DEPARTMENT OF HIGHWAYS ONTARIO

MEMORANDUM

To: Mr. B. R. Davis,
Bridge Engineer,
Bridge Division,
Admin. Bldg.

Attention: Mr. S. McCombie

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

Date: April 22, 1968

Our File Ref.

Your Ref.

Subject:

FOUNDATION INVESTIGATION REPORT
For
Proposed Extension of the Existing
Culvert at Hwy. 35 & 115 (Line 'P')
Southbound Lane Crossing at
Wilmot Creek, Twp. of Clarke, Ont.
District No. 7 (Port Hope)
W.J. 68-P-20 -- W.P. 301-66-0

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

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

K. G. Stermac
PRINCIPAL FOUNDATION ENGINEER

AGS/MdeP
Attach.
cc: Messrs. B. R. Davis (2)
H. A. Tregaskes
D. W. Farren
G. K. Hunter (2)
D. F. Collins
W. S. Melinyshyn
T. J. Kovich
B. A. Singh

Foundations Office
Gen. Files

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FOUNDATION INVESTIGATION REPORT
For
Proposed Extension of the Existing
Culvert at Hwy. 35 & 115 (Line 'F')
Southbound Lane Crossing at
Wilmot Creek, Twp. of Clarke, Ont.
District No. 7 (Port Hope)
W.J. 68-F-20 -- W.P. 301-66-0

1. INTRODUCTION:

The Foundation Section was requested to carry out an investigation at the crossing of Hwy. 35 and 115, Line 'F', Southbound Lane and Wilmot Creek in the Twp. of Clarke. The request was contained in a memo from the Bridge Location Section (Mr. W. S. Melinyshyn, Regional Bridge Location Engineer), dated March 15, 1968. The site is located about one mile east of Newcastle in Durham County. The general topography of the area is characterized by gently rolling hills.

An investigation was carried out by this Section to determine the subsoil conditions at the site of the proposed structure. Presented in this report are the results of this investigation, together with our recommendations pertaining to the foundations for the structure and the stability of the approach embankments.

2. SUBSOIL CONDITIONS:

Four sampled boreholes, with dynamic cone penetration tests, were carried out using a skid-mounted diamond drill adapted for soil sampling. The boundaries between different deposits, together with detailed description of the material in the deposits, are shown on the borelog sheets attached to this report. The estimated stratigraphical profile shown on Drawing 68-F-20A, is based upon this information. From ground level downward, the different soil types encountered are as follows:

cont'd. /2 ...

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

2.1) Fill Material (Clayey Silt, Sand and Gravel):

A surficial deposit, composed primarily of a mixture of brown clayey silt, sand and gravel, with organic inclusions, was encountered only in B.H.'s #3 and #4, having a total thickness of about 3 ft. Dynamic cone penetration tests indicate that the fill material is in a loose state of compaction.

2.2) Glacial Till (Heterogeneous Mixture of Clayey Silt, Sand and Gravel):

This deposit extends from original ground surface or immediately below the fill material and overlies the limestone bedrock. The thickness of the stratum varies from 18 ft. in B.H. #3 to 18.5 ft. in B.H. #1. The texture of the material clearly shows the deposit to be of glacial origin, being a heterogeneous mixture of clayey silt, sand and gravel with plasticity generally decreasing with depth. In B.H. #1 within this deposit, occasional boulders up to 6" Ø were encountered below elev. 254.0. Grain-size distribution curves obtained from samples of this deposit, are shown in the Appendix of this report.

Physical properties of the material in the deposits as determined from field and laboratory tests, are summarized below:

Liquid Limit	(w_L %)	:	16% - 30%
Plastic Limit	(w_P %)	:	11% - 15%
Moisture Content	(w %)	:	5% - 15%
'N' Values		:	56 blows/ft. - 100 blows/1"

The consistency of the deposit is estimated to range from very stiff to hard but is, in general, hard.

cont'd. /3 ...

