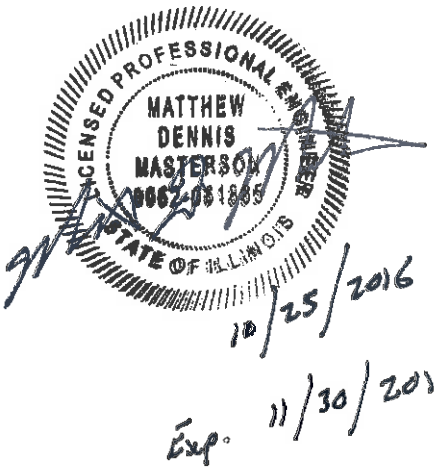
STRUCTURE GEOTECHNICAL REPORT

F.A.P. Route 331 (IL 13 E.B.) over
Crab Orchard Creek Overflow

S.N. 039-0019 (E)
S.N. 039-0078 (P)

F.A.P. ROUTE 331
SECTION (5-3) B-5
JACKSON COUNTY, ILLINOIS
JOB NO. D-99-019-12
CONTRACT NO. 78295
PTB 148/34 WO#18
KEG NO. 08-0061.18



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April 08, 2016
Revised October 21, 2016

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Engineering Group, LLC

EXECUTIVE SUMMARY

IL 13 E.B. over Crab Orchard Creek Overflow
F.A.P. 331
Section (5-3) B-5
Jackson County, Illinois
Job No. D-99-019-12
Contract No. 78295
PTB 148/34 WO #18
Existing Structure No. 039-0019
Proposed Structure No. 039-0078

The project includes replacing and adding a lane to an eastbound bridge (existing SN 039-0019) located in Jackson County, Illinois. The existing bridge will be removed and replaced with a triple-span bridge. The abutments will be removed and replaced with integral abutments. Traffic will be maintained utilizing cross-overs during construction.

The results of the slope stability analysis indicates that an acceptable FOS will exist at the east and west abutments under end-of-construction and long-term conditions. In order to achieve an acceptable FOS for the seismic condition, the abutment piles with a maximum spacing of 8 ft. were included in the model.

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1.0 Project Description and Proposed Structure Information

1.1 Introduction

The geotechnical study summarized in this report was performed for the proposed replacement of the bridge carrying eastbound IL 13 over Crab Orchard Creek Overflow in Jackson County, Illinois. The purpose of this report is to present design and construction recommendations for the proposed structure.

1.2 Project Description

The project includes the replacement of an existing triple-span bridge (SN 039-0019) located in Jackson County, Illinois. Traffic will be maintained utilizing cross-overs during construction. The general location of the structure is shown on a USGS Topographic Location Map, Exhibit A. The site lies within the limits of the Third Principal Meridian, (T. 9S R. 1W, Section 14) within the Mt. Vernon Hill Country of the Till Plains section of the Central Lowland Province.

1.3 Existing Structure

The existing structure was constructed in 1965 and is a three-span continuous wide-flange beam bridge. The substructure consists of pile bent abutments supported on H-piles driven to refusal and solid wall pile bent piers on H-pile supported spread footings. Back-to-back abutments measure 156 ft., with an out-to-out width of 36 ft. – 7.5 in., on a zero degree skew. The bridge carries two, 12 ft. driving lanes with shoulders of varying sizes. The bridge was rehabilitated in 1999.

1.4 Proposed Bridge Information

The proposed structure (SN 039-0078) located at F.A.P. Route 331 (IL 13) over Crab Orchard Creek Overflow will consist of a triple-span structure built on a zero skew. The structure will have a width of 66 ft. – 7 in. out-to-out deck. The outside spans will measure 46 ft. – 11.5 in., while the middle span will measure 50 ft. – 2 in. The structure will be located at approximate station 65+20 (IL 13). Integral abutments are proposed for the substructure.

The structure will measure 147 ft. – 9 in., measured parallel to the centerline of IL 13, from back-to-back of abutments. The structure will support three, 12-ft. lanes, with shoulder widths of approximately 6 ft. and 10 ft. Additionally, a 10 ft. wide multi-use path will be constructed on the south side of the roadway. Further substructure details will be based on the findings of this SGR.

2.0 Site Investigation, Subsurface Exploration, and Generalized Subsurface Conditions

The site investigation plan was developed and performed by IDOT. A KEG representative did not observe any part of the field exploration, or make site observations, including review of the soil samples retained during drilling.

Two Standard Penetration Test (SPT) borings, designated 1-S and 2-S were drilled between June 25 and June 26, 2014. The boring locations are shown on the Type, Size, and Location plan (TS&L), Exhibit B, as provided by Crawford, Murphy and Tilly, Inc. (CM&T). 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. A soil profile can be found under Subsurface Profile, Exhibit D.

Table 2.0 – Boring Summary

Boring Location	Station	Offset	Ground Surface Elevation
1-S	164+22* (64+27)	11 ft. RT CL EBL	390.5 ft.
2-S	166+15* (66+12)	14 ft. RT CL EBL	390.3 ft.

***The stationing of the borings are based off the previous IL 13 alignment. The stationing in parenthesis are approximations based off of the new stationing provided on the current TS&L.

2.1 Subsurface Conditions

Boring 1-S consisted of approximately 1.5 ft. of asphalt and concrete from the ground surface to approximately El. 389.0. A medium to very stiff clay followed to El. 373.5. The driving resistances (N-values) ranged from 2 to 8 blows per foot (bpf), with an average of 4 bpf. Unconfined compressive strength (Qu) values ranged from 0.6 to 3.3 tons per square foot (tsf), with an average of 1.7 tsf. The moisture content varied from 19 to 29 percent, with an average of 24 percent. A layer of medium clay to silty clay followed to El. 371.0. The N-value was 3 bpf, with a Qu value of 0.8 tsf, and a moisture content of 25 percent. Medium to very soft silty clay loams and silty clay followed to El. 361.0. The N-values ranged from 1 to 2 bpf. Qu values ranged from 0.2 to 0.8 tsf, with an average of 0.5 tsf. The moisture content varied from 27 to 30 percent, with an average of 29 percent. A stiff to very stiff clay followed to El. 336.0. The N-values ranged from 5 to 15 bpf, with an average of 9 bpf. Qu values ranged from 1.8 to 3.9 tsf, with an average of 2.7 tsf. Moisture content varied from 25 to 35 percent, with an average of 29 percent. A layer of loose to very loose, fine sand loam followed to El. 331.0. The N-value was 4 bpf, with a moisture content of 23 percent. A conglomerate with weathered clay shale followed to El. 327.5. The N-value was 18 bpf, with a Qu value of 1.2 tsf, and a moisture content of 18 percent. A hard clay shale followed to boring termination depth at El. 315.5 with N-values of 100 for 4 inches, 100 for 6 inches, and 100 for 4 inches. At El. 321.0, some layers of softer shale and coal were noted.

Boring 2-S consisted of approximately 2.5 ft. of asphalt and crushed aggregate from ground surface (El. 390.3) to El. 387.8. A medium clay with gravel followed to El. 383.3, with N-values ranging from 2 to 5 bpf, Qu values between 0.6 and 0.9 tsf, and moisture contents from 20 to 26 percent. A very stiff clay followed to El. 378.3. N-values ranged from 5 to 6 bpf, with Qu values between 2.9 to 3.3 tsf, and moisture contents from 20 to 21 percent. A very soft clay followed to El. 375.8, with an N-value of 1 bpf, a Qu value of 0.2 tsf, and a moisture content of 31 percent. A very stiff clay followed to El. 373.3, with an N-value of 8 bpf, a Qu value of 2.9 tsf, and a moisture content of 21 percent. A medium silty clay followed to El. 370.8, with an N-value of 4 bpf, a Qu of 0.9 tsf, and a moisture content of 24 percent. A stiff silty clay loam followed to El. 368.3, with an N-value of 5 bpf, a Qu of 1.1 tsf, and a moisture content of 26 percent. A soft silty clay loam followed to El. 363.3, with an N-value of 1 bpf, Qu values between 0.3 and 0.4 tsf, and moisture contents from 28 to 29 percent. A very soft silty clay followed to El. 355.8, with N-values of 0 bpf, Qu values of 0.1 to 0.2 tsf, and moisture contents from 30 to 32 percent. A very stiff clay followed to El. 353.3, with an N-value of 5 bpf, a Qu value of 2.5 tsf, and moisture content of 31 percent. A very stiff clay followed to El. 340.8, with N-values between 7 to 12 bpf, Qu values between 2.3 to 2.5 tsf, and moisture contents from 28 to 32 percent. A stiff clay followed to El. 335.8, with an N-value of 7 bpf, a Qu value of 1.5 tsf, and a moisture content of 27 percent. A stiff clay followed

to El. 330.8, with an N-value of 7 bpf, a Qu of 1.7 tsf, and a moisture content of 26 percent. A stiff clay followed to El. 326.3, with an N-value of 7 bpf, a Qu value of 1.5 tsf, and a moisture content of 23 percent. A hard clay shale followed to boring termination at El. 324.3, with an N-value of 100/12 inches.

2.2 Groundwater

Groundwater was encountered during drilling in Boring 1-S at El. 365.5 and El. 363.3 at Boring 2-S. 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

Since no significant grading or changes to the existing embankments are expected, and minimal changes in elevations from the existing substructure units are anticipated due to the retrofitting of the existing pier, it is estimated that settlement magnitudes of less than 0.4 inches will be experienced. Therefore, no settlement calculations were performed for the proposed structure and downdrag was not included in the pile capacity calculations.

3.2 Slope Stability

The construction of the proposed structure will result in new endslopes at the abutment locations.

The proposed endslopes at the west and east abutments are composed of a 1 Vertical to 2 Horizontal (1V:2H) slope to the toe in the streambed. Slope stability of the endslopes was analyzed using SLOPE-W; the soil properties at the site, including those in Borings 1-S and 2-S; and the endslope geometrics. Three conditions were modeled: end-of-construction, long-term, and a design seismic event. A critical factor of safety (FOS) was calculated for each condition. According to current standards of practice, the target FOS is 1.5 for end-of-construction and long-term slope stability and 1.0 for the design seismic event.

In order to model the end-of-construction condition, undrained soil parameters were used with a friction angle of 0 degrees assumed for cohesive soils. Drained soil parameters with assumed friction angles of 12 to 42 degrees were used to model the long-term and seismic conditions and to analyze the condition where excess pore water pressure from construction has dissipated. For non-engineered cohesive materials, a nominal cohesion value of 50 to 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 are shown in Table 3.2. SLOPE-W program output from this analysis can be found in SLOPE-W Slope Stability Analysis, Exhibit E.

Table 3.2 – Slope Stability Critical FOS

Location	Slope	End-of-Construction	Long-Term	Seismic	Seismic with Abutment Pile
East Abutment	1V:2H	3.3	1.7	0.9	1.1
West Abutment	1V:2H	3.2	1.7	0.9	1.0

The results of the analysis, as provided in Table 3.2, indicate an acceptable FOS will exist at the west and east abutment endslopes under end-of-construction and long-term conditions. In order to achieve an acceptable FOS for the seismic condition, the abutment piles with a maximum spacing of 8 ft. were included in the stability model.

3.3 Seismic Considerations

The determination of Seismic Site Class was based on the method described by IDOT AGMU Memo 09.1 - Seismic Site Class Definition and the IDOT-provided spreadsheet titled: *Seismic Site Class Determination*. Using these resources, the controlling global site class for this project is Soil Site Class D.

Additional seismic parameters were calculated for use in design of the structure and evaluation of liquefaction potential. The USGS published information and mapping (http://earthquake.usgs.gov/), including software directly applicable to the *AASHTO Guide Specifications for LRFD Seismic Bridge Design*, was used to develop the parameters for the project site location. The values, based on a 1000-Year Return Period with a Probability of Exceedance (PE) of 7 percent in 75 years and Soil Site Class D, are summarized below.

Table 3.3 – Summary of Seismic Parameters

Parameter	Value
Soil Site Class	D
Spectral Response Acceleration, 0.2 Sec, S_{DS}	0.845 g
Spectral Response Acceleration, 1.0 Sec, S_{D1}	0.360 g
Seismic Performance Zone	3

As indicated in the table above, the Seismic Performance Zone is 3, based on S_{D1} and Table 3.15.2-1 in the IDOT Bridge Manual, the Soil Site Class D, and Figure 2.3.10-3 in the IDOT Bridge Manual.

3.4 Scour

The design scour elevations for the proposed structure are shown in Table 3.4. Class A4 stone riprap will be placed on the surface of the proposed abutment endslopes to reduce the potential for future scour.

Table 3.4 – Design Scour Elevations

Event/Limit State	Design Scour Elevations (ft.)				
	West Abutment	Pier 1	Pier 2	East Abutment	Item 113
Q_{100}	382.53	365.8	365.8	382.46	5
Q_{200}	382.53	364.8	364.8	382.46	
Design	382.53	365.8	365.8	382.46	
Check	382.53	365.8	365.8	382.46	

3.5 Mining Activity

The Illinois State Geological Survey (ISGS) website indicates that coal mining has occurred in Jackson County. According to the Jackson County, Illinois Coal Mines and Underground Industrial Mines Map, dated January 29, 2015, obtained from the Illinois Geological Survey website (http://isgs.illinois.edu/ilmines), the project site was not undermined. However, there are several areas south and northwest of the project location that have mining activity. An area just northwest of the project area is designated as an underground industrial mine and surrounding buffer region. South of the project area are several underground coal mines, some that have indefinite or uncertain boundaries. The nearest boundary is approximately 0.5 mile south of the project limits.

The listed disclaimer indicates the locations of some features on the mine map may be offset by 500 ft. or more due to errors in the original source maps, the compilation process, digitizing, or a combination of these factors.

No visual indications were noted on the boring logs of apparent depressions, which could be due to mine subsidence or shafts beneath the site. A KEG representative did not make a site visit in order to observe if any indications of subsurface mining activities were present.

3.6 Liquefaction

A liquefaction analysis was performed using the liquefaction worksheet provided by IDOT BBS Central Geotechnical Unit (Mod. 5/24/2010). The Peak Horizontal Ground Acceleration value in the spreadsheet was set equivalent to the PGA (0.345g for NMSZ and n/a for CEUS), as determined based on information from the USGS website and the 2009 AASHTO Guide Specifications for LRFD Seismic Bridge Design. The Design Earthquake Mean Magnitude (7.7 for NMSZ and n/a for CEUS) was determined using the USGS data and deaggregation methods provided at http://earthquake.usgs.gov/. The soil profile for Boring 1-S and 2-S was analyzed.

Plasticity Index (PI) and liquid limits (LL) are a required input in the liquefaction spreadsheet. However, Atterberg limits testing was not available for the individual soil layers encountered in both borings; therefore, these values were estimated based off of the visual classifications provided on the boring logs.

Groundwater was encountered between 25 and 27 ft. below the ground surface. As previously mentioned, groundwater elevations will vary with climatic and seasonal conditions. The liquefaction analysis assumed that the depth to groundwater observed during the subsurface exploration, would be the same. The liquefaction spreadsheets indicated that there were not any layers susceptible to liquefaction; therefore, liquefaction was not considered as a reduction for pile design capacity at any of the substructure units.

4.0 Foundation Evaluations and Design Recommendations

4.1 General Feasibility

According to the IDOT All Bridge Designers (ABD) Memo 12.3 dated July 25, 2012 by IDOT, HP 8X36 or larger H-piles are feasible pile types for foundation support of the proposed Integral Abutments. Due to new embankment construction, the average shear strength ($Q_{u\ avg}$) within the critical depth zone is assumed to be 1.4 tsf.

The Modified IDOT Static Method of Estimating Pile Length, provided by IDOT BBS Foundations and Geotechnical Unit, was used to calculate the design length of the piles. While smaller H-piles are allowable support for the structure, existing borings encountered bedrock at approximately 63 ft. below the ground surface, exceeding the maximum recommended lengths of smaller H-piles. Drilled shafts were not considered due to cost and the depth to bedrock.

