

#60-F-221

W.P. # 84-59

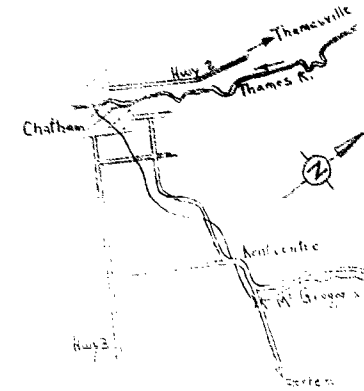
Hwy. # 401

PROP. CROSSING

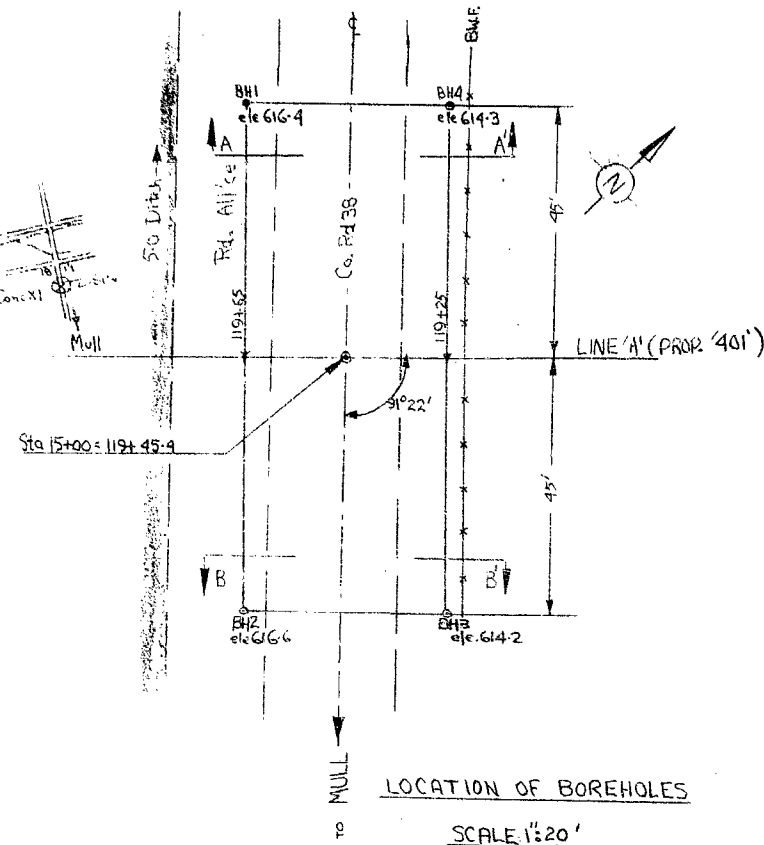
CON. # 11

HARWICH TWP.

401 J.S.



SCALE 1"=5 mi

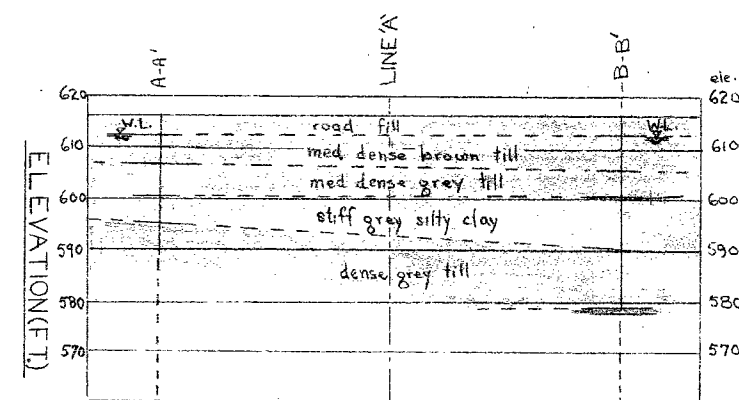


LEGEND

- WL - free water table level
- BH - bore hole
- Φ - construction line
- Cv - insitu vane shear strength (psi)
- Co.Rd - county road
- ELEVATION - geodetic datum ft.

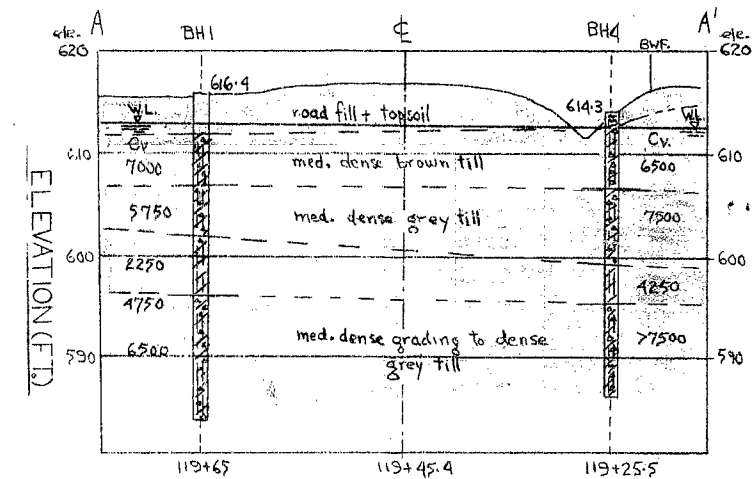
SOILS LEGEND

- Road fill: clay, sand, till, gravel
- Med dense till: grey, oxidizes to brown, silt, clay, sand, gravel
- Stiff grey silty clay
- Dense coarse black gravel: predom. shak, some sand
- Dense coarse grey sand, some silt



