

STRUCTURE GEOTECHNICAL REPORT

Illinois Route 37 over Unnamed Stream

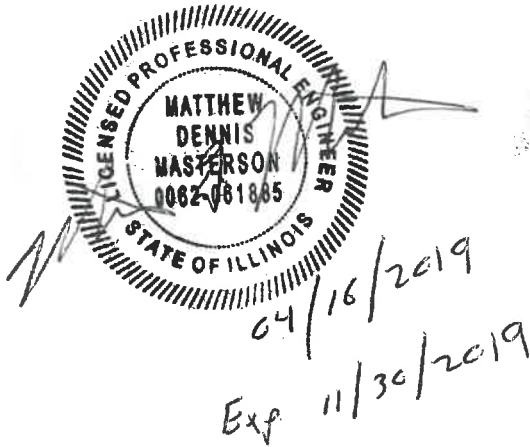
S.N. 041-2022

F.A.S. Route 2869
Section 1B-1
Jefferson County, ILLINOIS
JOB NO.D-99-007-13
PTB 184/034
CONTRACT NO. 78520
KEG NO. 17-1095.03

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Springfield, Illinois
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September 11, 2018
REVISED April 16, 2019



EXECUTIVE SUMMARY

Illinois Route 37 over Unnamed Stream
F.A.S Route 2869
Section 1B-1
Jefferson County, Illinois
Job No. D-99-007-13
Contract No. 78520
Structure No. 041-2022

This report summarizes the geotechnical study for the proposed triple box culvert replacement for Illinois Route 37 over Unnamed stream in Jefferson County, Illinois

Slope stability was analyzed for the proposed wingwall side-slopes, including an estimated wingwall side-slope geometry of 1V:2H. The required FOS for the end-of-construction and long-term were met.

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EXHIBITS

- Exhibit A – Location Map
- Exhibit B – Type, Size, and Location Plan (TS&L)
- Exhibit C – Boring Logs
- Exhibit D – Subsurface Profile
- Exhibit E – Slope/W Slope Stability Analysis

1.0 Project Description and Proposed Structure Information

1.1 Introduction

The geotechnical study summarized in this report was performed by Kaskaskia Engineering Group, LLC (KEG) for the proposed triple box culvert for Illinois Route 37 over Unnamed Stream in Jefferson County, Illinois. The purpose of this report is to document subsurface geotechnical conditions, provide analyses of anticipated site conditions as they pertain to the project described herein, and to present design and construction recommendations for the proposed structure.

1.2 Project Description

The project consists of replacement of a single span reinforced concrete slab bridge on closed abutments (existing SN 041-0035) with a new triple barrel box culvert located at Illinois 37 (Station 286+61) over an Unnamed Stream in Jefferson County, Illinois.

The general location of the proposed structure is shown on a Location Map, Exhibit A. The project is located north of Bonnie, Illinois on State Route 37. The site lies within the limits of the Third Principal Meridian (T. 3S, R. 3E, Section 32) within the Mt. Vernon Hill Country of the Till Plains Section of the Central Lowland Province.

1.3 Proposed Structure Information

The proposed structure will consist of a triple barrel box culvert with cantilever wingwalls. The proposed structure will be built perpendicular to IL Route 3 and will provide two 11-foot lanes with 8-foot shoulders, and strong post guardrails. The proposed culvert centerline station will be 286+61. The culvert will consist of three 10-foot by 9-foot barrels, and will measure 56 ft. – 0 in. out-to-out of headwalls. A Type, Size, and Location Plan (TS&L) is included in Exhibit B. Channel protection is recommended by placing Class A4 stone riprap at both ends of the culvert.

Further substructure details will be based on the findings of this SGR.

2.0 Site Investigation, Subsurface Exploration and Generalized Subsurface Conditions

The site exploration plan was developed and completed by IDOT. Two standard penetration test (SPT) borings, designated 1-S and 2-S were drilled on October 28 and 29, 2013. Boring 1-S was located at Station 286+21, and was offset 13 ft. left of centerline. Boring 2-S was located at Station 286+84, and was offset 13 ft. right of centerline. Detailed information regarding the nature and thickness of the soils encountered and the results of the field sampling and laboratory testing are shown on the Boring Logs in Exhibit C. The soil profile for the above mentioned borings can be found in Exhibit D, Subsurface Profile.

2.1 Subsurface Conditions

The profile at the boring locations exhibited layers of various loams and clays, overlying a clay shale bedrock. Isolated sand pockets and lenses were encountered approximately 35 ft. below the ground surface. The borings were terminated between El. 366.5 (1-S) and El. 378.8 (2-S). In general, the stratigraphy is as follows:

Silty Clay Loam/Silt
Loam –

The borings encountered a silty clay loam to silty loam material from the Ground Surface Elevation (GSE) (421.5) to an approximate elevation of 399.5. The driving resistance (N-value) ranged from the weight of hammer (WH) to 6 blows per foot (bpf), with unconfined compressive strengths (Q_u) between from 1 to 5 tons per square foot (tsf) at 13' deep. The moisture contents varied from 21 to 27 percent..

Clay to Clay Loam –

In boring 1-S the clay loam/clay layer extends from El. 399.5 to approximately El. 382.0. The N-values ranged from 3 to 35 bpf, with Q_u values between 0.8 to 5.0 tsf at 3.3' deep. The moisture content varied from 13 to 19 percent. Isolated sand pockets, sand lenses, and coal was encountered below El. 387.0. In Boring 2-S the clay loam/clay layer extends from El. 399.3 to approximately El. 379.3. The N-values ranged from 11 to 57 bpf with Q_u values between 1.7 to 8.2 tsf. The moisture contents varied from 9 to 17 percent. Sand pockets, sand layers, broken sandstone fragments, and weathered clay shale were encountered below elevation El. 386.8. In both borings, the clay loam/clay material is transitioning into a weathered shale material and strengthening with depth.

Clay Shale –

Below approximately El. 379.0 a clay shale material was encountered with blow counts ranging from 100 blows per 12 inches of penetration to 100 blows per 2 inches of penetration. Generally, the strength of the shale appears to be increasing with depth.

2.2 Bedrock

A clay shale bedrock was encountered at El. 378.5 (1-S) and El. 379.3 (2-S).

