STRUCTURE GEOTECHNICAL REPORT

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

S.N. 039-0021 (E)
S.N. 039-0079 (P)

F.A.P. ROUTE 331
SECTION (5-3) B-6
JOB NO. D-99-019-12
CONTRACT NO. 78295
JACKSON COUNTY, ILLINOIS
PTB 148/34 WO#18
KEG NO. 08-0061.18

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EXECUTIVE SUMMARY

IL 13 E.B. over Crab Orchard Creek
F.A.P. Route 331
Section (5-3) B-6
Jackson County, Illinois
Job No. D-99-019-12
Contract No. 78295
PTB 148/34 WO #18
Existing Structure No. 039-0021
Proposed Structure No. 039-0079

The project includes the replacement of the eastbound five-span bridge (SN 039-0021) 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 factor of safety (FOS) will exist at the east and west abutments during all conditions. In order to achieve an acceptable FOS for the seismic condition, piles with a maximum spacing of 8 ft. were included in the stability 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 five span structure carrying eastbound IL 13 over Crab Orchard Creek 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 the existing five span bridge (SN 039-0021) located in Jackson County, Illinois. The existing bridge will be removed and replaced with a triple-span bridge. 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 five span continuous wide flange bridge. It consists of six beam lines on pile bent abutments on H piles driven to refusal. Back-to-back abutments measure 255 ft. – 9 in., with an out-to-out width of 36 ft. – 0 in. The bridge is built on a 30 degree left ahead skew. The shoulders are 3 ft. wide. The piers are solid wall piers on H pile supported spread footings. The bridge had one major rehabilitation in 1999, and one minor rehabilitation in 2008.

1.4 Proposed Bridge Information

The proposed structure located at F.A.P. Route 331 (IL 13 E.B.) over Crab Orchard Creek will consist of a triple-span structure built on a 30 degree skew. The outside spans will measure 76 ft. – 6 in. and the middle span 91 ft. – 6 in. The structure will have a width of 66 ft. – 0 in. out-to-out deck. The structure will be located at approximate station 187+57.85 (IL 13). Integral abutments are proposed.

The structure will have a back-to-back abutment measure of 249 ft. – 0.25 in., measured parallel to the centerline of IL 13. The structure will support three, 12-ft. lanes, with shoulder widths of approximately 6 ft. and 10 ft. minimum. A 10 ft. multi-use path is proposed 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 on June 30 and July 1, 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	186+02	13 ft. RT CL EBL	390.4
2-S	188+92	14 ft. RT CL EBL	390.6

2.1 Subsurface Conditions

Boring 1-S consisted of approximately 2.0 ft. of asphalt and crushed aggregate from the ground surface to El. 388.4. A layer of stiff clay followed to El. 385.9. This clay had a driving resistance (N-value) of 5 blows per foot (bpf), an unconfined compressive strength (Qu) value of 1.4 tons per square foot (tsf), and a moisture content of 19 percent. A very soft layer of clay to silty clay followed to El. 383.4. The N-value was 2 bpf, with a Qu value of 0.2 tsf, and a moisture content of 28 percent. Stiff to very stiff clays followed to El. 373.4. The N-values ranged from 2 to 6 bpf, with an average of 4 bpf. The Qu values ranged from 1.8 to 2.3 tsf, with an average value of 2.1 tsf. Moisture content varied from 19 to 22 percent, with an average of 21 percent. A medium silty clay with rotten organics layer followed to El. 370.9. The N-value for this layer was 4 bpf, with a Qu value of 0.7 tsf, and a moisture content of 30 percent. Very soft to stiff silty clay loam followed to El. 358.4. The N-values ranged from 0 to 3 bpf, with an average of 2 bpf. Qu values ranged from 0.2 to 1.2 tsf, with an average value of 0.8 tsf. Moisture contents varied from 24 to 32 percent, with an average of 26 percent. A medium silty clay to clay followed to El. 355.9. This layer had an N-value of 1 bpf, a Qu value of 0.7 tsf, and a moisture content of 38 percent. Medium to very stiff clays with some layers of sand followed to El. 335.9. N-values ranged from 2 to 7 bpf, with an average of 4 bpf. The Qu values ranged from 0.8 to 3.1 tsf, with an average of 1.7 tsf. Moisture contents varied from 22 to 33 percent, with an average of 29 percent. A soft sandy clay loam with sand layers followed to El. 330.9. The N-value for this layer was 1 bpf, with a Qu value of 0.4 tsf, and a moisture content of 30 percent. A sand followed to El. 325.9, with an N-value of 3 bpf. A layer of stiff clay containing some coal and weathered clay shale followed to El. 323.4. N-values for this layer were 18 bpf, with a Qu value of 1.8 tsf. A hard clay shale followed until boring termination at El. 312.9, with blow counts of 100 for 8 inches, 100 for 5 inches, and 100 for 4 inches.

Boring 2-S consisted of approximately 3.5 ft. of asphalt over crushed aggregate from the ground surface to approximate El. 387.1, with an N-value of 5 bpf. A stiff clay followed to El. 383.6, with an N-value of 3 bpf, a Qu value of 1.2 tsf, and moisture content of 21 percent. A soft clay to silty clay followed to El. 381.1, with an N-value of 1 bpf, a Qu value of 0.4 tsf, and a moisture content of 27 percent. A stiff to very stiff clay followed to El. 373.6. N-values ranged from 6 to 7 bpf, with an average of 7 bpf. Qu values ranged from 1.6 to 2.5 tsf, with an average of 2.1 tsf. Moisture content varied from 22 to 24 percent, with an average of 23 percent. A hard silty loam to silty clay loam followed to El. 371.1 with an N-value of 13 bpf, a Qu of 5.5 tsf, and moisture content of 18 percent. Very soft to medium silty clay loam, silt loam, silty clay followed to El. 351.1. N-values ranged from WOH to 1 bpf. Qu values ranged from 0.1 to 0.6 tsf, with an average of 0.3 tsf.

Moisture content varied from 28 to 45 percent, with an average of 32 percent. Some organics were present in the silty clay layer from El. 353.6 to El. 351.1. Very stiff to stiff clay followed to El. 340.6. The N-values were 7 and 9 bpf. Qu values were 1.8 and 2.5 tsf. The moisture contents were 28 and 29 percent. Following was medium clay loam to sandy clay loam to El. 336.6 with an N-value of 3 bpf, a Qu of 0.6 tsf, and a moisture content of 23 percent. Loose sand with many clay layers followed to El. 331.1, with an N-value of 5 bpf. A medium clay followed to El. 326.1, with an N-value of 3 bpf, Qu value of 0.8 tsf, and moisture content of 21 percent. Soft clay loam to sandy clay loam followed to El. 323.1, with an N-value of 2 bpf, a Qu of 0.4 tsf, and 23 percent moisture content. Hard clay shale followed until boring termination at El. 320.6 with a driving resistance of 100 for 6 inches.

2.2 Groundwater

Groundwater was encountered during drilling in Boring 1-S at El. 355.4 and El. 336.4 at Boring 2-S. The surface water elevation of Crab Orchard Creek was recorded at El. 362.1 at the time of drilling. 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, 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 east and west abutments are composed of a top and bottom slope. The top slope at each abutment location consist of a 1 Vertical to 2 Horizontal slope (1V:2H). The bottom slope for the east abutment was modeled with a 1V:1.5H slope, and the bottom slope for the west abutment was modeled with a 1V:2H slope. If the geometrics of the bottom slopes exceed these values, KEG should be contacted to confirm the stability of steeper slopes. Slope stability of the endslopes were 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 an assumed friction angle 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 Pile Reinforcement
East Abutment (Top Slope)	1V:2H	3.5	3.5	1.2	n/a
East Abutment (Bottom Slope)	1V:1.5H	2.3	2.3	0.9	1.0
East Abutment (Full Slope)	1V:2H to 1V:1.5H	2.4	2.6	0.9	1.0
West Abutment (Top Slope)	1V:2H	6.6	2.7	1.1	n/a
West Abutment (Bottom Slope)	1V:2H	3.2	1.7	0.8	1.0
West Abutment (Full Slope)	1V:2H to 1V:2H	2.2	1.9	0.8	1.0

The results of the analysis, as provided in Table 3.2, indicate an acceptable FOS will exist at the east and west abutment endslopes under all conditions. In order to achieve an acceptable FOS for the seismic condition, 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 (Site Class D)
Spectral Response Acceleration, 1.0 Sec, S_{D1}	0.360 g (Site Class D)
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. Class A5 stone riprap will be placed on the slopes near the piers.

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}	381.97	340.61	351.07	382.14	5
Q_{200}	381.97	339.61	350.07	382.14	
Design	381.97	340.61	351.07	382.14	
Check	381.97	339.61	350.07	382.14	

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 some locations south designated as underground mines, some of which have undefined or indefinite boundaries. The nearest boundary is located approximately 0.7 miles south of the project area.

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 (7.8 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 35 and 54 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 10X57 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 2.1 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 47 ft. below the ground surface at the pier locations, exceeding the maximum recommended lengths of smaller H-piles. The available hydraulic report indicates scour depth elevations at the piers, which required taking into consideration a geotechnical loss of capacity. The amount of overburden remaining below estimated scour depths is sufficient to provide adequate lateral capacity for the piers per our analysis. Drilled shafts recommendations for support of the piers have been provided per IDOT's request.

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 substructure locations. The Modified IDOT Static Method uses the LRFD Pile Design Guide Procedure to estimate the pile lengths (Pile Length/Pile Type, Exhibit F). Scour elevations were taken into account for pile analysis support at the Piers and the pile length estimates are also included in Exhibit F.

The abutment and pier loads were provided by CM&T. The abutments and piers will each experience a Total Factored Load of 285 kips per pile. The estimated pile lengths for the recommended pile types are shown in Tables 4.2.1 through 4.2.5, 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 10X57 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)	319	362	199	65	384
	318	404	222	66	384
	317	454	250	67	384
East Abutment (2-S)	319.1	359	198	65	384.1
	318.1	401	221	66	384.1
	317.1	454	250	67	384.1
Pier 1 (1-S)	316.0	339	187	41	357.0
	315.0	381	210	42	357.0
	314.0	454	250	43	357.0
Pier 2 (2-S)	306.0	334	183	51	357.0
	305.0	376	206	52	357.0
	304.0	454	250	53	357.0

Table 4.2.2 – 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)	322	297	164	62	384
	321	366	201	63	384
	320	418	230	64	384
East Abutment (2-S)	321.1	300	165	63	384.1
	320.1	368	202	64	384.1
	319.1	418	230	65	384.1
Pier 1 (1-S)	319.0	266	146	38	357.0
	318.0	369	203	39	357.0
	317.0	418	230	40	357.0
Pier 2 (2-S)	308.0	292	160	49	357.0
	307.0	363	199	50	357.0
	306.0	418	230	51	357.0

Table 4.2.3 – 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)	318	533	293	66	384
	317	583	321	67	384
	316	589	324	68	384
East Abutment (2-S)	317.1	535	294	67	384.1
	316.1	585	322	68	384.1
	315.1	589	324	69	384.1
Pier 1 (1-S)	315.0	481	264	42	357.0
	314.0	531	292	43	357.0
	313.0	589	324	44	357.0
Pier 2 (2-S)	305.0	474	260	52	357.0
	304.0	524	288	53	357.0
	303.0	589	324	54	357.0

Table 4.2.4 – 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)	321	447	246	63	384
	320	519	285	64	384
	319	578	318	65	384
East Abutment (2-S)	321.1	442	243	63	384.1
	320.1	516	284	64	384.1
	319.1	578	318	65	384.1
Pier 1 (1-S)	318.0	366	201	39	357.0
	317.0	452	249	40	357.0
	316.0	578	318	41	357.0
Pier 2 (2-S)	307.0	441	242	50	357.0
	306.0	515	282	51	357.0
	305.0	578	318	52	357.0

Table 4.2.5 – 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)	316	801	441	68	384
	315	862	474	69	384
	314	929	511	70	384
East Abutment (2-S)	316.1	737	405	68	384.1
	315.1	798	439	69	384.1
	314.1	929	511	71	384.1
Pier 1 (1-S)	312.0	787	433	45	357.0
	311.0	847	466	46	357.0
	310.0	929	511	47	357.0
Pier 2 (2-S)	302.0	779	428	55	357.0
	301.0	839	461	56	357.0
	300.0	929	511	57	357.0

KEG recommends a test pile be performed at the pier 2 location. 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)	383.6	125	1200	0	50	26	500	3	80	0.007
	381.1	125	400	0	50	26	30	1	80	0.020
	373.6	125	2100	0	100	26	1000	7	80	0.005
	371.1	120	5500	0	100	26	2000	13	70	0.004
	368.6	120	300	0	50	26	30	1	70	0.020
	361.1	115	150	0	50	28	30	0	70	0.020
	351.1	120	500	0	50	26	30	0	70	0.020
	340.6	125	2150	0	100	26	1000	8	80	0.005
	336.6	120	600	0	50	27	100	3	70	0.010
	331.1	110	0	32	0	32	20	5	3	N/A
	326.1	125	800	0	50	26	100	3	80	0.010
	323.1	120	400	0	50	27	30	2	70	0.020
West Abutment (1-S)	383.4	120	200	0	50	26	30	2	75	0.020
	373.4	125	2075	0	100	26	1000	5	80	0.005
	360.9	120	900	0	50	26	100	3	70	0.010
	358.4	120	200	0	50	26	30	0	70	0.020
	355.9	125	700	0	50	26	100	1	70	0.010
	350.9	125	1650	0	100	26	500	3	80	0.007
	345.9	125	3100	0	100	26	1000	7	80	0.005
	335.9	125	1150	0	50	26	500	4	80	0.007
	330.9	120	400	0	50	27	30	1	70	0.020
	325.9	110	0	32	0	32	20	3	3	N/A

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)				
	323.4	125	1800	0	100	26	500	18	80	0.007
Pier 1 (1-S)	355.9	125	700	0	50	26	100	1	70	0.010
	350.9	125	1650	0	100	26	500	3	80	0.007
	345.9	125	3100	0	100	26	1000	7	80	0.005
	335.9	125	1150	0	50	26	500	4	80	0.007
	330.9	120	400	0	50	27	30	1	70	0.020
	325.9	110	0	32	0	32	20	3	3	N/A
	323.4	125	1800	0	100	26	500	18	80	0.007
Pier 2 (2-S)	361.1	115	150	0	50	28	30	0	70	0.020
	351.1	120	500	0	50	26	30	0	70	0.020
	340.6	125	2150	0	100	26	1000	8	80	0.005
	336.6	120	600	0	50	27	100	3	70	0.010
	331.1	110	0	32	0	32	20	5	3	N/A
	326.1	125	800	0	50	26	100	3	80	0.010
	323.1	120	400	0	50	27	30	2	70	0.020

4.4 Foundations on Drilled Shafts

Due to the depth of the shale bedrock, drilled shafts are an alternative foundation support choice for the pier locations. Recommendations for drilled shafts with sockets extending one shaft diameter into the underlying shale, developing capacity from end bearing resistance only, are provided for the support of the piers.

In absence of unconfined compressive strength data from the clayey shale, taking into consideration empirical correlations between moisture content, N-values, and Q_u values, the end bearing calculations were based on a Nominal Q_u of 14.4 ksf. Our calculations include the geotechnical resistance factor for drilled shafts in end bearing in the underlying clayey shale. The Intermediate Geomaterial (IGM) resistance factor to be used for end bearing is 0.55 (2012 LRFD). Resulting in an allowable Q_a of 20 ksf. Based on the results of the subsurface exploration, competent shale is encountered below El. 323.0 in Boring 1-S and El. 321.0 in Boring 2-S. Table 4.4 – LRFD Drilled Shaft Design below contains a summary of Factored Tip Resistance available for various pier diameters.

Table 4.4 – LRFD Drilled Shaft Design

Pier Diameter (ft.)	Factored Tip Resistance (Kips)
2.5	98
3	142
4	252
5	392
6	566
7	770
8	1006

Drilled shafts should extend at least one shaft diameter into competent shale. Settlement of drilled shaft foundations bearing in competent shale generally can be estimated to be less than 0.5 inches in addition to any calculated shaft compression. However, it should be noted that as the diameter of the drilled shaft increases so does the potential for increased settlement.

Minimum center-to-center shaft spacing is three times the shaft diameter. There is no reduction in Factored Resistance Available with this or larger shaft spacing, and the grouping effect can be ignored. Shafts will also need to be evaluated for lateral resistance, which may control the socket embedment lengths using the L-Pile factors given in Table 4.3.

Temporary smooth steel pipe casing is recommended from the top of shaft to the top of the shale during excavation.

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

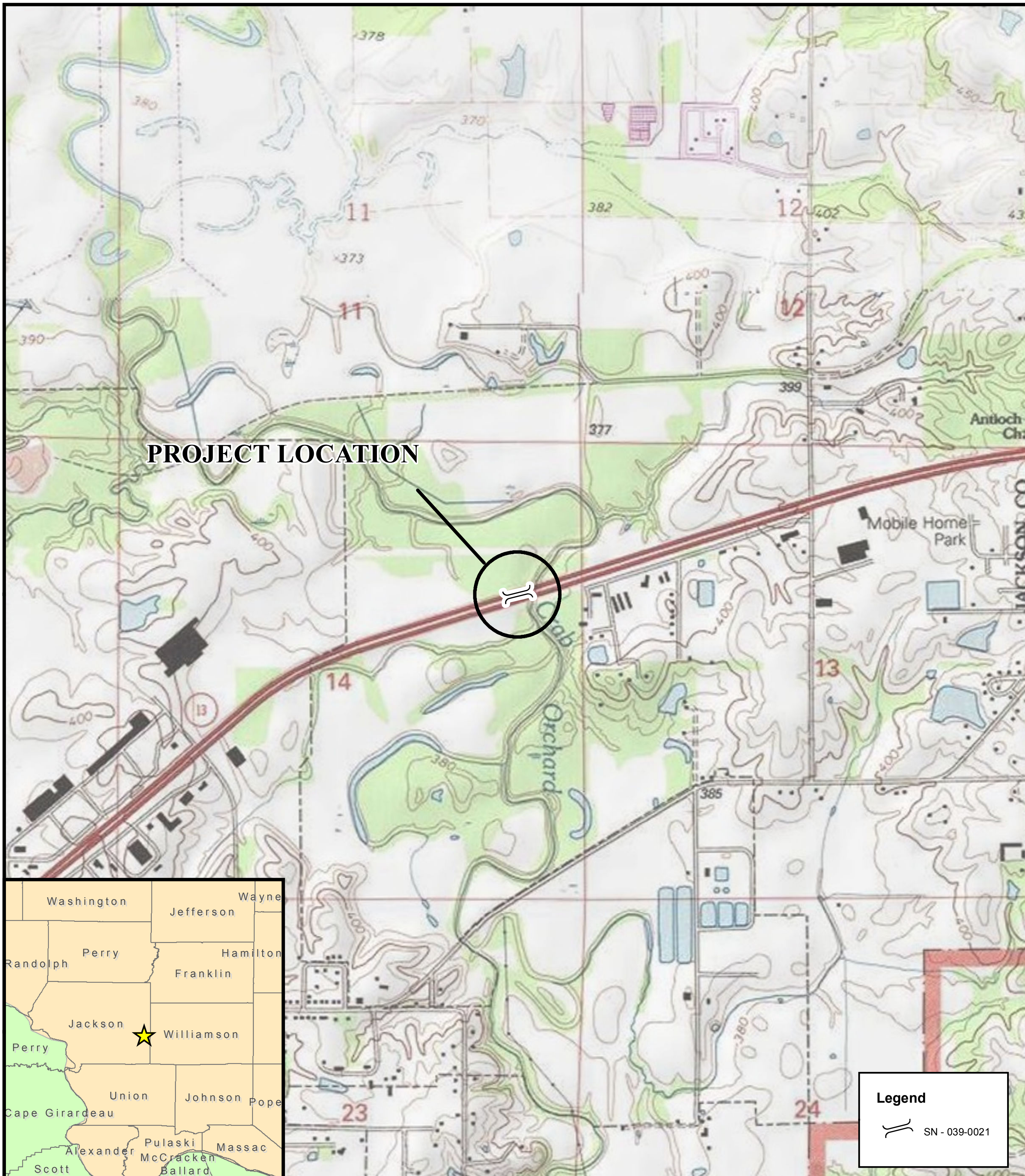


Exhibit A
Location Map
F.A.P. Route 331 (IL 13)
over Crab Orchard Creek
Jackson County, Illinois

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

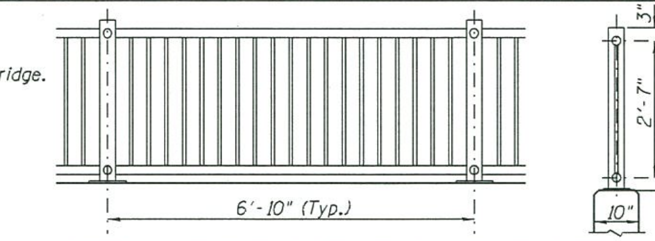
TYPE, SIZE, AND LOCATION PLAN (TS&L)

Bench Mark: Cut square on Southwest corner of Structure 039-0061 of Illinois Route 13 WBL @ Sta. 85+86±. Elev. 390.262

Existing Structure: S.N. 039-0021, built in 1965 is a five span continuous wide flange beam bridge. Substructure consists of pile bent abutments supported on steel piles and solid wall pile bent piers. Bk. to Bk. abutments measures 255'-9" and out-to-out width of 36'-0".

