

## DEPARTMENT OF HIGHWAYS ONTARIO

## MEMORANDUM

Mr. B. B. Davis,  
 Bridge Engineer,  
 Bridge Division.

FROM: Foundation Section,  
 Materials & Testing Div.,  
 Room 107, Lab. Bldg.

Attention: Mr. S. McCombie

DATE: August 4, 1965

Our File Ref.

IN REPLY TO

## SUBJECT:

FOUNDATION INVESTIGATION REPORT  
 For  
 Widening of Puce River Bridge over  
 Hwy. 401, District No. 1 (Chatham).  
 W.J. 65-F-76 --- W.P. 693-64

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

We believe that you will find the factual data and recommendations contained therein, adequate for your design requirements. Should you require additional information, please feel free to contact our Office.

KYL/MdeF  
 Attach.

cc: Messrs. B. R. Davis (2)  
 H. A. Tregaskes  
 D. W. Farren  
 A. Gater  
 F. C. Brown  
 J. Roy  
 A. Watt

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

Foundations Office  
 Gen. Files ✓

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# FOUNDATION INVESTIGATION REPORT

For

Widening of Puce River Bridge over  
Hwy. 401, District No. 1 (Chatham)  
W.J. 65-F-76 --- W.P. 693-64

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## 1. INTRODUCTION:

A request to conduct a foundation investigation at the Puce River crossing of Highway #401, dated June 17, 1965, was received from Mr. G. Scott, Regional Bridge Location Engineer.

It is proposed to widen the existing bridge by an additional lane on the south side. The bridge is located 8.6 miles east of Highway #98.

In order to determine the soil conditions, an investigation was carried out by this Section. Results and discussion of the field and laboratory work as well as recommendations for the foundations, are contained in this report.

## 2. DESCRIPTION OF SITE AND GEOLOGY:

The site is located in Concession V of Maidstone Township in the County of Essex. At this location, the Puce River flows northward towards Lake St. Clair and at the time of the investigation, the volume of flow was quite small. The right-of-way of Highway 401 at the crossing of the Puce River passes through a small, basically deciduous bush. The surrounding topography is quite flat.

2. DESCRIPTION OF SITE AND GEOLOGY: (cont'd.) ...

The general area of the site is part of the Essex Clay Plain which is a glacial deposit consisting of a clayey till underlain at a considerable depth by Paleozoic bedrock. The relatively soft nature of the Paleozoic sediments, which are believed to be the parent material of the till, may explain the general lack of gravel size and larger particles in the otherwise till-like deposits.

3. FIELD AND LABORATORY WORK:

Two sampled boreholes and one dynamic cone penetration test were carried out at the site using conventional diamond drilling equipment adapted for soil sampling purposes. A driving energy of 350 ft.-lbs. per blow was used for the dynamic cone penetration test.

Wherever possible, in cohesive materials, 2-inch I.D. Shelby tube samples were obtained by pushing the tubes into the soil manually. Otherwise, samples were obtained using a 2-inch O.D. split-spoon sampler driven according to the specifications of the Standard Penetration Test. In addition, in-situ vane tests were conducted in the field to determine the shear strength of cohesive materials.

Samples were visually examined and identified in the field and subsequently, in the laboratory. Laboratory tests were conducted on selected representative samples to determine, where applicable:

cont'd. /3 ...

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

- 1) Atterberg Limits
- 2) Bulk Density
- 3) Grain-Size Distribution
- 4) Natural Moisture Content
- 5) Undrained Shear Strength

Results of the laboratory and field test results, together with the location and elevation of the boreholes, are presented in Appendix I of this report.

4. SUMMARIZED SUBSOIL CONDITIONS:

Subsoil at the site consists mainly of a deposit of silty clay to clayey silt (Till). The upper grey-brown crust was found to be in a stiff to hard preconsolidated state. Beneath the upper crust (i.e., about elevation 588') and extending to the full depth of the exploration, the deposit is firm to stiff and grey in colour. At about elevation 583' the deposit is broken by a 3-to 4-foot thick layer of sandy silt.

5. WATER LEVELS:

Water levels in the boreholes were not obtained during the investigation, due to the impermeable nature of the subsoil; however, it may be assumed that the water table would be close to the level of the Puce River which was about elevation 594.5'.

cont'd. /4 ...

6. DISCUSSION AND RECOMMENDATIONS:

The upper stiff clay crust is suitable for spread footing type foundations. In order to provide for scour from the river, the footings should be below the river-bed level. The existing bridge is founded on spread footings at elevation 590.5' which is about 3 to 4 feet below the river-bed level.

