estimated time for the completion of 50 per cent consolidation is 9 years. However, conventional methods for determining the time for a certain per cent consolidation to take place, is generally found to underestimate the rate of settlement.

If spread footings are adopted, the approach embankments should be built in advance of the structure and settlement plates installed so that the settlements can be recorded and the most suitable time for the construction of the structure determined.

6.3.2) Spread Footings for the Piers with the Abutments Supported on Short Piles -

The piers can be supported on spread footings, as above. The abutments can be supported on short piles driven through the fill and some 5.0 feet into the desiccated crust.

cont'd. /8 ...

6. DISCUSSION AND RECOMMENDATIONS: (cont'd.) ...

6.3) Foundations: (cont'd.) ...

6.3.2) Spread Footings for the Piers with the Abutments Supported on Short Piles - (cont'd.) ...

Steel tubular piles with $12\frac{3}{4}$" O.D. and $\frac{1}{4}$" thick walls should be used. A safe design load of 30 tons per pile, can be used. The approach fills should be placed for a period as long as possible in advance of construction of the structure so as to allow as much of the anticipated settlements to take place as is possible.

6.3.3) Piers and Abutments Supported by Piles Driven to Bedrock -

The piers and abutments can be supported on steel H-piles driven to bedrock. For 14 BP 73, a safe design load of 70 tons/pile can be used.

7. SUMMARY:

(1) The subsoil at the site consists of a stratum of hard to firm clayey silt to silty clay, some 119 feet thick, lying on top of the black shale bedrock.

(2) It is proposed to build an overhead where the proposed extension of Hwy. 40-A crosses the Canadian National Railway tracks in the Twp. of Sarnia. The proposed profile grade is to be 27 feet above the railway tracks.

cont'd. /9 ...

7. SUMMARY: (cont'd.) ...

(3) The approach embankments should be constructed of well compacted acceptable fill. The stability of the embankment should not prove to be a problem. Due to the embankment loading, the maximum estimated settlement of the subsoil beneath the abutment location is 8.3 inches according to calculations using conventional methods.

(4) Three alternatives for the support of the piers and abutments have been described in detail, in the "Discussion and Recommendations". The choice to be adopted, will depend on which is the most economical.

8. MISCELLANEOUS:

The field investigation was carried out in the period 1st February to 23rd February, 1963, by the Canadian Longyear Drilling Co., under the supervision of Mr. T. F. Widdis, who also prepared this report under the supervision of Mr. K. G. Selby.

March 1963

ABBREVIATIONS USED IN THIS REPORT

PENETRATION RESISTANCE

STANDARD PENETRATION RESISTANCE 'N' :- THE NUMBER OF BLOWS REQUIRED TO ADVANCE A STANDARD SPLIT SPOON SAMPLER 12 INCHES INTO THE SUBSOIL, DRIVEN BY MEANS OF A 140 POUND HAMMER FALLING FREELY A DISTANCE OF 30 INCHES.

DYNAMIC PENETRATION RESISTANCE :- THE NUMBER OF BLOWS REQUIRED TO ADVANCE A 2 INCH, 60 DEGREE CONE, FITTED TO THE END OF DRILL RODS, 12 INCHES INTO THE SUBSOIL, THE DRIVING ENERGY BEING 350 FOOT POUNDS PER BLOW.

DESCRIPTION OF SOIL

THE CONSISTENCY OF COHESIVE SOILS AND THE RELATIVE DENSITY OR DENSENESS OF COHESIONLESS SOILS ARE DESCRIBED IN THE FOLLOWING TERMS :-

CONSISTENCY	'N' BLOWS / FT.	c LB. / SQ. FT.	DENSENESS	'N' BLOWS / FT.
VERY SOFT	0 - 2	0 - 250	VERY LOOSE	0 - 4
SOFT	2 - 4	250 - 500	LOOSE	4 - 10
FIRM	4 - 8	500 - 1000	COMPACT	10 - 30
STIFF	8 - 15	1000 - 2000	DENSE	30 - 50
VERY STIFF	15 - 30	2000 - 4000	VERY DENSE	> 50
HARD	> 30	> 4000		

TYPE OF SAMPLE

S.S.	SPLIT SPOON	T.W.	THINWALL OPEN
W.S.	WASHED SAMPLE	T.P.	THINWALL PISTON
S.B.	SCRAPER BUCKET SAMPLE	O.S.	OESTERBERG SAMPLE
A.S.	AUGER SAMPLE	F.S.	FOIL SAMPLE
C.S.	CHUNK SAMPLE	R.C.	ROCK CORE
S.T.	SLOTTED TUBE SAMPLE		

P.H. SAMPLE ADVANCED HYDRAULICALLY

P.M. SAMPLE ADVANCED MANUALLY

SOIL TESTS

Qu	UNCONFINED COMPRESSION	L.V.	LABORATORY VANE
Q	UNDRAINED TRIAXIAL	F.V.	FIELD VANE
Qcu	CONSOLIDATED UNDRAINED TRIAXIAL	C	CONSOLIDATION
Qd	DRAINED TRIAXIAL	S	SENSITIVITY

ABBREVIATIONS USED IN THIS REPORT

SOIL PROPERTIES

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	SPECIFIC GRAVITY OF SOLID PARTICLES $G = \frac{\gamma_s}{\gamma_w}$
e	VOID RATIO
n	POROSITY
w	WATER CONTENT
S_r	DEGREE OF SATURATION
w_L	LIQUID LIMIT
w_P	PLASTIC LIMIT
I_P	PLASTICITY INDEX
s	SHRINKAGE LIMIT
I_L	LIQUIDITY INDEX $= \frac{w - w_P}{I_P}$
I_C	CONSISTENCY INDEX $= \frac{w_L - w}{I_P}$
e_{max}	VOID RATIO IN LOOSEST STATE
e_{min}	VOID RATIO IN DENSEST STATE
I_D	DENSITY INDEX $= \frac{e_{max} - e}{e_{max} - e_{min}}$ RELATIVE DENSITY D_r IS ALSO USED
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
m_v	COEFFICIENT OF VOLUME CHANGE $= \frac{-\Delta e}{(1+e)\Delta\sigma'}$
c_v	COEFFICIENT OF CONSOLIDATION
C_c	COMPRESSION INDEX $= \frac{\Delta e}{\Delta \log_{10} \sigma'}$
T_v	TIME FACTOR $= \frac{c_v t}{d^2}$ (d, DRAINAGE PATH)
U	DEGREE OF CONSOLIDATION
τ_f	SHEAR STRENGTH
c'	EFFECTIVE COHESION INTERCEPT } IN TERMS OF EFFECTIVE STRESS $\tau_f = c' + \sigma' \tan \phi'$
ϕ'	EFFECTIVE ANGLE OF SHEARING RESISTANCE, OR FRICTION } IN TERMS OF EFFECTIVE STRESS
c_u	APPARENT COHESION } IN TERMS OF TOTAL STRESS $\tau_f = c_u + \sigma \tan \phi$
ϕ_u	APPARENT ANGLE OF SHEARING RESISTANCE, OR FRICTION } IN TERMS OF TOTAL STRESS
μ	COEFFICIENT OF FRICTION
S_t	SENSITIVITY

GENERAL

π	= 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

STRESS AND STRAIN

u	PORE PRESSURE
σ	NORMAL STRESS
σ'	NORMAL EFFECTIVE STRESS ($\bar{\sigma}$ IS ALSO USED)
τ	SHEAR STRESS
ε	LINEAR STRAIN
γ	SHEAR STRAIN
ν	POISSON'S RATIO (μ IS ALSO USED)
E	MODULUS OF LINEAR DEFORMATION (YOUNGS MODULUS)
G	MODULUS OF SHEAR DEFORMATION
K	MODULUS OF COMPRESSIBILITY
η	COEFFICIENT OF VISCOSITY

EARTH PRESSURE

d	DISTANCE FROM TOP OF WALL TO POINT OF APPLICATION OF PRESSURE
δ	ANGLE OF WALL FRICTION
K	DIMENSIONLESS COEFFICIENT TO BE USED WITH VARIOUS SUFFIXES IN EXPRESSIONS REFERRING TO NORMAL STRESS ON WALLS
K_o	COEFFICIENT OF EARTH PRESSURE AT REST

FOUNDATIONS

B	BREADTH OF FOUNDATION
L	LENGTH OF FOUNDATION
D	DEPTH OF FOUNDATION BENEATH GROUND
N	DIMENSIONLESS COEFFICIENT USED WITH A SUFFIX APPLYING TO SPECIFIC GRAVITY, DEPTH AND COHESION ETC. IN THE FORMULA FOR BEARING CAPACITY
k_s	MODULUS OF SUBGRADE REACTION

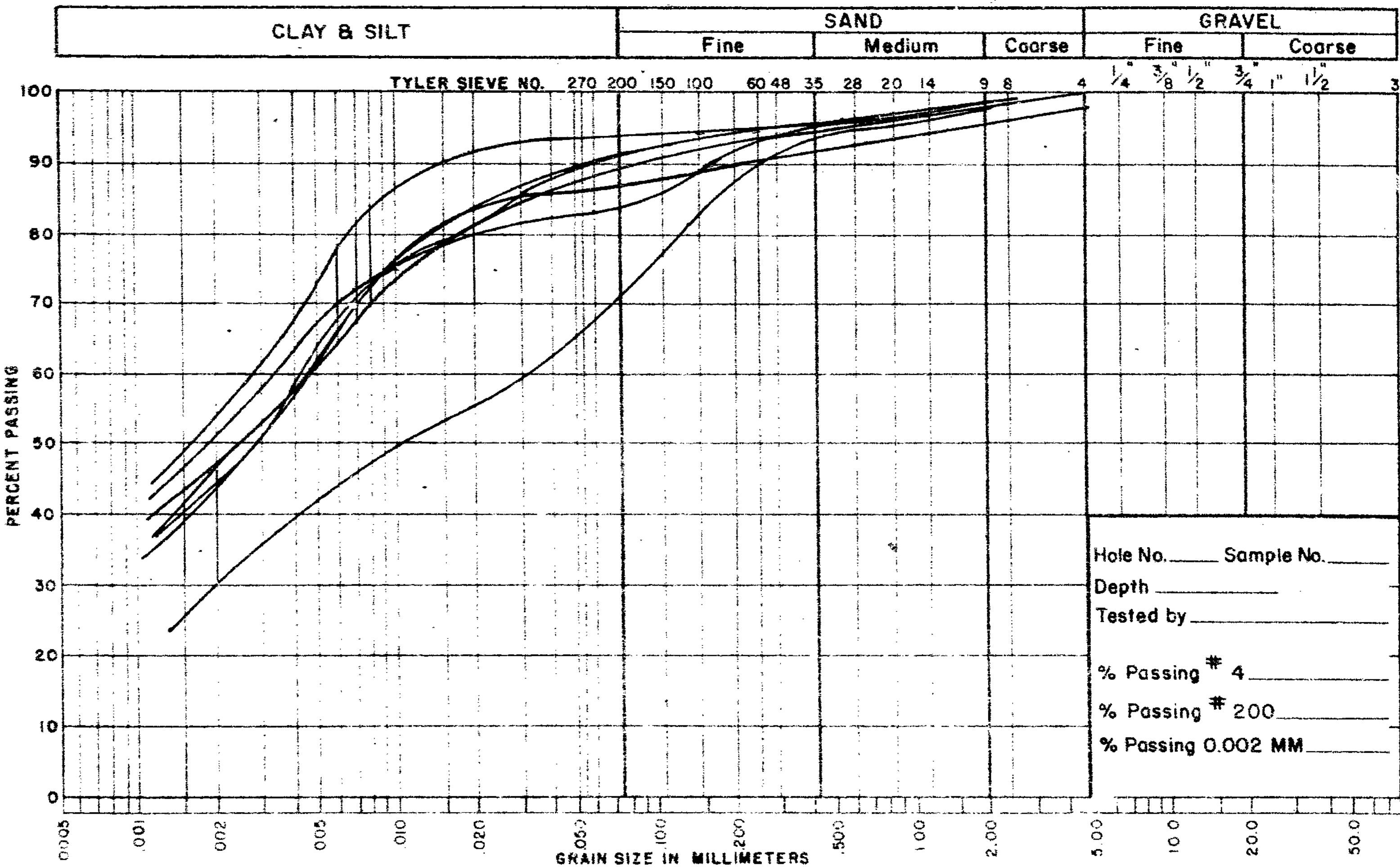
SLOPES

H	VERTICAL HEIGHT OF SLOPE
D	DEPTH BELOW TOE OF SLOPE TO HARD STRATUM
β	ANGLE OF SLOPE TO HORIZONTAL

APPENDIX I.

