



THURBER ENGINEERING LTD.

MEMORANDUM

To: Christopher Schueler, P.Eng.
AECOM

Date: December 16, 2015

From: Keli Shi, P.Eng.
Alastair Gorman, P.Eng.
(Reviewed by P.K. Chatterji, P.Eng.)

File: 19-4406-20

DETAIL FOUNDATION INVESTIGATION SHELTER VALLEY CREEK CULVERT (SITE 21-272/C) REPLACEMENT OF RETAINING WALLS AT CULVERT INLET (NORTH END) GEOCRES NO. 31C-236

1. INTRODUCTION

A preliminary memorandum dated September 22, 2015 presented a brief summary of the factual findings from a foundation review carried out for the existing Highway 401 Crossing at Shelter Valley Creek in the geographical township of Haldimand, Northumberland County, Ontario.

At the current detail design stage, information provided by AECOM indicated that a decision has been made to replace the retaining walls at the inlet (north end) of the culvert.

This memorandum presents the factual findings obtained from a field investigation conducted for the proposed replacement of retaining walls at the culvert inlet.

The Geocres report and historic drawings for the existing culvert are included in Appendix D for reference and information purpose.

The following reference numbers apply to this site:

- Current W.P. 4018-13-01
- Site No. 21-272/C
- Existing Geocres No. 31C00-045
- Historic W.P. 55-57

2. SITE DESCRIPTION

The site is located on Highway 401 northeast of Grafton and 3.5 km east of Regional Road 23. Based on the historic General Arrangement (GA) drawing, the existing stream crossing structure is a single-span concrete arch culvert with a span of 15 m and a length of approximately 100 m across highway embankment. At the inlet/outlet of the 8 m high arch structure, the lower 3.6 m is vertical with wing retaining walls attached at a right angle and the upper 4.4 m is inclined at approximately 1.5H: 1V to meet the embankment fill slope above the top of arch. The maximum thickness of embankment fill above the top of arch is in the order of 11 to 12 m.



The site lies within the physiographical area of Iroquois Plain. Based on published information, this plain consists of sand and lacustrine clay deposited in glacial Lake Iroquois. The underlying bedrock consists of limestone of the Shadow Lake formation.

3. SITE INVESTIGATION AND LAB TESTING

The current site investigation and field testing were carried out during the period of May 5 to 9, 2015. A total of two boreholes, identified as 15-01 and 15-02, were advanced through the embankment fill behind the retaining walls to depths of 10.9 m and 11.1 m on east side and west side of the culvert inlet, respectively. Temporary wooden platform was built, where required on the steep embankment slope, to provide a level working surface for drilling operations. Standpipe piezometer was installed in borehole 15-01 upon completion of drilling.

The approximate locations of the two boreholes are shown on the Borehole Location Plan included in Appendix C. Borehole coordinates were obtained by a hand-held GPS unit during field investigation. Borehole elevations were estimated based on the borehole coordinates and a ground contour map provided by AECOM.

Both boreholes were advanced using portable tripod drill rig in combination with NW casing/wash boring methods. Soil samples were obtained from the boreholes at selected intervals using a split spoon sampler in conjunction with Standard Penetration Testing (SPT).

The drilling and sampling operations were supervised on a full-time basis by a member of Thurber's technical staff. The supervisor logged the boreholes and processed the recovered soil samples for transport to Thurber's laboratory for further examination and testing.

The recovered soil samples were subjected to visual identification (VI) and to natural moisture content determination. The results of this testing are shown on the Record of Borehole sheets included in Appendix A. Selected samples were also subjected to gradation analysis and the results of this testing program are summarized on the Record of Borehole sheets in Appendix A and shown on the figures included in Appendix B.

4. SUBSURFACE CONDITIONS

The subsurface stratigraphy below the existing embankment fill encountered at this site generally consists of a layer of compact sand and silt underlain by typically dense to very dense silty sand to sand deposit.

4.1. Existing Fill

Existing fill of the Highway 401 embankment encountered in boreholes consists of sand and silt to clayey silt. The thicknesses of fill were 3.8 m in both boreholes, with the base of the fill at Elev. 129.2 to 129.8 m.

SPT-N values ranged from 2 to 24 blows per 0.3 m penetration in the sand and silt fill, indicating a very loose to compact relative density. SPT-N values ranged from 19 to 35 blows per 0.3 m penetration in the clayey silt fill, indicating a very stiff to hard consistency and typically increasing with depth. Moisture contents measured in the fill ranged from 10 to 18%.



The results of two gradation analyses conducted on fill samples are provided on the Record of Borehole sheets included in Appendix A and illustrated in Figures B1a and B1b. The clayey silt fill contains 1% gravel, 14% sand, 66% silt and 19% clay, and the sand and silt fill contains 1% gravel, 41% sand, 49% silt and 9% clay.

4.2. Sand and Silt

A native sand and silt layer was encountered below the fill in both boreholes. The thicknesses of the sand and silt were about 1.8 m, with the base of the layer at Elev. 127.4 to 128.0 m.

SPT-N values recorded in the sand and silt ranged between 11 and 12 blows per 0.3 m penetration, indicating a compact relative density. Moisture contents measured on the sand and silt samples ranged between 12 and 18%.

The results of two gradation analyses conducted on the cohesionless samples are provided on the Record of Borehole sheets included in Appendix A and illustrated in Figure B2. The sand and silt contains 1 to 2% gravel, 44 to 58% sand, 34 to 45% silt and 6 to 10% clay.

4.3. Sand

A relatively thick layer of native sand was encountered below the sand and silt in both boreholes. The sand contains some silt to silty. Both boreholes were terminated within the sand layer at Elev. 122.1 to 122.5 m.

SPT-N values recorded in the sand ranged from 29 blows per 0.3 m penetration to 325 blows for 0.25 m penetration, indicating a relative density of compact to very dense. Moisture contents measured on the sand samples ranged from 18 to 20%.

The results of four gradation analyses conducted on the sand samples are provided on the Record of Borehole sheets included in Appendix A and illustrated in Figure B3. The sand contains 0 to 10% gravel, 71 to 84% sand, 12 to 23% silt and 3 to 4% clay.

4.4. Water Levels

A standpipe piezometer was installed in Borehole 15-01 to monitor the groundwater levels after drilling. The groundwater level measurements are summarized in the table below.

Borehole	Date	Water Level (m)		Remark
		Depth	Elevation	
15-01	May 7, 2015	2.1	130.9	In piezometer
	May 8, 2015	2.0	131.0	
	May 9, 2015	2.1	130.9	

Based on the historic information, water level in the creek was reported at Elevation 128.1 in February 1954. The estimated high water level was at Elevation 131.5 approximately.

The creek and groundwater levels are expected to fluctuate seasonally and subject to precipitation patterns, and may vary from the levels presented above.



5. CLOSURE

Preparation of the memorandum were carried out by Mr. Keli Shi, P.Eng. The memo was reviewed by Mr. Alastair Gorman, P.Eng. and Dr. P.K. Chatterji, P.Eng., a Designated Principal Contact for MTO Foundations Projects.

Thurber Engineering Ltd.



Keli Shi, P.Eng.
Geotechnical Engineer



Alastair Gorman, P.Eng.
Associate, Senior Foundation Engineer



P.K. Chatterji, P.Eng.
Review Principal, Designated MTO Contact



Appendix A
Record of Borehole Sheets

SYMBOLS, ABBREVIATIONS AND TERMS USED ON RECORDS OF BOREHOLES

1. TEXTURAL CLASSIFICATION OF SOILS

CLASSIFICATION	PARTICLE SIZE	VISUAL IDENTIFICATION
Boulders	Greater than 200mm	same
Cobbles	75 to 200mm	same
Gravel	4.75 to 75mm	5 to 75mm
Sand	0.075 to 4.75mm	Not visible particles to 5mm
Silt	0.002 to 0.075mm	Non-plastic particles, not visible to the naked eye
Clay	Less than 0.002mm	Plastic particles, not visible to the naked eye

2. COARSE GRAIN SOIL DESCRIPTION (50% greater than 0.075mm)

TERMINOLOGY	PROPORTION
Trace or Occasional	Less than 10%
Some	10 to 20%
Adjective (e.g. silty or sandy)	20 to 35%
And (e.g. sand and gravel)	35 to 50%

3. TERMS DESCRIBING CONSISTENCY (COHESIVE SOILS ONLY)

DESCRIPTIVE TERM	UNDRAINED SHEAR STRENGTH (kPa)	APPROXIMATE SPT ⁽¹⁾ 'N' VALUE
Very Soft	12 or less	Less than 2
Soft	12 to 25	2 to 4
Firm	25 to 50	4 to 8
Stiff	50 to 100	8 to 15
Very Stiff	100 to 200	15 to 30
Hard	Greater than 200	Greater than 30

NOTE: Hierarchy of Soil Strength Prediction

- 1) Laboratory Triaxial Testing
- 2) Field Insitu Vane Testing
- 3) Laboratory Vane Testing
- 4) SPT value
- 5) Pocket Penetrometer



4. TERMS DESCRIBING DENSITY (COHESIONLESS SOILS ONLY)

DESCRIPTIVE TERM	SPT "N" VALUE
Very Loose	Less than 4
Loose	4 to 10
Compact	10 to 30
Dense	30 to 50
Very Dense	Greater than 50

5. LEGEND FOR RECORDS OF BOREHOLES

SYMBOLS AND ABBREVIATIONS FOR SAMPLE TYPE	SS Split Spoon Sample	WS Wash Sample	AS Auger (Grab) Sample
	TW Thin Wall Shelby Tube Sample	TP Thin Wall Piston Sample	
	PH Sampler Advanced by Hydraulic Pressure	PM Sampler Advanced by Manual Pressure	
	WH Sampler Advanced by Self Static Weight	RC Rock Core	SC Soil Core

$$\text{Sensitivity} = \frac{\text{Undisturbed Shear Strength}}{\text{Remoulded Shear Strength}}$$

 Water Level
 Shear Strength Determination by Pocket Penetrometer

- (1) SPT 'N' Value Standard Penetration Test 'N' Value – refers to the number of blows from a 63.5kg hammer free falling a height of 0.76m to advance a standard 50 mm outside diameter split spoon sampler for 0.3 m depth into undisturbed ground.
- (2) DCPT Dynamic Cone Penetration Test – Continuous penetration of a 50 mm outside diameter, 60° conical steel point attached to "A" size rods driven by a 63.5 kg hammer free falling a height of 0.76 m. The resistance to cone penetration is the number of hammer blows required for each 0.3 m advance of the conical point into undisturbed ground.

RECORD OF BOREHOLE No 15-01

1 OF 2

METRIC

W.P. 4018-13-01 LOCATION Site 21-272/C, Hwy 401 N 4 875 774.2 E 185 569.6 ORIGINATED BY ME
 HWY 401 BOREHOLE TYPE Tripod/Casing COMPILED BY MFA
 DATUM DATE 2015.05.05 - 2015.05.06 CHECKED BY KS

SOIL PROFILE			SAMPLES			GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT					UNIT WEIGHT γ kN/m ³	REMARKS & GRAIN SIZE DISTRIBUTION (%)
ELEV DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE	"N" VALUES			SHEAR STRENGTH kPa						
								20 40 60 80 100						
133.0	GROUND SURFACE													
0.0	SAND and SILT , trace rootlets, trace gravel Loose to Compact Brown Moist (FILL)		1	SS	6									
132.2														
0.8	Clayey SILT , some sand, trace gravel Very Stiff to Hard Brown Moist (FILL)		2	SS	19		132							
			3	SS	23									1 14 66 19
			4	SS	23		131							
			5	SS	35		130							
129.2														
3.8	SAND and SILT , trace clay, trace gravel Compact Brown Moist		6	SS	11		129							1 44 45 10
							128							
127.4														
5.6	SAND , some silt to silty, trace clay, trace gravel Very Dense Brown Moist		7	SS	105		127							3 81 12 4
							126							
			8	SS	150		125							
			9	SS	325/ 0.250		124							0 73 23 4

Continued Next Page

+³, ×³: Numbers refer to Sensitivity
 20
 15
 10
 (%) STRAIN AT FAILURE

RECORD OF BOREHOLE No 15-01

2 OF 2

METRIC

W.P. 4018-13-01 LOCATION Site 21-272/C, Hwy 401 N 4 875 774.2 E 185 569.6 ORIGINATED BY ME
 HWY 401 BOREHOLE TYPE Tripod/Casing COMPILED BY MFA
 DATUM DATE 2015.05.05 - 2015.05.06 CHECKED BY KS

