

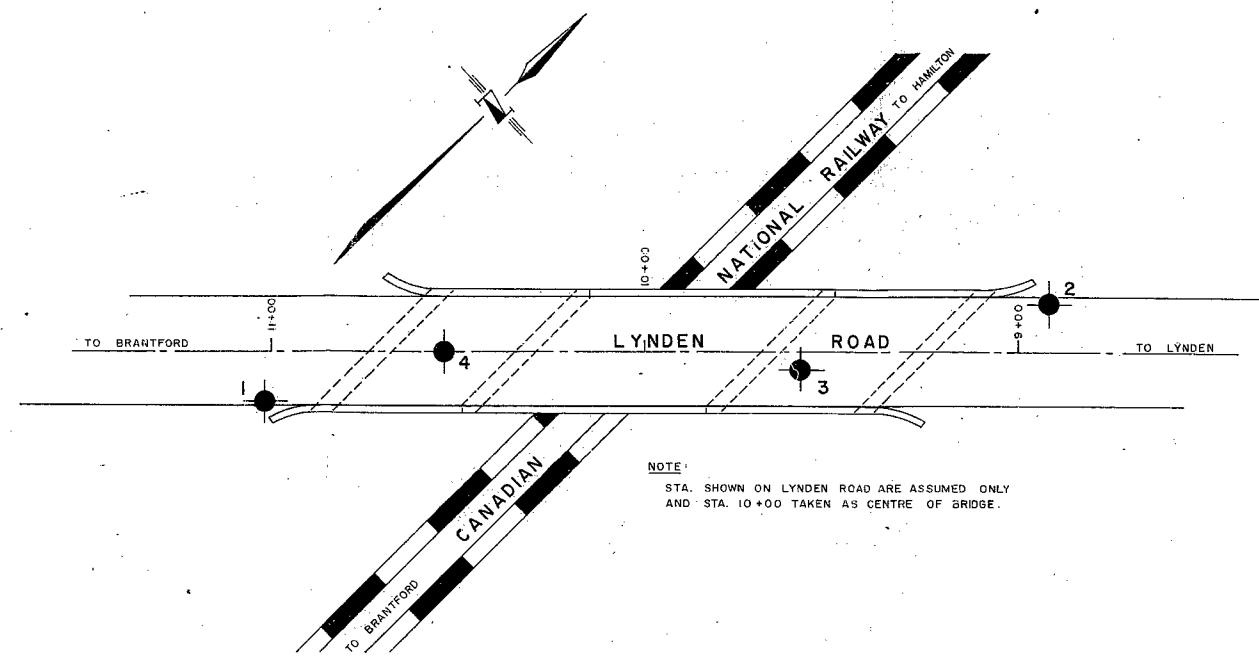
#61-F-122

NARROWWAY BRIDGE

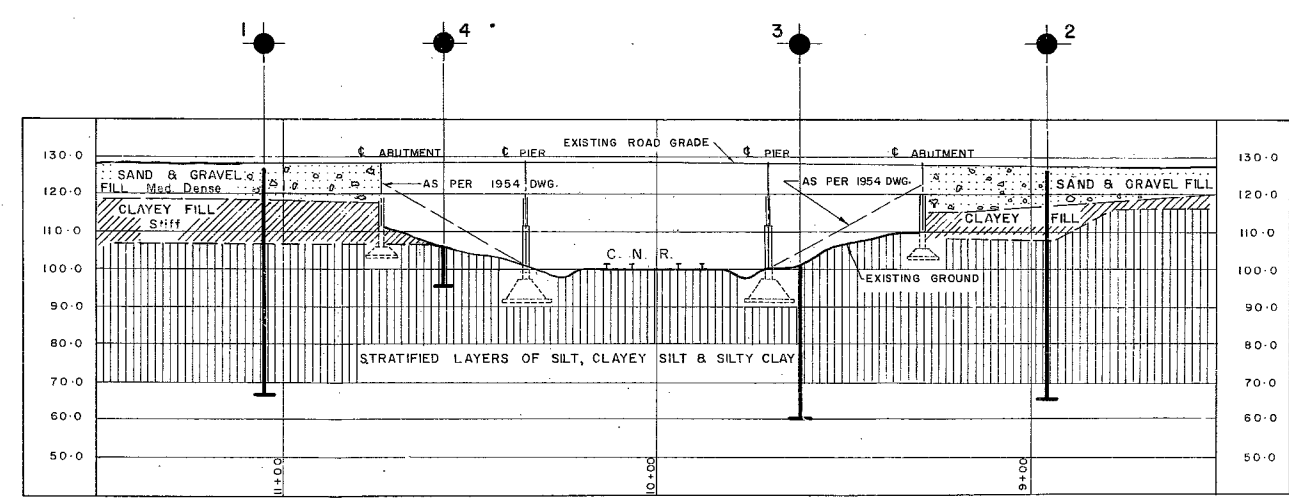
C.N.R. & LYNDEN

RD.

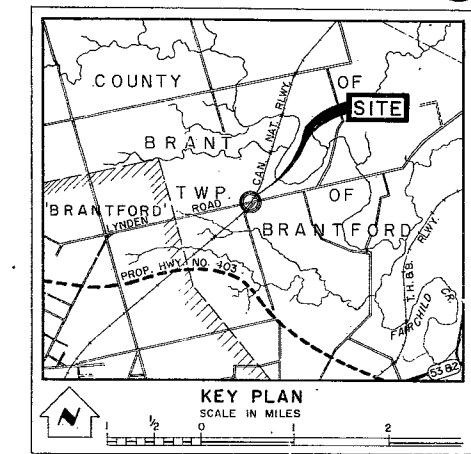
BRANTFORD.



PLAN
SCALE IN FEET
20 10 0 20 40 60



PROFILE
SCALE IN FEET
20 10 0 20 40 60



LEGEND			
	Bore Hole		
	Cone Penetration Hole		
	Bore & Cone Penetration Hole		
	Water Levels established at time of field investigation		

NO.	ELEVATION	STATION	OFFSET
1	127.0	11+02	13.5' LT.
2	126.5	8+92	13' RT.
3	101.0	9+59	5' LT.
4	106.0	10+54	E

563800
4750700
40P1E
17

- 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.

DEPARTMENT OF HIGHWAYS - ONTARIO MATERIALS & RESEARCH DIVISION - FOUNDATION SECTION		
NARROWWAY BRIDGE CANADIAN NATIONAL RAILWAY AND LYNDEN ROAD - BRANTFORD		
ORIGINATED T. WIDDIS	DISTRICT NO. 4	DATE MARCH 16, 1962
DRAWN F. CLARK	W.P. NO. MUNICIPAL	JOB NO. 61-F-122
CHECKED <i>CR</i>	CONTRACT NO.	DRAWING NO.
APPROVED <i>J.P.</i>		61-F-122 A

Mr. A. M. Toye,
Bridge Engineer.

Materials & Research Division,
(Foundation Section)

April 30, 1962.

D.H.O. FOUNDATION INVESTIGATION
REPORT.

W.J. 61-F-122 -- (Municipal)

Attention: Mr. K. L. Kleinsteinber,
Municipal Bridge Liaison Engr.