4.2 Pile Supported Foundations

The foundations supporting the proposed bridge must provide sufficient support to resist dead and live loads, including seismic loadings. Based on the encountered subsurface conditions, the Modified IDOT Static Method of Estimating Pile Length provided by IDOT BBS Foundations and Geotechnical Unit, and the information available to date, H-piles are acceptable for use at the abutment locations. The Modified IDOT Static Method uses the LRFD Pile Design Guide Procedure to estimate the pile lengths (Pile Length/Pile Type, Exhibit F).

The abutment and pier loads were provided by CM&T. The abutments will each experience a Total Factored Load of 241 kips per pile, and the piers will experience a Total Factored Load of 234 kips per pier. The estimated pile lengths for the recommended pile types are shown in Tables 4.2.1 through 4.2.6, below.

The Nominal Required Bearing (R_N) represents the resistance the pile will experience during driving, and will assist the contractor in selecting a proper hammer size. The Factored Resistance Available (R_F) documents the net long-term axial factored pile capacity available at the top of the pile to support factored substructure loadings. Estimated pile lengths and capacities of other feasible pile types that may be considered for the proposed structure are included in Pile Length/Pile Type, Exhibit F.

Table 4.2.1 – Estimated Pile Lengths for HP 8X36 H-pile

	Estimated Pile Tip Elevation (ft.)	R_n Nominal Required Bearing (kips)	R_F Factored Resistance Available (LRFD) (kips)	Estimated Pile Length (ft.)	Assumed Pile Cut-off Elevation (ft.)
West Abutment (1-S)	324.5	286	157	60	384.5
East Abutment (2-S)	323.5	286	157	61	384.5
Pier 1 (1-S)	323.5	286	157	61	384.5
Pier 2 (2-S)	322.5	286	157	62	384.5

Table 4.2.2 – Estimated Pile Lengths for HP 10X42 H-pile

	Estimated Pile Tip Elevation (ft.)	R_n Nominal Required Bearing (kips)	R_F Factored Resistance Available (LRFD) (kips)	Estimated Pile Length (ft.)	Assumed Pile Cut-off Elevation (ft.)
West Abutment (1-S)	324.5	335	184	60	384.5
East Abutment (2-S)	323.5	335	184	61	384.5
Pier 1 (1-S)	324.5	335	184	60	384.5
Pier 2 (2-S)	323.5	335	184	61	384.5

Table 4.2.3 – Estimated Pile Lengths for HP 12X53 H-pile

	Estimated Pile Tip Elevation (ft.)	R_n Nominal Required Bearing (kips)	R_F Factored Resistance Available (LRFD) (kips)	Estimated Pile Length (ft.)	Assumed Pile Cut-off Elevation (ft.)
West Abutment (1-S)	324.5	418	230	60	384.5
East Abutment (2-S)	323.5	418	230	61	384.5
Pier 1 (1-S)	324.5	418	230	60	384.5
Pier 2 (2-S)	323.5	418	230	61	384.5

Table 4.2.4 – Estimated Pile Lengths for HP 12X74 H-pile

	Estimated Pile Tip Elevation (ft.)	R_n Nominal Required Bearing (kips)	R_F Factored Resistance Available (LRFD) (kips)	Estimated Pile Length (ft.)	Assumed Pile Cut-off Elevation (ft.)
West Abutment (1-S)	320.5	589	324	64	384.5
East Abutment (2-S)	319.5	589	324	65	384.5
Pier 1 (1-S)	320.5	589	324	64	384.5
Pier 2 (2-S)	319.5	589	324	65	384.5

Table 4.2.5 – Estimated Pile Lengths for HP 14X73 H-pile

	Estimated Pile Tip Elevation (ft.)	R_n Nominal Required Bearing (kips)	R_F Factored Resistance Available (LRFD) (kips)	Estimated Pile Length (ft.)	Assumed Pile Cut-off Elevation (ft.)
West Abutment (1-S)	324.5	578	318	60	384.5
East Abutment (2-S)	323.5	578	318	61	384.5
Pier 1 (1-S)	323.5	578	318	61	384.5
Pier 2 (2-S)	322.5	578	318	62	384.5

Table 4.2.6 – Estimated Pile Lengths for HP 14X117 H-pile

	Estimated Pile Tip Elevation (ft.)	R_n Nominal Required Bearing (kips)	R_F Factored Resistance Available (LRFD) (kips)	Estimated Pile Length (ft.)	Assumed Pile Cut-off Elevation (ft.)
West Abutment (1-S)	318.5	929	511	66	384.5
East Abutment (2-S)	317.5	929	511	67	384.5
Pier 1 (1-S)	317.5	929	511	67	384.5
Pier 2 (2-S)	317.5	929	511	67	384.5

KEG recommends a test pile be performed at one of the abutments and at both pier locations. A test pile is performed prior to production driving so that actual, on-site field data can be gathered to further evaluate pile driving requirements for the project. This also is the manner in which the contractor's proposed equipment and methodologies identified in their Pile Installation Plan can be assessed.

4.3 Lateral Pile Response

Generally, the geotechnical engineer provides soil parameters to the structural engineer so that an L-Pile program or other approved software can be used for the lateral or displacement analysis of the foundations. Table 4.3 is included for the structural engineer's use in evaluating lateral pile response. The values were estimated based on the descriptions as listed on the boring logs. No specific hydrometer analyses were performed on the site soils for estimation of parameters.

Table 4.3 – Soil Parameters for Lateral Pile Load Analysis

Boring	Elev. At Bottom of Layer	γ (pcf)	Short-term		Long-term		K (pci)	N	Assumed % fines < #200	ε_{50}
			c'	Φ (degrees)	c'	Φ (degrees)				
East Abutment (2-S)	383.3	125	750	0	50	26	100	4	75	0.010
	378.3	125	3100	0	100	26	1000	6	80	0.005
	375.8	125	200	0	50	26	30	1	80	0.020
	373.3	125	2900	0	100	26	1000	8	80	0.005
	355.8	120	460	0	50	26	30	1	70	0.020
	326.3	125	2050	0	100	26	1000	8	80	0.005
West Abutment (1-S)	383.5	125	3300	0	100	26	1000	5	80	0.005
	378.5	125	1500	0	100	26	500	5	80	0.007
	376.0	125	600	0	50	26	100	2	80	0.010
	373.5	125	2300	0	100	26	1000	8	80	0.005
	361.0	120	560	0	50	26	100	2	70	0.010
	358.5	125	1800	0	100	26	500	5	80	0.007
	336.0	125	2800	0	100	26	1000	9	80	0.005
	331.0	115	0	28	0	28	20	4	3	N/A
	327.5	130	1200	0	50	36	500	18	3	0.007
Pier 1 (1-S)	361.0	120	560	0	50	26	100	2	70	0.010
	358.5	125	1800	0	100	26	500	5	80	0.007
	336.0	125	2800	0	100	26	1000	9	80	0.005
	331.0	115	0	28	0	28	20	4	3	N/A
	327.5	130	1200	0	50	36	500	18	3	0.007
Pier 2 (2-S)	355.8	120	460	0	50	26	30	1	70	0.020
	326.3	125	2050	0	100	26	1000	8	80	0.005

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.

5.2 Temporary Sheeting and Soil Retention

Since traffic will be maintained during construction utilizing cross-overs, temporary shoring should not be required at the substructure units; however, if during final design the use of temporary sheeting is determined to be necessary, the average unconfined compressive strength for an assumed embedment depth of 15 ft. is 1.5 tsf. The IDOT Temporary Sheet Piling Design Guide and Charts indicates that a Cantilevered Sheet Piling System would be feasible for retained heights up to 18 ft. However, if the retained height exceeds 18 ft., the design charts will no longer be feasible and a soil retention system will be required. An Illinois-licensed structural engineer is required to seal the design of the temporary soil retention system, if deemed necessary

5.3 Site and Soil Conditions

Should any bridge or embankment design considerations assumed by either IDOT or KEG change, KEG should be contacted to determine if the recommendations stated in this report still apply.

5.4 Foundation Construction

Conventional pile-driving equipment and methodologies should be assumed.

Prior to construction, a JULIE locate shall be conducted to determine if any underground utilities are present in the area of the proposed structure. IDOT shall also be contacted to locate any private utilities. If utilities become a problem during construction, the appropriate owner shall be contacted immediately.

5.5 Cofferdams

Cofferdams may be required at the proposed pier locations. The water surface elevation is not recorded on the provided boring logs; however, based off of the streambed elevation and the design high water elevation it should be anticipated that the surface water elevation will be greater than 6 ft. above the bottom elevation of the proposed pier foundations. Therefore, a Type 2 cofferdam will be required. All cofferdams are required to be dewatered. Cohesive silty clays and silty clay loam soils are present at the proposed sites of the cofferdams and proposed pier foundations and a use of a seal coat should not be required. If during construction pockets of sands and gravels are present at the pier foundation locations, a seal coat will reduce the potential for water from seeping beneath the cofferdam.

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 CM&T and IDOT. They are specific only to the project described and are based on the subsurface information obtained by IDOT at two boring locations in 2014, 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

USGS TOPOGRAPHIC LOCATION MAP

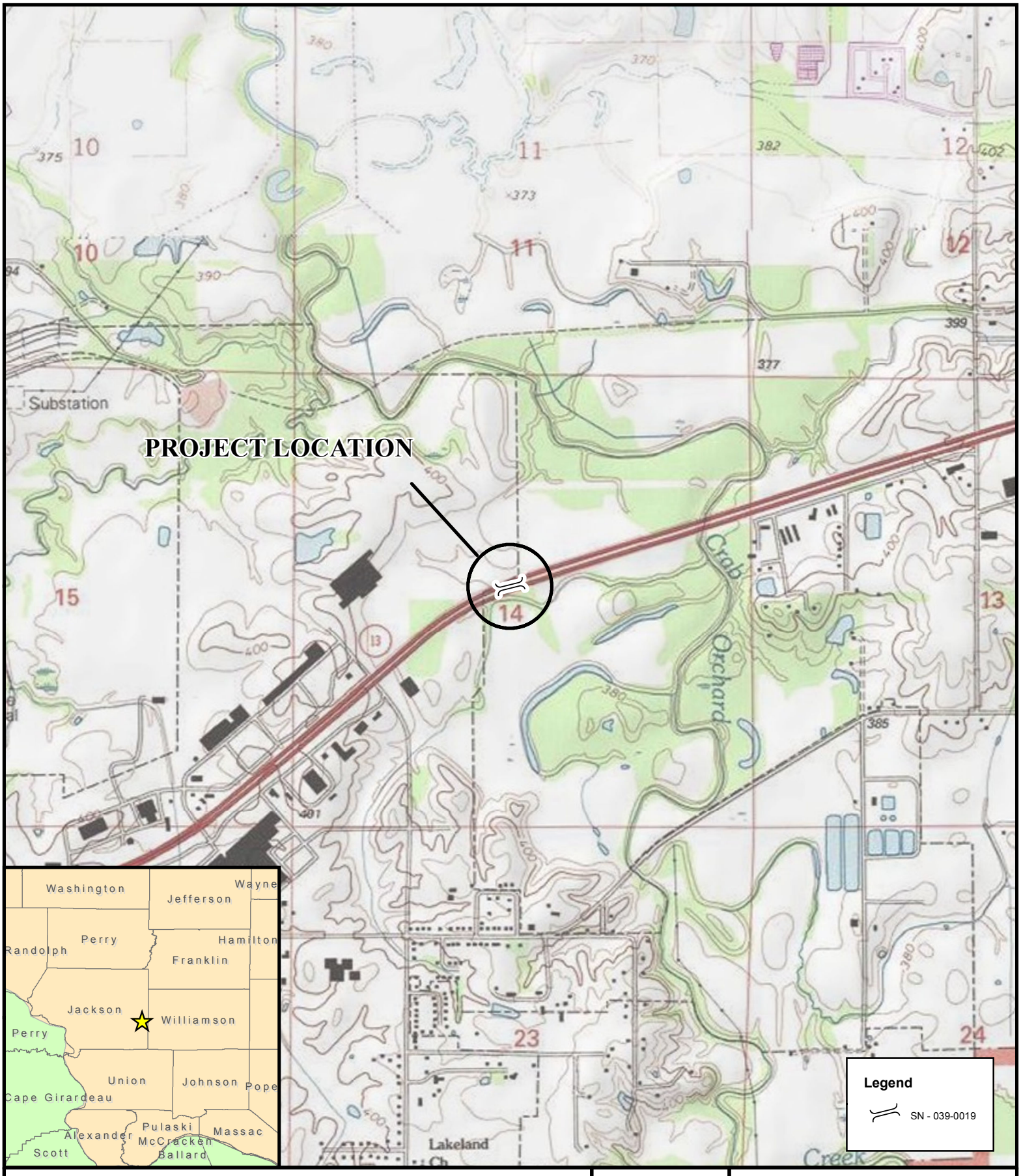


Exhibit A
Location Map
F.A.P. Route 331 (IL 13)
over Crab Orchard Creek Overflow
Jackson County, Illinois

N

Feet
0 500 1,000

Designed By: MMJ
Drawn By: MMJ
Checked By: CRG
Date: 03/30/16
Project #: 08-0061.18

Kaskaskia Engineering Group, LLC

EXHIBIT B

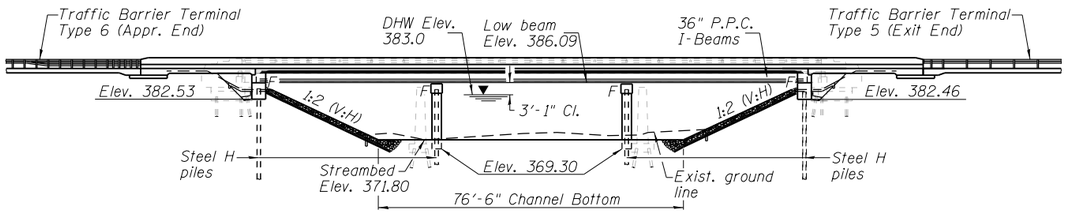
TYPE, SIZE, AND LOCATION PLAN (TS&L)

Bench Mark: Cut square on Southwest corner of Structure 039-0062 of Illinois Route 13 WBL @ Sta. 64+81±. Elev. 390.24

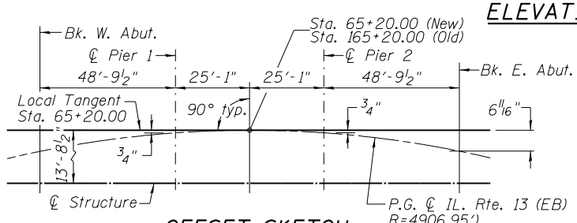
Existing Structure: S.N. 039-0019, built in 1965 is a three span 30WF108 beam bridge. Substructure consists of pile bent abutments supported on steel H-piles and solid wall pile bent piers supported on steel H-piles. Bk. to Bk. abutments measures 156'-0" and out-to-out width of 36'-7½".

Salvage: None

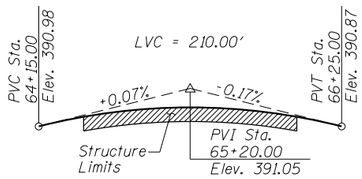
Traffic Maintenance: Traffic to be maintained utilizing median cross-overs.



