STRUCTURE
GEOTECHNICAL REPORT

Box Culvert Replacement
I-74 over Tributary to Saline Branch Drainage District Ditch

Existing S. N. 010-8054
Proposed S. N. 010-2045

F.A.I. ROUTE I-74
Section 10-6 RS-4 & 10-7 RS-3
Champaign County, Illinois
Contract No.: 70789
PTB: 181-13
Job No.: C-95-008-12
BFW No. 17178

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Executive Summary

Bacon Farmer Workman Engineering & Testing, Inc. (BFW) has developed this Structure Geotechnical Report (SGR) to provide a summary of geotechnical engineering analysis of a proposed replacement triple barrel, box culvert for FAI 74 crossing a tributary to the Saline Branch Drainage District Ditch in Champaign County, Illinois.

Based on an Undercut Study conducted by IDOT, a recommendation of undercutting an additional 24-inches below the proposed 6-inch typical undercut at the culvert bottom elevation. Based on subsurface data, BFW concurs with the additional undercut recommendation. The bearing capacity of the natural soils at this undercut depth indicate adequate ability to support the proposed loads.

BFW does not anticipate settlement that will be a concern for the proposed box culvert since the proposed loads are not anticipated to exceed the current applied structural loads.

Slope stability analysis for the box culvert end slopes was analyzed for a wingwall geometry of 1 vertical to 2 horizontal (1V:2V) slopes. The required factor of safety (FOS) for each of the three conditions analyzed were met or exceeded. If the final design of the wingwall sideslopes are greater than the assumed geometry, then BFW should be contacted to determine if the required FOS are still met.

The use of Temporary Sheet Piling for staged constructed will be limited based on the required retained height due to hard soil stratum encountered in each boring. If required retained heights are not met then a Temporary Soil Retention System will be required.

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1.0 General Project Description and Proposed Structure Information

1.1 Introduction

The purpose of this Structure Geotechnical Report (SGR) is to document subsurface conditions observed at the project site and provide geotechnical analysis of anticipated conditions related to the proposed structure and to provide engineering design and construction recommendations. This SGR was developed by Bacon Farmer Workman Engineering and Testing, Inc. (BFW) using drilling data provided by Midwest Engineering and Testing, Inc.

1.2 Project Description

The project will consist of the complete replacement of the existing box culvert (SN 010-8054) with a triple barrel, box culvert with precast concrete middle section with cast-in-place reinforced concrete end sections (Proposed SN 010-2045) located on FAI 74 crossing a tributary to the Saline Branch Drainage District Ditch in Champaign County, Illinois. The project site is 1.5 miles east of Urbana, Illinois.

A general structure location map is shown on a USGS Topographic Location Map, Appendix A. The site lies within the limits of Third Principal meridian (T. 19N R. 9E Section 12) within Champaign County in the Bloomington Ridge Physiographic Region.

1.3 Existing Structure Information

The existing structure (SN 010-8054) was building in 1960. The structure was originally building in 1960 as FAI 74, Section 10-6 by the State at Station 509+00. The existing culvert was constructed as a single-barrel, 8-ft by 3-ft reinforced concrete box culvert that is 138-ft in length (out-to-out headwalls), on a 0° skew with 45° wingwalls, carrying FAI 74 (I-74) over a tributary to the Saline Branch Drainage District Ditch.

An Abbreviated Bridge Condition Report (BCR) dated January 2015 recommends the complete replacement of the structure due to being undersized for drainage improvements that were made in 2015. The existing structure has at times caused intermittent drainage issues upstream.

1.4 Proposed Structure Information

The proposed structure (SN 010-2045) will consist of a triple barrel, 12 ft. by 5 ft. by 138 ft. concrete box culvert with precast middle section and cast-in-place end sections with no skew. The proposed structure length along FAI 74 is 42-ft 6-in out to out culvert walls. The proposed culvert centerline station will be 508+85.75.

A Type, Size and Location Plan (TS&L), as provided by Kaskaskia Engineering is included in Appendix B. Hydraulic Report does not recommend any channel protection at either end due to intermittent flow and low water velocities.

Based on TS&L, the upstream and downstream flowline elevations are El. 679.12 and 678.92, respectively. The proposed design will maintain the current roadway profile with only a nominal surface overlay. The structure is to be replaced using staged construction to maintain two lanes of traffic flow at all times.

A recent undercutting investigation conducted by IDOT, includes the recommendation for an additional 24-inch undercut below the typical 6-inch undercut outlined in standard specifications based on Dynamic Cone Penetrometer (DCP) tests.

2.0 Site Investigation, Subsurface Exploration and Generalized Subsurface Conditions

The subsurface investigation was conducted by Midwest Engineering and Testing, Inc. and logged by Kaskaskia Engineering. BFW was not present on-site during subsurface activities. Therefore, no observations were made by BFW concerning the conditions of subsurface surface samples or test results obtained.

Based on information provided, three Standard Penetration Test (SPT) borings were advanced on the east side of the existing structure and were designated as B-1 (Sta. 509+20 70 ft. RT), B-2 (Sta. 509+20) and B-3 (Sta. 509+20, 65 ft. LT). Boring were advanced on June 1, 2017.

Subsurface boring locations are shown on the TS&L Plan found in the Appendix B of this report. Boring logs provided by Midwest Engineering and Kaskaskia are included in Appendix C with a subsurface soil profile included in Appendix D.

2.1 Subsurface Conditions

Boring B-1, (El. 687.2) profile included a surface coverage of 0.5 ft. thick layer of topsoil/organics followed by approximately 5.5 ft. of brown, silty clay fill with trace organics. Standard Penetration Tests (SPT) driving resistances (N-values) ranged between 4 to 7 with unconfined compressive strengths (Q_u) ranging from 0.6 to 2.0 tons per square foot (tsf) with soil moistures ranging from 18 to 20 percent. Below El. 681.20 to El.676.20, the soil profile encountered, a black, silt, fill material with high plasticity (Atterberg Data: LL: 35%, PL=14%, PI=21%) with N-value of 10, Q_u values of 0.5 tsf and moisture contents between 20 to 27 percent. From El. 676.20 to El.668.70, firm to stiff brown to gray clayey silt layers were encountered with N-value ranging from 8 to 15, Q_u values between 1.4 to 2.1 tsf and moistures ranging from 11 to 14 percent. Below El. 668.70 the upper clays and sands transitioned into interbedded, stiff to hard till, sand and gravel. Within the tills, sands and gravels, N-value ranging from 26 to 58, Q_u values (where available) between 3.7 to greater than 4.5 tsf and moistures ranging from 9 to 14 percent. The boring was terminated in clay till at El. 657.20 approximately 30 ft. below ground surface.

Boring B-2, (El. 685.7) profile included a surface coverage of 0.3 ft. thick layer of topsoil/organics followed by approximately 6.0 ft. (El. 679.70) of brown, silty clay fill with trace gravel. N-values ranged from 7 to 9, Q_u values from 2.1 to 2.3 tsf and moisture contents from 23 to 24 percent. From El. 679.70 to El.669.70, a firm to stiff gray silty clay layer with trace sand and gravel was encountered with N-value ranging from 6 to 13, Q_u values between 0.5 to 1.9 tsf and moistures ranging from 12 to 23 percent. Below El. 669.70 the upper clays transitioned into interbedded, stiff to hard till, clayey sands and coarse-grained sands. Within the tills, sands and gravels, N-value ranging from 24 to 45, Q_u values (where available) greater than 4.5 tsf and moistures ranging from 10 to 19 percent. The boring was terminated in fine to coarse-grained sand at El. 655.70 approximately 30 ft. below ground surface.

Boring B-3, (El. 681.5) profile included a surface coverage of 1.0 ft. thick layer of topsoil/organics. Below the upper topsoil layer from El. 680.50 to El. 668.00, a brown to gray, stiff silty clay was encountered. N-values ranged from 7 to 12, Q_u values from 1.7 to 2.3 tsf and moisture contents from 12 to 17 percent. Below El. 668.00, the upper silty clays transitioned into interbedded, stiff to hard sandy clays, tills, and medium to coarse-grained sands. Within the tills, sands and gravels, N-value ranging from 18 to 63, Q_u values (where available) ranged from 2.0 to 8.3 tsf and moistures ranging from 9 to 15 percent. The boring was terminated in medium to coarse-grained sand at El. 651.50 approximately 30 ft. below ground surface.

2.2 Groundwater

Groundwater was first encountered during drilling activities in each of the borings at similar depths of between El. 666.7 to 668.2. Twenty-four hour groundwater readings were not conducted. Given the short time for groundwater elevation monitoring, the true groundwater elevation may not be known. Longer times are required for more accurate groundwater elevation readings. All groundwater readings are subject to seasonal and rainfall variations.