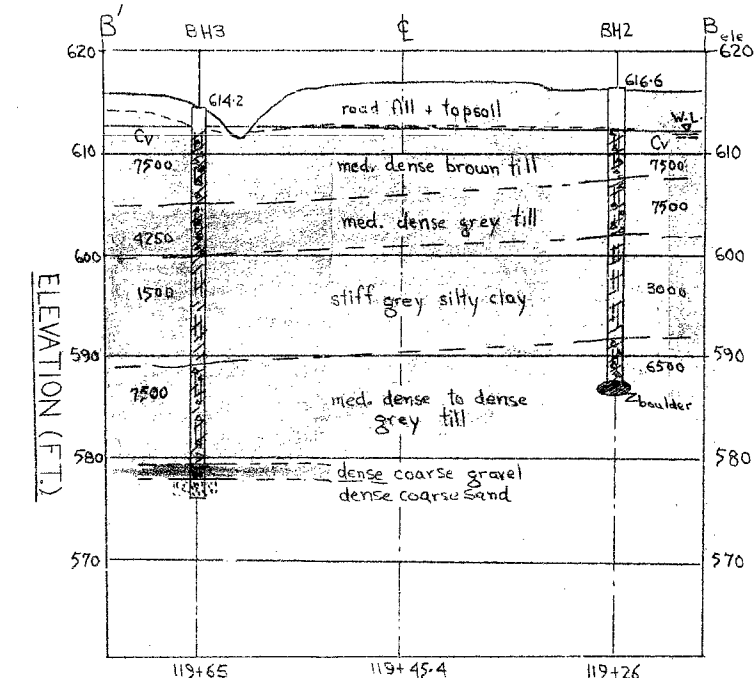
PROFILE ALONG Φ OF CO. RD. NO. 38

SCALE 1"=20'



SUBSURFACE SECTION NORTHWARD A-A'

SCALE 1"=10'



SUBSURFACE SECTION SOUTHWARD B-B'

SCALE 1"=10'

ONTARIO DEPARTMENT OF HIGHWAYS
MATERIALS & RESEARCH SECTION

SUBSURFACE SECTIONS
PROPOSED HWY 401 (LINE A) - KENT CO.
HARWICH TWP RD. NO. 38 - CONC. XI
W.P. 84-59

DOMINION SOIL INVESTIGATION LTD.
88 EGLINTON AVE. E - TORONTO
FIELD SUR - RL. DRAWN - RL.
JOB NO. 60-111 FEB 10/60 ENCL. #



ONTARIO
DEPARTMENT OF HIGHWAYS

Memo to Mr. A. M. Toye, **Date** April 20, 1960.
Bridge Engineer. **Subject** FOUNDATION INVESTIGATION -- by
From Materials & Research Section. Dominion Soil Investigation, Ltd.

Attention: Mr. S. McCombie.

Re: Proposed Crossing Road Allowance between
Lots 18 & 19, Hwy. 401, Concession XI,
Harwich Twp., Kent Cty., District No. 1
W.P. 84-59.

We have reviewed the Report on the foundation investigation at the above noted structure site, submitted by Dominion Soil Investigation, Ltd.

As a result of our study of the data presented in the Consultants' report, we submit the following recommendations pertaining to the substructure design at this site:-

1. The subsoil at this site consists of a stiff, relatively incompressible till material. The upper zone of this deposit has been weathered and is brown in colour. Below this upper zone, the material is not oxidized and is grey.
2. Spread footings loaded with an intensity of 3 Tons/sq.ft. can be used at this site. The recommended placement elevation is 610', or below, and a minimum footing width of 6 ft. should be used.
3. Settlements of the abutments will be of the order of 2 to 3 inches. If a rigid frame, single-span structure is used, the differential movement between the abutments will be negligible. If a multi-span structure is used, the differential movement between pier and abutment, will be of the order of 1 inch.
4. The till subsoil at this site is relatively impermeable and inflow of ground water into the footing excavations will not be a problem. Any seepage that does occur, can be handled by low-capacity sump pumps.

cont'd. /2 ...

Recommendations: (cont'd.) ...

5. The approach embankments can be safely designed using 2:1 slopes.

If we can be of further assistance in the interpretation of data contained in the attached report, please contact our Office.

L. G. Soderman

LGS/MdeF
Attach.

L. G. Soderman,
PRINCIPAL SOILS & FOUNDATIONS ENGINEER.

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

Foundations Office
Gen. Files.

Department of Highways Ontario
Materials and Research Section
Downsview Ontario

REPORT ON
FOUNDATION INVESTIGATION
PROPOSED CROSSING ROAD ALLOWANCE
BETWEEN LOTS 18 & 19 HWY. 401
WP-84-59

Submitted by
Dominion Soil Investigation Ltd.
88 Eglinton Avenue East
Toronto 12 Ontario
April 1960

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7. Foundation Recommendations & Conclusions	5

ENGINEERING DATA SHEETS

Location of Boreholes	Enclosure 1
Borehole Logs	Enclosures 2 to 5 incl.
Subsurface Sections	Enclosures 6
Laboratory Results	Enclosure 7

DOMINION SOIL INVESTIGATION LTD.

SOIL MECHANICS • FOUNDATION ENGINEERING

TORONTO 12, ONTARIO

FOUNDATION INVESTIGATION
PROPOSED CROSSING ROAD ALLOWANCE
BETWEEN LOTS 18 & 19, HWY 401
CONC. XI HARWICH TWP. KENT CO.
WP-84-39

INTRODUCTION:

A foundation investigation was requested by the Materials and Research Section of D.H.O. for a proposed bridge. The proposed structure is on County Road 38 over Highway 401, between lots 18 & 19 of Concession XI, Harwich Township in Kent County.

This Report Presents

Geology of the Area

Fieldwork and Tests

Laboratory Investigations and Results

Interpretation of results and REcommendations

Geology of the Area

The surface has no pronounced relief. It is a plain created by postglacial lakes. It is underlaid by Wisconsin clay till identified by field investigation as silty clay.

The silty clay layer is 36'[±] deep of which the top 9 feet is coloured by oxydization. This layer has small silt content and numerous black shale particles similar to the local bedrock.

Sand

At elevation 579'[±] a layer of dense coarse sand was encountered

Bedrock

Drilling operations were not carried into the bedrock. However, as can be established from the gaswell boring data, the bedrock lies about 70' below the ground level. This rock is black bituminous fissile shale, identified as Kettle Point - Devonian. Bedrock contours reveal a slight dome in the area.

2. Fieldwork & Tests

Fieldwork commenced on February 2, 1960 and was completed on February 5, 1960. Mr. Kobelak, P.Eng. acted as project engineer.

The drill holes were laid out, coinciding with corners of the proposed abutments.

No. 1 Hole was taken down to dense sand layer underlying silty clay. Other holes were stopped earlier as seen by the borehole logs.

Following tests were made in the field as ordered by project engineer.

(a) 2" Shelby tubes

(b) Insitu and remoulded vane shear tests were taken in clay material to a depth of 34' from existing ground surface.

(c) Water levels and standard cone penetration data were recorded.