2.3 Groundwater

Groundwater was encountered in the borings at El. 400.9 (1-S) and El. 400.3 (2-S). Surface water was noted at El. 409.7, and the stream bed appears to be between El. 408.0 to El. 407.8. It should be noted that the groundwater level is subject to seasonal and climatic variations. In addition, without extended periods of observation, measurement of true groundwater levels may not be possible.

3.0 Geotechnical Evaluations

3.1 Settlement

Due to the presence of soft soils in the vicinity of the proposed upstream (El. 407.98) and downstream (El. 407.77) inverts and the possibility of remaining materials from the existing structure, KEG recommends overexcavation of the soils to a depth a El. 404.0 and the construction of a working platform. The working platform should be at minimum 3.5 ft. thick and constructed of a 3-inch granular material. A geotextile fabric should be placed at the bottom of the granular material to limit migration of the soft underlying soils.

Since no significant grading or changes to the existing roadway elevations are anticipated for the proposed structure and the soil characteristics as detailed in the borings provided; it is estimated

that with proper preparation and construction of the working platform, the culvert will experience settlements of less than 0.5 inches. Therefore, no settlement calculations were performed for the proposed structure. It should be noted, that differential settlement may be a concern if any portion of the existing structure is not removed prior to construction of the working platform.

3.2 Slope Stability

A stability analysis using SLOPE/W was performed using the proposed roadway and culvert geometry on the TS&L and soil characteristics from Boring 1-S and 2-S. Two conditions were modeled: End-of-Construction (Undrained) and Long-Term (Drained). A critical factor of safety (FOS) was calculated for each condition. According to current standard of practice, the target FOS is 1.5 for End-of-Construction and Long-Term slope stability. The slope stability analyses indicated that the required minimum FOS for all conditions were met.

In order to model the End-of-Construction condition, full cohesion and a friction angle of 0 degrees were assumed. Nominal values for cohesion were used with full friction angle to model the Long-Term condition to analyze the theoretical condition where pore water pressure has dissipated. Nominal values were 50 to 250 psf for the cohesive soils, and friction angles were 26 degrees.

The Bishop Circular Method, which generates circular-shaped failure surfaces, was used to calculate the critical failure surfaces and FOS for the proposed conditions. The FOS obtained in the analysis is shown in Table 3.2. SLOPE/W program output from this analysis can be found in Exhibit E, SLOPE/W Slope Stability Analysis.

Table 3.2 – Slope Stability Critical FOS

Culvert Wingwall Sideslope (1V:2H)	FOS
End-of-Construction (Undrained)	2.4
Long Term (Drained)	1.6

3.3 Seismic Considerations

Per the 2015 Geotechnical Manual, seismic parameters are not required for buried structures, including box culverts.

3.4 Scour

The approximate elevation at the upstream invert (TS&L, Exhibit B) is El. 407.98, and at the downstream invert is El. 407.77. Class A4 stone riprap will be placed on the upstream and downstream ends of the triple box culvert to reduce the potential for future scour.

3.5 Mining Activity

According to the Illinois State Geological Survey (ISGS) website, and the coal mines and industrial mineral mines map for Jefferson County, Illinois, dated July 20, 2018; there are no historical or active mines in the vicinity of the project.

4.0 Foundation Evaluations and Design Recommendations

4.1 Bearing Resistance

The soil encountered in the borings at the anticipated bearing elevation of the culvert and working platform consist of a soft to medium-stiff silty clay loam material. The assumed bearing elevation at the bottom of the recommended construction platform is El. 404.0. The soil characteristics from Borings 1-S and 2-S at the assumed bearing elevation has an N-value of 3 bpf and a pocket penetrometer value of 0.4 tsf. The calculated allowable bearing resistance, using a Bearing Resistance Factor of 0.5, at the approximate bottom elevation of the working platform (El. 404.0); is estimated to be 1,480 psf. The applied bearing pressure from the culvert, including wingwalls, is estimated to be 479 psf.

If after final design the bearing elevation changes, KEG should be informed to assure that the above information is still accurate.

4.2 Box Culvert

Varying depths of existing stream bed will require excavation and removal to reach the proposed bottom elevation (El. 404.0) of the box culvert working platform. Typically, excavations to these depths will result in suitable bearing soils for construction. However, care during excavation must be taken to prevent disturbing the bearing surface soils. If the foundation soils are disturbed or soft pockets of material are encountered during construction, they must be removed and replaced. Due to the groundwater elevation during drilling, dewatering efforts may be required during excavation and construction.

In accordance with the IDOT Culvert Manual (Section 2.2.2), a pre-cast box culvert alternative is feasible at this site. However, the geometric limitations on the use of a pre-cast culvert alternative must be verified by the designers.

5.0 Construction Considerations

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 assumed by KEG change, KEG should be contacted to determine if the recommendations stated in this report still apply.

5.2 Temporary Sheet piling and Soil Retention

Temporary Soil Retention Systems will be required versus Cantilevered Sheet Piling, due to hard driving due to the depth to bedrock. An Illinois-licensed Structural Engineer is required to seal the design of Temporary Soil Retention Systems, if deemed necessary.

5.3 Site and Soil Conditions

Provisions of the Standard Specifications should adequately address site and soil conditions.

6.0 Computations

Computations and analyses for special circumstances, if any, are included as Exhibits. Please refer to each section of the report for reference to the Exhibit containing any such calculations or analysis used.