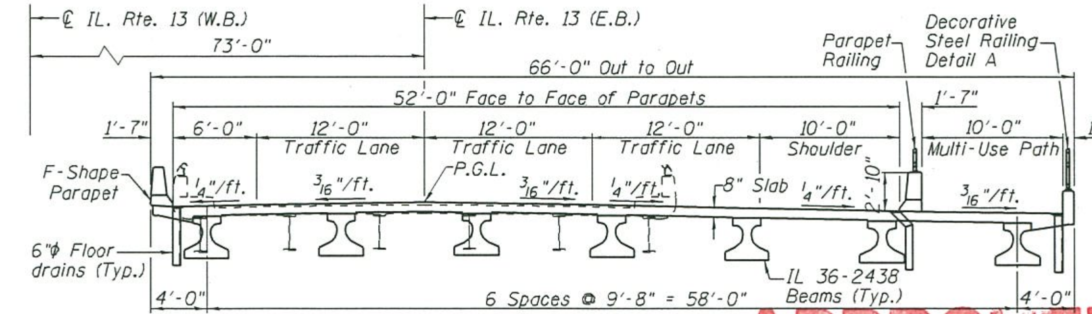
Salvage: None

Traffic Maintenance: Traffic to be maintained utilizing median cross-overs, onto W.B. bridge (039-0061)



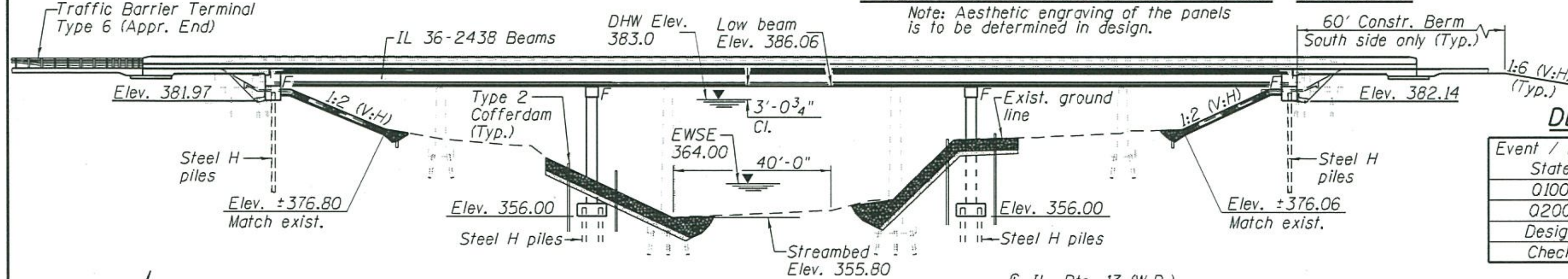
DECORATIVE RAILING ELEVATION   DETAIL A

Note: Aesthetic engraving of the panels is to be determined in design.

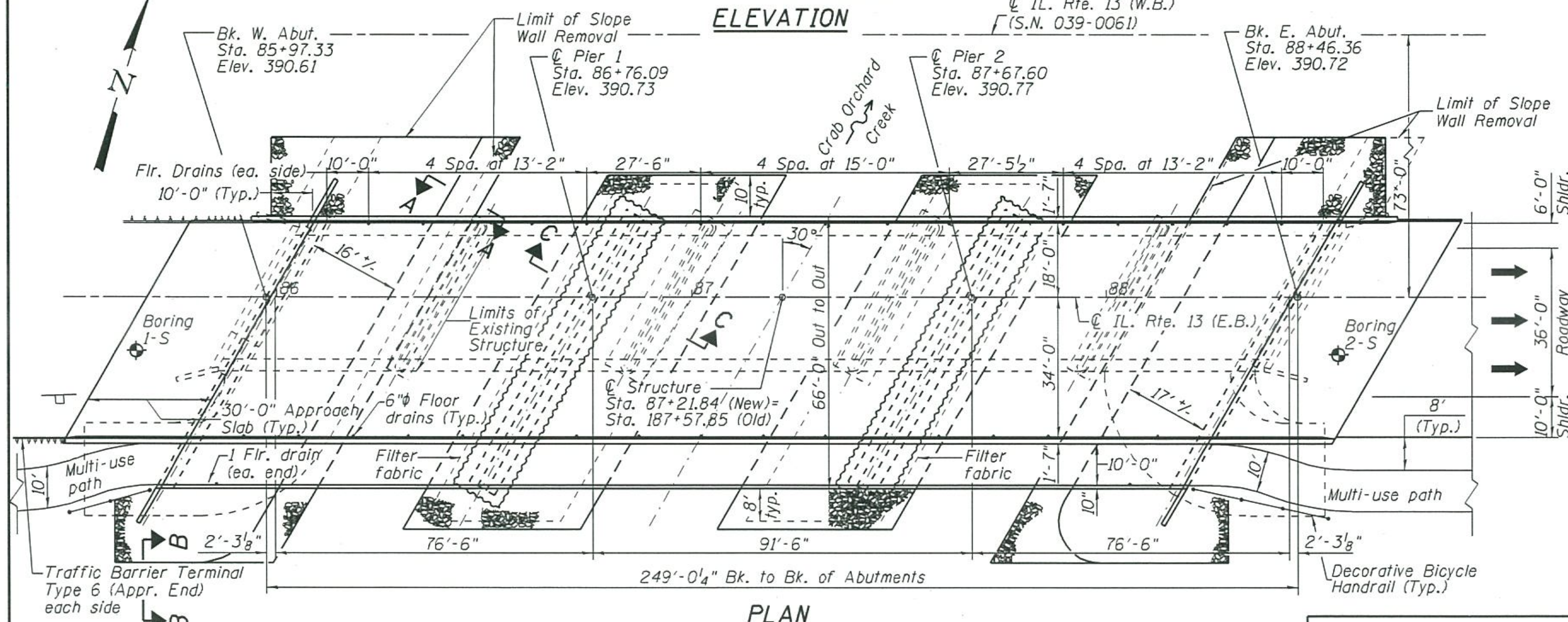


CROSS SECTION
(Looking East)

APPROVED
NOV 21 2016
AS A BASIS FOR PREPARATION OF DETAILED PLANS



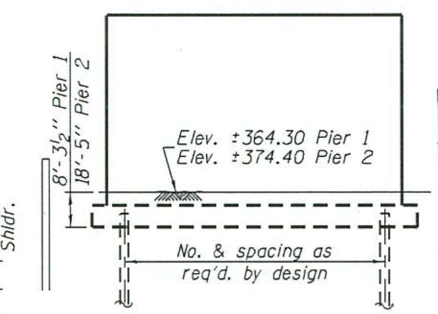
ELEVATION



PLAN

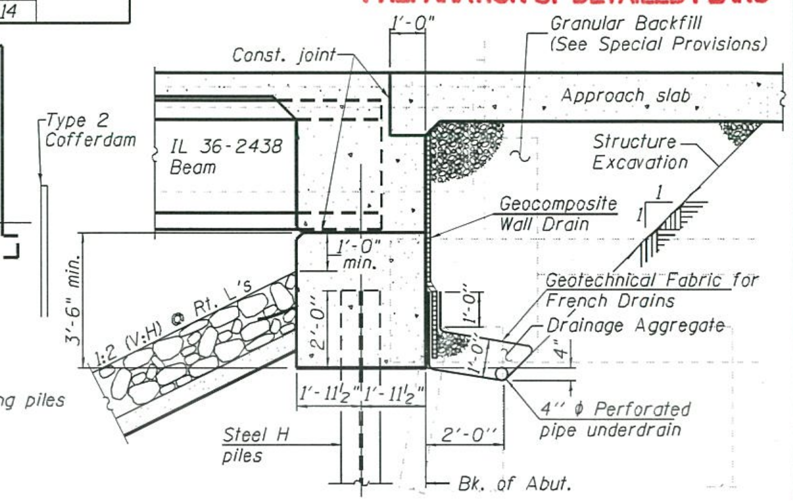
DESIGN SCOUR ELEVATION TABLE

Event / Limit State	Design Scour Elevations (ft.)				
	W. Abut.	Pier 1	Pier 2	E. Abut.	Item 113
Q100	381.97	340.61	351.07	382.14	5
Q200	381.97	339.61	350.07	382.14	
Design	381.97	340.61	351.07	382.14	
Check	381.97	339.61	350.07	382.14	



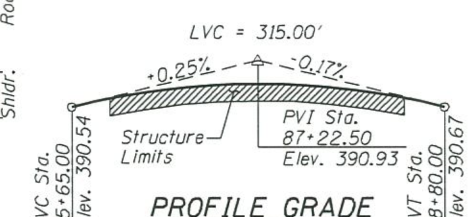
PIER SKETCH

Note: Space new piles to miss existing piles



SECTION THRU INTEGRAL ABUTMENT
(Horiz. dim. @ Rt. L's)

Note: Space new piles to miss existing piles



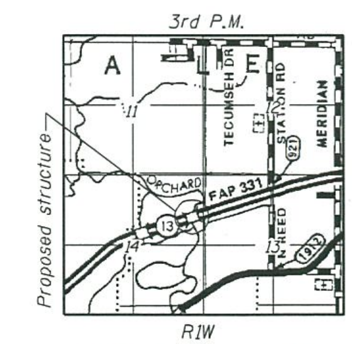
PROFILE GRADE
(Along ℄ IL. Rte. 13 E.B.)

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.	Q (C.F.S.) Prop.	Opening Sq. Ft. Exist.	Opening Sq. Ft. Prop.	Nat. H.W.E.	Head - Ft. Exist.	Head - Ft. Prop.	Headwater El. Exist.	Headwater El. Prop.
	10	039-0061/79	6,158	6,628	2,342	2,367	381.2	0.2	0.1	381.4	381.3
		O'flow Culvert	186	137	67	67					
		039-0062/78	2,056	1,635	779	772					
		Total	8,400		3,188	3,206					
Design	50	039-0061/79	8,788	9,417	2,682	2,715	383.0	0.3	0.2	383.3	383.2
		O'flow Culvert	269	235	85	85					
		039-0062/78	3,343	2,748	995	987					
		Total	12,400		3,762	3,787					
Base	100	039-0061/79	9,878	10,577	2,857	2,894	383.9	0.3	0.3	384.2	384.2
		O'flow Culvert	326	269	94	94					
		039-0062/78	3,896	3,254	1,109	1,099					
		Total	14,100		4,060	4,087					
Scour Design Check	200	039-0061/79	11,055	11,616	2,995	3,036	384.6	0.4	0.3	385.0	384.9
		O'flow Culvert	379	332	101	101					
		039-0062/78	4,576	4,062	1,200	1,189					
		Total	16,010		4,296	4,326					
Max. Calc.	500	039-0061/79	12,694	12,917	3,116	3,158	385.2	0.5	0.4	385.7	385.6
		O'flow Culvert	417	393	107	107					
		039-0062/78	5,389	5,190	1,279	1,268					
		Total	18,500		4,502	4,533					



LOCATION SKETCH

HIGHWAY CLASSIFICATION

F.A.P. Rte. 331 (IL 13 E.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 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

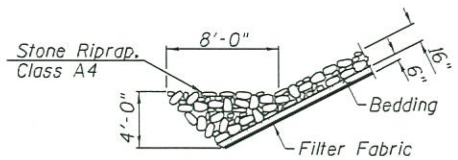
DESIGN STRESSES

FIELD UNITS

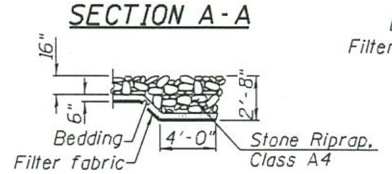
f'c = 3,500 psi (concrete)
f'c = 4,000 psi (Superstr. concrete)
fy = 60,000 psi (Reinforcement)

PRECAST PRESTRESSED UNITS

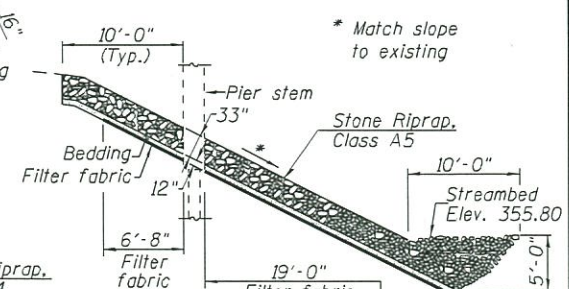
f'c = 8,500 psi (concrete)
f'ci = 7,000 psi
fpu = 270,000 psi (0.6"ϕ low lax strands)
fpbt = 202,300 psi (0.6"ϕ low lax strands)



SECTION A-A



SECTION B-B



SECTION C-C

GENERAL PLAN
F.A.P. ROUTE 331 (IL 13 E.B.)
OVER CRAB ORCHARD CREEK
SECTION (5-3) B-6
JACKSON COUNTY
STATION 87+21.84
STRUCTURE NO. 039-0079

CMT	USER NAME =	DESIGNED MJL	REVISED	STATE OF ILLINOIS DEPARTMENT OF TRANSPORTATION	GENERAL PLAN STRUCTURE NO. 039-0079	F.A.P. RTE. 331	SECTION (5-3)R-1,N-1,B-5,BR-1,B-6,BR-2	COUNTY JACKSON	TOTAL SHEETS	SHEET NO.
		CHECKED WLB/JMM	REVISED					CONTRACT NO. 78295		
	PLOT SCALE =	DRAWN GLD	REVISED							
	PLOT DATE =	CHECKED WLB/JMM	REVISED		SHEET NO. OF SHEETS		ILLINOIS FED. AID PROJECT			

EXHIBIT C

BORING LOGS

ILLINOIS DEPARTMENT OF TRANSPORTATION
District Nine Materials

Bridge Foundation
Boring Log

Eastbound FAP 331 (IL 13) Over Crab Orchard Creek

Route: FAP 331 (IL 13) Structure Number: 039-0021 Date: 6/30/2014

Section 5-3B-2 Bored By: R Moberly

County: Jackson Location: 0.6 mi West of Reed Station Road Checked By: R. Graeff

Boring No 1-S
Station 186+02
Offset 13' Rt CL EBL
Ground Surface 390.4 Ft

Surf Wat Elev: 362.1
Ground Water Elevation
when Drilling 355.4
At Completion
At: Hrs:

	DEPTH	BLOWS	Qu tsf	W%
Asphalt and crushed aggregate				
388.4				
Stiff, moist, grey and brown, Clay A7-6		3		
		3	1.4B	19
		2		
385.9				
Very soft, very moist, grey, Clay to Silty Clay A7-6	5.0	WH		
		1	0.2B	28
		1		
383.4				
Stiff, moist, grey and brown, Clay A7-6 (15) with medium layers		1		
		1	1.8B	21
		1		
380.9				
Very stiff, moist, brown, Clay A7-6	10.0	1		
		2	2.1B	19
		3		
		1		
		2	2.1B	22
		3		
	15.0	1		
		3	2.3B	22
		3		
373.4				
Medium, very moist, grey, Silty Clay A-6 with rotten organics		1		
		2	0.7B	30
		2		
370.9				
Medium, very moist, grey, Silty Clay Loam A-6	20.0	1		
		1	0.8B	24
		1		
368.4				
Stiff, moist, grey, Silty Clay Loam A-6		WH		
		1	1.1B	24
		2		
	25.0	1		

	DEPTH	BLOWS	Qu tsf	W%
Stiff, moist, grey, Silty Clay Loam A-6		1	1.2B	24
		2		
363.4				
Medium, very moist, brown mottled grey, Silty Clay Loam A-6		WH		
		1	0.6B	26
		1		
360.9				
Very soft, very moist, brown mottled grey, Silty Clay Loam A-6	30.0	WH		
		WH	0.2B	32
		WH		
358.4				
Medium, very moist, brown and grey, Silty Clay to Clay A7-6		WH		
		WH	0.7B	38
		1		
355.9				
Stiff, moist, grey, Clay A7-6	35.0	WH		
		1	1.5B	31
		2		
		1		
		1	1.8B	32
		2		
350.9				
Very stiff, moist, grey and brown, Clay A7-6	40.0	1		
		3	3.1B	29
		4		
345.9				
Stiff, moist, grey, Clay A7-6 with sandy layers	45.0	1		
		2	1.5B	22
		3		
340.4	50.0	WH		

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: 6/30/2014

Section: 5-3B-2

County: Jackson

Boring No: 1-S

Station: 186+02

Offset: 13' Rt CL EBL

Ground Surface: 390.4 Ft

	DEPTH	BLOWS	Qu tsf	W%
Medium, very moist, grey, Clay A7-6 with layers of wet fine Sand		1	0.8B	33
		1		
335.9				
Soft, very moist, grey, Sandy Clay Loam A-4 with Sand layers	55.0	WH		
		1	0.4B	30
		WH		
330.9		Washed		
Very loose, wet, grey, Sand (no recovery)	60.0	WH		
		1		
		2		
325.9				
Stiff, moist, grey and black, Clay A7-6 with Coal and weathered Clay Shale	65.0	3		
		6	1.8S	#188
		12		
323.4		14		
Hard, dry, grey, Clay Shale		100/8"		
	70.0			
		100/5"		
	75.0			

	DEPTH	BLOWS	Qu tsf	W%
Hard, dry, grey, Clay Shale				
312.9		100/4"		
Bottom of hole = 77.3 feet	80.0			
Free water observed at 35.0 feet				
Elevation referenced to BM 22 at SW corner SN 039-0061; Elev.= 390.3 feet				
Borehole advanced with hollow stem auger (8" O.D, 3.25" I.D.)				
	85.0			
To convert "N" values to "N60" multiply by 1.25				
	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

Eastbound FAP 331 (IL 13) Over Crab Orchard Creek

Route: FAP 331 (IL 13) Structure Number: 039-0021 Date: 7/1/2014

Section 5-3B-2 Bored By: R Moberly

County: Jackson Location: 0.6 mi West of Reed Station Road Checked By: R. Graeff

Boring No 2-S
Station 188+92
Offset 14' Rt CL EBL
Ground Surface 390.6 Ft

Surf Wat Elev: 362.1
Ground Water Elevation
when Drilling 336.4
At Completion
At: Hrs:

Description	DEPTH	BLOWS	Qu tsf	W%
Asphalt over crushed aggregate				
		2		
		4		
387.1		1		
Stiff, moist, grey and brown, Clay A7-6				
	5.0	1		
		1	1.2B	21
		2		
383.6				
Soft, very moist, grey and brown, Clay to Silty Clay A7-6		WH		
		WH	0.4B	27
		1		
381.1				
Very stiff, moist, brown and grey, Clay A7-6	10.0	1		
		3	2.1B	22
		3		
		1		
		3	2.5B	23
		4		
376.1				
Stiff, moist, brown and grey, Clay A7-6	15.0	1		
		3	1.6B	24
		4		
373.6				
Hard, damp, grey, Silt Loam to Silty Clay Loam A-4		1		
		6	5.5S	18
		7		
371.1				
Soft, very moist, grey, Silty Clay Loam A-4	20.0	WH		
		WH	0.3B	28
		1		
368.6				
Very soft, wet, grey, Silt Loam to Silty Clay Loam A-4		WH		
		WH	0.1B	31
		WH		
	25.0	WH		