ELEVATION



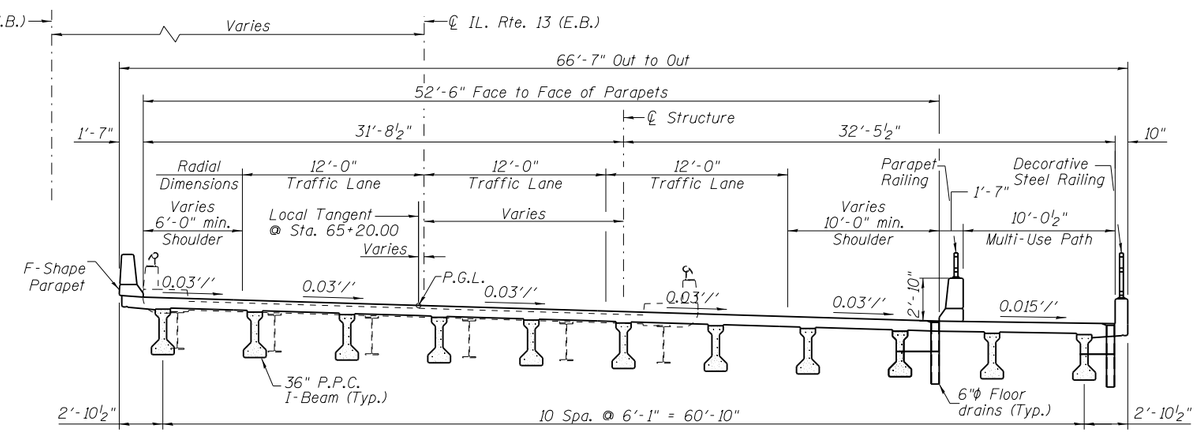
OFFSET SKETCH



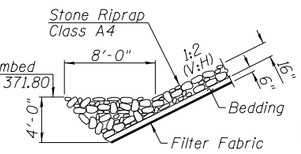
PROFILE GRADE
(Along ℄ IL. Rte. 13 E.B.)

CURVE DATA

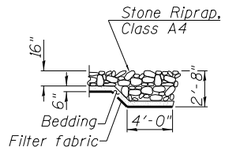
P.I. Sta. = 58+23.81
Δ = 22°27'48" Rt.
D = 1°10'04"
R = 4.906.95
T = 974.42'
L = 1.923.82'
E = 95.81
S.E. = 0.03'/'
P.C. Sta. = 48+49.39
P.T. Sta. = 67+73.20



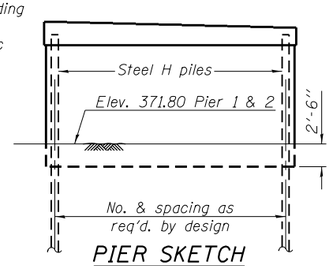
CROSS SECTION
(Looking East)



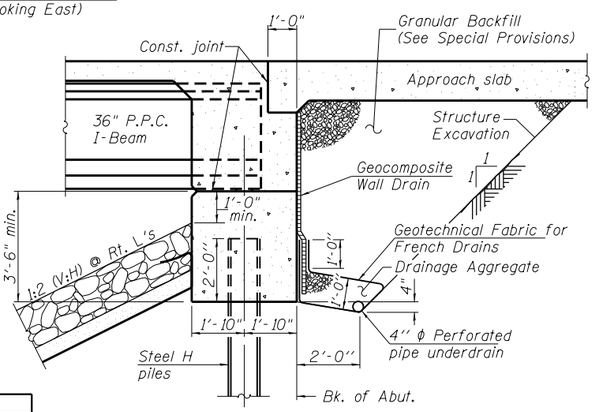
SECTION A-A



SECTION B-B



PIER SKETCH



SECTION THRU INTEGRAL ABUTMENT

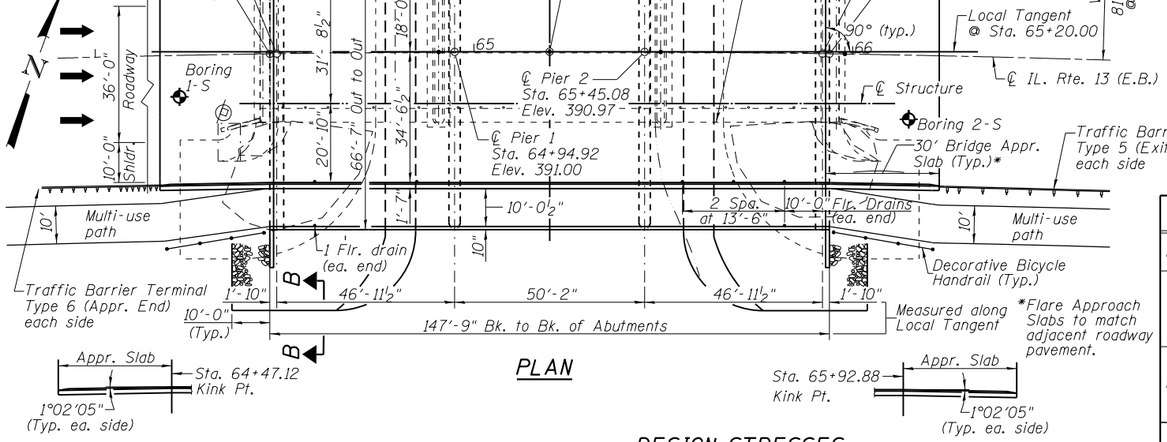
DESIGN SCOUR ELEVATION TABLE

Event / Limit State	Design Scour Elevations (ft.) W. Abut.	Pier 1	Pier 2	E. Abut.	Item 113
0100	382.53	369.30	369.30	382.46	8
0200	382.53	369.30	369.30	382.46	
Design	382.53	369.30	369.30	382.46	
Check	382.53	369.30	369.30	382.46	

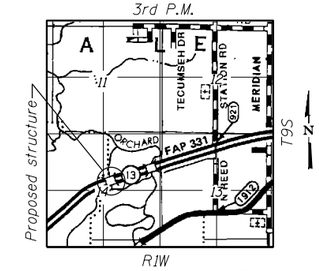
WATERWAY INFORMATION

Drainage Area = 255 Sq. Mi.
Exist. Low Grade Elev. 388.69 @ Sta. 80+50.00
Prop. Low Grade Elev. 388.88 @ Sta. 80+50.00

Flood	Freq. Yr.	Structure Number	Q (C.F.S.) Exist.	Prop.	Opening Sq. Ft. Exist.	Prop.	Nat. H.W.E.	Head - Ft. Exist.	Prop.	Headwater El. Exist.	Prop.
		039-0061/79	6,158	6.628	2,342	2,367					
	10	0'flow Culvert	186	137	67	67	381.2	0.2	0.1	381.4	381.3
		039-0062/78	2.056	1.635	779	772					
		Total	8,400		3,188	3,206					
		039-0061/79	8,788	9,417	2,682	2,715					
Design	50	0'flow Culvert	269	235	85	85	383.0	0.3	0.2	383.3	383.2
		039-0062/78	3,343	2,748	995	987					
		Total	12.400		3,762	3,787					
		039-0061/79	9,878	10,577	2,857	2,894					
Base	100	0'flow Culvert	326	269	94	94	383.9	0.3	0.3	384.2	384.2
		039-0062/78	3,896	3,254	1,109	1,099					
		Total	14.100		4,060	4,087					
		039-0061/79	11,055	11,616	2,995	3,036					
Scour Design Check	200	0'flow Culvert	379	332	101	101	384.6	0.4	0.3	385.0	384.9
		039-0062/78	4,576	4,062	1,200	1,189					
		Total	16,010		4,296	4,326					
		039-0061/79	12,694	12,917	3,116	3,158					
Max. Calc.	500	0'flow Culvert	417	393	107	107	385.2	0.5	0.4	385.7	385.6
		039-0062/78	5,389	5,190	1,279	1,268					
		Total	18,500		4,502	4,533					



PLAN



LOCATION SKETCH

HIGHWAY CLASSIFICATION

F.A.P. Rte. 331 (IL 13 W.B.)
Functional Class: Other Principal Arterial
ADT: 13,150 (2015); 19,328 (2032)
ADTT: 790 (2015); 1160 (2032)
DHV: 1,930
Design Speed: 65 m.p.h.
Posted Speed: 55 m.p.h.
One-Way Traffic
Directional Distribution: 100% EB

LOADING HL-93

Allow 50 psf for future wearing surface

DESIGN STRESSES

FIELD UNITS

f'c = 3,500 psi (concrete)
f'c = 4,000 psi (Superstr. concrete)
fy = 60,000 psi (Reinforcement)
fy = 50,000 psi (M270 Grade 50)

PRECAST PRESTRESSED UNITS

f'c = 6,000 psi (concrete)
f'ci = 5,000 psi
fpu = 270,000 psi (½"ϕ low lax strands)
fpbt = 201,960 psi (½"ϕ low lax strands)

DESIGN SPECIFICATIONS

2014 AASHTO LRFD Bridge Specifications, 7th Edition with 2015 & 2016 Interims

SEISMIC DATA

Seismic Performance Zone (SPZ) = 3
Design Spectral Acceleration at 1.0 sec (SD1) = 0.360g
Design Spectral Acceleration at 0.2 sec (SDS) = 0.845g
Soil Site Class = D

GENERAL PLAN
F.A.P. ROUTE 331 (IL 13 E.B.)
OVER CRAB ORCHARD CREEK
OVERFLOW
SECTION (5-3) B-5
JACKSON COUNTY
STATION 65+20.00
STRUCTURE NO. 039-0078

USER NAME =	DESIGNED	MJL	REVISED
	CHECKED	WLB/JMM	REVISED
PLOT SCALE =	DRAWN	GLD	REVISED
PLOT DATE =	CHECKED	WLB/JMM	REVISED

CMT

STATE OF ILLINOIS
DEPARTMENT OF TRANSPORTATION

GENERAL PLAN
STRUCTURE NO. 039-0078
SHEET NO. OF SHEETS

F.A.P. RTE.	SECTION	COUNTY	TOTAL SHEETS	SHEET NO.
331	(5-3)IR-1,N-1,B-5,BR-1,B-6,BR-2	JACKSON		
		CONTRACT NO. 78295		
	ILLINOIS FED. AID PROJECT			

L:\IDOT\080618\WD_18\Dgn\Sheets\...

EXHIBIT C

BORING LOGS

ILLINOIS DEPARTMENT OF TRANSPORTATION
District Nine Materials

Bridge Foundation Boring Log
Sheet 1 of 2

Eastbound FAP 331 (IL 13) Over Crab Orchard Creek Overflow
Route: FAP 331 (IL 13) Structure Number: 039-0019
Date: 6/25/2014
Section (5B-2) DR-1, (5B-2)
Bored By: R Moberly
County: Jackson Location: 0.4 mi East of Giant City Road
Checked By: R Graeff

Boring No 1-S
Station 164+22
Offset 11' Rt CL EBL
Ground Surface 390.5 Ft

Surf Wat Elev:
Ground Water Elevation
when Drilling 365.5
At Completion
At: Hrs:

DEPTH	BLOWS	Qu tsf	W%
4.5" Asphalt and 13.5" Concrete			
389.0			
Medium, very moist, grey and brow			
Clay A7-6	1	0.8B	25
	1		
386.0			
Very stiff, moist, grey, Clay A7-6 5.0	1		
	1	3.3B	19
	4		
383.5			
Stiff, moist, brown and grey, Clay	1		
A7-6	3	1.9B	21
	3		
10.0	1		
	2	1.1B	28
	2		
378.5			
Medium, verfy moist, brown,	WH		
Clay A7-6	1	0.6B	29
	1		
376.0			
Very stiff, moist, brown, Clay 15.0	1		
A7-6	3	2.3B	20
	5		
373.5			
Medium, very moist, grey mottled	1		
brown, Clay to silty Clay A7-6	1	0.8B	25
	2		
371.0			
Medium, very moist, grey mottled 20.0	1		
brown, Silty Clay Loam A-6	1	0.6B	27
	1		
368.5			
Soft, very moist, grey mottled	WH		
brown, Silty Clay Loam A-6	1	0.4B	28
	WH		
366.0			
25.0	WH		

DEPTH	BLOWS	Qu tsf	W%
Very soft, very moist, brown,	1	0.2B	30
Silty Clay Loam A-6	WH		
363.5			
Medium, very moist, grey mottled	WH		
brown, Silty Clay A-6	1	0.8B	30
	1		
361.0			
Stiff, moist, brown mottled grey, 30.0	1		
Clay A7-6	2	1.8B	30
	3		
358.5			
Very stiff, moist, brown and grey,	1		
Clay A7-6	2	2.7B	27
	3		
35.0	1		
	3	2.3B	31
	4		
	1		
	3	2.5B	32
	5		
40.0	2		
	4	2.9B	35
	5		
45.0	3		
	7	2.7B	26
	8		
50.0	2		

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

Route: FAP 331 (IL 13)
Date: 6/25/2014
Section: (5B-2) DR-1, (5B-2) DR
County: Jackson

Boring No: 1-S
Station: 164+22
Offset: 11' Rt CL EBL
Ground Surface: 390.5 Ft

	DEPTH	BLOWS	Qu tsf	W%
Very stiff, moist, brown, Clay A7-6		5 7	3.9B	25
336.0				
Loose to very loose, wet, grey,	55.0	1		
Fine Sand Loam		2		23
73% Sand		2		
16% Silt				
11% Clay				
331.0				
Stiff, moist, grey, brown and black,	60.0	1		
Conglomerate with weathered		7	1.2S	18
Clay Shale		11		
327.5				
Hard, dry, grey, Clay Shale				
	65.0	100/4"		
321.0				
Hard, dry, grey Clay Shale with	70.0	14		
layers of softer Shale and Coal		100/6"		
315.5	75.0	100/4"		

Bottom of hole = 74.8 feet

Free water observed at 25.0 feet

Elevation referenced to BM at SE corner of 039-0019; Elevation = 385.1 feet

Borehole advanced with hollow stem auger (8" O.D, 3.25" I.D.)