SOIL PROFILE			SAMPLES			GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT					PLASTIC LIMIT W _p	NATURAL MOISTURE CONTENT W	LIQUID LIMIT W _L	UNIT WEIGHT γ kN/m ³	REMARKS & GRAIN SIZE DISTRIBUTION (%) GR SA SI CL
ELEV DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE	"N" VALUES			SHEAR STRENGTH kPa									
	Continued From Previous Page																
122.1			10	SS	100/ .125												
10.9	END OF BOREHOLE AT 10.9m. Piezometer installation consists of 25.4mm diameter Schedule 40 PVC pipe with a 1.52m slotted screen. WATER LEVEL READINGS: DATE DEPTH (m) ELEV. (m) 2015.05.07 2.1 130.9 2015.05.08 2.0 131.0 2015.05.09 2.1 130.9																

RECORD OF BOREHOLE No 15-02

1 OF 2

METRIC

W.P. 4018-13-01 LOCATION Site 21-272/C, Hwy 401 N 4 875 771.0 E 185 549.3 ORIGINATED BY ME
 HWY 401 BOREHOLE TYPE Tripod/Casing COMPILED BY MFA
 DATUM DATE 2015.05.08 - 2015.05.09 CHECKED BY KS

SOIL PROFILE			SAMPLES			GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT					PLASTIC LIMIT NATURAL MOISTURE LIQUID CONTENT LIMIT			UNIT WEIGHT γ kN/m ³	REMARKS & GRAIN SIZE DISTRIBUTION (%)			
ELEV DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE	"N" VALUES			SHEAR STRENGTH kPa					WATER CONTENT (%)				GR	SA	SI	CL
								20	40	60	80	100	W _P	W	W _L					
133.6	GROUND SURFACE																			
0.0	SAND and SILT , trace clay, trace gravel Very Loose to Compact Brown Moist (FILL)		1	SS	2		133													
			2	SS	5															
			3	SS	13		132										1	41 49 9		
			4	SS	24															
	Becoming wet		5	SS	5		131													
							130													
129.8	SAND and SILT , trace clay, trace gravel Compact Brown Wet		6	SS	12		129										2	58 34 6		
							128													
128.0	SAND , some silt, trace clay, trace gravel Compact to Very Dense Brown Wet to Moist		7	SS	29		127										10	71 15 4		
							126													
			8	SS	74		125													
							124													
			9	SS	122															

Continued Next Page

+³, ×³: Numbers refer to Sensitivity
 20
 15
 10
 (%) STRAIN AT FAILURE

RECORD OF BOREHOLE No 15-02

2 OF 2

METRIC

W.P. 4018-13-01 LOCATION Site 21-272/C, Hwy 401 N 4 875 771.0 E 185 549.3 ORIGINATED BY ME
 HWY 401 BOREHOLE TYPE Tripod/Casing COMPILED BY MFA
 DATUM DATE 2015.05.08 - 2015.05.09 CHECKED BY KS

SOIL PROFILE			SAMPLES			GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT					PLASTIC LIMIT NATURAL MOISTURE CONTENT LIQUID LIMIT			UNIT WEIGHT γ kN/m ³	REMARKS & GRAIN SIZE DISTRIBUTION (%) GR SA SI CL
ELEV DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE	"N" VALUES			SHEAR STRENGTH kPa					WATER CONTENT (%)				
							20	40	60	80	100	W _p	W	W _L			
	Continued From Previous Page																
122.5			10	SS	168		123									0 84 13 3	
11.1	END OF BOREHOLE AT 11.1m. BOREHOLE BACKFILLED WITH BENTONITE HOLEPLUG.																



Appendix B

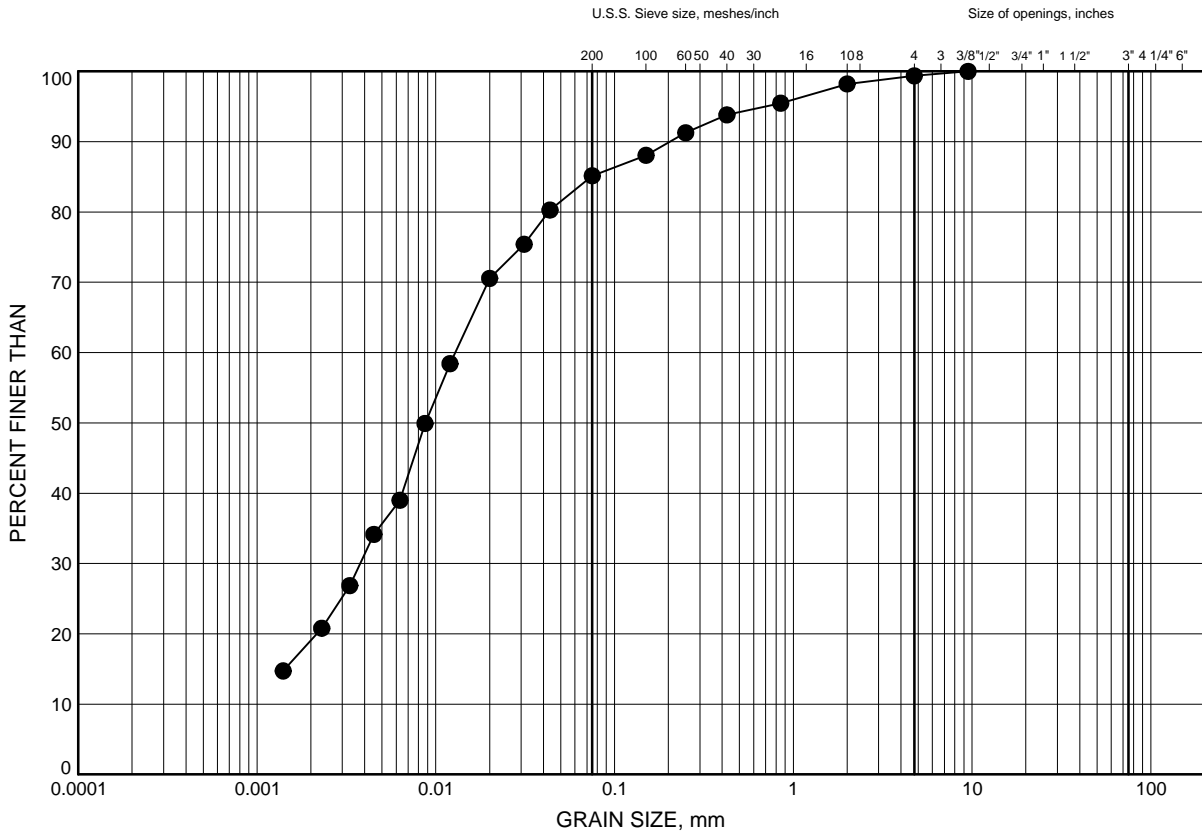
Lab Test Results

Eastern Rehabilitation 18 Structures

GRAIN SIZE DISTRIBUTION

FIGURE B1a

Clayey SILT (FILL)



SILT and CLAY	FINE	MEDIUM	COARSE	FINE	COARSE	COBBLE SIZE
FINE GRAINED	SAND			GRAVEL		

LEGEND

SYMBOL	BOREHOLE	DEPTH (m)	ELEV. (m)
●	15-01	1.52	131.48

Date June 2015
W.P. 4018-13-01

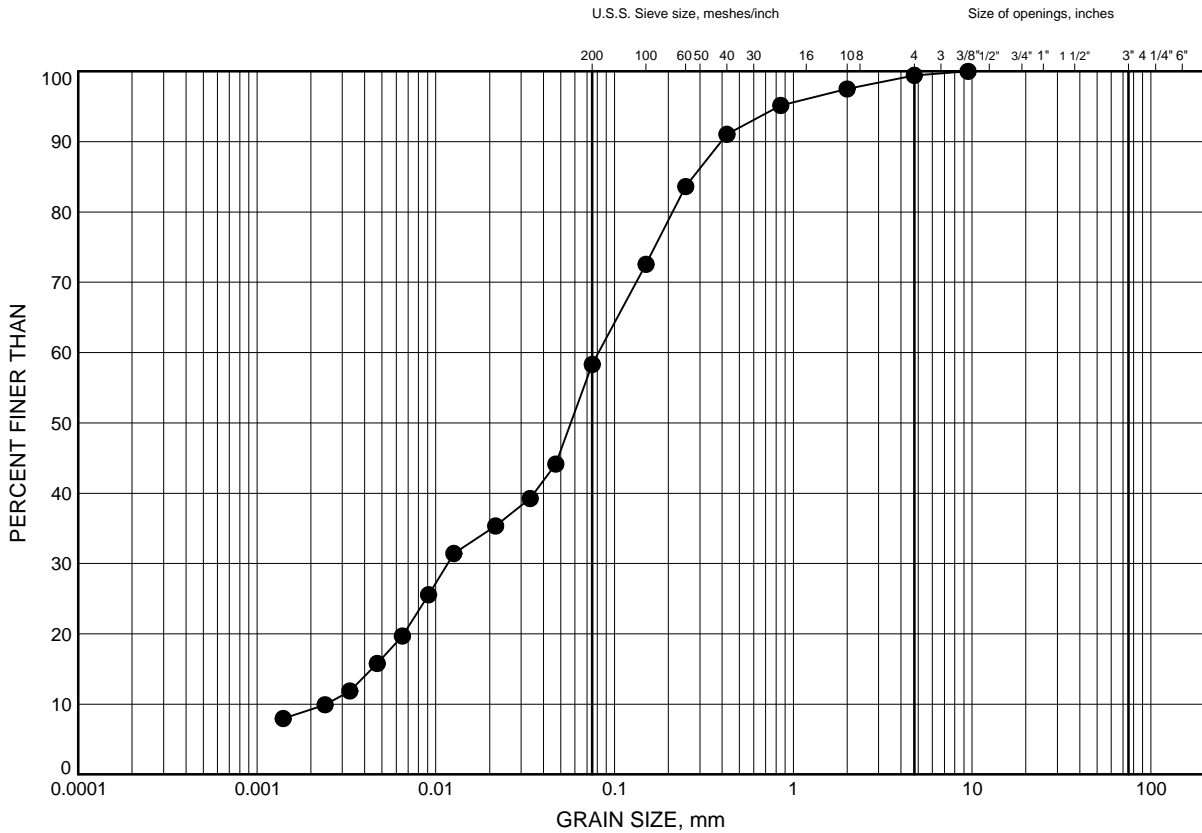


Prep'd AN
Chkd. KS

Eastern Rehabilitation 18 Structures
GRAIN SIZE DISTRIBUTION

FIGURE B1b

SAND & SILT (FILL)