Re: Narrowway Bridge over C.N.R., Brantford Twp.,
Lot 42, Con. II/III, Brant County, Dist. #4.

Attached, we are forwarding you our detailed foundation report on subsoil conditions existing at the site of Narrowway Bridge. The purpose of this investigation was to determine the cause, or causes of reported movements of the abutment walls for this structure.

Presented in this report are the results of this investigation, together with recommended remedial measures. We believe the information contained therein will prove adequate; however, should further assistance be required, please do not hesitate to contact our Office.

AGS/MdeF
Attach.

cc: Messrs. A. M. Toye (3)
J. P. Howard
W. H. Venn
T. J. Kovich
A. Watt

Foundations Office ✓
Gen. Files.

A. G. Stermac
A. G. Stermac,
PRINCIPAL FOUNDATION ENGINEER

TABLE OF CONTENTS

1. INTRODUCTION.
 2. DESCRIPTION OF THE SITE AND GEOLOGY.
 3. FIELD AND LABORATORY INVESTIGATION.
 4. SUBSOIL CONDITIONS:
 - 4.1) General.
 - 4.2) Sand & Gravel Fill.
 - 4.3) Clayey Fill.
 - 4.4) Stratified Layers of Silt, Clayey Silt & Silty Clay.
 5. GROUND WATER CONDITIONS.
 6. DISCUSSIONS & RECOMMENDATIONS.
 7. SUMMARY.
 8. MISCELLANEOUS.
-

FOUNDATION INVESTIGATION

For

Narrowway Bridge over C.N.R., Brantford Twp.,
Lot 42, Con. II/III Brant County, Dist. #4,
W.J. 61-F-122 - (Municipal Job)

1. INTRODUCTION:

A request to carry out an investigation at the site of the Narrowway Bridge over the C.N.R. in the Twp. of Brantford where some movements of the abutment walls have been reported, was received from the Municipal Bridge Liaison Engineer, Mr. K. L. Kleinsteinber, in a memo dated December 11th, 1961.

A field investigation was subsequently carried out by this Section to determine the subsoil conditions existing at the site. Presented in this report are the results of this investigation, together with recommended remedial measures.

2. DESCRIPTION OF THE SITE AND GEOLOGY:

The site is situated some 3 miles east of the City of Brantford, Ontario. The area, which is characterized by undulating topography, lies within the Norfolk Sand Plain. However, the subsoil conditions of silty clay and silts are characteristic of the Haldimand Clay Plain.

3. FIELD AND LABORATORY INVESTIGATION:

The field work consisted of four boreholes put down in BX and NX casing to depths varying from 60.0' in B.H.#1 to 10.0' in B.H.#4, using a skid-mounted machine and standard wash boring methods. Undisturbed samples were obtained using 2" I.D. Shelby tubes

cont'd. /2 ...

- 2 -

3. FIELD AND LABORATORY INVESTIGATION: (cont'd.) ...

Where possible, field vane tests were carried out to determine the insitu shear strength of the cohesive deposits. Disturbed samples were recovered by means of a 2" O.D. split spoon sampler. Driving energy to advance the split spoon was 350 ft.-lbs. Relative densities of the subsoil were obtained in the field by means of the Standard Penetration Test. The samples were returned to the laboratory where the following tests were carried out on selected representative samples:- Atterberg Limits and moisture content, density, undrained triaxial shear strength, consolidated undrained triaxial with pore pressure measurements and consolidation tests. Results of the above tests are given in the Appendix of this report. A plan of the site showing the location of the boreholes and the soil stratigraphy, is shown on Dwg. 61-F-122A.

4. SUBSOIL CONDITIONS:

4.1) General:

Subsoil at the site consists of stratified layers of silt, clayey silt and silty clay. These deposits are overlain by fill material at the bridge approaches. The boundaries of the different deposits are shown on the accompanying borelog sheets. The estimated stratigraphical profile of Dwg. No. 61-F-122A is based upon this information.

A detailed description of the various strata is given in the following paragraphs:-

cont'd. /3 ...

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

4.2) Sand & Gravel Fill:

This material is a fine to coarse sand containing some gravel and silt. The gravel is well rounded and its maximum diameter is approximately 2 inches. It is desiccated throughout its depth and as a result, has a brown colour. This material forms the upper portion of the approach embankments and was found to a depth of 8.0 ft. in B.H. #1 and 11.0' in B.H. #2, extending from el. 127.0 to el. 116.0.

Standard Penetration resistances or 'N' values of 7 to 17 blows/ft. were obtained in this material. From these values it is estimated that the relative density is loose to compact.

4.3) Clayey Fill:

This material forms the lower portion of the approach embankments. It was found immediately below the granular fill in B.H. #1 & #2 and its thickness was about 12 ft. in B.H. #1 and about 6.0 ft. in B.H. #2.

Occasional traces of sand and gravel with organic matter were found throughout the fill in B.H. #2, the organic content becoming more pronounced in the lower 2 feet.

Laboratory tests indicated that the liquid limits of the material ranged from 42% to 47%, with an average of 43%, and plastic limits ranged from 20% to 23%, with an average of 21%. Natural water contents were slightly above the plastic limit and averaged 22%. These Atterberg limits indicate the deposit to be generally a clay of intermediate plasticity.

Unit weights of 123 to 130 p.c.f. with an average of 126 p.c.f. were measured.

cont'd. /4 ...

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

4.3) Clayey Fill: (cont'd.) ...

The 'N' values range from 9 to 12 blows/ft. with an average value of 10, indicating the consistency of the material to be stiff.

4.4) Stratified Layers of Silt, Clayey Silt & Silty Clay:

This deposit extends from below the fill in B.H. #1 & #2 and from the ground surface in B.H. #3 and B.H. #4. It consists of irregularly occurring layers of silt, clayey silt and silty clay. The silt layers are generally very thin (less than 1/2 inch) and occur frequently throughout the entire stratum. In addition to the thin seams, a more extensive silt deposit 6 - 10 ft. was observed in B.H. #2, #3 and #4, the upper contact being 17 ft., 18 ft., and ground surface, respectively. The clayey silt layers varied in thickness from 1/2 inch to 2.5 ft. and occurred at frequent intervals throughout the entire depth. The silty clay layers varied in thickness from about 6 inches to 2.0 ft. and occurred frequently down to a depth of 45.0 ft. below the original ground surface. Below this, very few silty clay layers were observed.

'N' values varied from 8 to 28 blows/ft. for the stratified layers. In the thicker silt deposits, however, the 'N' values were generally higher, and ranged from 16 to 28 blows/ft.

Undrained triaxial tests and field vane tests showed poor agreement, with the vane results generally higher. This is probably due to the silty and stratified nature of the overall deposit. However, it is estimated that the shear strength of the cohesive deposit varies erratically from 1060 p.s.f. to 2390 p.s.f.

cont'd. /5 ...

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

4.4) Stratified Layers of Silt, Clayey Silt & Silty Clay:(cont'd)

Comparitive laboratory results of Atterberg limits, moisture contents and bulk densities for the separated and unseparated materials are given below:-

Material	LL %	WP %	W %	γ p.c.f.
Silt	-	-	21 - 28	129 - 132
Clayey Silt	25 - 33	19 - 23	19 - 29	119 - 127
Silty Clay	36 - 47	19 - 25	21 - 38	122 - 130
Unseparated material	35 - 45	18 - 22	21 - 28	123 - 130

Triaxial tests carried out on samples from the composite layers to determine the effective stress parameters gave average values of $C' = 0$ and $\phi' = 26^\circ$.