(d) Elevations were established with an engineering level from benchmarks given on D.H.Ø. Drawing #WP-84-59.

LABORATORY TESTS

All Shelby tube samples were tested for

- Unconfined compression
- Unit Weight
- Atterberg limits and Natural Moisture Content.

Detailed data provided by all laboratory tests are summarized on "Engineering Data Sheets" in Enclosure #7.

SUBSOIL CONDITIONS

From drilling results five major soil materials were classified. Subsurface profiles and borehole logs may be consulted in the rear section of the report for further details.

(a) Topsoil - roadfill:

The upper 3' consists of stiff brown clay with some grey silt bands and traces of sand and gravel. Clay content increases downward and this material grades transitionally into the clay silt below. The water table appeared to be at base of the fill in February at the time of drilling

(b) Medium Dense Brown to Grey Silty Clay

This Wisconsin till sheet is found below elevation 612⁺ and extends downwards to elevation 602⁺. It is oxidized brown in the upper 5' of the layer.

Traces of coarse sand and black shale particles were found in this layer.

An unconfined compression test, done on this material from elevation 594, gave a result of 2,860 psf. This material had a unit weight, $W = 132.9$ pcf and a moisture content of 21%. Its liquid limit was 33.4.

(c) Stiff Grey Silty Clay:

This 4' layer extends from elevation 602 to approximately 592. It appears to thin out towards the north.

The material is a stiff grey silty clay with average moisture content 20%.

Unconfined compression tests on the material gave values of 2,860 psf at elevation 593. See sample #5 BH.3.

Subsoil Conditions - Continued

(d) Med Dense Grey Clay

The same material as found in (b) above. It extends from elevation 592 to 578 below. It had an unconfined compression strength of 5,720 psf.

(e) Loose Coarse Gravels in a Dense Sand Matrix:

There was a sharp change from clay, as above, to a coarse gravel and sand at a elevation 579.7' .

Since this material continually blocked the hole, drilling was discontinued. This sandy layer appears to be found in drill holes throughout this area at this general horizon.

Black shale bedrock occurs at 90' below the ground level according to bedrock contour maps. This was not of course proven in our investigation.

FOUNDATION CONDITIONS:

The free water table, measured in February 1960, was at elevation 612.

It is estimated that the medium dense till has a safe bearing capacity in the range of 7,360 psf if footings were placed at elevation 610. This elevation is below frost limits in the area. It appears that the till will also distribute the applied pressure well.

There should be only minor settlement in the confined firm clay layer below the till. It is estimated that it should be in the order of $\frac{1}{2}$ " for a load of 7,000 psf on a footing of 10' x 26' placed at elevation 612.

Differential settlement due to variation of thicknesses of clay layers was calculated to be 0.25".

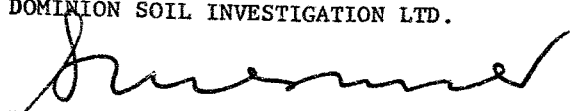
FOUNDATION RECOMMENDATIONS & CONCLUSIONS:

Free water table level was found to be about elevation 612 during field work in February 1960. No water troubles are foreseen concerning construction.

It is recommended that spread footings be placed at or below elevation 612. The safe bearing capacity is in the range of 7,360 psf.

Settlement will not be critical.

DOMINION SOIL INVESTIGATION LTD.



L. Maimets, P.Eng.

Job No. 60-111.

April 1960.

FOUNDATION CALCULATIONS

Reference -

Tschebotarioff - "Soil Mechanics, Foundations and Earth Structures" - p 217 -

Explanation -

Q_a , Safe Allowable Bearing Capacity, was calculated by use of Formula $Q_a = 0.95 \times Q_u (1 + 0.3 \frac{B}{L})$ using Q_u , unconfined compression test results.

The bearing capacity was checked, based on a minimum Q_a ie, a min. Q_a was set = G_z in Boussinesq's Formula. The smaller result of these previous steps was taken as Safe Bearing Capacity under the footing.

Curves were plotted, elevations vs stress - G_z, Q_a etc.

Safe Bearing Cap, Q_a - for 10x30' footing

$$\begin{aligned} Q_a &= 0.95 \times 7015 (1 + 0.3 \times \frac{10}{30}) = 7360 \text{ psf at elev. 610} \\ &= \quad \times 4325 \quad \quad \quad = 4550 \text{ psf} \quad \quad \quad \text{" " 604} \\ &\quad \times 2860 \quad \quad \quad = 3000 \text{ psf} \quad \quad \quad \text{" " 601} \\ &\quad \times 5720 \quad \quad \quad = 6000 \text{ psf} \quad \quad \quad \text{" " 594} \end{aligned}$$

Boussinesq's Stress Distⁿ under 10x30' footing

$$\begin{aligned} Z &= 17' & a &= 15.0' & \frac{a}{b} &= 3.0 & \frac{Z}{b} &= \frac{17}{5} = 3.4 \end{aligned}$$

$$\frac{G_z}{P} = .075$$

$$\text{Capacity, } P = \frac{G_z}{.075} = \frac{750}{.075} = 10,000 \text{ psf.}$$

$$10,000 > 7360$$

∴ Safe Bearing capacity to be used is 7360 psf.

Boussinesq's Stress Distⁿ Calc.

Elev.	Z	$\frac{Z}{b}$	$\frac{G_z}{P}$	$4 \times G_z$
610	0.0'	0.0	0.25	7360 psf
605	5.0'	1.0	0.20	5870 "
600	10.0	2.0	0.13	3820 "
595	15.0	3.0	0.09	2640 "

Elev	Z	Z/b	G_z/p	$4 \times G_z$
590	20.0'	4.0	.06	1770 psf.
585	25.0	5.0	.042	1235 "
580	30.0	6.0	.033	970 "
575	35.0	7.0	.025	735 "
570	40.0	8.0	.020	588 "
565	45.0	9.0	.017	500 "

