STRUCTURE GEOTECHNICAL REPORT

IL 14 over Bear Creek

Existing S.N. 033-0004
Proposed S.N. 033-2014

F.A.P. RTE. 853
SECTION 9B-1
HAMILTON COUNTY, ILLINOIS
JOB NO. D-99-071-18
CONTRACT NO. 78830
PTB 196-062 WO#9
KEG NO. 20-1109.06

07-17-2023
Exp 11/30/2023

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November 11, 2022
REVISED July 17, 2023

Kaskaskia Engineering Group, LLC

TABLE OF CONTENTS

EXHIBITS

1.0 Project Description and Scope

1.1 Introduction

The geotechnical study summarized in this report was performed by Kaskaskia Engineering Group, LLC (KEG) for the proposed triple box culvert at IL 14 over Bear Creek, located in Hamilton 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 present design and construction recommendations for the proposed structure.

1.2 Project Description

The project consists of the replacement of the existing single-span reinforced concrete slab bridge (SN 033-0004) located at IL 14 over Bear Creek. The existing structure is supported on closed abutments on spread footings. The bridge is 26'-0" long back-to-back abutments and has an out-to-out width of 40'-4".

The general location of the bridge is shown on the Location Map, Exhibit A. The project is located approximately 170 ft east of the Hamilton County Fair Grounds entrance. The site lies within the Mt. Vernon Hill Country of the Till Plains Section of the Central Lowland Province.

1.3 Proposed Structure Information

The proposed structure (SN 033-2014) will consist of a triple box culvert. The individual boxes will each measure 10' (Span) x 7' (Height). The structure will measure 32'-8" wide, and 45'-0" out-to-out headwalls. The culvert will provide two 12'-6" traffic lanes with 6'-0" paved outside shoulders and guardrails attached to the culvert. The centerline of the structure will be located at Station 196+56.25 (F.A.P. RTE. 853). Further substructure details will be based on the findings of this SGR. A Type, Size, and Location Plan (TS&L) is included in Exhibit B.

2.0 Field Exploration

2.1 Subsurface Exploration and Testing

The site investigation plan was developed and completed by Illinois Department of Transportation (IDOT) District 9 geotechnical personnel. A representative of Kaskaskia Engineering Group, LLC (KEG) did not conduct a site visit or observe the drilling operations.

Two (2) standard penetration test (SPT) borings, designated 1-S and 2-S, were drilled on May 14 and 15, 2021. Table 2.1.1 shows the borings stationing, offset and surface elevation. The boring locations are shown on the TS&L in Exhibit B. 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, Exhibit C. The soil profile for the above-mentioned borings can be found in Subsurface Profile, Exhibit D.

Table 2.1.1 - Boring Stations and Offsets

Designation	Stationing	Offset (ft.)	Surface Elevation (ft.)
1-S	196+75	12 RT	423.4
2-S	196+15	12 LT	423.1

2.2 Subsurface Conditions

The profiles at the two (2) boring locations exhibited layers of silty clay, silty clay loam, and sandstone. In both borings, a 10.5" layer of asphalt was encountered. Bedrock was also encountered in both borings at approximately 17 ft. below Ground Surface Elevation (GSE). The bedrock consisted of weathered sandstone until 19.5 ft, where it became more competent and increased its hardness.

N-values in the silty clay layers typically ranged from 0 to 10 blows per foot (bpf), with field Rimac (Qu) strength values ranging from 0.1 to 2.1 tons per square foot (tsf) and moisture contents of 17 to 32 percent. N-values in the silty clay loam layers ranged from 1 to 8 blows per foot (bpf), with field Rimac (Qu) strength values ranging from 0.1 to 0.7 tons per square foot (tsf) and moisture contents of 19 to 25 percent.

2.3 Groundwater

Groundwater was encountered in both borings. Table 2.3.1 shows the elevation that groundwater was encountered during drilling. A surface water elevation was also noted at El. 414.7 for Bear Creek at the time of drilling both borings. 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.

Table 2.3.1 - Groundwater Elevations

Boring	Stationing	Offset (ft.)	Elevation During drilling (ft.)
1-S	196+75	12.0 RT	403.9
2-S	196+15	12.0 LT	410.6

3.0 Geotechnical Evaluations

3.1 Settlement

Although the existing soils of the existing approach embankment have most likely consolidated over time, the proposed new structure will result in potential settlements during construction and after completion. Both borings (1-S and 2-S) were utilized for the settlement analysis. Specific consolidation testing was not completed, and empirical methods were used to estimate the settlement. The empirical methods estimated that the soils encountered were normally consolidated. The settlement for the west side (Boring 1-S) and east side (Boring 2-S) of the culvert was calculated to be 1.8- and 2.4-inches., respectively, giving a differential settlement of 0.6 inches. These results are based on approaches using empirical values including that the clays are normally consolidated; thus, the settlements are expected to be less than estimated in this report. The calculations are attached as Exhibit E - Settlement Calculations.

KEG recommends removing the overburden soils to elevation 410.0 and replacing with crushed stone for a working platform to support the culvert and the wing walls as a preventive solution. If

the culvert subgrade soils are observed during excavation of the culvert and appear to be stiff and capable of the recommended bearing pressures as recommended in this report, then they can remain in-place, or the recommended removal and replacement to elevation 410.0 reduced in thickness.

3.2 Slope Stability

The proposed structure will result in culvert wingwall side-slopes with inclinations of 1 Vertical to 2 Horizontal (1V:2H). Slope stability of the west side-slope and of the east side-slope were analyzed using SLOPE-W, the soil properties of 1-S and 2-S, and the side-slope geometrics. Two conditions were modeled: end-of-construction and long-term. A critical factor of safety (FOS) was calculated for each condition. According to the current standard of practice, the target FOS is 1.5 for end-of-construction and long-term slope stability.

In order to model the end-of-construction condition, undrained soil parameters were used and assumed a friction angle of 0 degrees for cohesive soils. The long-term condition used drained soil parameters and assumed friction angles ranging from 12 to 45 degrees to analyze where excess pore water pressure from construction has dissipated. For cohesive materials, a nominal cohesion value between 50 and 100 psf was included in the drained strength parameters. The Modified Bishop Method, which generates circular-arc failure surfaces, was used to calculate the critical failure surfaces and FOS for the analyzed conditions. The FOS obtained in the analysis is shown in Table 3.2.1 Slope Stability Critical FOS. The program output from this analysis can be found in SLOPE-W Stability Analysis, Exhibit F.

Table 3.2.1 - Slope Stability Critical FOS

Location	Reference Boring	End-of-Construction (Undrained)	Long-Term (Drained)
West of Culvert - Downstream	1-S	3.1	1.9
West of Culvert - Upstream	1-S	2.4	1.5
East of Culvert - Downstream	2-S	2.8	1.9
East of Culvert - Upstream	2-S	5.4	1.8

The results of the analysis, as provided in Table 3.2.1, indicate an acceptable FOS will exist under undrained and drained conditions at all locations.

3.3 Seismic Considerations

Per the 2020 Geotechnical Manual, seismic parameters are not required for buried structures, including box culverts.

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 consists of a silty clay loam material. The assumed bearing elevation at the bottom of the culvert is El. 411+/- ft. The soil from Boring 1-S at the approximate bearing elevation has an N-value of 8 bpf and a UCS of 0.7 tsf. The calculated allowable bearing resistance, using a Factor of Safety of 3, at the approximate bottom elevation of the culvert (El. 411), is estimated to be 1,450 psf. Sliding resistance is calculated as the lessor of the cohesion or one half of the vertical stress. See Exhibit G for calculations performed.

Table 4.1.1 – Factored Bearing and Sliding Resistances

Substructure Unit	Allow. Bearing Resistance (psf)	Sliding Resistance (psf)
Culvert	1,450	700

If after final design the bearing elevation changes, KEG should be informed to review that the above recommendations still apply.

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.

It is recommended that the existing structure be completely removed within 2 feet of the proposed culvert barrel and wingwall footprints and backfilled with rock fill.

5.2 Temporary Sheeting and Soil Retention

Temporary shoring may be required at various stages of this project, due to the proposed staged-construction layout shown in the TS&L. Temporary sheet piling methods are not feasible due to the depth to bedrock below the proposed structure.