5. GROUND WATER CONDITIONS:

Observations carried out during the time of the field investigation indicate that the ground water level is approx. 16 ft. to 24 ft. below the existing ground level. The exact water levels observed at the time of the investigation are shown on borehole logs (Appendix I). Artesian water condition was not observed in any of the boreholes during the time of investigation.

cont'd. /6 ...

6. DISCUSSIONS & RECOMMENDATIONS:

The Narrowway Bridge is a steel and concrete structure which was built in 1955. There are three spans of 26', 40', and 26'. The piers and abutments are supported on spread footings founded at elevations 91.24 and 102.07, respectively. The height of the approach embankments is about 20.0' at each abutment location. Soon after the bridge was constructed, it was observed that both abutments had moved forward slightly at the top. The movements have not been measured but have reached such an extent that cracking of the bridge seats has occurred. It was observed during the field investigation that the backfill material in front of the abutment walls had not been constructed to the height as shown on the bridge drawings. This is illustrated on Pwg. 61-F-122A. Subsoil at the site consists of stratified layers of silt, clayey silt and silty clay with an average undrained shear strength of 1300 p.s.f. at the abutment footing locations. The backfill consists of about 10 ft. of granular material, followed by about 10 ft. of clayey fill material.

Analyses were carried out to determine the factor of safety with regard to slip failure, sliding and overturning of the abutments. For purposes of calculation, the following assumptions have been made:-

Fill Material:-

$$\gamma = 120 \text{ p.c.f.}$$

$$\phi = 30^{\circ}$$

$$k_a = 0.33$$

$$k_p = 1.87$$

6. DISCUSSIONS & RECOMMENDATIONS: (cont'd.) ...

Analyses to determine the factor of safety: (cont'd.) ...

Subsoil:-

(stratified layers of
silt, clayey silt &
silty clay)

$$\gamma = 120 \text{ p.c.f.}$$

$$c' = 0$$

$$\phi' = 26^\circ$$

$$C = 1300 \text{ p.s.f.}$$

$$K_a = 0.39$$

Stability Analysis - (circular arc type failure):

The calculations showed that in terms of total stress, the S.F. is 1.46, whereas in terms of effective stresses, the S.F. is about 1.12. In view of these facts, it is felt that this type of failure probably has not occurred. This conclusion is further justified by the fact that there are no visible signs such as would be expected in a failure of this type.

Stability Analysis - (sliding of abutment base):

For this type of failure, a F.S. of slightly more than 2.0 was obtained. In consequence, it is concluded that significant sliding has not occurred.

Stability Analysis - (overturning of the abutment):

Calculations show that the maximum footing pressure occurs at the toe of the footing and is approximately equal to 8200 p.s.f. The ultimate bearing capacity was computed to be about 8200 p.s.f.

cont'd. /8 ...

6. DISCUSSIONS & RECOMMENDATIONS: (Cont'd.) ...

Stability Analysis - (overturning of the abutment): (cont'd.)

This gives a factor of safety of about 1.0. The calculations, however, do not take into account the horizontal thrust induced by the steel girders during expansion and contraction. It is felt that these forces would be sufficient to reduce the F.S. to a value less than 1.0. It is concluded, therefore, that this has probably occurred and that a local progressive failure has taken place at the toe of the abutment footing.

In order to rectify this situation, it is recommended that approach spans of about 25 ft. with new abutments, be constructed. The existing abutments will in this case, serve as piers and removal of the backfill behind the walls to about el. 110.0 will reduce the maximum pressure on the footing base to about 3000 p.s.f. This should be satisfactory.

The new abutments should be designed to resist all induced horizontal thrusts and in consequence, piled foundations are recommended. Treated timber piles driven to el. 80.0 should provide a design load of 15 tons/pile.

7. SUMMARY:

A field investigation was carried out to determine the subsoil conditions at the Narrowway Bridge in Brampton. The bridge is a three-span steel and concrete structure and was completed in 1955. Both abutments have moved forward at the top to such an extent that cracking of the concrete at the bridge seats has occurred.

cont'd. /9 ...

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

Subsoil at the site consists of about 20 ft. of fill material, followed by stratified layers of silt, clayey silt and silty clay. Various stability analyses have been carried out as a result of which it is concluded that a local shear failure has probably taken place at the toes of the abutment footings. As a remedial measure, it is proposed that additional 25-ft. approach spans be constructed with new abutments placed in the fill and supported on treated timber piles. Piles should be designed so as to resist all induced horizontal thrusts. For estimating purposes, it can be assumed that piles driven to approx. el. 80.0 can support a safe load of 15 tons per pile.

8. MISCELLANEOUS:

The field work was carried out from Monday, 18th December to Friday, 29th, December 1961, by the Dominion Soil Drilling Co., Ltd., and was supervised for the Department of Highways, Ontario, by Mr. T. F. Widdis.

T. F. Widdis

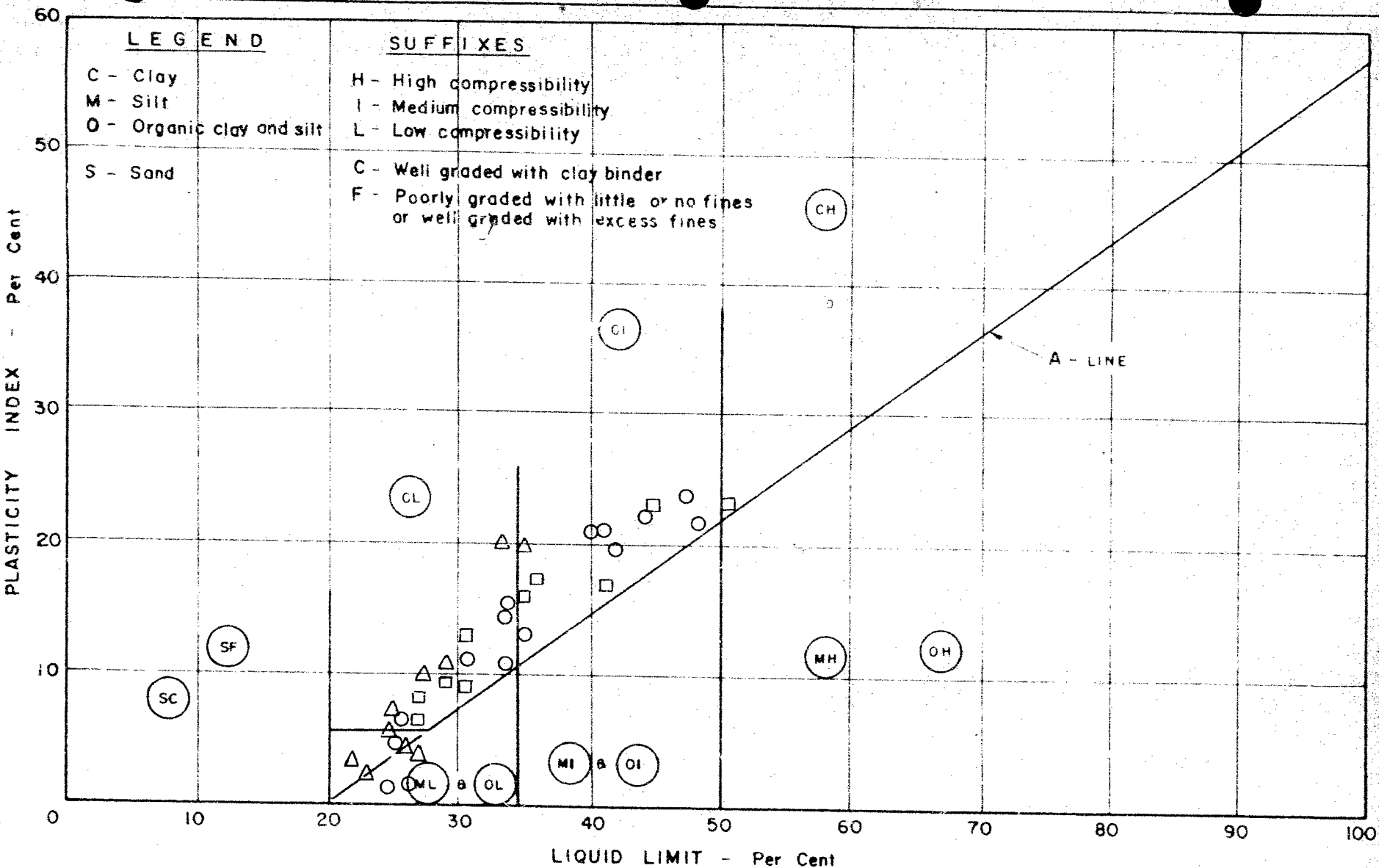
April 1962. REPORT PREPARED BY:

T. F. Widdis,
PROJECT FOUNDATION ENGINEER.

REPORT APPROVED BY:

M. Devata
M. Devata,
SR. PROJECT FOUNDATION ENGINEER.

APPENDIX I.



NOTES

BOREHOLE No. 1 ○
BOREHOLE No. 2 □
BOREHOLE No. 3 △

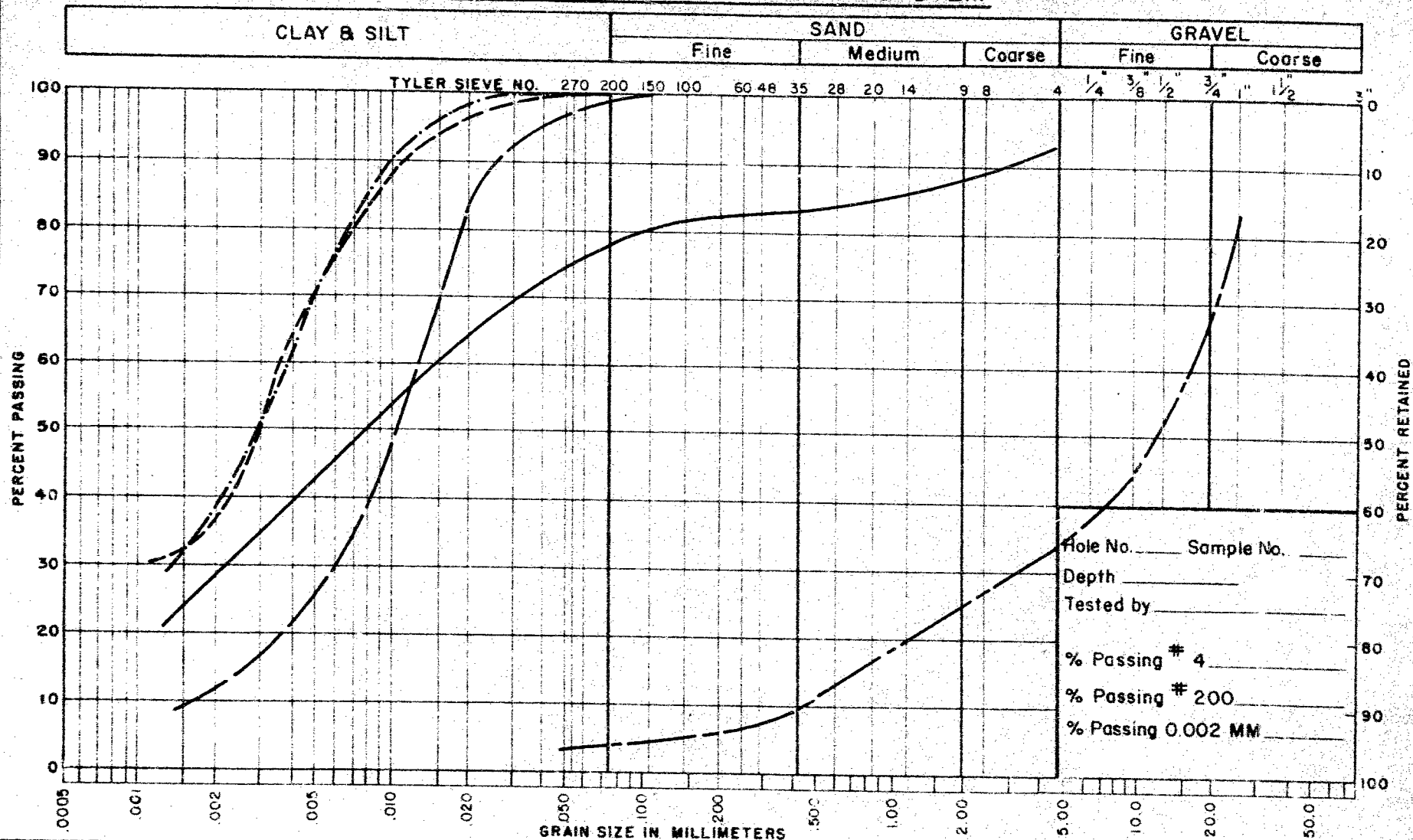
DEPARTMENT OF HIGHWAYS - ONTARIO
MATERIALS & RESEARCH SECTION
PLASTICITY CHART

Job No. 61 - F - 122

W.P. No.