FORM OB-ML-17
1M-59-3979

UNIFIED SOIL CLASSIFICATION SYSTEM



NOTES CLAYEY SILT TO SILTY CLAY WITH SAND & GRAVEL

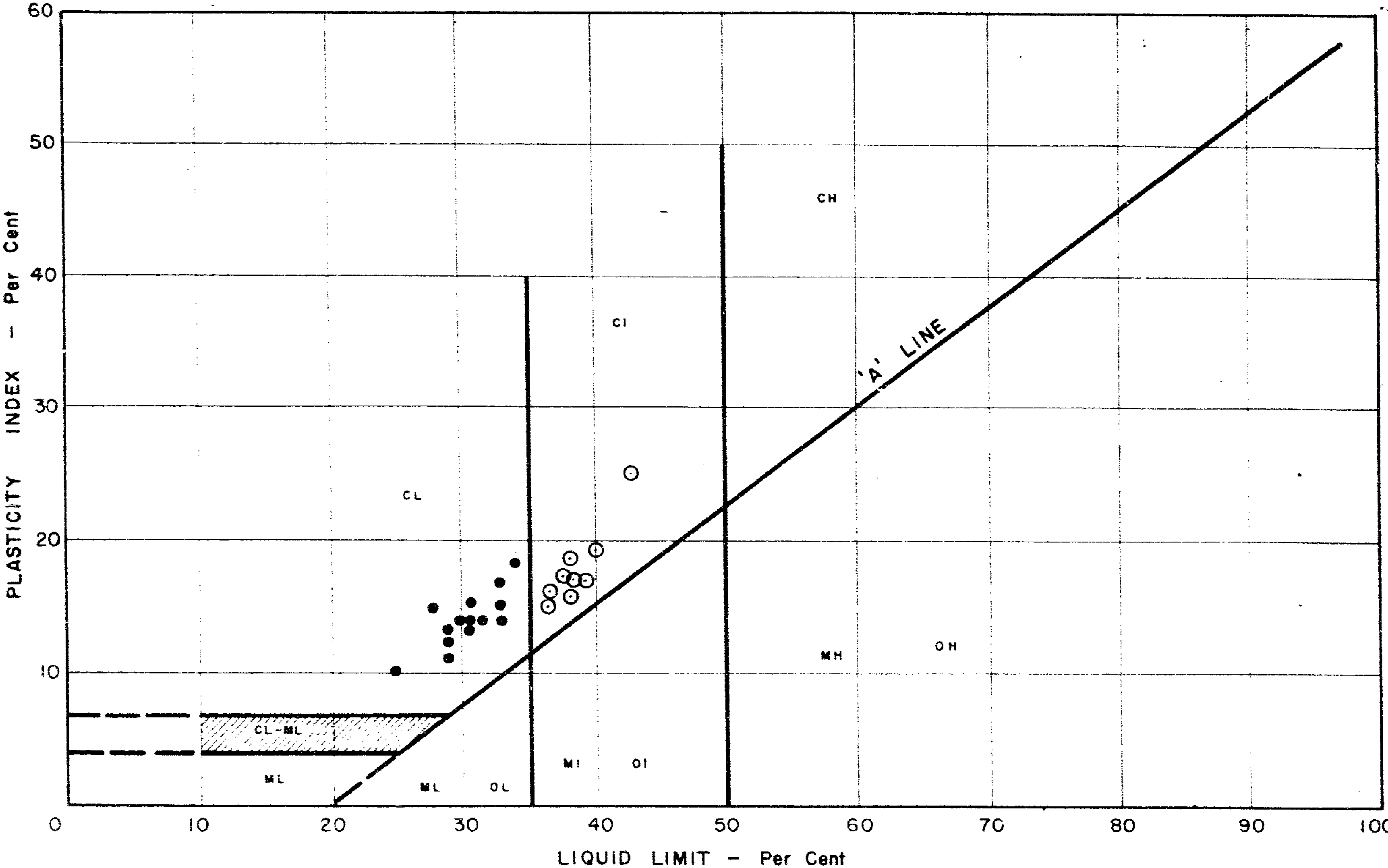
DEPARTMENT OF HIGHWAYS - ONTARIO
MATERIALS & RESEARCH SECTION
GRAIN SIZE DISTRIBUTION

Job No. 63 - F - 12 W.P. No. 53 - 63

Location C.N.R. & HWY. 40A — SARNIA

FIG. 1

FORM OB-ML-252 (REV. MARCH 62)



NOTES CLAYEY SILT — ●

SILTY CLAY — ⊙

DEPARTMENT OF HIGHWAYS - ONTARIO

MATERIALS & RESEARCH DIVISION

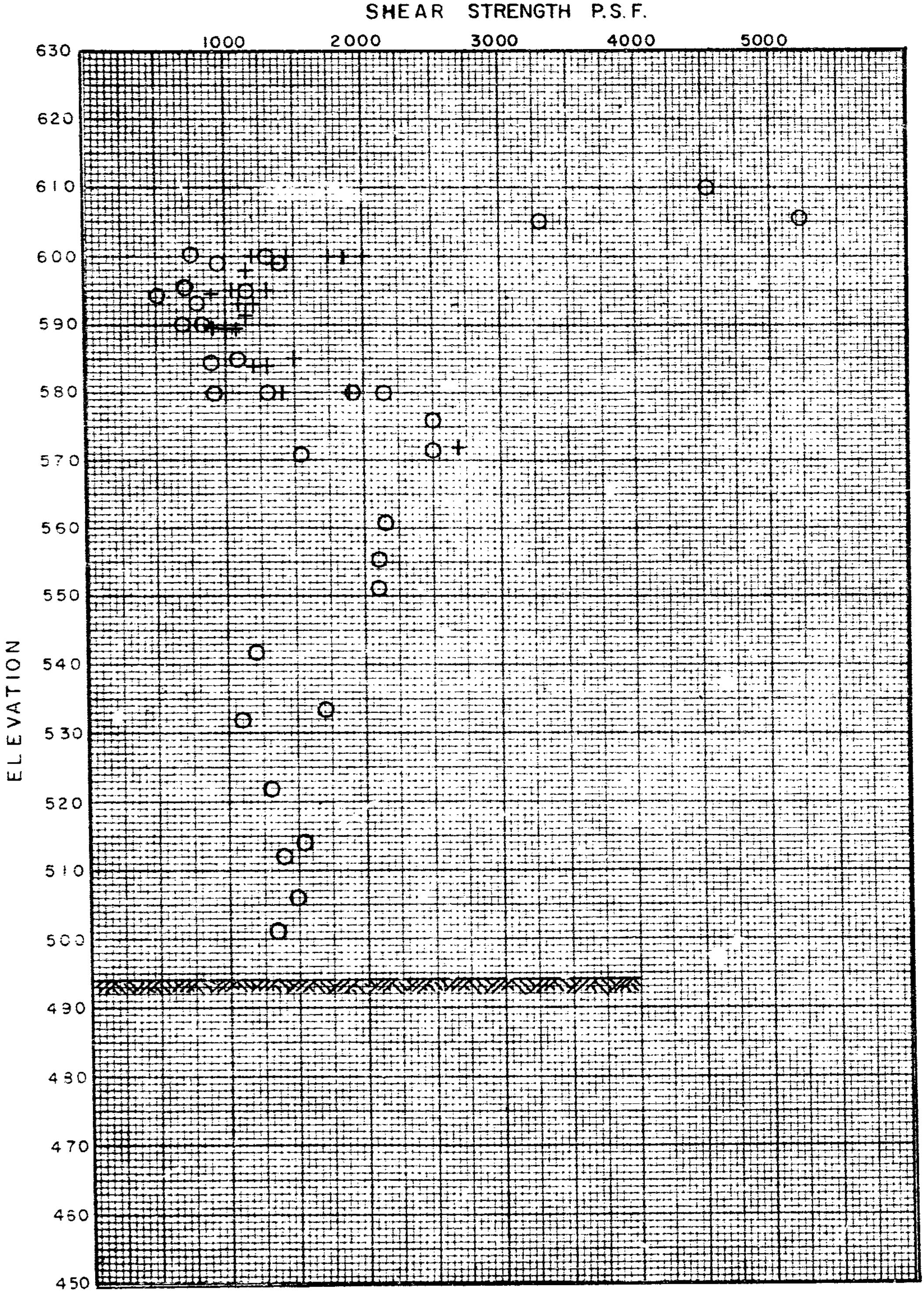
PLASTICITY CHART

Job No. 63 - F - 12 W.P. No. 53 - 63

Location C.N.R. & HWY. 40A — SARNIA

FIG. 2

W. P. 53 - 63 JOB 63 - F - 12



O — UNCONFINED SHEAR STRENGTH + — FIELD VANE

SHEAR STRENGTH WITH DEPTH

FIG. 3

GRAPH FOR FOUNDATION REPORTS.