3.0 Geotechnical Evaluations

3.1 Settlement

As stated in the Subsurface Conditions section of this report, the upper 12 ft. of the soil profile consists of soft to stiff consistency soils. Also, based on an Undercutting Investigation conducted by IDOT staff on March 23, 2017, it was recommended that quantities be included in the plans to undercut the culvert an additional 24-inches below the typical 6-inches outlined in the Standard Specification. Finally, the proposed loads for the new culvert are not anticipated to be much greater than the existing applied loads. Therefore, if the subgrade improvement recommendations provided in Section 4.0 are followed, total settlement resulting from the construction of the proposed structure should be less than 0.5-inch.

3.2 Bearing Capacity / Resistance

The soil profile consists of cohesive soils at the depth of the proposed box culvert with Q_u values ranging from 0.5 to 2.3 tsf. The calculated bearing resistances were developed using the lowest Q_u value of 0.5 tsf from boring B-2 at approximately 10 ft. depth. Firmer soils were encountered below this depth in all borings.

The calculated factored bearing resistance value for the box culvert was determined to be 1,330 psf, using a Bearing Resistance Factor of 0.45 (2012 AASHTO LRFD) at the approximate elevation of the culvert (El. 677.77) and using soil parameters from Boring B-2 with a cohesion of 500 psf. The applied bearing pressure from the four culvert barrels and horizontal wingwalls is estimated to be 350 psf.

Although the calculations indicated that the soils could support the culvert and wingwall, bearing requirements the soil bearing conditions are non-uniform across the proposed box culvert width. Due to the proposed use of a combination of a precast middle section and cast-in-place concrete end sections, any differences between bearing surfaces could negatively impact the connections of the different box sections. Soil types present at the site would also typically require the use of a working platform under normal conditions. Also, an Undercutting Investigation conducted by IDOT staff on March 23, 2017, recommended that quantities be included in the plans to undercut the culvert an additional 24-inches below the typical 6-inches outlined in the Standard Specification.

As a result, BFW recommends following the Undercutting Investigation recommendations of undercutting an additional 24-inches below the typical 6-inch cut as outlined in the Standard Specifications. This would improve the uniformity of the bearing conditions for the different box culvert sections, as well as, provide a working platform for construction.

If during construction, the conditions of the foundation subgrades encountered are not representative of the conditions of the borings, BFW should be contacted.

3.3 Slope Stability

Slope stability of the wingwall sideslopes was evaluated using a slope stability analysis software: *GSTABL7 with STEDwin* using a wingwall sideslope geometry of 1V:2H and soil characteristics from boring, B-3. Site conditions including end-of-construction, long term stability and design seismic event were modeled. The *GSTABL7* program calculated critical factor of safety (FOS) for each condition. Based on IDOT requirements, the target FOS for end-of-construction and long-term slope stability is 1.5 and 1.0 for the design seismic event.

To model the end-of-construction conditions, undrained soil parameters were used with a friction angle of 0° assumed for cohesive soils. Drained soil parameters with assumed friction angles ranging from 27° to 29° were used to model the long-term and seismic conditions to analyzed the conditions where excess pore water pressure from construction has dissipated. For cohesive materials, a nominal cohesion value of 50 to 60 psf was included in the drained strength parameters.

The Modified Bishop Method was used to calculate the factor of safety for given conditions. The Modified Bishop Method generates circular-arc failure surfaces to calculate critical failure surfaces. The calculated FOS are provided in Table 1.0 Output from the GSTABLE7 *with STEDwin* can be found in Appendix E.

Based on slope stability analysis, results indicated acceptable FOS for all three conditions.

Table 1.0

Location	Short Term (End of Construction	Long Term	Seismic
Wingwall Sideslope Station 509+20 (B-3)	2.5	1.5	1.2

3.4 Seismic Considerations

Per IDOT Bridge Manual (v. 2012), Section 2.3.10, seismic data is not required for buried structure which includes box culverts.

3.5 Scour

Based on the TS&L (Appendix B), the approximate invert elevation at the upstream end of the box culvert is El. 678.87 and at the discharge end is EL. 678.67. Based on the prepared Hydraulic Report (March 2017), the design scour elevations for the proposed box culvert are at the bottom of the cutoff wall, approximately 3 ft. below the invert elevations. In addition, based on calculated velocities (around 6 fps), intermittent flow, and the presence of cohesive soils, established grass should be enough to prevent erosion with no additional channel protection needed. According to All Bridge Designers (ABD) Memo 14.2 (November 7, 2014), a design scour elevation table is no longer required to be included in SGR.

3.6 Mining Activity

Based on a review of the Illinois State Geological Survey's (ISGS) website (http://isgs.illinois.edu/ilmines), no coal mining has been conducted in the area of the proposed box culvert area.

4.0 Foundation Evaluations and Design Recommendations

Based on the results of the subsurface exploration, current site conditions observed, and laboratory results, items of geotechnical interest and considerations are discussed in the following sections.

4.1 Box Culvert

Due to the proposed use of a combination of a precast concrete middle section and cast-in-place concrete end sections, any differences between bearing surfaces could negatively impact the connections of the different box sections. Variations in soil bearing characteristics were indicated within the boring logs at the proposed box culvert depth. Also, an Undercutting Investigation conducted by IDOT staff on March 23, 2017, recommended that quantities be included in the plans to undercut the culvert an additional 24-inches below the typical 6-inches outlined in the Standard Specification.

As a result, the Undercutting Investigation recommendations of undercutting an additional 24-inches below the typical 6-inch cut as outlined in the Standard Specifications should be followed. This would improve the uniformity of the bearing conditions for the different box culvert sections, as well as, provide a working platform for construction.

5.0 Construction Considerations

Based on the results of the subsurface exploration, current site conditions observed, and laboratory results, items of geotechnical interest and considerations are discussed in the following sections.

5.1 Construction Activities

Construction activities should be performed in accordance with the current IDOT Standard Specifications for Road and Bridge Construction and any pertinent Special Provisions or Policies. Should any design considerations that were assumed by BFW change, BFW should be contacted to determine if the recommendations are still valid.

5.2 Temporary Sheeting and Soil Retention

Based on information provided in the TS&L, the proposed box culvert will consist of staged construction. Stage 1 includes the removal of the existing box culvert center section and construction of the center precast box culvert section. Stage 2 includes the removal of both ends of the existing box culvert and the construction of cast-in-place end sections and wingwalls. Based on this sequence, shoring will be required during staged construction.

Temporary shoring using simple cantilevered temporary sheet piling may be feasible for the site under some cases depending on retained height and soil boring data used. The IDOT Temporary Sheet Piling Design Guide states in its limitations that the design charts may not be used if embedment falls below soil layers with a Qu value larger than 4.5 tsf or N-values larger than 45 blows since the sheet piling may not penetrate these layers. In each of the three soil borings, soil layers with Qu values larger than 4.5 and N-values larger than 45 are presence at varying depths with boring B-3 having the shallowest depth to hard layers. Approximate elevations to the hard stratum are provided in the following table.

Boring	Approx. Elevation of Hard Stratum (Q_u>4.5 or N>45)
B-1	661.20
B-2	659.70
B-3	665.5

Therefore, the use of simple cantilevered temporary sheet piling may be limited due to required retained heights.

If adequate retained heights cannot not be obtained using IDOT Temporary Sheet Piling Design Guide then a Temporary Soil Retention System will be required. If the Temporary Soil Retention System is required then an Illinois licensed structural engineer would be required for design.

5.3 Site and Soil Conditions

Based on subsurface soil data obtained the provisions of the Standard Specifications will adequately address the anticipated site and soils conditions.

5.4 Wing Wall Types

Based on the existing site conditions and the proposed box culvert dimensions, the use of Horizontal Cantilever Wingwalls appears suitable for the for the proposed precast box culvert with cast-in-place ends. Based on the IDOT Culvert Manual, the design height may not exceed 10 ft. with a maximum wingwall length of 16 ft. If the design height surpasses 10 ft. and/or the maximum wingwall length exceeds 16 ft., an L-Type Vertical Cantilever Wingwall shall be used. Based on the subsurface data, the in-situ soils are anticipated to be capable to support the footing pressures applied from an L-type vertical cantilever wingwall.

6.0 Computations

Any engineering computations that were conducted for special circumstances, if present, are provided in the appendix of this report. Slope stability calculations were conducted using *GSTABL7 with STEDwin*.