SILT and CLAY	FINE	MEDIUM	COARSE	FINE	COARSE	COBBLE SIZE
FINE GRAINED	SAND			GRAVEL		

LEGEND

SYMBOL	BOREHOLE	DEPTH (m)	ELEV. (m)
●	15-02	1.52	132.08

Date June 2015
W.P. 4018-13-01



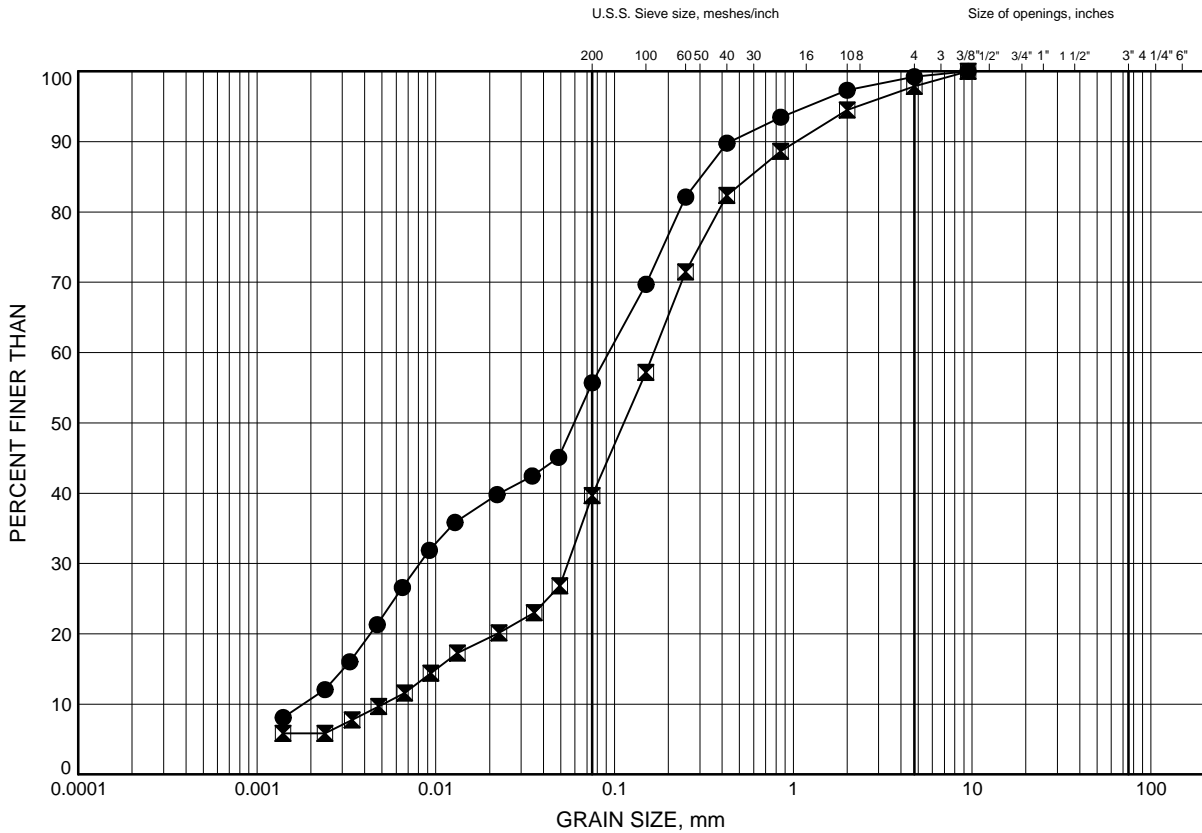
Prep'd AN
Chkd. KS

Eastern Rehabilitation 18 Structures

GRAIN SIZE DISTRIBUTION

FIGURE B2

SAND & SILT



SILT and CLAY	FINE	MEDIUM	COARSE	FINE	COARSE	COBBLE SIZE
FINE GRAINED	SAND			GRAVEL		

LEGEND

SYMBOL	BOREHOLE	DEPTH (m)	ELEV. (m)
●	15-01	4.88	128.12
⊠	15-02	4.88	128.72

Date June 2015
W.P. 4018-13-01

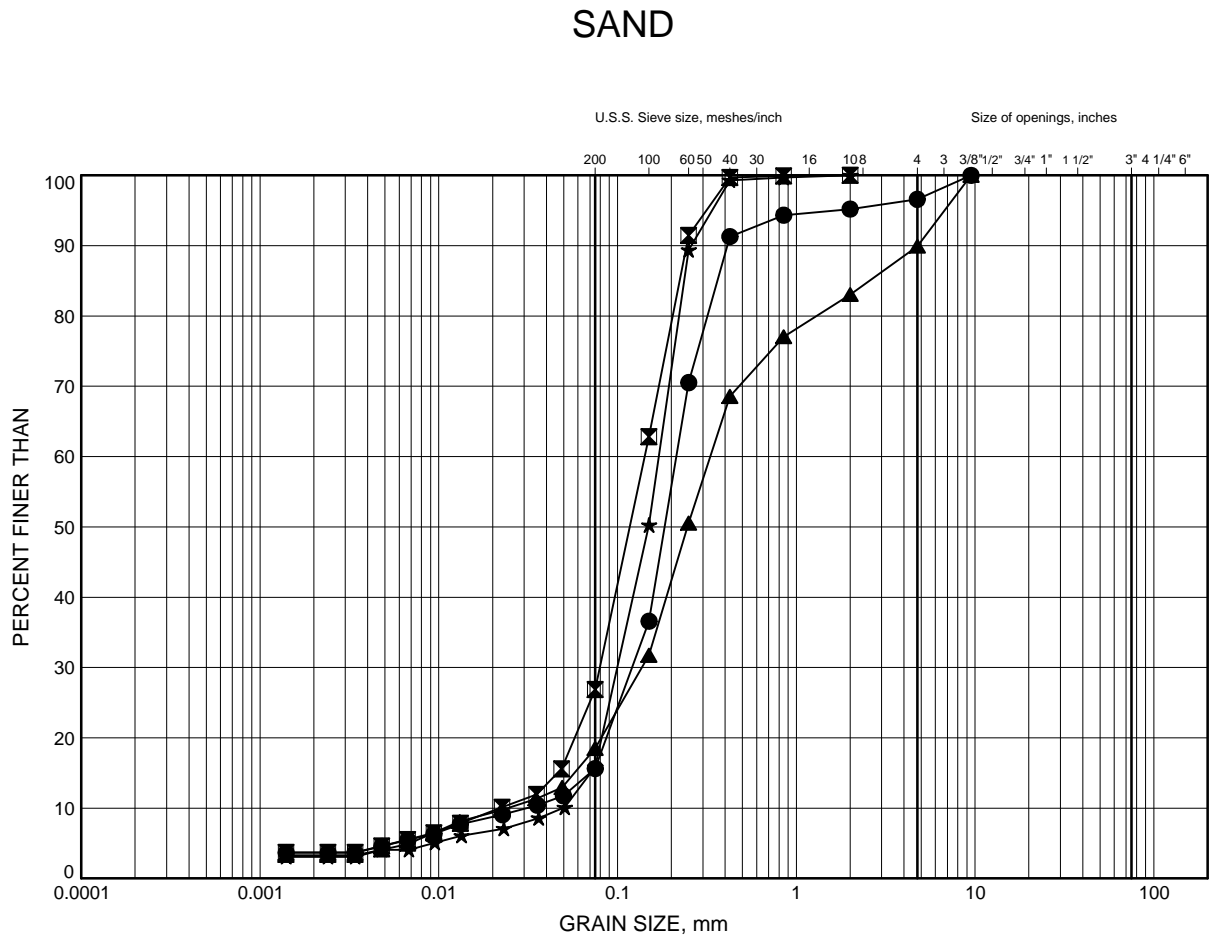


Prep'd AN
Chkd. KS

Eastern Rehabilitation 18 Structures

GRAIN SIZE DISTRIBUTION

FIGURE B3



SILT and CLAY	FINE	MEDIUM	COARSE	FINE	COARSE	COBBLE SIZE
FINE GRAINED	SAND			GRAVEL		

LEGEND

SYMBOL	BOREHOLE	DEPTH (m)	ELEV. (m)
●	15-01	6.40	126.60
⊠	15-01	9.35	123.65
▲	15-02	6.40	127.20
★	15-02	10.90	122.70

Date June 2015
W.P. 4018-13-01

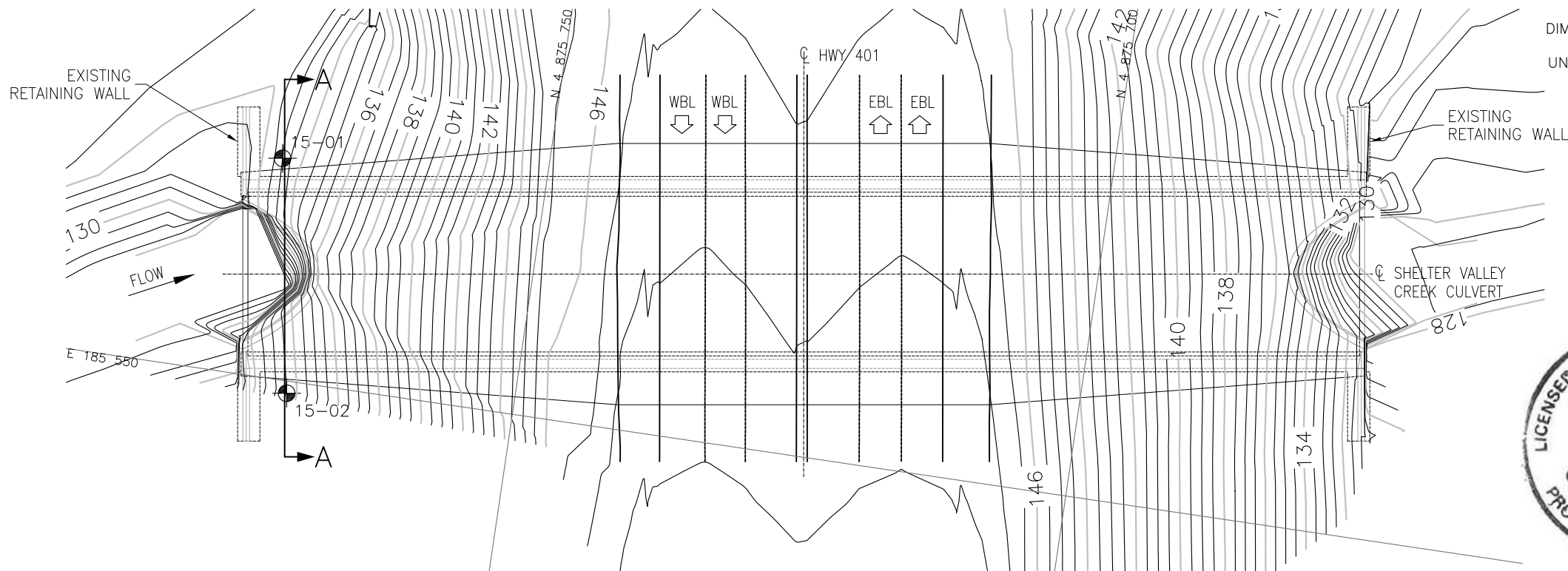


Prep'd AN
Chkd. KS

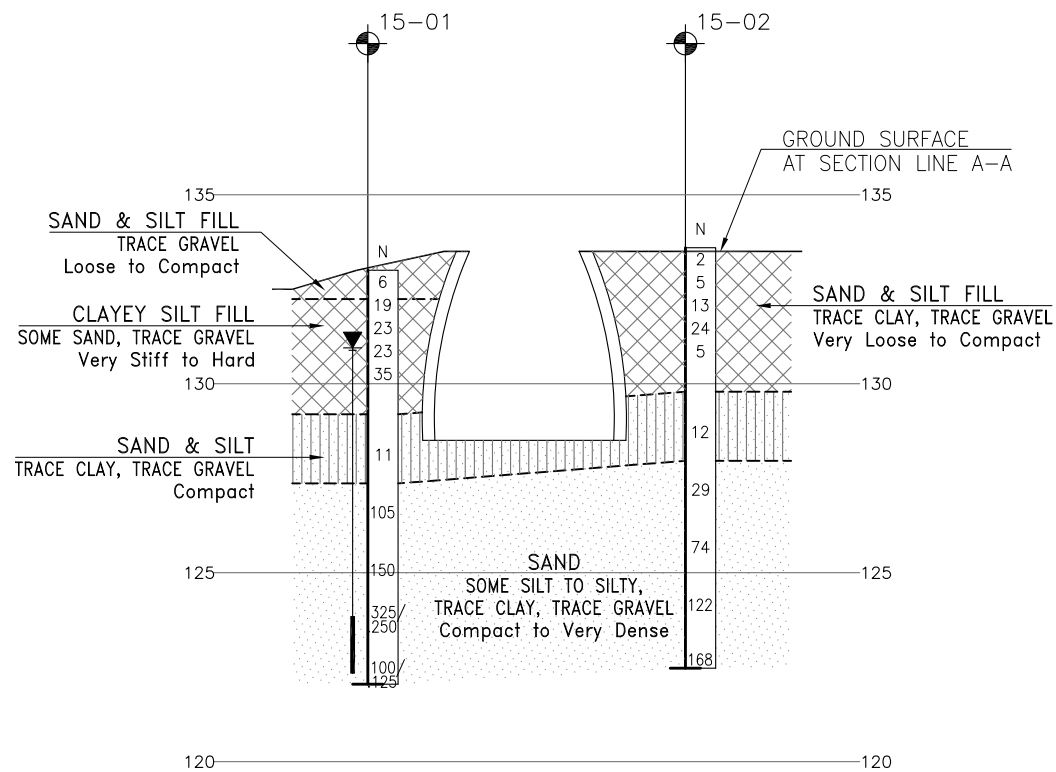


Appendix C

Borehole Locations and Soil Strata Drawing



PLAN
SCALE 1:500



SECTION ALONG A-A

SCALE 1:500
SCALE 1:200

METRIC
DIMENSIONS ARE IN METRES
AND/OR MILLIMETRES
UNLESS OTHERWISE SHOWN

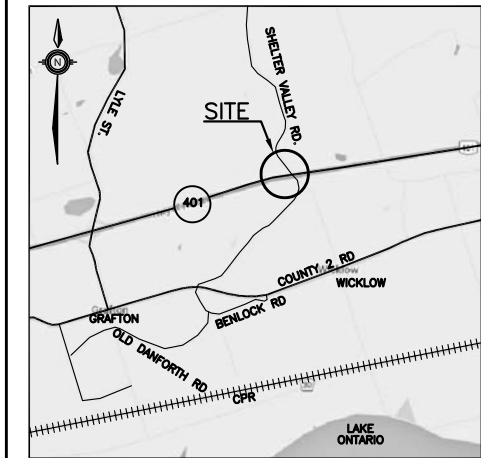


HWY
CONT No
WP No 4018-13-01

MEGA 4
SHELTER VALLEY CREEK CULVERT
BOREHOLE LOCATIONS AND SOIL STRATA

AECOM

THURBER ENGINEERING LTD.