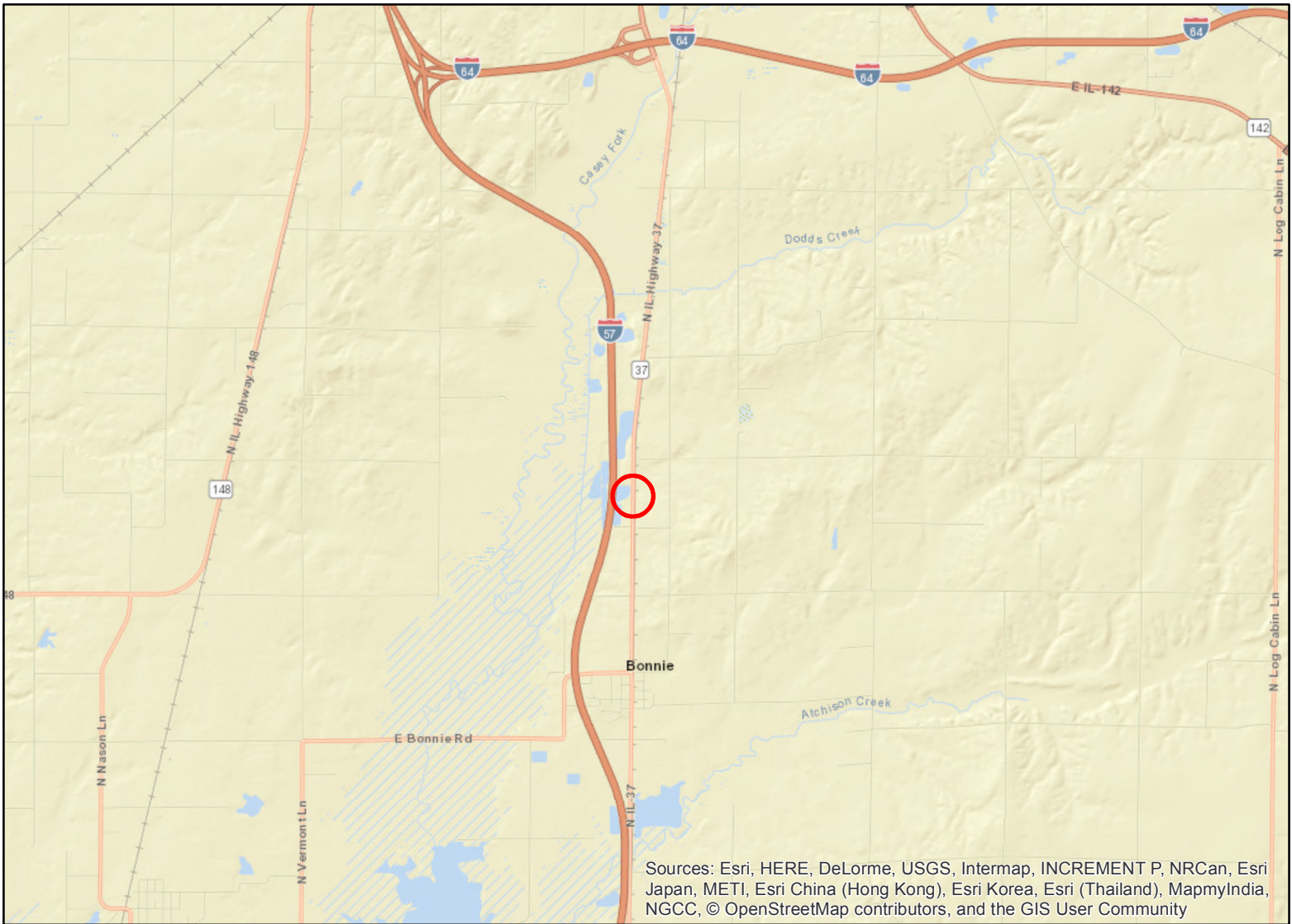
7.0 Geotechnical Data

The soil boring log can be found in Exhibit C. The Subsurface Profile can be found in Exhibit D.

8.0 Limitations

The recommendations provided herein are for the exclusive use of Veenstra & Kimm, Inc. and the Illinois Department of Transportation (IDOT). They are specific only to the project described and are based on the subsurface information obtained by IDOT at two boring locations within the structure area in 2013, KEG's understanding of the project as described herein, and geotechnical engineering practice consistent with the standard of care. No other warranty is expressed or implied. KEG should be contacted if conditions encountered during construction are not consistent with those described.

EXHIBIT A
LOCATION MAP



208 E. Main St., Suite 100
Belleville, Illinois 62220
618.233.5877 phone
618.233.5977 fax
www.kaskaskiaeng.com

PROFESSIONAL REGISTRATIONS
Illinois Professional Design Firm
Professional Engineering Group

LICENSE NO.
184.004773
20-5080586

LOCATION MAP
IL Route 37 over Unnamed Stream
Jefferson County, Illinois

Exhibit No.