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

2.3) Limestone Bedrock:

Bedrock was proven in B.H.'s #1 and #3 by obtaining AXT rock core samples, and was found to be limestone bedrock. The depth at which bedrock was encountered ranged from elev. 258 (B.H. #1 to elev. 260 (B.H. #3) - i.e., from 18.5 to 21 ft. below the existing ground surface. The upper 2.5 ft. of the bedrock in B.H. #1 is generally in a fractured or jointed condition; elsewhere the bedrock is generally sound.

3. GROUNDWATER CONDITIONS:

Groundwater level observations were carried out during the period of the investigation in the open boreholes. These observations which are recorded on the borelog sheets and summarized on Dwg. 68-P-20A, indicate that the water level in the deposit is about elev. 274 - elev. 277. The water level in Wilmot Creek at the time of investigation was at elev. 273.0.

4. DISCUSSION AND RECOMMENDATIONS:

It is proposed to widen the existing two-lane Hwy. 35 and 115 to a four-lane highway in this general area. The present structure, at the crossing of Wilmot Creek and Hwy. 35 and 115, will be widened to accommodate future four-lane traffic at the crossing. Present proposals are to extend the existing 38-ft. span concrete barrel arch culvert some 87 ft. in the northerly direction. The proposed grade of the four-lane Hwy. 35 and 115 will be at the same elevation as of the existing highway.

Subsoil at the site consists mainly of 18 feet of very stiff to hard glacial till (heterogeneous mixture of clayey silt, sand and gravel) followed by limestone bedrock. In certain areas the glacial stratum is overlain by a shallow deposit of fill material.

cont'd. /4 ...

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

Structure Foundations:

The proposed footings of the concrete barrel arch culvert can be supported on spread footings within the glacial till stratum at or below elev. 273.0, with a safe bearing pressure of 3.5 t.s.f. In view of the relatively impermeable nature of the subsoil, major dewatering problems are not anticipated. In order to carry out the excavations below creek water level, a temporary stream diversion may be required depending upon the location of the proposed footings. Care should be exercised to prevent softening of the foundation material by surface water.

It is recommended that vertical construction joints be constructed between the existing and new portion of the structure, since minor differential settlements are almost certain to occur.

Approach Fills:

The proposed fills for the widening will be in the order of 24 ft. above the existing ground surface. No stability problems are anticipated for the proposed approach fills with standard 2:1 slopes.

5. MISCELLANEOUS:

The field work, performed during the period of March 19, 1968 to March 22, 1968, was supervised by Mr. V. Korlu, Project Foundation Engineer, who also wrote this report.

The investigation was carried out under the general supervision of Mr. M. Devata, Supervising Foundation Engineer, who reviewed the report.

Equipment used was owned and operated by Dominion Soil Co. Ltd. of Toronto.

April, 1968.

DEPARTMENT OF HIGHWAYS - ONTARIO
MATERIALS & TESTING DIVISION

RECORD OF BOREHOLE NO 1

FOUNDATION SECTION

JOB 68-F-20 LOCATION Sta. 52+58 ℄ Prop. Southbound Lane (Hwy. 15) o/s 69' Lt. ORIGINATED BY VK
W P 301-66-0 BORING DATE March 19, 20, 1968 COMPILED BY WH
DATUM Geodetic BOREHOLE TYPE Diamond Drill - NX Casing CHECKED BY

SOIL PROFILE: ELEV / DEPTH	DESCRIPTION	STRAT PLOT	SAMPLES: NUMBER	TYPE	BLOWS / FOOT	ELEV SCALE	DYNAMIC PENETRATION RESISTANCE BLOWS / FOOT (20 40 60 80 100) / SHEAR STRENGTH PSF	LIQUID LIMIT / PLASTIC LIMIT / WATER CONTENT (10 20 30)		REMARKS
276.5	Ground Level									Gr.Sa.Si.Cl
0.0	Pet.mixture of clayey silt, sand & gravel. Hard. Glacial Till.		1	SS	56					▼ 275.0 5 32 42 21
			2	SS	100/2"	270				
			3	SS	100/6"					14 30 38 18
			4	SS	138					
	(with boulders up to 6" ø- below elev.264.)		5	BXL RC	144					
			6	SS	100/6"	260				
258.0 18.5	(Fractured & Weathered)		7	SS	100/1"					
255.5 21.0	(Sound)		8	BXLRC						
			9	AXT RC	100% Rec					
251.5	Limestone Bedrock					250				
25.0	End of Borehole									