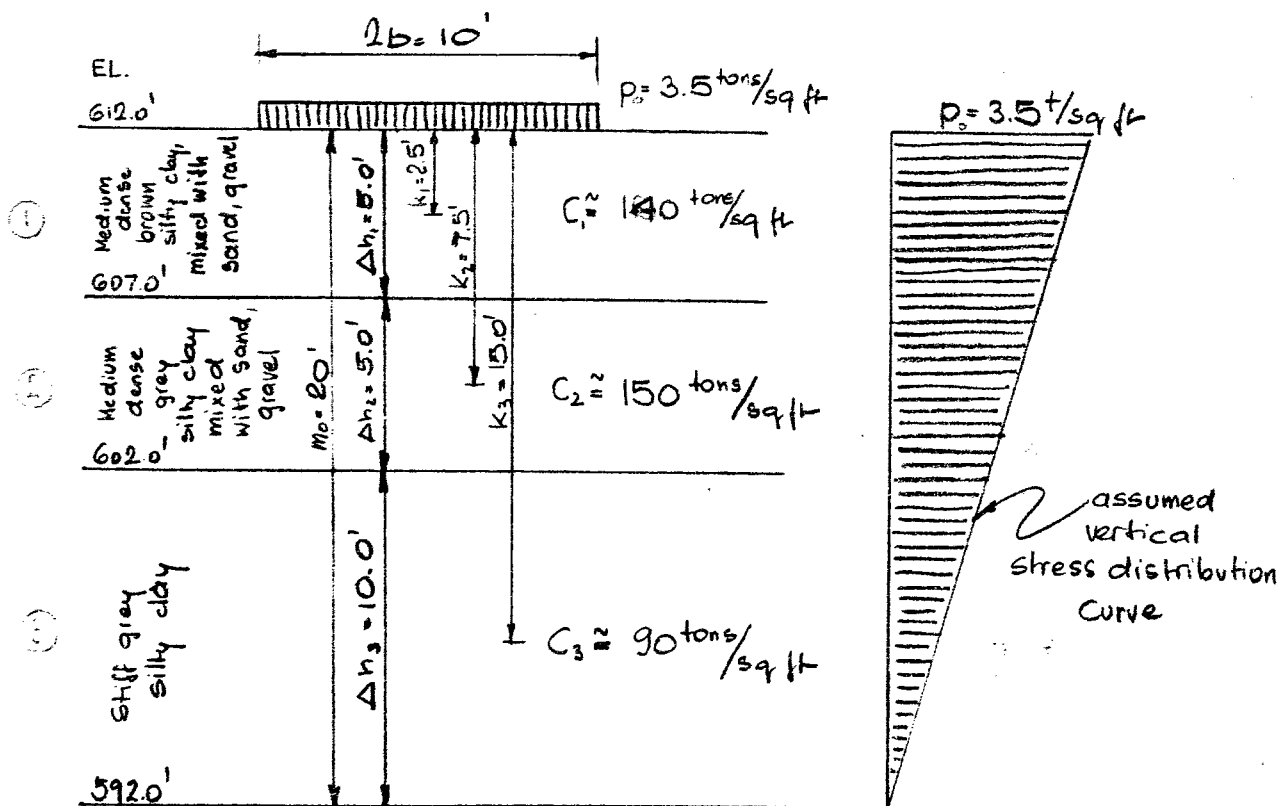
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C = 0.009 (1.5-1)

CALCULATION OF SETTLEMENT

The following calculations are based on the theory of Prof. Dr. JAKY, who considers that the stress distribution is limited to a depth of $4b$, where b = the half width of strip footing. In this case: $m_0 = 4b = 20'$. Plane of the bottom of footing. El. 612.00' Soil pressure in this plane: 3.5 tons/sq ft . The "C" values are taken according to the table of Kögler. Thus the calculation of the settlement gives only the order of magnitude of the settlement.

Southern Abutment:



CALCULATION OF SETTLEMENT - CONT'D

$$\text{settlement } \Delta s = \frac{p_o}{m_o} \sum_{i=1}^{i=3} \frac{\Delta h_i}{C_i} \left(1 - \frac{k_i}{m_o}\right)$$

	Δh_i	C_i	$\frac{\Delta h_i}{C_i}$	k_i	k_i/m_o	$1 - k_i/m_o$	$\frac{\Delta h_i}{C_i} \left(1 - \frac{k_i}{m_o}\right)$
①	5.0'	140 $\frac{1}{2}$ lb/ft ²	0.0357	2.5'	0.125	0.875	0.0312
②	5.0'	150 $\frac{1}{2}$ lb/ft ²	0.033	7.5'	0.375	0.625	0.0206
③	10.0'	90 $\frac{1}{2}$ lb/ft ²	0.111	15.0'	0.75	0.25	0.0278
						$\Sigma:$	0.0796

$$\frac{p_o}{m_o} = 0.175 \quad \Delta s = 0.175 \times 0.0796 = 0.014 \text{ ft.}$$

$$\Delta s = 0.168 \text{ in which is less than } \frac{3}{16}''.$$

The settlement below the northern abutment will be somewhat smaller, because the thickness of the clay layer is even less. The differential settlement of the two abutments is negligible.

April, 1960.