A

KEG JOB #17-1095.03

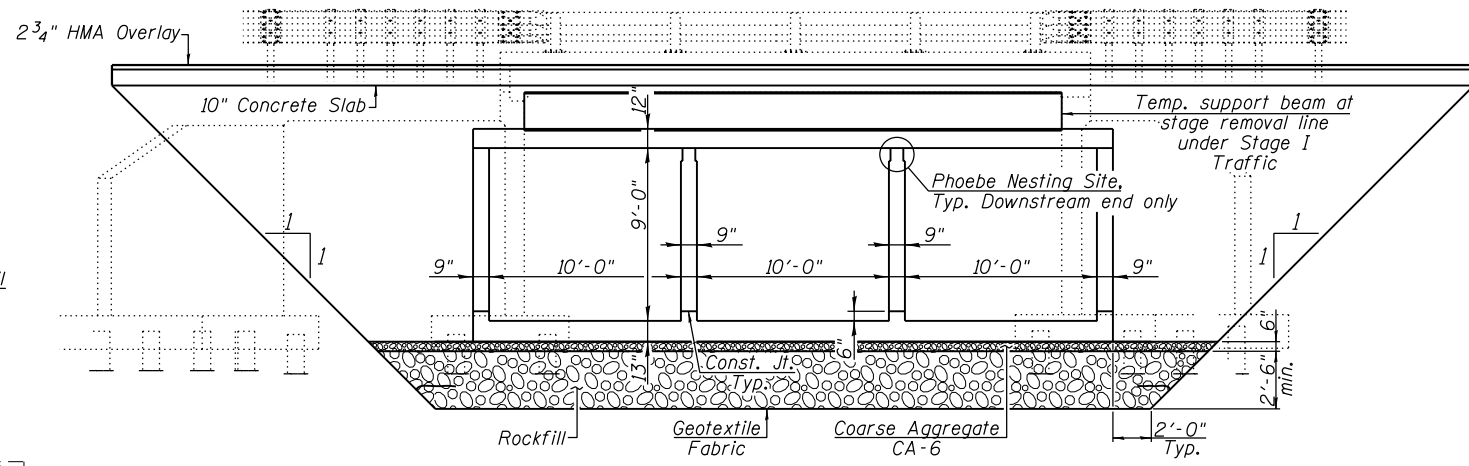
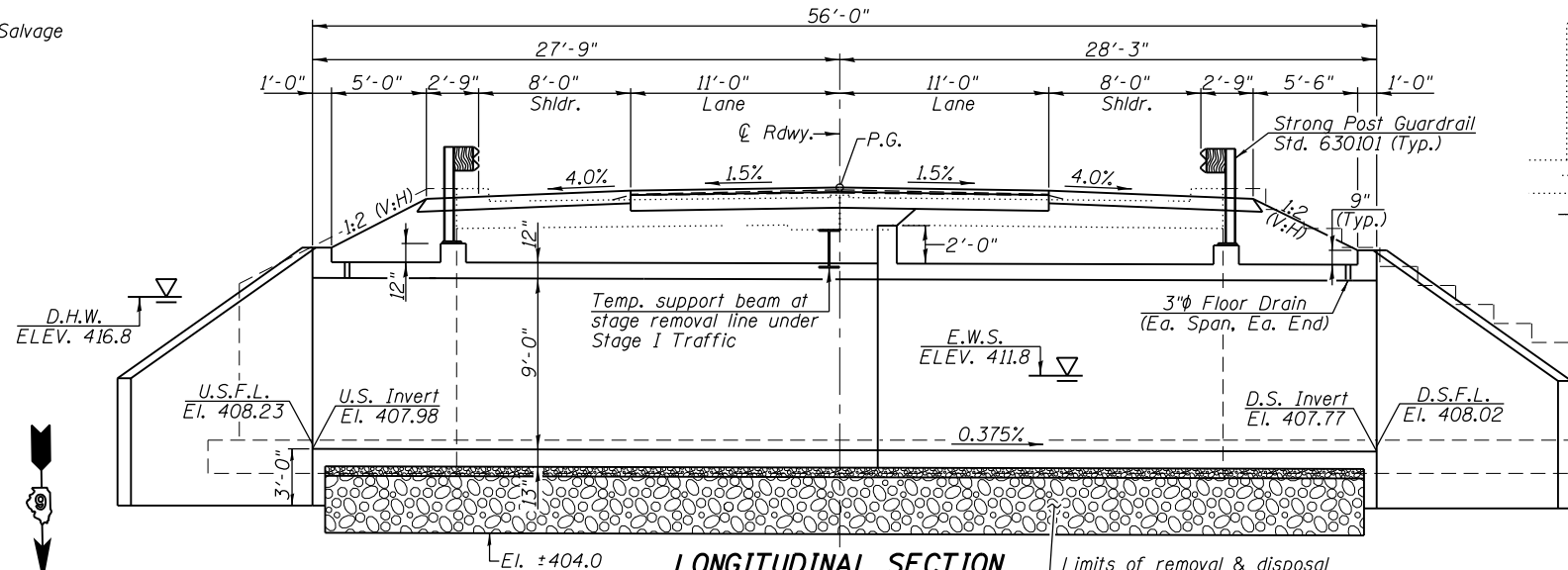
EXHIBIT B
TYPE, SIZE, AND LOCATION PLAN (TS&L)

Bench Mark 410035: Cut square "□" on N.E. wingwall of existing bridge. Elev. 421.59

Existing Structure: Structure No. 041-0035(E) was originally constructed in 1922 under SBI Route 37, Section 1D, as a single span reinforced concrete slab bridge on closed abutments. 30'-9" bk. to bk. of abutments on a 0° skew. Clear width is ±36'-9½" between curbs and overall width of ±40'-4". Traffic to be maintained utilizing Stage Construction.

Precast alternate is not allowed.

No Salvage



WATERWAY INFORMATION

Drainage Area = 1.94 Sq. Mi. Exist. Overtopping Elevation 421.72 @ Sta. 287+05.5
Prop. Overtopping Elevation 421.72 @ Sta. 287+05.5

Flood	Freq. Yr.	Q C.F.S.	Opening Sq. Ft.		Head - Ft.		Headwater El.		
			Exist.	Prop.	H.W.E. Exist.	Prop.	Exist.	Prop.	
Design	10	846	185	225	415.7	0.5	0.0	416.2	415.7
Base	50	1400	216	258	416.8	1.9	1.5	418.7	418.3
OVT(E)	351	2110	308		420.1	1.5		421.6	
OVT(P)	400	2155		270	420.3		1.4		421.7

10-Year Outlet Velocity from Existing Structure = 5.9 fps
10-Year Outlet Velocity from Proposed Structure = 3.7 fps

HIGHWAY CLASSIFICATION

F.A.S. Rte. 2869 - IL Rte. 37
Functional Class: Major Collector (Non-Urban)
ADT: 4000 (2017); 4933 (2038)
ADTT: 430 (2015); 580 (2036)
DHW: 493
Design Speed: 55 m.p.h.
Posted Speed: 55 m.p.h.