Description	DEPTH	BLOWS	Qu tsf	W%
Very soft, wet, grey, Silt Loam to Silty Clay Loam A-4		WH	0.1B	30
		WH		
		WH		
		WH	0.2B	33
		WH		
361.1				
Soft, very moist, grey mottled brown, Silty Clay Loam A-6	30.0	WH		
		WH	0.3B	31
		WH		
358.6				
Medium, very moist, grey mottled brown, Silty Clay Loam A-6		WH		
		WH	0.5B	31
		WH		
	35.0	WH		
		WH	0.6B	30
		1		
353.6				
Medium, very moist, grey, Silty Clay A-6 with organics		WH		
		WH	0.6B	45
		1		
351.1				
Very stiff, moist, grey mottled brown, Clay A7-6	40.0	1		
		3	2.5B	29
		4		
346.1				
Stiff, moist, grey, Clay A7-6	45.0	2		
		4	1.8B	28
		5		
340.6	50.0	WH		

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: 7/1/2014

Section: 5-3B-2

County: Jackson

Boring No: 2-S

Station: 188+92

Offset: 14' Rt CL EBL

Ground Surface: 390.6 Ft

Description	DEPTH	BLOWS	Qu tsf	W%
Medium, very moist, grey, Clay Loam to Sandy Clay Loam A-6 A-6		1	0.6B	23
		2		
Washed 5' blow-in 336.6				
Loose, wet, grey, Sand with many Clay layers (not enough sample for grain-size)	55.0	1		
		2		
		3		
331.1				
Medium, very moist, grey, Clay A7-6	60.0	1		
		1	0.8B	21
		2		
326.1				
Soft, very moist, grey, Clay Loam to Sandy Clay Loam A-6	65.0	WH		
		1	0.4B	23
		1		
323.1				
Hard, dry, grey, Clay Shale				
320.6	70.0	100/6"		
Bottom of hole = 70.0 feet				
Free water observed at 54.0 feet				
	75.0			

Description	DEPTH	BLOWS	Qu tsf	W%
Bottom of hole = 70.0 feet				
Free water observed at 54.0 feet				
Elevation referenced to BM 22 at SW corner SN 039-0061; Elev.= 390.3 feet	80.0			
Borehole advanced with hollow stem auger (8" O.D, 3.25" I.D.)				
To convert "N" values to "N60" multiply by 1.25				
	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)

EXHIBIT D

SUBSURFACE PROFILE

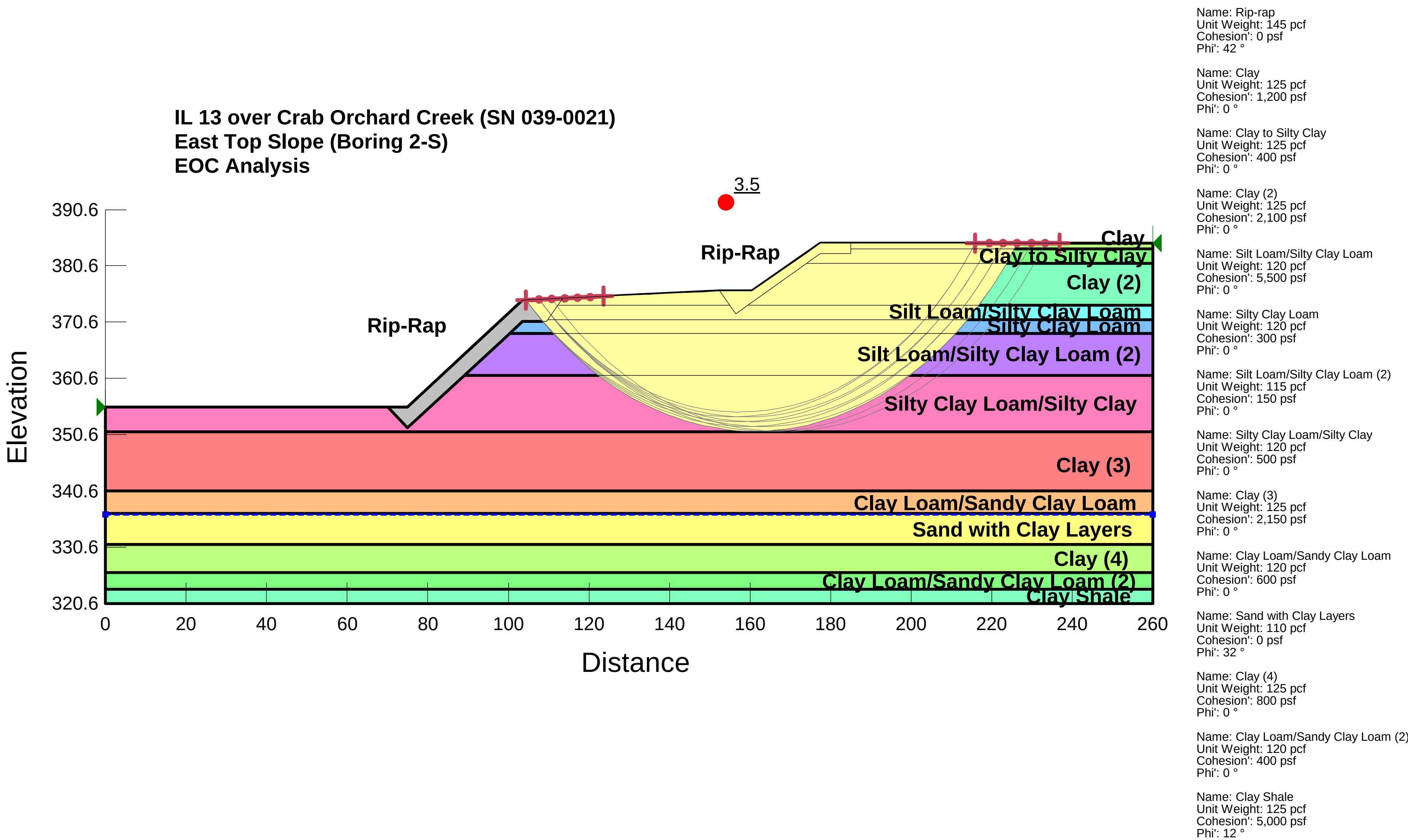
Kaskaskia Engineering Group, LLC

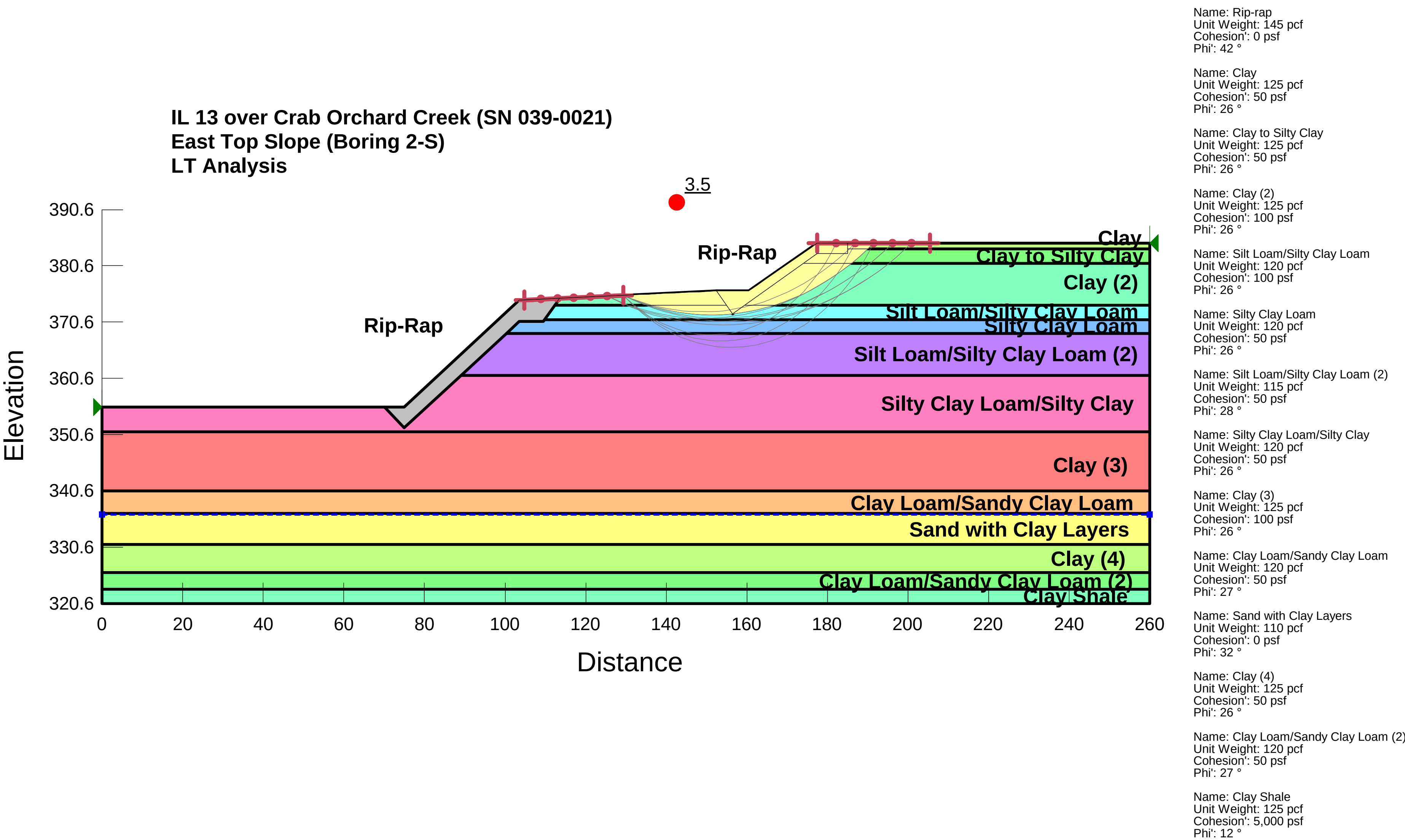
SUBSURFACE PROFILE: IL 13 over Crab Orchard Creek (SN 039-0021)

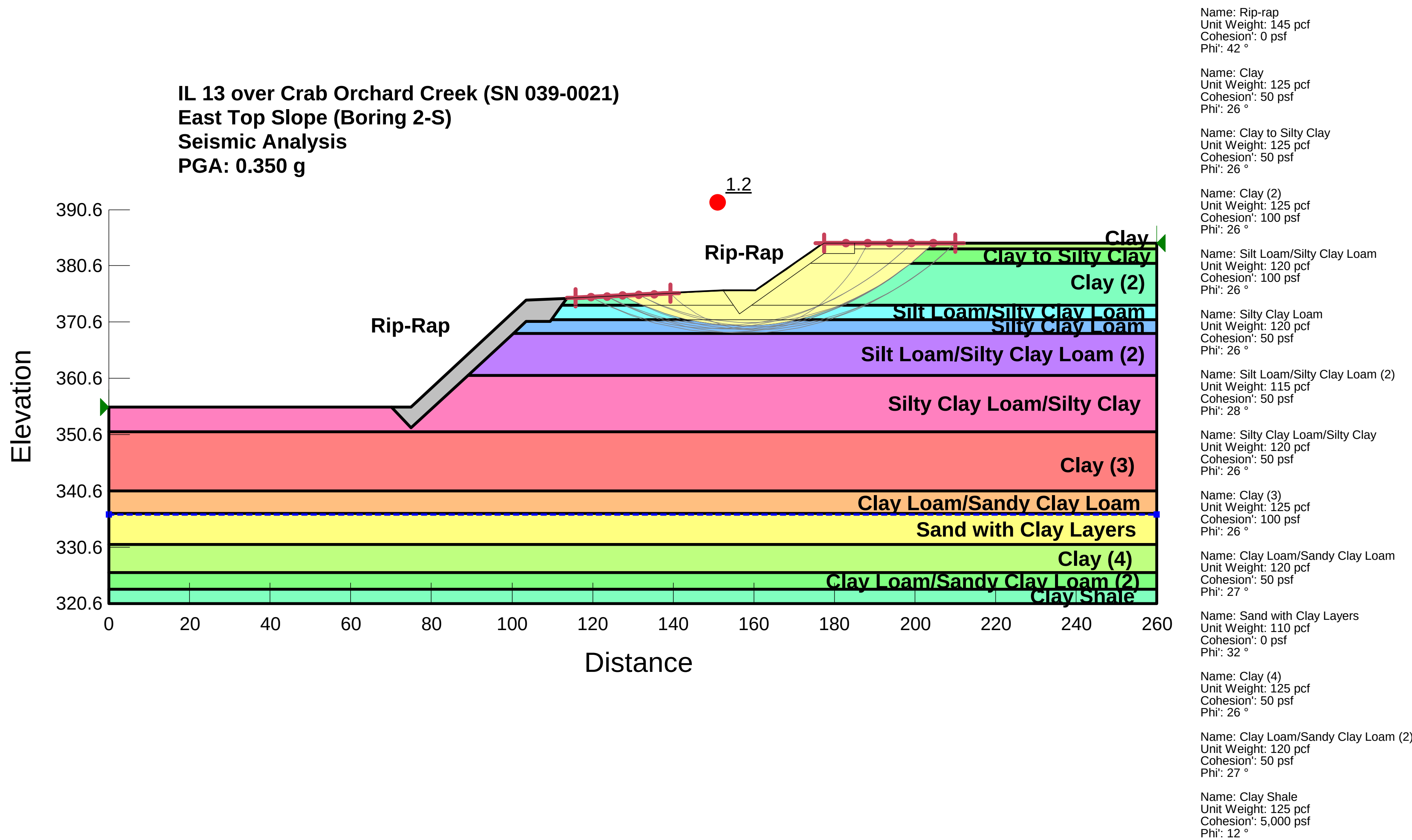
Route: F.A.P. 331
Section: 5-3B-2
County: Jackson

EXHIBIT E

SLOPE/W SLOPE STABILITY ANALYSIS

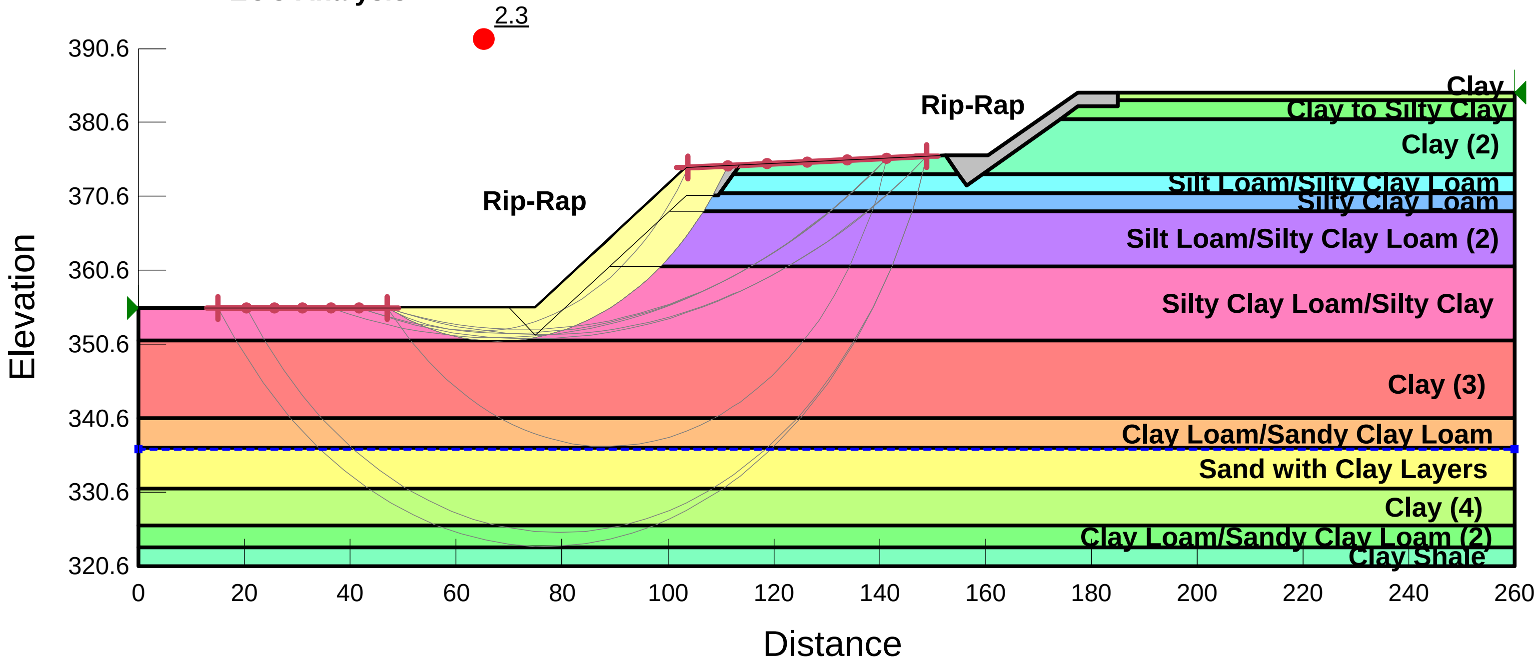

IL 13 over Crab Orchard Creek (SN 039-0021)
East Top Slope (Boring 2-S)
EOC Analysis
3.5
Rip-Rap
Rip-Rap
Clay
Clay to Silty Clay
Clay (2)
Silt Loam/Silty Clay Loam
Silty Clay Loam
Silt Loam/Silty Clay Loam (2)
Silty Clay Loam/Silty Clay
Clay (3)
Clay Loam/Sandy Clay Loam
Sand with Clay Layers
Clay (4)
Clay Loam/Sandy Clay Loam (2)
Clay Shale
Elevation
390.6
380.6
370.6
360.6
350.6
340.6
330.6
320.6
0
20
40
60
80
100
120
140
160
180
200
220
240
260
Distance
Name: Rip-rap
Unit Weight: 145 pcf
Cohesion': 0 psf
Phi': 42 °
Name: Clay
Unit Weight: 125 pcf
Cohesion': 1,200 psf
Phi': 0 °
Name: Clay to Silty Clay
Unit Weight: 125 pcf
Cohesion': 400 psf
Phi': 0 °
Name: Clay (2)
Unit Weight: 125 pcf
Cohesion': 2,100 psf
Phi': 0 °
Name: Silt Loam/Silty Clay Loam
Unit Weight: 120 pcf
Cohesion': 5,500 psf
Phi': 0 °
Name: Silty Clay Loam
Unit Weight: 120 pcf
Cohesion': 300 psf
Phi': 0 °
Name: Silt Loam/Silty Clay Loam (2)
Unit Weight: 115 pcf
Cohesion': 150 psf
Phi': 0 °
Name: Silty Clay Loam/Silty Clay
Unit Weight: 120 pcf
Cohesion': 500 psf
Phi': 0 °
Name: Clay (3)
Unit Weight: 125 pcf
Cohesion': 2,150 psf
Phi': 0 °
Name: Clay Loam/Sandy Clay Loam
Unit Weight: 120 pcf
Cohesion': 600 psf
Phi': 0 °
Name: Sand with Clay Layers
Unit Weight: 110 pcf
Cohesion': 0 psf
Phi': 32 °
Name: Clay (4)
Unit Weight: 125 pcf
Cohesion': 800 psf
Phi': 0 °
Name: Clay Loam/Sandy Clay Loam (2)
Unit Weight: 120 pcf
Cohesion': 400 psf
Phi': 0 °
Name: Clay Shale
Unit Weight: 125 pcf
Cohesion': 5,000 psf
Phi': 12 °