FORM OB-MI 778
500-58-6145

W. P. 53-63 JOB 63-F-12

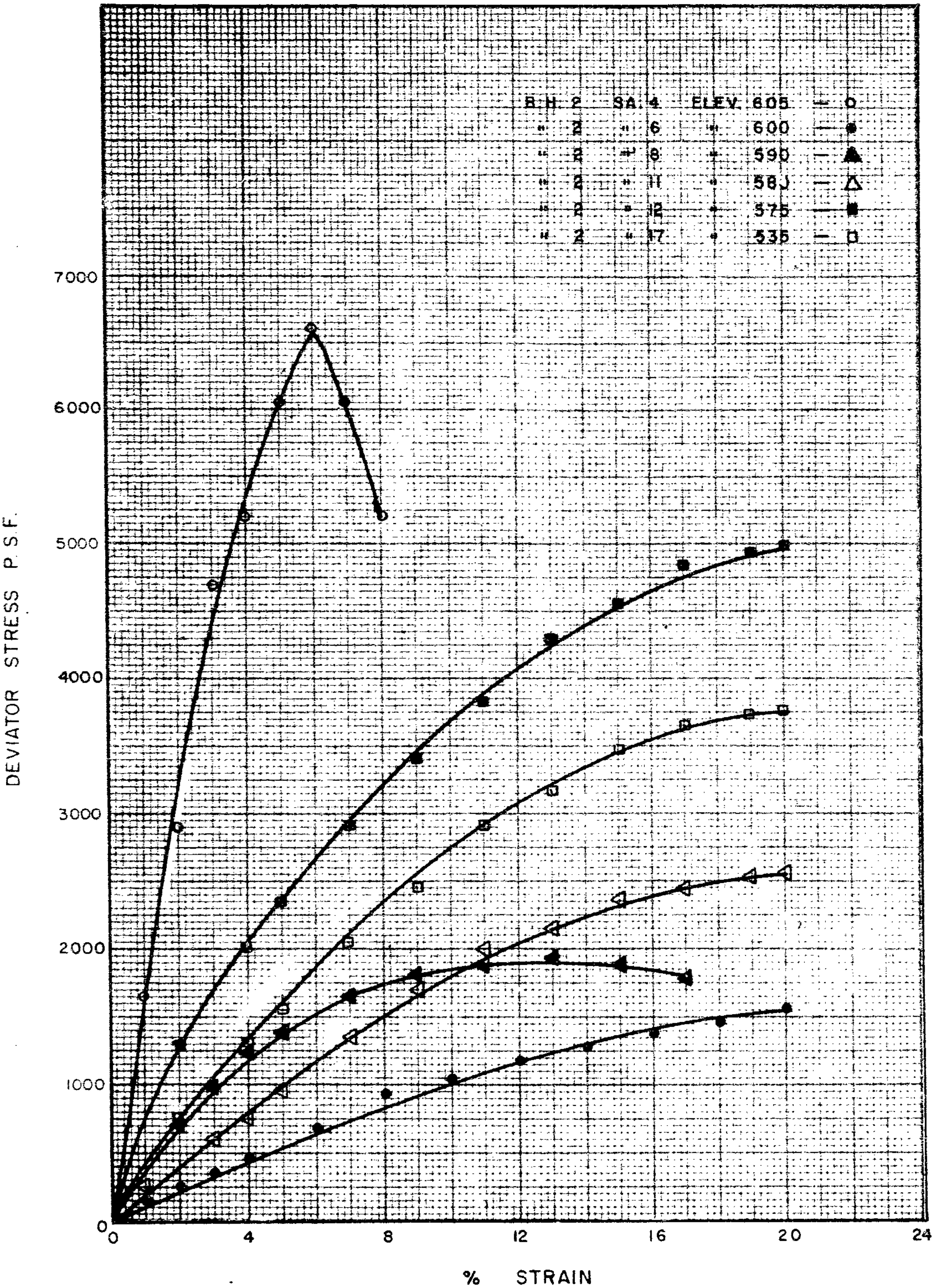


FIG. 4

GRAPH FOR FOUNDATION REPORTS,

FORM WES-ML-228
900-58-6145

GRAPH FOR FOUNDATION REPORTS.

W. P 53 - 63 JOB 63 - F - 12

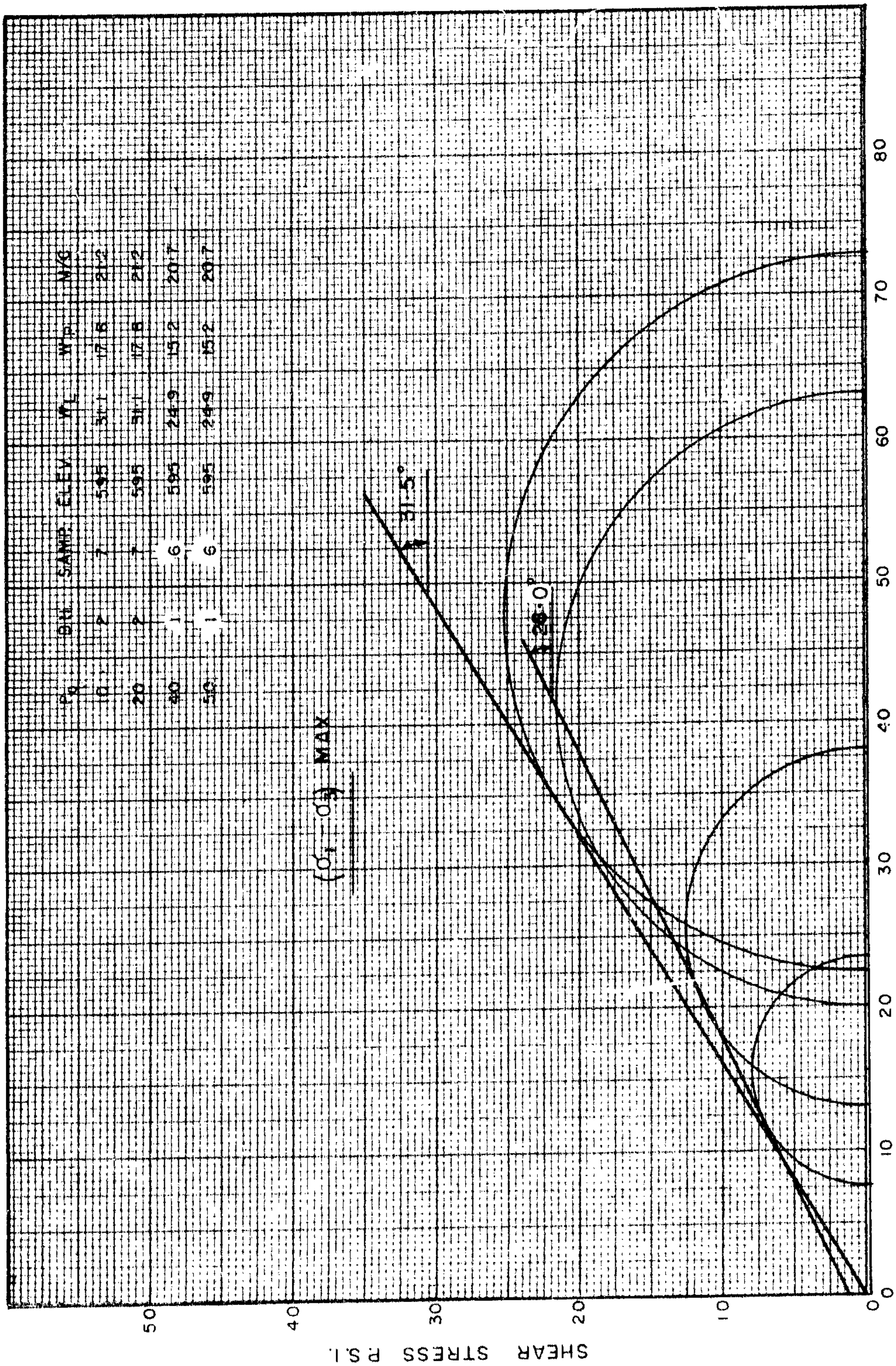


FIG. 5

FORM OB ML-228
500 58-6145

W. P. 53 - 63 JOB 63 - F - 12

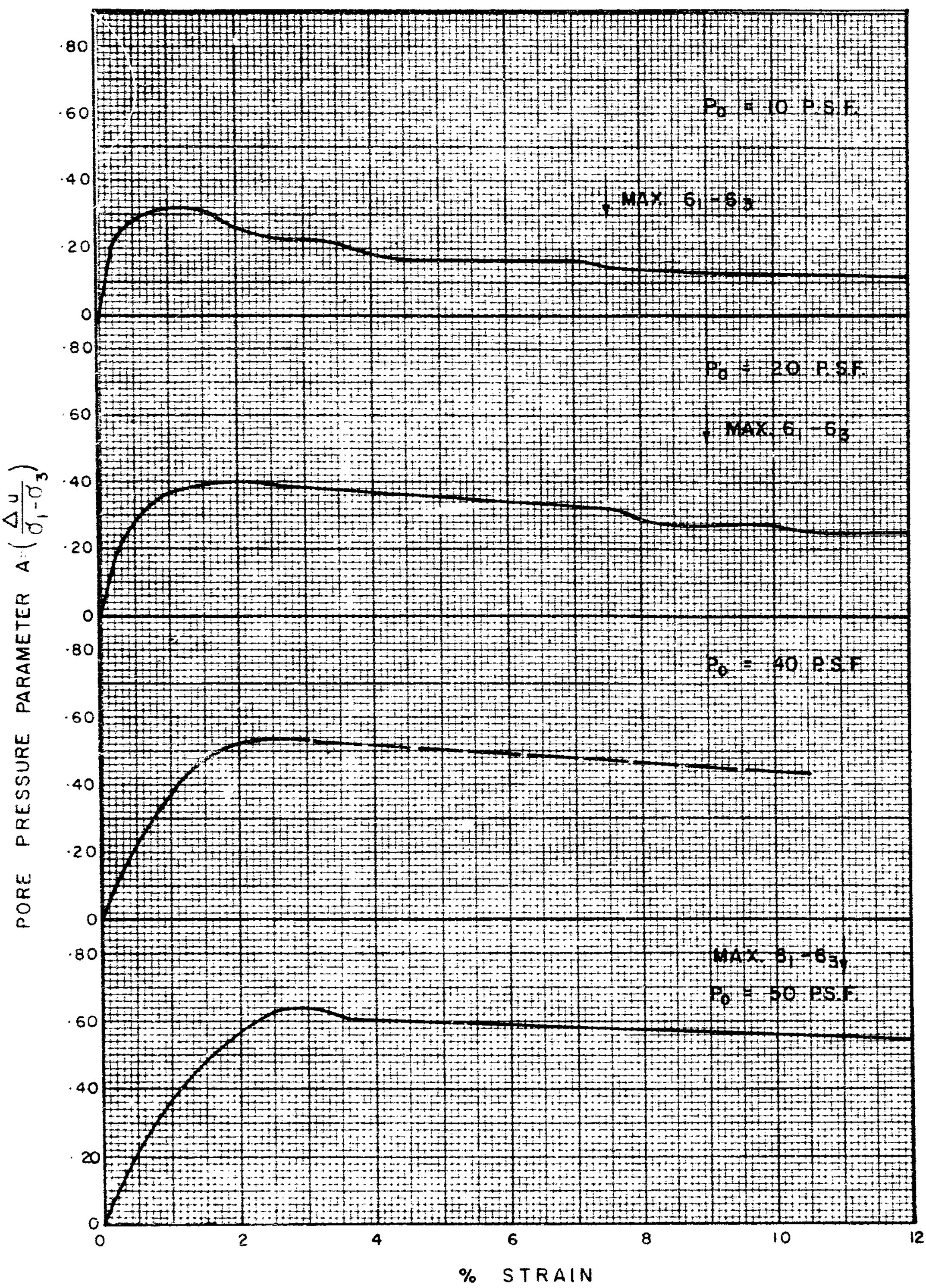


FIG. 6

GRAPH FOR FOUNDATION REPORTS.

FORM OB ML 229
500 58 6145

SEMI-LOG GRAPH FOR FOUNDATION REPORTS.