Therefore, a Temporary Soil Retention System is required to support the structure during construction. An Illinois-licensed Structural Engineer is required to design and seal the design of the Temporary Soil Retention System, 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

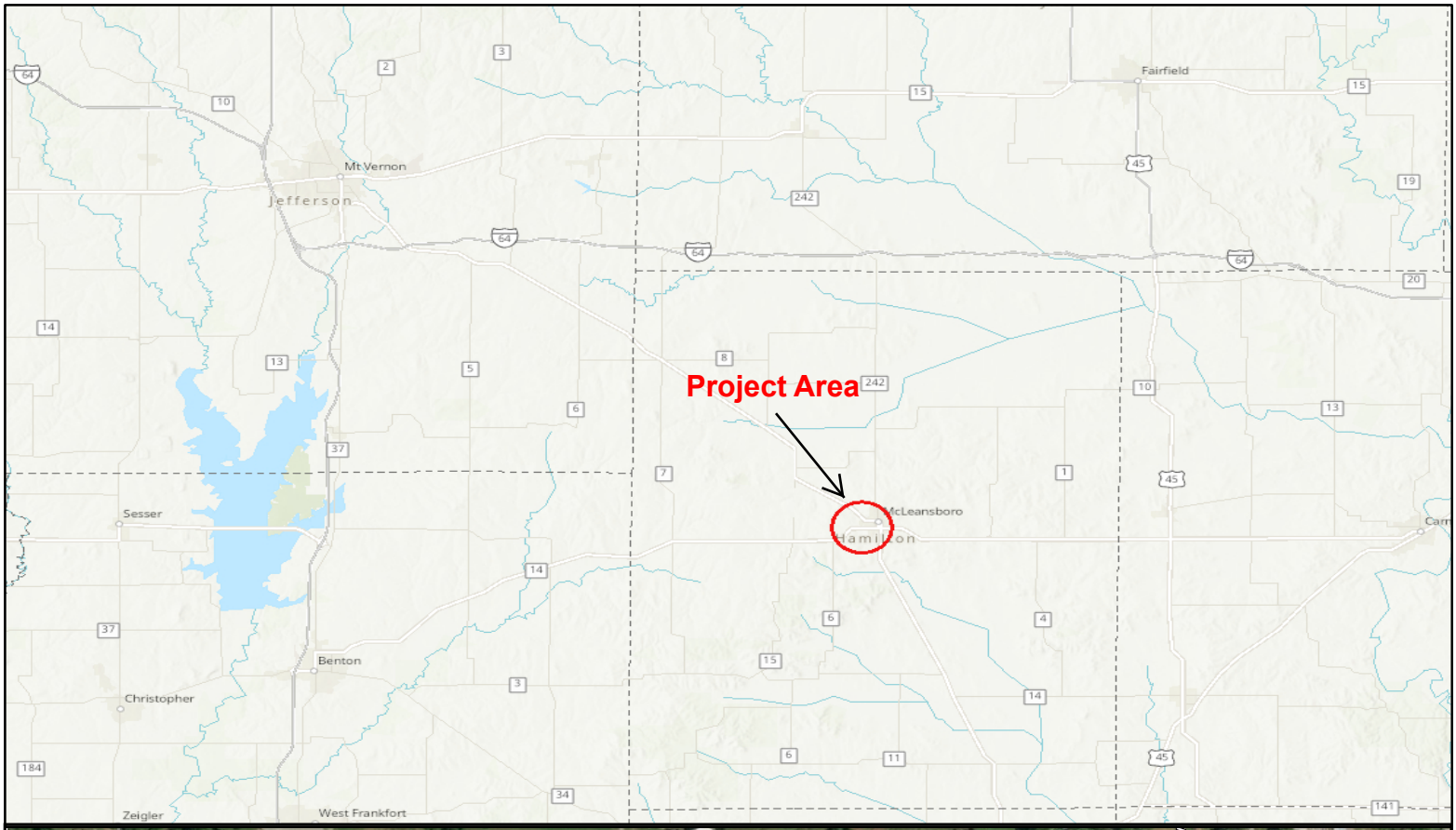
Soil boring logs can be found in Exhibit C. The Subsurface Profile can be found in Exhibit D.

8.0 Limitations

The recommendations provided herein are for the exclusive use of ESCA Consultants Inc. and the Illinois Department of Transportation (IDOT). They are specific only to the project described and are based on the subsurface information provided to KEG at the two boring locations within the structure area, 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



Kaskaskia Engineering Group, LLC

LOCATION MAP

IL 14 over Bear Creek
Hamilton County, Illinois

Exhibit No.

A

KEG JOB #20-1109.06

EXHIBIT B

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

BENCHMARK: BM0619 – Chiseled "□" on the top of southeast wingwall of SN 033-0004, elev. 423.633 (NAVD 88)

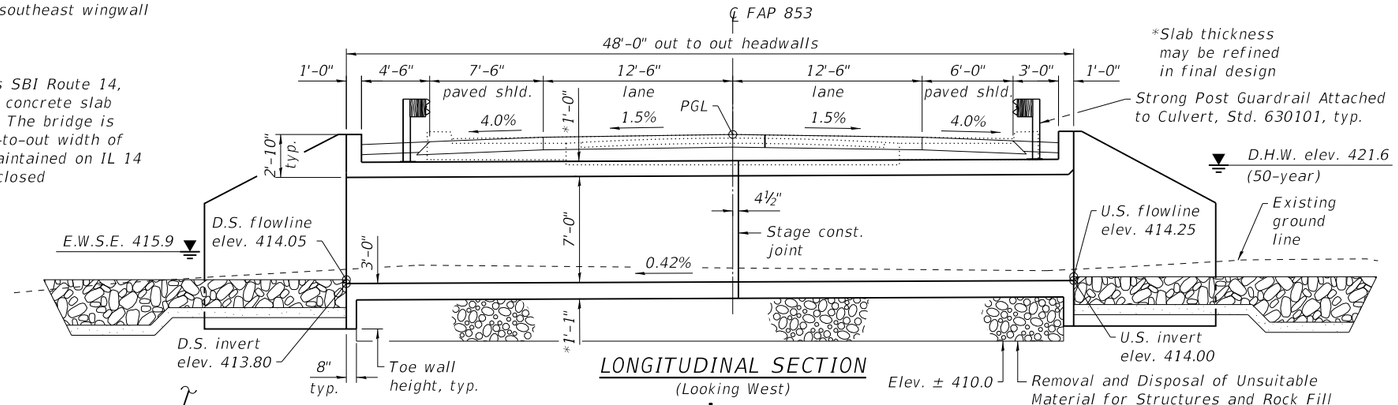
EXISTING STRUCTURE:
SN 033-0004 was originally constructed in 1923 as SBI Route 14, Section 9B. The bridge is a single-span reinforced concrete slab supported on closed abutments on spread footings. The bridge is 26'-0" long back-to-back abutments and has an out-to-out width of 40'-4". The bridge is not skewed. Traffic will be maintained on IL 14 using stage construction. Fairground Road will be closed during construction,

No salvage.