To convert "N" values to "N60" multiply by 1.25

DEPTH	BLOWS	Qu tsf	W%
80.0			
85.0			
90.0			
95.0			
100.0			

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
Sheet 1 of 2

Eastbound FAP 331 (IL 13) Over Crab Orchard Creek Overflow

Route: FAP 331 (IL 13) Structure Number: 039-0019 Date: 6/26/2014

Section (5B-2) DR-1, (5B-2) Bored By: R Moberly

County: Jackson Location: 0.4 mi East of Giant City Road Checked By: R Graeff

Boring No 2-S
Station 166+15
Offset 14' Rt CL EBL
Ground Surface 390.3 Ft

Surf Wat Elev:
Ground Water Elevation
when Drilling 363.3
At Completion
At: Hrs:

	DEPTH	BLOWS	Qu tsf	W%
Asphalt and crushed aggregate				
387.8		4		
Medium, very moist, grey, Clay A7-6 with Gravel		4	0.6E	20
		1		
	5.0	1		
		1	0.9B	26
		1		
383.3				
Very stiff, moist, brown, Clay A7-6		1		
		2	3.3B	20
		3		
	10.0	1		
		3	2.9B	21
		3		
378.3				
Very soft, very moist, grey, Clay A7-6 with stiffer layers (poor embankment construction)		WH		
		1	0.2B	31
		WH		
375.8				
Very stiff, moist, brown, Clay A7-6	15.0	1		
		4	2.9B	21
		4		
373.3				
Medium, moist to very moist, grey, Silty Clay A-6		1		
		2	0.9B	24
		2		
370.8				
Stiff, moist, grey mottled brown, Silty Clay Loam A-6	20.0	1		
		3	1.1B	26
		2		
368.3				
Soft, very moist, brown mottled grey, Silty Clay Loam A-6		WH		
		1	0.4B	28
		WH		
	25.0	WH		
Soft, very moist, brown mottled grey, Silty Clay Loam A-6		WH	0.3B	29
		1		
363.3				
Very soft, wet, brown mottled grey, Silty Clay A-6		WH		
		WH	0.2B	31
		WH		
	30.0	WH		
		WH	0.1B	32
		WH		
		WH		
		WH	0.2B	30.
		WH		
355.8				
Very stiff, moist, grey mottled brown, Clay A7-6	35.0	1		
		2	2.5B	31
		3		
353.3				
Very stiff, moist, brown mottled grey, Clay A7-6		1		
		3	2.5S	28
		5		
	40.0	1		
		3	2.3B	32
		4		
	45.0	2		
		5	2.3B	28
		7		
340.8				
Stiff, moist, brown, Clay A7-6	50.0	2		

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

Route: FAP 331 (IL 13)
Section: (5B-2) DR-1, (5B-2) DR
County: Jackson

Date: 6/26/2014

Boring No: 2-S
Station: 166+15
Offset: 14' Rt CL EBL
Ground Surface: 390.3 Ft

	DEPTH	BLOWS	Qu tsf	W%		DEPTH	BLOWS	Qu tsf	W%
Stiff, moist, brown, Clay A7-6		3 4	1.5B	27					
335.8									
Stiff, moist, brown, Clay A7-6 with sand seams	55.0	1 3 4	1.7B	26		80.0			
330.8									
Stiff, moist, grey and brown, Clay A7-6 with some gravel	60.0	1 3 4	1.5B	23		85.0			
326.3									
Hard, dry grey, weathered Clay Shale	65.0	14 100/12				90.0			
324.8									
Hard, dry, grey Clay Shale 324.3									
Bottom of hole = 66.0 feet									
Free water observed at 27.0 feet	70.0					95.0			
Elevation referenced to BM at SE corner of 039-0019; Elevation = 385.1 feet									
Borehole advanced with hollow stem auger (8" O.D, 3.25" I.D.)									
To convert "N" values to "N60" multiply by 1.25	75.0					100.0			

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

Elevation (ft)

400
390
380
370
360
350
340
330
320
310

Boring 1-S

Top El. 390.5

N	Qu	w%	
			4.5" Asphalt and 13.5" Concrete
1	0.8	25	Medium, very moist, grey and brown Clay A7-6
5	3.3	19	Very stiff, moist, grey, Clay A7-6
6	1.9	21	
4	1.1	28	Stiff, moist, brown and grey, Clay A7-6
2	0.6	29	Medium, very moist, brown, Clay A7-6
8	2.3	20	Very stiff, moist, brown, Clay A7-6
3	0.8	25	Medium, very moist, grey mottled brown, Clay to Silty Clay A7-6
2	0.6	27	Medium, very moist, grey mottled brown, Silty Clay Loam A-6
1	0.4	28	Soft, very moist, grey mottled brown, Silty Clay Loam A-6
1	0.2	30	Very soft, very moist, brown, Silty Clay Loam A-6
2	0.8	30	Medium, very moist, grey mottled brown, Silty Clay A-6
5	1.8	30	Stiff, moist, brown mottled grey, Clay A7-6
5	2.7	27	
7	2.3	31	
8	2.5	32	
9	2.9	35	
15	2.7	26	Very stiff, moist, brown and grey, Clay A7-6
12	3.9	25	
4	-	23	Loose to very loose, wet, grey, Fine Sand Loam
18	1.2	18	Stiff, moist, grey, brown and black, Conglomerate with weathered Clay Shale
100/4"	-	-	Hard, dry, grey, Clay Shale
100/6"	-	-	
100/4"	-	-	Hard, dry, grey, Clay Shale with layers of softer Shale and Coal
			Bot. El. 315.7

Boring 2-S

Top El. 390.3

N	Qu	w%	
			Asphalt and crushed aggregate
5	0.6	20	
2	0.9	26	Medium, very moist, grey, Clay A7-6 with Gravel
5	3.3	20	
6	2.9	21	Very stiff, moist, brown, Clay A7-6
1	0.2	31	Very soft, very moist, grey, Clay A7-6 with stiffer layers (poor embankment construction)
8	2.9	21	Very stiff, moist, brown, Clay A7-6
4	0.9	24	Medium, moist to very moist, grey, Silty Clay A-6
5	1.1	26	Stiff, moist, grey mottled brown, Silty Clay Loam A-6
1	0.4	28	
1	0.3	29	Soft, very moist, brown mottled grey, Silty Clay Loam A-6
0	0.2	31	
0	0.1	32	Very soft, wet, brown mottled grey, Silty Clay A-6
0	0.2	30	
5	2.5	31	Very stiff, moist, grey mottled brown, Clay A7-6
8	2.5	28	
7	2.3	32	
12	2.3	28	Very stiff, moist, brown mottled grey, Clay A7-6
7	1.5	27	Stiff, moist, brown, Clay A7-6
7	1.7	26	Stiff, moist, brown, Clay A7-6 with sand seams
7	1.5	23	Stiff, moist, grey and brown, Clay A7-6 with some gravel
100/12"	-	-	Hard, dry, grey, weathered Clay Shale
			Hard, dry, grey, Clay Shale
			Bot. El. 324.3

Kaskaskia Engineering Group, LLC

SUBSURFACE PROFILE: IL 13 over Crab Orchard Creek Overflow (SN 039-0019)

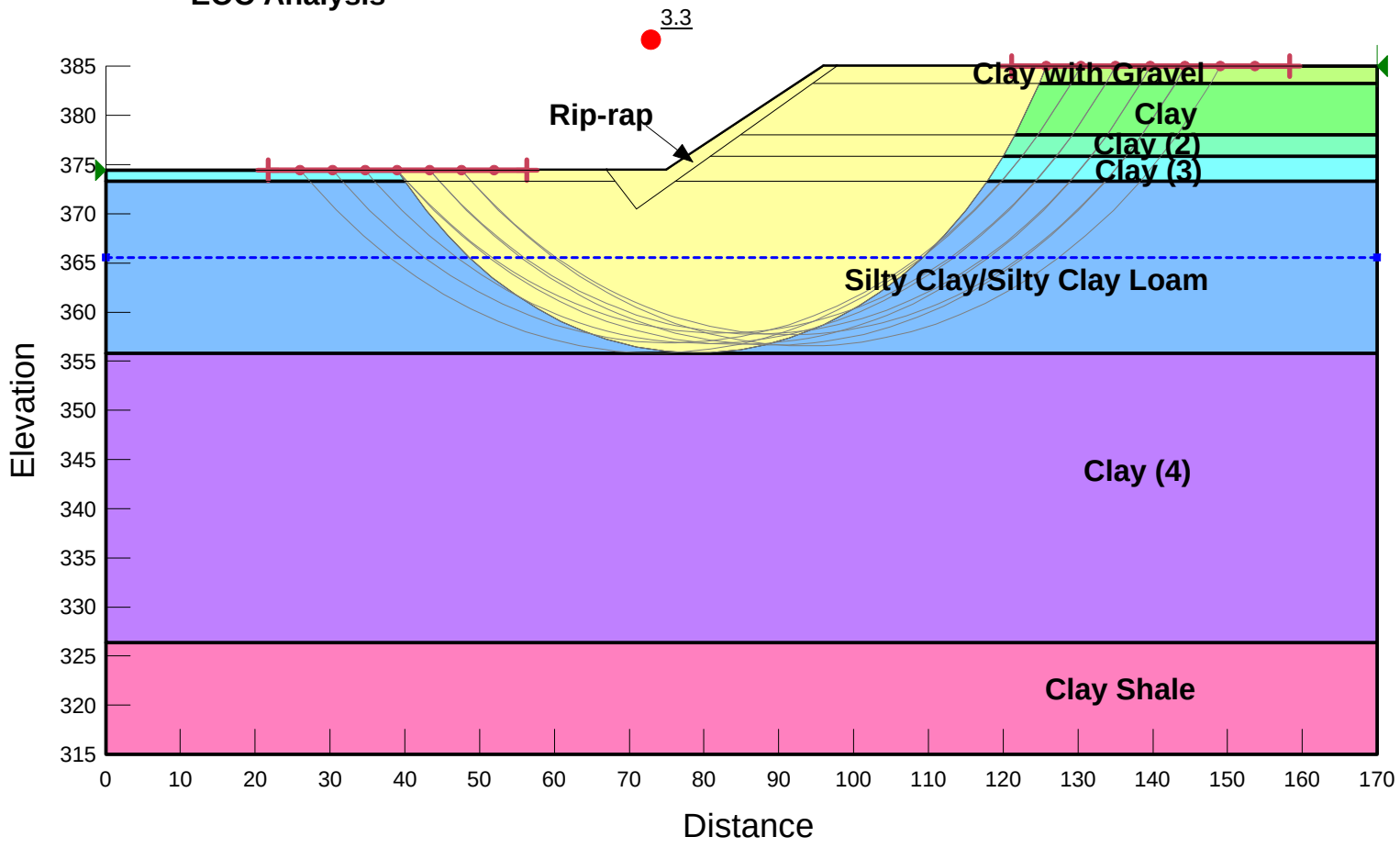
Route: F.A.P. 331
Section: (5B-2) DR-1, (5B-2)
County: Jackson

PRINTERMOD2 11X17 08-0061.18 IL 13 OVER CRAB ORCHARD CREEK OVERFLOW SN 039-0019.GPJ IL_DOT.GDT 12/23/15

EXHIBIT E

SLOPE/W SLOPE STABILITY ANALYSIS

IL 13 over Crab Orchard Creek Overflow (SN 039-0019)
East Abutment (Boring 2-S)
EOC Analysis



Name: Rip-rap
Unit Weight: 145 pcf
Cohesion': 0 psf
Phi': 42 °

Name: Clay with Gravel
Unit Weight: 125 pcf
Cohesion': 750 psf
Phi': 0 °

Name: Clay
Unit Weight: 125 pcf
Cohesion': 3,100 psf
Phi': 0 °

Name: Clay (2)
Unit Weight: 125 pcf
Cohesion': 200 psf
Phi': 0 °

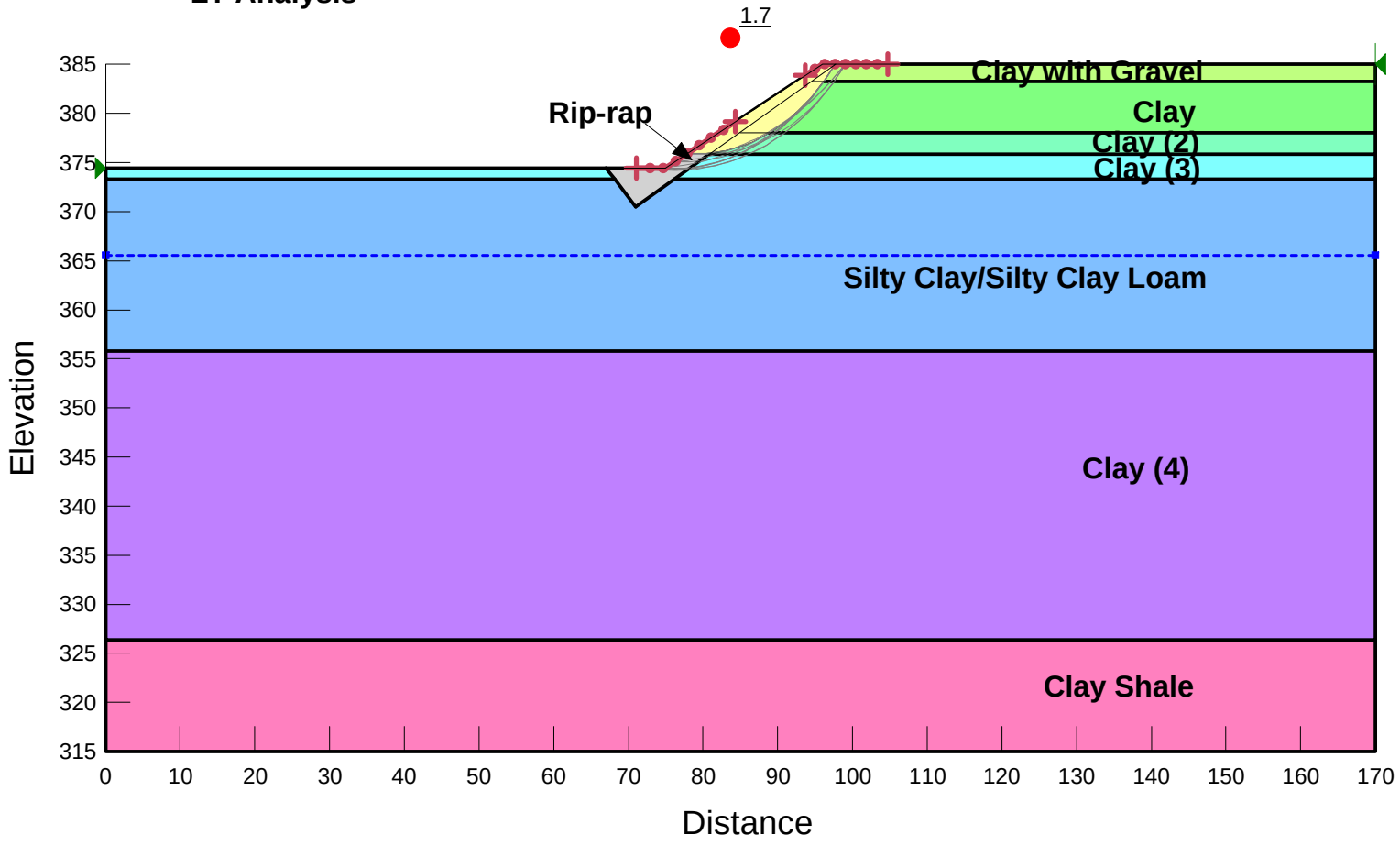
Name: Clay (3)
Unit Weight: 125 pcf
Cohesion': 2,900 psf
Phi': 0 °

Name: Silty Clay/Silty Clay Loam
Unit Weight: 120 pcf
Cohesion': 460 psf
Phi': 0 °

Name: Clay (4)
Unit Weight: 125 pcf
Cohesion': 2,050 psf
Phi': 0 °

Name: Clay Shale
Unit Weight: 125 pcf
Cohesion': 0 psf
Phi': 12 °

IL 13 over Crab Orchard Creek Overflow (SN 039-0019)
East Abutment (Boring 2-S)
LT Analysis