The extension to the bridge can similarly be founded on spread footings at elevation 590.5' with an allowable bearing pressure of 2 t.s.f. Provision should be made for differential settlement between the existing bridge and the proposed extensions.

For all practical purposes, the subsoil can be considered as relatively impervious, hence dewatering of the excavations should present no special problems. However, a working slab should be cast at the footing elevation to prevent softening of the clay materials.

No stability problems are anticipated for embankments provided that standard 2 to 1 side slopes are used.

7. SUMMARY:

The results of a foundation investigation for the extension of the Puce River bridge on Highway 401 are presented in this report.

The subsoil at the site consists of a deep deposit of silty clay to clayey silt with some sand and traces of gravel (glacial till). The upper crust is suitable for the use of spread footings. An allowable bearing pressure of 2 t.s.f. can be applied at elevation 590.5'.

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

Some differential settlement between the existing bridge and the extension can be expected. Provision should be made to accommodate this settlement.

There should be no stability problems for the embankment for standard 2 to 1 side slopes.

No dewatering problems are anticipated.

8. MISCELLANEOUS:

The field investigation was carried out in July 1965. The equipment was owned and operated by Master Soil Investigation Limited, under the supervision of Mr. L. Palmer, Project Foundation Engineer, who subsequently prepared this report.

The entire project was under the general supervision of Mr. M. Devata, Senior Foundation Engineer, who also reviewed this report.

August 1965

APPENDIX I.