LOADING HL 93

Allow 50#/sq. ft. for future wearing surface

DESIGN SPECIFICATIONS

2017 AASHTO LRFD Bridge Design Specifications, 8th Edition.

DESIGN STRESSES

FIELD UNITS

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

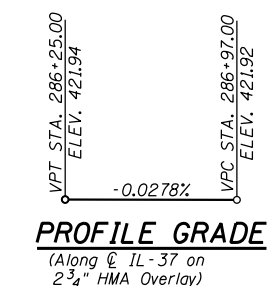
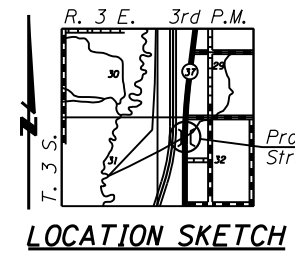
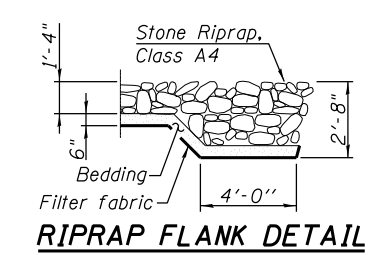
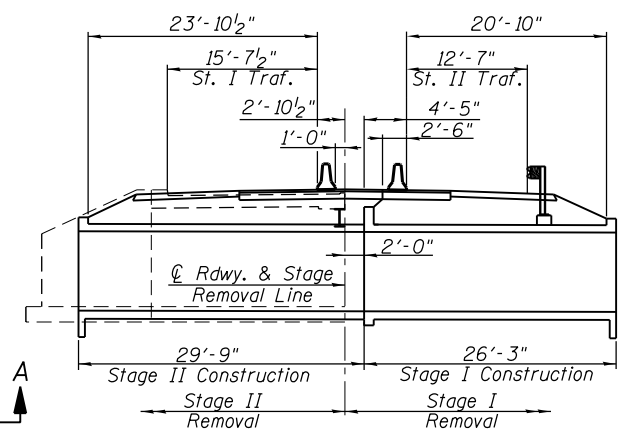
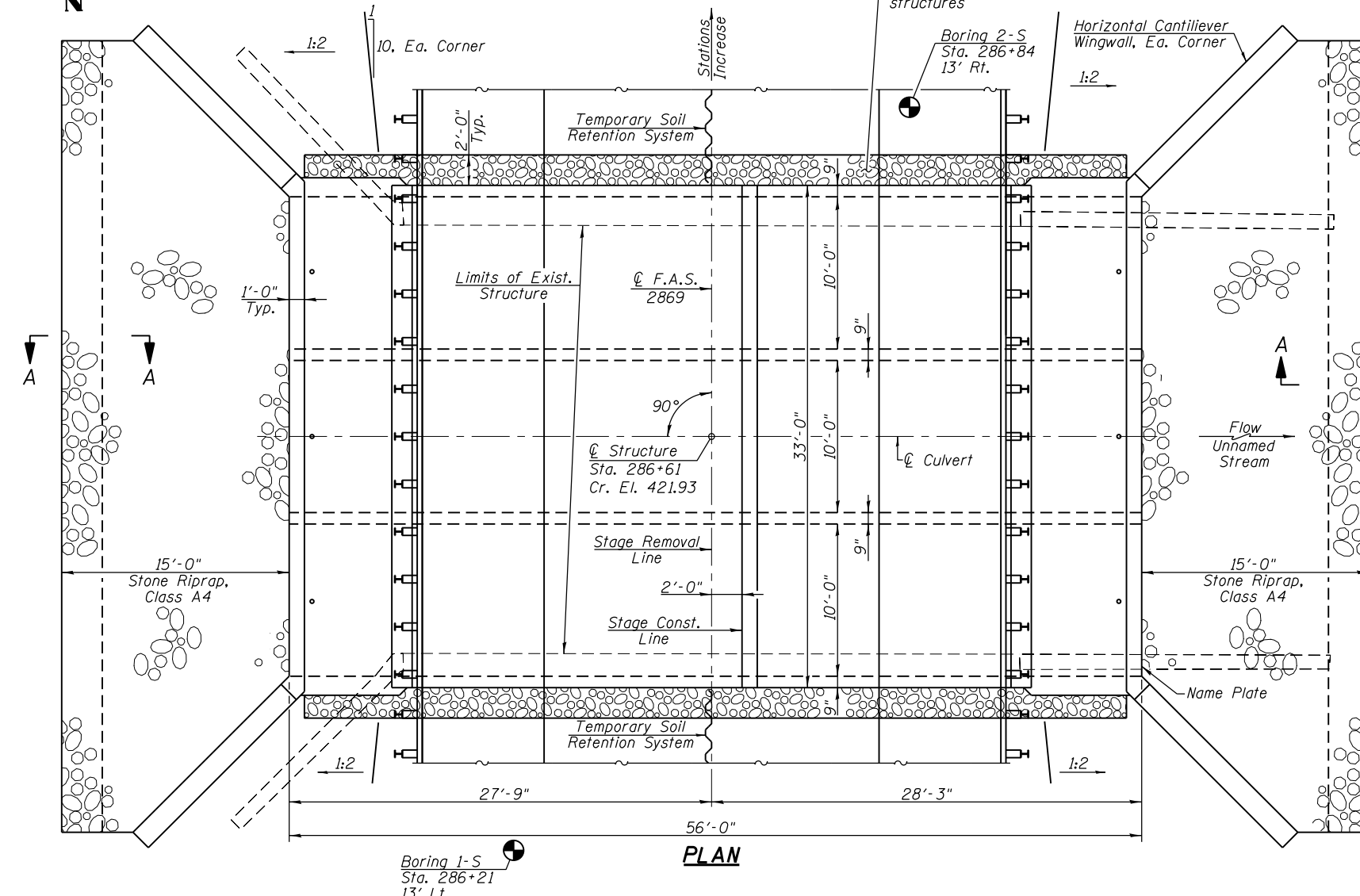
STA. 286+61.00
BUILT 20 BY
STATE OF ILLINOIS
F.A.S. ROUTE 2869
SECTION 1B-1
LOADING HL 93
STR. NO. 041-2022

NAME PLATE

(Standard 515001)

GENERAL PLAN AND ELEVATION

**IL ROUTE 37
OVER UNNAMED STREAM
F.A.S. ROUTE 2869
SECTION 1B-1
JEFFERSON COUNTY
STA. 286+61
STRUCTURE NO. 041-2022**



USER NAME =	DESIGNED -	REVISD -
PLOT SCALE =	CHECKED -	REVISD -
PLOT DATE = 11-15-18	DRAWN -	REVISD -
	CHECKED -	REVISD -