DEPARTMENT OF HIGHWAYS ONTARIO
MATERIALS & TESTING DIVISION

RECORD OF BOREHOLE NO. 2

FOUNDATION SECTION

JOB 68-F-20
W.P. 30L-66-0
DATUM Geodetic

LOCATION Sta. 59+40 ± ft. m. South Bound Lane (Hwy. 35) o/s 30' Lt.
BORING DATE March 20, 1968
BOREHOLE TYPE Diamond Drill - NX Casing

DESIGNATED BY VK
COMPILED BY MH
CHECKED BY

SOIL PROFILE: ELEV. / DEPTH	DESCRIPTION	STRATA PLOT	SAMPLES: NUMBER	TYPE	BLOWS/6"	ELEV. SCALE	DYNAMIC PENETRATION RESISTANCE BLOWS/FOOT 20 40 60 80 100 / SHEAR STRENGTH PSF	LIQUID LIMIT / PLASTIC LIMIT / WATER CONTENT / WATER CONTENT % 10 20 30	% PASS 200 MESH	REMARKS
275.0	Ground Level									Gr.Sa.Si.Cl
0.0	Het. mixture of clayey silt, sand & gravel.		1	SS	17/3"	270				▼ 274.0
			2	SS	100/4"					0 1 55 44
	Glacial Till Hard.		3	SS	100/6"					
264.5 10.5	End of Borehole					260				

DEPARTMENT OF HIGHWAYS - ONTARIO

MATERIALS & TESTING DIVISION

RECORD OF BOREHOLE NO 3

FOUNDATION SECTION

JOB 68-F-20 LOCATION Sta. 53+82 ℄ Prop.South Bound Lane(Hwy.35) o/s 25' Lt. LOGGED BY VK

W.P. 301-66-0 BORING DATE March 21, 1968 COMPILED BY WH

DATUM Geodetic BOREHOLE TYPE Diamond Drill - NX Casing CHECKED BY

SOIL PROFILE: Elev. / Depth	DESCRIPTION	STRATA PLOT	SAMPLES: Number	Type	Blows / Recovery	Elev. Scale	DYNAMIC PENETRATION RESISTANCE: Blows/foot 20 40 60 80 100 / SHEAR STRENGTH psf	QU ● / PL ⊢ / NAT ✱ / LL ⊣ / WATER CONTENT % 10 20 30		REMARKS
281.2	Ground level									
0.0 / 278.0 / 3.0	Fill mat'l.(clayey silt sand & gravel with some organics.		1	SS	20					▼277.0
	Het.mixture of clayey silt, sand & gravel.		2	SS	59					
			3	SS	111	270				
	Very stiff to hard.		4	SS	100/5"					
	Glacial Till		5	SS	155	260				
260.0 / 21.0	(Sound) Limestone Bedrock		6	AXT RC	100% Rec.					
255.0 / 26.0	End of Borehole					250				