Name: Rip-rap
Unit Weight: 145 pcf
Cohesion': 0 psf
Phi': 42 °

Name: Clay with Gravel
Unit Weight: 125 pcf
Cohesion': 50 psf
Phi': 26 °

Name: Clay
Unit Weight: 125 pcf
Cohesion': 100 psf
Phi': 26 °

Name: Clay (2)
Unit Weight: 125 pcf
Cohesion': 50 psf
Phi': 26 °

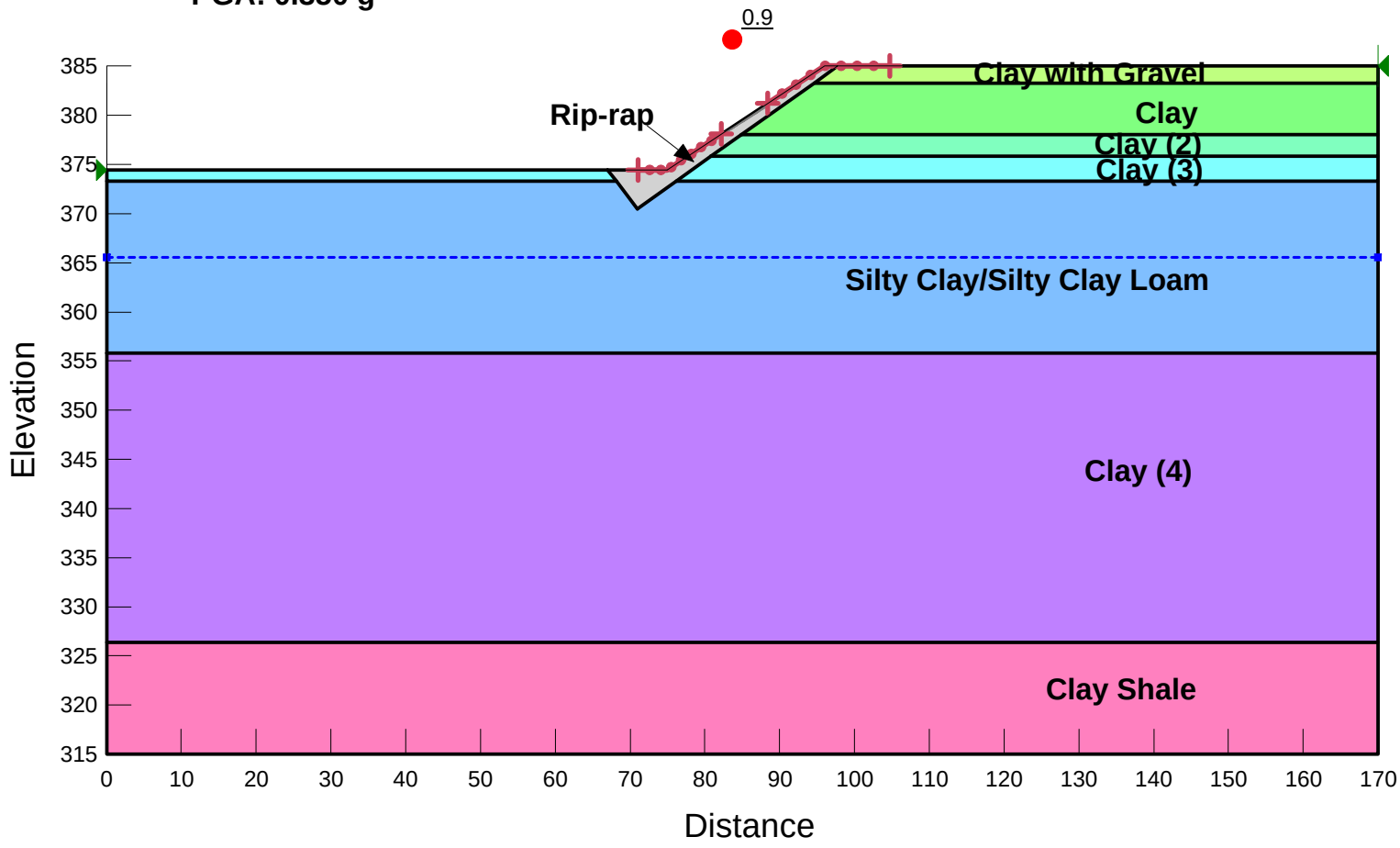
Name: Clay (3)
Unit Weight: 125 pcf
Cohesion': 100 psf
Phi': 26 °

Name: Silty Clay/Silty Clay Loam
Unit Weight: 120 pcf
Cohesion': 50 psf
Phi': 26 °

Name: Clay (4)
Unit Weight: 125 pcf
Cohesion': 100 psf
Phi': 26 °

Name: Clay Shale
Unit Weight: 125 pcf
Cohesion': 0 psf
Phi': 12 °

IL 13 over Crab Orchard Creek Overflow (SN 039-0019)
East Abutment (Boring 2-S)
Seismic Analysis
PGA: 0.350 g



Name: Rip-rap
Unit Weight: 145 pcf
Cohesion': 0 psf
Phi': 42 °

Name: Clay with Gravel
Unit Weight: 125 pcf
Cohesion': 50 psf
Phi': 26 °

Name: Clay
Unit Weight: 125 pcf
Cohesion': 100 psf
Phi': 26 °

Name: Clay (2)
Unit Weight: 125 pcf
Cohesion': 50 psf
Phi': 26 °

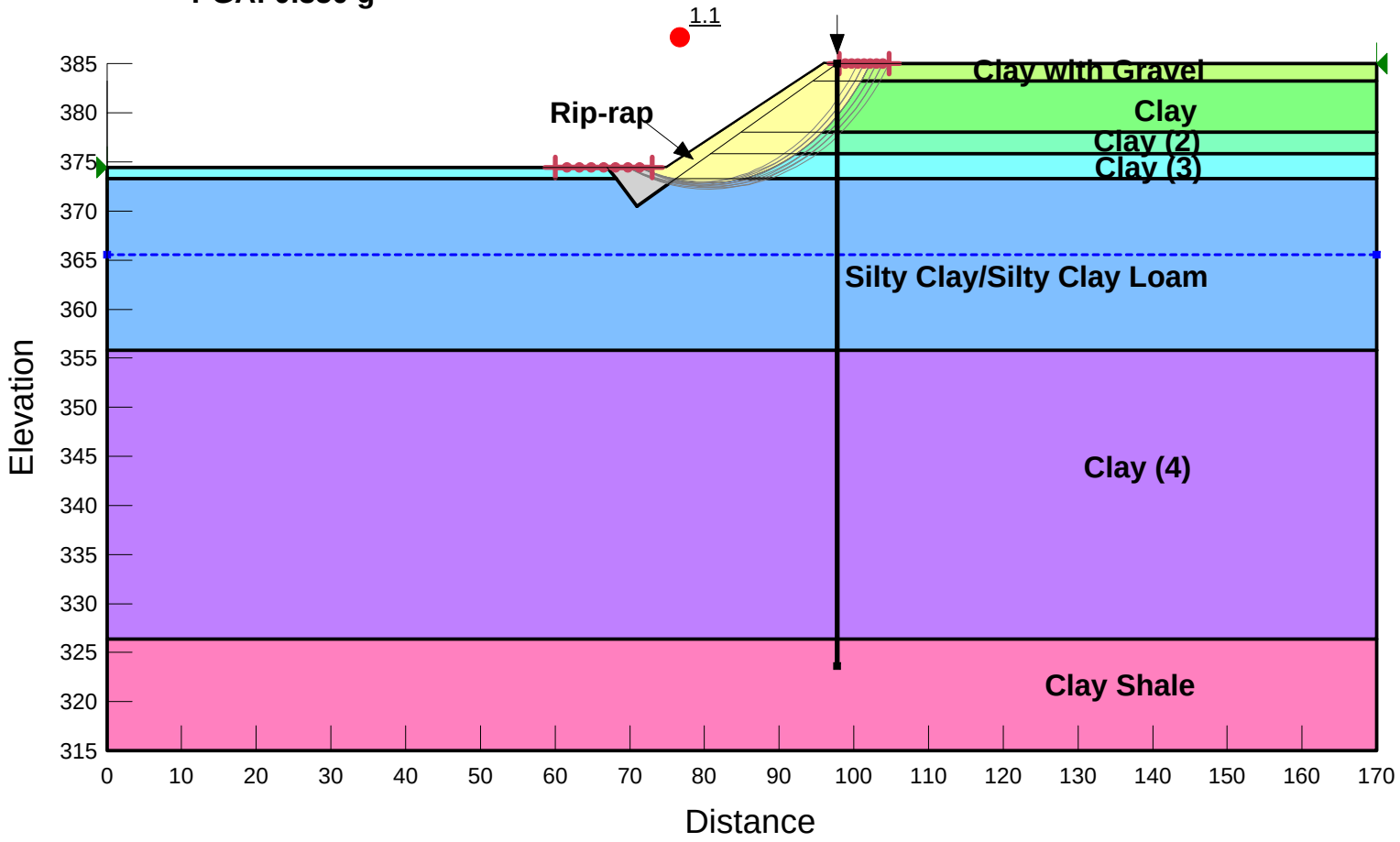
Name: Clay (3)
Unit Weight: 125 pcf
Cohesion': 100 psf
Phi': 26 °

Name: Silty Clay/Silty Clay Loam
Unit Weight: 120 pcf
Cohesion': 50 psf
Phi': 26 °

Name: Clay (4)
Unit Weight: 125 pcf
Cohesion': 100 psf
Phi': 26 °

Name: Clay Shale
Unit Weight: 125 pcf
Cohesion': 0 psf
Phi': 12 °

IL 13 over Crab Orchard Creek Overflow (SN 039-0019)
East Abutment (Boring 2-S) w/ Abutment Pile
Seismic Analysis
PGA: 0.350 g



Name: Rip-rap
Unit Weight: 145 pcf
Cohesion': 0 psf
Phi': 42 °

Name: Clay with Gravel
Unit Weight: 125 pcf
Cohesion': 50 psf
Phi': 26 °

Name: Clay
Unit Weight: 125 pcf
Cohesion': 100 psf
Phi': 26 °

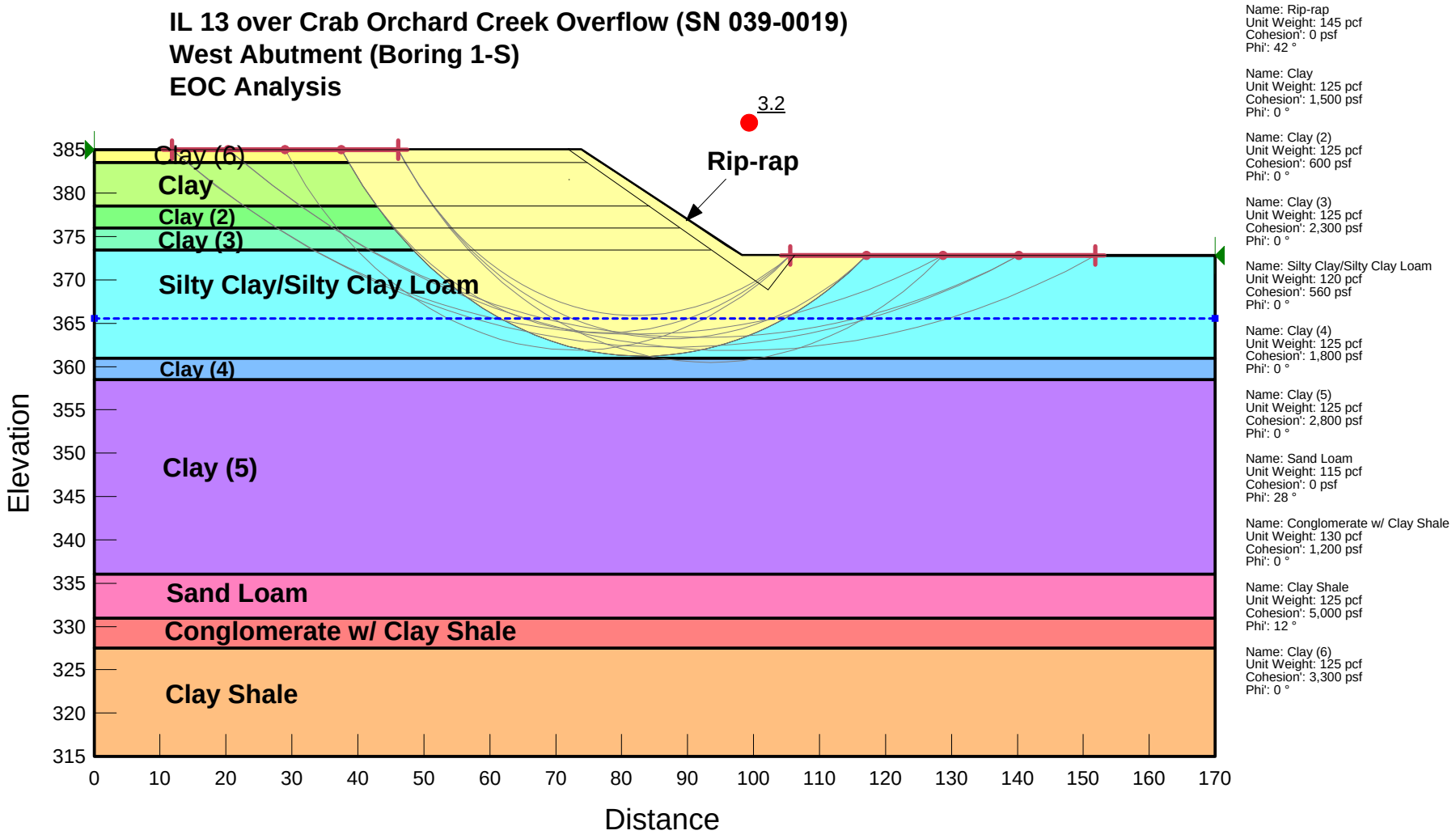
Name: Clay (2)
Unit Weight: 125 pcf
Cohesion': 50 psf
Phi': 26 °

Name: Clay (3)
Unit Weight: 125 pcf
Cohesion': 100 psf
Phi': 26 °

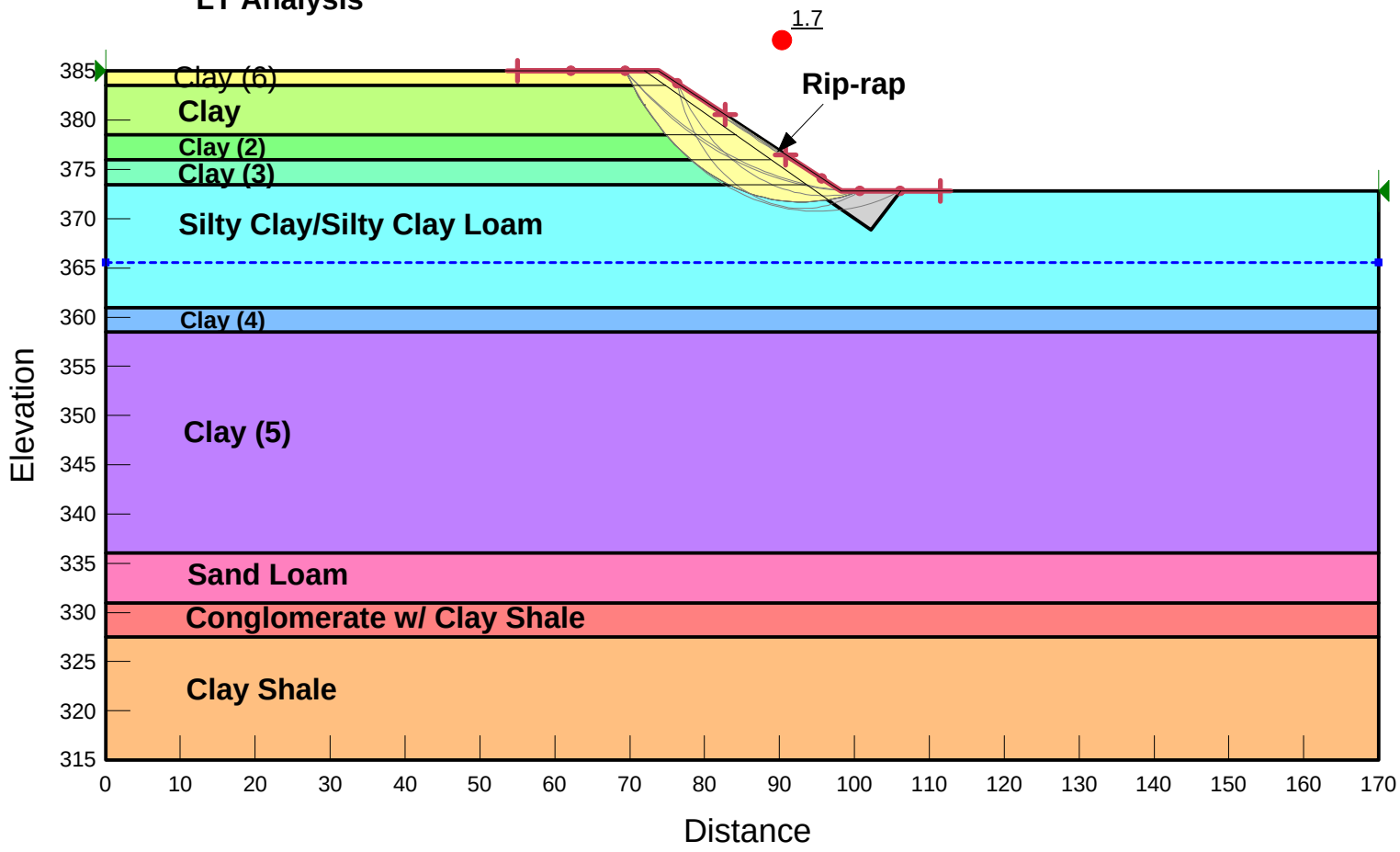
Name: Silty Clay/Silty Clay Loam
Unit Weight: 120 pcf
Cohesion': 50 psf
Phi': 26 °