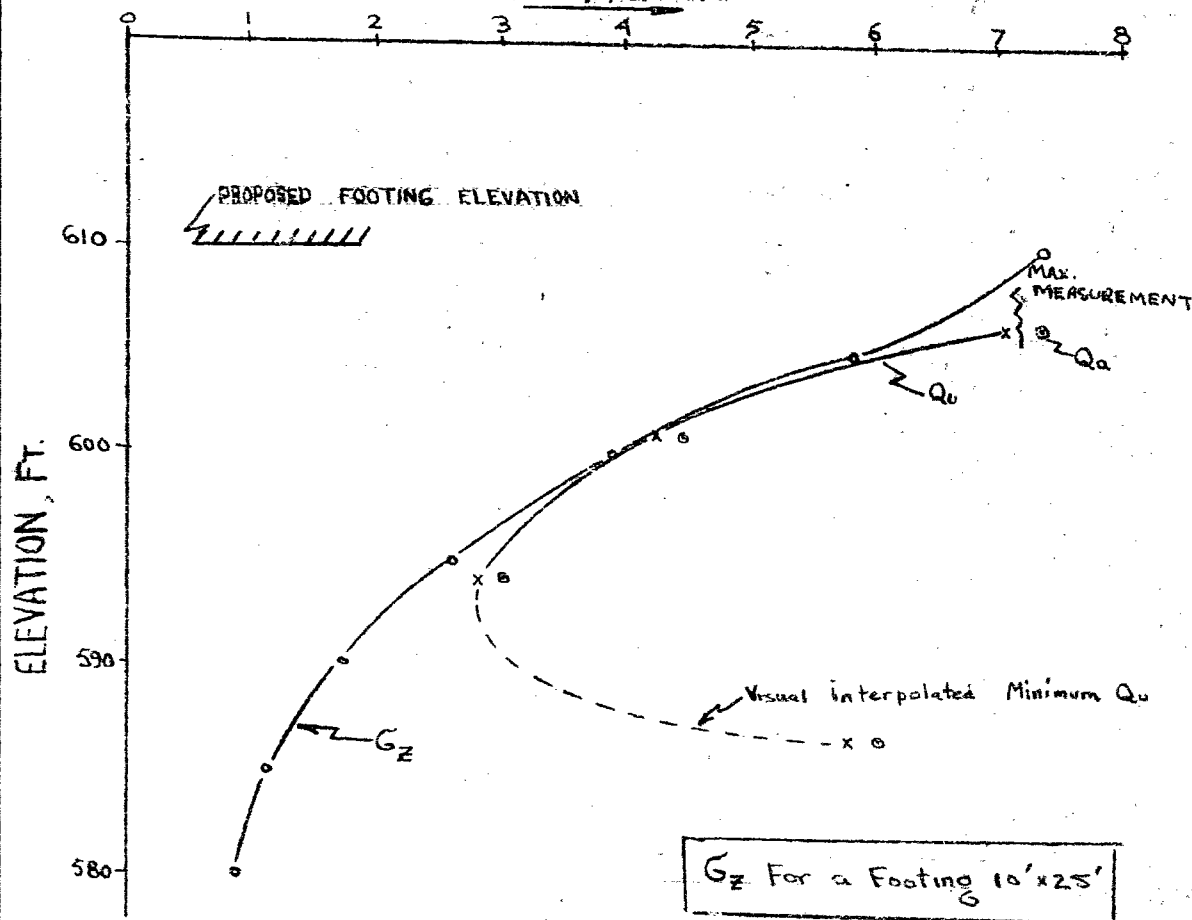
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L. R. Szalatkay P. Eng.
/L. R. SZALATKAY/

Prep. By

STRESS & CAPACITY DISTRIBUTION GRAPH

STRESS VS ELEVATION

STRESS, PSF $\times 10^3$ LEGEND:

- G_z - Boussinesq Vertical Stress Distribution Curve, psf.
- x Q_u - Unconfined Compression Test Results, psf.
- Q_a - Safe Allowable Bearing Capacity, psf. $= 0.95 Q_u (1 + 0.3 \frac{B}{L})$
where: $\frac{B}{L} = \frac{10}{25}$

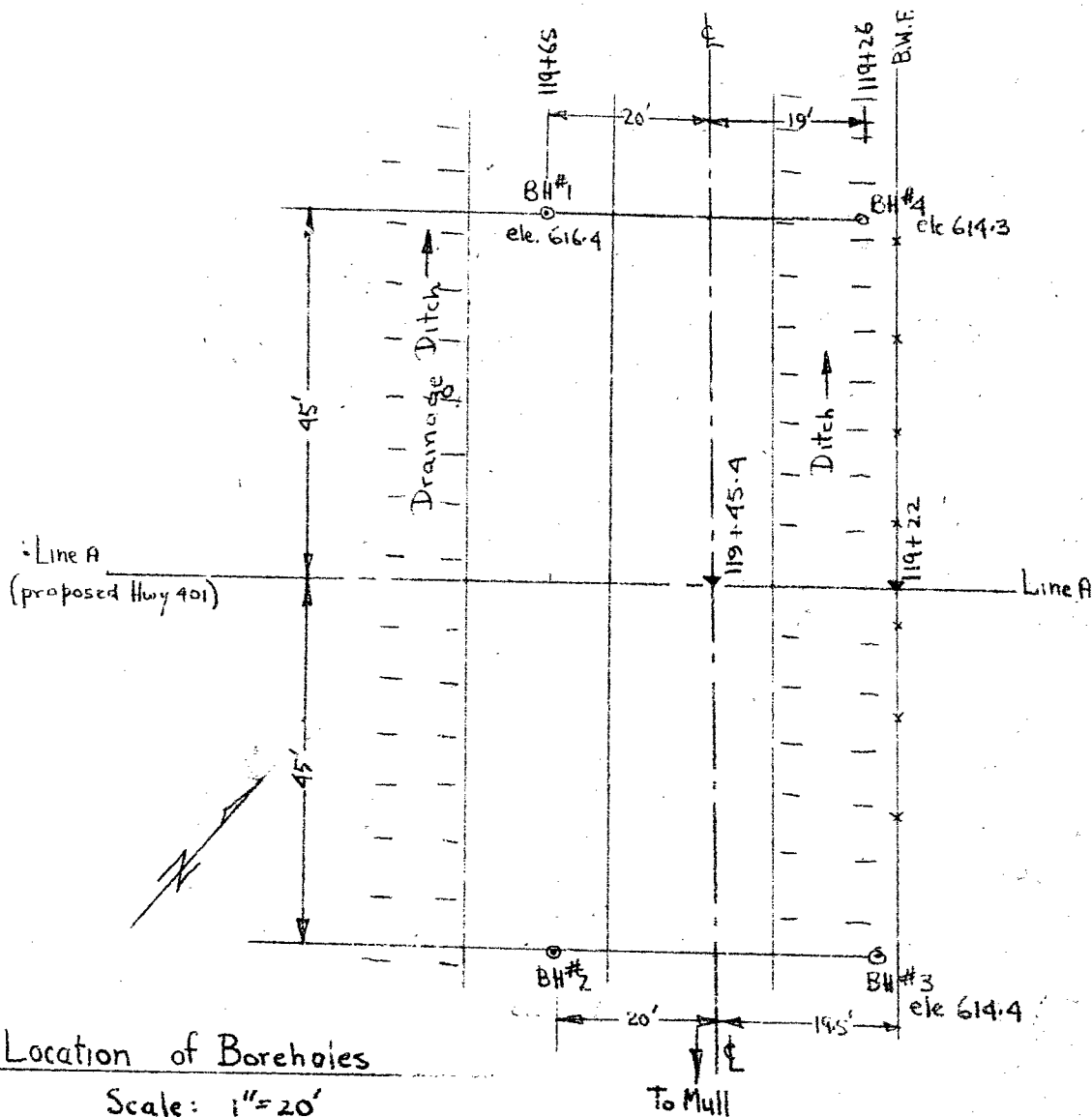
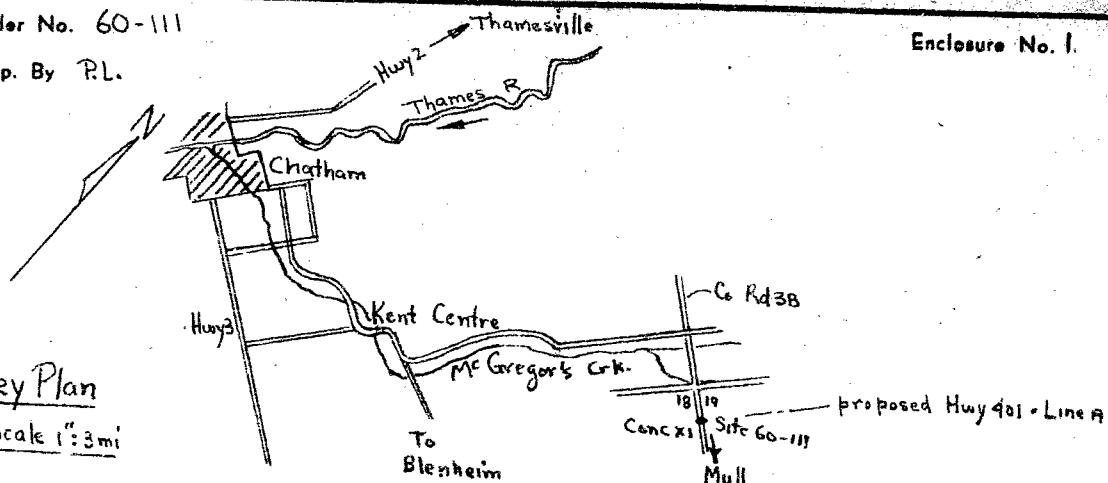
Order No. 60-111