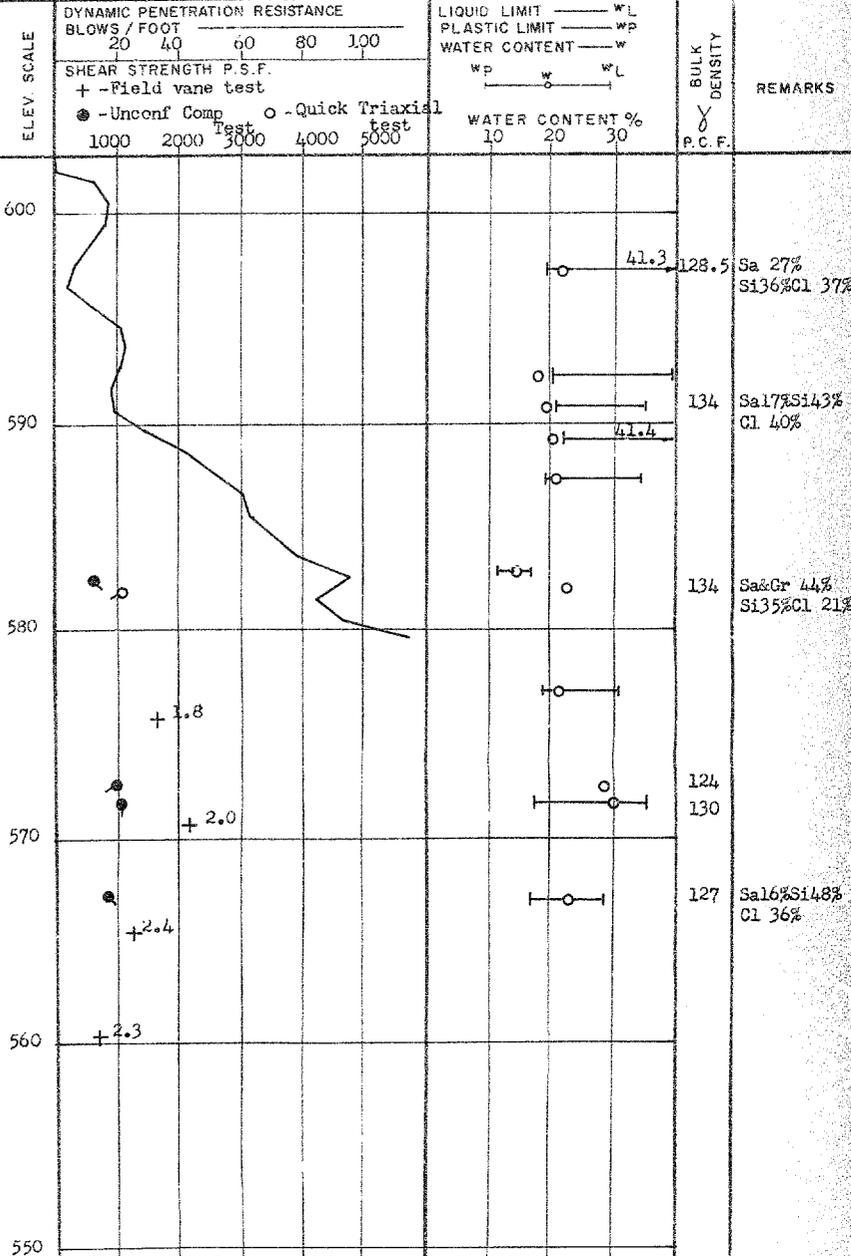
DEPARTMENT OF HIGHWAYS - ONTARIO  
MATERIALS & TESTING DIVISION

RECORD OF BOREHOLE NO. 1

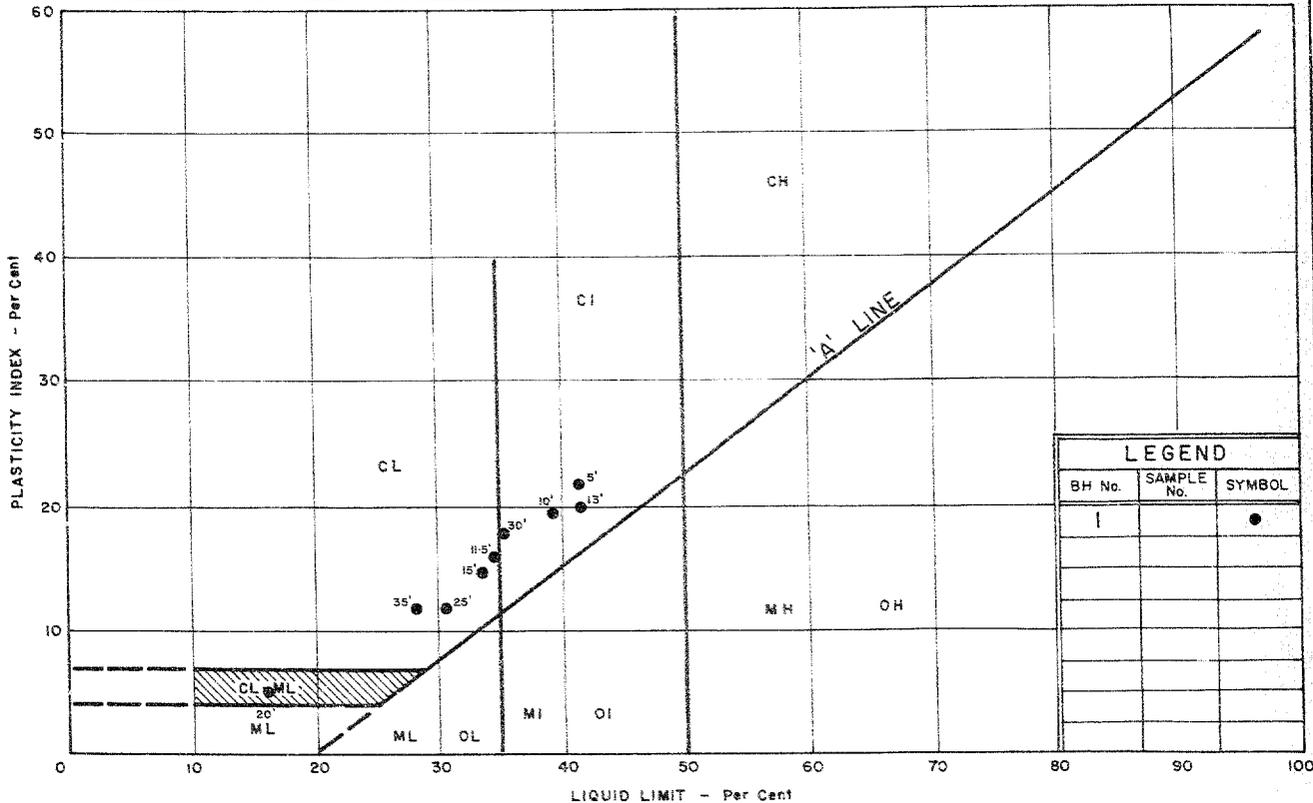
FOUNDATION SECTION

JOB 65-F-76 LOCATION Puce River Crossing of Hwy 401, Southeast of Bridge ORIGINATED BY L.P.  
 W.P. 693-64 BORING DATE July 15, 1965. COMPILED BY L.P.  
 DATUM Geodetic BOREHOLE TYPE Washboring CHECKED BY M.D. [Signature]