KEYPLAN

LEGEND

	Borehole
N	Blows /0.3m (Std Pen Test, 475J/blow)
	Water Level In Open Borehole
	Water Level In Standpipe Piezometer
90%	Rock Quality Designation (RQD)
A/R	Auger Refusal

NO	ELEVATION	NORTHING	EASTING
15-01	133.0	4 875 774.2	185 569.6
15-02	133.6	4 875 771.0	185 549.3

-NOTES-

- 1) The boundaries between soil strata have been established only at Borehole locations. Between Boreholes the boundaries are assumed from geological evidence.
- 2) This drawing is for subsurface information only. Surface details and features are for conceptual illustration.

GEOCRES No. 31C-236

REVISIONS	DATE	BY	DESCRIPTION
DESIGN	KS	CHK AEG	CODE
DRAWN	AN	CHK KS	SITE 21-272/C/STRUCT
DATE	NOV 2015	DATE	NOV 2015
DWG	1	DWG	1



Appendix D

GEOCRES Report and Historic Drawings

FOUNDATION REPORT

on

New Bridge at Highway 401
Crossing Shelter Valley Creek,
about 2 miles North East of Grafton.

Plan No: F-3133-4

Station No: 307/00

Distribution:

Mr. A. Toye
Bridge Engineer (2)

Mr. H. Tregaskes
Construction Engineer (1)

Mr. D. G. Ramsay
Design Engineer (1)

Mr. H. D. Duff
Dist.Eng. PORT HOPE (1)

Foundation Section (1)

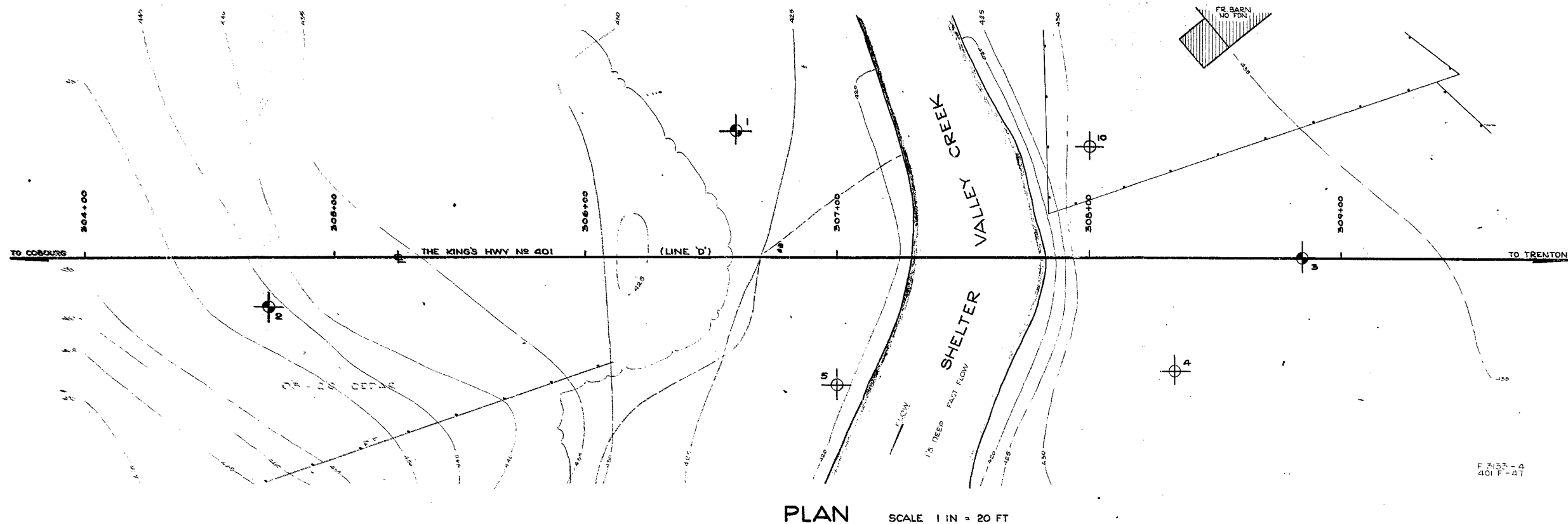
File (1)

W.P. 55-57

W.J. F-57-27

57-F-27
W.P. # 55-57
Hwy. # 401
CROSSING
SHELTER VALLEY
CR. - 2 MI. N.E. OF
GRAFTON

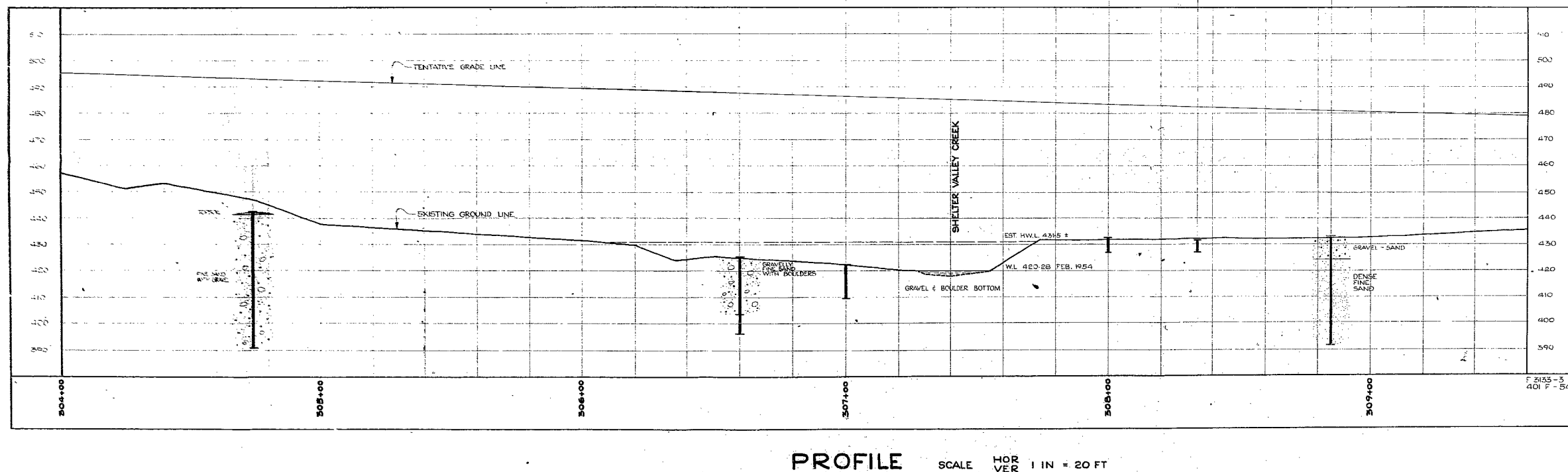
EDITED
FOR MICROFILMING
BY *LB* DATE *1/1/72*



LEGEND			
BORE HOLES			
PENETRATION HOLE			
BORE & PENETRATION HOLE			
HOLE NO.	ELEVATION	STATION	DISTANCE FROM #
1	425.65'	306+60'	50' LT
2	442.5'	304+74'	20' RT
3	437.25'	308+65'	4'
4	431.4'	308+34'	45' RT
5	422.5'	307+00'	51' RT
10	432.6'	308+00'	44' 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.



DEPARTMENT OF HIGHWAYS - ONTARIO

MATERIALS & RESEARCH SECTION - DOWNSVIEW

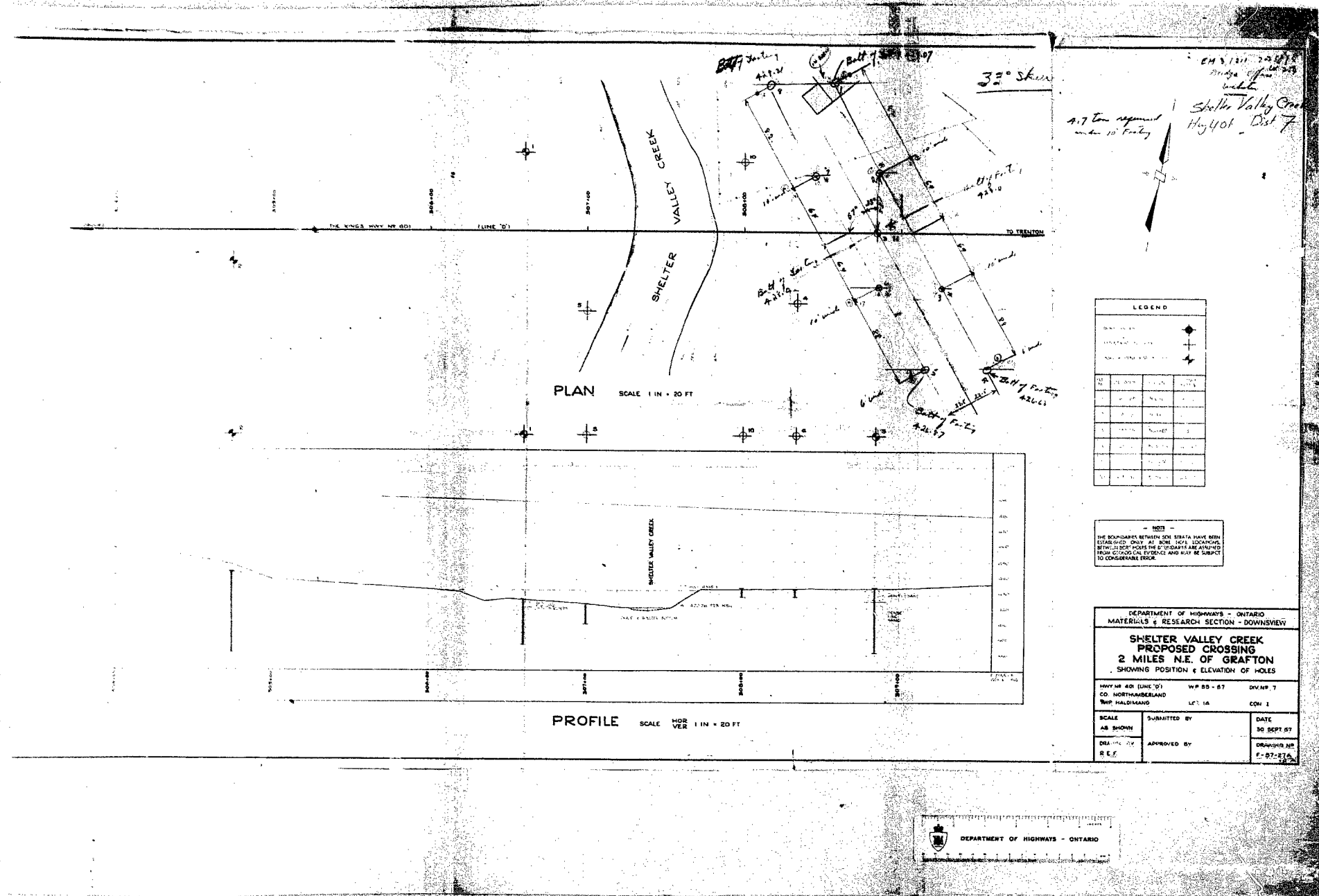
**SHELTER VALLEY CREEK
PROPOSED CROSSING
2 MILES N.E. OF GRAFTON**

SHOWING POSITION & ELEVATION OF HOLES

HWY. NO. 401 (LINE 'D') W.P. 55-57 DIV. NO. 7
CO. NORTHUMBERLAND
TWP. HALDIMAND LOT. 14 CON. 1

SCALE AS SHOWN	SUBMITTED BY	DATE 30 SEPT. 57
DRAWN BY R.E.F.	APPROVED BY	DRAWING NO. F-57-27A

SOME DEFECTS IN NEGATIVE DUE
TO CONDITION OF ORIGINAL DOCUMENTS



Introduction:

A subsoil investigation was carried out to determine the bearing values of the layers for supporting the foundations of a proposed bridge and approach fills to the structure.

The location is where the new highway No. 401 crosses the Upper Valley Creek about 2 miles North East of Grafton, Haldimand Township. (Station 307+00, Profile F-3133-4).

The job started on July 23, 1957 and was completed on August 2, 1957.

Procedure:

The subsoil investigations were carried out by means of a skid mounted coredrill machine. In the course of investigations one borehole with dynamic cone penetration (No. 1), and three dynamic cone penetrations (Nos. 4, 5, 10) were made separately to investigate for supporting the foundations. Also, two boreholes (Nos. 2 & 3) were made to investigate for approach fill stability.

The location of the boreholes is shown on drawing F-57-27A, and their elevations on log sheets under Appendix I.