Name: Clay (4)
Unit Weight: 125 pcf
Cohesion': 100 psf
Phi': 26 °

Name: Clay Shale
Unit Weight: 125 pcf
Cohesion': 0 psf
Phi': 12 °


IL 13 over Crab Orchard Creek Overflow (SN 039-0019)
West Abutment (Boring 1-S)
EOC Analysis
3.2
Rip-rap
Clay (6)
Clay
Clay (2)
Clay (3)
Silty Clay/Silty Clay Loam
Clay (4)
Clay (5)
Sand Loam
Conglomerate w/ Clay Shale
Clay Shale
Elevation
385
380
375
370
365
360
355
350
345
340
335
330
325
320
315
0
10
20
30
40
50
60
70
80
90
100
110
120
130
140
150
160
170
Distance
Name: Rip-rap
Unit Weight: 145 pcf
Cohesion': 0 psf
Phi': 42 °
Name: Clay
Unit Weight: 125 pcf
Cohesion': 1,500 psf
Phi': 0 °
Name: Clay (2)
Unit Weight: 125 pcf
Cohesion': 600 psf
Phi': 0 °
Name: Clay (3)
Unit Weight: 125 pcf
Cohesion': 2,300 psf
Phi': 0 °
Name: Silty Clay/Silty Clay Loam
Unit Weight: 120 pcf
Cohesion': 560 psf
Phi': 0 °
Name: Clay (4)
Unit Weight: 125 pcf
Cohesion': 1,800 psf
Phi': 0 °
Name: Clay (5)
Unit Weight: 125 pcf
Cohesion': 2,800 psf
Phi': 0 °
Name: Sand Loam
Unit Weight: 115 pcf
Cohesion': 0 psf
Phi': 28 °
Name: Conglomerate w/ Clay Shale
Unit Weight: 130 pcf
Cohesion': 1,200 psf
Phi': 0 °
Name: Clay Shale
Unit Weight: 125 pcf
Cohesion': 5,000 psf
Phi': 12 °
Name: Clay (6)
Unit Weight: 125 pcf
Cohesion': 3,300 psf
Phi': 0 °

IL 13 over Crab Orchard Creek Overflow (SN 039-0019)
West Abutment (Boring 1-S)
LT Analysis



Name: Rip-rap
Unit Weight: 145 pcf
Cohesion': 0 psf
Phi': 42 °

Name: Clay
Unit Weight: 125 pcf
Cohesion': 100 psf
Phi': 26 °

Name: Clay (2)
Unit Weight: 125 pcf
Cohesion': 50 psf
Phi': 26 °

Name: Clay (3)
Unit Weight: 125 pcf
Cohesion': 100 psf
Phi': 26 °

Name: Silty Clay/Silty Clay Loam
Unit Weight: 120 pcf
Cohesion': 50 psf
Phi': 26 °

Name: Clay (4)
Unit Weight: 125 pcf
Cohesion': 100 psf
Phi': 26 °

Name: Clay (5)
Unit Weight: 125 pcf
Cohesion': 100 psf
Phi': 26 °

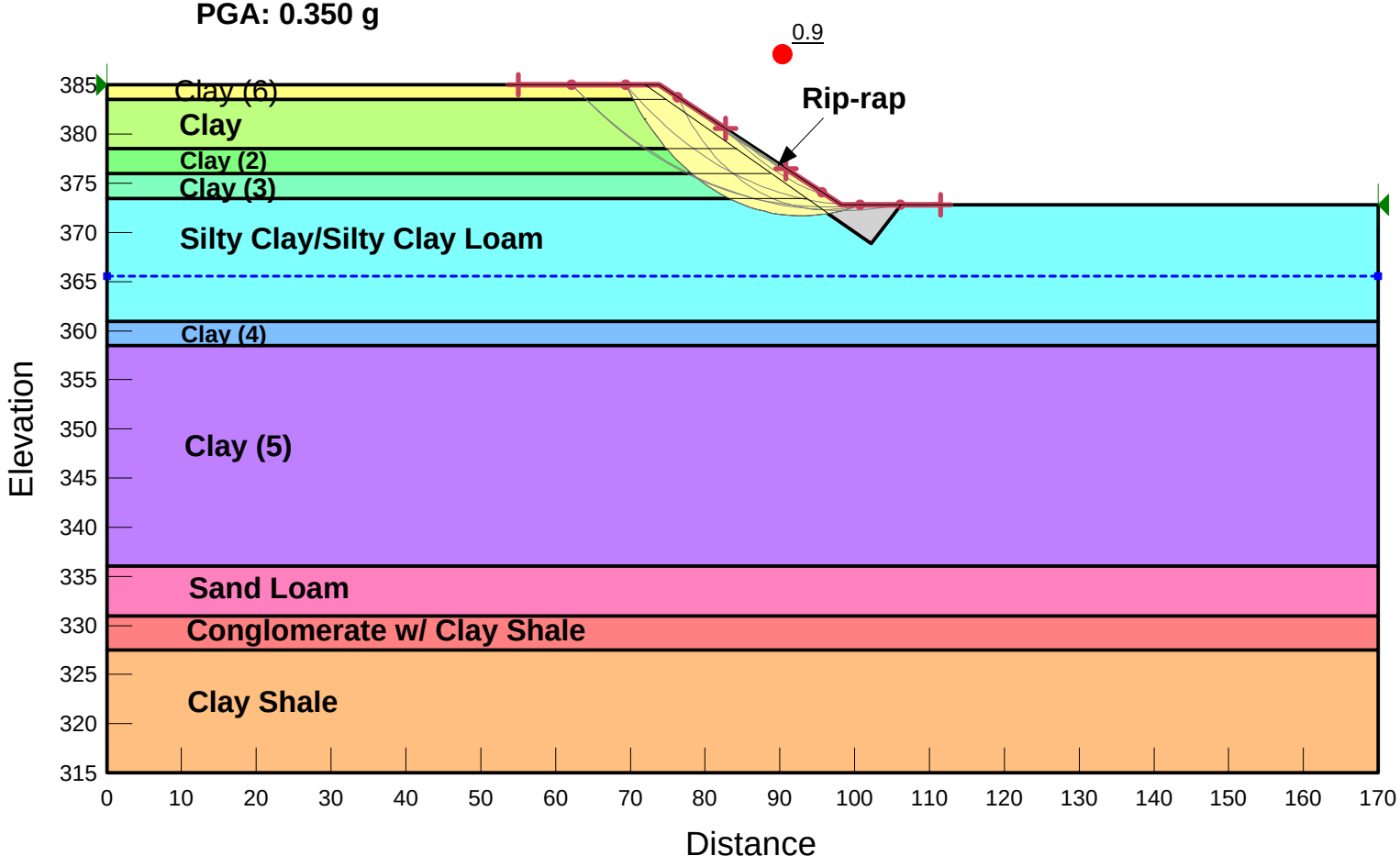
Name: Sand Loam
Unit Weight: 115 pcf
Cohesion': 0 psf
Phi': 28 °

Name: Conglomerate w/ Clay Shale
Unit Weight: 130 pcf
Cohesion': 50 psf
Phi': 36 °

Name: Clay Shale
Unit Weight: 125 pcf
Cohesion': 5,000 psf
Phi': 12 °

Name: Clay (6)
Unit Weight: 125 pcf
Cohesion': 100 psf
Phi': 26 °

IL 13 over Crab Orchard Creek Overflow (SN 039-0019)
West Abutment (Boring 1-S)
Seismic Analysis
PGA: 0.350 g



Name: Rip-rap
Unit Weight: 145 pcf
Cohesion': 0 psf
Phi': 42 °

Name: Clay
Unit Weight: 125 pcf
Cohesion': 100 psf
Phi': 26 °

Name: Clay (2)
Unit Weight: 125 pcf
Cohesion': 50 psf
Phi': 26 °

Name: Clay (3)
Unit Weight: 125 pcf
Cohesion': 100 psf
Phi': 26 °

Name: Silty Clay/Silty Clay Loam
Unit Weight: 120 pcf
Cohesion': 50 psf
Phi': 26 °

Name: Clay (4)
Unit Weight: 125 pcf
Cohesion': 100 psf
Phi': 26 °

Name: Clay (5)
Unit Weight: 125 pcf
Cohesion': 100 psf
Phi': 26 °

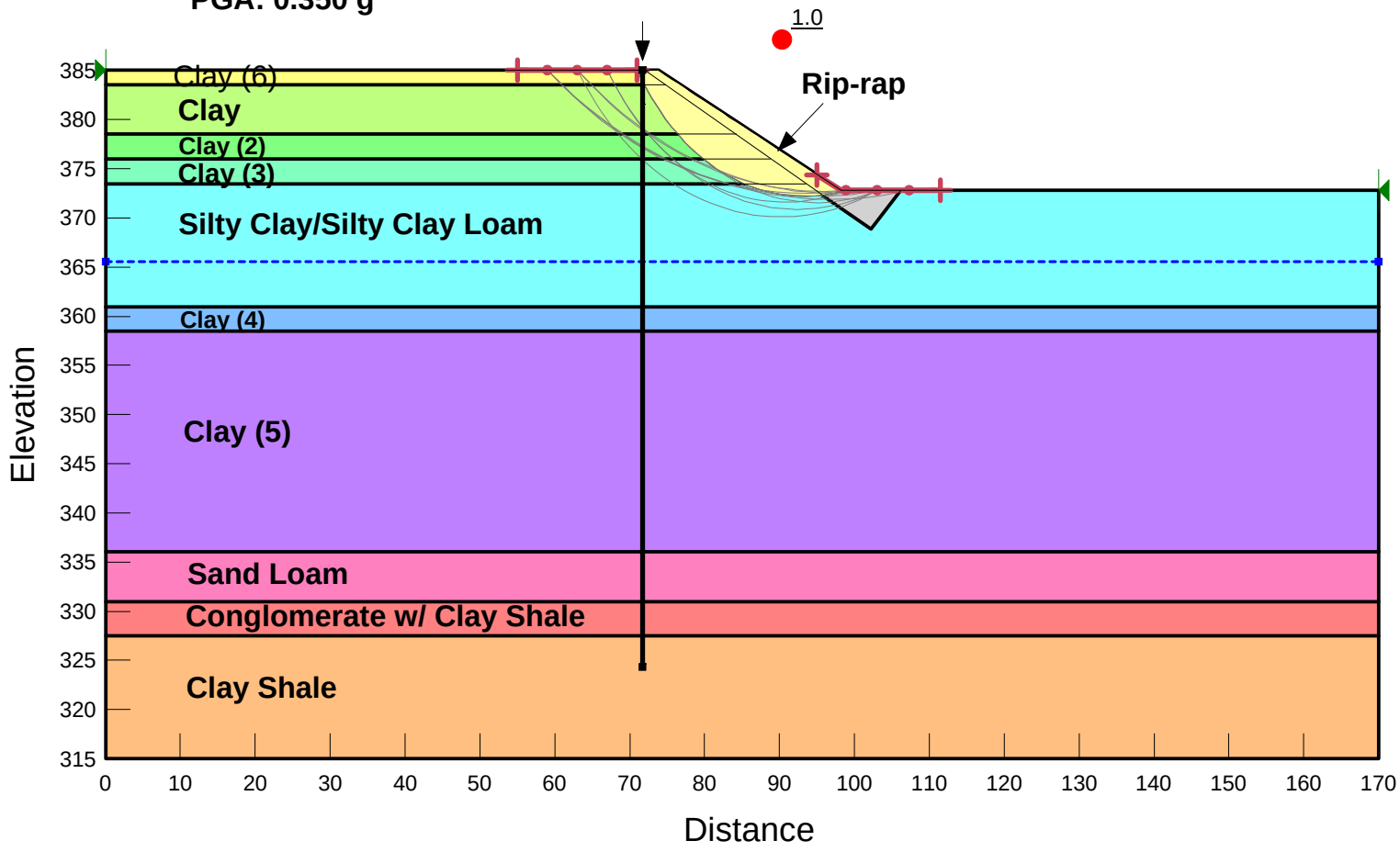
Name: Sand Loam
Unit Weight: 115 pcf
Cohesion': 0 psf
Phi': 28 °

Name: Conglomerate w/ Clay Shale
Unit Weight: 130 pcf
Cohesion': 50 psf
Phi': 36 °

Name: Clay Shale
Unit Weight: 125 pcf
Cohesion': 5,000 psf
Phi': 12 °

Name: Clay (6)
Unit Weight: 125 pcf
Cohesion': 100 psf
Phi': 26 °

IL 13 over Crab Orchard Creek Overflow (SN 039-0019)
West Abutment (Boring 1-S) w/ Abutment Pile
Seismic Analysis
PGA: 0.350 g



Name: Rip-rap
Unit Weight: 145 pcf
Cohesion': 0 psf
Phi': 42 °

Name: Clay
Unit Weight: 125 pcf
Cohesion': 100 psf
Phi': 26 °

Name: Clay (2)
Unit Weight: 125 pcf
Cohesion': 50 psf
Phi': 26 °

Name: Clay (3)
Unit Weight: 125 pcf
Cohesion': 100 psf
Phi': 26 °

Name: Silty Clay/Silty Clay Loam
Unit Weight: 120 pcf
Cohesion': 50 psf
Phi': 26 °

Name: Clay (4)
Unit Weight: 125 pcf
Cohesion': 100 psf
Phi': 26 °

Name: Clay (5)
Unit Weight: 125 pcf
Cohesion': 100 psf
Phi': 26 °

Name: Sand Loam
Unit Weight: 115 pcf
Cohesion': 0 psf
Phi': 28 °

Name: Conglomerate w/ Clay Shale
Unit Weight: 130 pcf
Cohesion': 50 psf
Phi': 36 °

Name: Clay Shale
Unit Weight: 125 pcf
Cohesion': 5,000 psf
Phi': 12 °

Name: Clay (6)
Unit Weight: 125 pcf
Cohesion': 100 psf
Phi': 26 °

EXHIBIT F

PILE LENGTH/PILE TYPE

IDOT STATIC METHOD OF ESTIMATING PILE LENGTH

I.D.O.T. BBS FOUNDATIONS AND GEOTECHNICAL UNIT

Modified 10/18/2011

SUBSTRUCTURE========== west abut.
REFERENCE BORING ========== 1-S
LRFD or ASD or SEISMIC ========== LRFD
PILE CUTOFF ELEV. ========== 384.50 ft
GROUND SURFACE ELEV. AGAINST PILE DURING DRI 379.50 ft
GEOTECHNICAL LOSS TYPE (None, Scour, Liquef., DD) None
BOTTOM ELEV. OF SCOUR, LIQUEF., or DD ========== ft
TOP ELEV. OF LIQUEF. (so layers above apply DD) ========== ft

TOTAL FACTORED SUBSTRUCTURE LOAD ========== 1868 kips
TOTAL LENGTH OF SUBSTRUCTURE (along skew)==== 62.00 ft
NUMBER OF ROWS OF PILES PER SUBSTRUCTURE = 1
Approx. Factored Loading Applied per pile at 8 ft. Cts ===== 241.03 KIPS
Approx. Factored Loading Applied per pile at 3 ft. Cts ===== 90.39 KIPS

PILE TYPE AND SIZE ========== Steel HP 12 X 74
Plugged Pile Perimeter========== 4.050 FT. Unplugged Pile Perimeter========== 5.908 FT.
Plugged Pile End Bearing Area========== 1.025 SQFT. Unplugged Pile End Bearing Area===== 0.151 SQFT.