W. P. 55 – 65

JOB 63 – F – 12

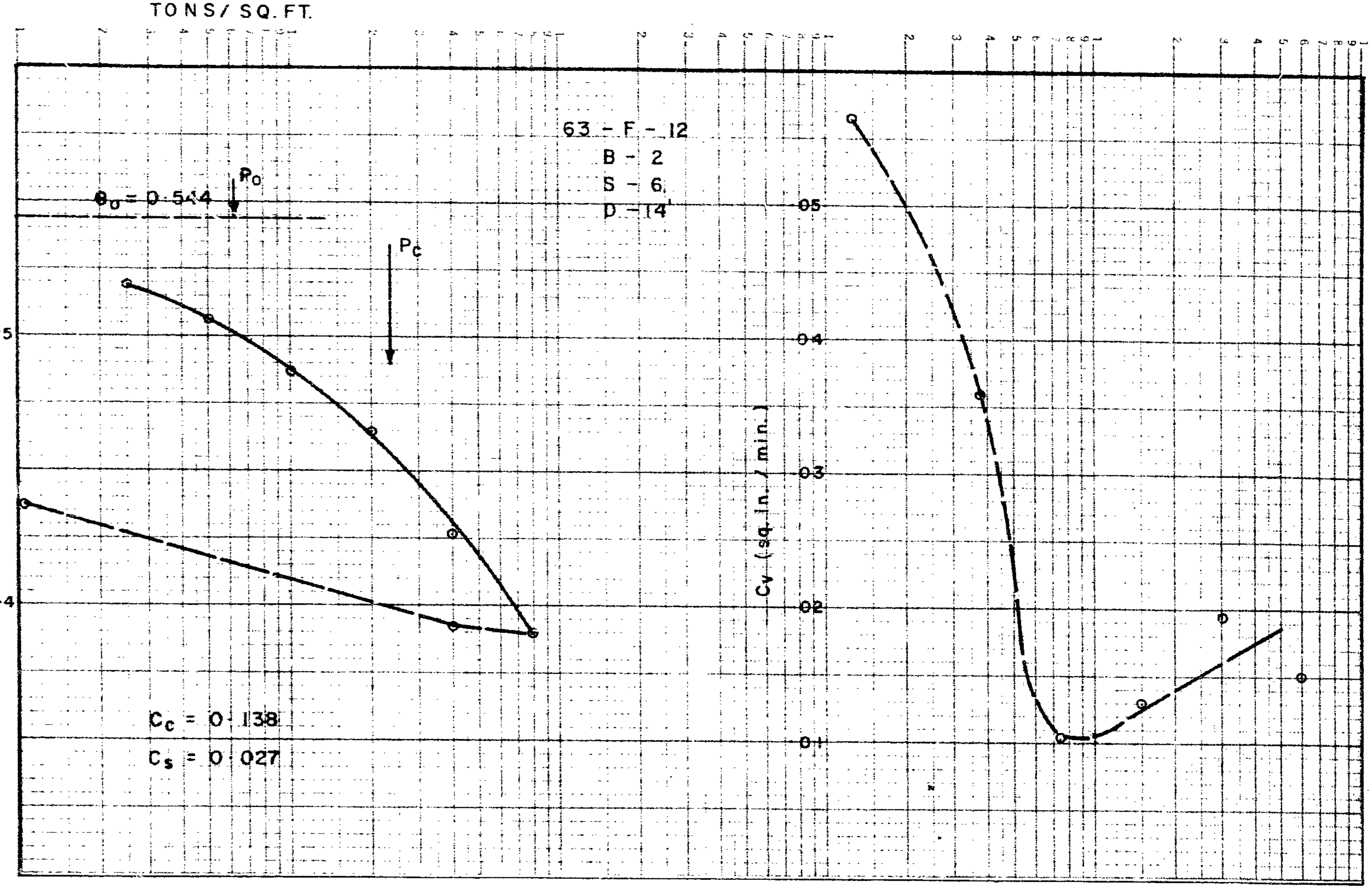


FIG. 7

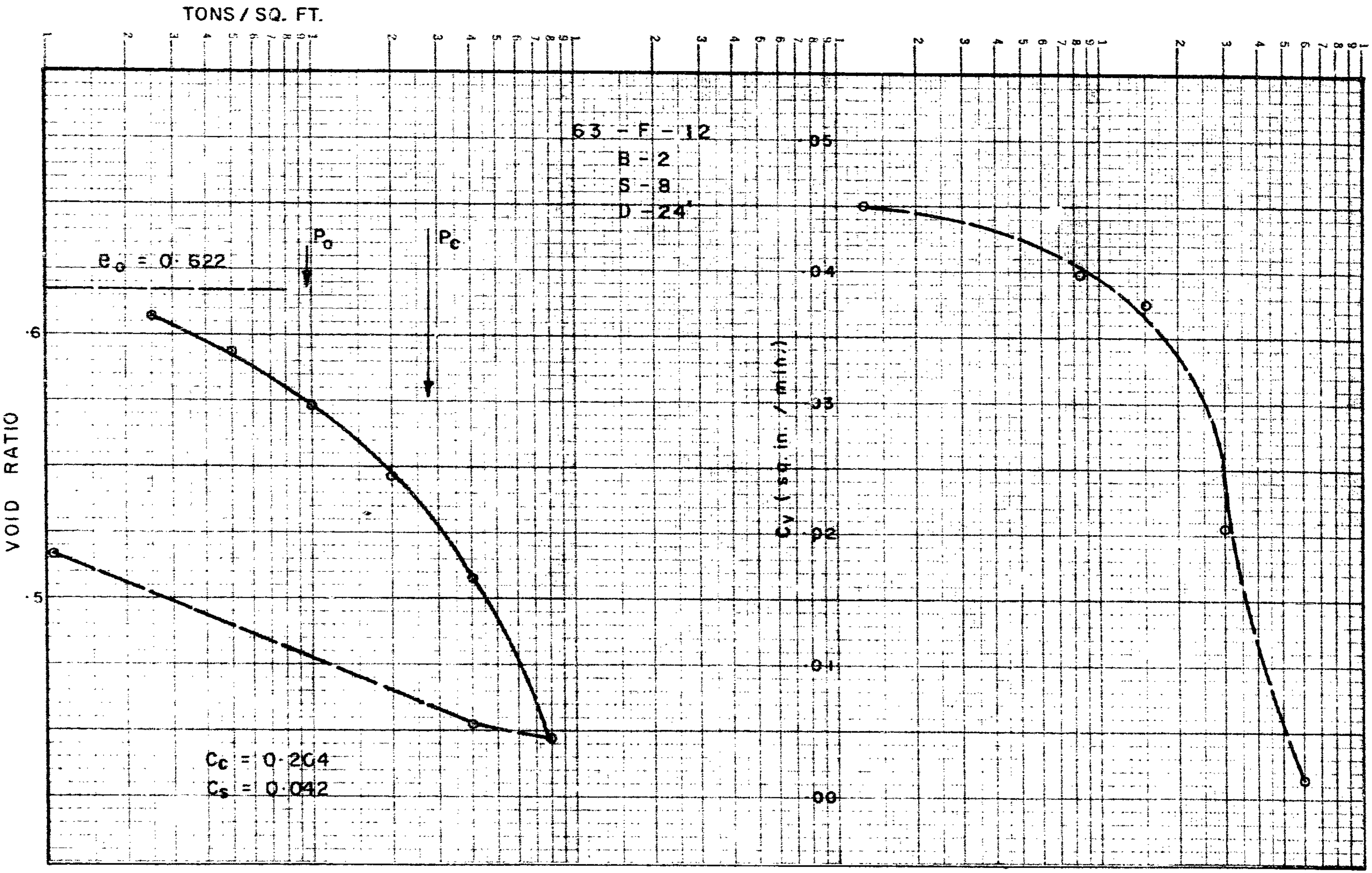

TONS / SQ. FT.
VOID RATIO
·6
·5
63 - F - 12
B - 2
S - 8
D - 24'
P_o
P_c
e_o = 0·622
C_c = 0·204
C_s = 0·042
C_v (sq. in. / min.)
0·5
0·4
0·3
0·2
0·1
0·0

FIG. 8

FORM OB-ML-227
500-58-6146

SEMI-LOG GRAPH FOR FOUNDATION REPORTS.