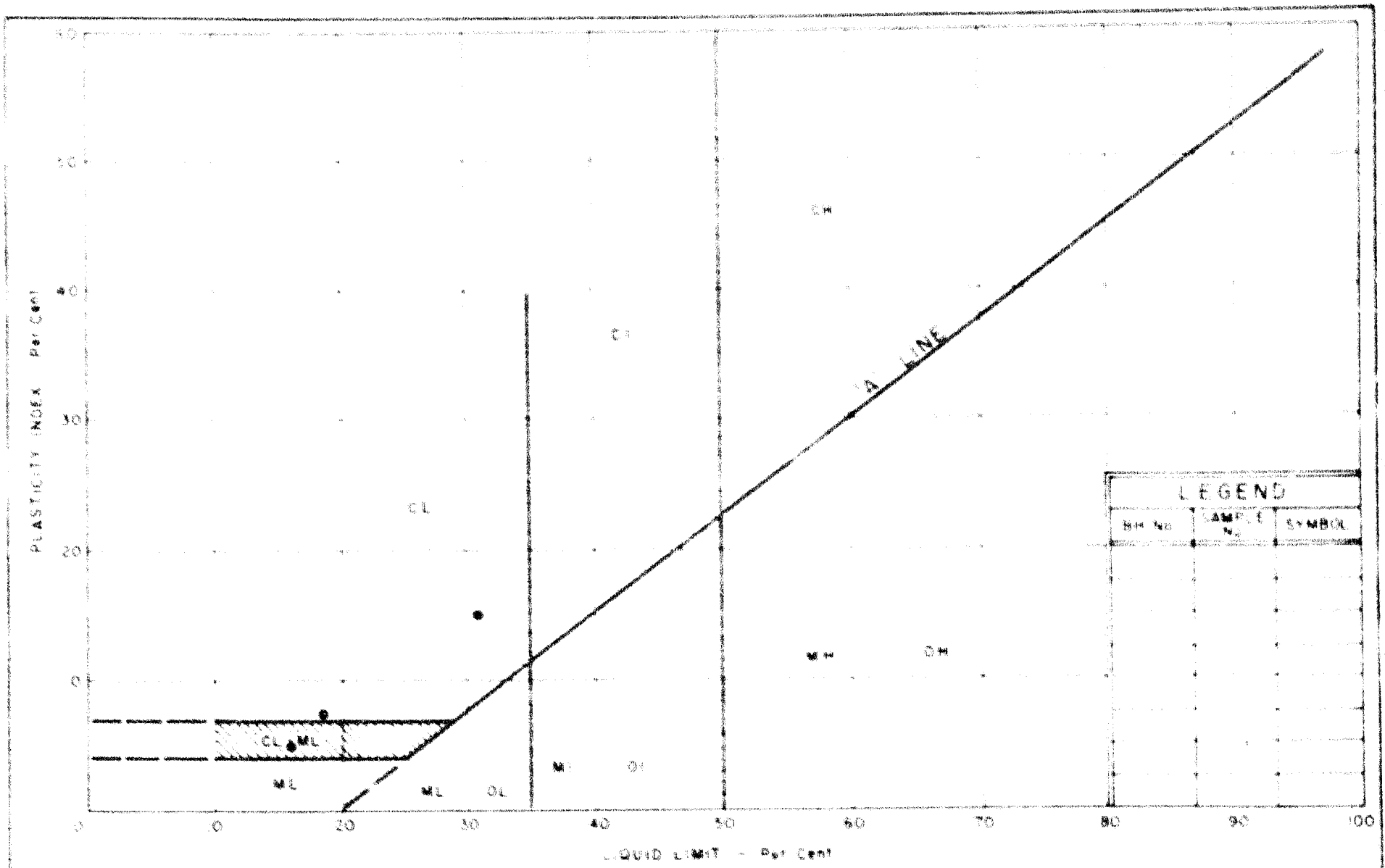
DEPARTMENT OF HIGHWAYS, ONTARIO
MATERIALS & TESTING DIVISION

RECORD OF BOREHOLE NO L

FOUNDATION SECTION

JOB 68-F-20 LOCATION Sta. 58 + 90 ℄ Prop. South Bound Lane(Hwy.35) o/s 90' ORIGINATED BY VK
W P 301-66-0 BORING DATE March 22, 1968 COMPILED BY WN
DATUM Geodetic BOREHOLE TYPE Diamond Drill - NX Casing CHECKED BY

SOIL PROFILE: ELEV / DEPTH	DESCRIPTION	STRAT PLOT	SAMPLES: NUMBER	TYPE	BLOWS/FOOT	ELEV SCALE	DYNAMIC PENETRATION RESISTANCE BLOWS/FOOT 20 40 60 80 100 / SHEAR STRENGTH ▲ S ▼	LIQUID LIMIT ——— ●, PLASTIC LIMIT ——— ○, WATER CONTENT ——— ● ○ ●, WATER CONTENT % 10 20 30	ELEV. / DEPTH	REMARKS
279.3	Ground Level									
0.0	Fill material(clayey silt,sand & gravel with organics)									Gr.Sa.Si.Cl
276.3			1	SS	4				276.3	▼ 6 25 39 30
3.0	Net. mixture of clayey silt, sand & gravel. Hard. (Glacial Till)		2	SS	50					
268.8			3	SS	95					
10.5	End of Borehole									