Subsoil Findings and Analysis:

In this area the topography is characterized by large drumlins, some with steep slopes, cut by deep stream valleys.

The terrain is spillway deposit, filled with sand and gravel and large boulders. The investigations all across the valley revealed the same subsoil stratigraphy.

Boreholes No. 1 & 2 on the west side of the creek were made by driving the casing by means of BX casing shoe. While borehole No. 3 on the eastern side of the creek was driven down by hammering. From the holes, samples were extracted and tested in the laboratory. During sampling standard Penetration tests were also registered.

In all the samples the soil was identified as gravelly sand. The standard penetration tests indicated the very dense nature of the layer. The natural moisture content of the layer was found to be 14%.

The eroded banks and the washed down large boulders in and around the streambed picture the impressive scouring action taking place along the valley during flood water times.

CONCLUSIONS AND RECOMMENDATIONS:

From the above discussion it will follow that:

1. The terrain is spillway deposit. The subsoil is uniform layer of gravelly sand with large boulders down to elevation 391 ft.
2. From the standard penetration tests the layer starting at elevation about 420 ft. and down can provide a bearing value of 2.5-3 T.s.f. to support the spread footing foundations.
3. However, the scouring hazards at this site constitute an important problem. From calculations developed by the Connecticut Highway Department, it is found that the footings should be placed some 10 ft. below the bottom of stream elevation. This gives a safety factor of 4 against scouring hazards at this crossing.

4. It will be convenient to support the structure on spread footing type foundations. These footings, while they may be placed at elevation 420 ft., should not be placed higher than elevation about 410 ft., due to scouring hazards mentioned in (3) above. At this elevation the layer can provide a conservative 3 T.s.f. bearing value.
5. The subsoil layer can provide sufficient bearing value to support the amount of fill anticipated for the approaches to the structure.

V. Korlu,
Foundation Engineer.

APPENDIX I.

DEPARTMENT OF HIGHWAYS - ONTARIO
MATERIALS & RESEARCH BRANCH - FOUNDATIONS SECTION - DOWNSVIEW
OFFICE REPORT ON SOIL EXPLORATION

DRILL RIG 54-1 OPERATION BORING & PENIT'N JOB F-57-27 WP 55-57 BORING 1 STA. 306+60 (50' LT.)
CASING BX (standard samplers to fit unless noted) DATUM GEODITIC DATE REPORT SEPT 1957
SAMPLER HAMMER WT. 250 LBS. DROP 19 INCHES COMPILED BY H.S. CHECKED BY A.L. DATE BORING 23 JULY 1957

ABBREVIATIONS

V - INSITU VANE SHEAR TEST Q - TRIAXIAL QUICK K - PERMIABILITY
M - MECHANICAL ANALYSIS S - TRIAXIAL SLOW C - CONSOLIDATION
U - UNCONFINED COMPRESSION WL - WATER LEVEL IN CASING CA - CASING
Qc - TRIAXIAL CONSOLIDATED QUICK WT - WATER TABLE IN SOIL γ - UNIT WEIGHT

SAMPLE TYPES

C.S. - CHUNK S.S. - SLEEVE SAMPLE
D.O. - DRIVE OPEN P.S. - PISTON SAMPLE
D.F. - DRIVE FOOT VALVE W.S. - WASHED SAMPLE
T.O. - THIN WALLED OPEN R.C. - ROCK CORE

SAMPLE CONDITION

 - DISTURBED
- FAIR
- GOOD
- LOST

SOIL PROFILE					SAMPLES																	
ELEVATION DEPTH	WATER CONDITIONS	DESCRIPTION	STRAT PLOT	ELEVATION SCALE	WATER CONTENT W %				O - NAT		□ - P.W.		Δ - L.W.		CASING BLOWS (ACTUAL)	OTHER TESTS	CONDITION	TYPE	NO.	PENETRATION RESISTANCE	ELEV. RECOV. %	
					PENETRATION TEST RESISTANCE BLOWS PER FOOT AT STANDARD ENERGY (4200 IN. LBS. PER BLOW)				D. CONE PEN. X-----X-----X		STAND. PEN. •-----•-----•											
					100	200	300	400														
425.65 435.65		GROUND LEVEL		435 425																		425.65 435.65
435.65				435																		435.65
435.65				425																		425.65
435.65				420																		420.65 435.65
435.65				415																		415.65 425.65
435.65				410																		410.65 425.65
435.65				405																		405.65 425.65
435.65				400																		400.65 425.65
435.65				395																		395.65 425.65

DRILL RIG 54-1 OPERATION BORING PINETON JOB F-57-27 W.P. 55-57 BORING 2 STA. 304+74 (20' BT)
CASING BK (standard samplers to fit unless noted) DATUM GEODETIC DATE REPORT SEPT 1957
SAMPLER HAMMER WT. 250 LBS. DROP 19 INCHES COMPILED BY _____ CHECKED BY AL DATE BORING 25 JULY 1957

SAMPLE TYPES

SAMPLE CONDITION



- DISTURBED
- FAIR
- GOOD
- LOST

[illegible]

DRILL RIG 541 OPERATION BORE & PENETIN JOB F 57-27 W.P. 55 57 BORING 3 STA. 308 +85 ON 4
CASING BA (standard samplers to fit unless noted) DATUM GEODINIC DATE REPORT SEPT. 1957
SAMPLER HAMMER WT. 350 LBS. DROP 40 INCHES COMPILED BY H.S. CHECKED BY M.L. DATE BORING 31 JULY 1957

SAMPLE TYPES

SAMPLE CONDITION

V - INSITU VANE SHEAR TEST	Q - TRIAXIAL QUICK	K - PERMIABILITY	C.S. - CHUNK	S.S. - SLEEVE SAMPLE
M - MECHANICAL ANALYSIS	S - TRIAXIAL SLOW	C - CONSOLIDATION	D.O. - DRIVE OPEN	P.S. - PISTON SAMPLE
U - UNCONFINED COMPRESSION	WL - WATER LEVEL IN CASING	CA - CASING	D.F. - DRIVE FOOT VALVE	WS - WASHED SAMPLE
Q _c - TRIAXIAL CONSOLIDATED QUICK	WT - WATER TABLE IN SOIL	γ - UNIT WEIGHT	T.O. - THIN WALLED OPEN	R.C. - ROCK CORE



- DISTURBED
- FAIR
- GOOD
- LOST

SAMPLES

ELEVATION DEPTH	WATER CONDITIONS	DESCRIPTION	STRAT PLOT	ELEVATION SCALE	WATER CONTENT W % 0 - NAT □ - PW △ - LW	PENETRATION TEST RESISTANCE BLOWS PER FOOT AT STANDARD ENERGY (4200 IN. LBS. PER BLOW) D. CONE PEN. X-----X-----X STAND. PEN.	CASING BLOW (ACTUAL)	OTHER TESTS	CONDITION	TYPE	NO.	PENETRATION RESISTANCE	ELEV. RECOV.
												%	
433.25 437.26		GROUND LEVEL											433.25 437.26
3.5		GRAVEL-SAND		130 130									428.25 430.26
9.5	424.25 437.26 9.3'			425 425					X	D.O.	1	72	67
13.5				420 420									423.25 433.26
17.5				415 415									418.25 420.26
21.5				410 410					/	S.S.	2	49	100
25.5		DENSE FINE SAND		405 405					/	S.S.	3	38	33
29.5				400 400									413.25 423.26
33.5				395 395					/	S.S.	4	67	78
37.5				390 390					/	S.S.	5	98	100
41.5	391.75 401.26 41.5'	END OF BOREHOLE		385 385					/	S.S.	6	>100	100
45.5				380 380					/	S.S.	7	90	100
				375 375					/	S.S.	8	>100	100

DEPARTMENT OF HIGHWAYS - ONTARIO
MATERIALS & RESEARCH BRANCH - FOUNDATIONS SECTION - DOWNSVIEW
OFFICE REPORT ON SOIL EXPLORATION

DRILL RIG 5- OPERATION PENETRATION JOB F-37-27 W.P. 55-57 BORING 4 STA. 308+34.45 (RT.)
CASING 3" (standard samplers to fit unless noted) DATUM GIODITIC DATE REPORT SEPT 1957
SAMPLER HAMMER WT. 25 LBS. DROP 19 INCHES COMPILED BY U.S. CHECKED BY A.L. DATE BORING 30 JULY 1957

ABBREVIATIONS

V - INSITU VANE SHEAR TEST Q - TRIAXIAL QUICK K - PERMIABILITY
M - MECHANICAL ANALYSIS S - TRIAXIAL SLOW C - CONSOLIDATION
U - UNCONFINED COMPRESSION WL - WATER LEVEL IN CASING CA - CASING
QC - TRIAXIAL CONSOLIDATED QUICK WT - WATER TABLE IN SOIL γ - UNIT WEIGHT

SAMPLE TYPES

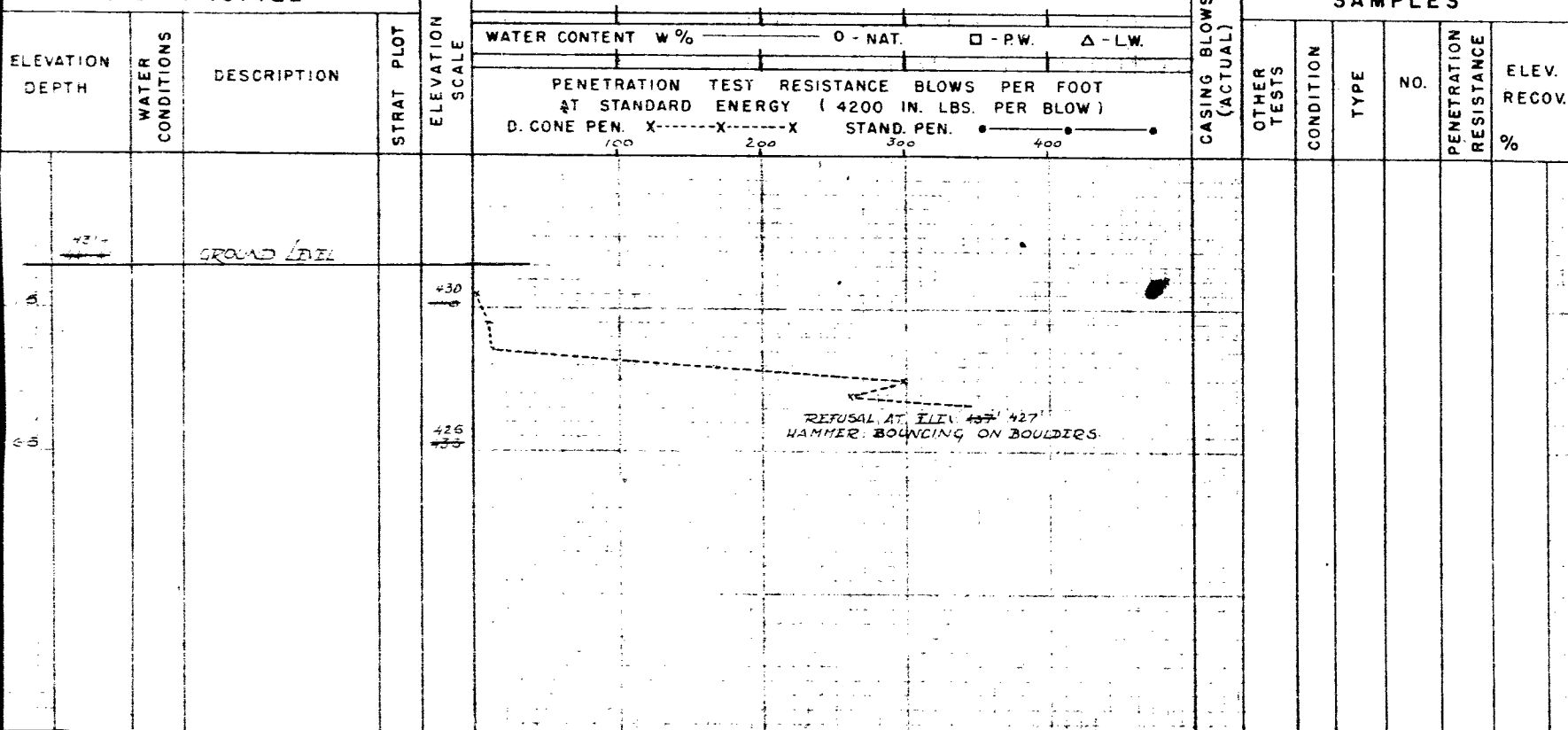
C.S. - CHUNK S.S. - SLEEVE SAMPLE
D.O. - DRIVE OPEN P.S. - PISTON SAMPLE
D.F. - DRIVE FOOT VALVE W.S. - WASHED SAMPLE
T.O. - THIN WALLED OPEN R.C. - ROCK CORE