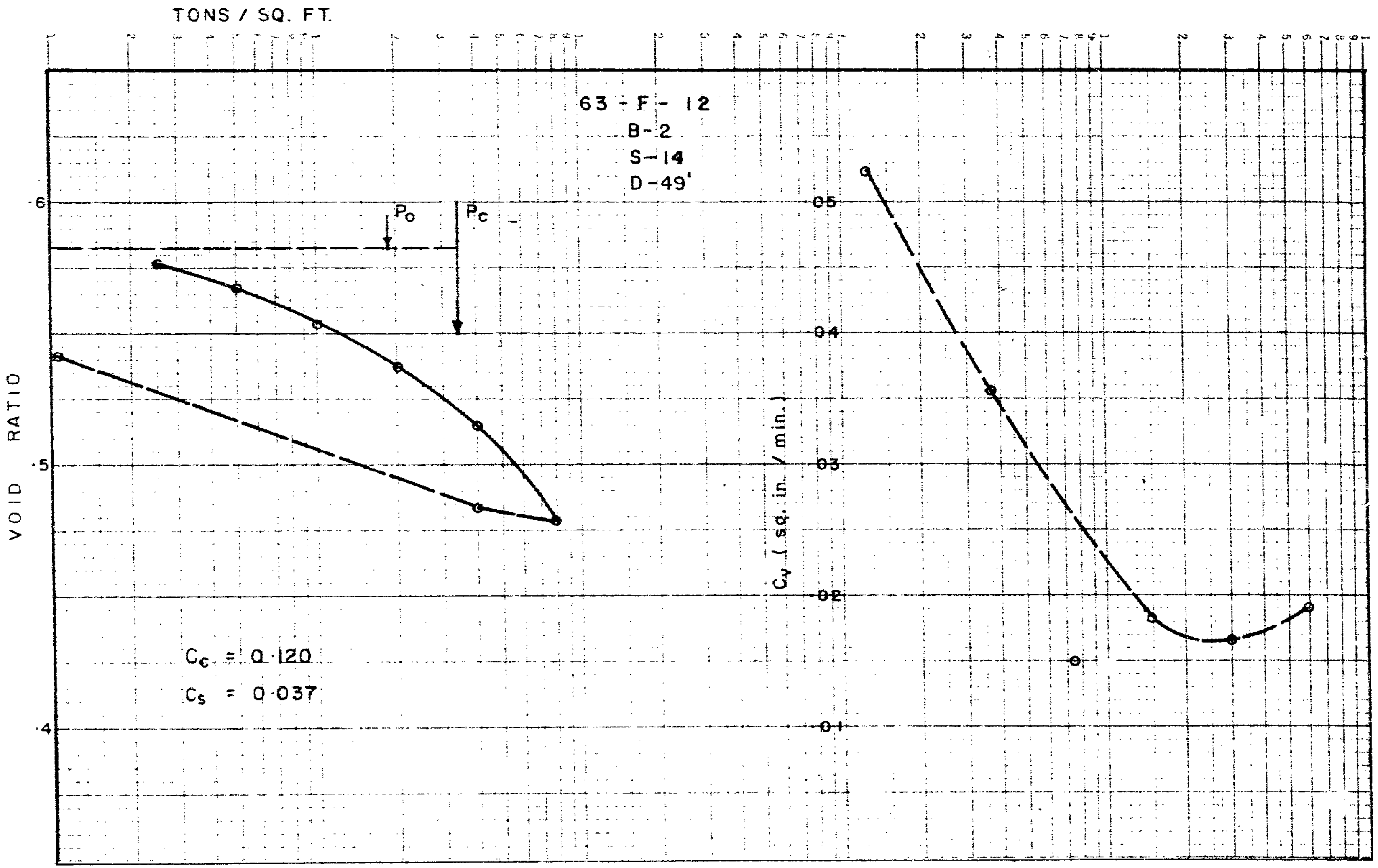


FIG. 9

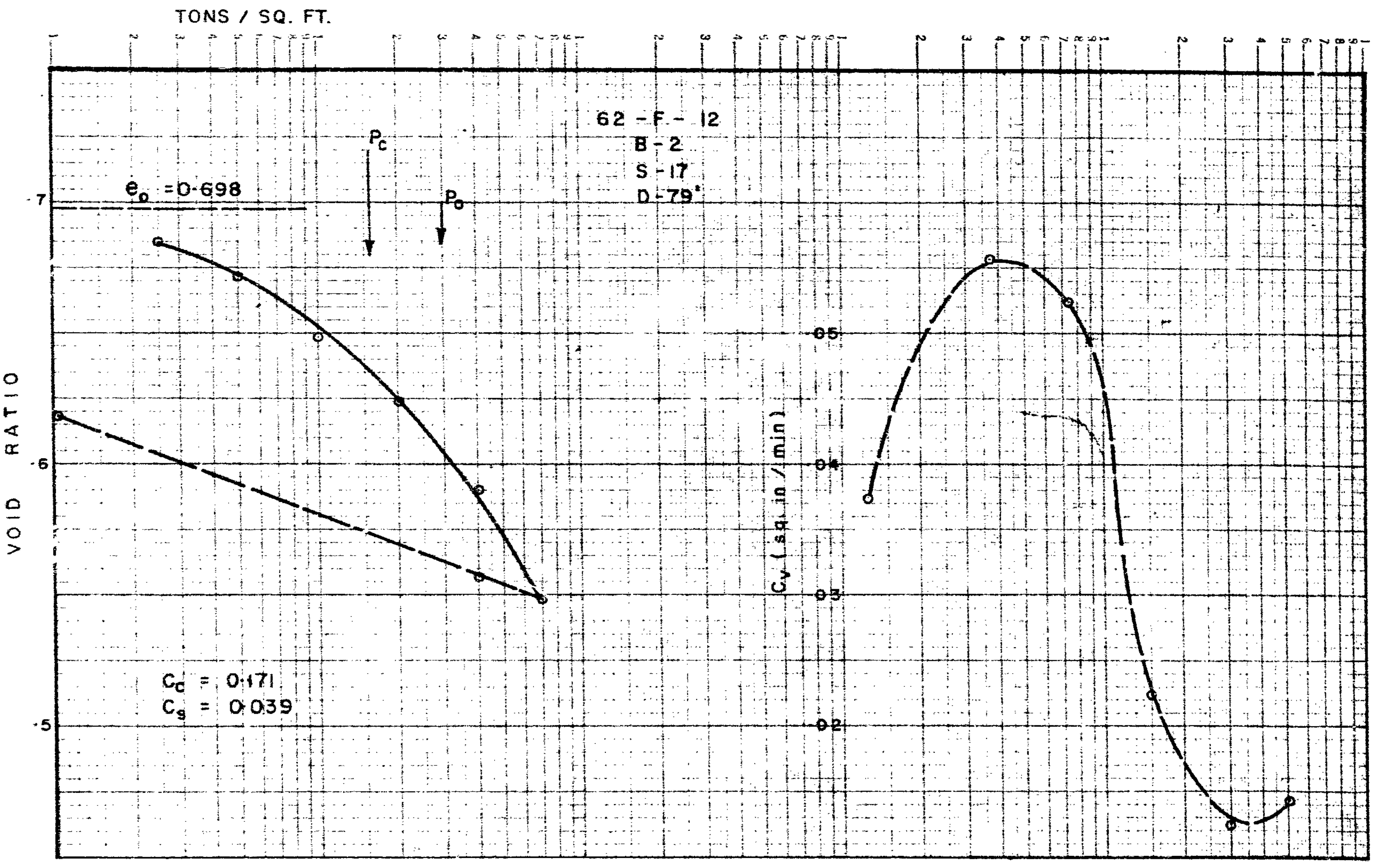

TONS / SQ. FT.
VOID RATIO
62 - F - 12
B - 2
S - 17
D - 79'
e_o = 0·698
P_c
P_o
C_c = 0·171
C_s = 0·039
C_v (sq. in / min)
·7
·6
·5
0·5
0·4
0·3
0·2

FIG. 10

FORM C8-M1-227
500-58-6146

SEMI-LOG GRAPH FOR FOUNDATION REPORTS.

W. P. ________ JOB 63-F-12

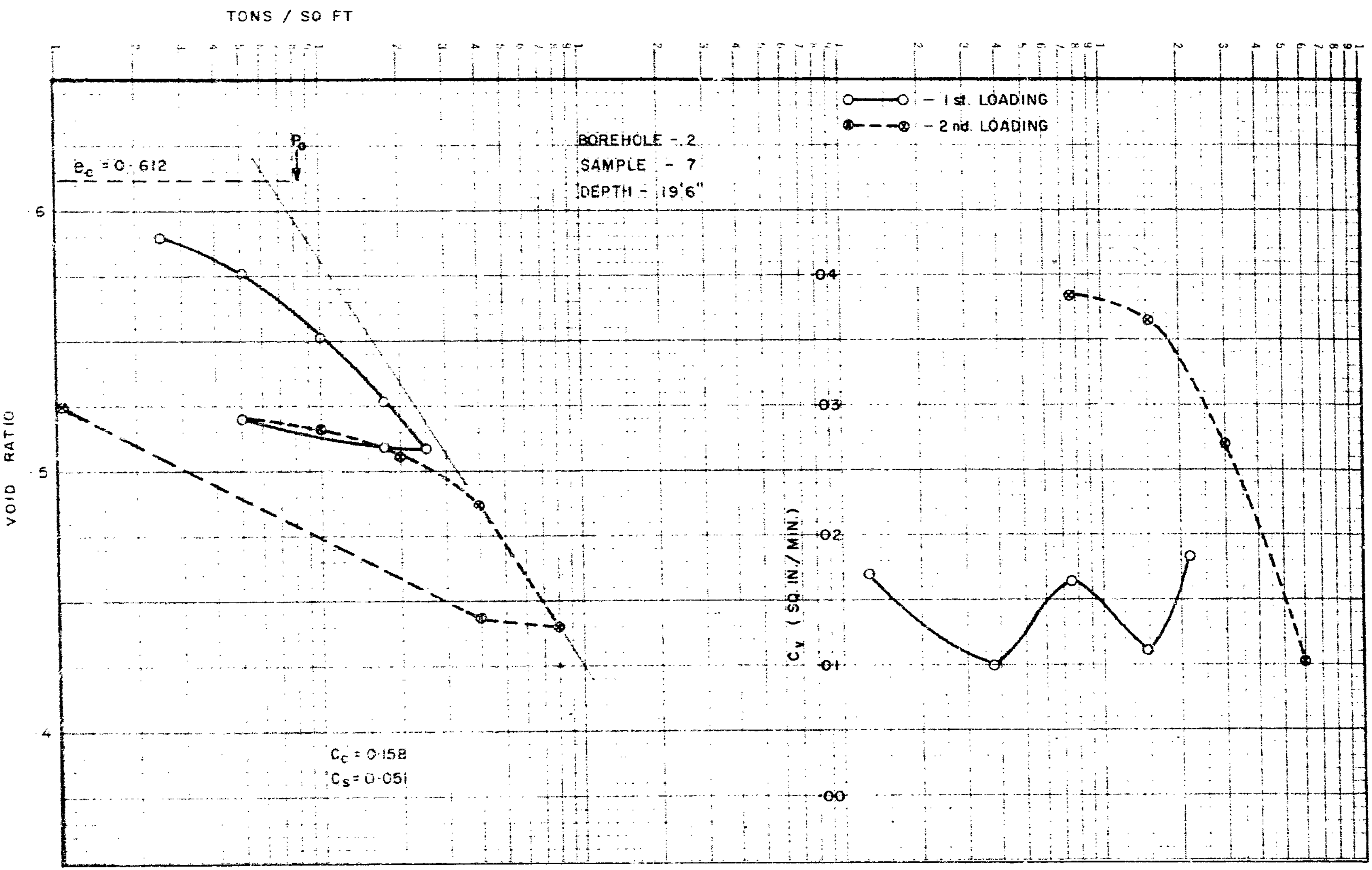


FIG. 11

W. P. ______ JOB 63-F-12

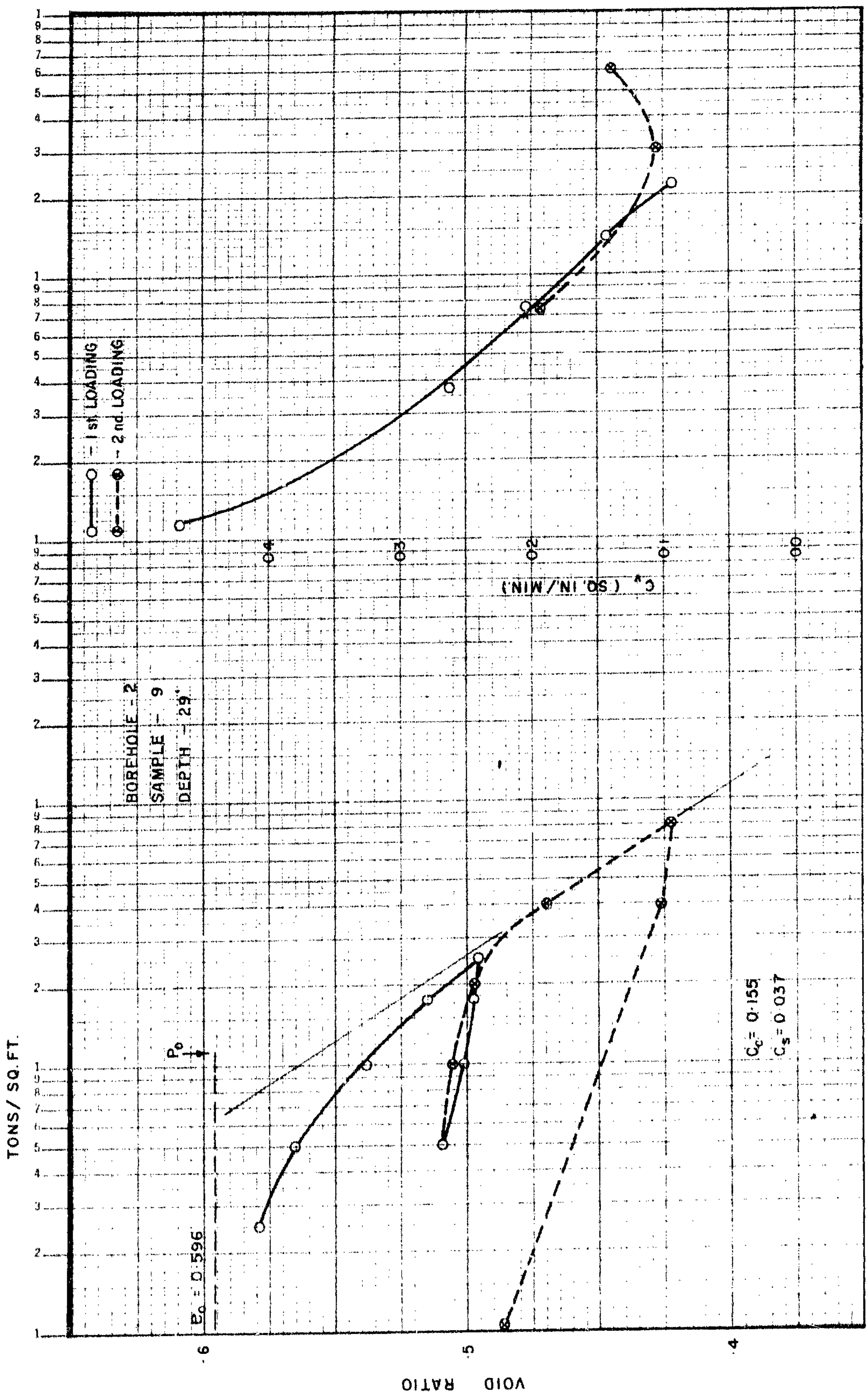


FIG 12

SEMI-LOG GRAPH FOR FOUNDATION REPORTS.

FORM CR-MI-227
500-58-6144

ABBREVIATIONS USED IN THIS REPORT

PENETRATION RESISTANCE

STANDARD PENETRATION RESISTANCE 'N' : - THE NUMBER OF BLOWS REQUIRED TO ADVANCE A STANDARD SPLIT SPOON SAMPLER 12 INCHES INTO THE SUBSOIL, DRIVEN BY MEANS OF A 140 POUND HAMMER FALLING FREELY A DISTANCE OF 30 INCHES.

DYNAMIC PENETRATION RESISTANCE : - THE NUMBER OF BLOWS REQUIRED TO ADVANCE A 2 INCH, 60 DEGREE CONE, FITTED TO THE END OF DRILL RODS, 12 INCHES INTO THE SUBSOIL, THE DRIVING ENERGY BEING 350 FOOT POUNDS PER BLOW.