IL 13 over Crab Orchard Creek (SN 039-0021)
East Top Slope (Boring 2-S)
LT Analysis
3.5
Rip-Rap
Rip-Rap
Clay
Clay to Silty Clay
Clay (2)
Silt Loam/Silty Clay Loam
Silty Clay Loam
Silt Loam/Silty Clay Loam (2)
Silty Clay Loam/Silty Clay
Clay (3)
Clay Loam/Sandy Clay Loam
Sand with Clay Layers
Clay (4)
Clay Loam/Sandy Clay Loam (2)
Clay Shale
Elevation
390.6
380.6
370.6
360.6
350.6
340.6
330.6
320.6
0
20
40
60
80
100
120
140
160
180
200
220
240
260
Distance
Name: Rip-rap
Unit Weight: 145 pcf
Cohesion': 0 psf
Phi': 42 °
Name: Clay
Unit Weight: 125 pcf
Cohesion': 50 psf
Phi': 26 °
Name: Clay to Silty Clay
Unit Weight: 125 pcf
Cohesion': 50 psf
Phi': 26 °
Name: Clay (2)
Unit Weight: 125 pcf
Cohesion': 100 psf
Phi': 26 °
Name: Silt Loam/Silty Clay Loam
Unit Weight: 120 pcf
Cohesion': 100 psf
Phi': 26 °
Name: Silty Clay Loam
Unit Weight: 120 pcf
Cohesion': 50 psf
Phi': 26 °
Name: Silt Loam/Silty Clay Loam (2)
Unit Weight: 115 pcf
Cohesion': 50 psf
Phi': 28 °
Name: Silty Clay Loam/Silty Clay
Unit Weight: 120 pcf
Cohesion': 50 psf
Phi': 26 °
Name: Clay (3)
Unit Weight: 125 pcf
Cohesion': 100 psf
Phi': 26 °
Name: Clay Loam/Sandy Clay Loam
Unit Weight: 120 pcf
Cohesion': 50 psf
Phi': 27 °
Name: Sand with Clay Layers
Unit Weight: 110 pcf
Cohesion': 0 psf
Phi': 32 °
Name: Clay (4)
Unit Weight: 125 pcf
Cohesion': 50 psf
Phi': 26 °
Name: Clay Loam/Sandy Clay Loam (2)
Unit Weight: 120 pcf
Cohesion': 50 psf
Phi': 27 °
Name: Clay Shale
Unit Weight: 125 pcf
Cohesion': 5,000 psf
Phi': 12 °



IL 13 over Crab Orchard Creek (SN 039-0021)
East Top Slope (Boring 2-S)
Seismic Analysis
PGA: 0.350 g
1.2
Rip-Rap
Rip-Rap
Clay
Clay to Silty Clay
Clay (2)
Silt Loam/Silty Clay Loam
Silty Clay Loam
Silt Loam/Silty Clay Loam (2)
Silty Clay Loam/Silty Clay
Clay (3)
Clay Loam/Sandy Clay Loam
Sand with Clay Layers
Clay (4)
Clay Loam/Sandy Clay Loam (2)
Clay Shale
Elevation
390.6
380.6
370.6
360.6
350.6
340.6
330.6
320.6
0
20
40
60
80
100
120
140
160
180
200
220
240
260
Distance
Name: Rip-rap
Unit Weight: 145 pcf
Cohesion': 0 psf
Phi': 42 °
Name: Clay
Unit Weight: 125 pcf
Cohesion': 50 psf
Phi': 26 °
Name: Clay to Silty Clay
Unit Weight: 125 pcf
Cohesion': 50 psf
Phi': 26 °
Name: Clay (2)
Unit Weight: 125 pcf
Cohesion': 100 psf
Phi': 26 °
Name: Silt Loam/Silty Clay Loam
Unit Weight: 120 pcf
Cohesion': 100 psf
Phi': 26 °
Name: Silty Clay Loam
Unit Weight: 120 pcf
Cohesion': 50 psf
Phi': 26 °
Name: Silt Loam/Silty Clay Loam (2)
Unit Weight: 115 pcf
Cohesion': 50 psf
Phi': 28 °
Name: Silty Clay Loam/Silty Clay
Unit Weight: 120 pcf
Cohesion': 50 psf
Phi': 26 °
Name: Clay (3)
Unit Weight: 125 pcf
Cohesion': 100 psf
Phi': 26 °
Name: Clay Loam/Sandy Clay Loam
Unit Weight: 120 pcf
Cohesion': 50 psf
Phi': 27 °
Name: Sand with Clay Layers
Unit Weight: 110 pcf
Cohesion': 0 psf
Phi': 32 °
Name: Clay (4)
Unit Weight: 125 pcf
Cohesion': 50 psf
Phi': 26 °
Name: Clay Loam/Sandy Clay Loam (2)
Unit Weight: 120 pcf
Cohesion': 50 psf
Phi': 27 °
Name: Clay Shale
Unit Weight: 125 pcf
Cohesion': 5,000 psf
Phi': 12 °

IL 13 over Crab Orchard Creek (SN 039-0021)
East Bottom Slope (Boring 2-S)
EOC Analysis



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

Name: Clay
Unit Weight: 125 pcf
Cohesion': 1,200 psf
Phi': 0 °

Name: Clay to Silty Clay
Unit Weight: 125 pcf
Cohesion': 400 psf
Phi': 0 °

Name: Clay (2)
Unit Weight: 125 pcf
Cohesion': 2,100 psf
Phi': 0 °

Name: Silt Loam/Silty Clay Loam
Unit Weight: 120 pcf
Cohesion': 5,500 psf
Phi': 0 °

Name: Silty Clay Loam
Unit Weight: 120 pcf
Cohesion': 300 psf
Phi': 0 °

Name: Silt Loam/Silty Clay Loam (2)
Unit Weight: 115 pcf
Cohesion': 150 psf
Phi': 0 °

Name: Silty Clay Loam/Silty Clay
Unit Weight: 120 pcf
Cohesion': 500 psf
Phi': 0 °

Name: Clay (3)
Unit Weight: 125 pcf
Cohesion': 2,150 psf
Phi': 0 °

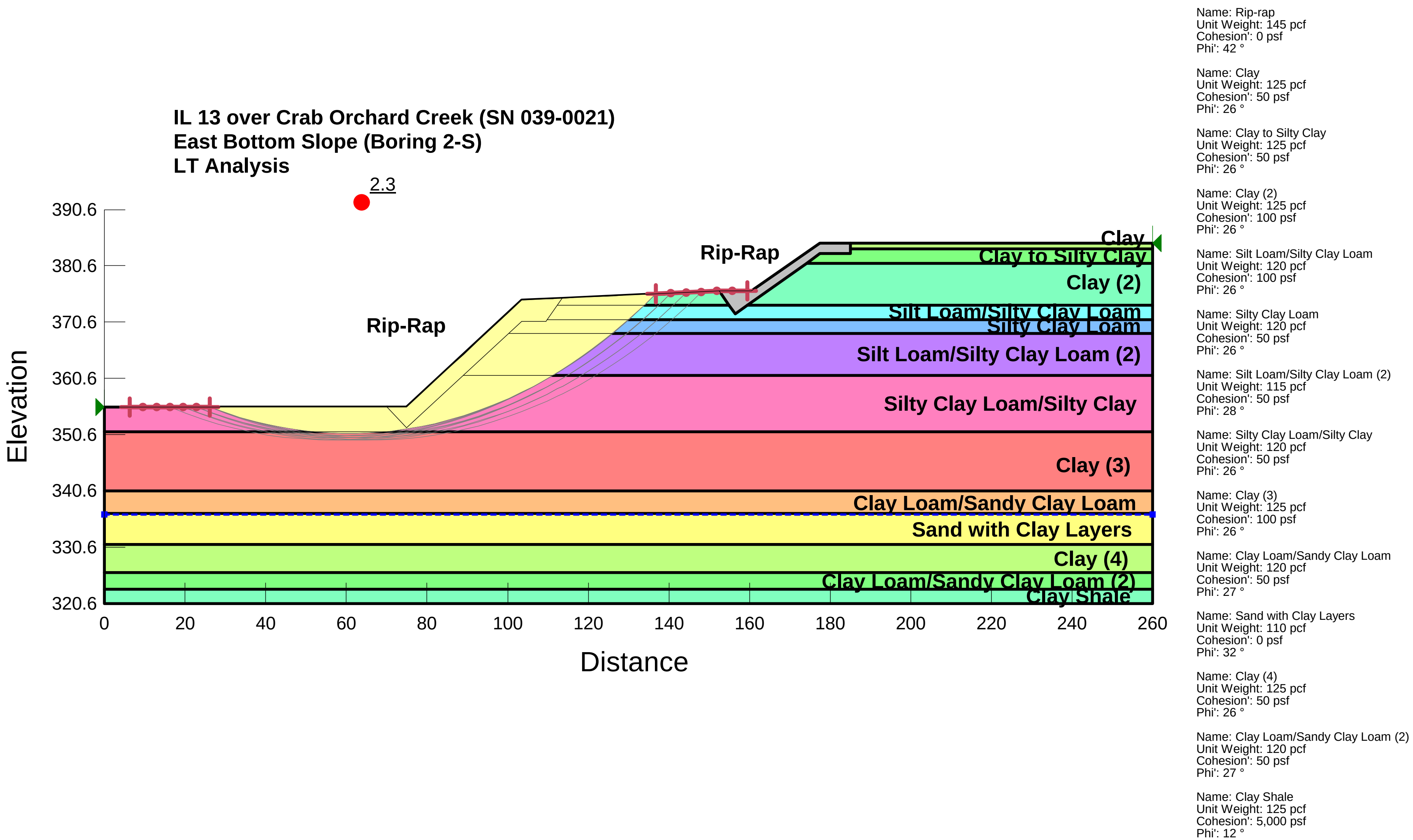
Name: Clay Loam/Sandy Clay Loam
Unit Weight: 120 pcf
Cohesion': 600 psf
Phi': 0 °

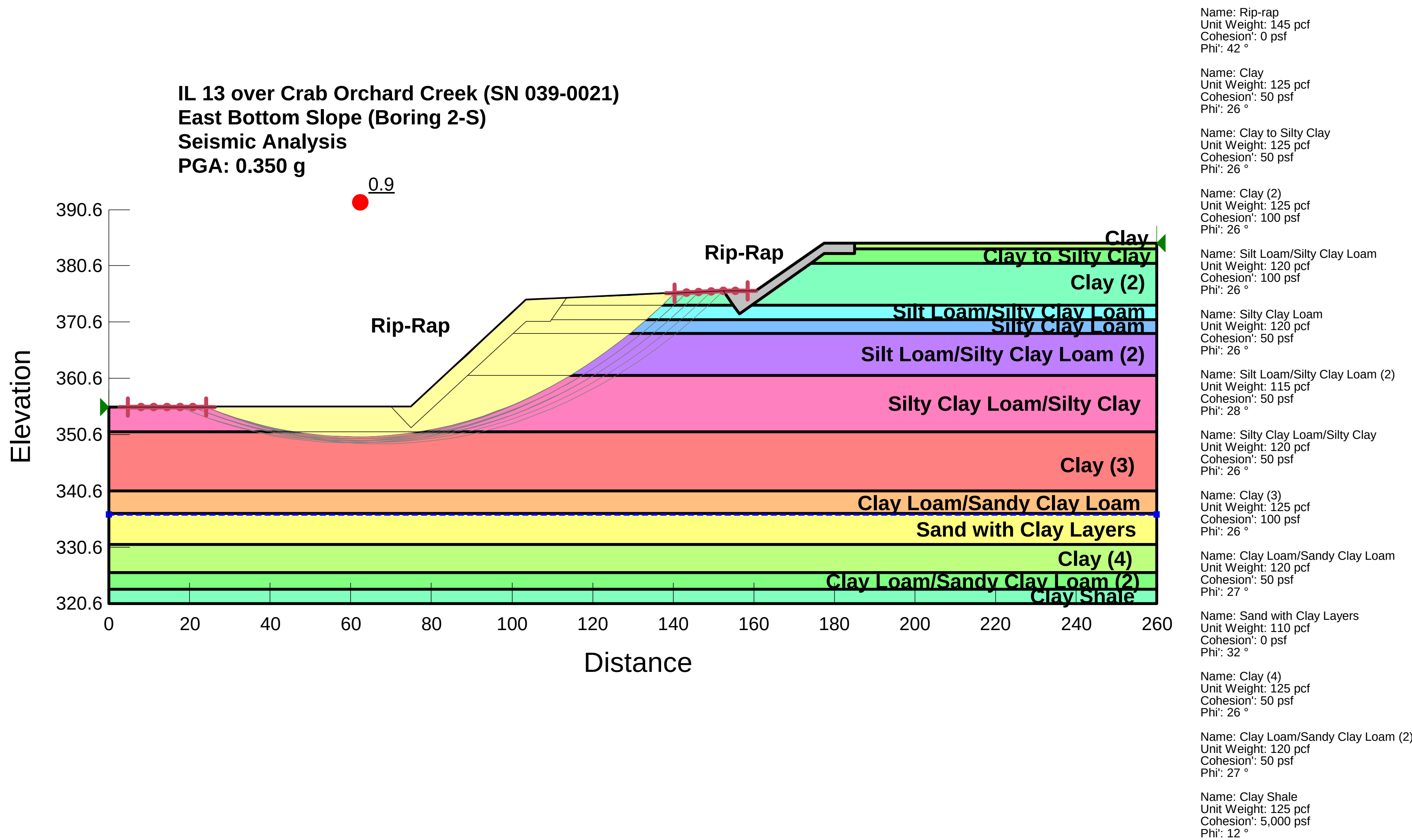
Name: Sand with Clay Layers
Unit Weight: 110 pcf
Cohesion': 0 psf
Phi': 32 °

Name: Clay (4)
Unit Weight: 125 pcf
Cohesion': 800 psf
Phi': 0 °

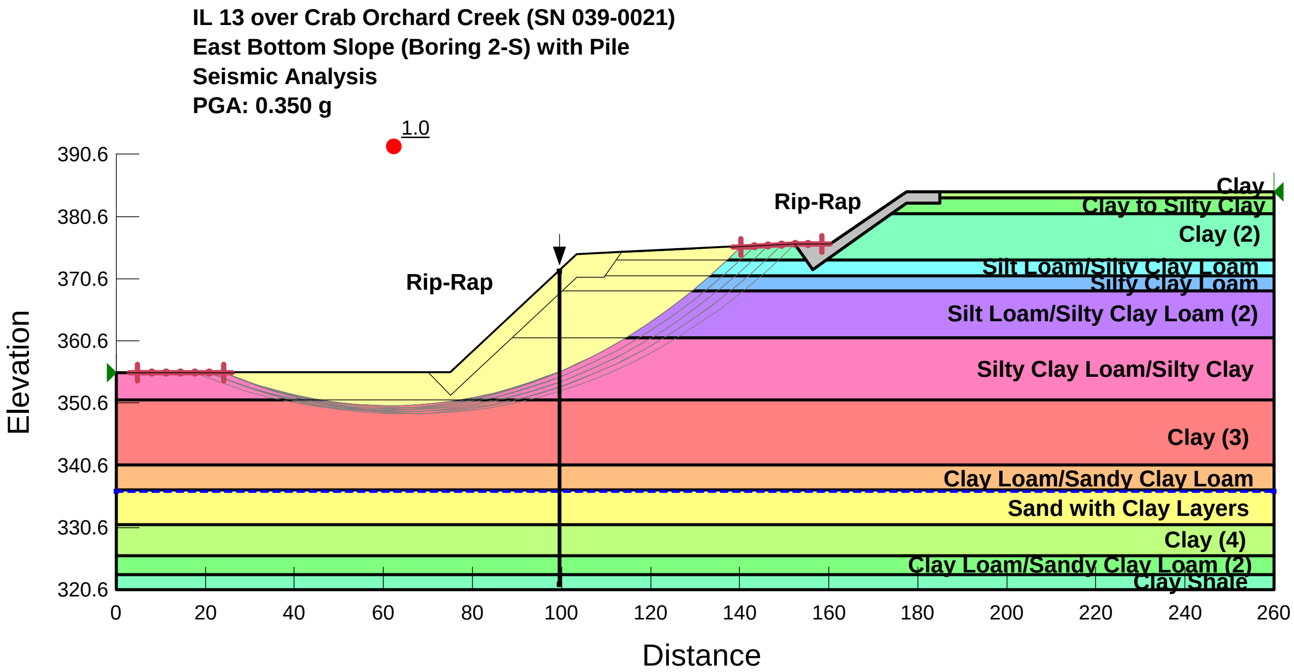
Name: Clay Loam/Sandy Clay Loam (2)
Unit Weight: 120 pcf
Cohesion': 400 psf
Phi': 0 °

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


IL 13 over Crab Orchard Creek (SN 039-0021)
East Bottom Slope (Boring 2-S)
LT Analysis
2.3
Rip-Rap
Rip-Rap
Clay
Clay to Silty Clay
Clay (2)
Silt Loam/Silty Clay Loam
Silty Clay Loam
Silt Loam/Silty Clay Loam (2)
Silty Clay Loam/Silty Clay
Clay (3)
Clay Loam/Sandy Clay Loam
Sand with Clay Layers
Clay (4)
Clay Loam/Sandy Clay Loam (2)
Clay Shale
Elevation
390.6
380.6
370.6
360.6
350.6
340.6
330.6
320.6
0
20
40
60
80
100
120
140
160
180
200
220
240
260
Distance
Name: Rip-rap
Unit Weight: 145 pcf
Cohesion': 0 psf
Phi': 42 °
Name: Clay
Unit Weight: 125 pcf
Cohesion': 50 psf
Phi': 26 °
Name: Clay to Silty Clay
Unit Weight: 125 pcf
Cohesion': 50 psf
Phi': 26 °
Name: Clay (2)
Unit Weight: 125 pcf
Cohesion': 100 psf
Phi': 26 °
Name: Silt Loam/Silty Clay Loam
Unit Weight: 120 pcf
Cohesion': 100 psf
Phi': 26 °
Name: Silty Clay Loam
Unit Weight: 120 pcf
Cohesion': 50 psf
Phi': 26 °
Name: Silt Loam/Silty Clay Loam (2)
Unit Weight: 115 pcf
Cohesion': 50 psf
Phi': 28 °
Name: Silty Clay Loam/Silty Clay
Unit Weight: 120 pcf
Cohesion': 50 psf
Phi': 26 °
Name: Clay (3)
Unit Weight: 125 pcf
Cohesion': 100 psf
Phi': 26 °
Name: Clay Loam/Sandy Clay Loam
Unit Weight: 120 pcf
Cohesion': 50 psf
Phi': 27 °
Name: Sand with Clay Layers
Unit Weight: 110 pcf
Cohesion': 0 psf
Phi': 32 °
Name: Clay (4)
Unit Weight: 125 pcf
Cohesion': 50 psf
Phi': 26 °
Name: Clay Loam/Sandy Clay Loam (2)
Unit Weight: 120 pcf
Cohesion': 50 psf
Phi': 27 °
Name: Clay Shale
Unit Weight: 125 pcf
Cohesion': 5,000 psf
Phi': 12 °



IL 13 over Crab Orchard Creek (SN 039-0021)
East Bottom Slope (Boring 2-S)
Seismic Analysis
PGA: 0.350 g
0.9
Rip-Rap
Rip-Rap
Clay
Clay to Silty Clay
Clay (2)
Silt Loam/Silty Clay Loam
Silty Clay Loam
Silt Loam/Silty Clay Loam (2)
Silty Clay Loam/Silty Clay
Clay (3)
Clay Loam/Sandy Clay Loam
Sand with Clay Layers
Clay (4)
Clay Loam/Sandy Clay Loam (2)
Clay Shale
Elevation
390.6
380.6
370.6
360.6
350.6
340.6
330.6
320.6
Distance
0
20
40
60
80
100
120
140
160
180
200
220
240
260
Name: Rip-rap
Unit Weight: 145 pcf
Cohesion': 0 psf
Phi': 42 °
Name: Clay
Unit Weight: 125 pcf
Cohesion': 50 psf
Phi': 26 °
Name: Clay to Silty Clay
Unit Weight: 125 pcf
Cohesion': 50 psf
Phi': 26 °
Name: Clay (2)
Unit Weight: 125 pcf
Cohesion': 100 psf
Phi': 26 °
Name: Silt Loam/Silty Clay Loam
Unit Weight: 120 pcf
Cohesion': 100 psf
Phi': 26 °
Name: Silty Clay Loam
Unit Weight: 120 pcf
Cohesion': 50 psf
Phi': 26 °
Name: Silt Loam/Silty Clay Loam (2)
Unit Weight: 115 pcf
Cohesion': 50 psf
Phi': 28 °
Name: Silty Clay Loam/Silty Clay
Unit Weight: 120 pcf
Cohesion': 50 psf
Phi': 26 °
Name: Clay (3)
Unit Weight: 125 pcf
Cohesion': 100 psf
Phi': 26 °
Name: Clay Loam/Sandy Clay Loam
Unit Weight: 120 pcf
Cohesion': 50 psf
Phi': 27 °
Name: Sand with Clay Layers
Unit Weight: 110 pcf
Cohesion': 0 psf
Phi': 32 °
Name: Clay (4)
Unit Weight: 125 pcf
Cohesion': 50 psf
Phi': 26 °
Name: Clay Loam/Sandy Clay Loam (2)
Unit Weight: 120 pcf
Cohesion': 50 psf
Phi': 27 °
Name: Clay Shale
Unit Weight: 125 pcf
Cohesion': 5,000 psf
Phi': 12 °