Location

UNIFIED SOIL CLASSIFICATION SYSTEM



NOTES

BOREHOLE -2 SAMPLE No. 2 _____

BOREHOLE -2 SAMPLE No. 5 _____

BOREHOLE -2 SAMPLE No. 1 _____

BOREHOLE -1 SAMPLE No. 14 _____

BOREHOLE -3 SAMPLE No. 8 _____

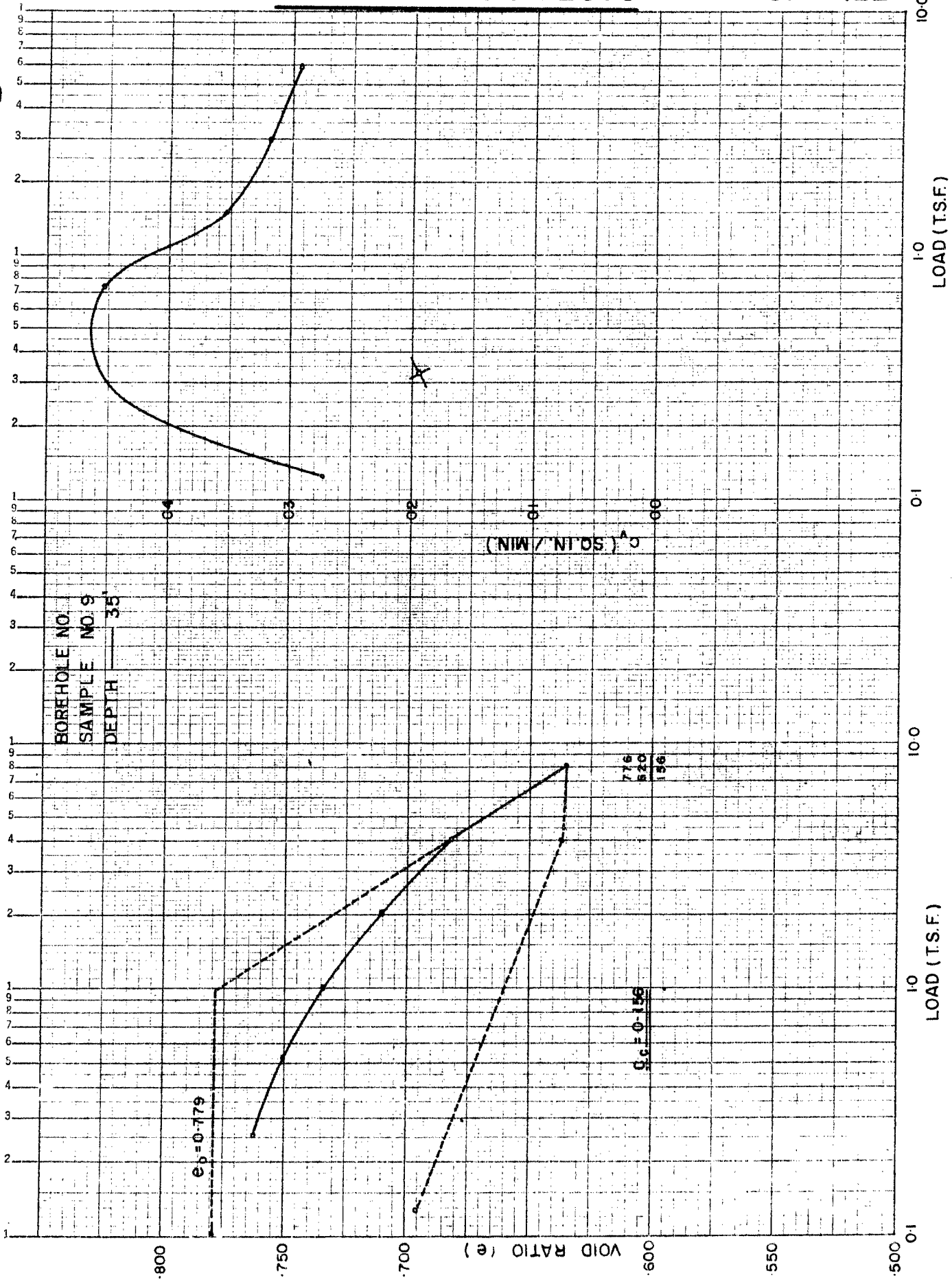
DEPARTMENT OF HIGHWAYS - ONTARIO
MATERIALS & RESEARCH SECTION
GRAIN SIZE DISTRIBUTION

Job No. **61-F-122** W.P. No. _____

Location _____

CONSOLIDATION TESTS

61-F-122



CONSOLIDATION TESTS

61-F-122

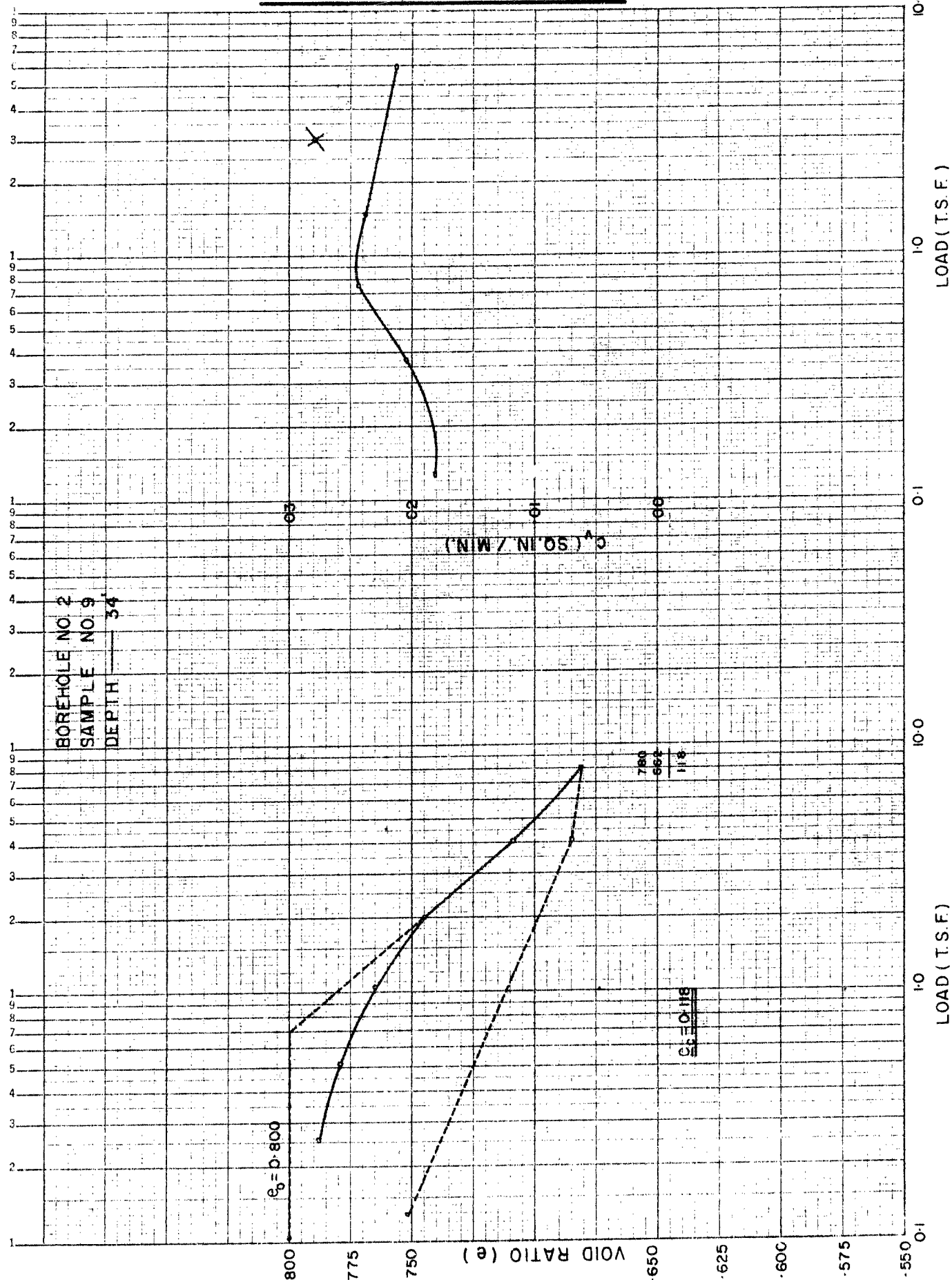
SEMI-LOGARITHMIC 359-91
NEUFELD & COMPANY, INC. PITTSBURGH, PA.
5 CYCLES A 75 DIVISIONS