DESCRIPTION OF SOIL

THE CONSISTENCY OF COHESIVE SOILS AND THE RELATIVE DENSITY OR DENSENESS OF COHESIONLESS SOILS ARE DESCRIBED IN THE FOLLOWING TERMS : -

CONSISTENCY	'N' BLOWS / FT.	c LB. / SQ. FT.	DENSENESS	'N' BLOWS / FT.
VERY SOFT	0 - 2	0 - 250	VERY LOOSE	0 - 4
SOFT	2 - 4	250 - 500	LOOSE	4 - 10
FIRM	4 - 8	500 - 1000	COMPACT	10 - 30
STIFF	8 - 15	1000 - 2000	DENSE	30 - 50
VERY STIFF	15 - 30	2000 - 4000	VERY DENSE	> 50
HARD	> 30	> 4000		

TYPE OF SAMPLE

S.S	SPLIT SPOON	T.W.	THINWALL OPEN
W.S.	WASHED SAMPLE	T.P.	THINWALL PISTON
S.B	SCRAPER BUCKET SAMPLE	O.S.	OESTERBERG SAMPLE
A.S.	AUGER SAMPLE	F.S.	FOIL SAMPLE
C.S	CHUNK SAMPLE	R.C.	ROCK CORE
S.T	SLOTTED TUBE SAMPLE		

P.H SAMPLE ADVANCED HYDRAULICALLY

P.M. SAMPLE ADVANCED MANUALLY

SOIL TESTS

Qu	UNCONFINED COMPRESSION	L.V.	LABORATORY VANE
Q	UNDRAINED TRIAXIAL	F.V.	FIELD VANE
Qcu	CONSOLIDATED UNDRAINED TRIAXIAL	C	CONSOLIDATION
Qd	DRAINED TRIAXIAL	S	SENSITIVITY

ABBREVIATIONS USED IN THIS REPORT

SOIL PROPERTIES

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 SPECIFIC GRAVITY OF SOLID PARTICLES $G = \dfrac{\gamma_s}{\gamma_w}$
e VOID RATIO
n POROSITY
w WATER CONTENT
S_r DEGREE OF SATURATION
w_L LIQUID LIMIT
w_P PLASTIC LIMIT
I_P PLASTICITY INDEX
s SHRINKAGE LIMIT
I_L LIQUIDITY INDEX $= \dfrac{w - w_P}{I_P}$
I_C CONSISTENCY INDEX $= \dfrac{w_L - w}{I_P}$
e_{max} VOID RATIO IN LOOSEST STATE
e_{min} VOID RATIO IN DENSEST STATE
I_D DENSITY INDEX $= \dfrac{e_{max} - e}{e_{max} - e_{min}}$
RELATIVE DENSITY D_r IS ALSO USED
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
m_v COEFFICIENT OF VOLUME CHANGE $= \dfrac{-\Delta e}{(1+e)\Delta\sigma'}$
c_v COEFFICIENT OF CONSOLIDATION
C_c COMPRESSION INDEX $= \dfrac{\Delta e}{\Delta \log_{10} \sigma'}$
T_v TIME FACTOR $= \dfrac{c_v t}{d^2}$ (d, DRAINAGE PATH)
U DEGREE OF CONSOLIDATION
τ_f SHEAR STRENGTH
c' EFFECTIVE COHESION INTERCEPT
ϕ' EFFECTIVE ANGLE OF SHEARING RESISTANCE, OR FRICTION
— IN TERMS OF EFFECTIVE STRESS $\tau_f = c' + \sigma' \tan \phi'$
c_u APPARENT COHESION
ϕ_u APPARENT ANGLE OF SHEARING RESISTANCE, OR FRICTION
— IN TERMS OF TOTAL STRESS $\tau_f = c_u + \sigma \tan \phi$
μ COEFFICIENT OF FRICTION
S_t SENSITIVITY

GENERAL

π $= 3{\cdot}1416$
e BASE OF NATURAL LOGARITHMS $2{\cdot}7183$
$\log_e a$ 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

STRESS AND STRAIN

u PORE PRESSURE
σ NORMAL STRESS
σ' NORMAL EFFECTIVE STRESS ($\bar{\sigma}$ IS ALSO USED)
τ SHEAR STRESS
ε LINEAR STRAIN
γ SHEAR STRAIN
ν POISSON'S RATIO (μ IS ALSO USED)
E MODULUS OF LINEAR DEFORMATION (YOUNGS MODULUS)
G MODULUS OF SHEAR DEFORMATION
K MODULUS OF COMPRESSIBILITY
η COEFFICIENT OF VISCOSITY

EARTH PRESSURE

d DISTANCE FROM TOP OF WALL TO POINT OF APPLICATION OF PRESSURE
δ ANGLE OF WALL FRICTION
K DIMENSIONLESS COEFFICIENT TO BE USED WITH VARIOUS SUFFIXES IN EXPRESSIONS REFERRING TO NORMAL STRESS ON WALLS
K_o COEFFICIENT OF EARTH PRESSURE AT REST

FOUNDATIONS

B BREADTH OF FOUNDATION
L LENGTH OF FOUNDATION
D DEPTH OF FOUNDATION BENEATH GROUND
N DIMENSIONLESS COEFFICIENT USED WITH A SUFFIX APPLYING TO SPECIFIC GRAVITY. DEPTH AND COHESION ETC. IN THE FORMULA FOR BEARING CAPACITY
k_s MODULUS OF SUBGRADE REACTION

SLOPES

H VERTICAL HEIGHT OF SLOPE
D DEPTH BELOW TOE OF SLOPE TO HARD STRATUM
β ANGLE OF SLOPE TO HORIZONTAL

cc: Foundations Office

Mr. S. McCombie,
Bridge Planning Engr.,
Bridge Division.

Attention: Mr. G. Scott

Mr. A. G. Stermac,
Principal Foundation Engr.,
Foundation Section,
Materials & Research Division.

September 5, 1963

Preliminary Plan D-5312-P1,
C.N.R. Overhead on Hwy. #40A,
District #1.

The designer appears to have complied with the recommendations contained in the Foundation Report #63-F-12.

K. G. Selby

K. G. Selby,
SENIOR FOUNDATION ENGR.

KGS/MdeF
cc: Foundations Office
Gen. Files

1966 SEP 15 PM 2:47

File

CL

MX DOWN SEPTEMBER 15/66 2.30 P VR

CHAT 4 F C BROWN DIST ENGR

LOND 9 COPY TO J ROY REG MATLS ENGR

RE G AND D SARNIA BY PASS SOUTHERLY TO HWY 80 NEW HWY 40 YOUR TELETYPE OF SEPTEMBER 14/66.

WP-43-65-1 MEMO OF SEPT 7/66 BY K G FELBY TO B R DAVIS BRIDGE ENGR RECOMMENDATIONS REFERS TO THE SUBSOIL CONDITION AND THE PERFORMANCE OF THE STRUCTURE WE HAVE CHECKED WITH BRIDGE MAINTCE AND THEY CONFIRMED SATISFACTORY PERFORMANCE OF STRUCTURE MOVEMENT OF GUIDE RAIL POST AT C N R OVERHEAD ON HWY 40 (WP-53-63) ARE DUE TO INSTABILITY OF EMBANKMENT SLOPES THIS IS WELL DIAGNOSED AND EXPLAINED IN MEMO OF JUNE 27/66 BY J FORSTER FOR J R ROY TO YOU .

A G STERMACK PRINC FOUNDATION ENGR MATLS AND TEST DIV

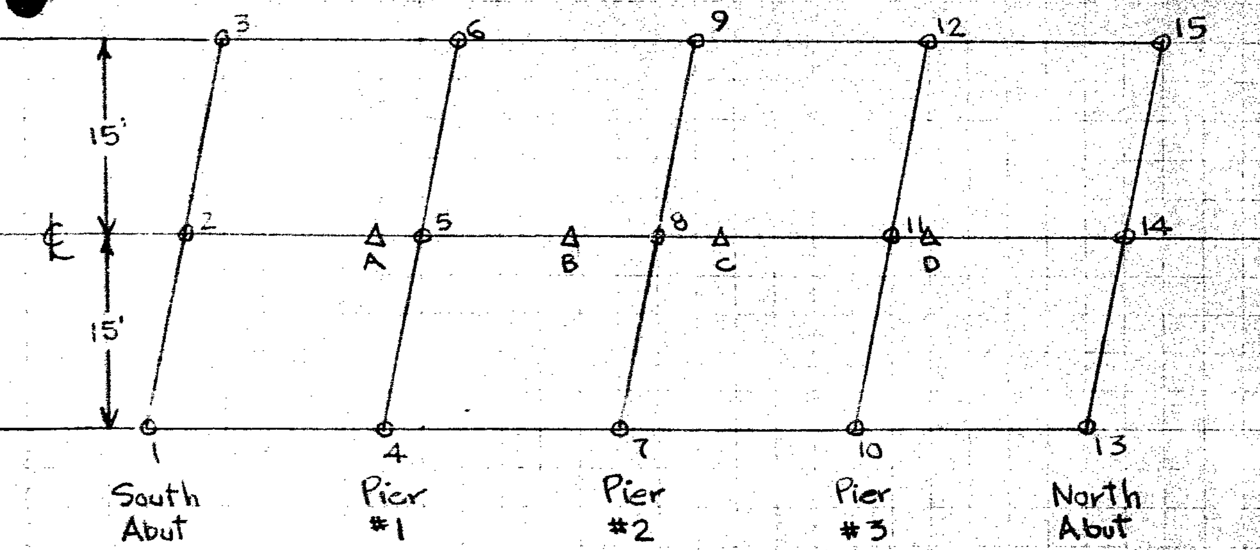
RB

Bridge Settlement Records

C.N.R. OVERHEAD ON HWY. # 40A

CONTRACT NO. 64-307

N →



Point	Station	Theoretical El. Feb. 3/66	Actual Elevation Feb. 3/66	δ	Apr. 10/68	δ		δ		δ	
1	275+55.26	647.47			647.21	.26					
2	275+57.04	647.78			647.50	.28					
3	275+58.32	647.49			647.30	.19					
4	275+00.26	647.64			647.67	.03					
5	276+02.04	647.95			647.90	.05					
6	276+03.82	647.65			647.65	.00					
7	276+75.59	647.68			647.78	.10					
8	276+77.37	647.98			647.98	.00					
9	276+79.15	647.68			647.74	.06					
10	277+49.15	647.43			647.42	.01					
11	277+41.37	647.72			647.64	.08					
12	277+46.59	647.41			647.35	.06					
13	277+90.57	647.13			646.93	.20					
14	277+92.37	647.42			647.12	.30					
15	277+94.15	647.10			646.82	.28					
A	276+00	647.94	648.00	.06	647.90	.04					
B	276+50	648.04	648.10	.06	648.03	.01					
C	277+00	647.95	648.00	.05	647.91	.04					
D	277+50	647.74	647.70	.04	647.60	.14					