ELEV. DEPTH	SOIL PROFILE DESCRIPTION	STRAT. PLOT	SAMPLES			ELEV. SCALE	DYNAMIC PENETRATION RESISTANCE BLOWS / FOOT				LIQUID LIMIT — WL PLASTIC LIMIT — wp WATER CONTENT — w			BULK DENSITY P.C.F.	REMARKS		
			NUMBER	TYPE	BLOWS / FOOT		20	40	60	80	100	wp	w			wL	
602.8 0.0	Silty clay, some sand, trace gravel (Glacial till) Stiff to hard, Grey-brown.	[Hatched pattern]	1	SS	11												
			2	SS	32												
			3	SS	26												
			4	SS	23												
587.8 15.0	Clayey silt, some sand trace gravel, (Glacial till) stiff to firm, grey.	[Dotted pattern]	5	SS	17												
582.6 20.2			6	TW	PM												
579.2 23.5	Layer of sandy silt.	[Dotted pattern]	7	SS	11												
			8	TW	PM												
			9	TW	PM												
551.8 41.0	Thin layer or pocket of silty sand	[Dotted pattern]	10	TW	PM												
559.8 43.0																	
	End of borehole.																







LEGEND		
BH No.	SAMPLE No.	SYMBOL
1		●

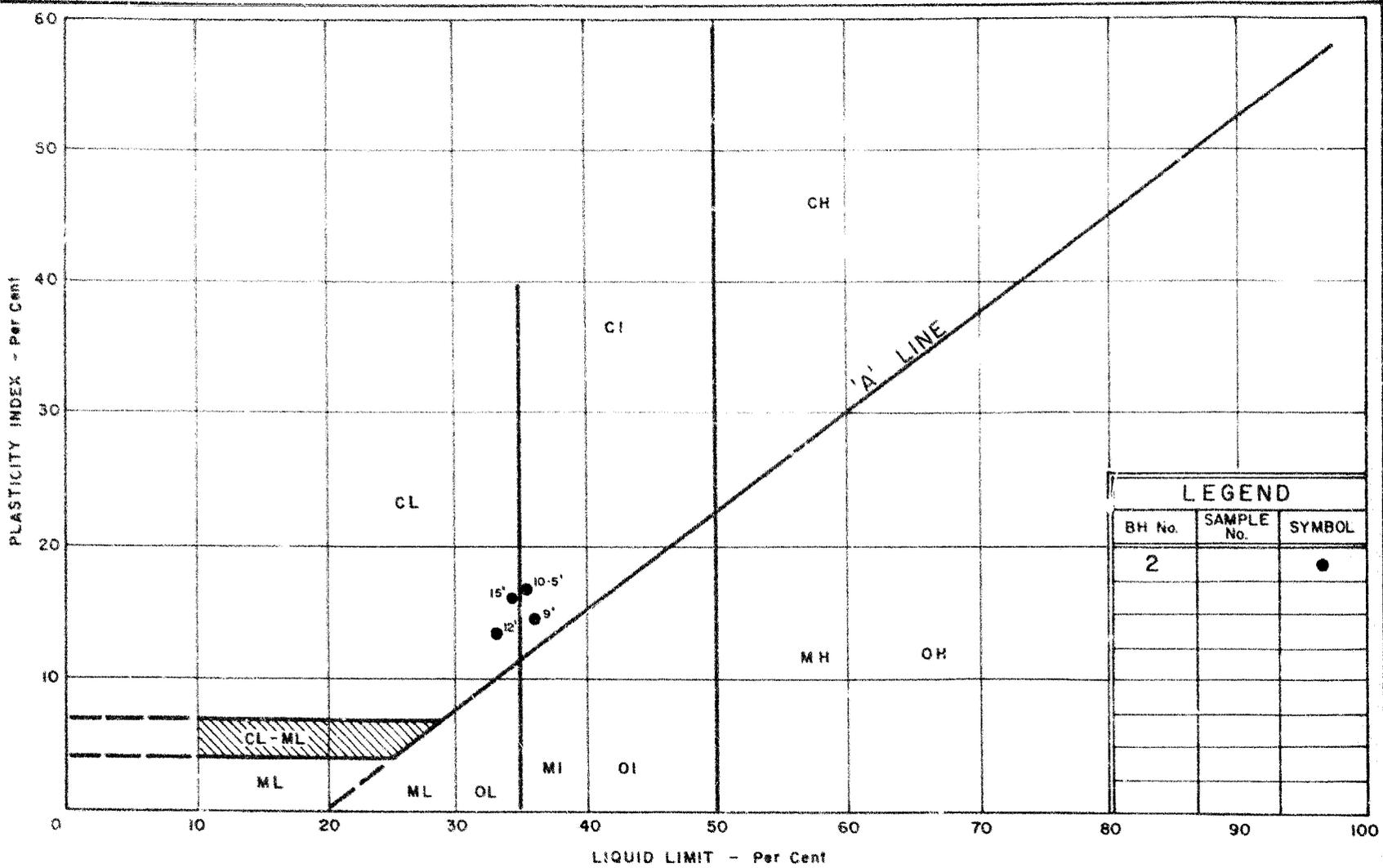


DEPARTMENT OF HIGHWAYS  
 MATERIALS and  
 TESTING  
 DIVISION

### PLASTICITY CHART

W.P. No. 693-64

JOB No. 65-F-76



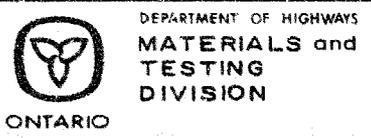
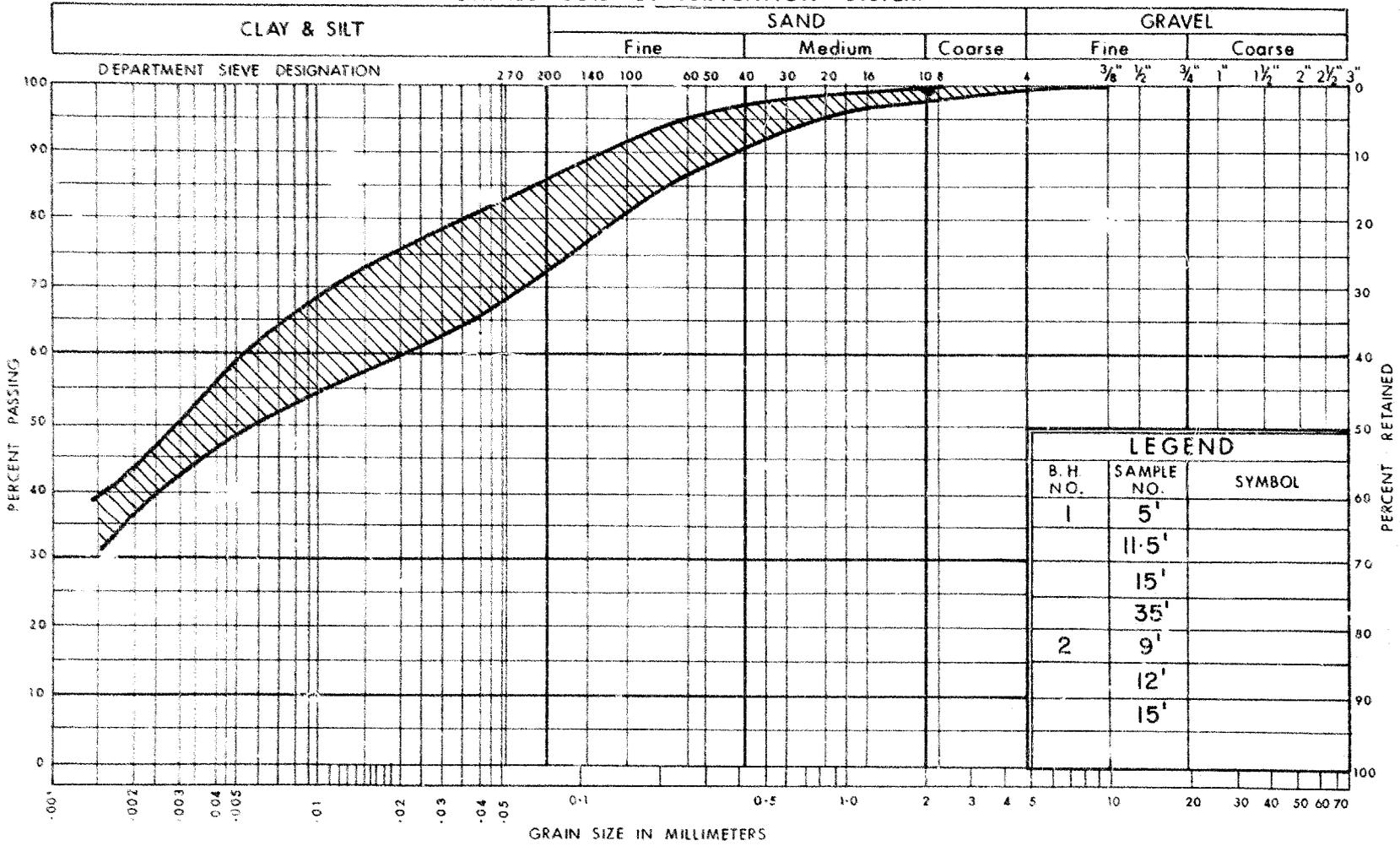
LEGEND		
BH No.	SAMPLE No.	SYMBOL
2		●