DEPARTMENT OF HIGHWAYS
MATERIALS and TESTING DIVISION

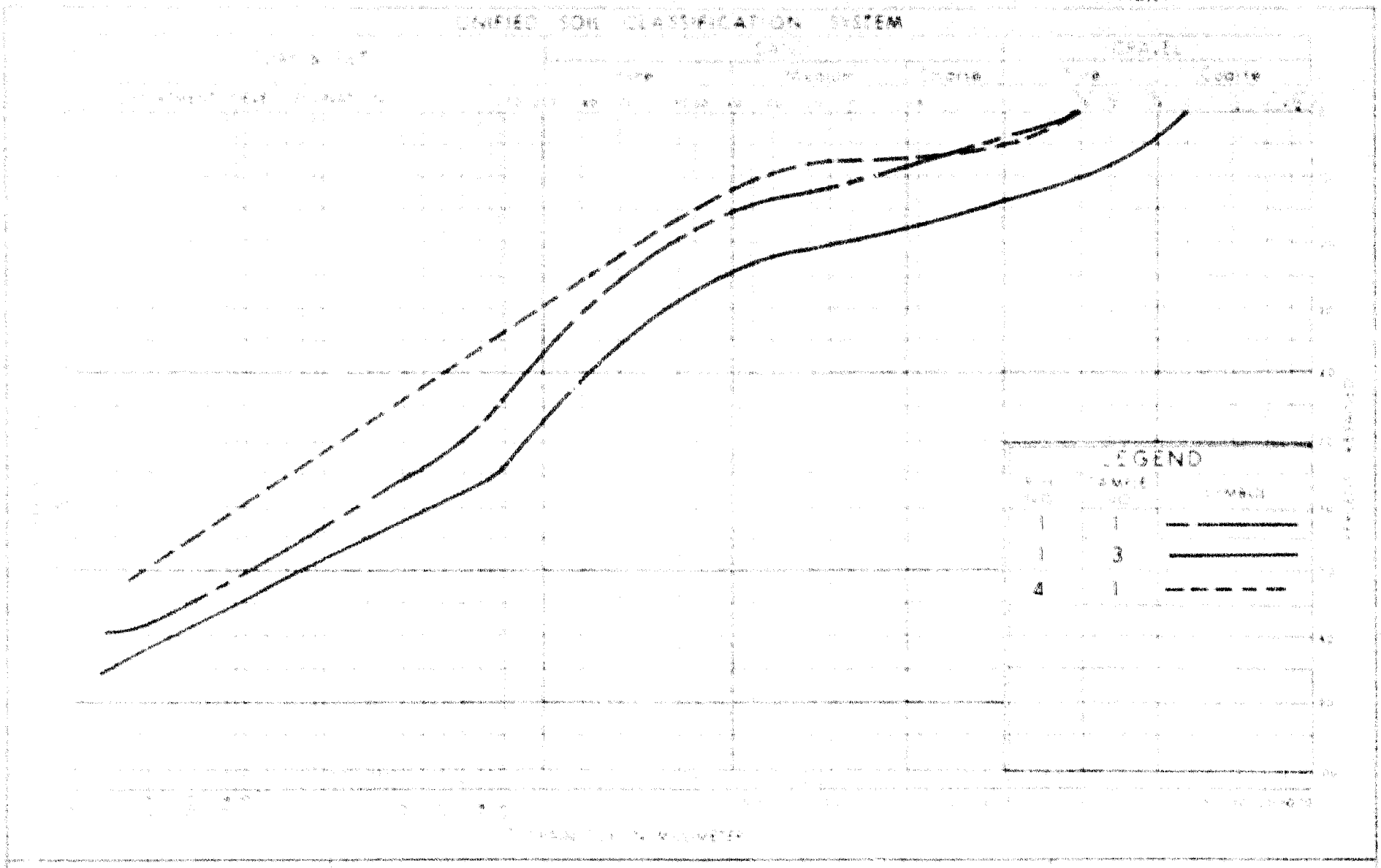
PLASTICITY CHART

GLACIAL TILL

WP No 301-66-0

JOB No 68 F 20

DEFECTS IN NEGATIVE DUE TO CONDITION OF ORIGINAL DOCUMENT



DEPARTMENT OF HIGHWAYS MATERIALS AND TESTING DIVISION	GRAIN SIZE DISTRIBUTION GLACIAL TILL	INF No 301 - 66 - 0 JOB No 68 - F - 20