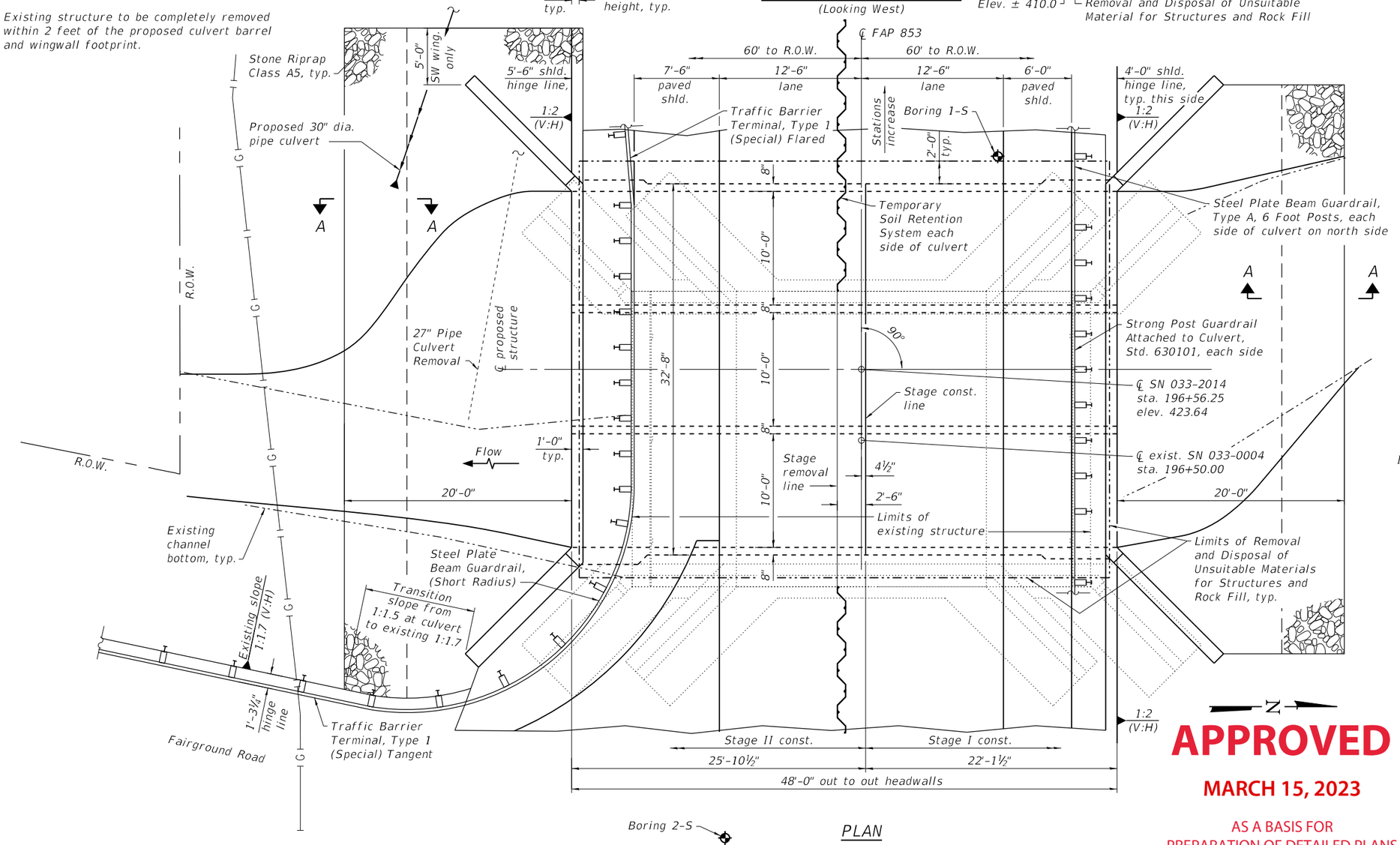
Precast alternate is not allowed.

Excavation behind existing abutment walls shall be performed to balance front and back soil pressure before removing the existing superstructure.

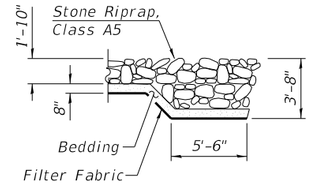
Existing structure to be completely removed within 2 feet of the proposed culvert barrel and wingwall footprint.



LONGITUDINAL SECTION
(Looking West)



PLAN



SECTION A-A

HIGHWAY CLASSIFICATION

FAP 853 (IL 14)
Functional Class: Minor Arterial
ADT: 4220 (2022) / 5150 (2042)
DHV: 465 (2042)
ADTT: 260 (2022) / 315 (2042)
Design Speed: 45 mph
Posted Speed: 45 mph
Two-Way Traffic
Directional Distribution: 50:50

LOADING HL-93

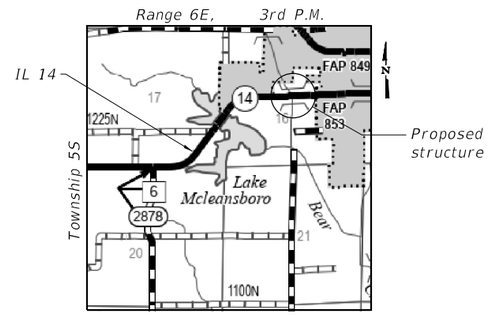
Allow 50 psf for future wearing surface

DESIGN SPECIFICATIONS

2020 AASHTO LRFD Bridge Design Specifications, 9th Edition

DESIGN STRESSES
FIELD UNITS

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



LOCATION SKETCH

APPROVED
MARCH 15, 2023
AS A BASIS FOR PREPARATION OF DETAILED PLANS

GENERAL PLAN
IL 14 OVER BEAR CREEK
FAP ROUTE 853 - SECTION 9B-1
HAMILTON COUNTY
STATION 196+56.25
STRUCTURE NO. 033-2014

ESCA CONSULTANTS, INC. CIVIL & STRUCTURAL ENGINEERS

USER NAME = shl	DESIGNED - SHL 02/23	REVISED -	
ESCA PROJECT NO. 1359.09	CHECKED - ELH 02/23	REVISED -	
PLOT SCALE = 0.167 ' / in.	DRAWN - NHC 02/23	REVISED -	
PLOT DATE = 2/22/2023	CHECKED - SHL 02/23	REVISED -	

STATE OF ILLINOIS
DEPARTMENT OF TRANSPORTATION

SHEET 1 OF 2 SHEETS

F.A.P. RTE.	SECTION	COUNTY	TOTAL SHEETS	SHEET NO.
853	9B-1	HAMILTON		
		CONTRACT NO. 78830		
	ILLINOIS FED. AID PROJECT			

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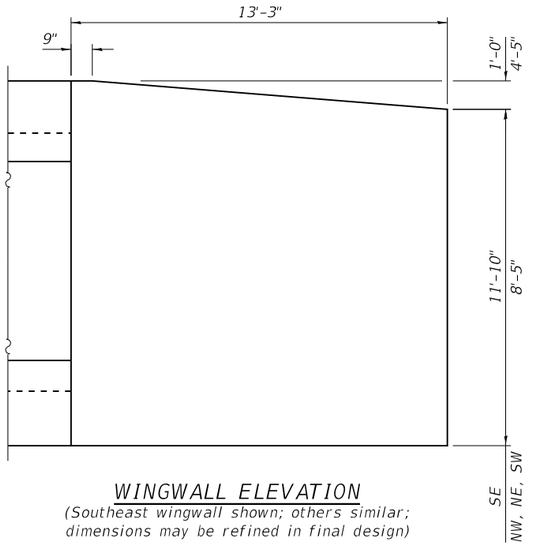
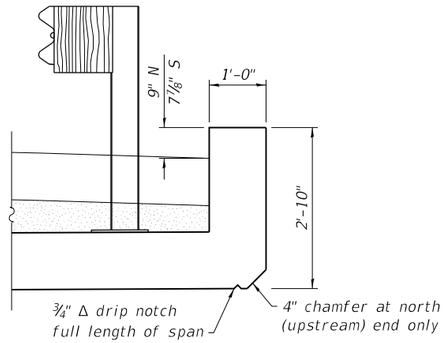
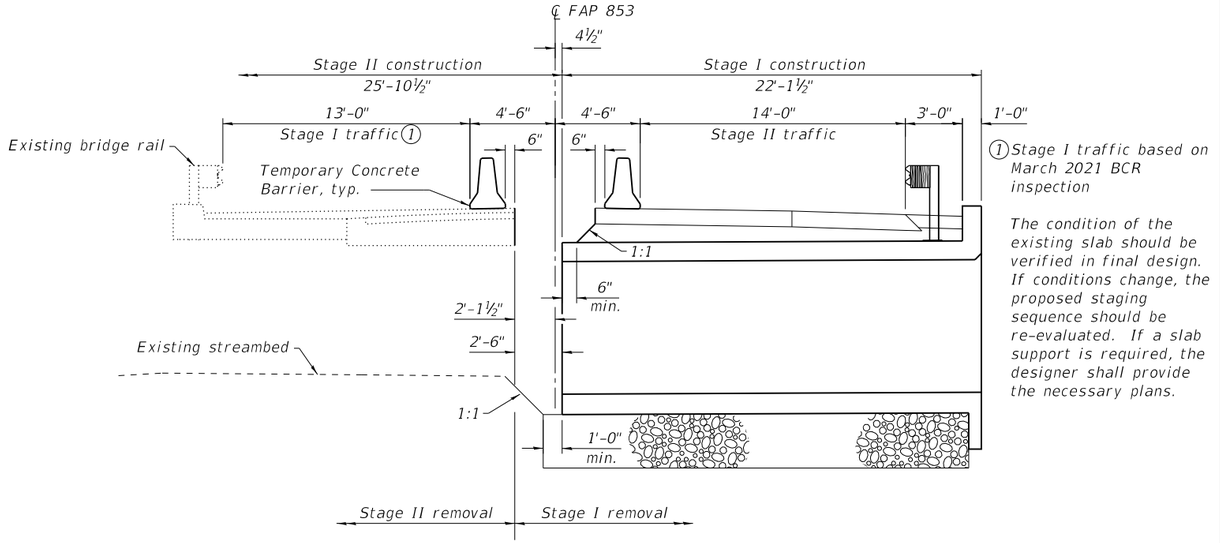


WINGWALL ELEVATION

(Southeast wingwall shown; others similar; dimensions may be refined in final design)