Prep. By P.L.

Enclosure No. 1.

Key Plan

Scale 1"=3 mi



Location of Boreholes

Scale: 1"=20'

Dominion Soil Investigation Ltd.

Dominion Soil Investigation Ltd.

Engineering Data Sheet for Borehole: 1 of 4

Project: 401 Hwy. Bridge

Location: 401 Hwy., Line A, Co. Rd. 38

Hole Location: Sta. 119+65-45 ft. Rt. Line A

Hole Elevation and Datum: 616.4

Field Supervisor: P.L.

Prep.: P.L.

Driller: C.I.

Checked:

LEGEND

Shear Strength (C)

Unconfined compression
Vane test and sensitivity (S)

Penetration Resistance (P)

2" Split tube

2" Dia. Cone

Casing

Date: Feb. 2, 60.

Sampling Method

2" Dia. split tube

2" Shelby tube

LEGEND

Consistency

Natural moisture and

Liquidity Index (LI)

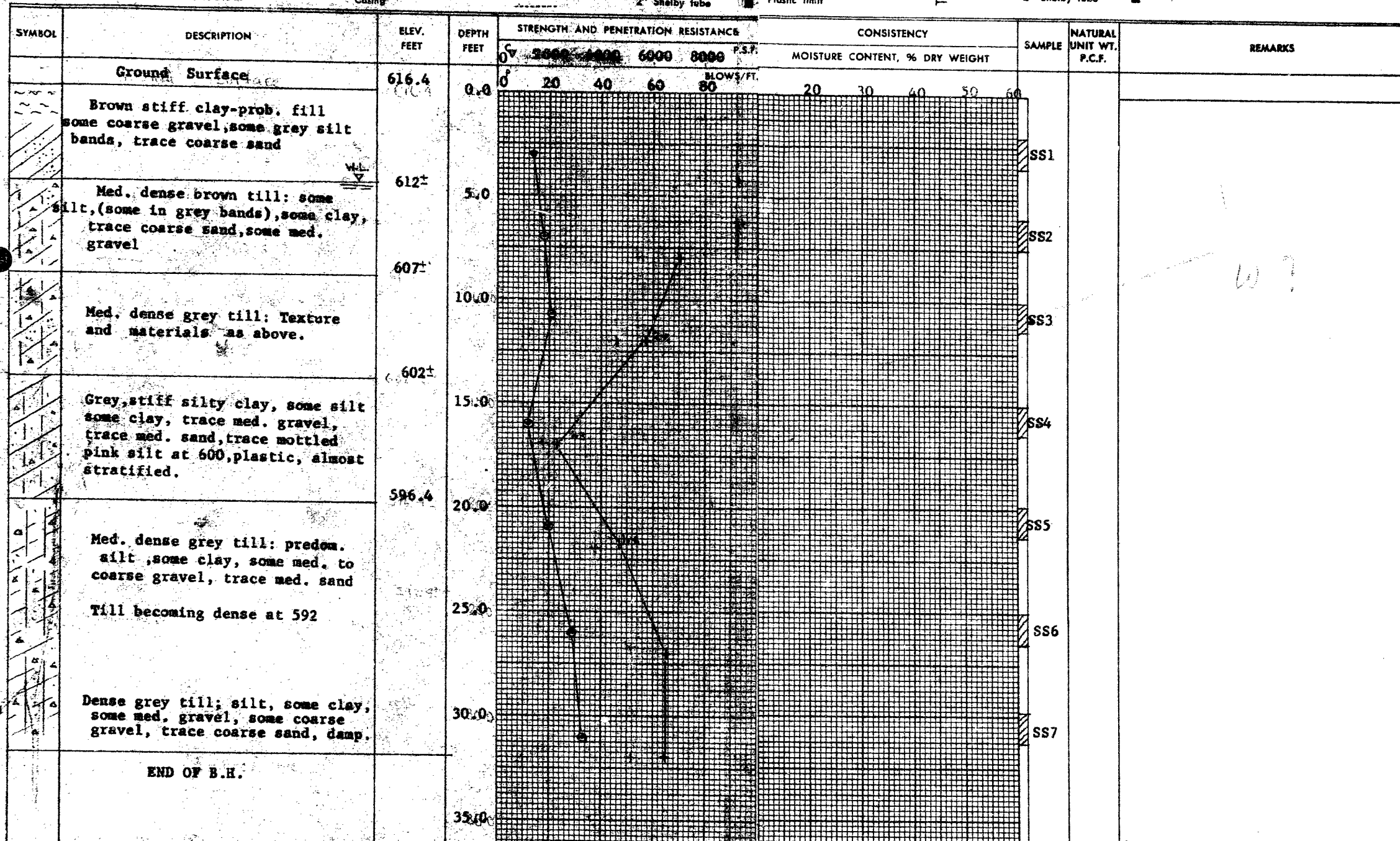
Liquid limit

Plastic limit

Sampling Method

2" Dia. split tube

2" Shelby tube



Dominion Soil Investigation Ltd.