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 $\tau_f = c' + \sigma' \tan \phi$
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 $\tau_f = c_u + \sigma \tan \phi$
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

#68-F-20

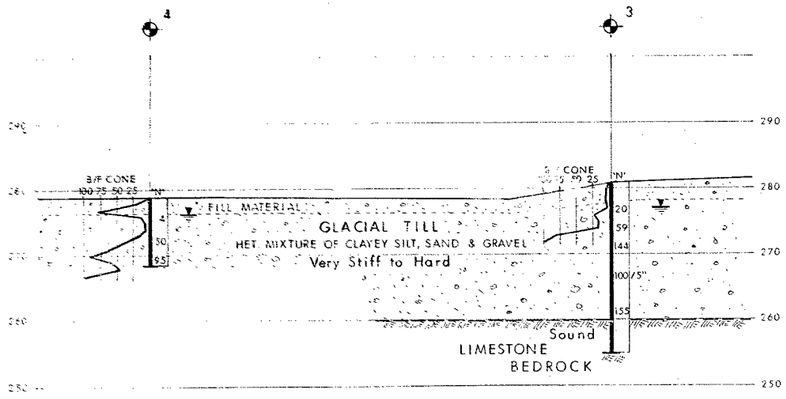
W.P. #301-66-0

HWY. 35 & 115 LINE F

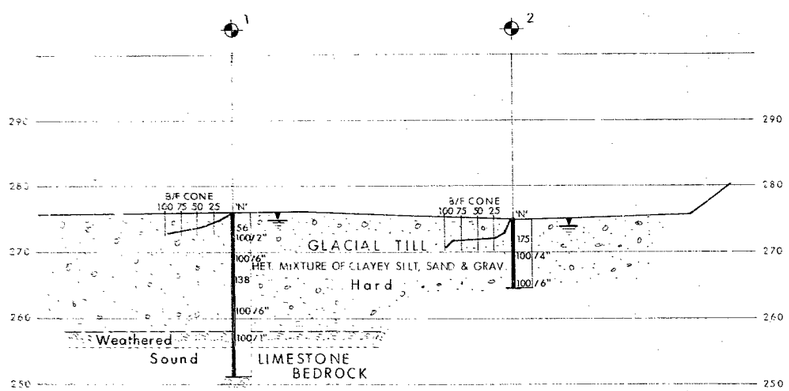
WILMOT CREEK

CLARKE

TWP.