# PLASTICITY CHART

WP. No. 693-64  
 JOB No. 65-F-76

UNIFIED SOIL CLASSIFICATION SYSTEM



GRAIN SIZE DISTRIBUTION  
 CLAYEY SILT to SILTY CLAY  
 ENVELOPE of SAMPLES

W.P. No. 693-64  
 JOB No. 65-F-76

## 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

$\gamma$	UNIT WEIGHT OF SOIL (BULK DENSITY)
$\gamma_s$	UNIT WEIGHT OF SOLID PARTICLES
$\gamma_w$	UNIT WEIGHT OF WATER
$\gamma_d$	UNIT DRY WEIGHT OF SOIL (DRY DENSITY)
$\gamma'$	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
$\tau_f$	SHEAR STRENGTH
$c'$	EFFECTIVE COHESION
$\phi'$	EFFECTIVE ANGLE OF SHEARING RESISTANCE, OR FRICTION
$c_u$	APPARENT COHESION
$\phi_u$	APPARENT ANGLE OF SHEARING RESISTANCE, OR FRICTION
$\mu$	COEFFICIENT OF FRICTION
$S_t$	SENSITIVITY

## GENERAL

$\pi$	= 3.1416
e	BASE OF NATURAL LOGARITHMS 2.7183
$\log_e \sigma$ OR $\ln \sigma$	NATURAL LOGARITHM OF $\sigma$
$\log_{10} \sigma$ OR $\log \sigma$	LOGARITHM OF $\sigma$ 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
$\sigma$	NORMAL STRESS
$\sigma'$	NORMAL EFFECTIVE STRESS ( $\bar{\sigma}$ IS ALSO USED)
$\tau$	SHEAR STRESS
$\epsilon$	LINEAR STRAIN
$\gamma$	SHEAR STRAIN
$\nu$	POISSON'S RATIO ( $\mu$ IS ALSO USED)
E	MODULUS OF LINEAR DEFORMATION (YOUNG'S MODULUS)
G	MODULUS OF SHEAR DEFORMATION
K	MODULUS OF COMPRESSIBILITY
$\eta$	COEFFICIENT OF VISCOSITY

## EARTH PRESSURE

d	DISTANCE FROM TOP OF WALL TO POINT OF APPLICATION OF PRESSURE
$\delta$	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
$\beta$	ANGLE OF SLOPE TO HORIZONTAL

## MEMORANDUM

65-F-76

WP-693-64

To: Mr. K.Y. Lo,  
Supervising Foundation Engineer,  
Room 107, Lab. Building.

FROM: Bridge Division,  
Downsview, Ontario.

DATE: June 17, 1965.

OUR FILE REF.

IN REPLY TO

SUBJECT: W.P. 693-64  
Site 6-83  
Puce River Br. Widening  
Highway # 401 District # 1.

We are sending to you herewith two prints of Bridge Site Plan E-4355-1 on which we have marked in red the proposed location of the widening of the above structure.

The bridge site is readily accessible. It is 8.6 miles east of Highway #98. No problems are anticipated regarding the accommodation.

Please make the necessary arrangement for foundation investigation. We will be pleased to have your report in due course.



N. Zoltay,  
for G. Scott,  
Regional Bridge Location Engineer.

NZ/kp  
c.c. S. McCombie  
G. Scott  
N.D. Smith  
W. Kinnear  
R. Fitzgibbon

Rush

5/8/65 - to be checked with V. S. R.

Mr. G. Scott,  
Regional Bridge Location Engr.,  
Bridge Division.

Foundation Section,  
Materials & Testing Div.,  
Room 107, Lab. Bldg.

Attn: Mr. N. Zoltay

January 27, 1966

Your Memo -- Jan. 21/66

W.P. 693-64, Site 6-83,  
Puce River Bridge Widening,  
Hwy. 401 - District 1 (Chatham).

65-76

We have reviewed the Preliminary Drawing  
for the above mentioned structure.

The foundation design appears to comply with  
recommendations contained in our foundation report.