DEPARTMENT OF HIGHWAYS - ONTARIO
MATERIALS & RESEARCH DIVISION

RECORD OF BOREHOLE NO. 1

FOUNDATION SECTION

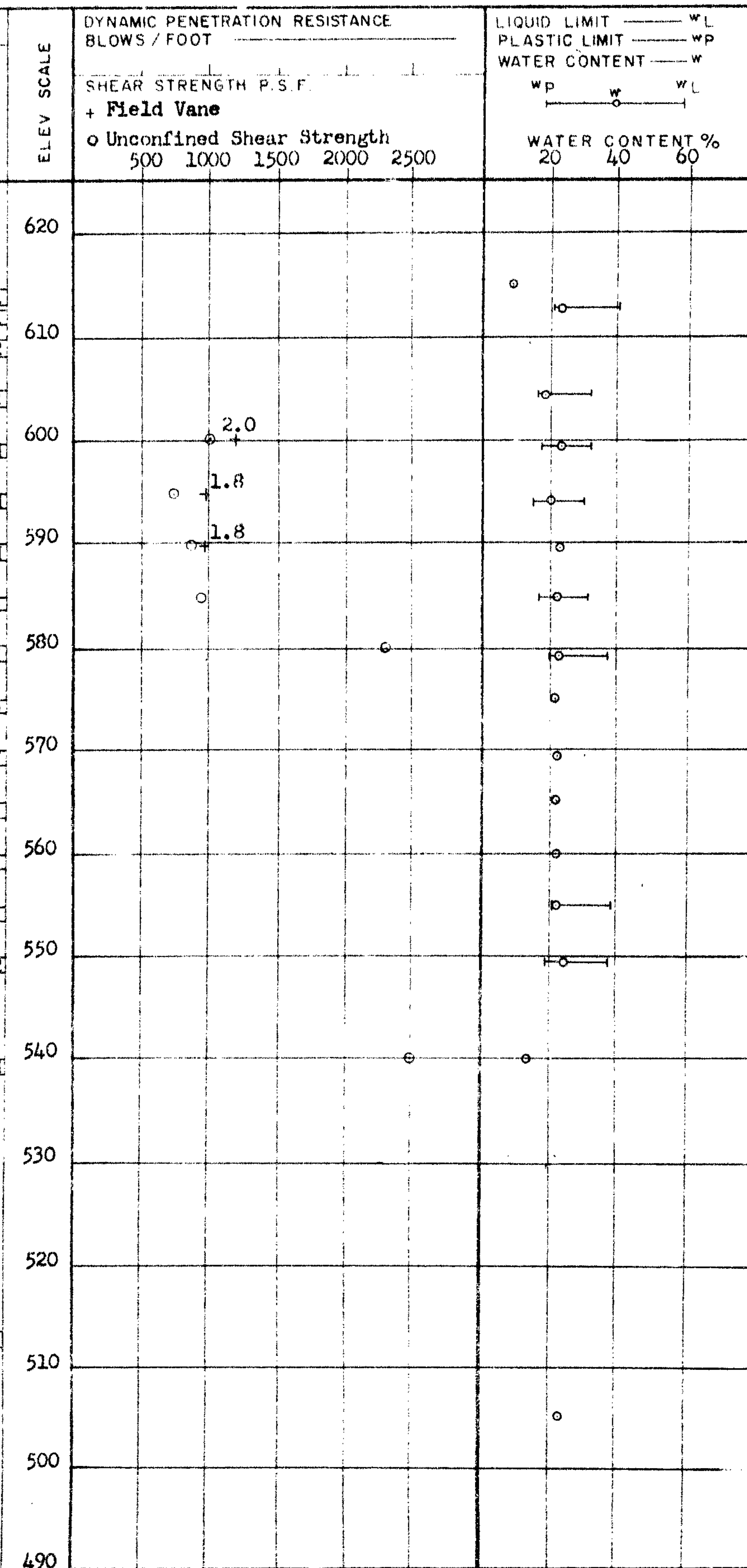
W.P.	63-F-12	LOCATION	276+14 53' Lt.	ORIGINATED BY	T.F.W.
JOB	53-63	BORING DATE	Jan. 29, 1963.	COMPILED BY	T.F.W.
DATUM	Geodetic	BOREHOLE TYPE	5" Ø Auger.	CHECKED BY	H.S.

Soil Profile

Elev. / Depth	Description
619.5 / 0.0	Groundlevel. Hard to soft Heterogeneous clay fill.
610.5 / 9.0	Hard to firm Brown to grey clay silt with sand and gravel.
580.5 / 39.0	Very stiff Grey silty clay with sand and gravel.
494.0 / 125.0	End of borehole. Probable Bedrock.

Samples

Number	Type	Blows / Foot	Bulk Density γ P.C.F.	Remarks
1	SS	24		
2	SS	4		wl 611.5 / 8.0
3	SS	42	137.0	
4	SS	22		
5	TW	PH	128.0	
6	TW	PH	133.0	
7	TW	PH	128.0	
8	TW	PH	128.0	
9	TW	PH	128.0	
10	SS	26		
11	SS	27	133.0	
12	SS	22	129.0	
13	SS	26	128.0	
14	SS	27	130.0	
15	SS	22		
16	TW	PH		
17	SS	23		



FORM DB MI 26 REV
61-4391

OFFICE REPORT ON SOIL EXPLORATION

DEPARTMENT OF HIGHWAYS - ONTARIO
MATERIALS & RESEARCH DIVISION

RECORD OF BOREHOLE NO. 2

FOUNDATION SECTION

JOB 63-F-12 | LOCATION 275+52 ℄ | ORIGINATED BY T.F.W.
W P 53-63 | BORING DATE Feb. 1, 1963. | COMPILED BY T.F.W.
DATUM Geodetic | BOREHOLE TYPE 5" Ø Auger | CHECKED BY H.S.

DYNAMIC PENETRATION RESISTANCE BLOWS / FOOT
SHEAR STRENGTH P.S.F.
+ Field Vane
○ Unconfined Shear Strength
1000 2000 3000 4000 5000

LIQUID LIMIT — w_L
PLASTIC LIMIT — w_P
WATER CONTENT — w
WATER CONTENT %
20 40 60

BULK DENSITY γ P.C.F.

REMARKS

Soil Profile

ELEV. / DEPTH	DESCRIPTION
614.0	Groundlevel
0.0	Hard to firm Brown to grey clayey silt with sand and gravel.
575.0 / 39.0	Very stiff to firm, grey, silty clay with sand and gravel.
495.0 / 119.0	Shale Bedrock.
490.0 / 124.0	End of borehole.

Samples

NUMBER	TYPE	BLOWS / FOOT	BULK DENSITY P.C.F.
1	SS	18	137.0
2	TW		133.0
3	SS	42	133.0
4	TW		133.0
5	SS	25	
6	TW	PH	128.0
7	TW	PH	123.0
8	TW	PH	125.0
9	TW	PH	125.0
10	SS	P	
11	TW	PH	125.0
12	TW	PH	130.0
13	TW	PH	130.0
14	TW	PH	129.0
15	TW	PH	126.0
16	TW	PH	
17	TW	PH	129.0
18	TW	PH	122.0
19	TW	PH	125.0
20	TW	PH	123.0
21	SS	30for½"	

ELEV SCALE: 620, 610, 600, 590, 580, 570, 560, 550, 540, 530, 520, 510, 500, 490

Shear strength annotations: >4550; 1.6; 2.2

REMARKS: ▽wl 610.0 / 4.0

DEPARTMENT OF HIGHWAYS ONTARIO
MATERIALS & RESEARCH DIVISION

RECORD OF BOREHOLE NO. 3

FOUNDATION SECTION

JOB 63-F-12 LOCATION 275+52 48.0' Rt. ORIGINATED BY T.F.W.
W.P. 53-63 BORING DATE Feb. 5, 1963. COMPILED BY T.F.W.
DATUM Geodetic BOREHOLE TYPE 5" Ø Auger CHECKED BY H.S.

ELEV. DEPTH	DESCRIPTION	STRAT. PLOT	NUMBER	TYPE	BLOWS / FOOT	ELEV. SCALE	SHEAR STRENGTH P.S.F. (+ Field Vane, o Unconfined Shear Strength)	WATER CONTENT %	BULK DENSITY γ P.C.F.	REMARKS
						620				
614	Groundlevel									
						610				▽wl 610.5 3.5
	Hard to firm. Brown to grey clayey silt with sand and gravel.		1	SS	29				136	
			2	SS	25					
						600	2.1			
			3	TW	PH				137.0	
			4	TW	PH		2.0		139.0	
						590	1.8			
			5	TW	PH				128.0	
			6	TW	PH		1.8		129.0	
						580				
			7	TW	PH				129.	
						570				
						560				
						550				
						540				
						530				
						520				
						510				
						500				
495.0 119.0	End of borehole Probable Bedrock.									

Chart scales: DYNAMIC PENETRATION RESISTANCE BLOWS / FOOT; SHEAR STRENGTH P.S.F. 500 1000 1500 2000 2500; LIQUID LIMIT w_L, PLASTIC LIMIT w_P, WATER CONTENT w; WATER CONTENT % 20 40 60.

HWAYS – ONTARIO
RESEARCH DIVISION

RECORD OF BOREHOLE NO. 4

FOUNDATION SECTION

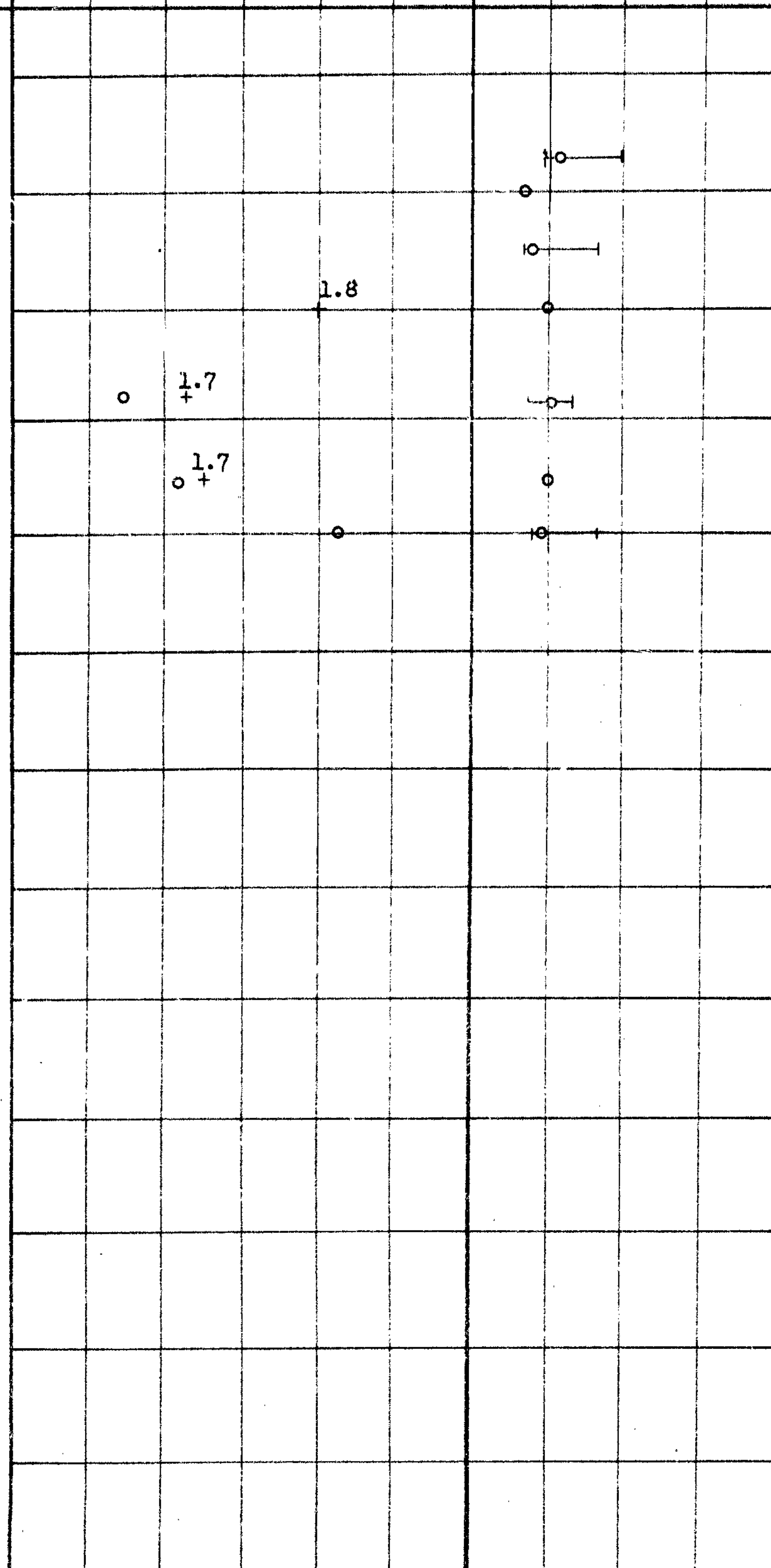
-12	LOCATION 276+55 33' Rt.	ORIGINATED BY T.F.W.
-63	BORING DATE Feb. 6, 1963.	COMPILED BY T.F.W.
eodetic	BOREHOLE TYPE 5" Ø Auger.	CHECKED BY H.S.