MAX. REQUIRED BEARING & RESISTANCE for Selected Pile, Soil Profile, & Losses

Maximum Nominal Req'd Bearing of Pile	Maximum Nominal Req.d Bearing of Boring	Maximum Factored Resistance Available in Boring	Maximum Pile Driveable Length in Boring
589 KIPS	**589** KIPS	**324** KIPS	**64** FT.

BOT. OF LAYER ELEV. (FT.)	LAYER THICK. (FT.)	UNCONF. COMPR. STRENGTH (TSF.)	S.P.T. N VALUE (BLOWS)	GRANULAR OR ROCK LAYER DESCRIPTION	NOMINAL PLUGGED SIDE RESIST. (KIPS)	NOMINAL PLUGGED END BRG. RESIST. (KIPS)	NOMINAL PLUGGED TOTAL RESIST. (KIPS)	NOMINAL UNPLUG'D SIDE RESIST. (KIPS)	NOMINAL UNPLUG'D END BRG. RESIST. (KIPS)	NOMINAL UNPLUG'D TOTAL RESIST. (KIPS)	NOMINAL REQ'D BEARING (KIPS)	FACTORED GEOTECH. LOSS FROM SCOUR or DD (KIPS)	FACTORED GEOTECH. LOSS LOAD FROM DD (KIPS)	FACTORED RESISTANCE AVAILABLE (KIPS)	ESTIMATED PILE LENGTH (FT.)
378.50	1.00	1.10			3.1		11.7	4.5		***5.8***	6	0	0	3	6
376.00	2.50	0.60			4.7	8.6	40.8	6.8	1.3	***16.2***	16	0	0	9	9
373.50	2.50	2.30			12.9	33.0	32.1	18.8	4.9	***31.8***	32	0	0	18	11
371.00	2.50	0.80			6.0	11.5	***35.3***	8.7	1.7	40.1	35	0	0	19	14
368.50	2.50	0.60			4.7	8.6	***37.0***	6.8	1.3	46.5	37	0	0	20	16
366.00	2.50	0.40			3.2	5.7	***37.4***	4.7	0.8	50.8	37	0	0	21	19
363.50	2.50	0.20			1.7	2.9	***47.7***	2.4	0.4	54.5	48	0	0	26	21
361.00	2.50	0.80			6.0	11.5	68.0	8.7	1.7	***65.3***	65	0	0	36	24
358.50	2.50	1.80			11.0	25.9	91.9	16.1	3.8	***83.3***	83	0	0	46	26
356.00	2.50	2.70			14.4	38.8	***100.6***	21.0	5.7	103.4	101	0	0	55	29
353.50	2.50	2.30			12.9	33.0	***116.3***	18.8	4.9	122.6	116	0	0	64	31
351.00	2.50	2.50			13.6	35.9	***135.7***	19.9	5.3	143.4	136	0	0	75	34
348.50	2.50	2.90			15.1	41.7	***150.8***	22.1	6.2	165.4	151	0	0	83	36
346.00	2.50	2.90			15.1	41.7	***163.1***	22.1	6.2	187.1	163	0	0	90	39
343.50	2.50	2.70			14.4	38.8	***177.5***	21.0	5.7	208.0	177	0	0	98	41
341.00	2.50	2.70			14.4	38.8	***176.0***	21.0	5.7	226.7	176	0	0	97	44
338.50	2.50		12	Hard Till	1.3	23.0	***177.4***	1.9	3.4	228.6	177	0	0	98	46
336.00	2.50		12	Hard Till	1.3	23.0	***163.4***	1.9	3.4	228.3	163	0	0	90	49
333.50	2.50		4	Very Fine Silty Sand	0.6	7.7	***164.0***	0.9	1.1	229.2	164	0	0	90	51
331.00	2.50		4	Very Fine Silty Sand	0.6	7.7	***174.2***	0.9	1.1	231.5	174	0	0	96	54
328.50	2.50	1.20			8.3	17.2	***182.5***	12.1	2.5	243.6	183	0	0	100	56
327.50	1.00	1.20			3.3	17.2	296.3	4.8	2.5	***264.8***	265	0	0	146	57
327.30	0.20			Shale	10.1	127.7	306.4	14.7	18.9	***279.5***	280	0	0	154	57.2
327.10	0.20			Shale	10.1	127.7	316.5	14.7	18.9	***294.2***	294	0	0	162	57.4
326.90	0.20			Shale	10.1	127.7	326.6	14.7	18.9	***309.0***	309	0	0	170	57.6
326.70	0.20			Shale	10.1	127.7	336.7	14.7	18.9	***323.7***	324	0	0	178	57.8
326.50	0.20			Shale	10.1	127.7	346.7	14.7	18.9	***338.4***	338	0	0	186	58
326.30	0.20			Shale	10.1	127.7	356.8	14.7	18.9	***353.1***	353	0	0	194	58.2
325.80	0.50			Shale	25.2	127.7	***382.1***	36.8	18.9	389.9	382	0	0	210	58.7
324.80	1.00			Shale	50.5	127.7	***432.5***	73.6	18.9	463.5	433	0	0	238	59.7
323.80	1.00			Shale	50.5	127.7	***483.0***	73.6	18.9	537.1	483	0	0	266	60.7
322.80	1.00			Shale	50.5	127.7	***533.4***	73.6	18.9	610.7	533	0	0	293	61.7
321.80	1.00			Shale	50.5	127.7	***583.9***	73.6	18.9	684.3	584	0	0	321	62.7
320.80	1.00			Shale	50.5	127.7	***634.3***	73.6	18.9	757.9	~~634~~	~~0~~	~~0~~	~~349~~	~~63.7~~
319.80	1.00			Shale	50.5	127.7	***684.8***	73.6	18.9	831.5	~~685~~	~~0~~	~~0~~	~~377~~	~~64.7~~
318.80	1.00			Shale	50.5	127.7	***735.2***	73.6	18.9	905.1	~~735~~	~~0~~	~~0~~	~~404~~	~~65.7~~
317.80	1.00			Shale	50.5	127.7	***785.7***	73.6	18.9	978.7	~~786~~	~~0~~	~~0~~	~~432~~	~~66.7~~
316.80	1.00			Shale		127.7			18.9						

IDOT STATIC METHOD OF ESTIMATING PILE LENGTH

I.D.O.T. BBS FOUNDATIONS AND GEOTECHNICAL UNIT

Modified 10/18/2011

SUBSTRUCTURE========== east abut.
REFERENCE BORING ========== 2-S
LRFD or ASD or SEISMIC ========== LRFD
PILE CUTOFF ELEV. ========== 384.50 ft
GROUND SURFACE ELEV. AGAINST PILE DURING DRI 379.50 ft
GEOTECHNICAL LOSS TYPE (None, Scour, Liquef., DD) None
BOTTOM ELEV. OF SCOUR, LIQUEF., or DD ========== ft
TOP ELEV. OF LIQUEF. (so layers above apply DD) ========== ft

TOTAL FACTORED SUBSTRUCTURE LOAD ========= 1868 kips
TOTAL LENGTH OF SUBSTRUCTURE (along skew)==== 62.00 ft
NUMBER OF ROWS OF PILES PER SUBSTRUCTURE = 1
Approx. Factored Loading Applied per pile at 8 ft. Cts ===== 241.03 KIPS
Approx. Factored Loading Applied per pile at 3 ft. Cts ===== 90.39 KIPS

MAX. REQUIRED BEARING & RESISTANCE for Selected Pile, Soil Profile, & Losses

Maximum Nominal Req'd Bearing of Pile	Maximum Nominal Req.d Bearing of Boring	Maximum Factored Resistance Available in Boring	Maximum Pile Driveable Length in Boring
589 KIPS	**589** KIPS	**324** KIPS	**65** FT.

PILE TYPE AND SIZE ========== Steel HP 12 X 74
Plugged Pile Perimeter========== 4.050 FT. Unplugged Pile Perimeter========== 5.908 FT.
Plugged Pile End Bearing Area========== 1.025 SQFT. Unplugged Pile End Bearing Area===== 0.151 SQFT.

BOT. OF LAYER ELEV. (FT.)	LAYER THICK. (FT.)	UNCONF. COMPR. STRENGTH (TSF.)	S.P.T. N VALUE (BLOWS)	GRANULAR OR ROCK LAYER DESCRIPTION	NOMINAL PLUGGED SIDE RESIST. (KIPS)	NOMINAL PLUGGED END BRG. RESIST. (KIPS)	NOMINAL PLUGGED TOTAL RESIST. (KIPS)	NOMINAL UNPLUG'D SIDE RESIST. (KIPS)	NOMINAL UNPLUG'D END BRG. RESIST. (KIPS)	NOMINAL UNPLUG'D TOTAL RESIST. (KIPS)	NOMINAL REQ'D BEARING (KIPS)	FACTORED GEOTECH. LOSS FROM SCOUR or DD (KIPS)	FACTORED GEOTECH. LOSS LOAD FROM DD (KIPS)	FACTORED RESISTANCE AVAILABLE (KIPS)	ESTIMATED PILE LENGTH (FT.)
378.30	1.20	2.90			7.3		***10.1***	10.6		11.0	10	0	0	6	6
375.80	2.50	0.20			1.7	2.9	50.6	2.4	0.4	***19.2***	19	0	0	11	9
373.30	2.50	2.90			15.1	41.7	***37.0***	22.1	6.2	37.0	37	0	0	20	11
370.80	2.50	0.90			6.6	12.9	***46.4***	9.6	1.9	47.0	46	0	0	26	14
368.30	2.50	1.10			7.8	15.8	***44.1***	11.3	2.3	56.9	44	0	0	24	16
365.80	2.50	0.40			3.2	5.7	***45.9***	4.7	0.8	61.3	46	0	0	25	19
363.30	2.50	0.30			2.5	4.3	***46.9***	3.6	0.6	64.7	47	0	0	26	21
360.80	2.50	0.20			1.7	2.9	***47.2***	2.4	0.4	66.9	47	0	0	26	24
358.30	2.50	0.10			0.8	1.4	***49.4***	1.2	0.2	68.4	49	0	0	27	26
355.80	2.50	0.20			1.7	2.9	84.2	2.4	0.4	***75.7***	76	0	0	42	29
353.30	2.50	2.50			13.6	35.9	97.8	19.9	5.3	***95.6***	96	0	0	53	31
350.80	2.50	2.50			13.6	35.9	***108.6***	19.9	5.3	115.0	109	0	0	60	34
348.30	2.50	2.30			12.9	33.0	***121.5***	18.8	4.9	133.9	121	0	0	67	36
345.80	2.50	2.30			12.9	33.0	***134.3***	18.8	4.9	152.7	134	0	0	74	39
343.30	2.50	2.30			12.9	33.0	***147.2***	18.8	4.9	171.5	147	0	0	81	41
340.80	2.50	2.30			12.9	33.0	***148.6***	18.8	4.9	188.6	149	0	0	82	44
338.30	2.50	1.50			9.7	21.5	***158.4***	14.2	3.2	202.8	158	0	0	87	46
335.80	2.50	1.50			9.7	21.5	***171.0***	14.2	3.2	217.4	171	0	0	94	49
333.30	2.50	1.70			10.6	24.4	***181.6***	15.5	3.6	232.9	182	0	0	100	51
330.80	2.50	1.70			10.6	24.4	***189.3***	15.5	3.6	247.9	189	0	0	104	54
328.30	2.50	1.50			9.7	21.5	***199.1***	14.2	3.2	262.2	199	0	0	109	56
326.30	2.00	1.50			7.8	21.5	313.0	11.4	3.2	***289.2***	289	0	0	159	58
326.10	0.20			Shale	10.1	127.7	323.1	14.7	18.9	***303.9***	304	0	0	167	58.4
325.90	0.20			Shale	10.1	127.7	333.2	14.7	18.9	***318.6***	319	0	0	175	58.6
325.70	0.20			Shale	10.1	127.7	343.3	14.7	18.9	***333.4***	333	0	0	183	58.8
325.50	0.20			Shale	10.1	127.7	353.4	14.7	18.9	***348.1***	348	0	0	191	59
325.30	0.20			Shale	10.1	127.7	363.5	14.7	18.9	***362.8***	363	0	0	200	59.2
325.10	0.20			Shale	10.1	127.7	***373.6***	14.7	18.9	377.5	374	0	0	205	59.4
324.90	0.20			Shale	10.1	127.7	***383.6***	14.7	18.9	392.2	384	0	0	211	59.6
323.90	1.00			Shale	50.5	127.7	***434.1***	73.6	18.9	465.8	434	0	0	239	60.6
322.90	1.00			Shale	50.5	127.7	***484.5***	73.6	18.9	539.4	485	0	0	267	61.6
321.90	1.00			Shale	50.5	127.7	***535.0***	73.6	18.9	613.0	535	0	0	294	62.6
320.90	1.00			Shale	50.5	127.7	***585.5***	73.6	18.9	686.6	585	0	0	322	63.6
319.90	1.00			Shale	50.5	127.7	***635.9***	73.6	18.9	760.2	~~636~~	~~0~~	~~0~~	~~350~~	~~64.6~~
318.90	1.00			Shale	50.5	127.7	***686.4***	73.6	18.9	833.8	~~686~~	~~0~~	~~0~~	~~377~~	~~65.6~~
317.90	1.00			Shale	50.5	127.7	***736.8***	73.6	18.9	907.4	~~737~~	~~0~~	~~0~~	~~405~~	~~66.6~~
316.90	1.00			Shale	50.5	127.7	***787.3***	73.6	18.9	981.0	~~787~~	~~0~~	~~0~~	~~433~~	~~67.6~~
315.90	1.00			Shale		127.7			18.9						

IDOT STATIC METHOD OF ESTIMATING PILE LENGTH

I.D.O.T. BBS FOUNDATIONS AND GEOTECHNICAL UNIT

Modified 10/18/2011

SUBSTRUCTURE========== pier 1
REFERENCE BORING ========== 1-S
LRFD or ASD or SEISMIC ========== LRFD
PILE CUTOFF ELEV. ========== 384.50 ft
GROUND SURFACE ELEV. AGAINST PILE DURING DRI 366.40 ft
GEOTECHNICAL LOSS TYPE (None, Scour, Liquef., DD) None
BOTTOM ELEV. OF SCOUR, LIQUEF., or DD ========== ft
TOP ELEV. OF LIQUEF. (so layers above apply DD) ========== ft

TOTAL FACTORED SUBSTRUCTURE LOAD ========= 1814 kips
TOTAL LENGTH OF SUBSTRUCTURE (along skew)==== 62.00 ft
NUMBER OF ROWS OF PILES PER SUBSTRUCTURE = 1
Approx. Factored Loading Applied per pile at 8 ft. Cts ===== 234.06 KIPS
Approx. Factored Loading Applied per pile at 3 ft. Cts ===== 87.77 KIPS

PILE TYPE AND SIZE ========== Steel HP 12 X 74
Plugged Pile Perimeter========== 4.050 FT. Unplugged Pile Perimeter========== 5.908 FT.
Plugged Pile End Bearing Area========== 1.025 SQFT. Unplugged Pile End Bearing Area===== 0.151 SQFT.

MAX. REQUIRED BEARING & RESISTANCE for Selected Pile, Soil Profile, & Losses

Maximum Nominal Req'd Bearing of Pile	Maximum Nominal Req.d Bearing of Boring	Maximum Factored Resistance Available in Boring	Maximum Pile Driveable Length in Boring
589 KIPS	**589** KIPS	**324** KIPS	**64** FT.