Engineering Data Sheet for Borehole:

Date: Feb. 3, 69.

Unconfined compression
Vane test and sensitivity (S)

Penetration Resistance (P)

2" Split tube

2" Dia. Cone

Casing

2" Dia. split tube

2" Shelby tube

Consistency

Natural moisture and
Liquidity Index (LI)
Liquid limit
Plastic limit

Sampling Method

2" Dia. split tube

2' Shelby tube

SYMBOL	DESCRIPTION	ELEV. FEET	DEPTH FEET	STRENGTH AND PENETRATION RESISTANCE					CONSISTENCY					SAMPLE	NATURAL UNIT WT. P.C.F.	REMARKS
				1000	4000	5000	6000	7000	MOISTURE CONTENT, % DRY WEIGHT							
	Ground surface	616.6	0.0													
	Compact brown fill; some clay, some silt, some coarse sand, trace coarse gravel, iron stained, moist. W.L.	612.0	5.0											SS1		
	Med. dense brown glacial till - silt, some clay (some grey silt bands), trace coarse sand, some fine gravel, moist.	607.6±	10.0											SS2		
	Med. dense grey till - silt, some clay, some coarse sand, trace grey silt blobs, some med. gravel, damp.	602 ±	15.0											TW3		
	Grey plastic clay with till fabric, some pink mottled silt, trace coarse sand, some med. gravel, moist.	592.0	20.0											TW4		
	Firm grey silty clay, trace coarse sand, trace med. & coarse gravel, plastic, very moist.													SS5		
	Dense grey glacial till - predominantly silt, some clay, trace coarse sand, some med. gravel, damp.	587 ±												SS6		
	END OF B.H.															

Dominion Soil Investigation Ltd.

Engineering Data Sheet for Borehole: 3

Dominion Soil Investigation Ltd.

Engineering Data Sheet for Borehole:

Project: 401 Hwy. Bridge

Location: 401 Hwy. Line 'A', Kent Co. Rd. 38.

Hole Location: Sta. 119+25.5 - 45' Lft.

Hole Elevation and Datum: 614.2

Field Supervisor: P.L. Prep.: P.L.

Driller: C.I. Checked:

Date: Feb. 5, 60.

LEGEND

Shear Strength (C)

Unconfined compression
Vane test and sensitivity (S)

Penetration Resistance (P)

2" Split tube

2" Dia. Cone

Casing

⊕
+^s⊕
⊕

Sampling Method

2" Dia. split tube

2" Shelby tube

LEGEND

Consistency

Natural moisture and
Liquidity index (LI)
Liquid limit
Plastic limit

— x — o

x LI

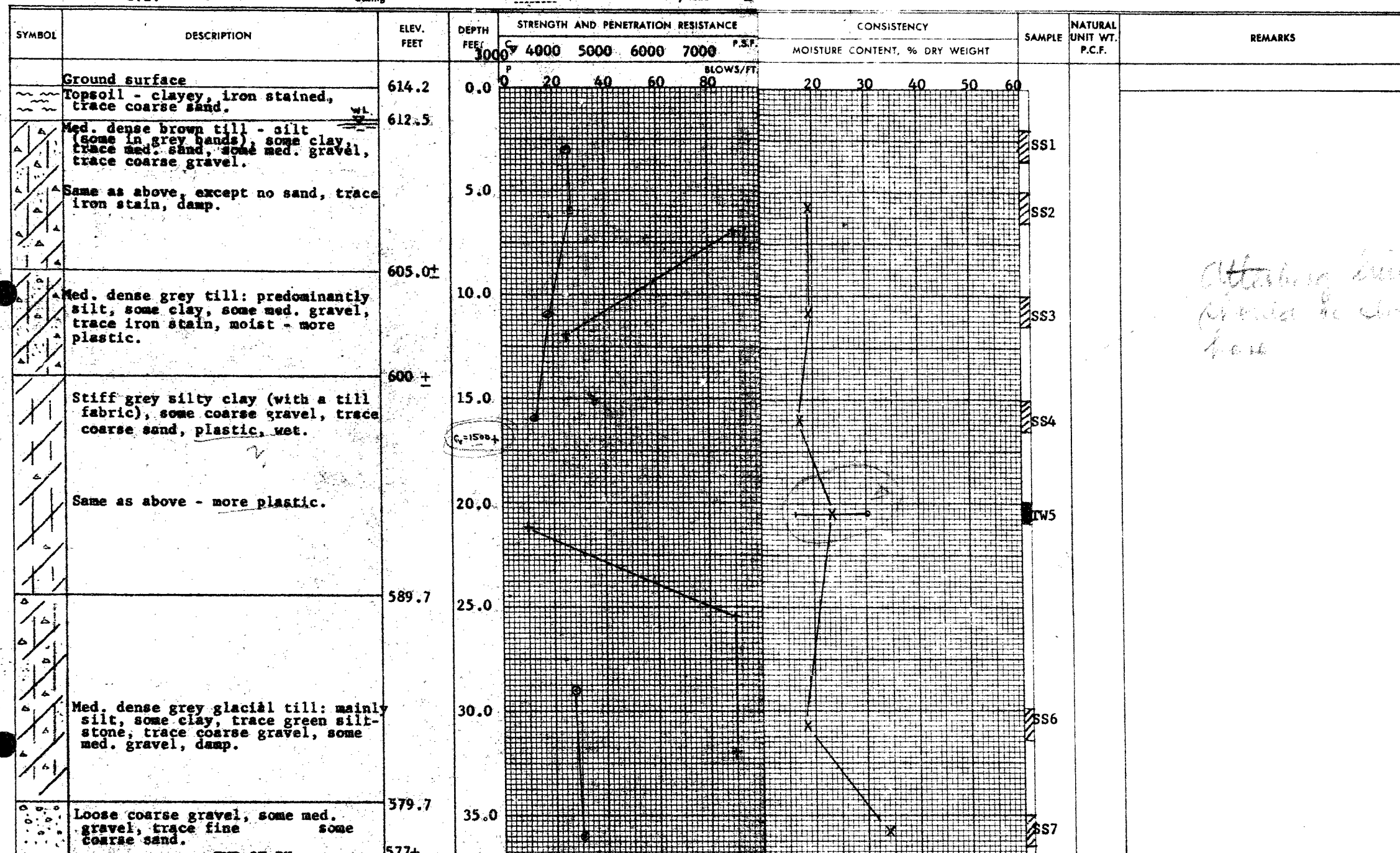
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Sampling Method

2" Dia. split tube

2" Shelby tube



Dominion Soil Investigation Ltd.