HEADWALL DETAILS

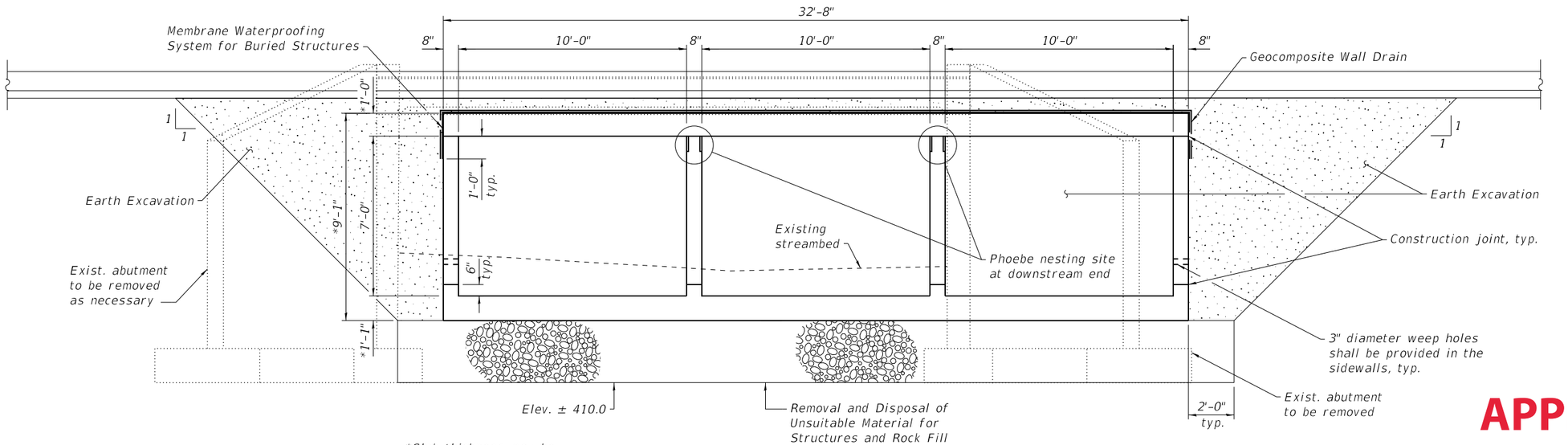


① Stage I traffic based on March 2021 BCR inspection

The condition of the existing slab should be verified in final design. If conditions change, the proposed staging sequence should be re-evaluated. If a slab support is required, the designer shall provide the necessary plans.

STAGE CONSTRUCTION SKETCH

(Looking West)



*Slab thickness may be refined in final design

SECTION THRU BARREL

(Looking South)

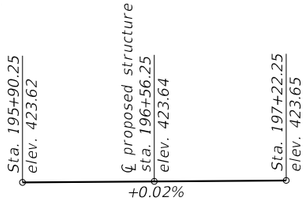
WATERWAY INFORMATION

Drainage Area = 1.1 sq. mi.

Existing Overtopping Elev. 423.59 at Sta. 195+50.04
Proposed Overtopping Elev. 423.59 at Sta. 195+50.04

Flood	Freq. Yr.	Discharge (C.F.S.)	Waterway Opening (sq. ft.) Existing	Waterway Opening (sq. ft.) Proposed	Natural H.W.E. (ft.)	Head (ft.) Existing	Head (ft.) Proposed	Headwater Elev. (ft.) Existing	Headwater Elev. (ft.) Proposed
	10	1,060	143	202	421.0	1.2	0.1	422.2	421.1
Overtop Existng	18	1,343	143	–	421.3	2.3	–	423.6	–
Design	50	1,750	143	202	421.6	2.4	1.2	424.0	422.8
Overtop Proposed	65	1,914	–	202	421.7	–	1.9	–	423.6
Base	100	2,060	143	202	421.8	2.5	2.1	424.3	423.9
Scour Design Check	200	2,414	143	202	422.0	2.5	2.2	424.5	424.2

10-year velocity through existing bridge = 8.2 ft/s
10-year velocity through proposed culvert = 5.2 ft/s



IL 14 PROFILE GRADE

(Along ℄ Roadway)

APPROVED

MARCH 15, 2023

AS A BASIS FOR PREPARATION OF DETAILED PLANS

DETAILS
IL 14 OVER BEAR CREEK
FAP ROUTE 853 – SECTION 9B-1
HAMILTON COUNTY
STATION 196+56.25
STRUCTURE NO. 033-2014

ESCA CONSULTANTS, INC. CIVIL & STRUCTURAL ENGINEERS

USER NAME = shl	DESIGNED - SHL	02/23	REVISED -	
ESCA PROJECT NO. 1359.09	CHECKED - ELH	02/23	REVISED -	
PLOT SCALE = 0.167 ' / in.	DRAWN - NHC	02/23	REVISED -	
PLOT DATE = 2/22/2023	CHECKED - SHL	02/23	REVISED -	

STATE OF ILLINOIS
DEPARTMENT OF TRANSPORTATION

SHEET 2 OF 2 SHEETS

F.A.P. RTE.	SECTION	COUNTY	TOTAL SHEETS	SHEET NO.
853	9B-1	HAMILTON		
		CONTRACT NO. 78830		
	ILLINOIS	FED. AID PROJECT		

MODEL: PLOT
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EXHBIT C

BORING LOGS

Illinois Department of Transportation
Division of Highways

SOIL BORING LOG

Date 5/14/21

ROUTE IL 14 **DESCRIPTION** Bridge over Bear Creek **LOGGED BY** L. Estel

SECTION 9B-1 **LOCATION** Int. with Fairground Rd (Near E. Abut), SEC. 16, TWP. 5S, RNG. 6E, PM

COUNTY Hamilton **DRILLING METHOD** Hollow Steam Auger (8"O.D., 3.25"I.D.) **HAMMER TYPE** Auto SPT 140 Lbs

STRUCT. NO. 033-0004
Station 196+50

BORING NO. 1-S
Station 196+75
Offset 12.0 ft Rt
Ground Surface Elev. 423.40 ft

Surface Water Elev. 414.70 ft
Stream Bed Elev. 414.70 ft

Groundwater Elev.:
First Encounter 403.9 ft ▼
Upon Completion ft
After Hrs. ft

DEPTH (ft)	BLOWS (/6")	UCS Qu (tsf)	MOIST (%)
Cored Pavement, 10.5" of HMA 422.5			
Soft Brown and Tan, Moist SILTY CLAY LOAM	1		
	WOH 1	0.4 B	24
418.9			
V. Soft Brown, Moist SILTY CLAY LOAM -5	WOH		
	1 2	0.1 B	21
(Soft)	WOH		
	1 2	0.3 B	25
413.9			
Soft Grey, Moist SILTY CLAY -10	WOH		
	1 2	0.3 B	25
411.4			
M. Stiff Brown, Moist SILTY CLAY LOAM	1		
	3 5	0.7 B	19
-15	3		
	3 2	0.6 B	20
406.4			
V. Dense Brown and Tan, Damp Weathered SANDSTONE	5		
	33 40		13
403.9 ▼			
Hard Brown and Tan, Damp -20	100/6"		16
SANDSTONE -25			
Bottom of hole @ 20 feet			
-30			
-35			
-40			

Ground surface elevation referenced to BM 0619; Square cut in top of Wing Wall @ SE Corner of SN 033-0004; EL 423.63

Hammer efficiency: 86.5%
To convert "N" values to "N60", multiply by 1.44

End of Boring

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 6/15/21

ROUTE IL 14 **DESCRIPTION** Bridge over Bear Creek **LOGGED BY** L. Estel

SECTION 9B-1 **LOCATION** Int. with Fairground Rd (Near E. Abut), SEC. 16, TWP. 5S, RNG. 6E, PM

COUNTY Hamilton **DRILLING METHOD** Hollow Steam Auger (8"O.D., 3.25"I.D.) **HAMMER TYPE** Auto SPT 140 Lbs