7.0 Geotechnical Data

Subsurface boring logs and boring profile sheet are provided in the appendix of this report.

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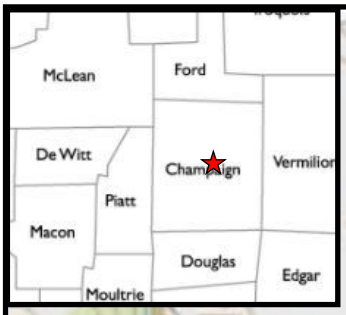
Appendix A

USGS Topographic Location Map



Project Location

Project Location

ANTHONY DR

N COTTONWOOD RD

Saline Br Drainage Ditch

74

150

1700 E

Project Location Map

I-74 Over Tributary to the Saline Branch Drainage District Ditch

BFW
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500 SOUTH 17TH STREET
PADUCAH, KY 42003

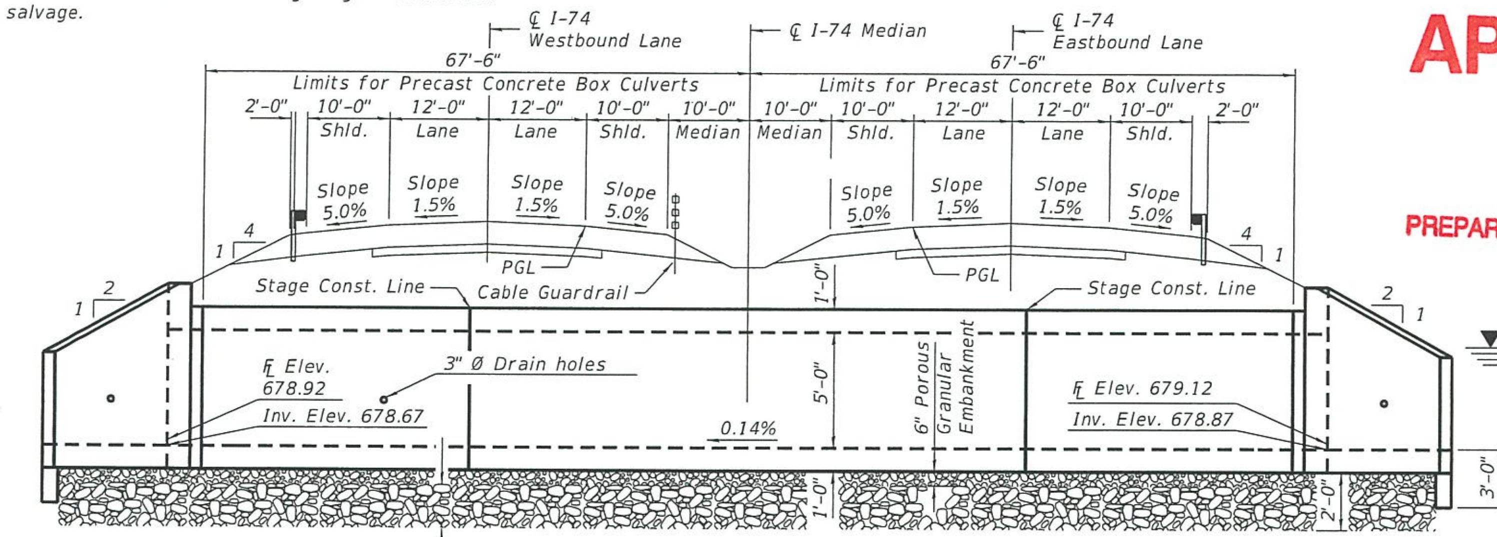
Appendix B

Type, Size, and Location Plan (TS&L)

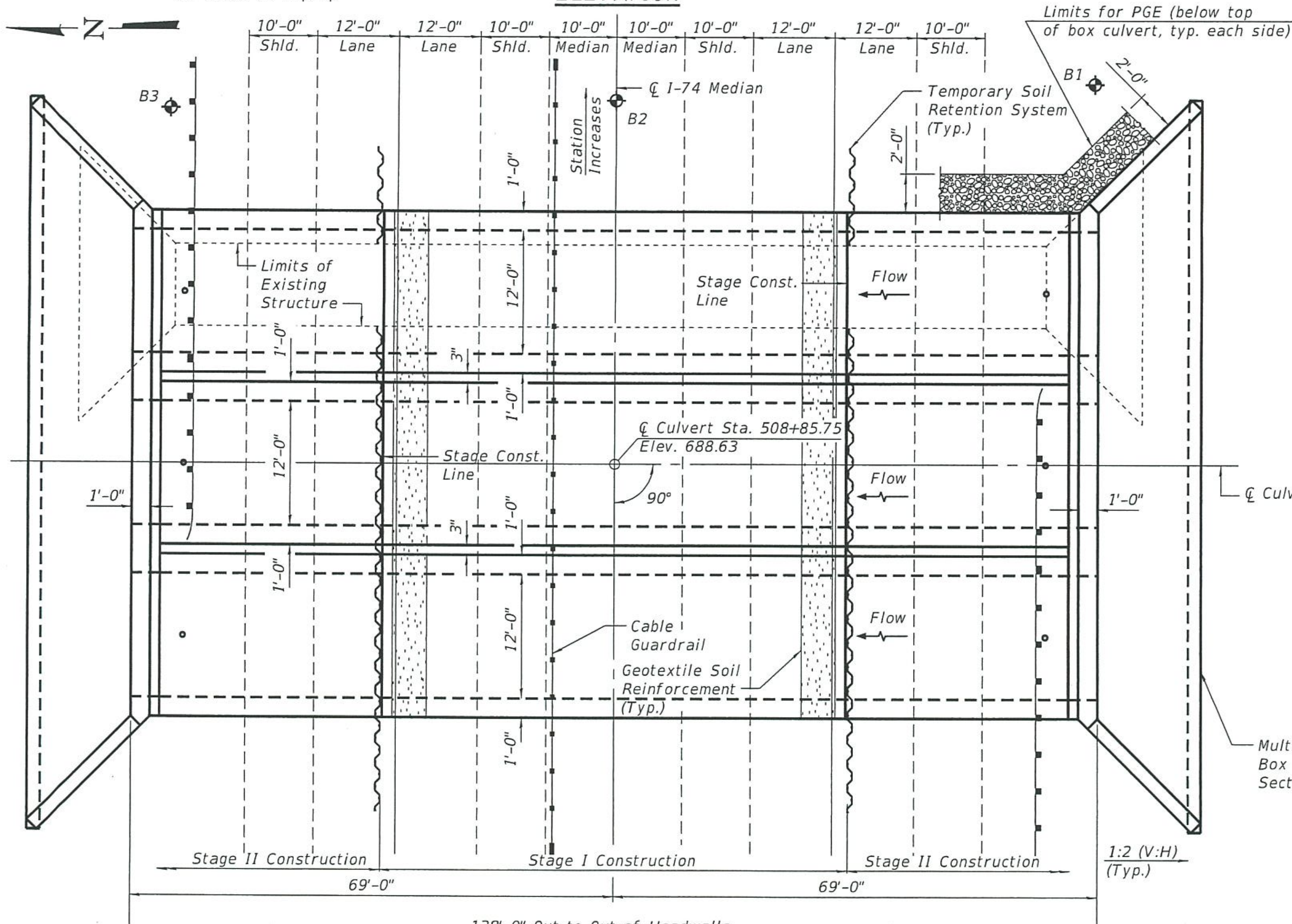
Benchmark: IP with cap. Located at Station 485+26.42, 3.72 Left, Elevation 691.87.
Existing Structure: SN 010-8054 built in 1960 as FAI 74, a single cell 8'x3'x134'-4" cast-in-place box culvert on a 0° skew with 45° wingwalls.
Traffic to be maintained utilizing stage construction.
No salvage.

Note: See Sheet 2 for Construction Staging Detail.