MD/MdeF

cc: Foundations Office  
Gen. Files

*M. Devata*

M. Devata,  
SENIOR FOUNDATION ENGR.  
For:  
A. G. Stermac,  
PRINCIPAL FOUNDATION ENGR.

## MEMORANDUM

To: Mr. A. Stermac,  
Principal Foundation Engineer,  
Room 107, Lab. Bldg.

FROM: Bridge Division,  
Downsview, Ontario.

DATE: January 21, 1966.

OUR FILE REF.

IN REPLY TO

SUBJECT: W.P. 693-64, Site 6-83,  
Puce River Bridge Widening,  
Hwy. 401 - Dist. 1.

We are sending to you herewith one print of Preliminary Plan D 5819-P of the above structure.

Would you please let us have your written comments.



NZ/sp  
Encl.

cc. S. McCombie  
G. Scott

N. Zoltay,  
for G. Scott,  
Regional Bridge Location Engineer.

*cc. [unclear]*  
*[unclear]*

(50'-62'-62'-50')

A few span structure some 250 ft wide - Replace  
the existing <sup>up</sup> single span structure some 100 ft wide

Existing footing <sup>Elev</sup> 54.6

Five Sampled boreholes.

Proposed structure at Hwy 400 & Finch Ave

Lot# 20827

con V West of Yonge St  
County of York

Twp of N. York

65-F-130

WP No 699-64

W interchange will accommodate the same traffic on Finch Ave.

B.H # 1 & 5 for Abutments.

B.H # 2, 3 & 4 are for the piers.

## MEMORANDUM

65-F-76  
WP-693-64

To: Mr. K.Y. Lo,  
Supervising Foundation Engineer,  
Room 107, Lab. Building.

From: Bridge Division,  
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Date: June 17, 1965.

OUR FILE REF.

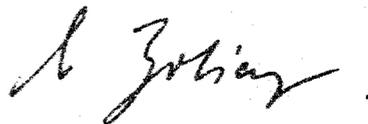
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Regional Bridge Location Engineer.

Rush

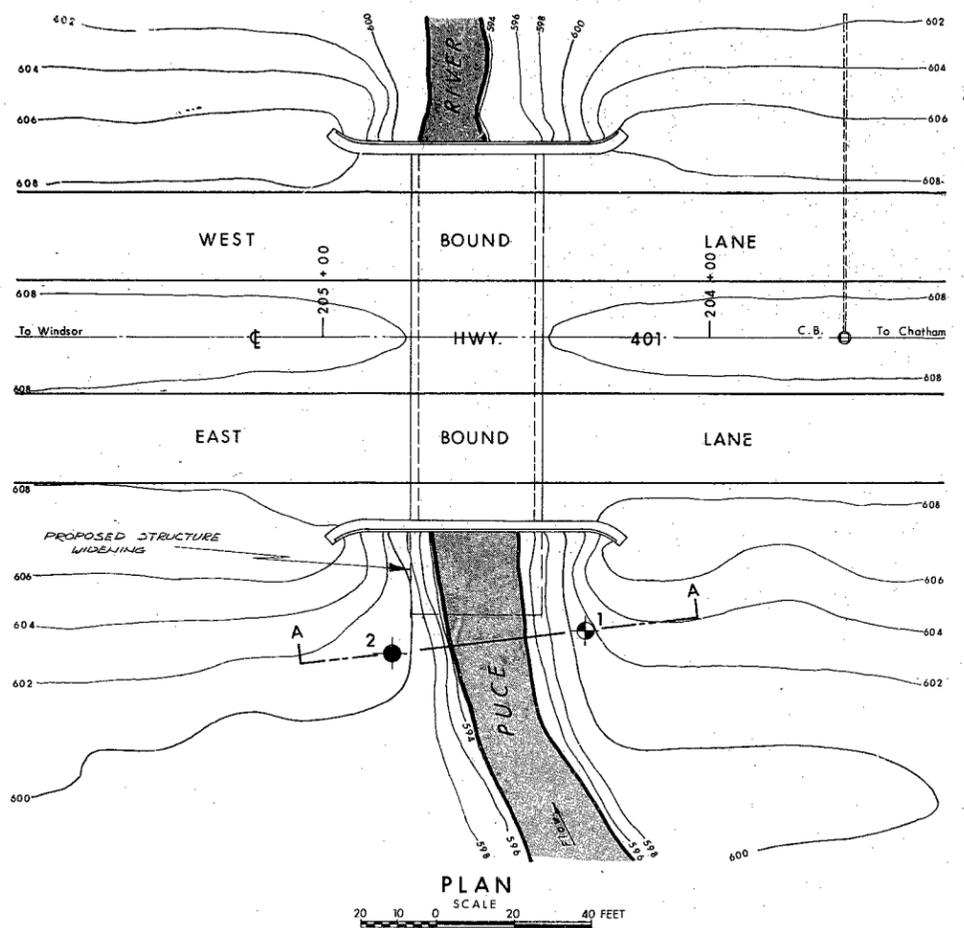
25/8/65 - to be checked with U.S. R.