Phi': 26 °

Name: Clay to Silty Clay
Unit Weight: 125 pcf
Cohesion': 50 psf
Phi': 26 °

Name: Clay (2)
Unit Weight: 125 pcf
Cohesion': 100 psf
Phi': 26 °

Name: Silt Loam/Silty Clay Loam
Unit Weight: 120 pcf
Cohesion': 100 psf
Phi': 26 °

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

Name: Silt Loam/Silty Clay Loam (2)
Unit Weight: 115 pcf
Cohesion': 50 psf
Phi': 28 °

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

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

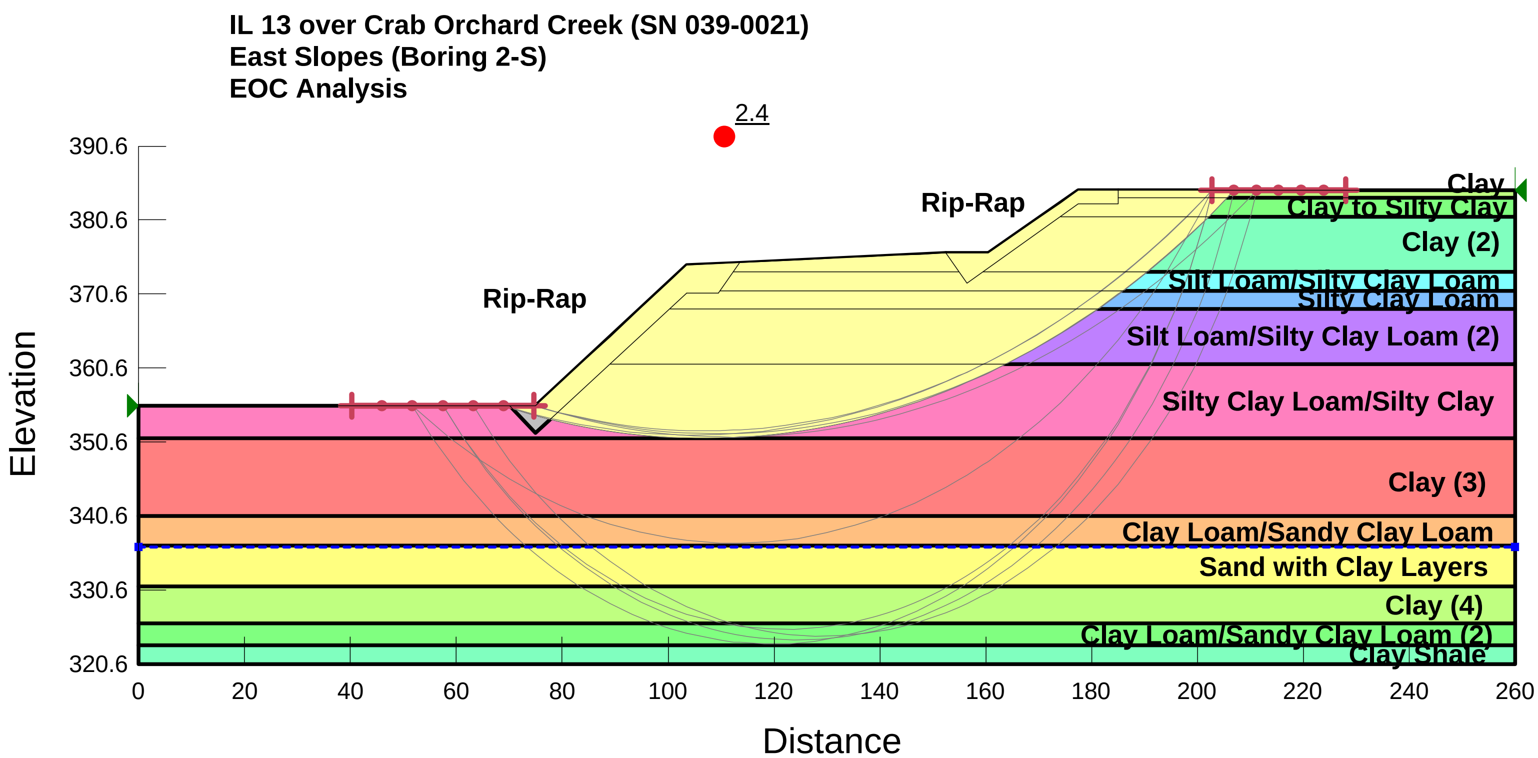
Name: Clay Loam/Sandy Clay Loam
Unit Weight: 120 pcf
Cohesion': 50 psf
Phi': 27 °

Name: Sand with Clay Layers
Unit Weight: 110 pcf
Cohesion': 0 psf
Phi': 32 °

Name: Clay (4)
Unit Weight: 125 pcf
Cohesion': 50 psf
Phi': 26 °

Name: Clay Loam/Sandy Clay Loam (2)
Unit Weight: 120 pcf
Cohesion': 50 psf
Phi': 27 °

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



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

Name: Clay
Unit Weight: 125 pcf
Cohesion': 1,200 psf
Phi': 0 °

Name: Clay to Silty Clay
Unit Weight: 125 pcf
Cohesion': 400 psf
Phi': 0 °

Name: Clay (2)
Unit Weight: 125 pcf
Cohesion': 2,100 psf
Phi': 0 °

Name: Silt Loam/Silty Clay Loam
Unit Weight: 120 pcf
Cohesion': 5,500 psf
Phi': 0 °

Name: Silty Clay Loam
Unit Weight: 120 pcf
Cohesion': 300 psf
Phi': 0 °

Name: Silt Loam/Silty Clay Loam (2)
Unit Weight: 115 pcf
Cohesion': 150 psf
Phi': 0 °

Name: Silty Clay Loam/Silty Clay
Unit Weight: 120 pcf
Cohesion': 500 psf
Phi': 0 °

Name: Clay (3)
Unit Weight: 125 pcf
Cohesion': 2,150 psf
Phi': 0 °

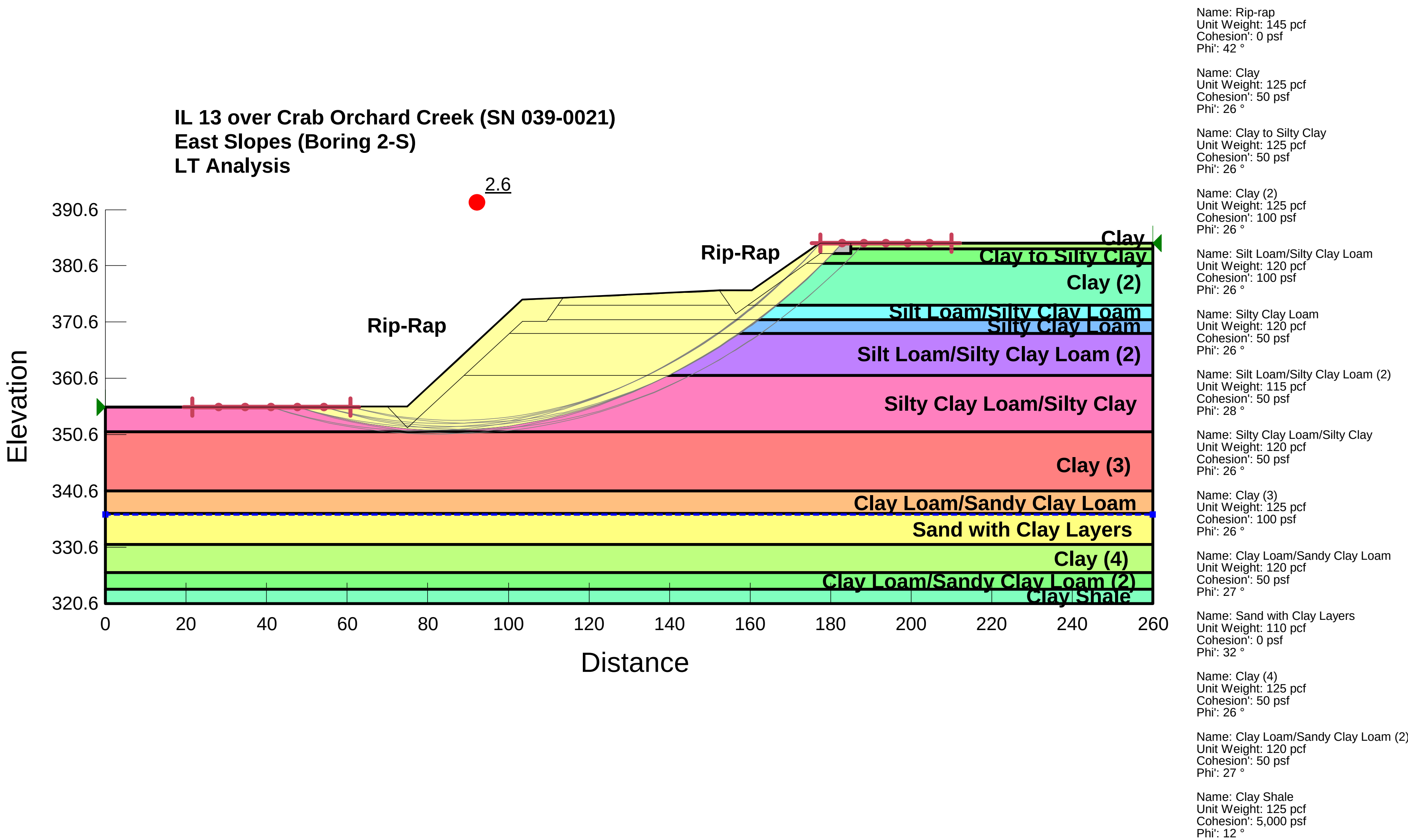
Name: Clay Loam/Sandy Clay Loam
Unit Weight: 120 pcf
Cohesion': 600 psf
Phi': 0 °

Name: Sand with Clay Layers
Unit Weight: 110 pcf
Cohesion': 0 psf
Phi': 32 °

Name: Clay (4)
Unit Weight: 125 pcf
Cohesion': 800 psf
Phi': 0 °

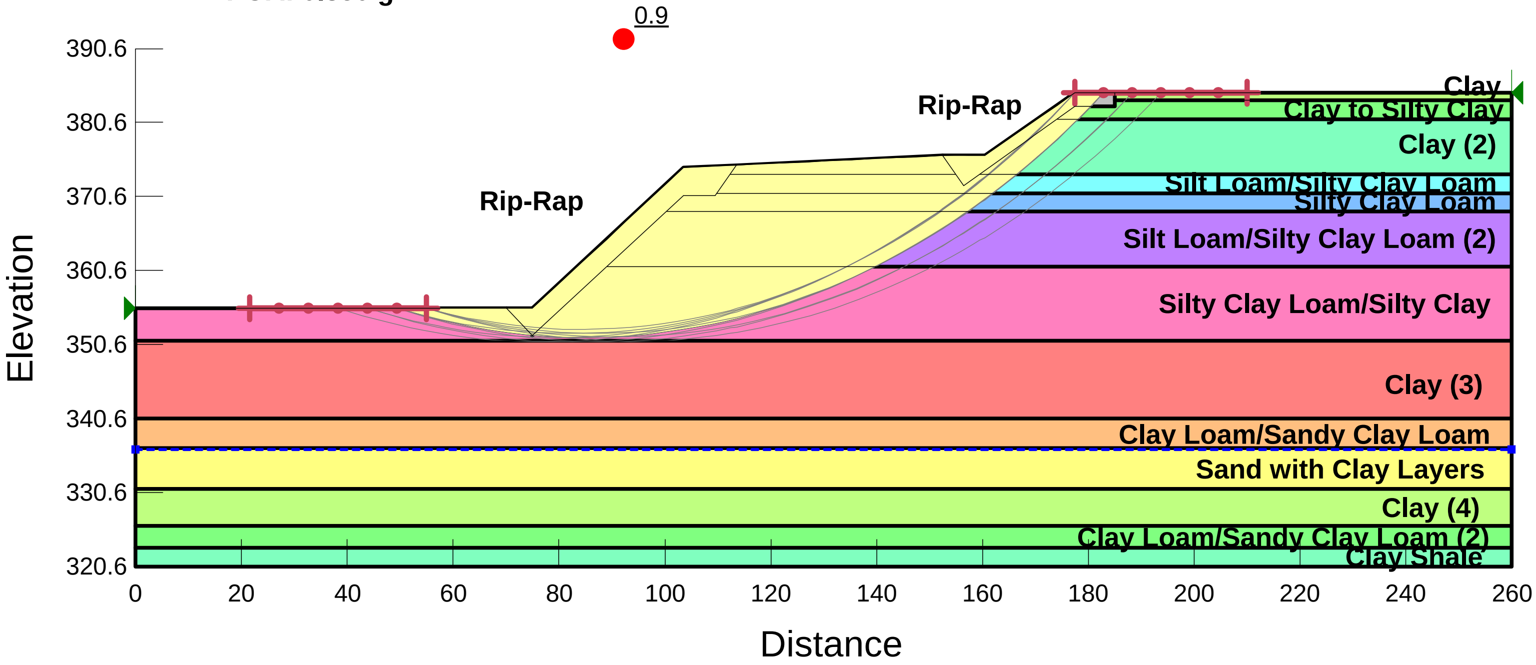
Name: Clay Loam/Sandy Clay Loam (2)
Unit Weight: 120 pcf
Cohesion': 400 psf
Phi': 0 °

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



IL 13 over Crab Orchard Creek (SN 039-0021)
East Slopes (Boring 2-S)
LT Analysis
2.6
Rip-Rap
Rip-Rap
Clay
Clay to Silty Clay
Clay (2)
Silt Loam/Silty Clay Loam
Silty Clay Loam
Silt Loam/Silty Clay Loam (2)
Silty Clay Loam/Silty Clay
Clay (3)
Clay Loam/Sandy Clay Loam
Sand with Clay Layers
Clay (4)
Clay Loam/Sandy Clay Loam (2)
Clay Shale
Elevation
390.6
380.6
370.6
360.6
350.6
340.6
330.6
320.6
0
20
40
60
80
100
120
140
160
180
200
220
240
260
Distance
Name: Rip-rap
Unit Weight: 145 pcf
Cohesion': 0 psf
Phi': 42 °
Name: Clay
Unit Weight: 125 pcf
Cohesion': 50 psf
Phi': 26 °
Name: Clay to Silty Clay
Unit Weight: 125 pcf
Cohesion': 50 psf
Phi': 26 °
Name: Clay (2)
Unit Weight: 125 pcf
Cohesion': 100 psf
Phi': 26 °
Name: Silt Loam/Silty Clay Loam
Unit Weight: 120 pcf
Cohesion': 100 psf
Phi': 26 °
Name: Silty Clay Loam
Unit Weight: 120 pcf
Cohesion': 50 psf
Phi': 26 °
Name: Silt Loam/Silty Clay Loam (2)
Unit Weight: 115 pcf
Cohesion': 50 psf
Phi': 28 °
Name: Silty Clay Loam/Silty Clay
Unit Weight: 120 pcf
Cohesion': 50 psf
Phi': 26 °
Name: Clay (3)
Unit Weight: 125 pcf
Cohesion': 100 psf
Phi': 26 °
Name: Clay Loam/Sandy Clay Loam
Unit Weight: 120 pcf
Cohesion': 50 psf
Phi': 27 °
Name: Sand with Clay Layers
Unit Weight: 110 pcf
Cohesion': 0 psf
Phi': 32 °
Name: Clay (4)
Unit Weight: 125 pcf
Cohesion': 50 psf
Phi': 26 °
Name: Clay Loam/Sandy Clay Loam (2)
Unit Weight: 120 pcf
Cohesion': 50 psf
Phi': 27 °
Name: Clay Shale
Unit Weight: 125 pcf
Cohesion': 5,000 psf
Phi': 12 °

IL 13 over Crab Orchard Creek (SN 039-0021)
East Slopes (Boring 2-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': 50 psf
Phi': 26 °

Name: Clay to Silty Clay
Unit Weight: 125 pcf
Cohesion': 50 psf
Phi': 26 °

Name: Clay (2)
Unit Weight: 125 pcf
Cohesion': 100 psf
Phi': 26 °

Name: Silt Loam/Silty Clay Loam
Unit Weight: 120 pcf
Cohesion': 100 psf
Phi': 26 °

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

Name: Silt Loam/Silty Clay Loam (2)
Unit Weight: 115 pcf
Cohesion': 50 psf
Phi': 28 °

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

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

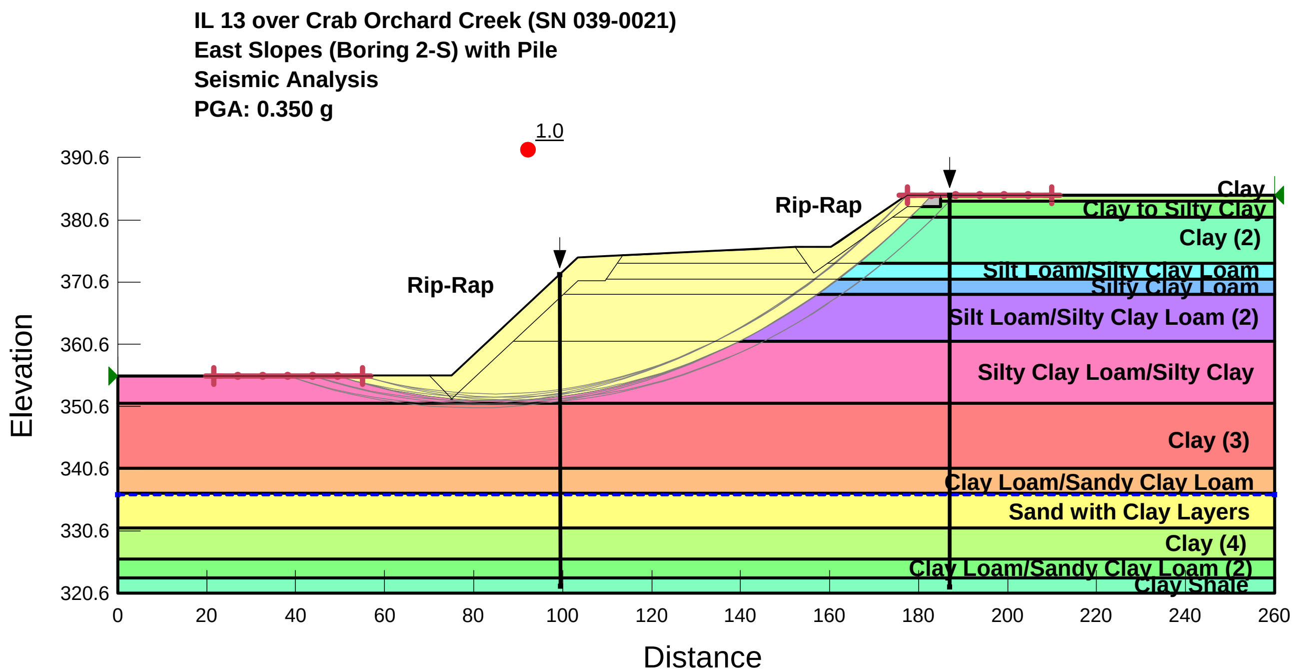
Name: Clay Loam/Sandy Clay Loam
Unit Weight: 120 pcf
Cohesion': 50 psf
Phi': 27 °

Name: Sand with Clay Layers
Unit Weight: 110 pcf
Cohesion': 0 psf
Phi': 32 °

Name: Clay (4)
Unit Weight: 125 pcf
Cohesion': 50 psf
Phi': 26 °

Name: Clay Loam/Sandy Clay Loam (2)
Unit Weight: 120 pcf
Cohesion': 50 psf
Phi': 27 °

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



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

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

Name: Clay to Silty Clay
Unit Weight: 125 pcf
Cohesion': 50 psf
Phi': 26 °

Name: Clay (2)
Unit Weight: 125 pcf
Cohesion': 100 psf
Phi': 26 °

Name: Silt Loam/Silty Clay Loam
Unit Weight: 120 pcf
Cohesion': 100 psf
Phi': 26 °