APPROVED
SEP 25 2017
AS A BASIS FOR PREPARATION OF DETAILED PLANS



ELEVATION



PLAN

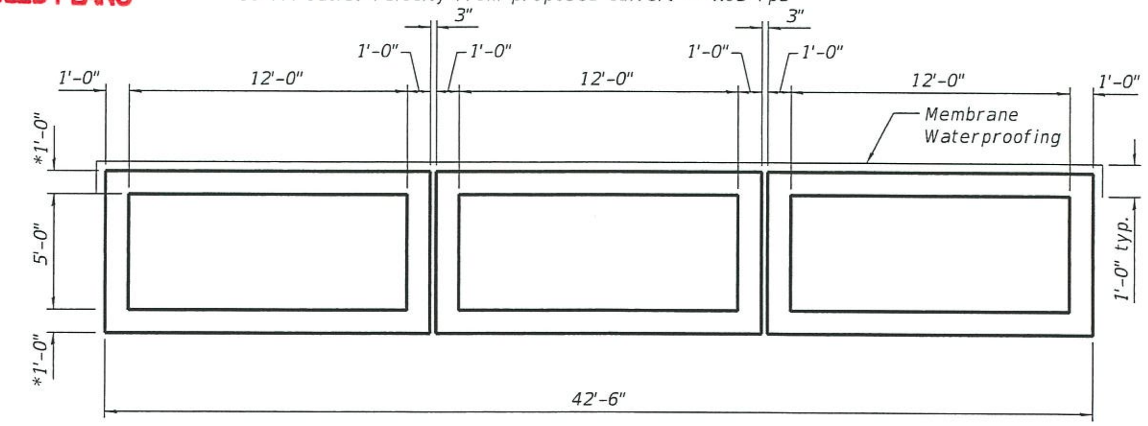
NOT TO SCALE

WATERWAY INFORMATION

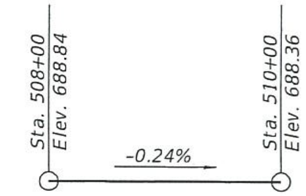
Drainage Area = 3.14 sq. mi. Existing Low Grade Elev. = 686.19 @ Sta. 520+00
Proposed Low Grade Elev. = 686.19 @ Sta. 520+00

Flood	Freq. Yr.	Q C.F.S.	Opening Sq. Ft. Exist.	Opening Sq. Ft. Prop.	Nat. H.W.E.	Head - Ft. Exist.	Head - Ft. Prop.	Headwater El. Exist.	Headwater El. Prop.
	10	610	24	165	683.7	3.1	0.0	686.8	683.7
Design	50	1000	24	176	684.0	2.9	0.6	686.9	684.6
Base	100	1180	24	180	684.2	2.8	1.1	687.0	685.3
Overtopping	2	239	24	-	682.9	3.3	-	686.2	-
Max. Calc.	500	1620	-	180	684.5	-	1.9	-	686.4

10 Yr. Outlet Velocity from existing culvert = 10.3 fps
10 Yr. Outlet Velocity from proposed culvert = 4.03 fps



SECTION THROUGH BARREL
(Looking North)
* Subject to refinement during final design



PROFILE GRADE

DESIGN SPECIFICATIONS

2014 AASHTO LRFD Bridge Design Specifications 7th Edition with 2015 and 2016 interims, ASTM C1577

HIGHWAY CLASSIFICATION

FAI 74
Functional Class: Interstate
ADT: 30,000 (2017); 38,600 (2037)
DHV: 2,960
ADTT: 23.2%
Design Speed: 70 m.p.h.
Posted Speed: 70 m.p.h.
Directional Distribution: 55:45

LOADING HL-93

Allow for 50 psf for Future Wearing Surface
Design Earth Cover 2 feet.

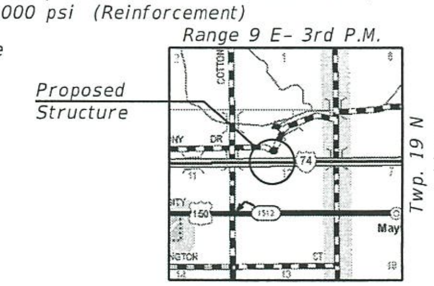
DESIGN STRESSES

PRECAST UNITS

f'c = 5,000 psi
fy = 65,000 psi (Welded Wire Reinforcement)

FIELD UNITS

f'c = 3,500 psi
fy = 60,000 psi (Welded Wire Reinforcement)
fy = 60,000 psi (Reinforcement)



LOCATION SKETCH

GENERAL PLAN AND ELEVATION
F.A.I. RTE. I-74 OVER TRIBUTARY TO THE SALINE BRANCH DRAINAGE DISTRICT DITCH
F.A.I. RTE. 74 SEC. 10-6 RS-4 & 10-7 RS-3
CHAMPAIGN COUNTY
STATION 508+85.75
S.N. 010-2045

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STATE OF ILLINOIS
DEPARTMENT OF TRANSPORTATION

GENERAL PLAN AND ELEVATION F.A.I. 74
OVER TRIBUTARY TO THE SALINE BRANCH DRAINAGE DISTRICT DITCH
SHEET NO. 1 OF 2 SHEETS

F.A.I. RTE.	SECTION	COUNTY	TOTAL SHEETS	SHEET NO.
74	10-6 RS-4 & 10-7 RS-3	CHAMPAIGN		
		CONTRACT NO. 70789		
		ILLINOIS FED. AID PROJECT		

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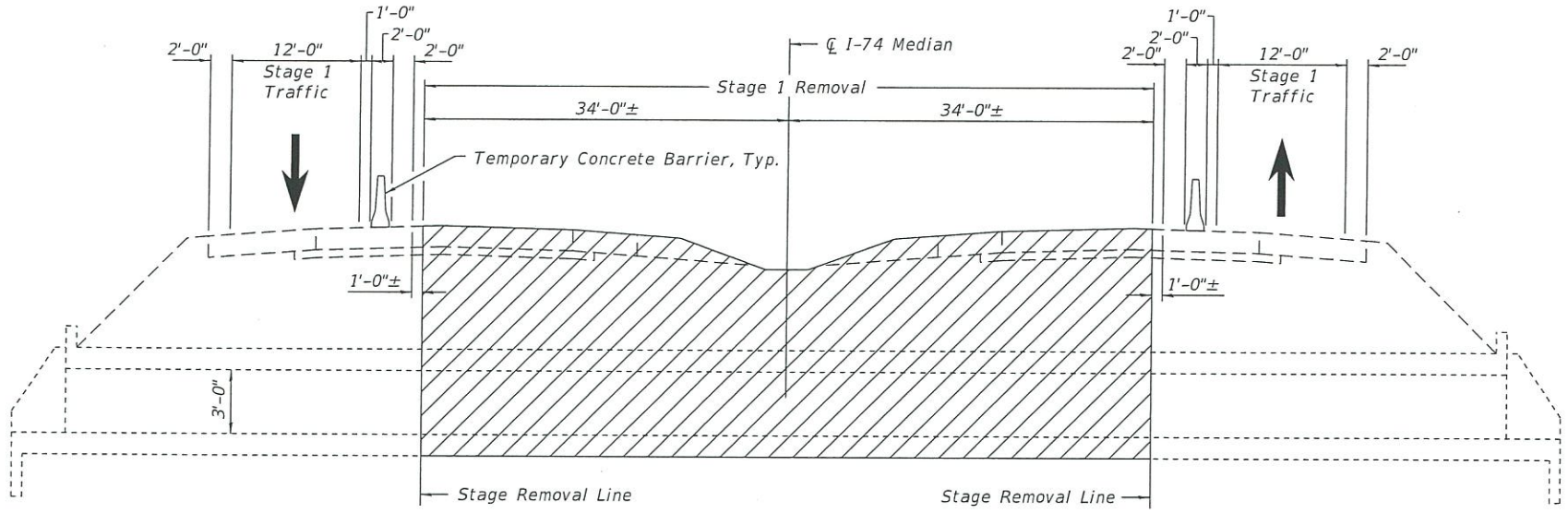
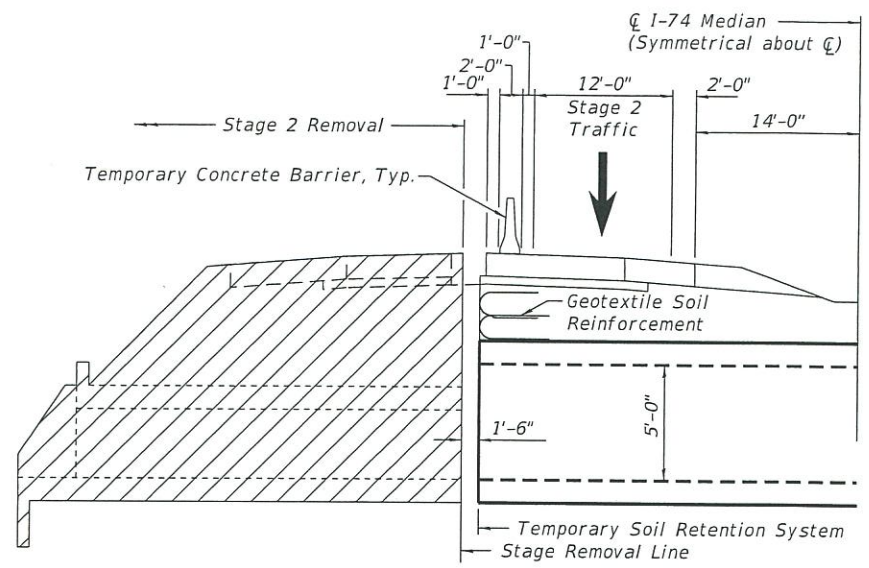