STRUCT. NO. 033-0004
Station 196+50

BORING NO. 2-S
Station 196+15
Offset 12.0 ft Lt
Ground Surface Elev. 423.10 ft

Surface Water Elev. 414.70 ft
Stream Bed Elev. 414.70 ft

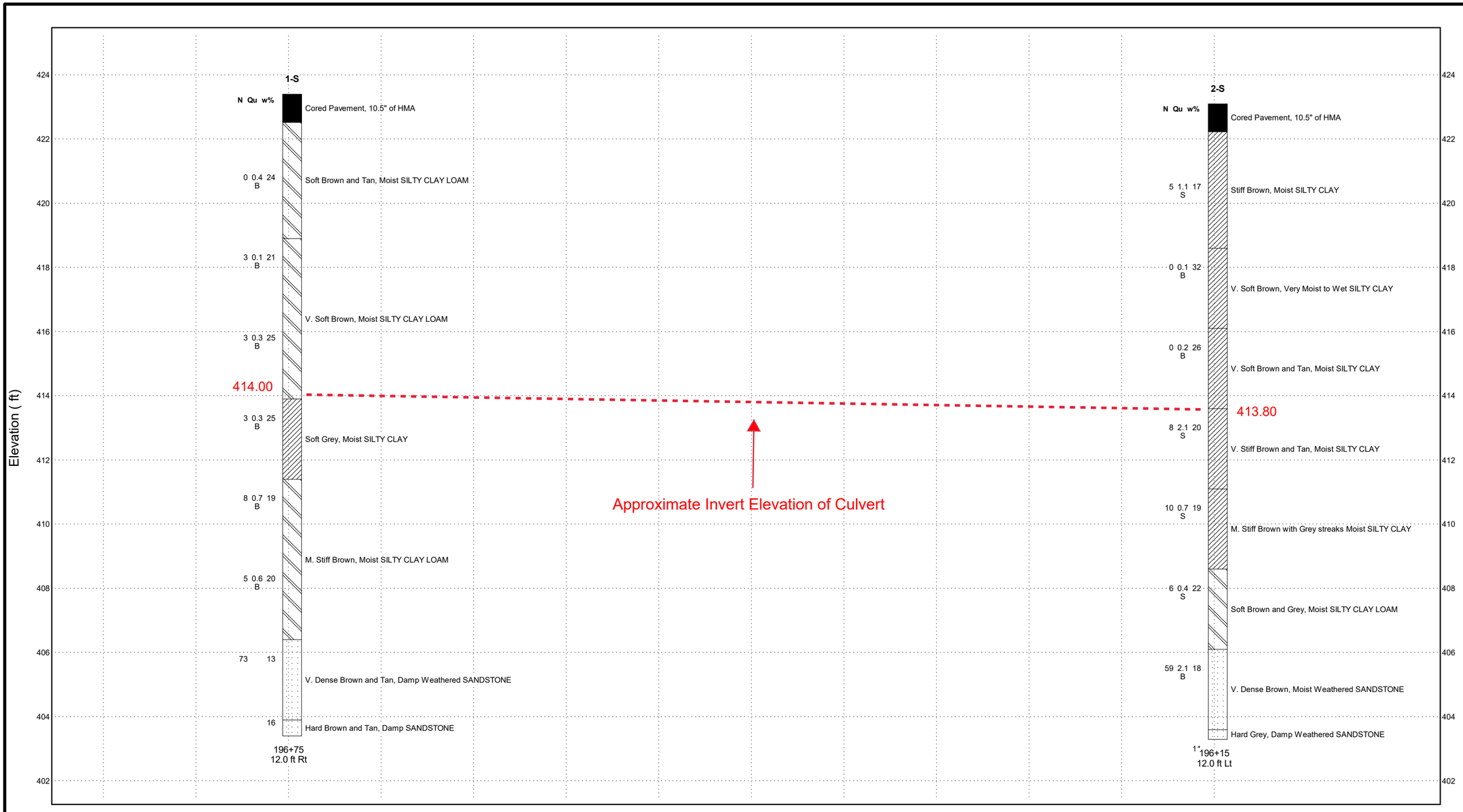
Groundwater Elev.:
First Encounter 410.6 ft ▼
Upon Completion ft
After Hrs. ft

DEPTH (ft)	BLOWS (/6")	UCS Qu (tsf)	MOIST (%)	Description
0				Cored Pavement, 10.5" of HMA
422.2				
				Stiff Brown, Moist SILTY CLAY
	2			
	2 3	1.1 S	17	
418.6				
-5	WOH			V. Soft Brown, Very Moist to Wet SILTY CLAY
	WOH WOH	0.1 B	32	
416.1				
	WOH			V. Soft Brown and Tan, Moist SILTY CLAY
	WOH 1	0.2 B	26	
413.6				
-10	3			V. Stiff Brown and Tan, Moist SILTY CLAY
	5 3	2.1 S	20	
411.1				
	1			M. Stiff Brown with Grey streaks Moist SILTY CLAY ▼
	4 6	0.7 S	19	
408.6				
-15	2			Soft Brown and Grey, Moist SILTY CLAY LOAM
	3 3	0.4 S	22	
406.1				
	6			V. Dense Brown, Moist Weathered SANDSTONE
	29 30	2.1 B	18	
403.6				
-20	100/4"			Hard Grey, Damp Weathered SANDSTONE
			11	
-25				Bottom of hole @ 19.8 feet
				Hammer efficiency: 86.5% To convert "N" values to "N60", multiply by 1.44
				Ground surface elevation referenced to BM 0619; Square cut in top of Wing Wall @ SE Corner of SN 033-0004; EL 423.63
-30				
-35				
-40				End of Boring

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)

EXHIBIT D

SUBSURFACE PROFILE



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Belleville, Illinois 62220
618.233.5877 phone
618.233.5977 fax
www.kaskaskiaeng.com

PROFESSIONAL REGISTRATIONS	LICENSE NO.
Illinois Professional Design Firm	184.004773
Professional Engineering Group	20-5080586

NOT TO HORIZONTAL SCALE

SUBSURFACE DATA PROFILE

Route: IL 14 (FAP Route 853) over Bear Creek
Section: 9B-1
County: Hamilton

EXHIBIT E
SETTLEMENT CALCULATIONS

Kaskaskia
Engineering Group, LLC
208 E. Main Street
Suite 100
Belleville, Illinois 62220
618.233.5877 *phone*
618.233.5977 *fax*
www.kaskaskiaeng.com

Project Title: IL-1A over Beaucoup Creek Sheet: 1 of 1
Project Number: 20-1109.06
Calculated By: TG Date: 1/9/2022
Checked By: MDM Date: 11/9/2022
Comments:

Using Boring 1-S

Soft layer = 4.6 ft of Silty Clay loam
using $w_c = 19\%$ $\gamma = 120$
$LL = w_c\%$

$e_o = 2.7\, w_c/100 = 2.7 \times 19/100 = 0.513$
$C_c = 0.009\,(LL-10) = 0.081$

Assume the soil is Normally Consolidated. the Δp will be calculated using 2:1 method using weight of Culvert and Fill calculated at BC

Layer	Δz (ft)	z_f (ft)	P_o (psf)	ΔP (psf)	S_p (in)
1	2	1	120	853.94	1.10
2	2	3	360	1023.92	0.58
3	0.6	4.3	516	1139.68	0.13

$S_p = 1.81$ in

Using Boring 2-S
Soft layer 4.00 ft of Silty Clay / Silty Clay loam
$w_c = 19\%$ → $C_c = 0.081$, $e_o = 0.513$

Layer	Δz (ft)	z_f (ft)	P_o (psf)	ΔP (psf)	S_p (ft)
1	1.5	0.75	43.20	786.67	1.21
2	1.5	2.25	129.60	818.54	0.77
3	1	3.5	201.60	849.59	0.40