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

Name: Silt Loam/Silty Clay Loam (2)
Unit Weight: 115 pcf
Cohesion': 50 psf
Phi': 28 °

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

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

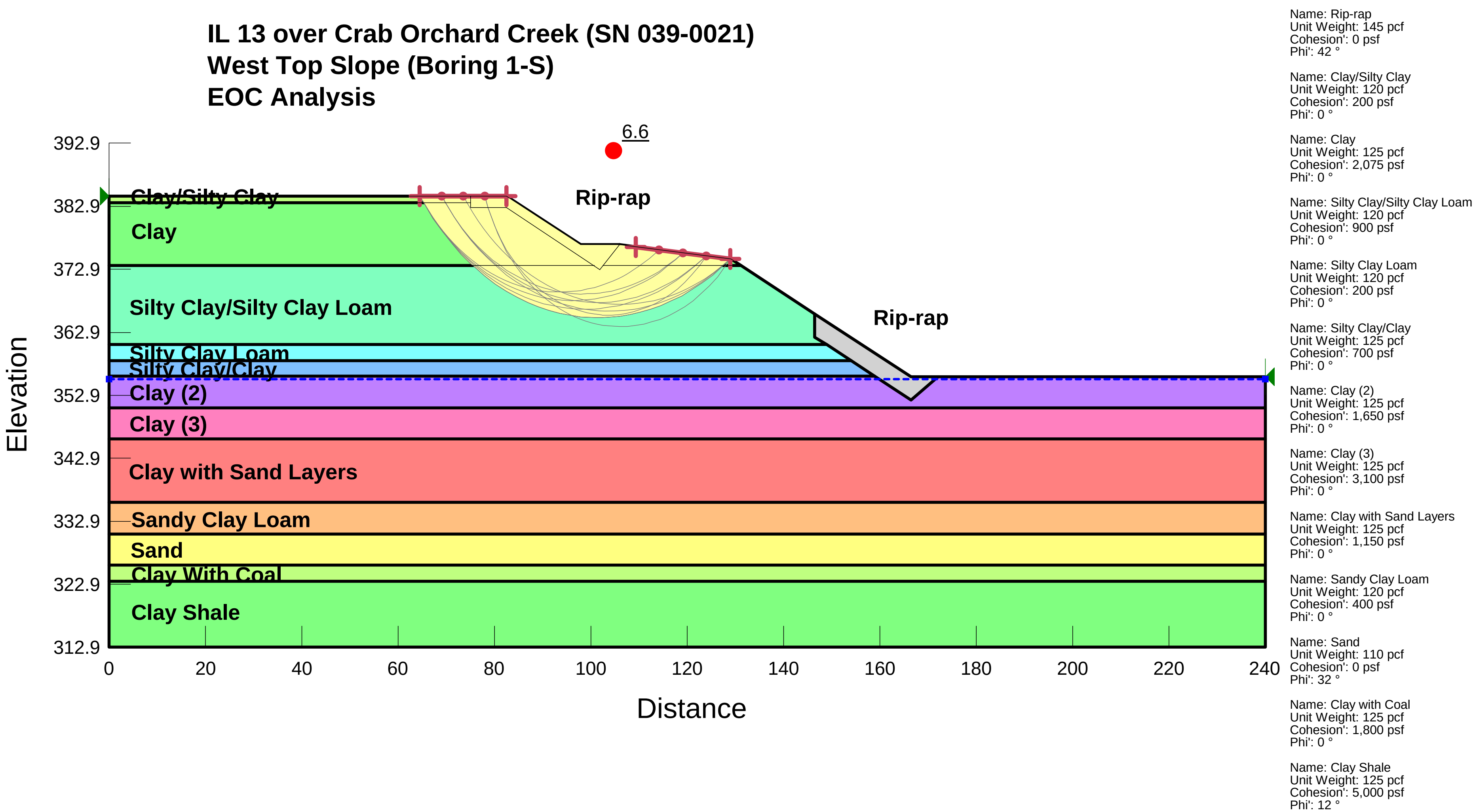
Name: Clay Loam/Sandy Clay Loam
Unit Weight: 120 pcf
Cohesion': 50 psf
Phi': 27 °

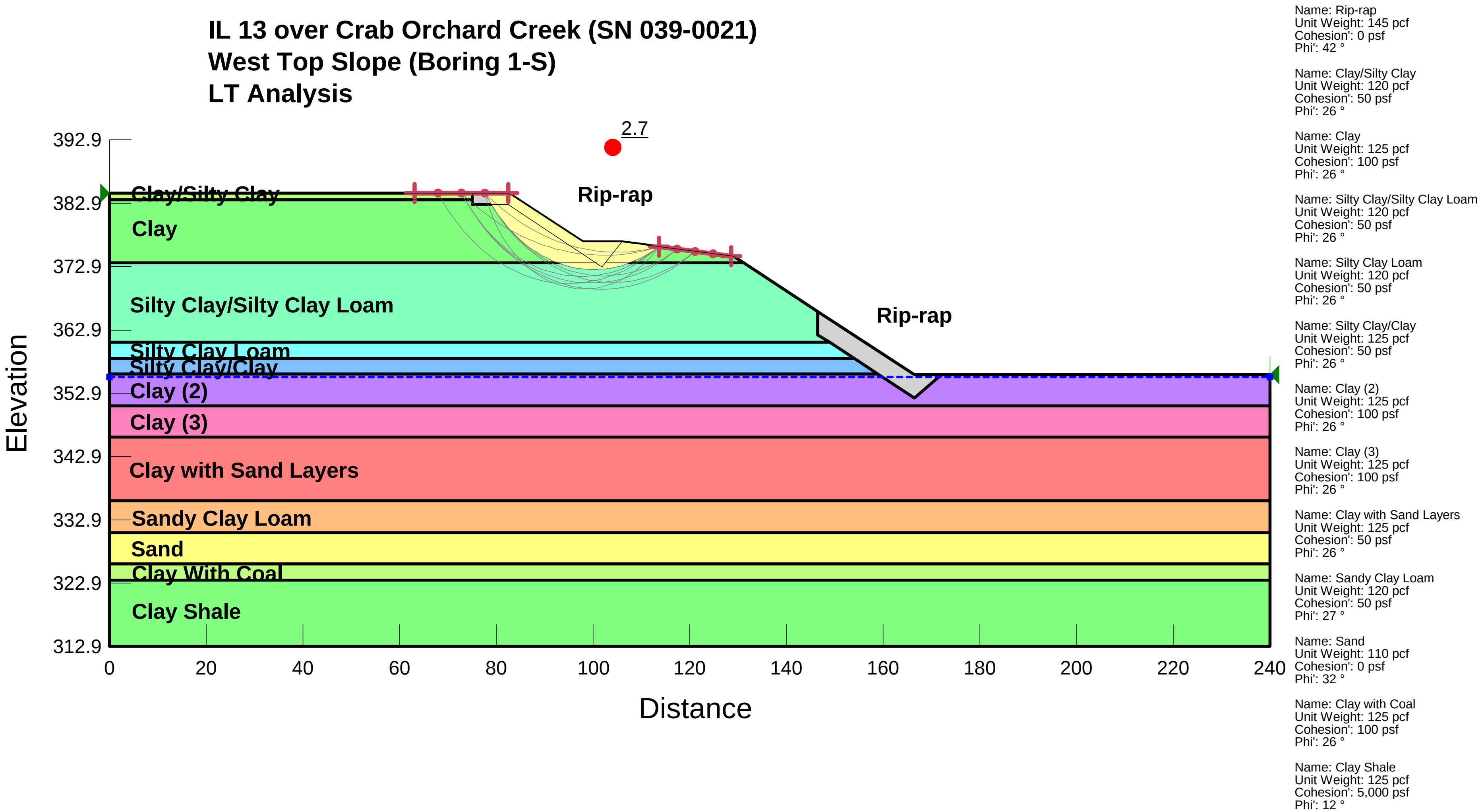
Name: Sand with Clay Layers
Unit Weight: 110 pcf
Cohesion': 0 psf
Phi': 32 °

Name: Clay (4)
Unit Weight: 125 pcf
Cohesion': 50 psf
Phi': 26 °

Name: Clay Loam/Sandy Clay Loam (2)
Unit Weight: 120 pcf
Cohesion': 50 psf
Phi': 27 °

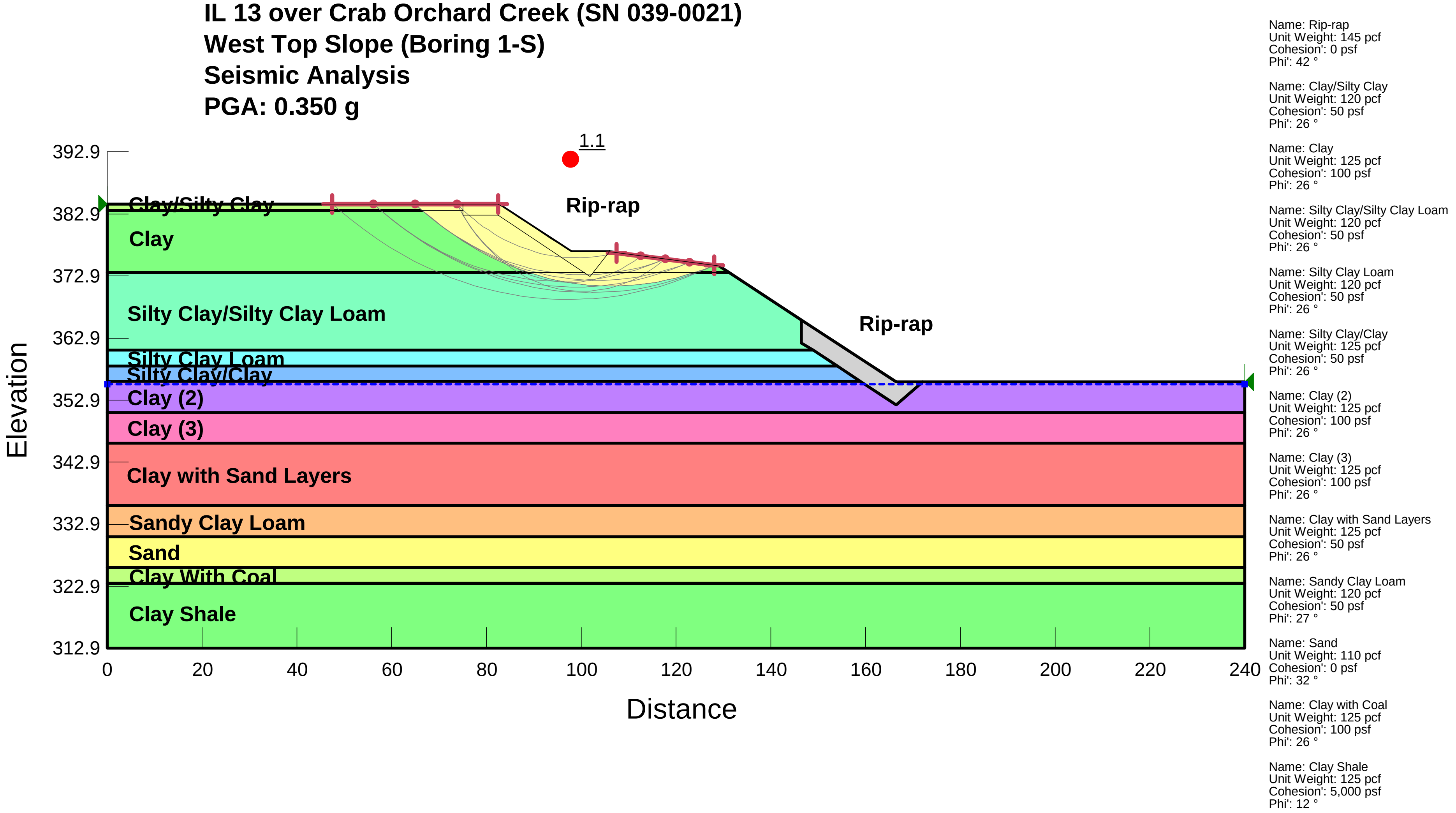
Name: Clay Shale
Unit Weight: 125 pcf
Cohesion': 5,000 psf
Phi': 12 °


IL 13 over Crab Orchard Creek (SN 039-0021)
West Top Slope (Boring 1-S)
EOC Analysis
6.6
Rip-rap
Rip-rap
Clay/Silty Clay
Clay
Silty Clay/Silty Clay Loam
Silty Clay Loam
Silty Clay/Clay
Clay (2)
Clay (3)
Clay with Sand Layers
Sandy Clay Loam
Sand
Clay With Coal
Clay Shale
Elevation
392.9
382.9
372.9
362.9
352.9
342.9
332.9
322.9
312.9
Distance
0
20
40
60
80
100
120
140
160
180
200
220
240
Name: Rip-rap
Unit Weight: 145 pcf
Cohesion': 0 psf
Phi': 42 °
Name: Clay/Silty Clay
Unit Weight: 120 pcf
Cohesion': 200 psf
Phi': 0 °
Name: Clay
Unit Weight: 125 pcf
Cohesion': 2,075 psf
Phi': 0 °
Name: Silty Clay/Silty Clay Loam
Unit Weight: 120 pcf
Cohesion': 900 psf
Phi': 0 °
Name: Silty Clay Loam
Unit Weight: 120 pcf
Cohesion': 200 psf
Phi': 0 °
Name: Silty Clay/Clay
Unit Weight: 125 pcf
Cohesion': 700 psf
Phi': 0 °
Name: Clay (2)
Unit Weight: 125 pcf
Cohesion': 1,650 psf
Phi': 0 °
Name: Clay (3)
Unit Weight: 125 pcf
Cohesion': 3,100 psf
Phi': 0 °
Name: Clay with Sand Layers
Unit Weight: 125 pcf
Cohesion': 1,150 psf
Phi': 0 °
Name: Sandy Clay Loam
Unit Weight: 120 pcf
Cohesion': 400 psf
Phi': 0 °
Name: Sand
Unit Weight: 110 pcf
Cohesion': 0 psf
Phi': 32 °
Name: Clay with Coal
Unit Weight: 125 pcf
Cohesion': 1,800 psf
Phi': 0 °
Name: Clay Shale
Unit Weight: 125 pcf
Cohesion': 5,000 psf
Phi': 12 °

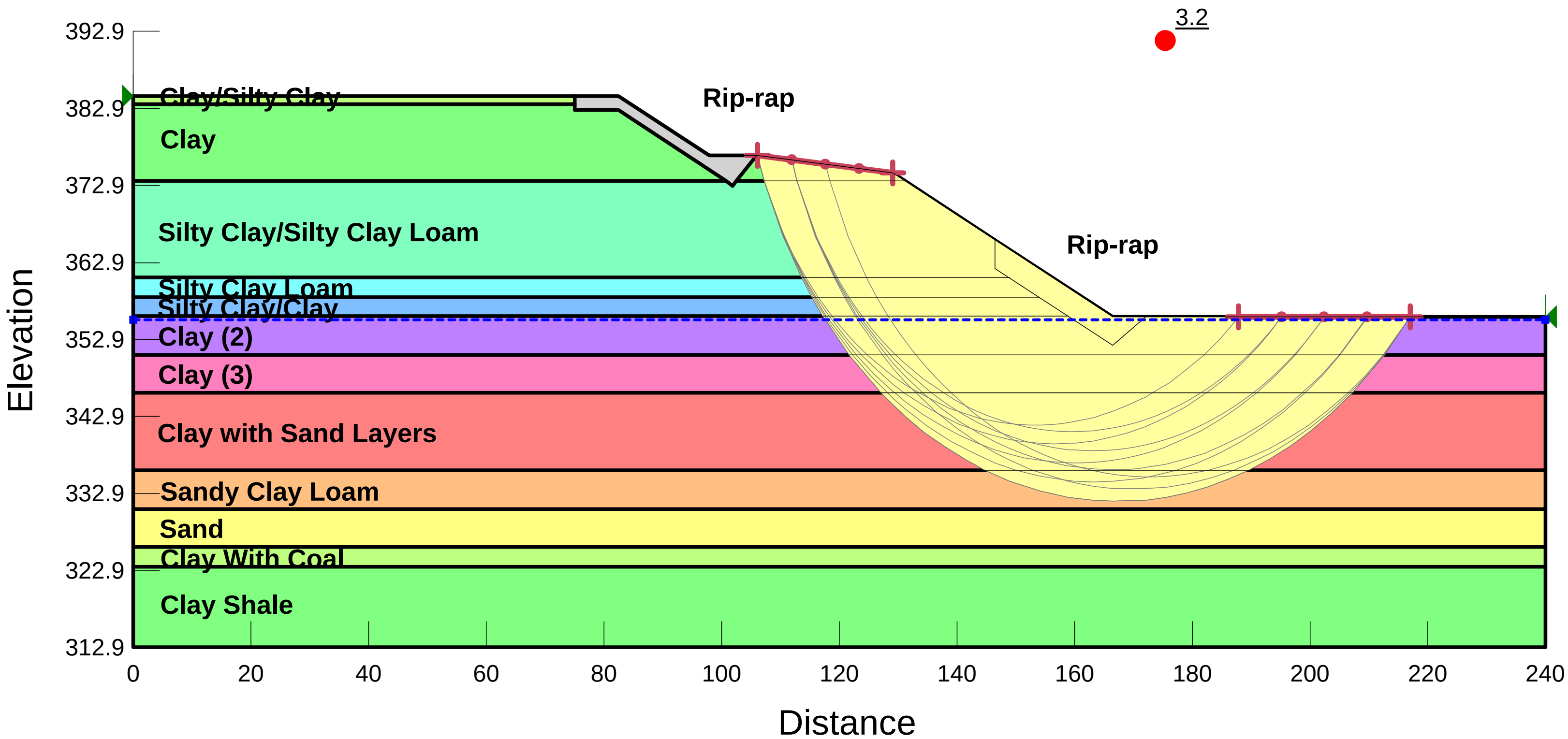


IL 13 over Crab Orchard Creek (SN 039-0021)
West Top Slope (Boring 1-S)
LT Analysis
2.7
Rip-rap
Rip-rap
Clay/Silty Clay
Clay
Silty Clay/Silty Clay Loam
Silty Clay Loam
Silty Clay/Clay
Clay (2)
Clay (3)
Clay with Sand Layers
Sandy Clay Loam
Sand
Clay With Coal
Clay Shale
Elevation
392.9
382.9
372.9
362.9
352.9
342.9
332.9
322.9
312.9
0
20
40
60
80
100
120
140
160
180
200
220
240
Distance
Name: Rip-rap
Unit Weight: 145 pcf
Cohesion': 0 psf
Phi': 42 °
Name: Clay/Silty Clay
Unit Weight: 120 pcf
Cohesion': 50 psf
Phi': 26 °
Name: Clay
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: Silty Clay Loam
Unit Weight: 120 pcf
Cohesion': 50 psf
Phi': 26 °
Name: Silty Clay/Clay
Unit Weight: 125 pcf
Cohesion': 50 psf
Phi': 26 °
Name: Clay (2)
Unit Weight: 125 pcf
Cohesion': 100 psf
Phi': 26 °
Name: Clay (3)
Unit Weight: 125 pcf
Cohesion': 100 psf
Phi': 26 °
Name: Clay with Sand Layers
Unit Weight: 125 pcf
Cohesion': 50 psf
Phi': 26 °
Name: Sandy Clay Loam
Unit Weight: 120 pcf
Cohesion': 50 psf
Phi': 27 °
Name: Sand
Unit Weight: 110 pcf
Cohesion': 0 psf
Phi': 32 °
Name: Clay with Coal
Unit Weight: 125 pcf
Cohesion': 100 psf
Phi': 26 °
Name: Clay Shale
Unit Weight: 125 pcf
Cohesion': 5,000 psf
Phi': 12 °

IL 13 over Crab Orchard Creek (SN 039-0021)
West Top Slope (Boring 1-S)
Seismic Analysis
PGA: 0.350 g



IL 13 over Crab Orchard Creek (SN 039-0021)
West Bottom Slope (Boring 1-S)
EOC Analysis



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

Name: Clay/Silty Clay
Unit Weight: 120 pcf
Cohesion': 200 psf
Phi': 0 °

Name: Clay
Unit Weight: 125 pcf
Cohesion': 2,075 psf
Phi': 0 °

Name: Silty Clay/Silty Clay Loam
Unit Weight: 120 pcf
Cohesion': 900 psf
Phi': 0 °