#65-F-76

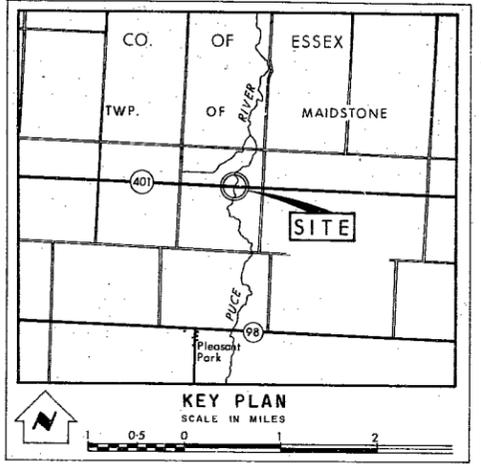
W.P. #693-64

HWY. #401 &

WIDENING OF  
PUCE RIVER  
BRIDGE



PLAN  
SCALE 1" = 40 FEET



**LEGEND**

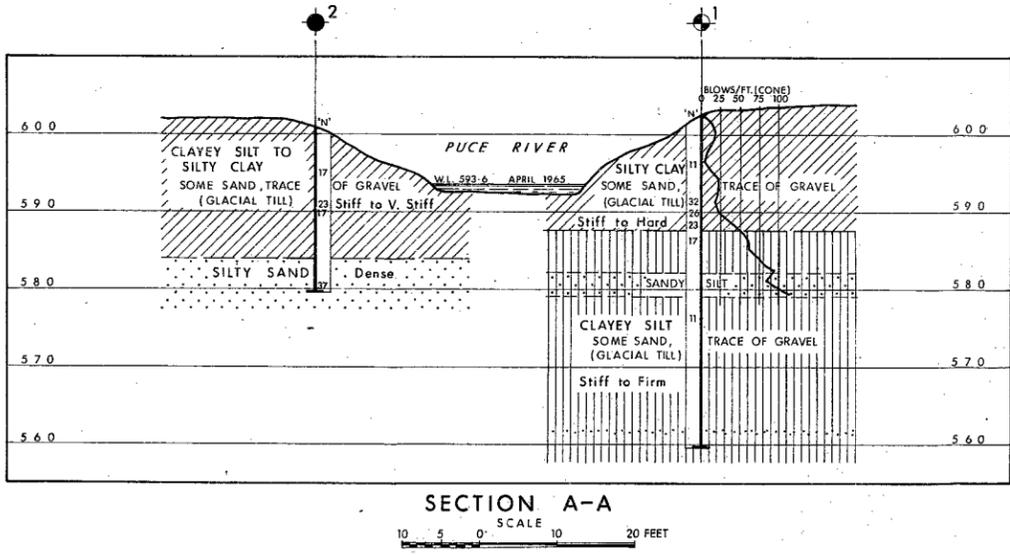
- Bore Hole
- Cone Penetration Hole
- Bore & Cone Penetration Hole
- Water Levels established at time of field investigation.

NO.	ELEVATION	STATION	OFFSET
1	602.8	204+32	76' LT.
2	601.0	204+82	81' 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.

REVISIONS	DATE	BY	DESCRIPTION



SECTION A-A  
SCALE 1" = 20 FEET

PRINT RECORD		
NO.	FOR	DATE

DEPARTMENT OF HIGHWAYS - ONTARIO  
MATERIALS & TESTING DIVISION - FOUNDATION SECTION

**PUCE RIVER**

KING'S HIGHWAY NO. 401 DIST. NO. 1  
CO. ESSEX  
TWP. MAIDSTONE LOT 18 CON. V

**BORE HOLE LOCATIONS & SOIL STRATA**

SUBM'D. L.P. CHECKED <i>[initials]</i>	W.P. NO. 693-64	M.B.T. DRAWING NO.
DRAWN S.O. CHECKED <i>[initials]</i>	JOB NO. 65-F-76	<b>65-F-76 A</b>
DATE 18 AUG. 1965	SITE NO.	BRIDGE DRAWING NO.
APPROVED <i>[Signature]</i>	CONT. NO.	