STAGE 1 REMOVAL



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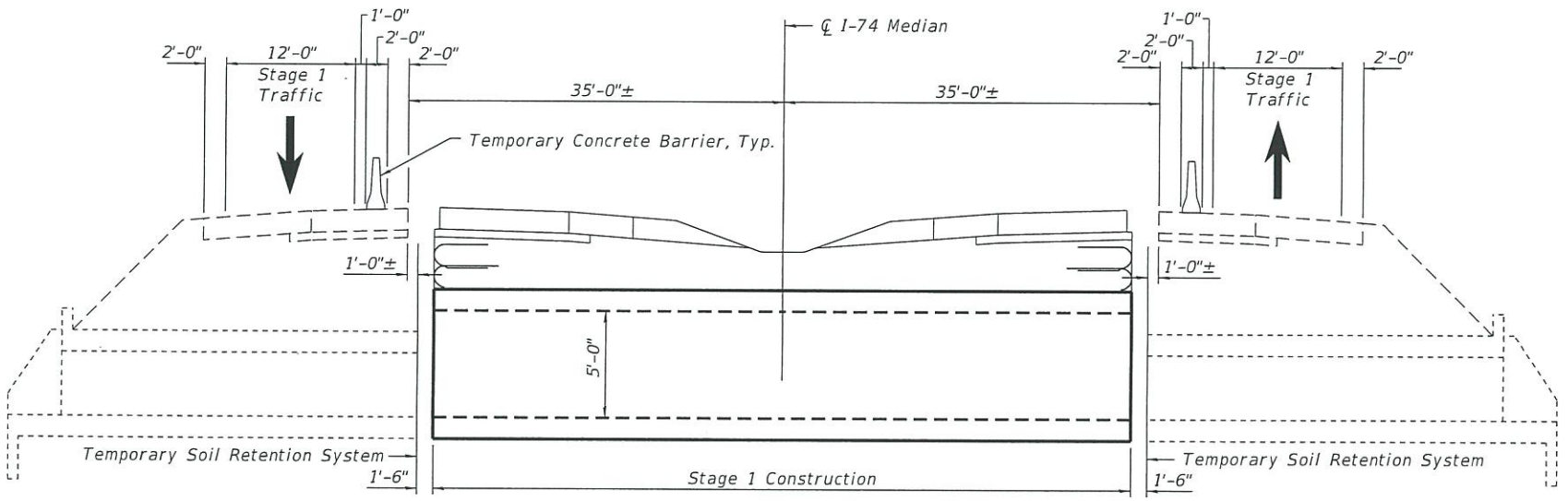
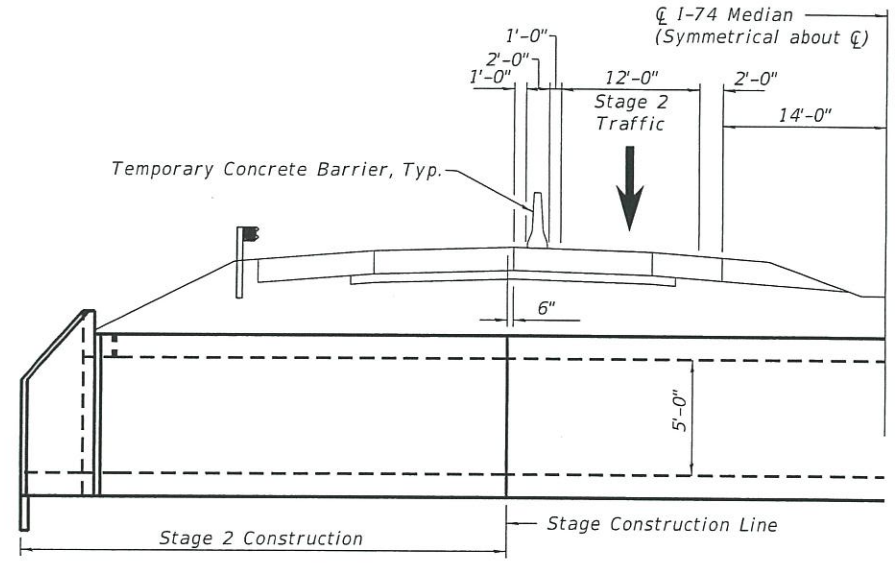
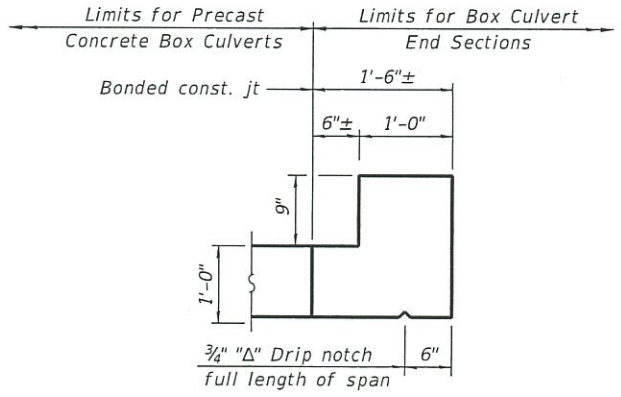


STAGE 1 CONSTRUCTION



STAGE 2 CONSTRUCTION



HEADWALL DETAIL

NOT TO SCALE

APPROVED

SEP 25 2017

AS A BASIS FOR
PREPARATION OF DETAILED PLANS

Notes:
1. All sections are looking Upstation.
2. One lane of traffic in each direction shall be maintained during each stage.

STAGE CONSTRUCTION DETAILS
F.A.I. RTE. I-74 OVER TRIBUTARY TO THE
SALINE BRANCH DRAINAGE DISTRICT DITCH
F.A.I. RTE. 74 SEC. 10-6 RS-4 & 10-7 RS-3
CHAMPAIGN COUNTY
STATION 508+85.75
S.N. 010-2045

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Kaskaskia Engineering Group, LLC
PROFESSIONAL ENGINEERING CORPORATION
Illinois Fundamental Design Firm
Professional Engineering Group

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STATE OF ILLINOIS
DEPARTMENT OF TRANSPORTATION

STAGING PLAN AND DETAILS F.A.I. RTE. 74
OVER TRIBUTARY TO THE SALINE BRANCH DRAINAGE DISTRICT DITCH
SHEET NO. 2 OF 2 SHEETS

F.A.I. RTE.	SECTION	COUNTY	TOTAL SHEETS	SHEET NO.
74	10-6 RS-4 & 10-7 RS-3	CHAMPAIGN		
		CONTRACT NO. 70789		
	ILLINOIS FED. AID PROJECT			

Appendix C

Soil Boring Logs

Illinois Department of Transportation
Division of Highways

SOIL BORING LOG

Date 6/1/17

ROUTE I-74 **DESCRIPTION** Culvert Replacement **LOGGED BY** KEG

SECTION 10-CRS-4 and 10-7RS-3 **LOCATION** I-74 Between Urbana and St. Joseph

COUNTY Champaign **DRILLING METHOD** Hollow Stem Auger **HAMMER TYPE** AUTO

STRUCT. NO. 010-8054
Station 509+00

BORING NO. B-1
Station 509+20
Offset 70.00ft RT
Ground Surface Elev. 687.2 ft

Surface Water Elev. ft
Stream Bed Elev. ft

Groundwater Elev.:
First Encounter 668.2 ft ▼
Upon Completion ft
After Hrs. ft

	DEPTH (ft)	BLOWS (/6")	UCS Qu (tsf)	MOIST (%)
TOPSOIL: 6 IN	686.70			
SILTY CLAY: Brown, fill, trace organics, soft		2		
		2	0.6	20
		2	B	
trace sand, fill, medium		3		
		3	2.0	18
	-5	4	P	
	681.20			
SILT: Black, fill, medium		3		
		4	0.5	27
		6	P	
SHELBY TUBE RECOVERY: 11 IN				
Atterberg Data: LL=35%			0.5	20
PL=14%	-10		P	
PI = 21%				
	676.20			
CLAYEY SILT: Brown, medium		3		
		3	2.0	14
		5	B	
becomes brown to gray, trace gravel, stiff		6		
		7	2.1	13
	-15	8	B	
becomes gray, trace gravel		4		
		4	1.4	11
		6	B	
	668.70			
TILL: Gray, sand pocket, hard ▼		12		
		14	3.7	9
	-20	14	S	