STATE OF ILLINOIS
DEPARTMENT OF TRANSPORTATION

GENERAL PLAN AND ELEVATION
STRUCTURE NO. 041-2022

SHEET NO. 1 OF 1 SHEETS

F.A.S. RTE. 2869	SECTION 1B-1	COUNTY JEFFERSON	TOTAL SHEETS	SHEET NO.
ILLINOIS FED. AID PROJECT			CONTRACT NO. 78520	

EXHIBIT C
BORING LOGS

ILLINOIS DEPARTMENT OF TRANSPORTATION
District Nine Materials

Bridge Foundation
Boring Log

FAS 2869 (IL 37) Over stream

Sheet 1 of 2

Route: FAS 2869 (IL 37) Structure Number: 041-0035

Date: 10/28/2013

Section 1, BY

Bored By: R Moberly

County: Jefferson Location: 1 mi North of Bonnie

Checked By: R Graeff

Boring No	Station	Offset	Ground Surface	DEPTH	BLOWS	Qu tsf	W%	Surf Wat Elev:	DEPTH	BLOWS	Qu tsf	W%
								409.7				
								Ground Water Elevation				
								when Drilling				
								400.9				
								At Completion				
								At:				
								Hrs:				
Crushed aggregate												
	420.5									10	4.1B	14
Medium, very moist, brown mottled grey, Silty Clay Loam A-6					1					16		
					1	0.8S	22			3		
					2					10	4.1B	13
										15		
								392.0				
				5.0	1					30.0	3	
					2	0.9B	24				7	3.5B
					1						10	
	414.5							389.5				
Medium, very moist, grey, Silty Clay Loam to Silt Loam A-4					WH						5	
					WH	0.6B	26				11	5.0S
					WH						15	
				10.0	WH							
					1	0.5B	26			35.0	5	
					1						12	0.8S
											16	
	409.5							384.5				
Stiff, moist, brown mottled grey, Silty Clay Loam A-6					1						8	
					2	1.1S	22				15	2.6S
					4						20	
	407.0							382.0				
Medium, very moist, brown mottled grey, Silty Clay Loam A-6		15.0			1					40.0	5	
					1	0.7B	25				12	1.5S
					3						16	
	404.5											
Soft, very moist, brown mottled grey, Silty Clay Loam A-6					1							
					1	0.4B	22				12	
					2							
	402.0							378.5				
											100/12"	
Medium, very moist, brown, Silty Clay to Silty Clay Loam A-6 with sand seams		20.0			1					45.0	100/4"	
					1	0.7B	24					
					2							
	399.5											
Stiff, moist, brown mottled grey, Clay to Clay Loam A7-6 with sand seams					1							
					1	1.1B	19					
					2							
	397.0											
				25.0	3					50.0	100/3"	

N-Std Pentr Test: 2" OD Sampler, 140# Hammer, 30" Fall (Type Fail. B-Bulge S-Shear E-Estimated P-Penetrometer)