Name: Silty Clay Loam
Unit Weight: 120 pcf
Cohesion': 200 psf
Phi': 0 °

Name: Silty Clay/Clay
Unit Weight: 125 pcf
Cohesion': 700 psf
Phi': 0 °

Name: Clay (2)
Unit Weight: 125 pcf
Cohesion': 1,650 psf
Phi': 0 °

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

Name: Clay with Sand Layers
Unit Weight: 125 pcf
Cohesion': 1,150 psf
Phi': 0 °

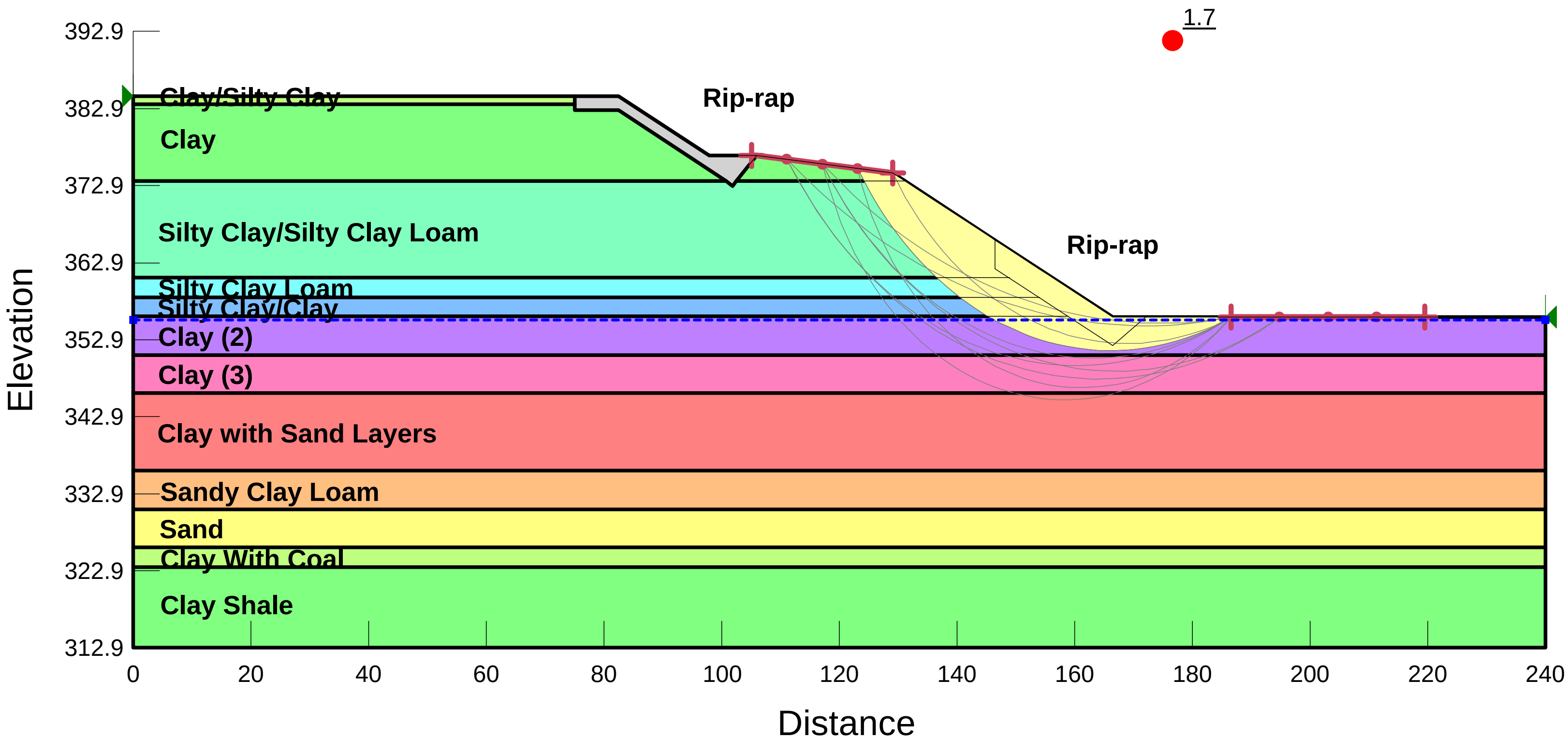
Name: Sandy Clay Loam
Unit Weight: 120 pcf
Cohesion': 400 psf
Phi': 0 °

Name: Sand
Unit Weight: 110 pcf
Cohesion': 0 psf
Phi': 32 °

Name: Clay with Coal
Unit Weight: 125 pcf
Cohesion': 1,800 psf
Phi': 0 °

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

IL 13 over Crab Orchard Creek (SN 039-0021)
West Bottom Slope (Boring 1-S)
LT Analysis



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

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

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

Name: Silty Clay/Clay
Unit Weight: 125 pcf
Cohesion': 50 psf
Phi': 26 °

Name: Clay (2)
Unit Weight: 125 pcf
Cohesion': 100 psf
Phi': 26 °

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

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

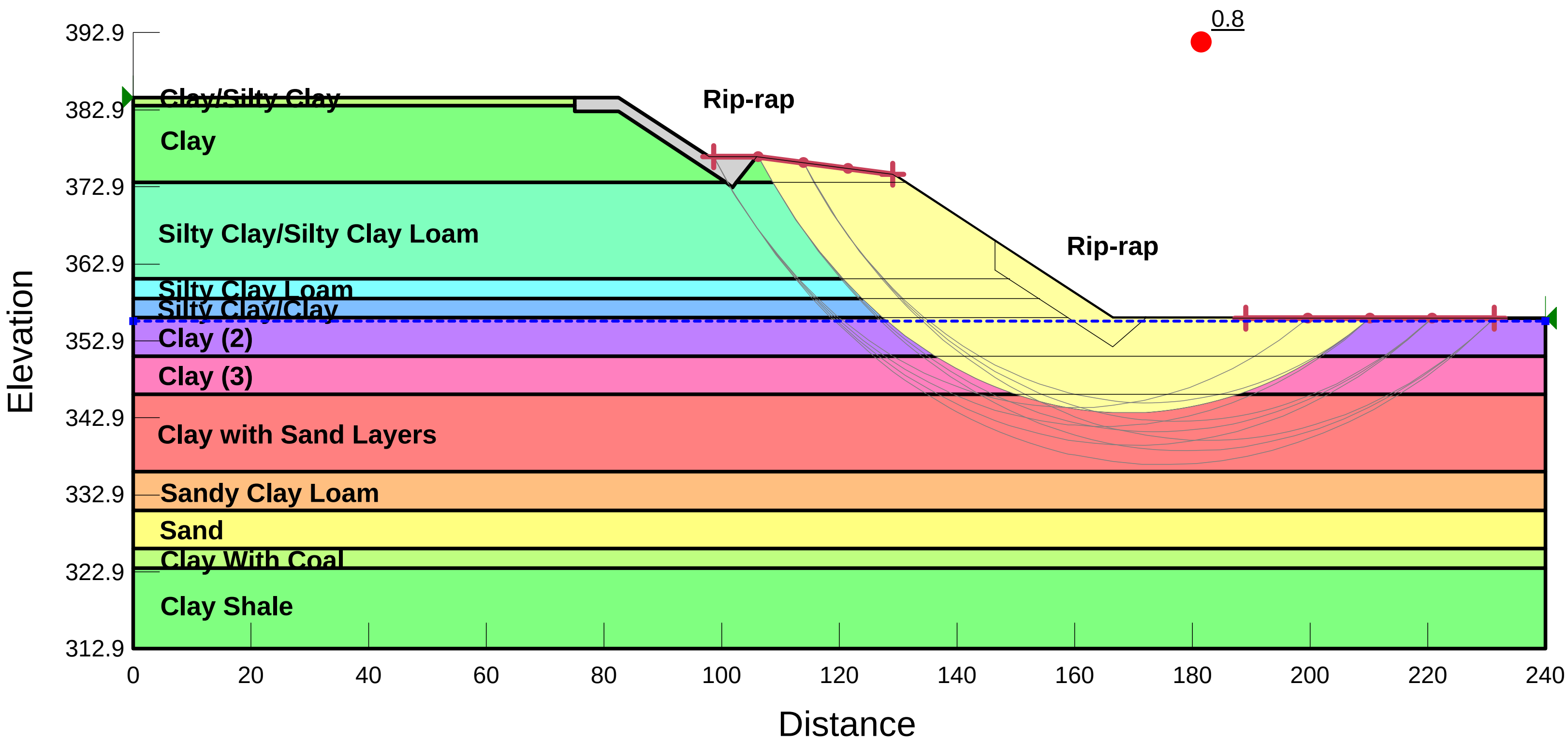
Name: Sandy Clay Loam
Unit Weight: 120 pcf
Cohesion': 50 psf
Phi': 27 °

Name: Sand
Unit Weight: 110 pcf
Cohesion': 0 psf
Phi': 32 °

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

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

IL 13 over Crab Orchard Creek (SN 039-0021)
West Bottom Slope (Boring 1-S)
Seismic Analysis
PGA: 0.350 g



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

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

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

Name: Silty Clay/Clay
Unit Weight: 125 pcf
Cohesion': 50 psf
Phi': 26 °

Name: Clay (2)
Unit Weight: 125 pcf
Cohesion': 100 psf
Phi': 26 °

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

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

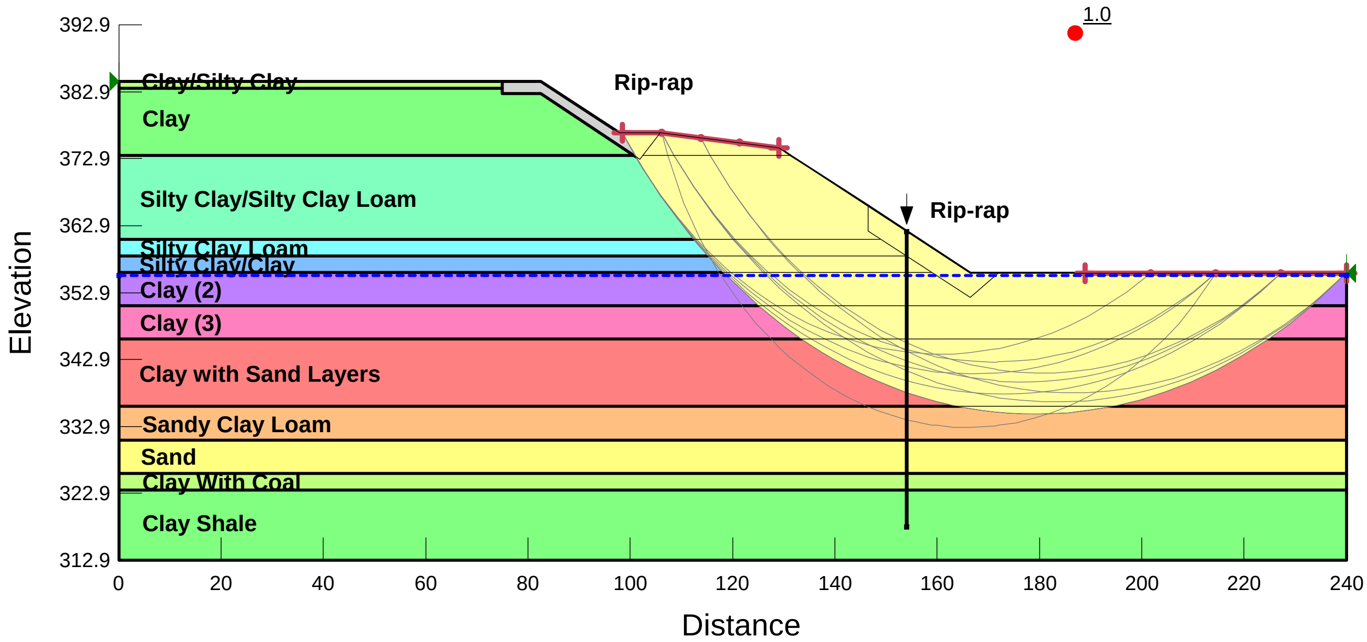
Name: Sandy Clay Loam
Unit Weight: 120 pcf
Cohesion': 50 psf
Phi': 27 °

Name: Sand
Unit Weight: 110 pcf
Cohesion': 0 psf
Phi': 32 °

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

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

IL 13 over Crab Orchard Creek (SN 039-0021)
West Bottom Slope (Boring 1-S) with Pile
Seismic Analysis
PGA: 0.350 g



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

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

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

Name: Silty Clay/Clay
Unit Weight: 125 pcf
Cohesion': 50 psf
Phi': 26 °

Name: Clay (2)
Unit Weight: 125 pcf
Cohesion': 100 psf
Phi': 26 °

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

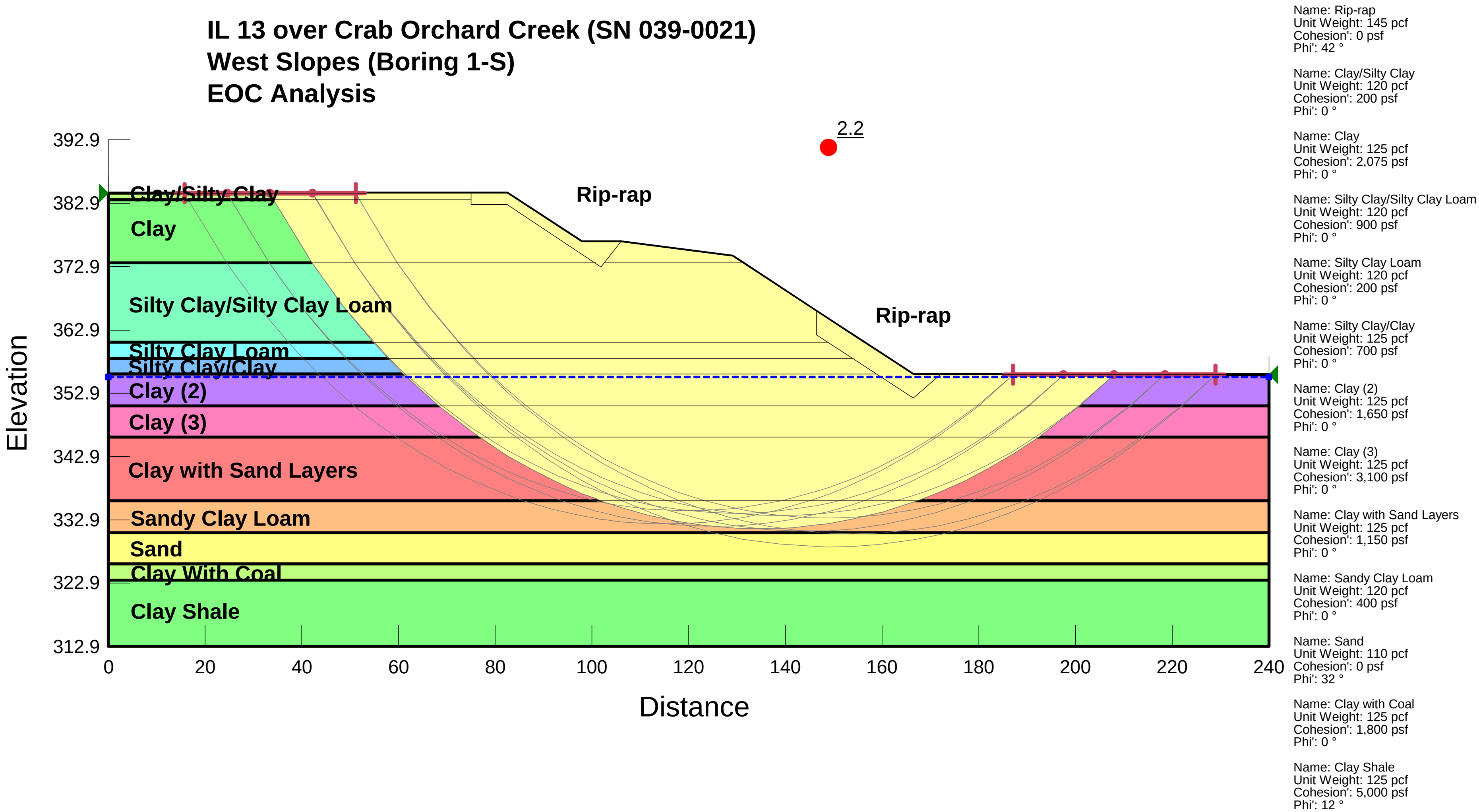
Name: Clay with Sand Layers
Unit Weight: 125 pcf
Cohesion': 50 psf
Phi': 26 °

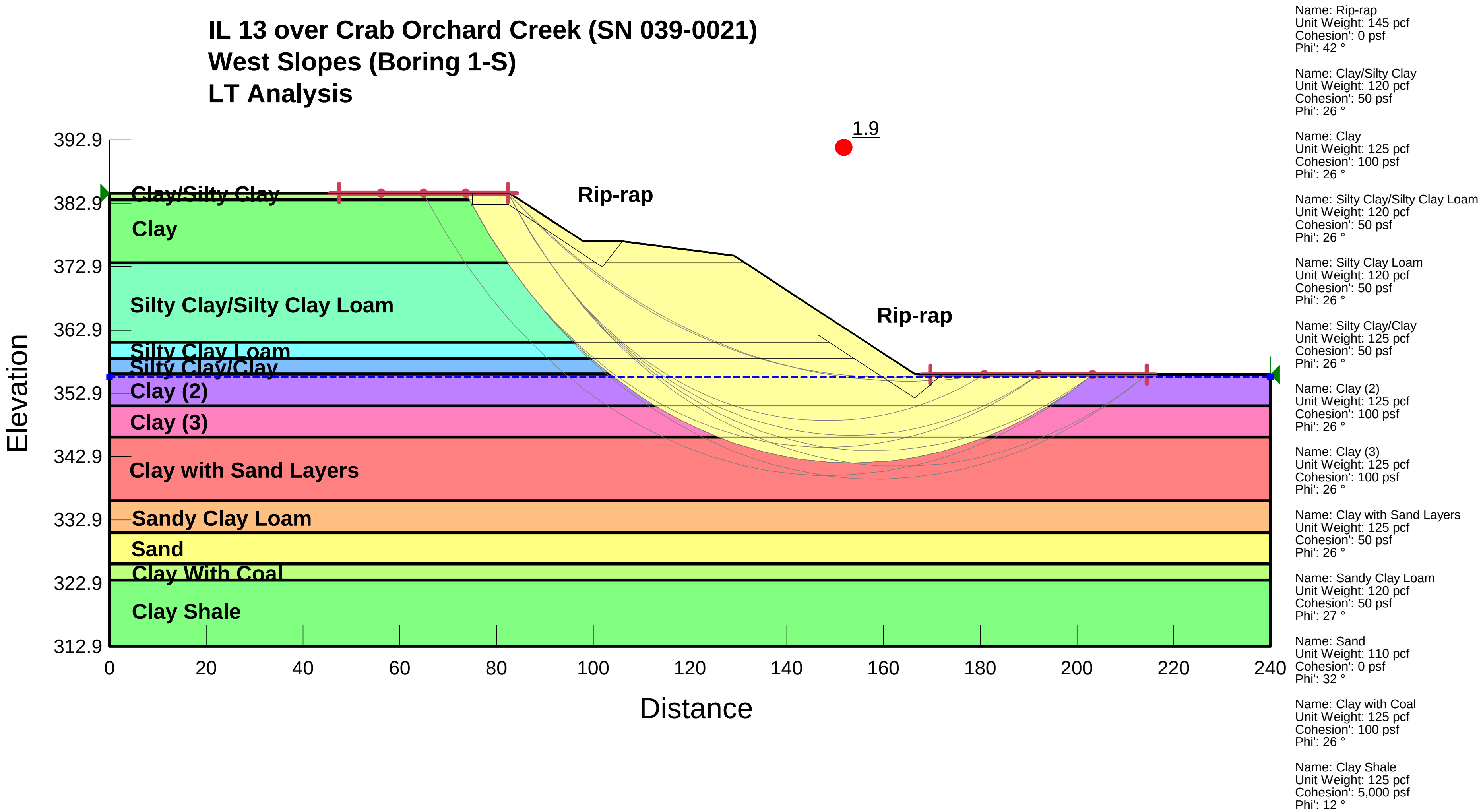
Name: Sandy Clay Loam
Unit Weight: 120 pcf
Cohesion': 50 psf
Phi': 27 °