A – A



B – B

SECTIONS

SCALE

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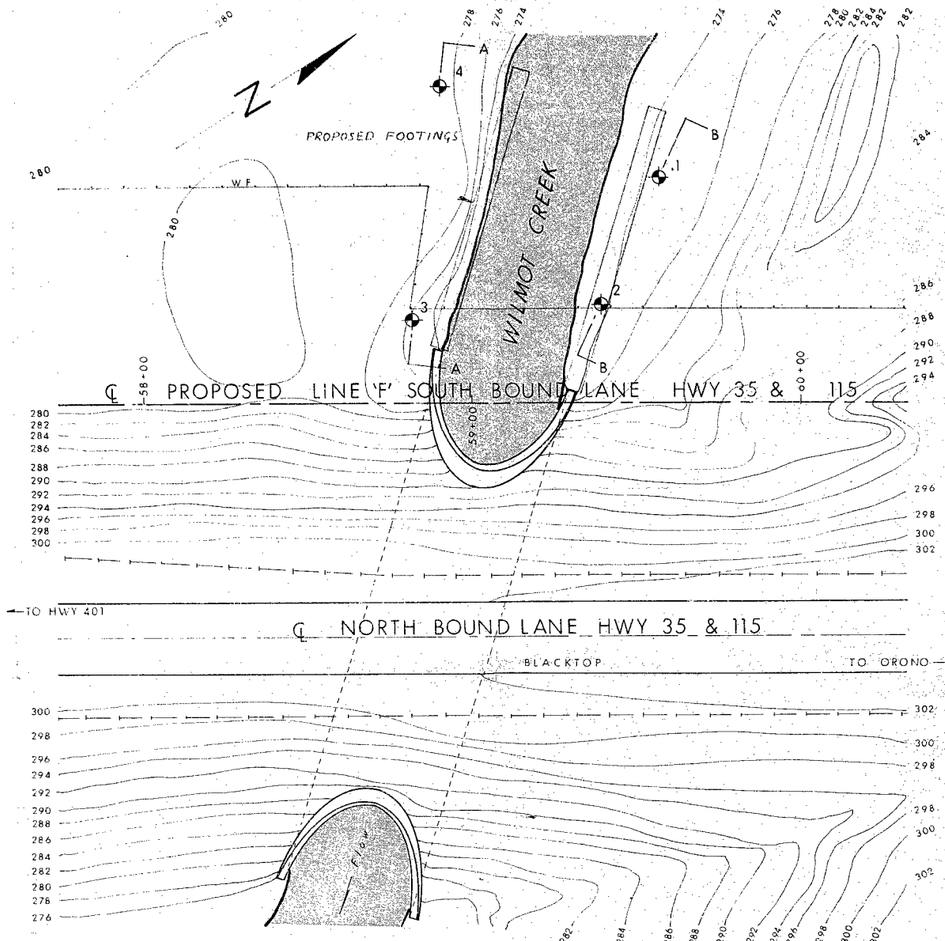
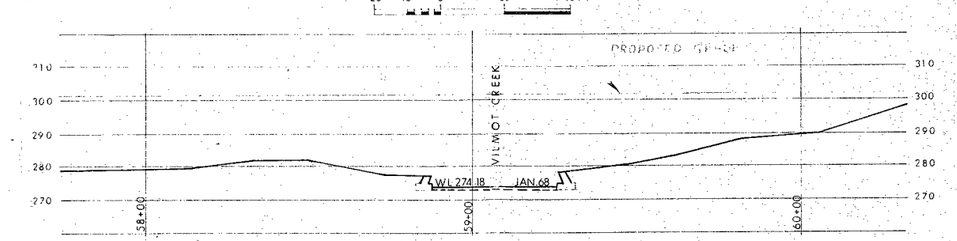


PLAN

SCALE

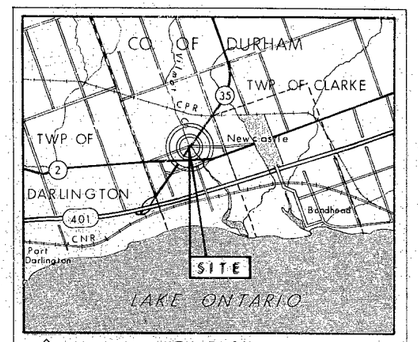
20 10 0 20 40 FT



PROFILE

SCALE

20 10 0 20 40 FT



LEGEND

- Bore Hole
- Cone Penetration Hole
- Bore & Cone Penetration Hole
- Water Levels established at time of field investigation, MAR, 1968

NO.	ELEVATION	STATION	OFFSET
1	276.5	59+58	69' LT
2	274.9	59+40	30' LT
3	280.9	58+82	25' LT
4	279.3	58+90	96' 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 & TESTING DIVISION – FOUNDATION SECTION

WILMOT CREEK

KING'S HIGHWAY NO. 35 & 115 LINE 'F' DIST. NO. 7

CO. DURHAM

TWP. CLARKE LOT 32 CON. 2

BORE HOLE LOCATIONS & SOIL STRATA

SUBM'D. V.K.	CHECKED	W.P. NO. 301-66-0	M.B.T. DRAWING NO. 68-F-20A
DRAWN A.B.	CHECKED	JOB NO. 68-F-20	
DATE APRIL 18, 1968		SITE NO.	BRIDGE DRAWING NO.
APPROVED (PRINCIPAL FOUNDATION ENGINEER)		CONT NO.	

REF. NO. E-4909-1