PROFILE DESCRIPTION	STRAT. PLOT	SAMPLES NUMBER	TYPE	BLOWS / FOOT	ELEV SCALE	BULK DENSITY γ P.C.F.	REMARKS
roundlevel					620		
eterogeneous fill. ayey silt with sand d boulders.		1	SS	10			
		2	SS	8			wl 612.0 8.0
		3	SS	20	610		
		4	SS	38			
		5	SS	10	600		
		6	TW	PH		130.0	
					590		
ard to firm. rown to grey clayey ilt with sand and avel.		7	TW	PH		129.0	
		8	TW	PH	580	130.0	
					570		
					560		
					550		
					540		
					530		
					520		
					510		
					500		
nd of borehole. robable Bedrock.							

DYNAMIC PENETRATION RESISTANCE BLOWS / FOOT

SHEAR STRENGTH P.S.F.
+ Field Vane
o Unconfined Shear strength
500 1000 1500 2000 2500

LIQUID LIMIT w_L
PLASTIC LIMIT w_P
WATER CONTENT w
WATER CONTENT %
20 40 60



FORM OB-ML-126 REV 1961 — OFFICE REPORT ON SOIL EXPLORATION

61-4391

DEPARTMENT OF HIGHWAYS ONTARIO
MATERIALS & RESEARCH DIVISION

RECORD OF BOREHOLE NO. 5

FOUNDATION SECTION

JOB 63-F-12
W P 53-63
DATUM Geodetic

LOCATION 276+55 29.0' Lt.
BORING DATE Feb. 7, 1963.
BOREHOLE TYPE 5" Ø Auger

ORIGINATED BY T.F.W.
COMPILED BY T.F.W.
CHECKED BY H.S.

ELEV DEPTH	SOIL PROFILE DESCRIPTION	SAMPLE NUMBER	TYPE	BLOWS / FOOT	ELEV SCALE	SHEAR STRENGTH P.S.F. (+ Field Vane, o Unconfined Shear Strength)	WATER CONTENT %	BULK DENSITY γ P.C.F.	REMARKS
619.5	Groundlevel				620				
0.0	Heterogeneous fill. Clayey silt with sand and boulders.	1	SS	6					
		2	TW	PH				119.0	wl 611.5 8.0
610.5 / 9.0	Hard to firm. Brown to grey clayey silt with sand and gravel.	3	SS	29	610				
		4	SS	40				131.0	
		5	TW	PH	600	1.5		132.0	
		6	TW	PH		2.3		130.0	
		7	TW	PH	590	1.8		128.0	
		8	TW	PH		1.8		128.0	
		9	TW	PH	580			129.0	
494.0 / 125.0	End of borehole. Probable Bedrock.								

Elevation scale: 620, 610, 600, 590, 580, 570, 560, 550, 540, 530, 520, 510, 500

DYNAMIC PENETRATION RESISTANCE BLOWS / FOOT
Shear strength scale: 500 1000 1500 2000 2500
LIQUID LIMIT w_L PLASTIC LIMIT w_P WATER CONTENT w
Water content scale: 20 40 60

DEPARTMENT OF HIGHWAYS - ONTARIO
MATERIALS & RESEARCH DIVISION

RECORD OF BOREHOLE NO. 6

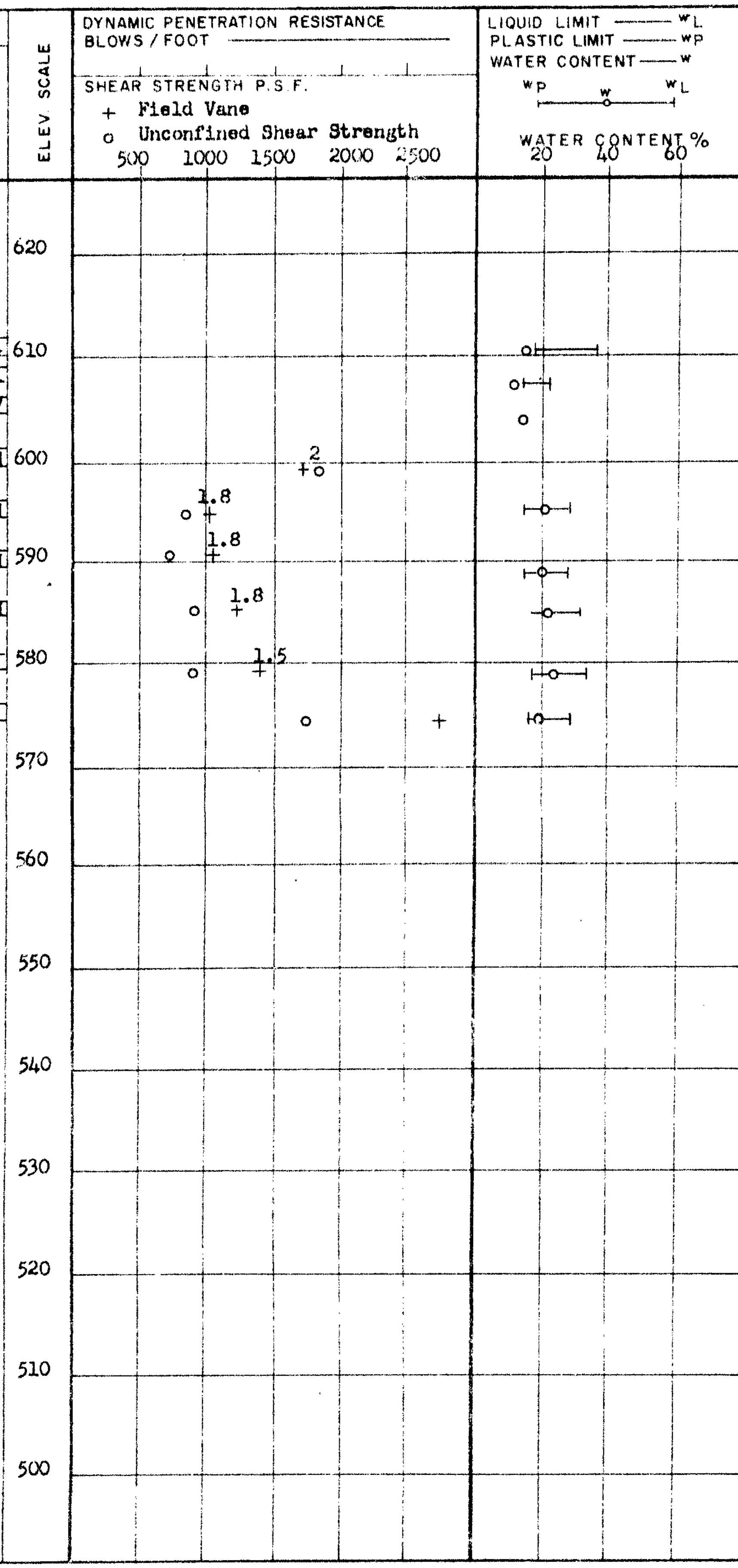
FOUNDATION SECTION

JOB 63-F-12 LOCATION 277+65 38.0' Lt. ORIGINATED BY T.F.W.

W.P. 53-63 BORING DATE Feb. 8, 1963. COMPILED BY T.F.W.

DATUM Geodetic BOREHOLE TYPE 5" Ø Auger CHECKED BY H.S.

ELEV DEPTH	SOIL PROFILE DESCRIPTION	SAMPLE NUMBER	TYPE	BLOWS / FOOT	BULK DENSITY γ P.C.F.	REMARKS
615.0 0.0	Groundlevel					
	Hard to firm Brown to grey clayey silt with sand and gravel.	1	SS	14	134.0	
		2	SS	31	142	
		3	SS	37	137	
		4	TW	PH	131	▽ wl 599. 16.0
		5	TW	PH	132	
		6	TW	PH	125	
		7	TW	PH	128	
		8	TW	PH	128	
		9	TW	PH	130	
494.5 120.5	End of borehole Probable Bedrock					



FORM OB M. 26 REV. 961

OFFICE REPORT ON SOIL EXPLORATION

DEPARTMENT OF HIGHWAYS - ONTARIO
MATERIALS & RESEARCH DIVISION

RECORD OF BOREHOLE NO. 7

FOUNDATION SECTION

JOB 63-F-12 LOCATION 278+00 49.0' Rt. ORIGINATED BY T.F.W.

W P 53-63 BORING DATE Feb. 11, 1963. COMPILED BY T.F.W.

DATUM Geodetic BOREHOLE TYPE 5" Ø Auger CHECKED BY H.S.

ELEV. DEPTH	SOIL PROFILE DESCRIPTION	STRAT. PLOT
615.0 / 0.0	Groundlevel	
	Hard to firm Brown to grey clayey silt with sand and gravel.	
570.0 / 45.0	Very stiff to stiff grey. Silty clay with sand and gravel.	
494.0 / 121.0	Shale Bedrock	
122.0	End of borehole	

SAMPLE NUMBER	TYPE	BLOWS / FOOT	BULK DENSITY P.C.F.
1	TW	PH	
2	TW	PH	
3	TW	PH	128
4	TW	PH	133
5	TW	PH	128
6	TW	PH	129
7	TW	PH	128
8	TW	PH	128
9	TW	PH	128
10	TW	PH	128.0
11	TW	PH	125.0
12	TW	PH	125.0
13	TW	PH	124.0
14	TW	PH	124.0
15	TW	PH	125.0
16	TW	PH	124.0

ELEV SCALE: 620, 610, 600, 590, 580, 570, 560, 550, 540, 530, 520, 510, 500, 490

DYNAMIC PENETRATION RESISTANCE BLOWS / FOOT

SHEAR STRENGTH P.S.F.
+ Field Vane
o Unconfined Shear Strength
500 1000 1500 2000 2500

>5000
1.8
2.5
1.8
3.0
1.6

LIQUID LIMIT — w_L
PLASTIC LIMIT — w_P
WATER CONTENT — w

WATER CONTENT %
20 40 60

REMARKS

∇wl 595.0
2.0

...TMENT OF HIGHWAYS - ONTARIO
...RIALS & RESEARCH DIVISION

RECORD OF BOREHOLE NO. 8

FOUNDATION SECTION

63-F-12	LOCATION 278+12 50.0' Lt.	ORIGINATED BY T.F.W.
53-63	BORING DATE Feb. 11, 1963.	COMPILED BY T.F.W.
...UM Geodetic	BOREHOLE TYPE 5" Ø Auger	CHECKED BY H.S.

Elev./Depth	SOIL PROFILE DESCRIPTION	STRAT. PLOT	SAMPLE NUMBER	TYPE	BLOWS / FOOT	ELEV SCALE	SHEAR STRENGTH P.S.F. (+ Field Vane, o Unconfined Shear Strength)	WATER CONTENT %	BULK DENSITY γ P.C.F.	REMARKS
						620				
615.0 / 0.0	Groundlevel									
	Hard to firm Brown to grey clayey silt with sand and gravel.		1	SS	27	610			137	
			2	SS	36				137.0	
			3	TW	PH	600	2.0		132.0	
			4	TW	PH		2.0		127.0	
			5	SS	9	590	2.1			
584.5 / 30.5	End of borehole.		6	SS	21		1.8		132.0	
						580				

DYNAMIC PENETRATION RESISTANCE BLOWS / FOOT

SHEAR STRENGTH P.S.F.: 500 1000 1500 2000 2500

LIQUID LIMIT w_L, PLASTIC LIMIT w_P, WATER CONTENT w

WATER CONTENT %: 20 40 60