BOREHOLE NO. 2
SAMPLE NO. 9
DEPTH 34'

$e_0 = 0.800$

$C_c = 0.18$

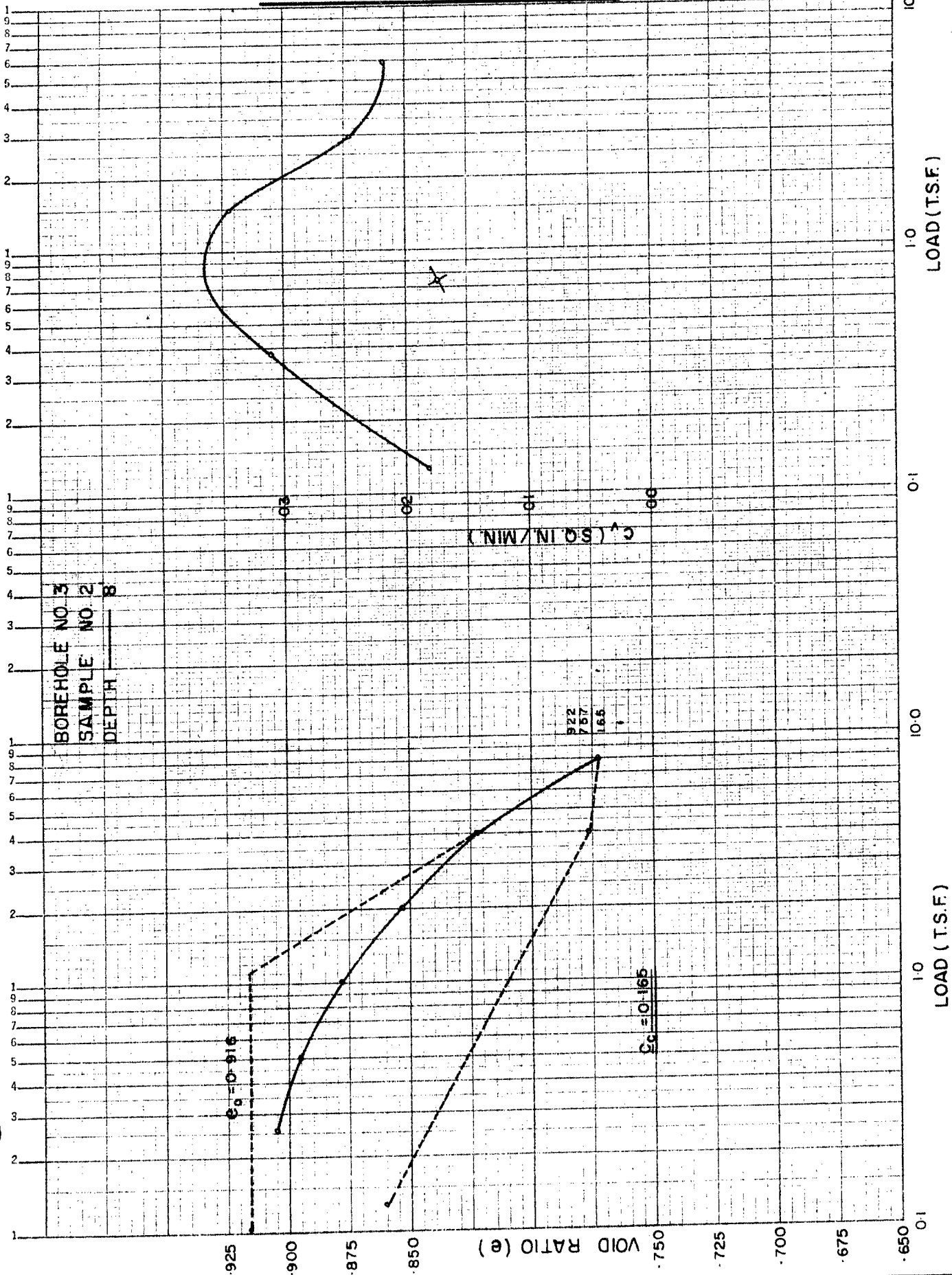
$C_u = 0.18$



CONSOLIDATION TESTS

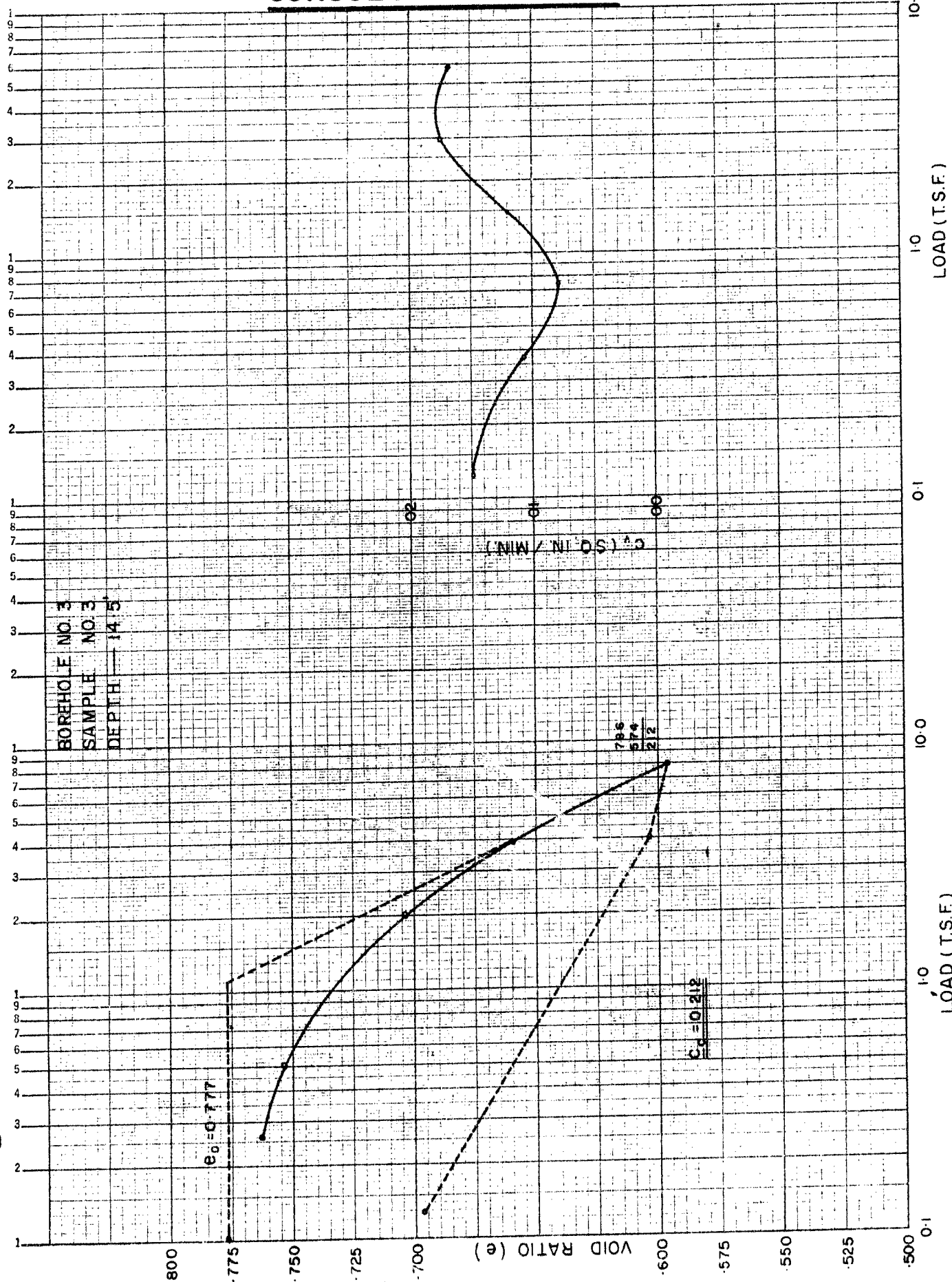
61-F-122

K&E SEMI-LOGARITHMIC 359-91
KEUFFEL & ESSER CO. MADE IN U.S.A.
5 CYCLES X 70 DIVISIONS



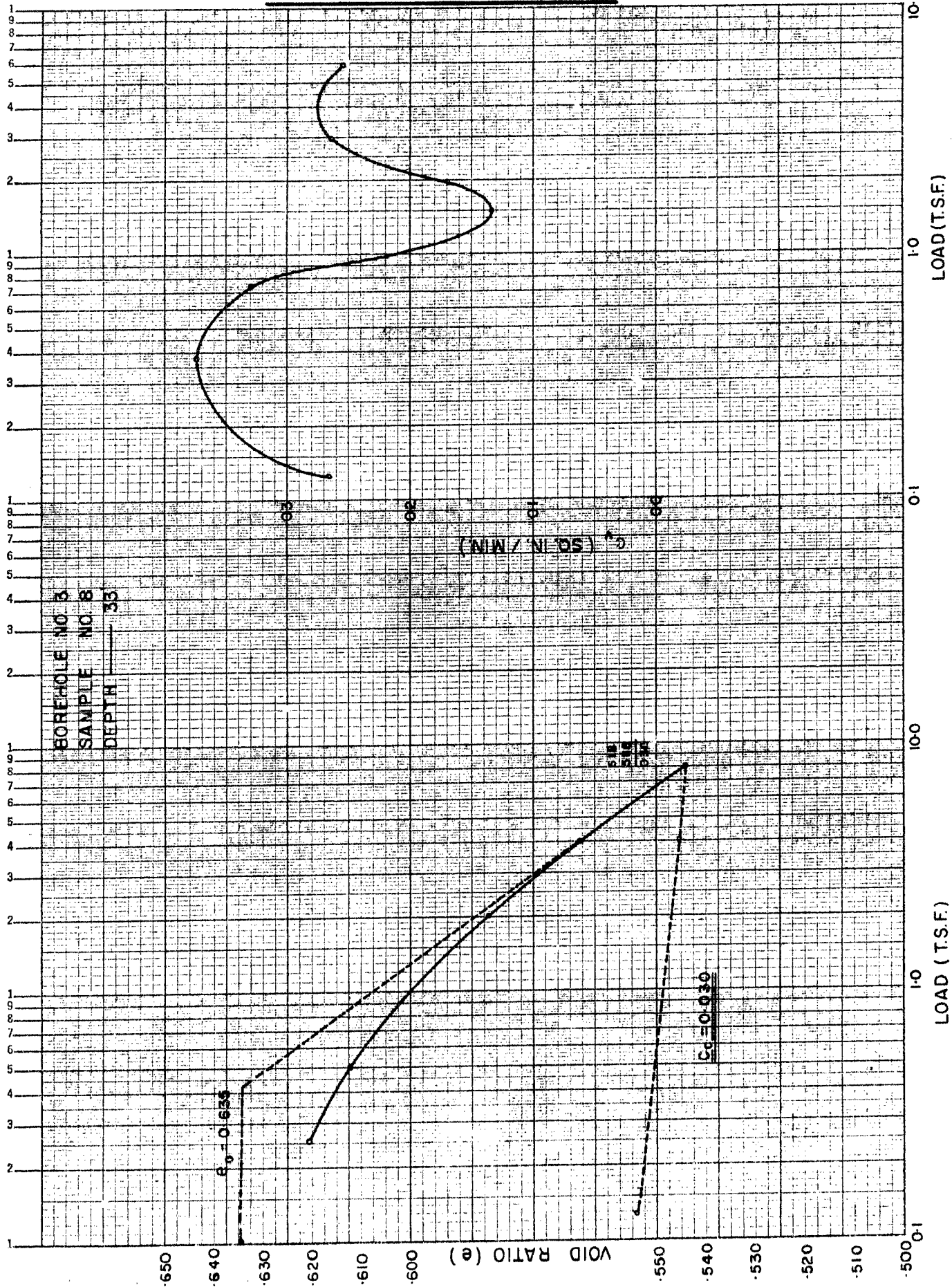
CONSOLIDATION TESTS

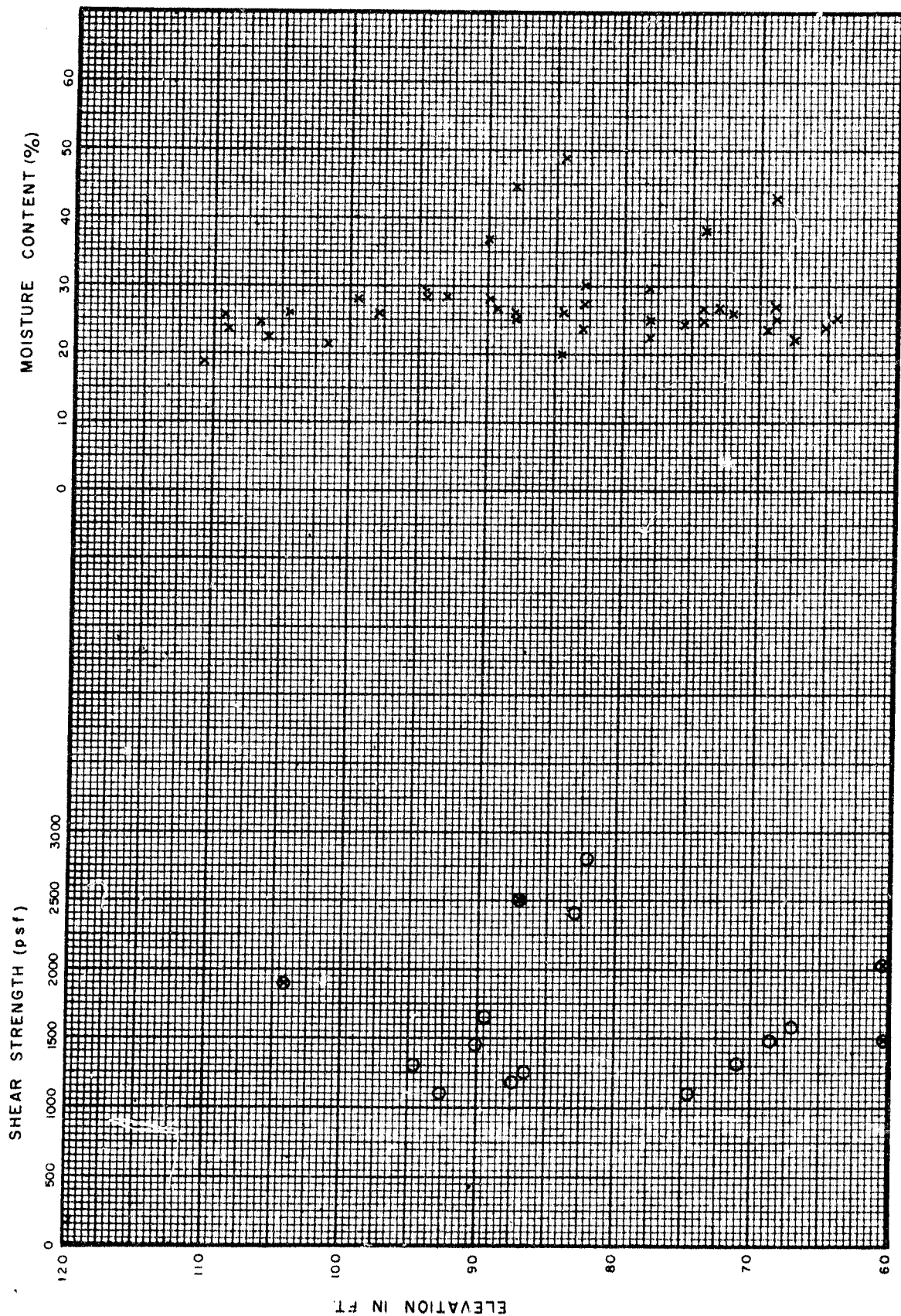
61-F-122



CONSOLIDATION TESTS

61-F-122





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 :-

<u>CONSISTENCY</u>	<u>'N' BLOWS / FT.</u>	<u>c LB. / SQ. FT.</u>	<u>DENSENESS</u>	<u>'N' BLOWS / FT.</u>
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'
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_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 (YOUNG'S 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_0	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

SOIL PROFILE			SAMPLES			DYNAMIC PENETRATION RESISTANCE BLOWS / FOOT		LIQUID LIMIT ——— w _L PLASTIC LIMIT ——— w _p WATER CONTENT ——— w			BULK DENSITY P.C.F.	REMARKS
ELEV. DEPTH	DESCRIPTION	STRAT. PLOT	NUMBER	TYPE	BLOWS / FOOT	ELEV. SCALE	SHEAR STRENGTH P.S.F. Field Vane Test	WATER CONTENT %				
							500 1000 1500 2000 2500 3000	20 40 60				
27.0	Groundlevel					130						
0.0	Fill material Compact Fine to coarse sand and gravel.		1	S.S.	14	120						
19.0	Stiff, grey to brown silty clay. - Probably fill material.		2	S.S.	9	110						
8.0			3	S.S.	12							124.9
			4	S.S.	9							130.0