	DEPTH (ft)	BLOWS (/6")	UCS Qu (tsf)	MOIST (%)
TILL: Gray, sand pocket, hard *(continued)*	666.20			
SAND: Gray, medium to coarse grain, medium dense		4		
		9		14
		18		
	663.70			
SAND TO GRAVEL: Coarse grain, medium dense		8		
		12		9
	-25	14		
	661.20			
CLAY TILL: Gray, trace gravel, hard		10		
		18	>4.5	12
		26	P	
		10		
		25	>4.5	10
	657.20 -30	33	P	
	-35			
	-40			

The Unconfined Compressive Strength (UCS) Failure Mode is indicated by (B-Bulge, S-Shear, P-Penetrometer)
The SPT (N value) is the sum of the last two blow values in each sampling zone (AASHTO T206)

Illinois Department of Transportation
Division of Highways

SOIL BORING LOG

Date 6/1/17

ROUTE I-74 **DESCRIPTION** Culvert Replacement **LOGGED BY** KEG

SECTION 10-CRS-4 and 10-7RS-3 **LOCATION** I-74 Between Urbana and St. Joseph

COUNTY Champaign **DRILLING METHOD** Hollow Stem Auger **HAMMER TYPE** AUTO

STRUCT. NO. 010-8054
Station 509+00

BORING NO. B-2
Station 509+20
Offset 0.00ft
Ground Surface Elev. 685.7 ft

Surface Water Elev. ft
Stream Bed Elev. ft

Groundwater Elev.:
First Encounter 666.7 ft ▼
Upon Completion ft
After Hrs. ft

DEPTH (ft)	BLOWS (/6")	UCS Qu (tsf)	MOIST (%)	Material Description
				TOPSOIL: 4" 685.45
	3			SILTY CLAY FILL: Brown, trace gravel, medium
	3	2.1	24	
	4	B		
	3			becomes stiff
	4	2.3	23	
-5	5	B		
				679.70
	3			SILTY CLAY: Gray, trace sand, medium
	3	1.7	14	
	5	B		
	3			
	3	0.5	23	
-10	3	P		
	3			becomes stiff, trace gravel
	6	1.9	13	
	7	B		
	3			trace gravel and sand
	4	1.0	12	
-15	5	B		
				669.70
	7			CLAYEY SAND: Gray, medium to coarse grained, dense
	16		13	
	21			
				667.20
▼	12			SAND: Gray, medium to coarse grained, medium dense
	12		11	
-20	12			

DEPTH (ft)	BLOWS (/6")	UCS Qu (tsf)	MOIST (%)	Material Description
				SAND: Gray, medium to coarse grained, medium dense *(continued)*
	5			becomes fine grained, wet
	10		18	
	17			
	10			becomes medium to coarse grained
	13		11	
-25	14			
				659.70
	13			CLAY: Gray, Tillish, trace sand, wet, hard
	13	>4.5	10	
	19	P		
				657.20
	11			SAND: Gray, fine to coarse grained, dense
	27		19	
-30	18			655.70
-35				
-40				

The Unconfined Compressive Strength (UCS) Failure Mode is indicated by (B-Bulge, S-Shear, P-Penetrometer)
The SPT (N value) is the sum of the last two blow values in each sampling zone (AASHTO T206)

BBS, from 137 (Rev. 8-99)

Illinois Department of Transportation
Division of Highways

SOIL BORING LOG

Date 6/1/17

ROUTE I-74 **DESCRIPTION** Culvert Replacement **LOGGED BY** KEG

SECTION 10-CRS-4 and 10-7RS-3 **LOCATION** I-74 Between Urbana and St. Joseph

COUNTY Champaign **DRILLING METHOD** Hollow Stem Auger **HAMMER TYPE** AUTO

STRUCT. NO. 010-8054
Station 509+00

BORING NO. B-3
Station 509+20
Offset 65.00ft LT
Ground Surface Elev. 681.5 ft

Surface Water Elev. ft
Stream Bed Elev. ft

Groundwater Elev.:
First Encounter 667.5 ft ▼
Upon Completion ft
After Hrs. ft

DEPTH (ft)	BLOWS (/6")	UCS Qu (tsf)	MOIST (%)	Description
				TOPSOIL: 12"
				680.50
	2			SILTY CLAY: Brown, stiff
	4 5	2.1 B	16	
	6			becomes medium
	2 5	1.7 B	17	
-5				
	4			becomes gray, stiff, trace gravel
	5 7	2.3 B	12	
				SHELBY TUBE: Recovery - 24", very stiff
		3.3 P	10	**Atterberg Data: LL=19% PL=11% PI = 8%**
-10				
				670.50
	4			CLAY: Gray, dry, sand at bottom, very stiff
	9 19	2.1 B	10	
				668.00
	1			SAND: Gray, medium grained, wet, very loose ▼
	2 1		18	
-15				
	12			becomes fine grained, very dense
	21 29		18	
				663.00
	4			SANDY CLAY: Gray, trace rounded gravel, tillish, hard
	15 24	>4.5 P	10	
-20				

DEPTH (ft)	BLOWS (/6")	UCS Qu (tsf)	MOIST (%)	Description
				SANDY CLAY: Gray, trace rounded gravel, tillish, hard *(continued)*
				660.50
	9			TILL: Gray, hard
	27 36	8.3 B	9	
	16			trace sand
	14 16	2.5 S	9	
-25				
				655.50
	6			SANDY CLAY: Gray, contained a sand pocket, very stiff
	8 10	2.0 S	13	
				653.00
	4			SAND: Gray, medium to coarse grained, wet, medium dense
	7 16		15	
				651.50
-30				
-35				
-40				

The Unconfined Compressive Strength (UCS) Failure Mode is indicated by (B-Bulge, S-Shear, P-Penetrometer)
The SPT (N value) is the sum of the last two blow values in each sampling zone (AASHTO T206)

Appendix D

Subsurface Soil Boring Profile

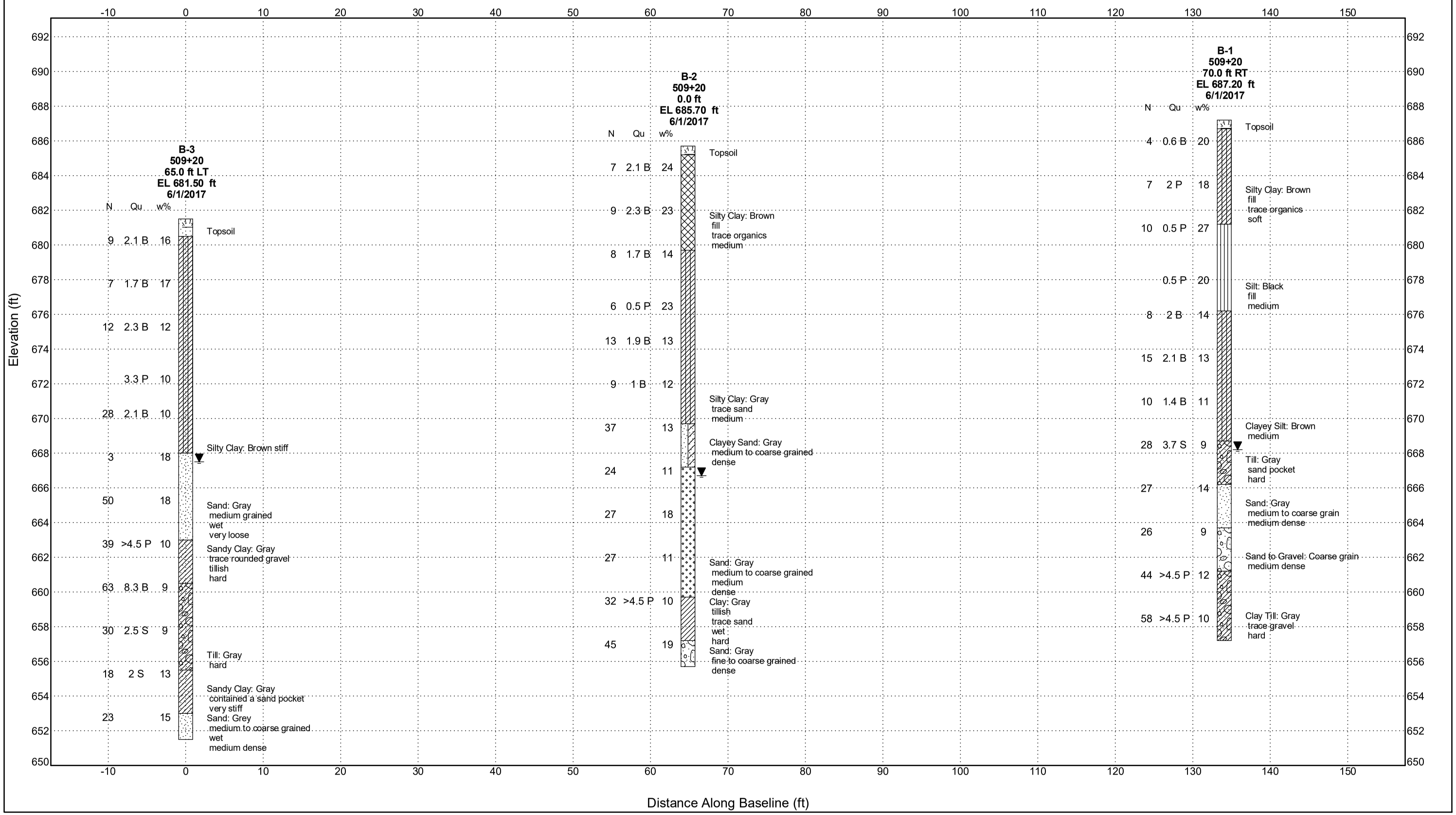
Illinois Department of Transportation
Division of Highways
BFW Engineering & Testing Inc.