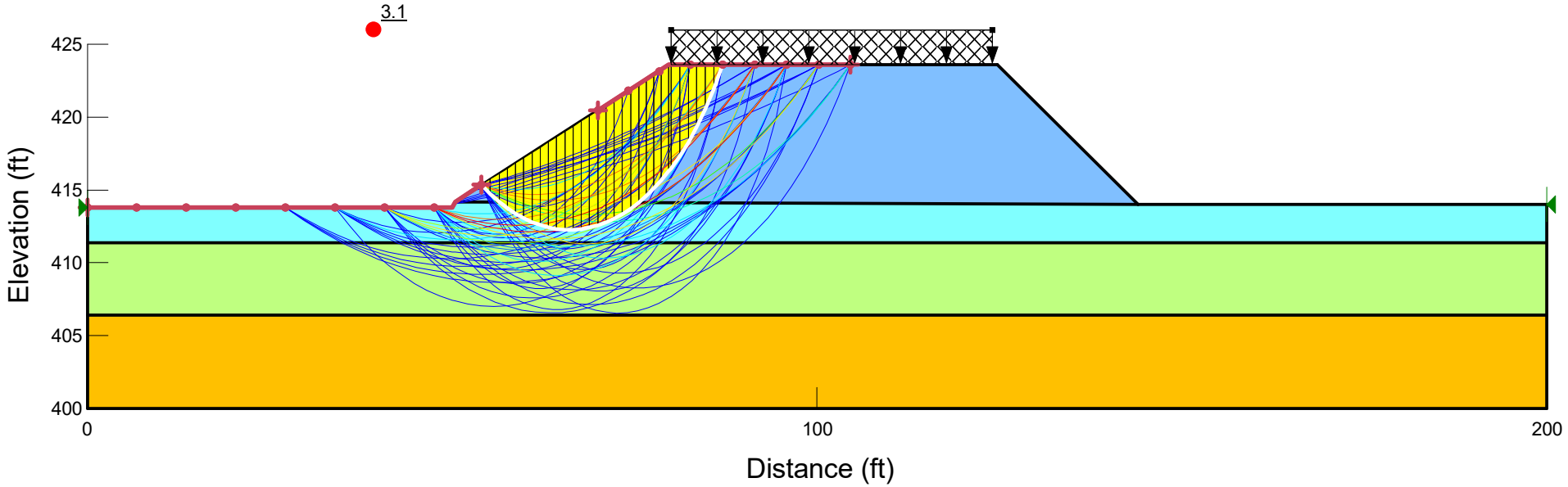
$S_p = 2.39$ in

Differential Settlement = 0.58 in

EXHIBIT F

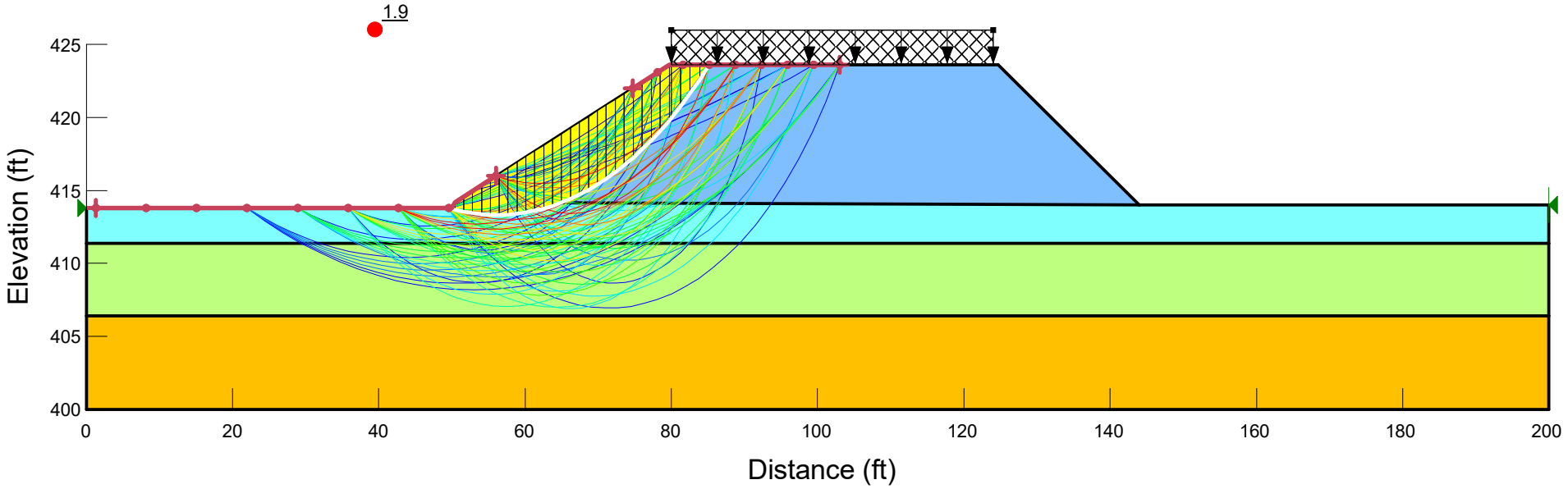
SLOPE STABILITY ANALYSIS

IL 14 over Bear Creek
Downstream Slope - Boring 1-S
Short Term Condition (Undrained)



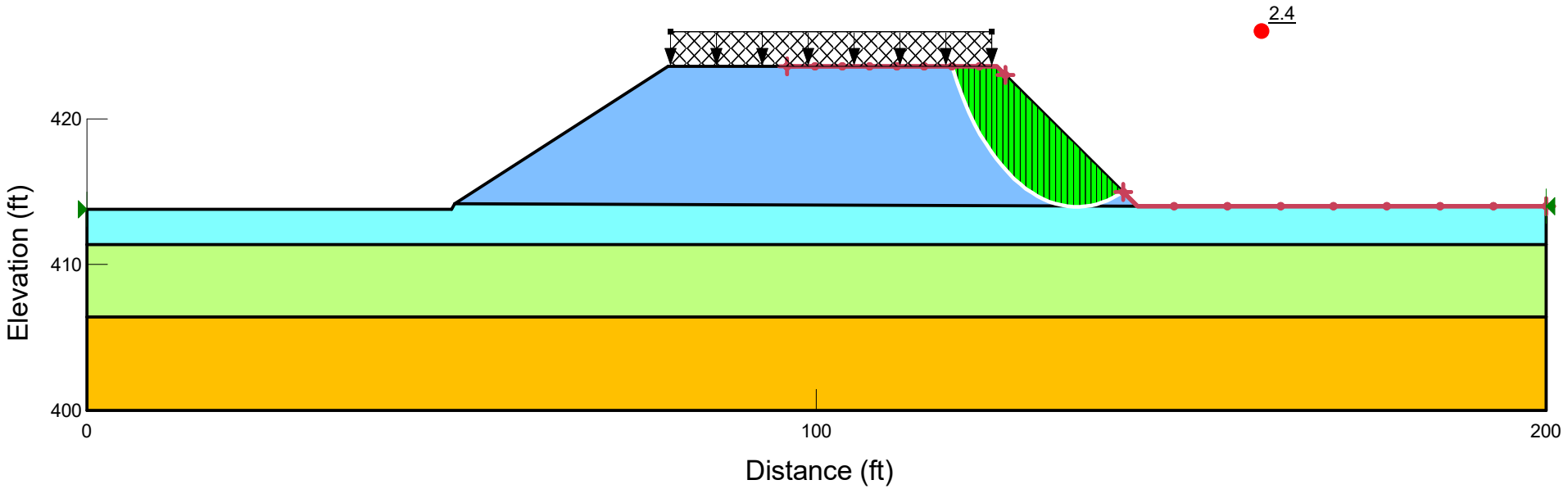
Color	Name	Slope Stability Material Model	Unit Weight (pcf)	Effective Cohesion (psf)	Effective Friction Angle (°)
	SANDSTONE	Mohr-Coulomb	125	1,000	45
	SILTY CLAY	Mohr-Coulomb	120	250	28
	SILTY CLAY LOAM I	Mohr-Coulomb	120	250	28
	SILTY CLAY LOAM II	Mohr-Coulomb	120	650	28

IL 14 over Bear Creek
Downstream Slope - Boring 1-S
Long Term Condition (Drained)



Color	Name	Slope Stability Material Model	Unit Weight (pcf)	Effective Cohesion (psf)	Effective Friction Angle (°)
	SANDSTONE	Mohr-Coulomb	125	1,000	45
	SILTY CLAY	Mohr-Coulomb	120	50	26
	SILTY CLAY LOAM I	Mohr-Coulomb	120	50	28
	SILTY CLAY LOAM II	Mohr-Coulomb	120	100	28

IL 14 over Bear Creek
Upstream Slope - Boring 1-S
Short Term Condition (Undrained)