			5	T.W.	P							123.5
07.0	Very stiff, brown clayey silt to silty clay with seams of silt - (below 45.0' the material is predominantly clayey silt containing thin seams of silt).		6	S.S.	25	100						
20.0			7	S.S.	18							123.5
			8	S.S.	27							126.5
			9	T.W.	P							125.0
			10	T.W.	P							126.0
			11	S.S.	9							119.3
			12	S.S.	14							
			13	S.S.	12							
			14	T.W.	P							123.0
			15	S.S.	8							
6.0	End of Hole.		16	T.W.	P	70						
1.0			17	S.S.	13							
						60						

JOB 61-F-122 LOCATION 8-92 13.0 ft. Lt. (Assumed) ORIGINATED BY T.F.W.
W.P. - BORING DATE Dec. 20, 1961. COMPILED BY H.S.
DATUM 126.5 BOREHOLE TYPE NX Casing Washboring CHECKED BY M.D.

SOIL PROFILE			SAMPLES			ELEV. SCALE ELEV. FEET	DYNAMIC PENETRATION RESISTANCE BLOWS / FOOT	Liquid Limit — W _L Plastic Limit — W _P	WATER CONTENT % w _p w w _L 20 40 60	γ P.C.F.	REMARKS
ELEV. DEPTH	DESCRIPTION	STRAT. PLOT	NUMBER	TYPE	BLOWS / FOOT		SHEAR STRENGTH P.S.F. Field Vane Test +	O			
126.5	Groundlevel					126					
0.0	Fill Material Compact Fine to coarse sand and gravel.		1	S.S.	17						
115.5			2	S.S.	7	116					
11.0	Fill Material Clay with sand and traces of organic matter. Firm.		3	S.S.	17						
109.5			4	S.S.	28						
17.0	Compact brown silt with slight plasticity		5	S.S.	25	106					
101.5			6	S.S.	16						
25.0	Firm to stiff, grey, silty clay to clayey silt with thin seams of silt (below 44.0' the material is generally clayey silt with thin seams of silt).		7	T.W.	P	96					