BOT. OF LAYER ELEV. (FT.)	LAYER THICK. (FT.)	UNCONF. COMPR. STRENGTH (TSF.)	S.P.T. N VALUE (BLOWS)	GRANULAR OR ROCK LAYER DESCRIPTION	NOMINAL PLUGGED SIDE RESIST. (KIPS)	NOMINAL PLUGGED END BRG. RESIST. (KIPS)	NOMINAL PLUGGED TOTAL RESIST. (KIPS)	NOMINAL UNPLUG'D SIDE RESIST. (KIPS)	NOMINAL UNPLUG'D END BRG. RESIST. (KIPS)	NOMINAL UNPLUG'D TOTAL RESIST. (KIPS)	NOMINAL REQ'D BEARING (KIPS)	FACTORED GEOTECH. LOSS FROM SCOUR or DD (KIPS)	FACTORED GEOTECH. LOSS LOAD FROM DD (KIPS)	FACTORED RESISTANCE AVAILABLE (KIPS)	ESTIMATED PILE LENGTH (FT.)
366.00	0.40	0.40			0.5		3.4	0.8		***1.2***	1	0	0	1	19
363.50	2.50	0.20			1.7	2.9	13.7	2.4	0.4	***4.9***	5	0	0	3	21
361.00	2.50	0.80			6.0	11.5	34.0	8.7	1.7	***15.7***	16	0	0	9	24
358.50	2.50	1.80			11.0	25.9	58.0	16.1	3.8	***33.7***	34	0	0	19	26
356.00	2.50	2.70			14.4	38.8	66.6	21.0	5.7	***53.8***	54	0	0	30	29
353.50	2.50	2.30			12.9	33.0	82.4	18.8	4.9	***73.1***	73	0	0	40	31
351.00	2.50	2.50			13.6	35.9	101.7	19.9	5.3	***93.8***	94	0	0	52	34
348.50	2.50	2.90			15.1	41.7	116.9	22.1	6.2	***115.9***	116	0	0	64	36
346.00	2.50	2.90			15.1	41.7	***129.1***	22.1	6.2	137.5	129	0	0	71	39
343.50	2.50	2.70			14.4	38.8	***143.5***	21.0	5.7	158.5	143	0	0	79	41
341.00	2.50	2.70			14.4	38.8	***142.1***	21.0	5.7	177.1	142	0	0	78	44
338.50	2.50		12	Hard Till	1.3	23.0	***143.4***	1.9	3.4	179.0	143	0	0	79	46
336.00	2.50		12	Hard Till	1.3	23.0	***129.4***	1.9	3.4	178.7	129	0	0	71	49
333.50	2.50		4	Very Fine Silty Sand	0.6	7.7	***130.0***	0.9	1.1	179.6	130	0	0	72	51
331.00	2.50		4	Very Fine Silty Sand	0.6	7.7	***140.2***	0.9	1.1	182.0	140	0	0	77	54
328.50	2.50	1.20			8.3	17.2	***148.5***	12.1	2.5	194.1	149	0	0	82	56
327.50	1.00	1.20			3.3	17.2	262.3	4.8	2.5	***215.2***	215	0	0	118	57
327.30	0.20			Shale	10.1	127.7	272.4	14.7	18.9	***229.9***	230	0	0	126	57.2
327.10	0.20			Shale	10.1	127.7	282.5	14.7	18.9	***244.7***	245	0	0	135	57.4
326.90	0.20			Shale	10.1	127.7	292.6	14.7	18.9	***259.4***	259	0	0	143	57.6
326.70	0.20			Shale	10.1	127.7	302.7	14.7	18.9	***274.1***	274	0	0	151	57.8
326.50	0.20			Shale	10.1	127.7	312.8	14.7	18.9	***288.8***	289	0	0	159	58
326.30	0.20			Shale	10.1	127.7	322.8	14.7	18.9	***303.5***	304	0	0	167	58.2
326.10	0.20			Shale	10.1	127.7	332.9	14.7	18.9	***318.3***	318	0	0	175	58.4
325.90	0.20			Shale	10.1	127.7	343.0	14.7	18.9	***333.0***	333	0	0	183	58.6
325.70	0.20			Shale	10.1	127.7	353.1	14.7	18.9	***347.7***	348	0	0	191	58.8
325.50	0.20			Shale	10.1	127.7	363.2	14.7	18.9	***362.4***	362	0	0	199	59
325.30	0.20			Shale	10.1	127.7	***373.3***	14.7	18.9	377.1	373	0	0	205	59.2
325.10	0.20			Shale	10.1	127.7	***383.4***	14.7	18.9	391.9	383	0	0	211	59.4
324.10	1.00			Shale	50.5	127.7	***433.8***	73.6	18.9	465.5	434	0	0	239	60.4
323.10	1.00			Shale	50.5	127.7	***484.3***	73.6	18.9	539.1	484	0	0	266	61.4
322.10	1.00			Shale	50.5	127.7	***534.7***	73.6	18.9	612.7	535	0	0	294	62.4
321.10	1.00			Shale	50.5	127.7	***585.2***	73.6	18.9	686.3	585	0	0	322	63.4
320.10	1.00			Shale	50.5	127.7	***635.6***	73.6	18.9	759.9	~~636~~	~~0~~	~~0~~	~~350~~	~~64.4~~
319.10	1.00			Shale	50.5	127.7	***686.1***	73.6	18.9	833.5	~~686~~	~~0~~	~~0~~	~~377~~	~~65.4~~
318.10	1.00			Shale	50.5	127.7	***736.5***	73.6	18.9	907.1	~~737~~	~~0~~	~~0~~	~~405~~	~~66.4~~
317.10	1.00			Shale	50.5	127.7	***787.0***	73.6	18.9	980.7	~~787~~	~~0~~	~~0~~	~~433~~	~~67.4~~
316.10	1.00			Shale		127.7			18.9						

IDOT STATIC METHOD OF ESTIMATING PILE LENGTH

I.D.O.T. BBS FOUNDATIONS AND GEOTECHNICAL UNIT — Modified 10/18/2011

SUBSTRUCTURE========== pier 2
REFERENCE BORING ========== 2-S
LRFD or ASD or SEISMIC ========== LRFD
PILE CUTOFF ELEV. ========== 384.50 ft
GROUND SURFACE ELEV. AGAINST PILE DURING DRI 367.50 ft
GEOTECHNICAL LOSS TYPE (None, Scour, Liquef., DD) None
BOTTOM ELEV. OF SCOUR, LIQUEF., or DD ========== ft
TOP ELEV. OF LIQUEF. (so layers above apply DD) ========== ft

TOTAL FACTORED SUBSTRUCTURE LOAD ========= 1814 kips
TOTAL LENGTH OF SUBSTRUCTURE (along skew)==== 62.00 ft
NUMBER OF ROWS OF PILES PER SUBSTRUCTURE = 1
Approx. Factored Loading Applied per pile at 8 ft. Cts ===== 234.06 KIPS
Approx. Factored Loading Applied per pile at 3 ft. Cts ===== 87.77 KIPS

PILE TYPE AND SIZE ========== Steel HP 12 X 74
Plugged Pile Perimeter========== 4.050 FT. Unplugged Pile Perimeter========== 5.908 FT.
Plugged Pile End Bearing Area========== 1.025 SQFT. Unplugged Pile End Bearing Area===== 0.151 SQFT.

MAX. REQUIRED BEARING & RESISTANCE for Selected Pile, Soil Profile, & Losses

Maximum Nominal Req'd Bearing of Pile	Maximum Nominal Req.d Bearing of Boring	Maximum Factored Resistance Available in Boring	Maximum Pile Driveable Length in Boring
589 KIPS	**589** KIPS	**324** KIPS	**65** FT.

BOT. OF LAYER ELEV. (FT.)	LAYER THICK. (FT.)	UNCONF. COMPR. STRENGTH (TSF.)	S.P.T. N VALUE (BLOWS)	GRANULAR OR ROCK LAYER DESCRIPTION	NOMINAL PLUGGED SIDE RESIST. (KIPS)	NOMINAL PLUGGED END BRG. RESIST. (KIPS)	NOMINAL PLUGGED TOTAL RESIST. (KIPS)	NOMINAL UNPLUG'D SIDE RESIST. (KIPS)	NOMINAL UNPLUG'D END BRG. RESIST. (KIPS)	NOMINAL UNPLUG'D TOTAL RESIST. (KIPS)	NOMINAL REQ'D BEARING (KIPS)	FACTORED GEOTECH. LOSS FROM SCOUR or DD (KIPS)	FACTORED GEOTECH. LOSS LOAD FROM DD (KIPS)	FACTORED RESISTANCE AVAILABLE (KIPS)	ESTIMATED PILE LENGTH (FT.)
365.80	1.70	0.40			2.2		6.5	3.2		***3.8***	4	0	0	2	19
363.30	2.50	0.30			2.5	4.3	7.5	3.6	0.6	***7.2***	7	0	0	4	21
360.80	2.50	0.20			1.7	2.9	***7.7***	2.4	0.4	9.4	8	0	0	4	24
358.30	2.50	0.10			0.8	1.4	***10.0***	1.2	0.2	10.8	10	0	0	6	26
355.80	2.50	0.20			1.7	2.9	44.7	2.4	0.4	***18.2***	18	0	0	10	29
353.30	2.50	2.50			13.6	35.9	58.4	19.9	5.3	***38.0***	38	0	0	21	31
350.80	2.50	2.50			13.6	35.9	69.1	19.9	5.3	***57.5***	58	0	0	32	34
348.30	2.50	2.30			12.9	33.0	82.0	18.8	4.9	***76.3***	76	0	0	42	36
345.80	2.50	2.30			12.9	33.0	***94.9***	18.8	4.9	95.1	95	0	0	52	39
343.30	2.50	2.30			12.9	33.0	***107.8***	18.8	4.9	114.0	108	0	0	59	41
340.80	2.50	2.30			12.9	33.0	***109.2***	18.8	4.9	131.1	109	0	0	60	44
338.30	2.50	1.50			9.7	21.5	***119.0***	14.2	3.2	145.3	119	0	0	65	46
335.80	2.50	1.50			9.7	21.5	***131.6***	14.2	3.2	159.9	132	0	0	72	49
333.30	2.50	1.70			10.6	24.4	***142.2***	15.5	3.6	175.4	142	0	0	78	51
330.80	2.50	1.70			10.6	24.4	***149.9***	15.5	3.6	190.4	150	0	0	82	54
328.30	2.50	1.50			9.7	21.5	***159.6***	14.2	3.2	204.6	160	0	0	88	56
326.30	2.00	1.50			7.8	21.5	273.6	11.4	3.2	***231.7***	232	0	0	127	58
326.10	0.20			Shale	10.1	127.7	283.7	14.7	18.9	***246.4***	246	0	0	136	58.4
325.90	0.20			Shale	10.1	127.7	293.8	14.7	18.9	***261.1***	261	0	0	144	58.6
325.70	0.20			Shale	10.1	127.7	303.9	14.7	18.9	***275.8***	276	0	0	152	58.8
325.50	0.20			Shale	10.1	127.7	313.9	14.7	18.9	***290.6***	291	0	0	160	59
325.30	0.20			Shale	10.1	127.7	324.0	14.7	18.9	***305.3***	305	0	0	168	59.2
325.10	0.20			Shale	10.1	127.7	334.1	14.7	18.9	***320.0***	320	0	0	176	59.4
324.60	0.50			Shale	25.2	127.7	359.4	36.8	18.9	***356.8***	357	0	0	196	59.9
324.10	0.50			Shale	25.2	127.7	***384.6***	36.8	18.9	393.6	385	0	0	212	60.4
323.60	0.50			Shale	25.2	127.7	***409.8***	36.8	18.9	430.4	410	0	0	225	60.9
323.10	0.50			Shale	25.2	127.7	***435.0***	36.8	18.9	467.2	435	0	0	239	61.4
322.60	0.50			Shale	25.2	127.7	***460.3***	36.8	18.9	504.0	460	0	0	253	61.9
322.10	0.50			Shale	25.2	127.7	***485.5***	36.8	18.9	540.8	485	0	0	267	62.4
321.10	1.00			Shale	50.5	127.7	***535.9***	73.6	18.9	614.4	536	0	0	295	63.4
320.10	1.00			Shale	50.5	127.7	***586.4***	73.6	18.9	688.0	586	0	0	323	64.4
319.10	1.00			Shale	50.5	127.7	***636.8***	73.6	18.9	761.6	~~637~~	~~0~~	~~0~~	~~350~~	~~65.4~~
318.10	1.00			Shale	50.5	127.7	***687.3***	73.6	18.9	835.2	~~687~~	~~0~~	~~0~~	~~378~~	~~66.4~~
317.10	1.00			Shale	50.5	127.7	***737.7***	73.6	18.9	908.8	~~738~~	~~0~~	~~0~~	~~406~~	~~67.4~~
316.10	1.00			Shale	50.5	127.7	***788.2***	73.6	18.9	982.4	~~788~~	~~0~~	~~0~~	~~434~~	~~68.4~~
315.10	1.00			Shale	50.5	127.7	***838.6***	73.6	18.9	1056.0	~~839~~	~~0~~	~~0~~	~~461~~	~~69.4~~
314.10	1.00			Shale	50.5	127.7	***889.1***	73.6	18.9	1129.6	~~889~~	~~0~~	~~0~~	~~489~~	~~70.4~~
313.10	1.00			Shale		127.7			18.9						

EXHIBIT G

MINES MAP

ILLINOIS STATE GEOLOGICAL SURVEY
PRAIRIE RESEARCH INSTITUTE

ILLINOIS
UNIVERSITY OF ILLINOIS AT URBANA-CHAMPAIGN

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Coal Mines and Underground Industrial Mines

JACKSON

County

County Coal Map Series

ISGS Coal Section

Map construction: January 29, 2015

This product is under review and may not meet the standards of the Illinois State Geological Survey.

County coal maps and select quadrangle maps available as downloadable PDF files at:
http://www.isgs.illinois.edu

PROJECT LOCATION

0 1:100,000 3
Miles

Pennsylvanian Extent

Herrin Coal Depth
Springfield Coal Depth
Colchester Coal Depth
Herrin Coal Thickness
Springfield Coal Thickness
Colchester Coal Thickness

0 to 100 ft
100 to 200 ft
200 to 300 ft
300 to 400 ft
400 to 500 ft
500 to 600 ft
600 to 700 ft
700 to 800 ft
800 to 900 ft
900 to 1000 ft
1000 to 1100 ft
1100 to 1200 ft
1200 to 1300 ft
1300 to 1400 ft
1400 to 1500 ft
Faults

Underground Mine
Surface Mine
Insufficient data
<28 inches
28 to 42 inches
42 to 66 inches
>66 inches
Channel
Split Coal

- County
- Township
- Section
- Quadrangle study (Available on Website)
- Lake or river
- Coal mine - active
- Underground coal mine - abandoned
- Surface coal mine - abandoned
- Indefinite underground coal mine boundary - abandoned
- Underground industrial mine and surrounding buffer region
- Opening type unknown
- Uncertain location
- Active surface tipple
- Abandoned surface tipple
- Active shaft
- Abandoned shaft
- Active slope
- Abandoned slope
- Active drift
- Abandoned drift
- Underground industrial mine entrance or general location

951, 951 Coal mine index number (polygon label, point label)

Map Explanation

This map accompanies the coal mines directory for this county. Please consult the directory for an explanation of the coal mine information shown on this map. Buffer regions for industrial mineral mines were incorporated into this map due to limited information regarding these mines. The size of the buffer region is dependent on the uncertainty or inaccuracy of the mine location. For more information regarding industrial mineral mines please contact the ISGS Industrial Minerals Section.

The maps and digital files used for this study were compiled from data obtained from a variety of public and private sources and have varying degrees of completeness and accuracy. They present reasonable interpretations of the geology of the area and are based on available data. These data were compiled and digitized at a scale of 1:62,500. Locations of some features may be offset by 500 feet or more due to errors in the original source maps, the compilation process, digitizing, or a combination of these factors.

These data are not intended for use in site-specific screening or decision-making. Data included in this map are suitable for use at a scale of 1:100,000.

Disclaimer

The Illinois State Geological Survey and the University of Illinois make no guarantee, expressed or implied, regarding the correctness of the interpretations presented in this data set and accept no liability for the consequences of decisions made by others on the basis of the information presented here.