SAMPLE CONDITION



- DISTURBED
- FAIR
- GOOD
- LOST

SOIL PROFILE



DEPARTMENT OF HIGHWAYS - ONTARIO
 MATERIALS & RESEARCH BRANCH - FOUNDATIONS SECTION - DOWNSVIEW
OFFICE REPORT ON SOIL EXPLORATION

DRILL RIG 54-1 OPERATION PENETRATION JOB F-57-27 W.P. 53-57 BORING 5 STA. 307+00 (51' BT.)
 CASING BX (standard samplers to fit unless noted) DATUM GEODETIC DATE REPORT SEPT. 1957
 SAMPLER HAMMER WT. 250 LBS. DROP 19 INCHES COMPILED BY H.S. CHECKED BY A.I. DATE BORING 29 JULY 1957

ABBREVIATIONS

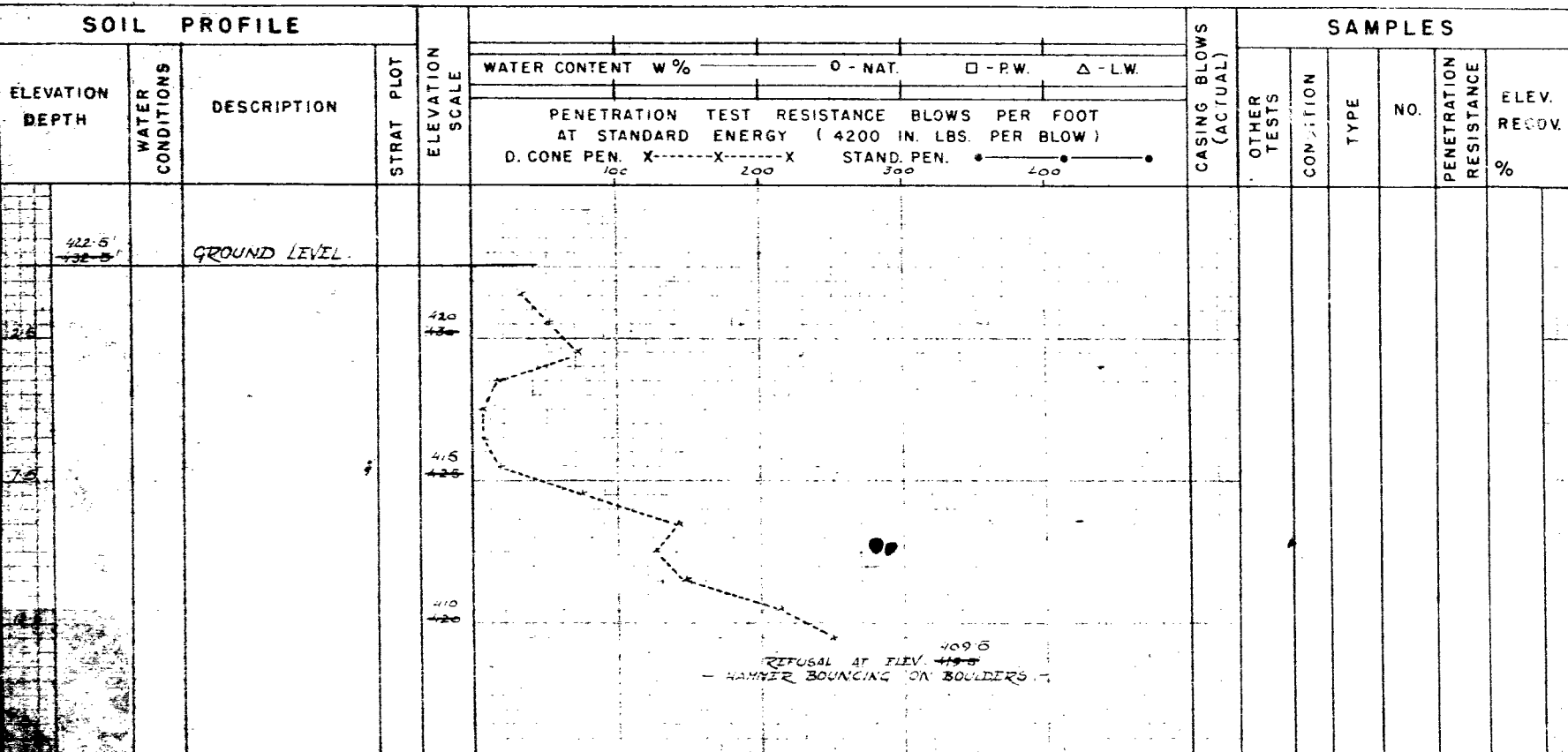
V - INSITU VANE SHEAR TEST Q - TRIAXIAL QUICK K - PERMIABILITY
 M - MECHANICAL ANALYSIS S - TRIAXIAL SLOW C - CONSOLIDATION
 U - UNCONFINED COMPRESSION WL - WATER LEVEL IN CASING CA - CASING
 QC - TRIAXIAL CONSOLIDATED QUICK WT - WATER TABLE IN SOIL γ - UNIT WEIGHT

SAMPLE TYPES

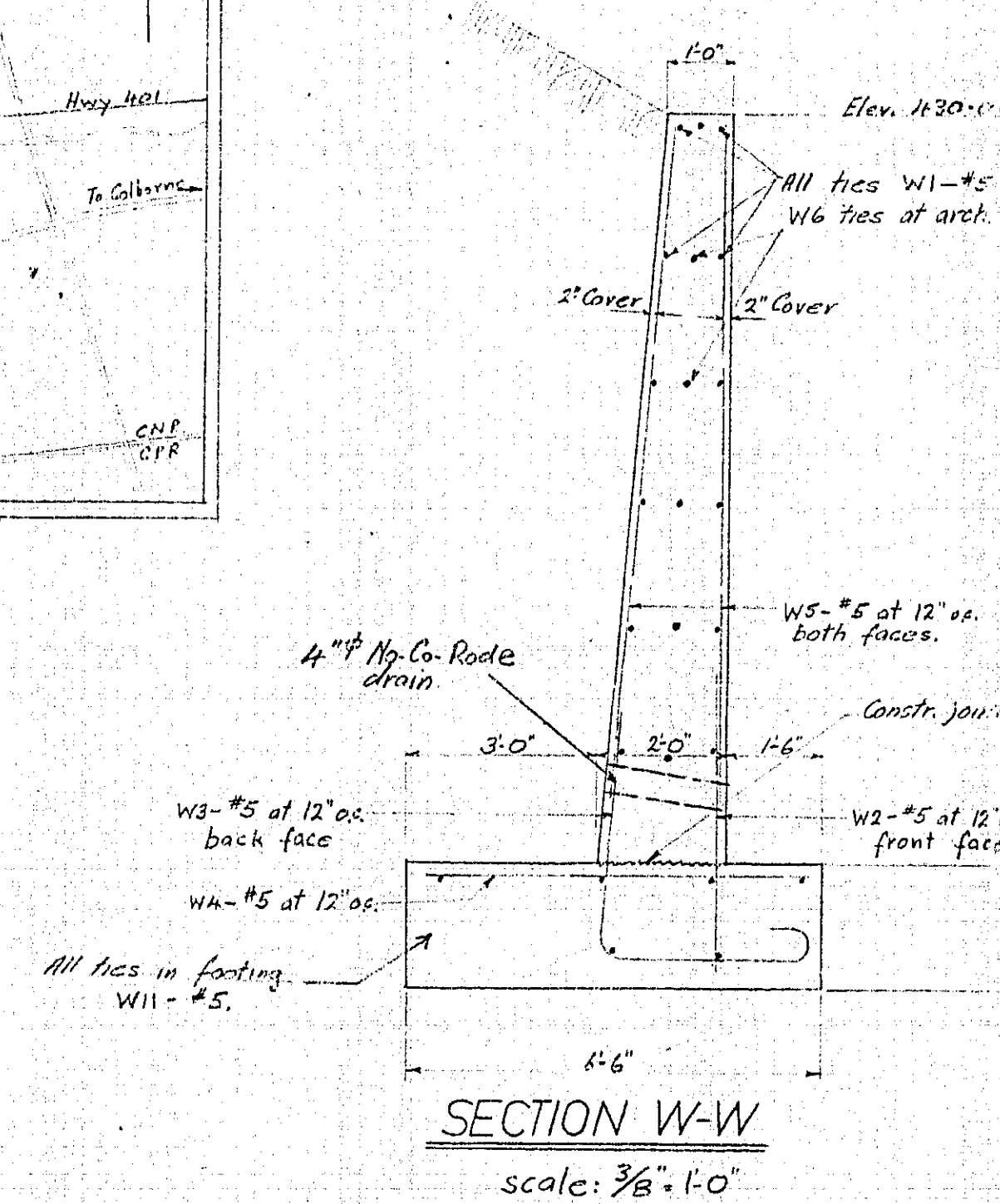
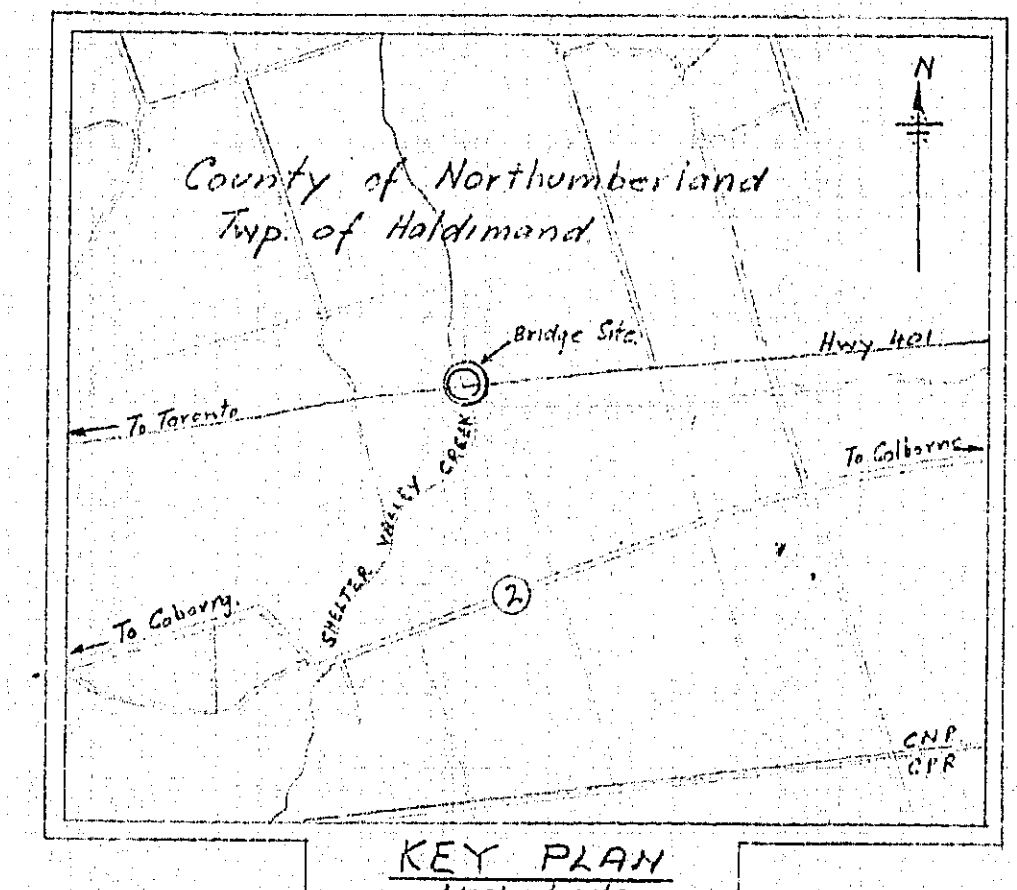
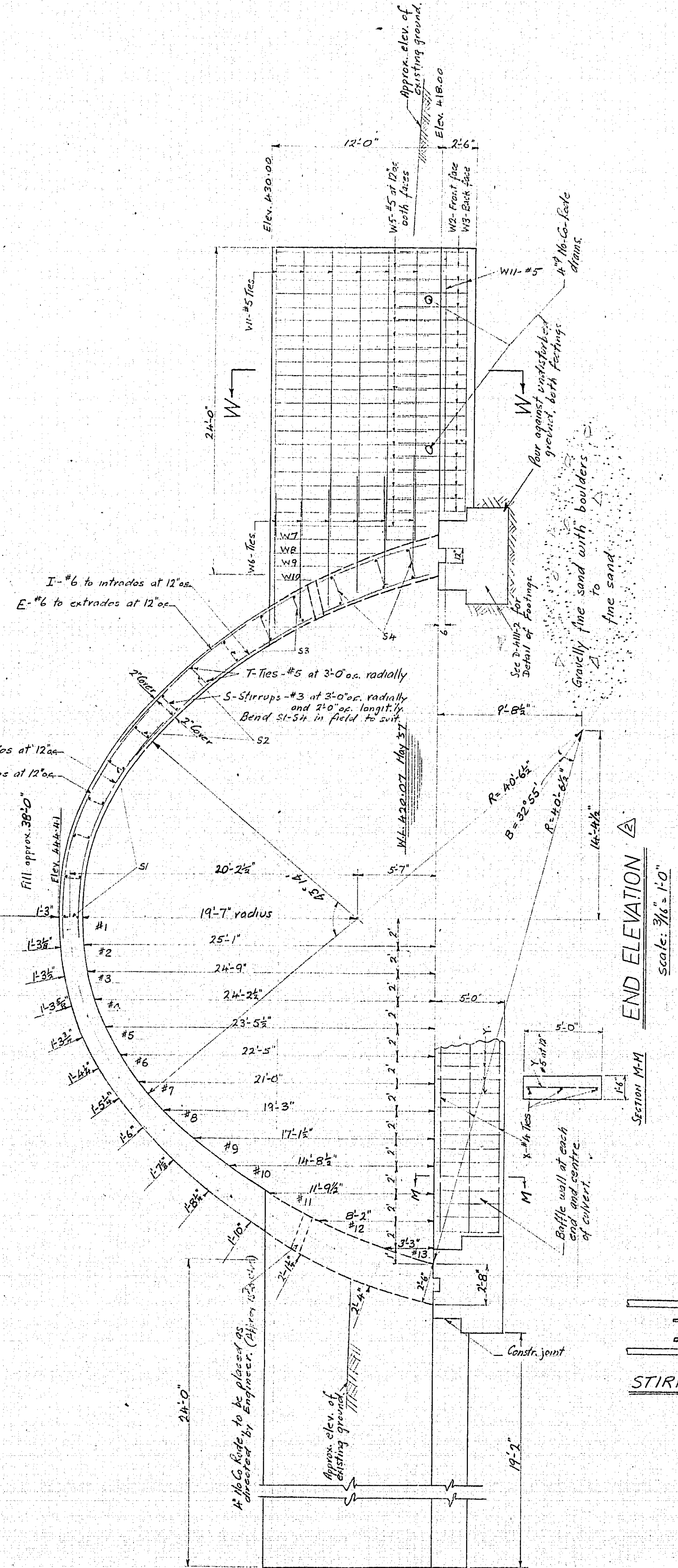
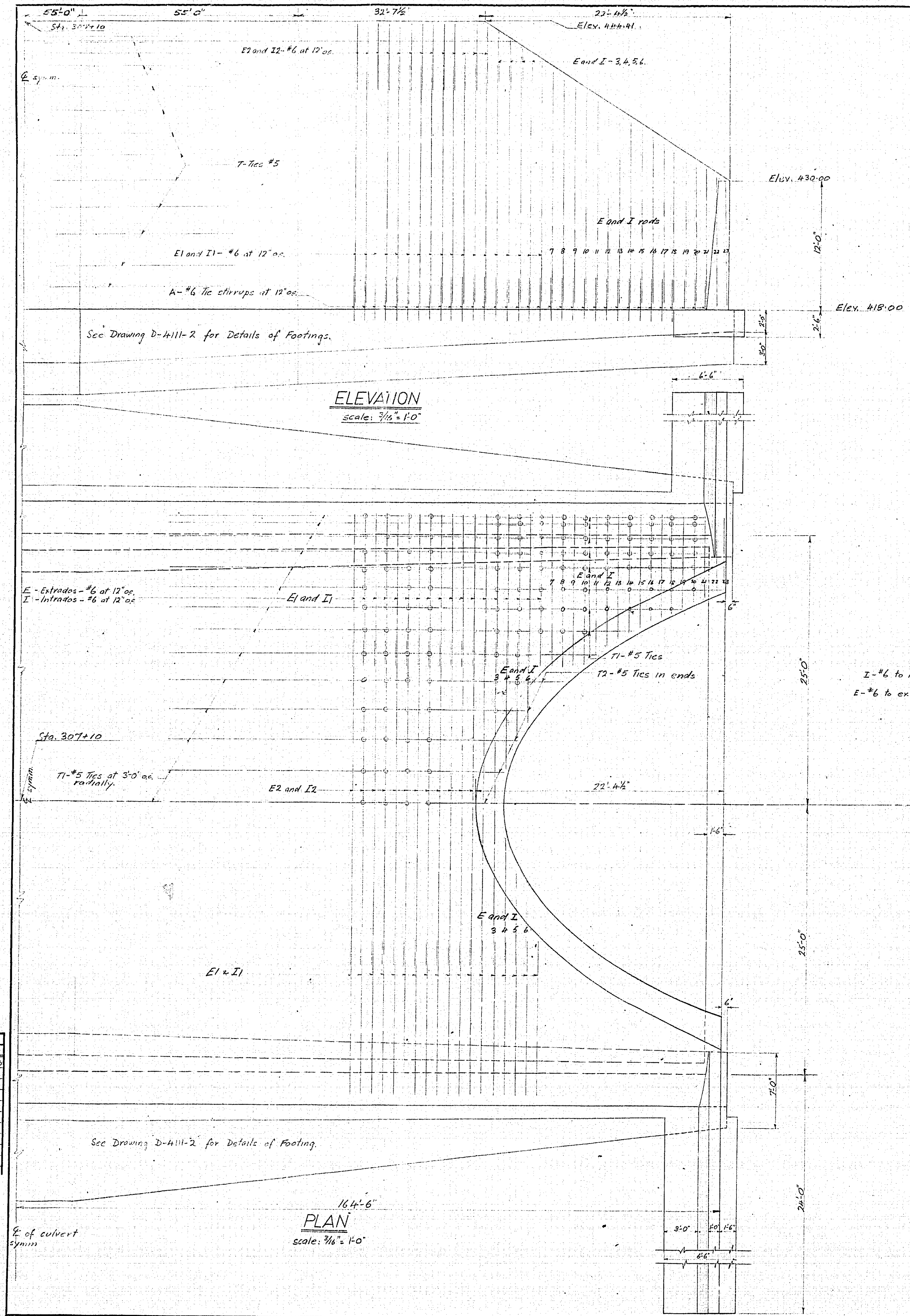
C.S. - CHUNK SS - SLEEVE SAMPLE
 D.O. - DRIVE OPEN PS - PISTON SAMPLE
 D.F. - DRIVE FOOT VALVE WS - WASHED SAMPLE
 T.O. - THIN WALLED OPEN R.C. - ROCK CORE