Engineering Data Sheet for Borehole: 4

Project: 401 Hwy. Bridge

Location: Hwy. 401; Line 'A', Kent Co. Rd. 38

Hole Location: Sta. 119+26 - 45' Rt. of Line 'A'

Hole Elevation and Datum: 614.3

Field Supervisor: P.L. Prep.: P.L.

Driller: C.I. Checked:

LEGEND

Shear Strength (C)

Unconfined compression

Vane test and sensitivity (S)

Penetration Resistance (P)

2" Split tube

2" Dia. Cone

Casing

Date: Feb. 5, 60.

Sampling Method

2" Dia. split tube

2" Shelby tube

LEGEND

Consistency

Natural moisture and

Liquidity Index (LI)

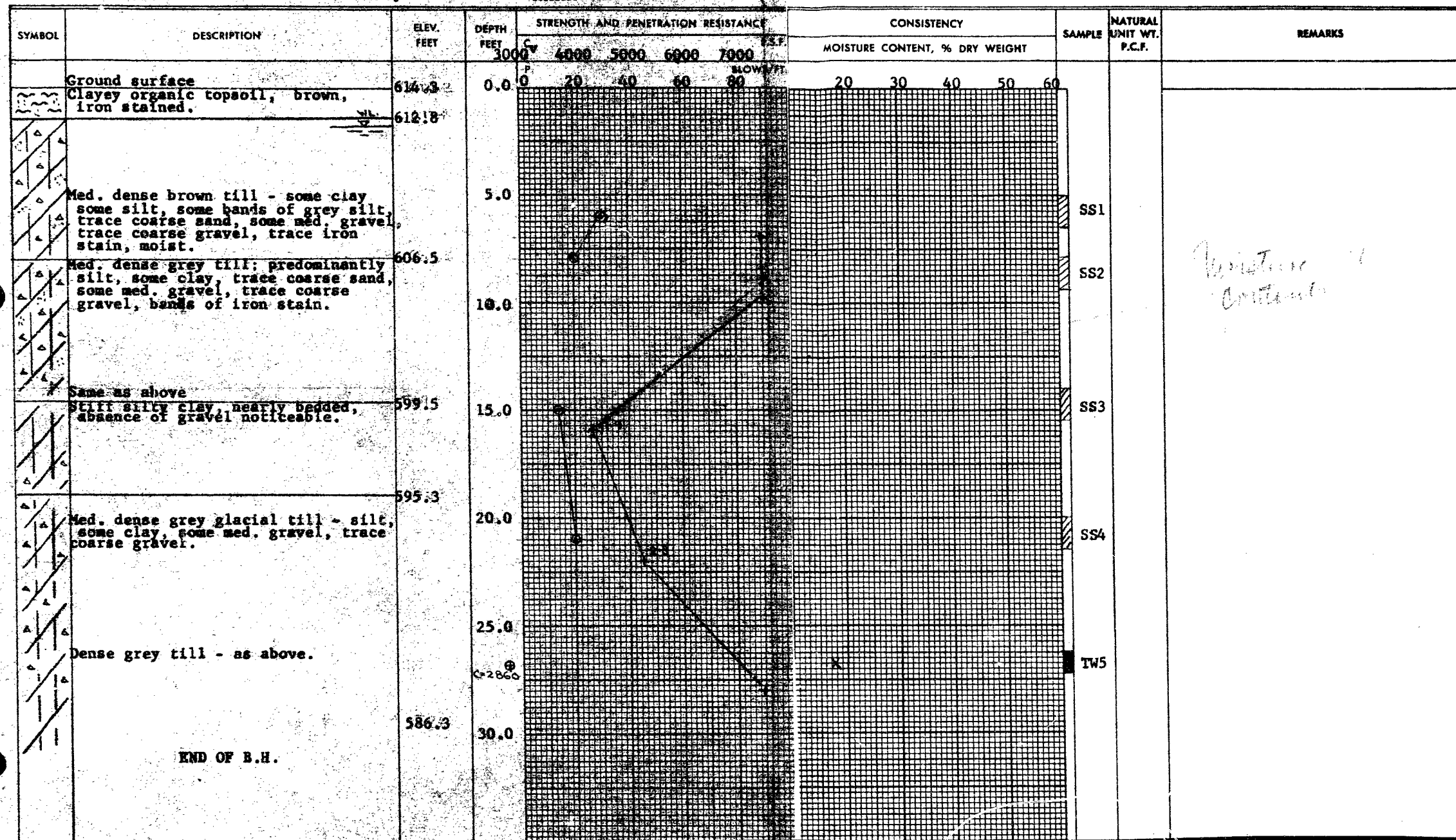
Liquid limit

Plastic limit

Sampling Method

2" Dia. split tube

2" Shelby tube



LAB TEST SUMMARY

Enclos. 7

<u>Borehole & Sample No.</u>	<u>Moisture Content %</u>	<u>w - pcf</u>	<u>Qu(psf)</u>	<u>Strain</u>	<u>Liquid Limit</u>	<u>Plastic Limit</u>
BH#2 - S#2	21.4					
3	21.1	132.9	7,015	14.15%		
4	18.2	130.3	4,325	20%	33.4	17.45
5	20.0					
6	18.3					
BH#3 - S#2	19.2					
3	19.4					
4	17.3					
5	23.9	132.6	2,860	20%	30.1	16.7
6	18.1					
7	34.3					
BH#4 - S#5	17.9	134.6	5,720	20%		