			8	S.S.	12						
			9	T.W.	P						
			10	S.S.	12						
			11	T.W.	P	86					
			12	S.S.	18						
			13	T.W.	P						
			14	S.S.	10						
			15	T.W.	P	76					
			16	S.S.	10						
			17	T.W.	P						
			18	S.S.	14						
55.0			19	T.W.	P	66					
11.5	End of borehole.					56					

CHECKED BY M.D.

$\phi' = 27^\circ$
 $C' = 0$
 $\sqrt{84.70W.T}$
 $\phi' = 27.5^\circ$
 $C' = 0$

CHECKED BY M.D.

SOIL PROFILE			SAMPLES			DYNAMIC PENETRATION RESISTANCE				LIQUID LIMIT ——— WL				BULK DENSITY P.C.F.	REMARKS		
ELEV. DEPTH	DESCRIPTION	STRAT. PLOT	NUMBER	TYPE	BLOWS / FOOT	ELEV. SCALE	BLOWS / FOOT				PLASTIC LIMIT ——— WP					WATER CONTENT ——— W	
							SHEAR STRENGTH P.S.F.				WATER CONTENT %						
						110											
106.0	Groundlevel																
0.0	Compact brown silt with slight plasticity																
	Grey silty clay					100											
	From elev. 960.0'																
95.25	End of Borehole.			T.W.	P												
						90											

December 15, 1961.

Mr. K. L. Kleinstelber,
Bridge Office,
Department of Highways,
Queens Park,
Toronto, Ontario

Murphy
Dec 18, 1961

ag

Dear Sir:

Re: Narrowway Bridge.

Following our telephone conversation today, I hereby authorize the Department to carry out soils investigation on either side of the Narrowway Bridge, the estimated cost of which is \$2500.00.

Yours very truly,

R. H. R. R.

PRH/mw.

County Engineer.

File under 61-122

DEC 11 11 21 AM '61

D. H. O.
TORONTO
RECEIVED
DEC 18 1961
BRIDGE
OFFICE