SAMPLE CONDITION

- DISTURBED
 - FAIR
 - GOOD
 - LOST

SOIL PROFILE

PRINT RECORD		
NO.	FOR	DATE
9	F.S.D.	8-5-58
11	F.S.D.	2-6-59
30	TRACED	8-10-58
32	REVISED	4-23-59



NOTE TO DISTRICT ENGINEER.
Concrete work on this structure must not be commenced until monuments to fix control points have been erected and checked by the District Engineer.

NOTE TO CONTRACTOR.
Structure to be built in accordance with Form No. 2, revised March 1957 and the Special Provisions, extra copies of which may be obtained from the District Engineer. All construction joints must be approved by the Bridge Engineer. Particular attention is to be given to the expansion joints, see D-4111-2.

CONCRETE MIX.
All concrete in footings to be 2500 p.s.i. at 28 days. Arch and wing wall concrete to be 3000 p.s.i. at 28 days. Maximum size of aggregate to be 3/4".

BORING DATA.
The complete soil report BA 673 may be examined at the D.H.O. Bridge Design Office, 380 Davenport Road, Toronto. The Dept. does not guarantee the accuracy of this report or the abridged version shown on these plans.

REINFORCING STEEL.
Clear cover in footings to be 3" and is noted. Clear cover elsewhere to be 2". All exposed edges of concrete to be chamfered 1".

WP 55-57

DEPARTMENT OF HIGHWAYS, ONTARIO
BRIDGE OFFICE - TORONTO

SHELTER VALLEY CREEK
HALDIMAND TWP. BRIDGE NO. 14

THE KING'S HIGHWAY NO. 401 DIST. NO. 7
CO. Northumberland Sta. 307+10
TWP. Haldimand LOT CON.