ILLINOIS DEPARTMENT OF TRANSPORTATION
District Nine Materials

Bridge Foundation
Boring Log

FAS 2869 (IL 37) Over stream

Sheet 1 of 1

Route: FAS 2869 (IL 37) Structure Number: 041-0035

Date: 10/29/2013

Section 1, BY _____

Bored By: R Moberly

County: Jefferson

Location: 1 mi North of Bonnie

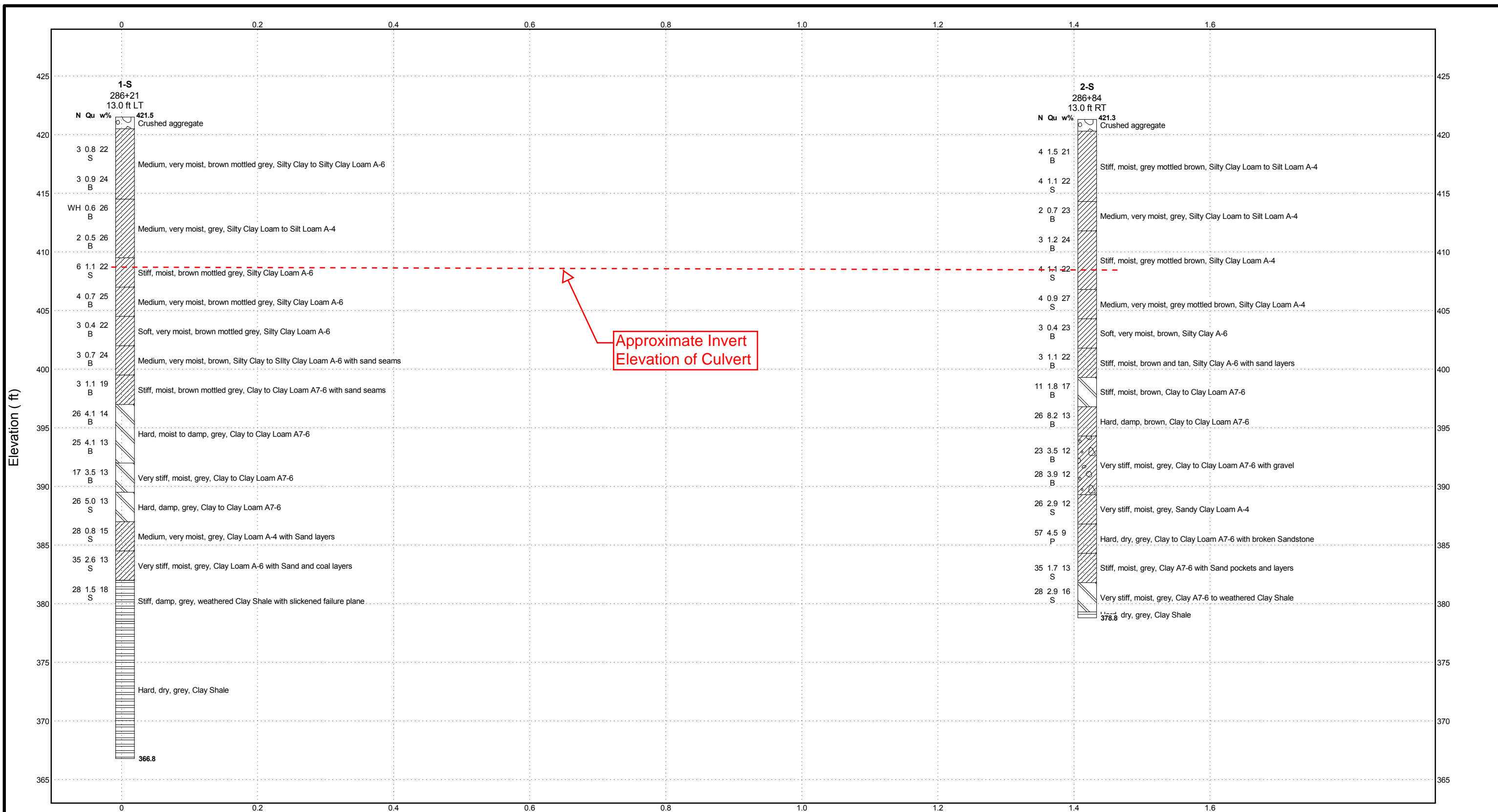
Checked By: R Graeff

Boring No	Station	Offset	Ground Surface	DEPTH	BLOWS	Qu tsf	W%	Surf Wat Elev:	DEPTH	BLOWS	Qu tsf	W%
								409.7				
								Ground Water Elevation				
								when Drilling				
								400.3				
								At Completion				
								At:				
								Hrs:				
Crushed aggregate												
	420.3									11	8.2B	13
Stiff, moist, grey mottled brown, Silty Clay Loam to Silt Loam A-4										15		
								394.3				
					1					3		
					2	1.5B	21			9	3.5B	12
					2					14		
				5.0	1				30.0	2		
					2	1.1S	22			12	3.9B	12
					2					16		
	414.3							389.3				
Medium, very moist, grey, Silty Clay Loam to Silt Loam A-4					1					5		
					1	0.7B	23			11	2.9S	12
					1					15		
	411.8							386.8				
Stiff, moist, grey mottled brown, Silty Clay Loam A-4		10.0			1				35.0	14		
					1	1.2B	24			27	4.5P	9
					2					30		
								384.3				
					1					3		
					2	1.1S	22			16	1.7S	13
					2					19		
	406.8							381.8				
Medium, very moist, grey mottled brown, Silty Clay Loam A-4		15.0			1				40.0	5		
					2	0.9B	27			12	2.9S	16
					2					16		
	404.3							379.3				
Soft, very moist, brown, Silty Clay A-6					1					100/6"		
					1	0.4B	23					
					2							
	401.8											
Stiff, moist, brown and tan, Silty Clay A-6 with sand layers		20.0			1				45.0			
					1	1.1B	22					
					2							
	399.3											
Stiff, moist, brown, Clay to Clay Loam A7-6					1							
					4	1.8B	17					
					7							
	396.8											
	25.0				3				50.0			

N-Std Pentr Test: 2" OD Sampler, 140# Hammer, 30" Fall (Type Fail. B-Bulge S-Shear E-Estimated P-Penetrometer)

EXHIBIT D
SUBSURFACE PROFILE

PRINTERMOD2 11X17 17-1095.03 IL 37 OVER UNNAMED 2018.GPJ IL_DOT.GDT 9/10/18

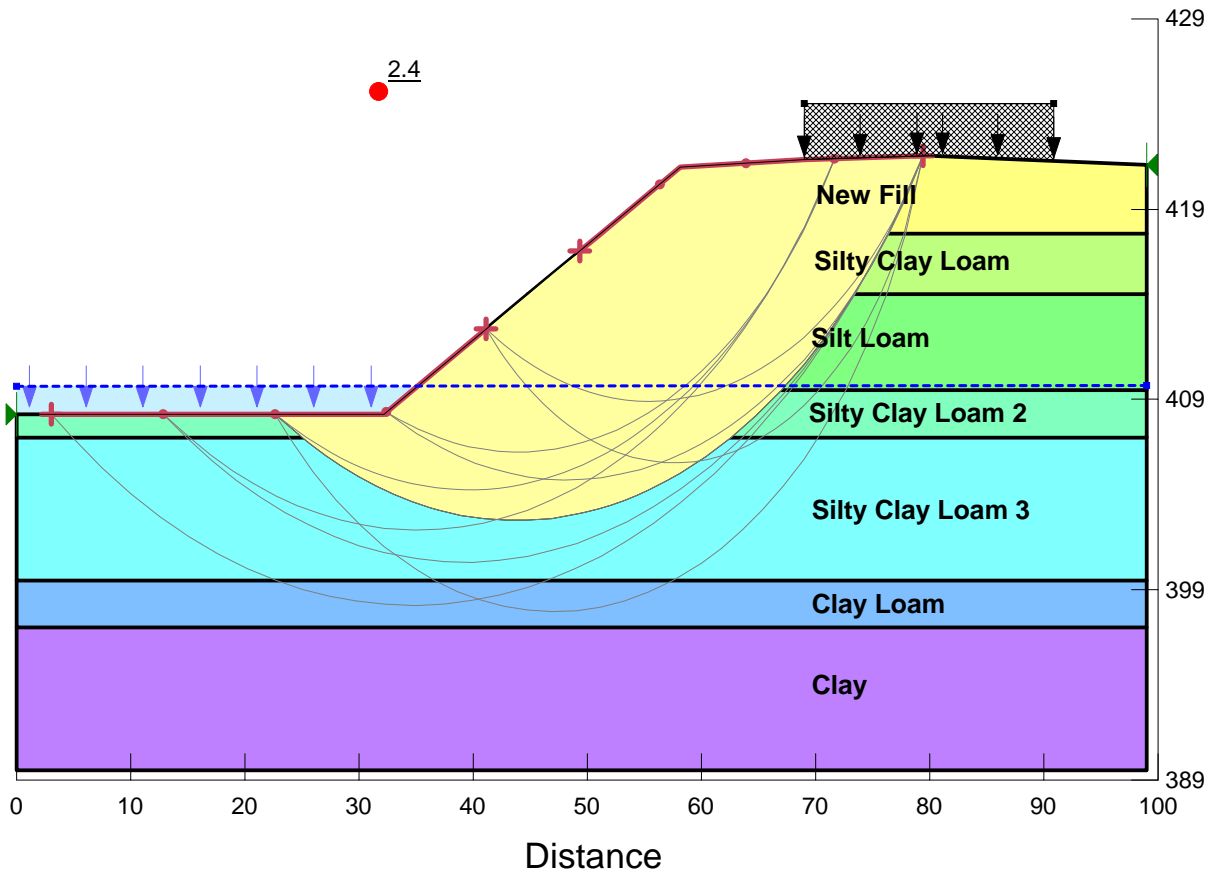


SUBSURFACE PROFILE

Route: F.A.S. 2869 (IL 37)
 Section: 1B-1
 County: Jefferson

EXHIBIT E
SLOPE/W SLOPE STABILITY ANALYSIS

**IL 37 over Unnamed Stream
Culvert Side-slope Boring 1-S
End-of-Construction (Undrained)**



Model: Mohr-Coulomb
Unit Weight: 125 pcf
Cohesion': 1,500 psf
Phi': 0 °
Piezometric Line: 1