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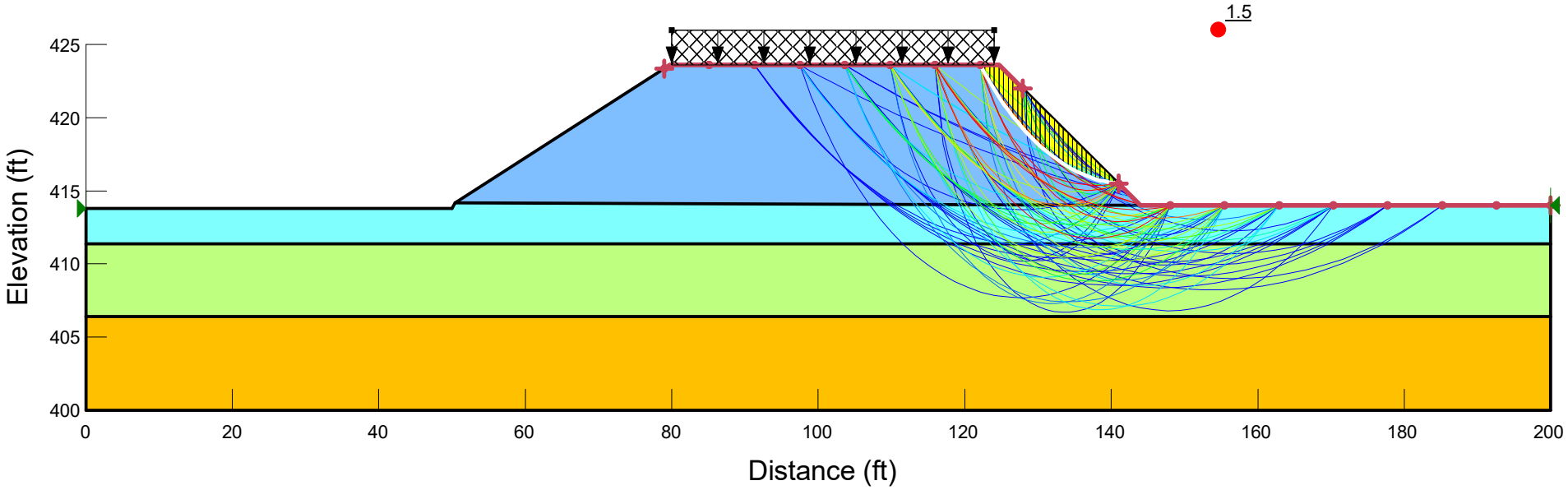
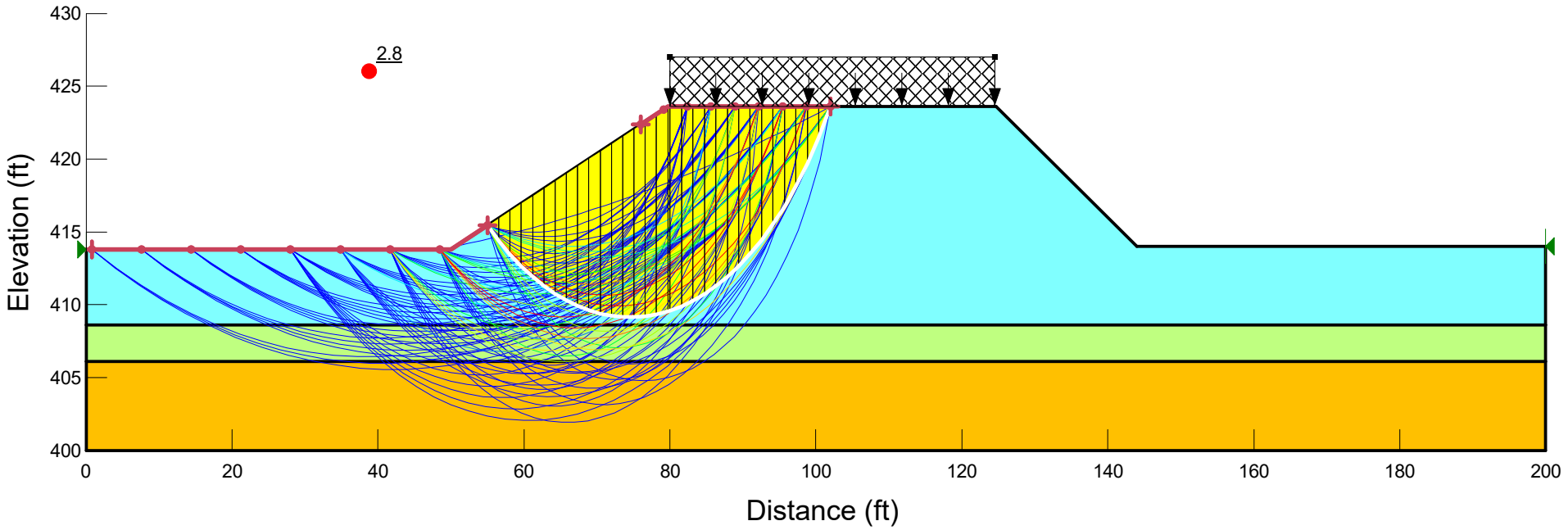
	SILTY CLAY LOAM II	Mohr-Coulomb	120	650	28

IL 14 over Bear Creek
Upstream Slope - Boring 1-S
Long Term Condition (Drained)



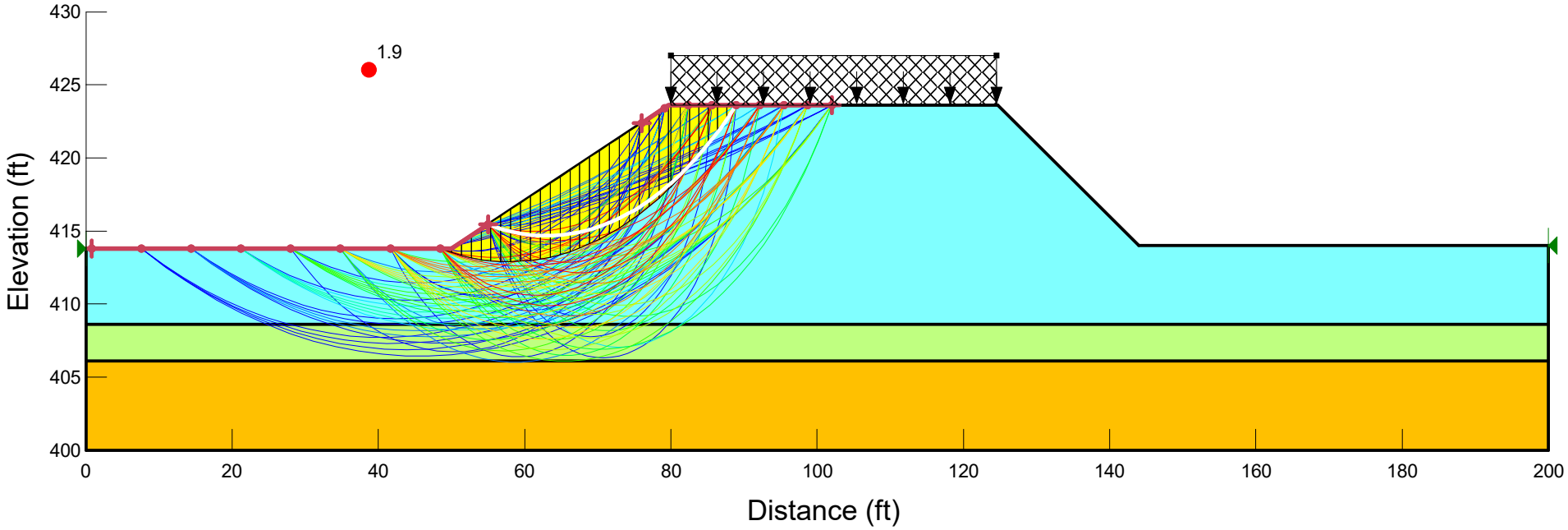
Color	Name	Slope Stability Material Model	Unit Weight (pcf)	Effective Cohesion (psf)	Effective Friction Angle (°)
	SANDSTONE	Mohr-Coulomb	125	1,000	45
	SILTY CLAY	Mohr-Coulomb	120	50	26
	SILTY CLAY LOAM I	Mohr-Coulomb	120	50	28
	SILTY CLAY LOAM II	Mohr-Coulomb	120	100	28

IL 14 over Bear Creek
Downstream Slope - Boring 2-S
Short Term Condition (Undrained)