GENERAL PLAN

APPROVED

BRIDGE ENGINEER

DESIGN ENGINEER

DESIGN

CHECK

WITH

CONTRACT

NUMBERS

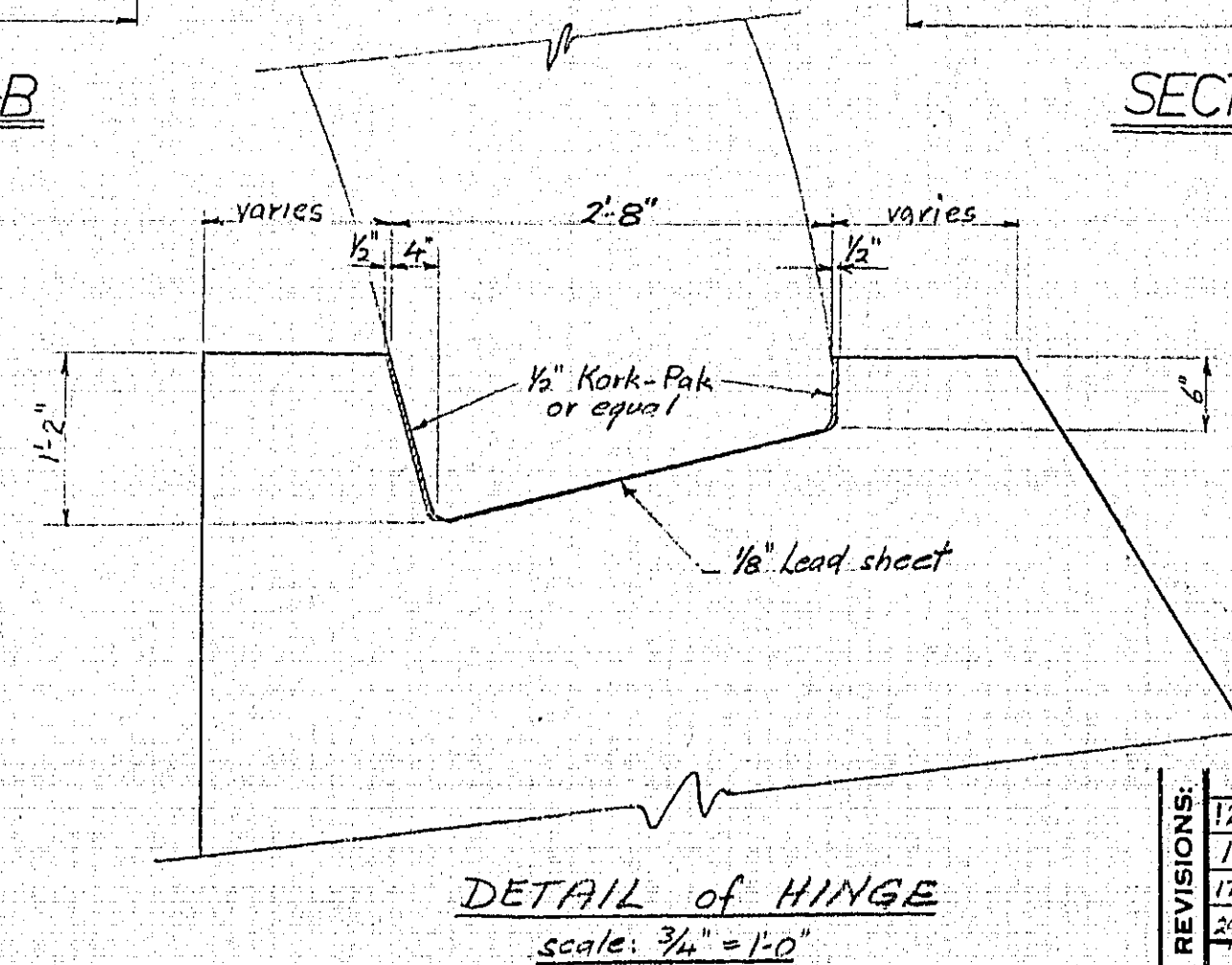
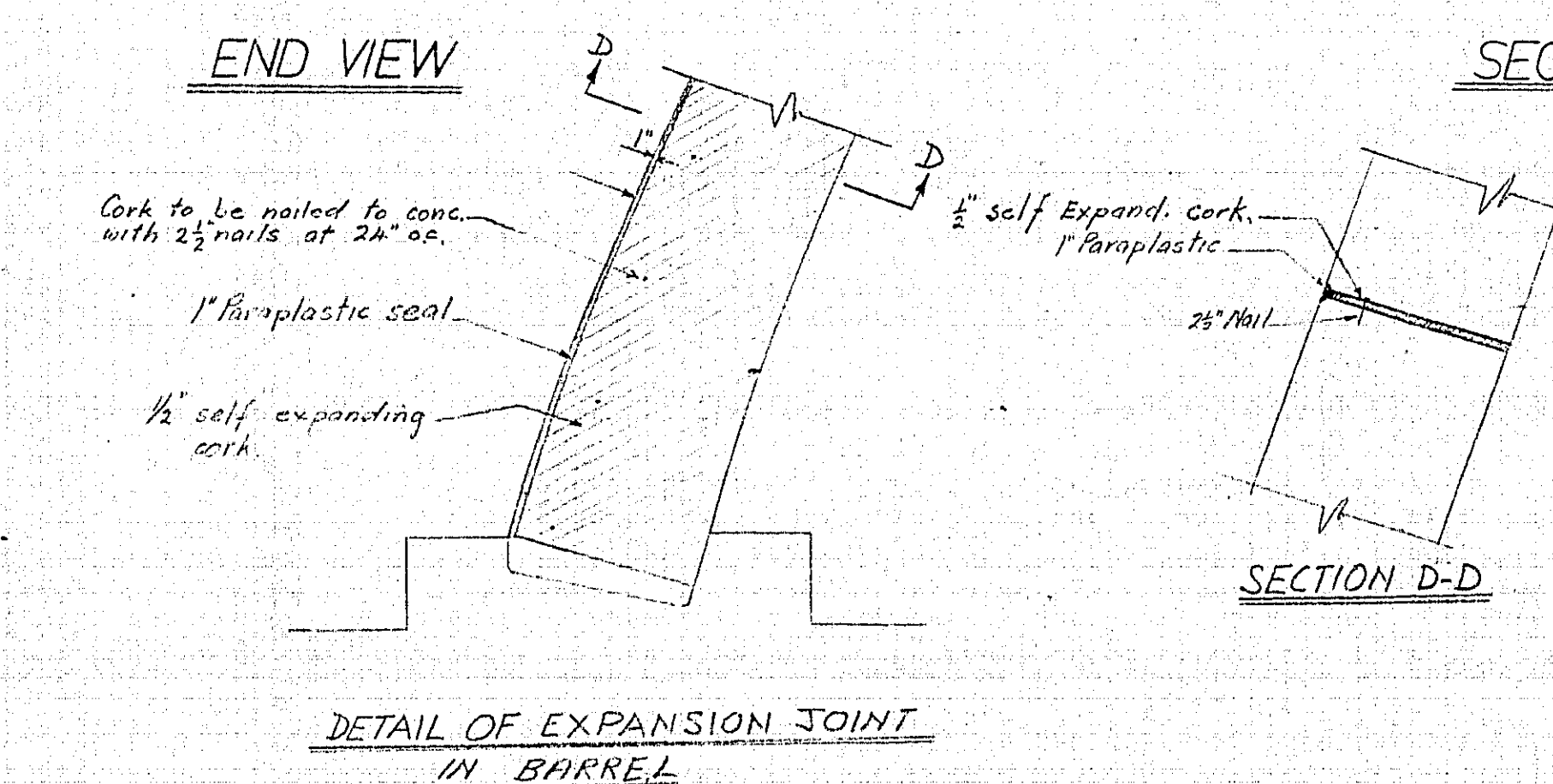
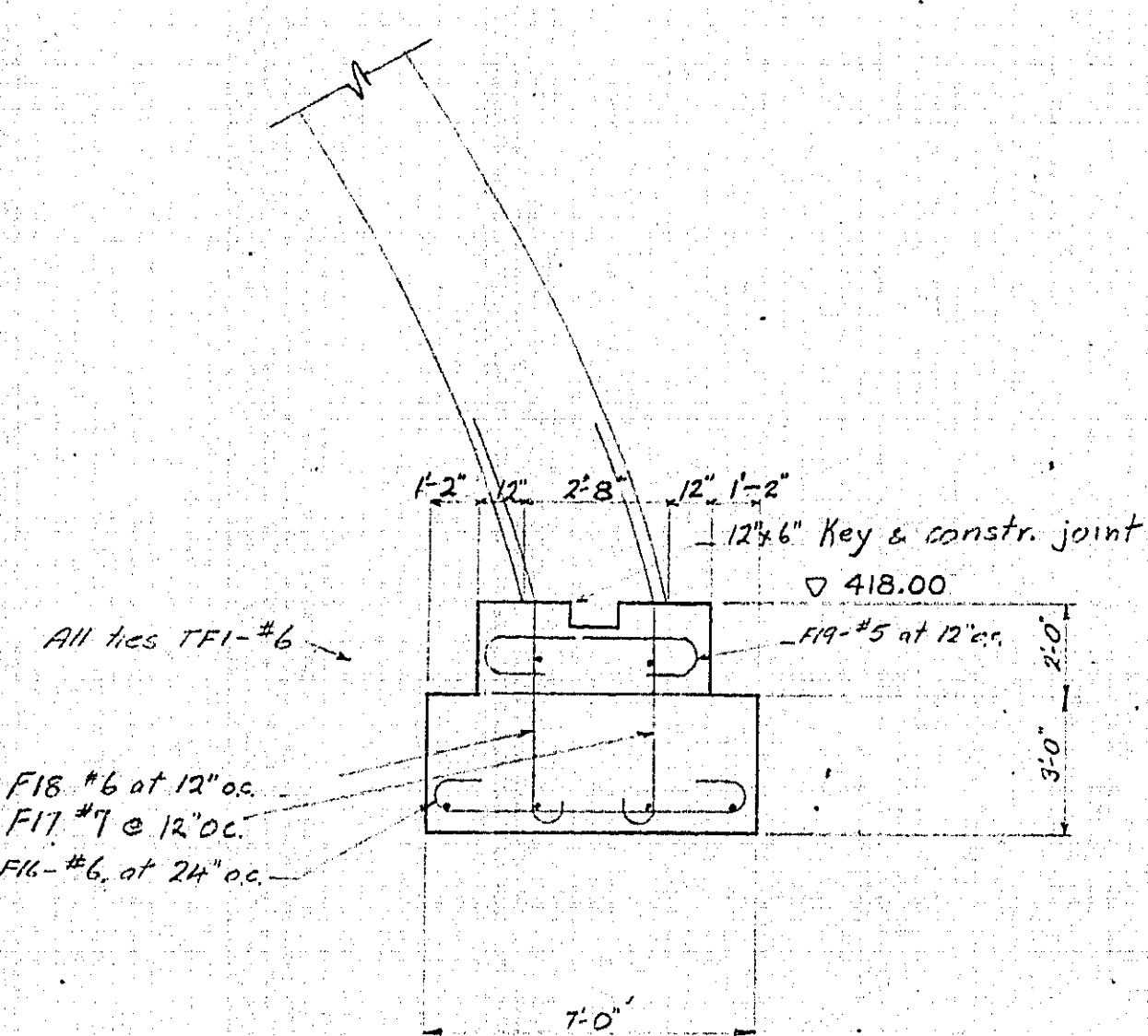
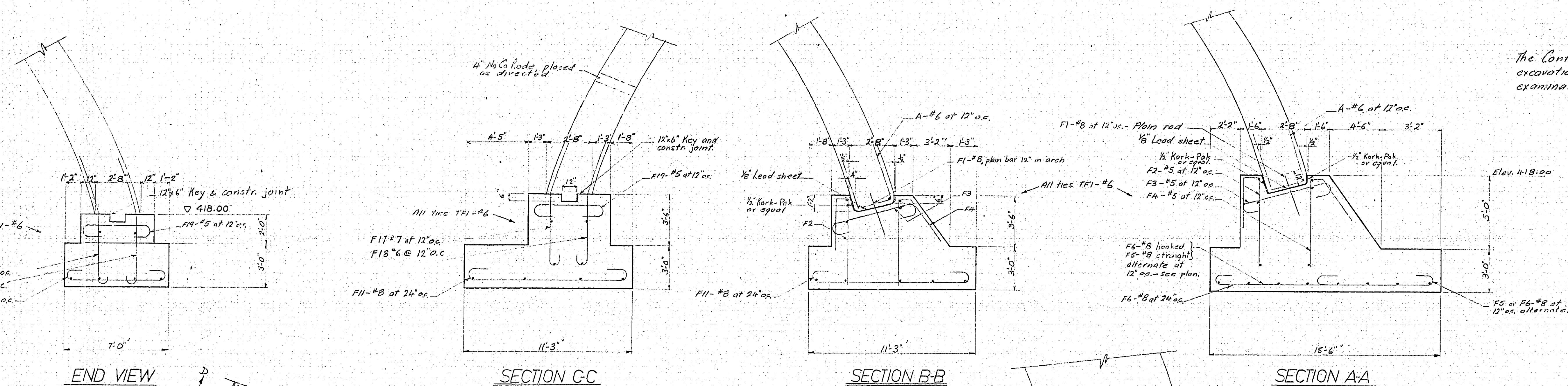
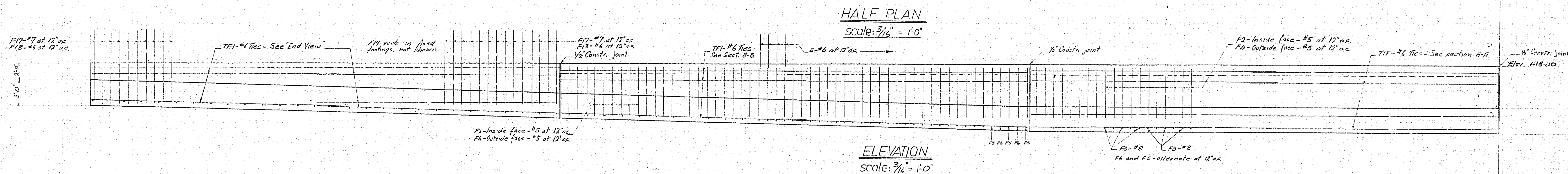
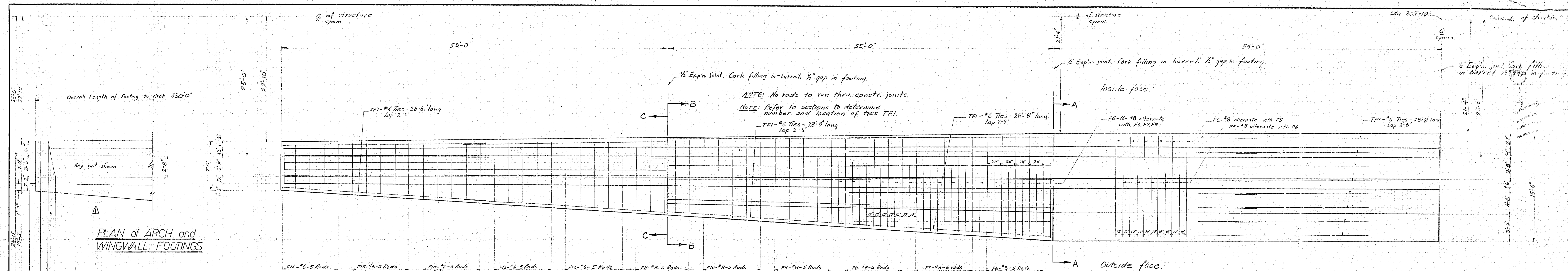
5-3-291

REVISIONS	DATE	BY	DESCRIPTION
12-7-63	J.G.G.		ADDITIONAL INFORMATION TO END ELEVATION.
2-6-68	H.G.		Design revisions.

REFERENCE PLANS	DATE	BY	DESCRIPTION
NO. 673			
2-3-63-4			
2-3-7-74			
2-3-8-1			

TWP# 9-272-1-A

1 to 4



The Contractor to notify the Design Engineer of this structure when excavation of footings is to be completed, in order that an examination may be made before any concrete is poured.

[illegible]

DEPARTMENT OF HIGHWAYS - ONTARIO
BRIDGE OFFICE - TORONTO

*RECEIVED
BRIDGE DIV.
MAY 1958*

SHELTER VALLEY CREEK
HALDIMAND TWP. BRIDGE NO. 14.

THE KING'S HIGHWAY NO. 401 DIST. NO. 7
CO. Northumberland Sta. 307+10
TWP. Haldimand LOT CON.

FOOTING DETAILS

Am. L.
BRIDGE ENGINEER

DESIGN	<i>SPR</i>	CHECK	<i>MB</i>	CONTRACT NUMBER LOAN NO.
DRAWING	<i>MB</i>	CHECK	<i>SPR</i>	
TRACING	<i>MB</i>	CHECK	<i>MB</i>	
DATE	<i>MAY 1958</i>			

401

Twp # 9-25-2-A