ROUTE I-74
SECTION 10-CRS-4 and 10-7RS-3
COUNTY Champaign
PROJECT LOCATION I-75 Between Urbana and St. Joseph

SUBSURFACE PROFILE

LEGEND
EL = Elevation (ft)
D = Depth Below Existing Ground Surface (ft)
N = SPT N-Value (AASHTO T206)
Qu = Unconfined compressive Strength (tsf)
Failure Mode (B= Bulge, S= shear, P= penetrometer)
w% = Moisture Content Percentage

WATER TABLE LEGEND
▼ = First Encountered
▽ = Upon Completion
▼ = After __ hours



Appendix E

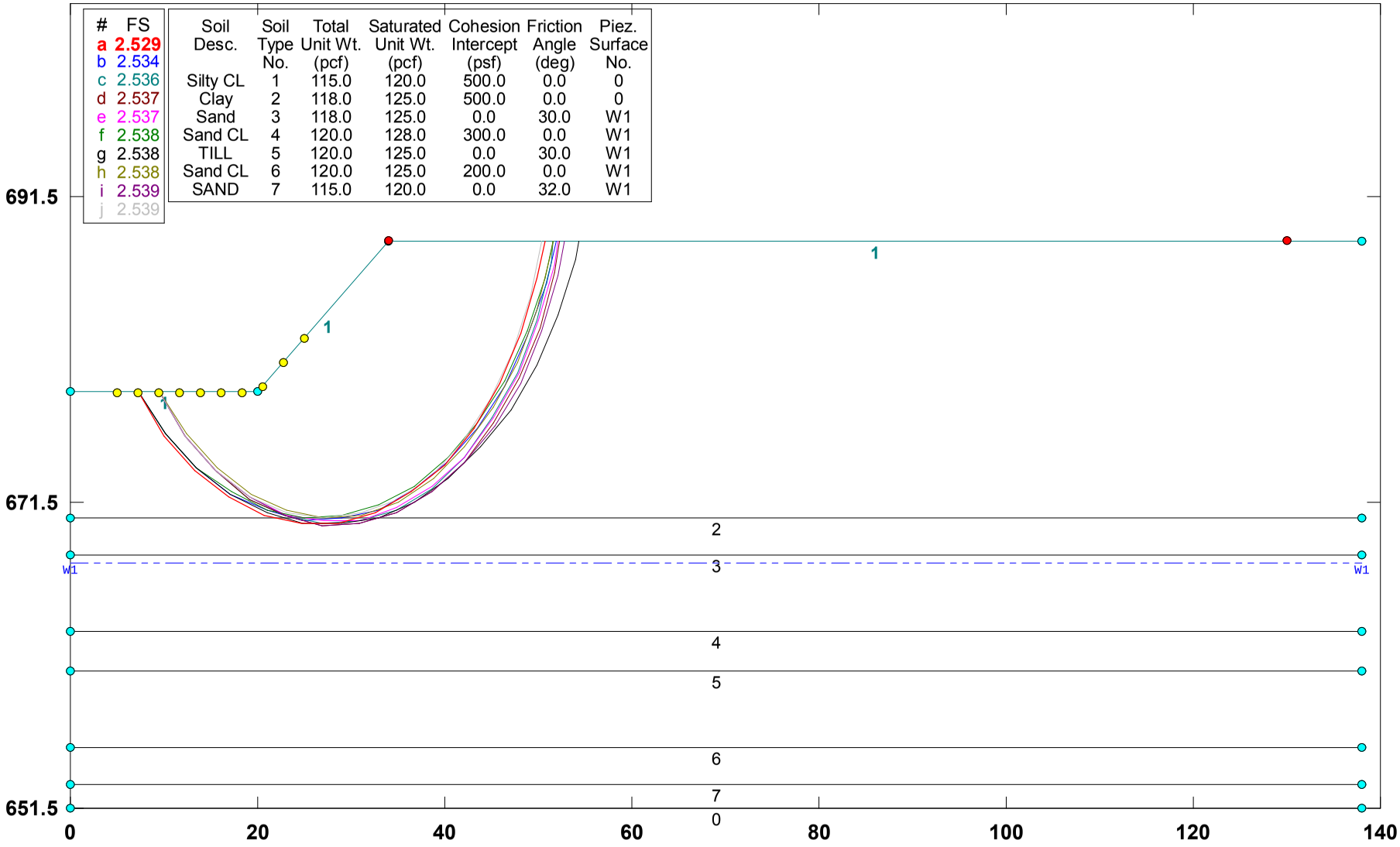
GSTABL 7 Slope Stability Analysis

IDOT Box Culvert Replacement (010-2045) End of Construction (Short Term)

x:\17178 - idot d5 wo #2\sgr\slope stability short term.pl2 Run By: Bacon Farmer Workman Engineering

#	FS
a	2.529
b	2.534
c	2.536
d	2.537
e	2.537
f	2.538
g	2.538
h	2.538
i	2.539
j	2.539

Soil Desc.	Soil Type No.	Total Unit Wt. (pcf)	Saturated Unit Wt. (pcf)	Cohesion Intercept (psf)	Friction Angle (deg)	Piez. Surface No.
Silty CL	1	115.0	120.0	500.0	0.0	0
Clay	2	118.0	125.0	500.0	0.0	0
Sand	3	118.0	125.0	0.0	30.0	W1
Sand CL	4	120.0	128.0	300.0	0.0	W1
TILL	5	120.0	125.0	0.0	30.0	W1
Sand CL	6	120.0	125.0	200.0	0.0	W1
SAND	7	115.0	120.0	0.0	32.0	W1