Name: Silty Clay Loam
Model: Mohr-Coulomb
Unit Weight: 110 pcf
Cohesion': 900 psf
Phi': 0 °
Piezometric Line: 1

Name: Silt Loam
Model: Mohr-Coulomb
Unit Weight: 105 pcf
Cohesion': 500 psf
Phi': 0 °
Piezometric Line: 1

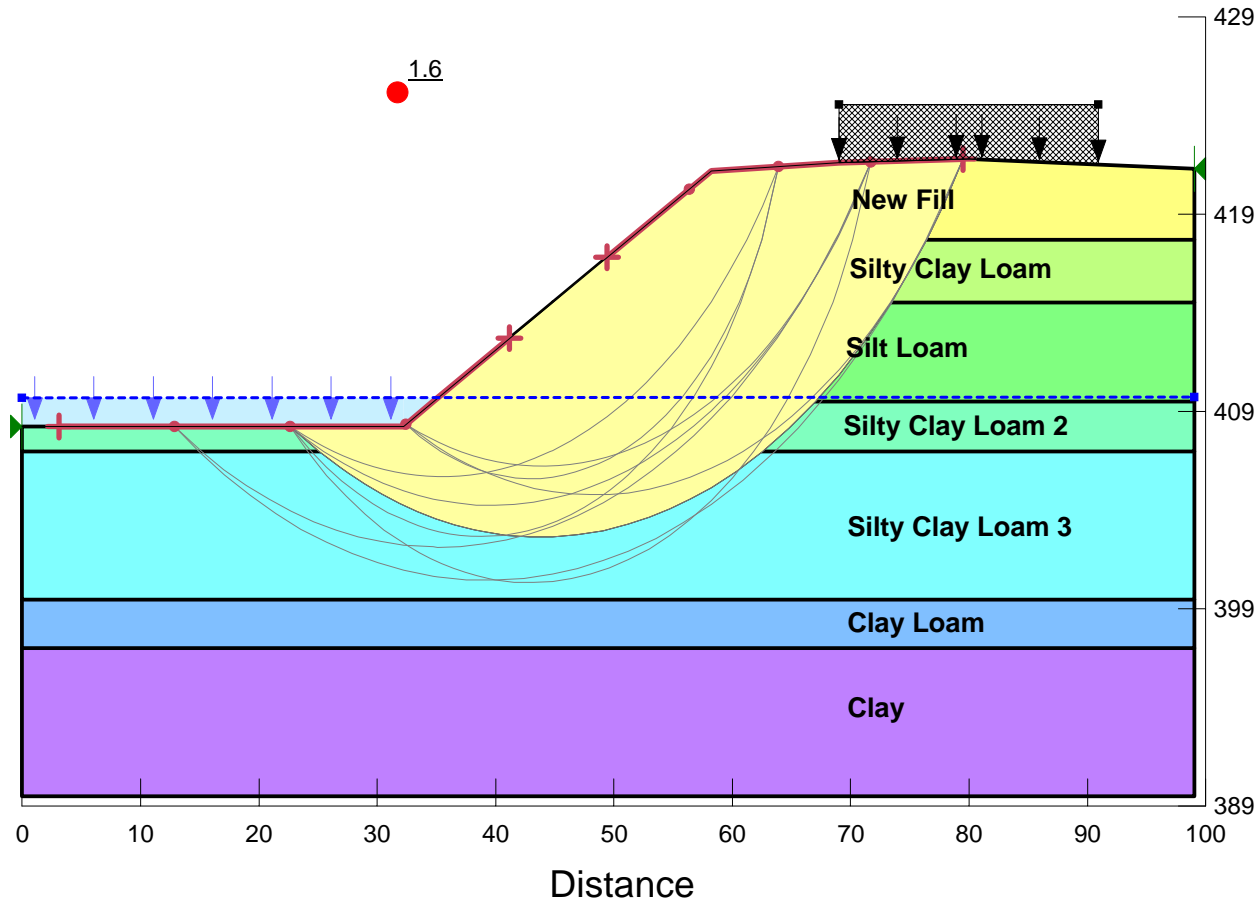
Name: Silty Clay Loam 2
Model: Mohr-Coulomb
Unit Weight: 110 pcf
Cohesion': 1,100 psf
Phi': 0 °
Piezometric Line: 1

Name: Silty Clay Loam 3
Model: Mohr-Coulomb
Unit Weight: 110 pcf
Cohesion': 600 psf
Phi': 0 °
Piezometric Line: 1

Name: Clay Loam
Model: Mohr-Coulomb
Unit Weight: 105 pcf
Cohesion': 1,100 psf
Phi': 0 °
Piezometric Line: 1

Name: Clay
Model: Mohr-Coulomb
Unit Weight: 125 pcf
Cohesion': 3,900 psf
Phi': 0 °
Piezometric Line: 1

**IL 37 over Unnamed Stream
Culvert Side-slope Boring 1-S
Long Term (Drained)**



Name: New Fill
Model: Mohr-Coulomb
Unit Weight: 125 pcf
Cohesion': 250 psf
Phi': 26 °
Piezometric Line: 1

Name: Silty Clay Loam
Model: Mohr-Coulomb
Unit Weight: 110 pcf
Cohesion': 100 psf
Phi': 26 °
Piezometric Line: 1

Name: Silt Loam
Model: Mohr-Coulomb
Unit Weight: 105 pcf
Cohesion': 50 psf
Phi': 26 °
Piezometric Line: 1

Name: Silty Clay Loam 2
Model: Mohr-Coulomb
Unit Weight: 110 pcf
Cohesion': 150 psf
Phi': 26 °
Piezometric Line: 1

Name: Silty Clay Loam 3
Model: Mohr-Coulomb
Unit Weight: 110 pcf
Cohesion': 50 psf
Phi': 26 °
Piezometric Line: 1

Name: Clay Loam
Model: Mohr-Coulomb
Unit Weight: 105 pcf
Cohesion': 150 psf
Phi': 26 °
Piezometric Line: 1

Name: Clay
Model: Mohr-Coulomb
Unit Weight: 125 pcf
Cohesion': 250 psf
Phi': 26 °
Piezometric Line: 1