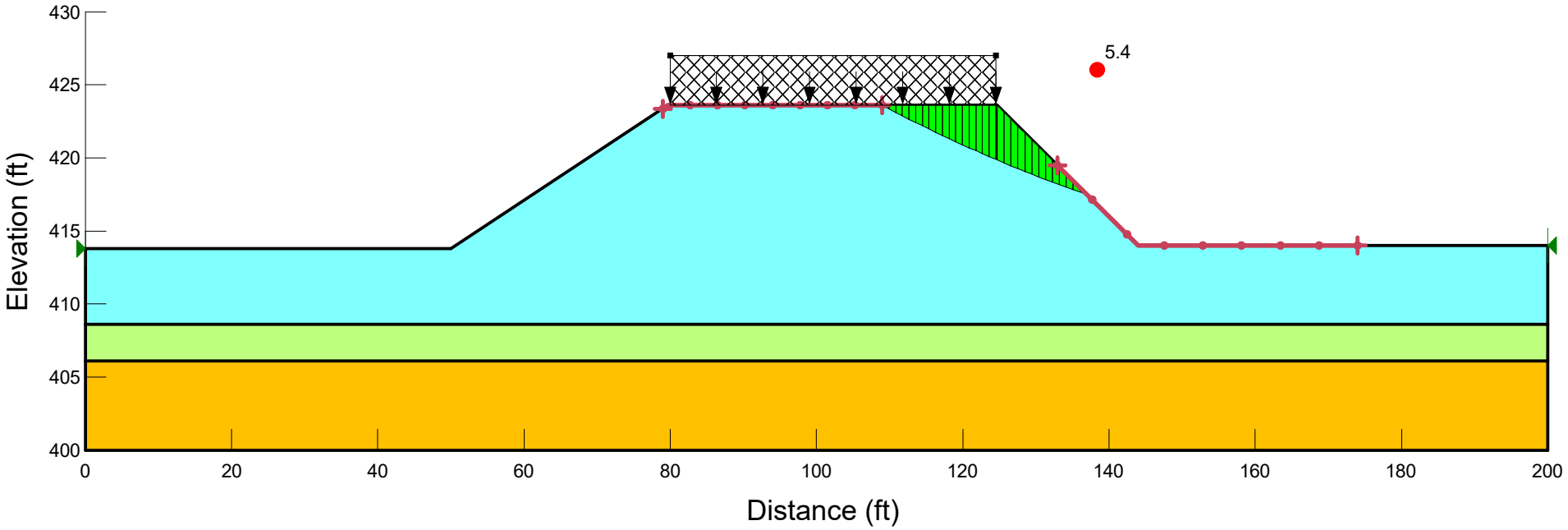
Color	Name	Slope Stability Material Model	Unit Weight (pcf)	Effective Cohesion (psf)	Effective Friction Angle (°)
	SANDSTONE	Mohr-Coulomb	125	1,000	45
	SILTY CLAY	Mohr-Coulomb	120	840	0
	SILTY CLAY LOAM	Mohr-Coulomb	120	400	28

IL 14 over Bear Creek
Downstream Slope - Boring 2-S
Long Term Condition (Drained)



Color	Name	Slope Stability Material Model	Unit Weight (pcf)	Effective Cohesion (psf)	Effective Friction Angle (°)
	SANDSTONE	Mohr-Coulomb	125	1,000	45
	SILTY CLAY	Mohr-Coulomb	120	100	26
	SILTY CLAY LOAM	Mohr-Coulomb	120	100	28

IL 14 over Bear Creek
Upstream Slope - Boring 2-S
Short Term Condition (Undrained)



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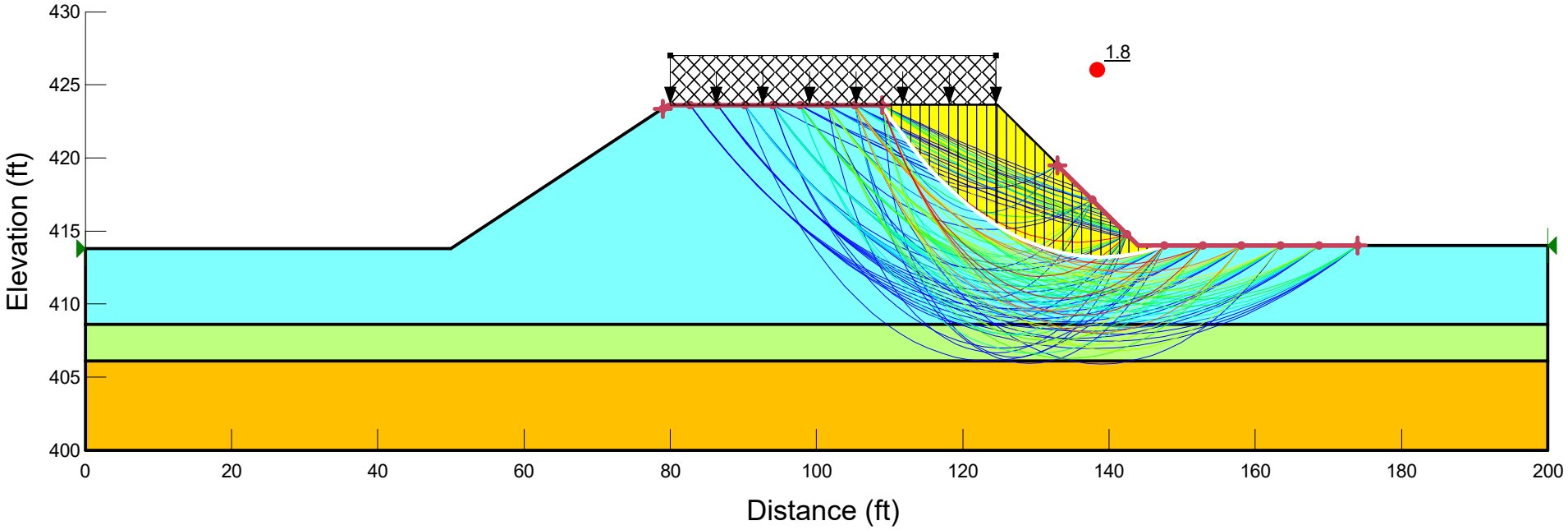
	SANDSTONE	Mohr-Coulomb	125	1,000	45
	SILTY CLAY	Mohr-Coulomb	120	840	0
	SILTY CLAY LOAM	Mohr-Coulomb	120	400	28

IL 14 over Bear Creek
Upstream Slope - Boring 2-S
Long Term Condition (Drained)



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	SANDSTONE	Mohr-Coulomb	125	1,000	45
	SILTY CLAY	Mohr-Coulomb	120	100	26
	SILTY CLAY LOAM	Mohr-Coulomb	120	100	28

EXHIBIT G

BEARING CAPACITY CALCULATIONS

Kaskaskia Engineering Group, LLC
208 E. Main Street
Suite 100
Belleville, Illinois 62220
618.233.5877 *phone*
618.233.5977 *fax*
www.kaskaskiaeng.com

Project Title: IL-14 over Bear Creek Sheet: 1 of 2
Project Number: 20-1109.06
Calculated By: CO Date: 2/15/23
Checked By: MDM Date: 2/15/2023
Comments: Bearing Capacity Revisions

Culvert's Weight

$V_c = (2 + 1/12) \times (32 + 8/12) \times 45 + 7 \times 4 \times 45 \times 8/12$
$= 3062.5 + 840$
$= 3902.5 \text{ ft}^3$

$W_c = 4322.5 \text{ ft}^3 \times 150 \text{ pcf}$
$= 585,375 \text{ lbs}$

Fill Material
$V_c = 45 \times (32 + 8/12) \times 3$
$= 4410 \text{ ft}^3$

$W_f = 4410 \text{ ft}^3 \times 125 \text{ pcf}$
$= 551,250 \text{ lbs}$

Wingwalls' Weight
$V_c = \left[\frac{9'8" + 12'8" \cdot 13'}{2}\right] \times 1'$
$= 145.2 \text{ ft}^3$

$W_w = 145.2 \times 4 \times 150 = 87,000 \text{ lbs}$

TOTAL WEIGHT → $W_t = W_c + W_f + W_w = 1,223,725 \text{ lbs}$

Bearing Pressure: $W_t/A = 1223725 / (45' \times 32'8") = 832.38 \text{ psf}$

Bearing Capacity for Continuous

$q_u = cN_c + (D_f N_q + 1/2 B N_\gamma) \Rightarrow$ $\phi = 0$, $c = 700 \text{ psf}$,
$N_c = 5.7$, $N_q = 1.0$, $N_\gamma = 0.0$
$D_f = 3 \text{ ft}$ $\gamma = 120 \text{ pcf}$

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Project Title: IL 14 over Bear Creek Sheet: 2 of 2
Project Number: 20-1109.06
Calculated By: CO Date: 2/15/23
Checked By: MDM Date: 2/15/2023
Comments: Bearing Capacity Revision

$q_u = (700\ psf)(5.7) + (120\ pcf)(3')(1) + 0$
$= 4350\ psf$

$q_a = q_u/3 = 4350\ psf/3 = 1450\ psf$

$q_a = 1{,}450 > 832$ ✓ OK

Sliding Resistance (Using I-5 Boring)

Assumed $H = 12.5\ ft$

Bearing in Silty Clay Loam → $\gamma = 120\ pcf$
$c = 700\ psf$

Sliding Resistance = lessor of ½ vertical stress or cohesion

$\frac{1}{2}\sigma_v = \frac{1}{2}\gamma H = \frac{1}{2}(120)(12.5) = 750\ psf$

$\frac{1}{2}\sigma_v = 750\ psf > c = 700\ psf$

Sliding Resistance = 700 psf