GSTABL7 v.2 FSmin=2.529

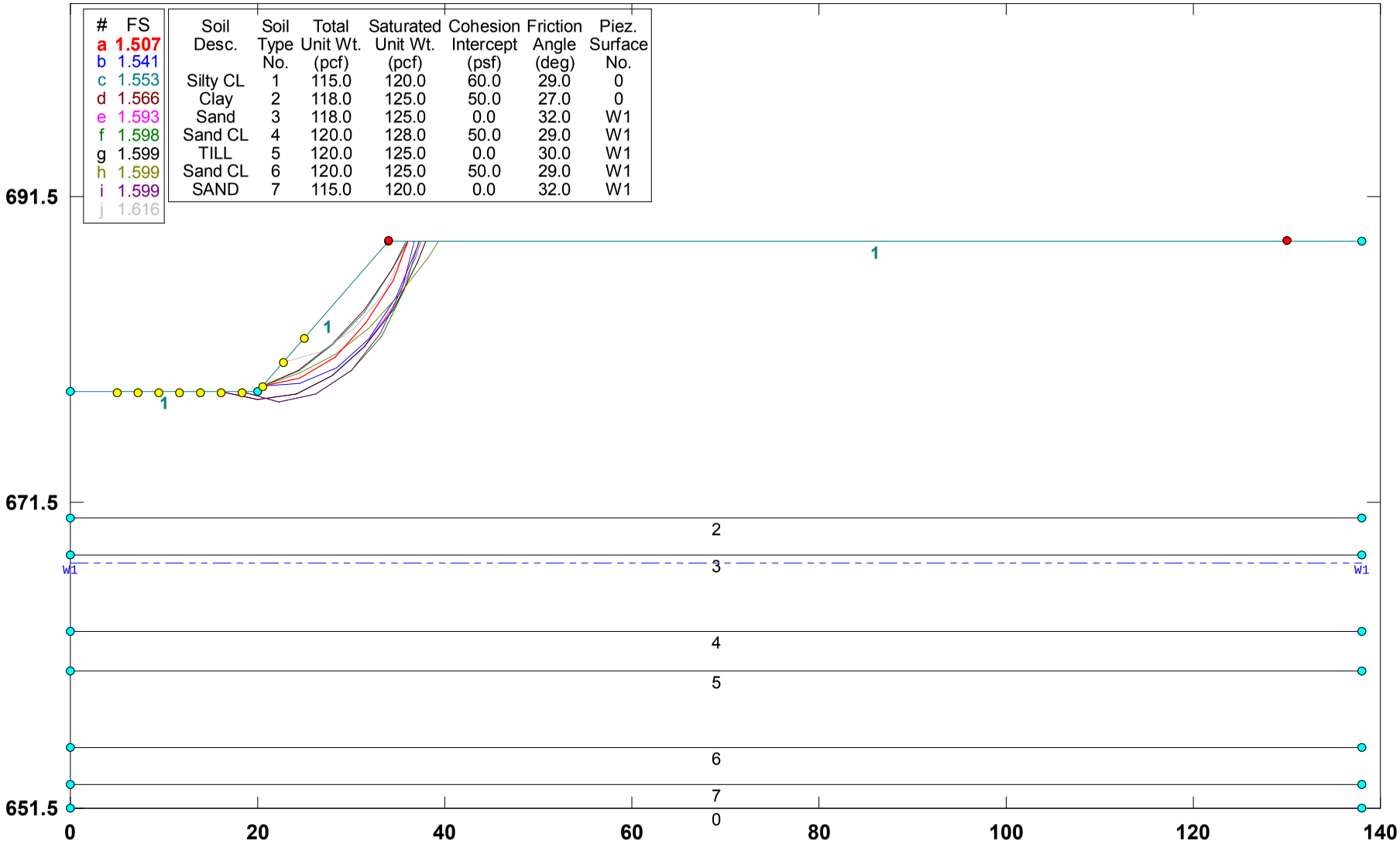
Safety Factors Are Calculated By The Modified Bishop Method

IDOT Box Culvert Replacement (010-2045) Long Term

x:\17178 - idot d5 wo #2\sgr\long term slope stability.pl2 Run By: Bacon Farmer Workman Engineering

#	FS
a	1.507
b	1.541
c	1.553
d	1.566
e	1.593
f	1.598
g	1.599
h	1.599
i	1.599
j	1.616

Soil Desc.	Soil Type No.	Total Unit Wt. (pcf)	Saturated Unit Wt. (pcf)	Cohesion Intercept (psf)	Friction Angle (deg)	Piez. Surface No.
Silty CL	1	115.0	120.0	60.0	29.0	0
Clay	2	118.0	125.0	50.0	27.0	0
Sand	3	118.0	125.0	0.0	32.0	W1
Sand CL	4	120.0	128.0	50.0	29.0	W1
TILL	5	120.0	125.0	0.0	30.0	W1
Sand CL	6	120.0	125.0	50.0	29.0	W1
SAND	7	115.0	120.0	0.0	32.0	W1

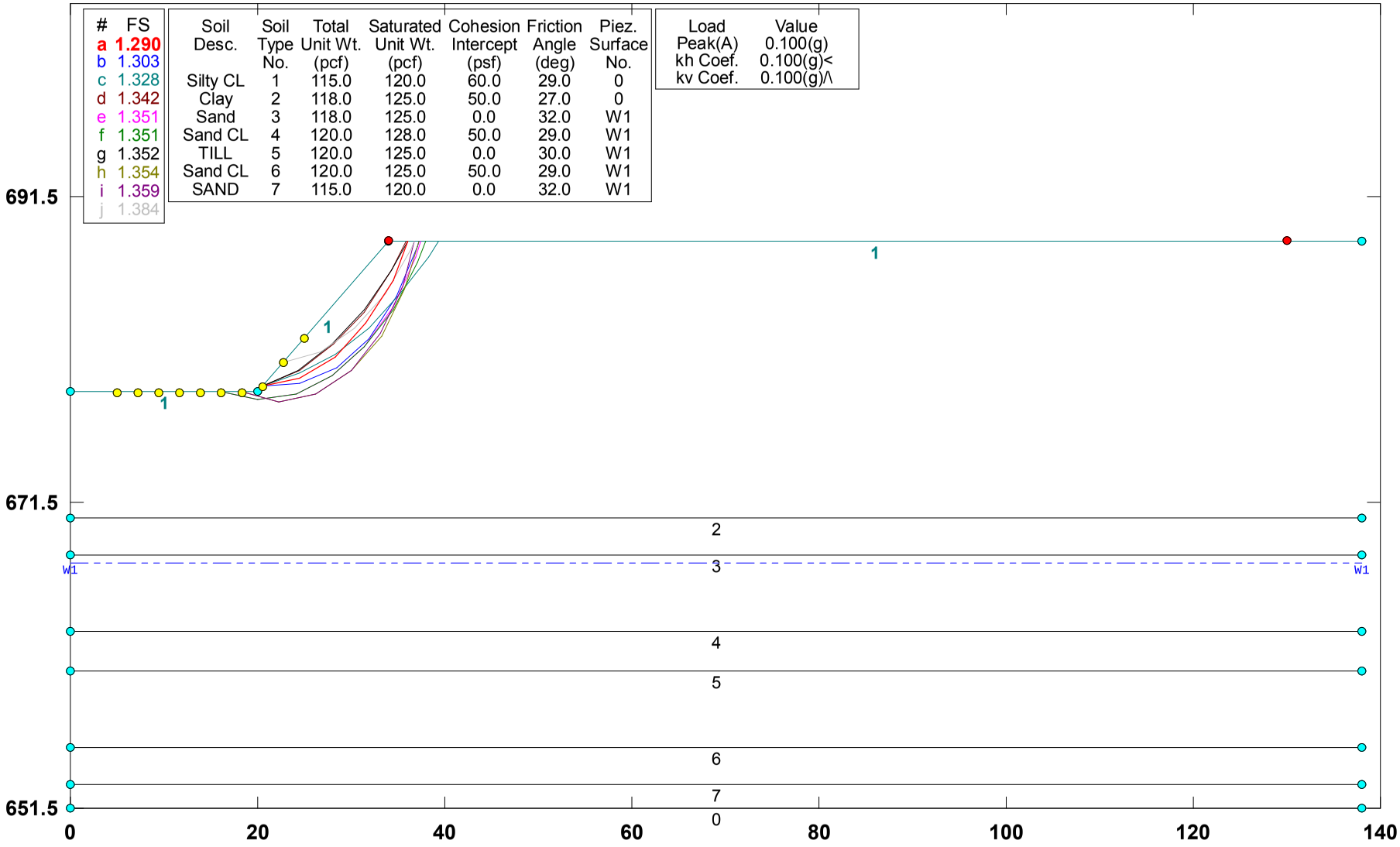


GSTABL7 v.2 FSmin=1.507

Safety Factors Are Calculated By The Modified Bishop Method

IDOT Box Culvert Replacement (010-2045) Earthquake

x:\17178 - idot d5 wo #2\sgr\earthquake loading slope stability.pl2 Run By: Bacon Farmer Workman Engineering



#	FS
a	1.290
b	1.303
c	1.328
d	1.342
e	1.351
f	1.351
g	1.352
h	1.354
i	1.359
j	1.384

Soil Desc.	Soil Type No.	Total Unit Wt. (pcf)	Saturated Unit Wt. (pcf)	Cohesion Intercept (psf)	Friction Angle (deg)	Piez. Surface No.
Silty CL	1	115.0	120.0	60.0	29.0	0
Clay	2	118.0	125.0	50.0	27.0	0
Sand	3	118.0	125.0	0.0	32.0	W1
Sand CL	4	120.0	128.0	50.0	29.0	W1
TILL	5	120.0	125.0	0.0	30.0	W1
Sand CL	6	120.0	125.0	50.0	29.0	W1
SAND	7	115.0	120.0	0.0	32.0	W1

Load	Value
Peak(A)	0.100(g)
kh Coef.	0.100(g)<
kv Coef.	0.100(g)/\

GSTABL7 v.2 FSmin=1.290

Safety Factors Are Calculated By The Modified Bishop Method