Name: Sand
Unit Weight: 110 pcf
Cohesion': 0 psf
Phi': 32 °

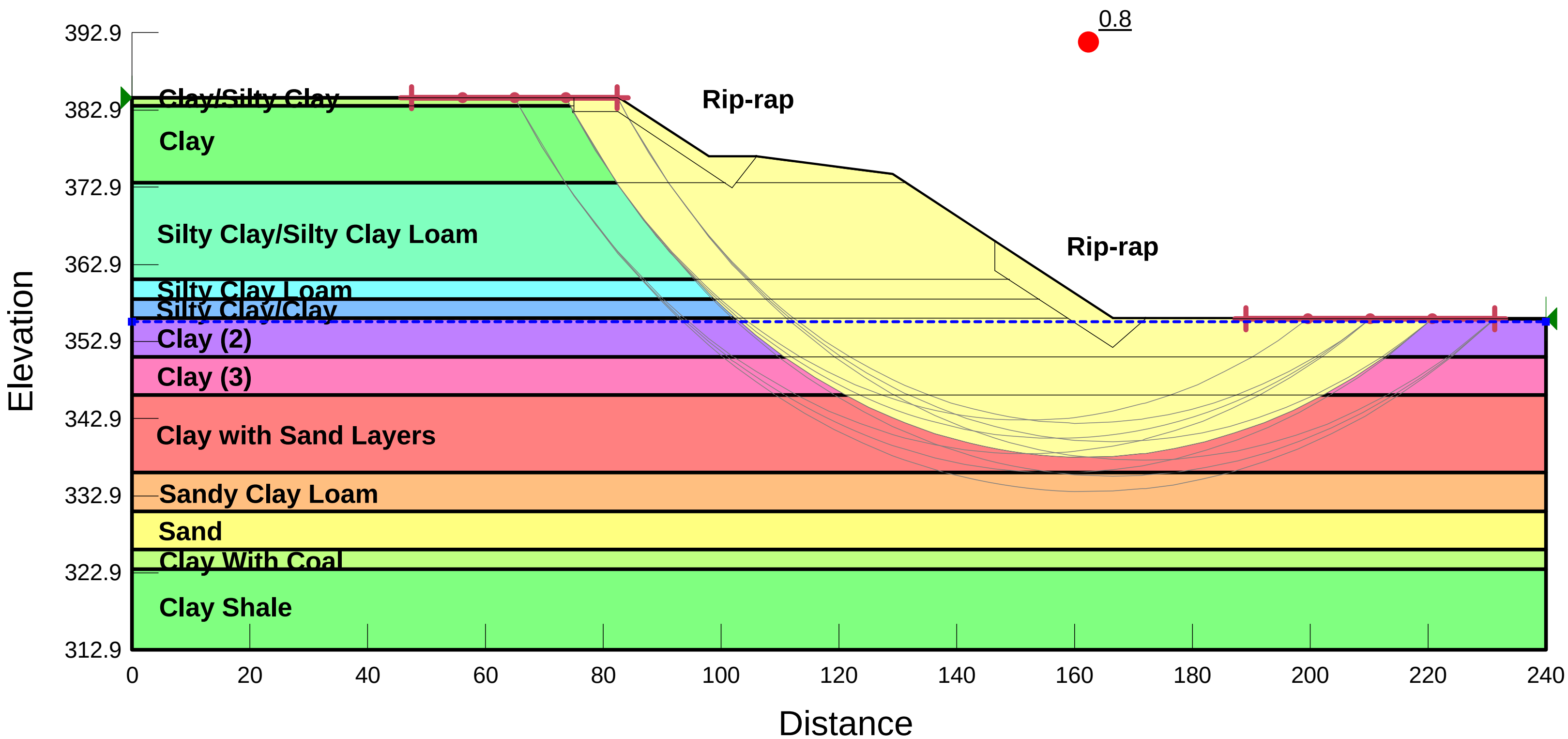
Name: Clay with Coal
Unit Weight: 125 pcf
Cohesion': 100 psf
Phi': 26 °

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


IL 13 over Crab Orchard Creek (SN 039-0021)
West Slopes (Boring 1-S)
EOC Analysis
2.2
Rip-rap
Rip-rap
Clay/Silty Clay
Clay
Silty Clay/Silty Clay Loam
Silty Clay Loam
Silty Clay/Clay
Clay (2)
Clay (3)
Clay with Sand Layers
Sandy Clay Loam
Sand
Clay With Coal
Clay Shale
Elevation
Distance
392.9
382.9
372.9
362.9
352.9
342.9
332.9
322.9
312.9
0
20
40
60
80
100
120
140
160
180
200
220
240
Name: Rip-rap
Unit Weight: 145 pcf
Cohesion': 0 psf
Phi': 42 °
Name: Clay/Silty Clay
Unit Weight: 120 pcf
Cohesion': 200 psf
Phi': 0 °
Name: Clay
Unit Weight: 125 pcf
Cohesion': 2,075 psf
Phi': 0 °
Name: Silty Clay/Silty Clay Loam
Unit Weight: 120 pcf
Cohesion': 900 psf
Phi': 0 °
Name: Silty Clay Loam
Unit Weight: 120 pcf
Cohesion': 200 psf
Phi': 0 °
Name: Silty Clay/Clay
Unit Weight: 125 pcf
Cohesion': 700 psf
Phi': 0 °
Name: Clay (2)
Unit Weight: 125 pcf
Cohesion': 1,650 psf
Phi': 0 °
Name: Clay (3)
Unit Weight: 125 pcf
Cohesion': 3,100 psf
Phi': 0 °
Name: Clay with Sand Layers
Unit Weight: 125 pcf
Cohesion': 1,150 psf
Phi': 0 °
Name: Sandy Clay Loam
Unit Weight: 120 pcf
Cohesion': 400 psf
Phi': 0 °
Name: Sand
Unit Weight: 110 pcf
Cohesion': 0 psf
Phi': 32 °
Name: Clay with Coal
Unit Weight: 125 pcf
Cohesion': 1,800 psf
Phi': 0 °
Name: Clay Shale
Unit Weight: 125 pcf
Cohesion': 5,000 psf
Phi': 12 °


IL 13 over Crab Orchard Creek (SN 039-0021)
West Slopes (Boring 1-S)
LT Analysis
1.9
Rip-rap
Rip-rap
Clay/Silty Clay
Clay
Silty Clay/Silty Clay Loam
Silty Clay Loam
Silty Clay/Clay
Clay (2)
Clay (3)
Clay with Sand Layers
Sandy Clay Loam
Sand
Clay With Coal
Clay Shale
Elevation
392.9
382.9
372.9
362.9
352.9
342.9
332.9
322.9
312.9
0
20
40
60
80
100
120
140
160
180
200
220
240
Distance
Name: Rip-rap
Unit Weight: 145 pcf
Cohesion': 0 psf
Phi': 42 °
Name: Clay/Silty Clay
Unit Weight: 120 pcf
Cohesion': 50 psf
Phi': 26 °
Name: Clay
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: Silty Clay Loam
Unit Weight: 120 pcf
Cohesion': 50 psf
Phi': 26 °
Name: Silty Clay/Clay
Unit Weight: 125 pcf
Cohesion': 50 psf
Phi': 26 °
Name: Clay (2)
Unit Weight: 125 pcf
Cohesion': 100 psf
Phi': 26 °
Name: Clay (3)
Unit Weight: 125 pcf
Cohesion': 100 psf
Phi': 26 °
Name: Clay with Sand Layers
Unit Weight: 125 pcf
Cohesion': 50 psf
Phi': 26 °
Name: Sandy Clay Loam
Unit Weight: 120 pcf
Cohesion': 50 psf
Phi': 27 °
Name: Sand
Unit Weight: 110 pcf
Cohesion': 0 psf
Phi': 32 °
Name: Clay with Coal
Unit Weight: 125 pcf
Cohesion': 100 psf
Phi': 26 °
Name: Clay Shale
Unit Weight: 125 pcf
Cohesion': 5,000 psf
Phi': 12 °

IL 13 over Crab Orchard Creek (SN 039-0021)
West Slopes (Boring 1-S)
Seismic Analysis
PGA: 0.350 g



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

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

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

Name: Silty Clay/Clay
Unit Weight: 125 pcf
Cohesion': 50 psf
Phi': 26 °

Name: Clay (2)
Unit Weight: 125 pcf
Cohesion': 100 psf
Phi': 26 °

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

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

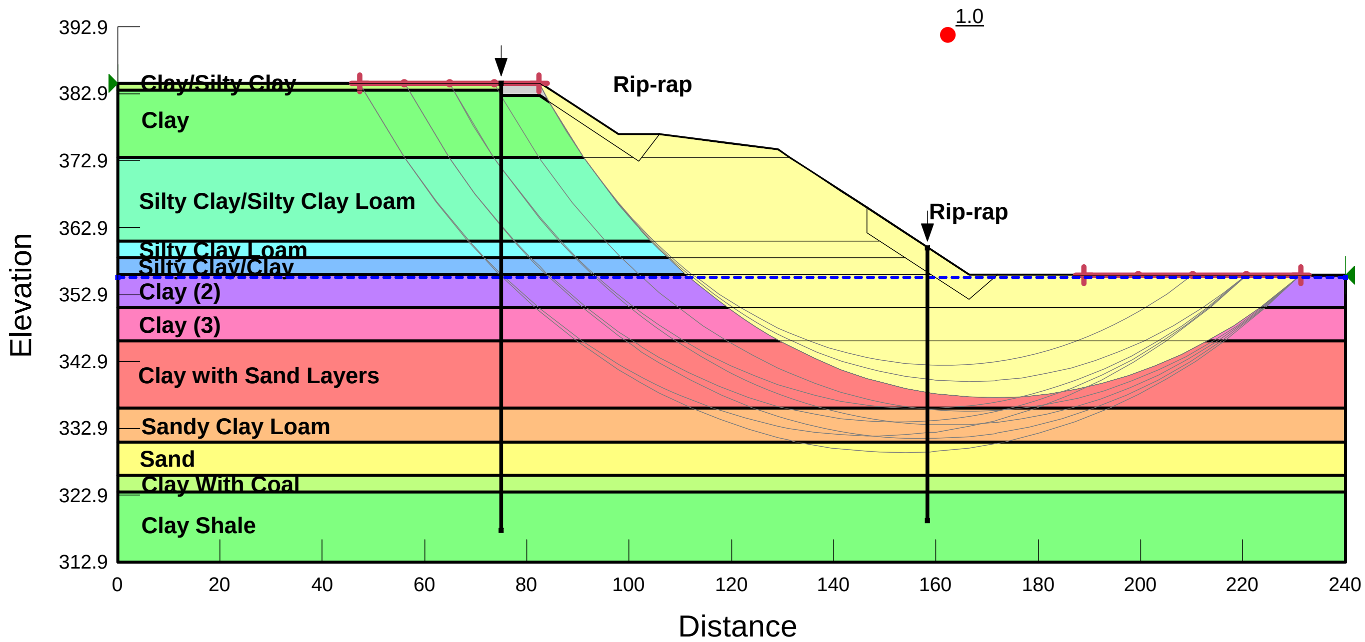
Name: Sandy Clay Loam
Unit Weight: 120 pcf
Cohesion': 50 psf
Phi': 27 °

Name: Sand
Unit Weight: 110 pcf
Cohesion': 0 psf
Phi': 32 °

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

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

IL 13 over Crab Orchard Creek (SN 039-0021)
West Slopes (Boring 1-S) with Pile
Seismic Analysis
PGA: 0.350 g



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

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

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

Name: Silty Clay/Clay
Unit Weight: 125 pcf
Cohesion': 50 psf
Phi': 26 °

Name: Clay (2)
Unit Weight: 125 pcf
Cohesion': 100 psf
Phi': 26 °

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

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

Name: Sandy Clay Loam
Unit Weight: 120 pcf
Cohesion': 50 psf
Phi': 27 °

Name: Sand
Unit Weight: 110 pcf
Cohesion': 0 psf
Phi': 32 °

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

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

EXHIBIT F

PILE LENGTH/PILE TYPE

I D O T   S T A T I C   M E T H O D   O F   E S T I M A T I N G   P I L E   L E N G T H

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. ============================ 384.00 ft
GROUND SURFACE ELEV. AGAINST PILE DURING DRI 379.00 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

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	**68** FT.

TOTAL FACTORED SUBSTRUCTURE LOAD ========= 1853 kips
TOTAL LENGTH OF SUBSTRUCTURE (along skew)==== 52.00 ft
NUMBER OF ROWS OF PILES PER SUBSTRUCTURE = 1
Approx. Factored Loading Applied per pile at 8 ft. Cts ===== 285.08 KIPS
Approx. Factored Loading Applied per pile at 3 ft. Cts ===== 106.90 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.

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.)
376.50	2.50	2.10			12.2		42.3	17.7		***22.2***	22	0	0	12	8
374.50	2.00	2.10			9.7	30.2	54.9	14.2	4.5	***36.8***	37	0	0	20	10
373.40	1.10	2.30			5.7	33.0	***37.6***	8.3	4.9	41.7	38	0	0	21	11
370.90	2.50	0.70			5.3	10.1	***44.4***	7.8	1.5	49.7	44	0	0	24	13
368.40	2.50	0.80			6.0	11.5	***54.7***	8.7	1.7	59.0	55	0	0	30	16
365.90	2.50	1.10			7.8	15.8	***63.9***	11.3	2.3	70.6	64	0	0	35	18
363.40	2.50	1.20			8.3	17.2	***63.5***	12.1	2.5	81.4	64	0	0	35	21
360.90	2.50	0.60			4.7	8.6	***62.4***	6.8	1.3	87.3	62	0	0	34	23
358.40	2.50	0.20			1.7	2.9	***71.3***	2.4	0.4	90.8	71	0	0	39	26
355.90	2.50	0.70			5.3	10.1	***88.1***	7.8	1.5	100.3	88	0	0	48	28
353.40	2.50	1.50			9.7	21.5	***102.2***	14.2	3.2	115.1	102	0	0	56	31
350.90	2.50	1.80			11.0	25.9	***100.7***	16.1	3.8	129.4	101	0	0	55	33
348.40	2.50		7	Hard Till	0.8	13.4	***101.5***	1.1	2.0	130.5	101	0	0	56	36
345.90	2.50		7	Hard Till	0.8	13.4	***110.4***	1.1	2.0	132.8	110	0	0	61	38
343.40	2.50	1.50			9.7	21.5	***120.1***	14.2	3.2	147.0	120	0	0	66	41
340.90	2.50	1.50			9.7	21.5	***119.8***	14.2	3.2	159.7	120	0	0	66	43
338.40	2.50	0.80			6.0	11.5	***125.8***	8.7	1.7	168.5	126	0	0	69	46
335.90	2.50	0.80			6.0	11.5	***126.0***	8.7	1.7	176.3	126	0	0	69	48
333.40	2.50	0.40			3.2	5.7	***129.3***	4.7	0.8	181.0	129	0	0	71	51
330.90	2.50	0.40			3.2	5.7	***132.5***	4.7	0.8	185.7	132	0	0	73	53
328.40	2.50		3	Very Fine Silty Sand	0.5	5.7	***132.9***	0.7	0.8	186.4	133	0	0	73	56
325.90	2.50		3	Very Fine Silty Sand	0.5	5.7	***127.7***	0.7	0.8	186.2	128	0	0	70	58
323.40	2.50				0.0	0.0	255.4	0.0	0.0	***205.1***	205	0	0	113	61
323.20	0.20			Shale	10.1	127.7	265.5	14.7	18.9	***219.8***	220	0	0	121	60.8
323.00	0.20			Shale	10.1	127.7	275.6	14.7	18.9	***234.6***	235	0	0	129	61
322.80	0.20			Shale	10.1	127.7	285.6	14.7	18.9	***249.3***	249	0	0	137	61.2
322.60	0.20			Shale	10.1	127.7	295.7	14.7	18.9	***264.0***	264	0	0	145	61.4
322.40	0.20			Shale	10.1	127.7	305.8	14.7	18.9	***278.7***	279	0	0	153	61.6
321.90	0.50			Shale	25.2	127.7	331.0	36.8	18.9	***315.5***	316	0	0	174	62.1
320.90	1.00			Shale	50.5	127.7	***381.5***	73.6	18.9	389.1	382	0	0	210	63.1
319.90	1.00			Shale	50.5	127.7	***432.0***	73.6	18.9	462.7	432	0	0	238	64.1
318.90	1.00			Shale	50.5	127.7	***482.4***	73.6	18.9	536.3	482	0	0	265	65.1
317.90	1.00			Shale	50.5	127.7	***532.9***	73.6	18.9	609.9	533	0	0	293	66.1
316.90	1.00			Shale	50.5	127.7	***583.3***	73.6	18.9	683.5	583	0	0	321	67.1
315.90	1.00			Shale	50.5	127.7	***633.8***	73.6	18.9	757.1	~~634~~	~~0~~	~~0~~	~~349~~	~~68.1~~
314.90	1.00			Shale	50.5	127.7	***684.2***	73.6	18.9	830.7	~~684~~	~~0~~	~~0~~	~~376~~	~~69.1~~
313.90	1.00			Shale	50.5	127.7	***734.7***	73.6	18.9	904.3	~~735~~	~~0~~	~~0~~	~~404~~	~~70.1~~
312.90	1.00			Shale		127.7			18.9						

I D O T S T A T I C M E T H O D O F E S T I M A T I N G P I L E L E N G T H

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. =========================== 384.10 ft
GROUND SURFACE ELEV. AGAINST PILE DURING DRI 379.10 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 ======== 1853 kips
TOTAL LENGTH OF SUBSTRUCTURE (along skew)==== 52.00 ft
NUMBER OF ROWS OF PILES PER SUBSTRUCTURE = 1
Approx. Factored Loading Applied per pile at 8 ft. Cts ===== 285.08 KIPS
Approx. Factored Loading Applied per pile at 3 ft. Cts ===== 106.90 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	**69** 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.)
377.60	1.50	2.50			8.2		44.1	11.9		***17.2***	17	0	0	9	7
376.10	1.50	2.50			8.2	35.9	39.4	11.9	5.3	***27.3***	27	0	0	15	8
373.60	2.50	1.60			10.2	23.0	51.4	14.8	3.4	***42.4***	42	0	0	23	11
371.10	2.50		13	Hard Till	1.4	24.9	***32.3***	2.1	3.7	41.5	32	0	0	18	13
368.60	2.50	0.30			2.5	4.3	***31.9***	3.6	0.6	44.6	32	0	0	18	16
366.10	2.50	0.10			0.8	1.4	***32.7***	1.2	0.2	45.8	33	0	0	18	18
363.60	2.50	0.10			0.8	1.4	***35.0***	1.2	0.2	47.3	35	0	0	19	21
361.10	2.50	0.20			1.7	2.9	***38.1***	2.4	0.4	49.9	38	0	0	21	23
358.60	2.50	0.30			2.5	4.3	***43.4***	3.6	0.6	53.9	43	0	0	24	26
356.10	2.50	0.50			3.9	7.2	***48.8***	5.8	1.1	59.9	49	0	0	27	28
353.60	2.50	0.60			4.7	8.6	***53.5***	6.8	1.3	66.7	53	0	0	29	31
351.10	2.50	0.60			4.7	8.6	85.4	6.8	1.3	***77.5***	78	0	0	43	33
348.60	2.50	2.50			13.6	35.9	99.0	19.9	5.3	***97.4***	97	0	0	54	36
346.10	2.50	2.50			13.6	35.9	***102.6***	19.9	5.3	115.8	103	0	0	56	38
343.60	2.50	1.80			11.0	25.9	***113.6***	16.1	3.8	131.9	114	0	0	62	41
341.10	2.50	1.80			11.0	25.9	***107.4***	16.1	3.8	145.4	107	0	0	59	43
338.60	2.50	0.60			4.7	8.6	***112.1***	6.8	1.3	152.2	112	0	0	62	46
336.60	2.00	0.60			3.7	8.6	***116.7***	5.4	1.3	157.7	117	0	0	64	48
333.85	2.75		5	Very Fine Silty Sand	0.9	9.6	***117.6***	1.3	1.4	159.0	118	0	0	65	50
331.10	2.75		5	Very Fine Silty Sand	0.9	9.6	***120.4***	1.3	1.4	160.6	120	0	0	66	53
328.60	2.50	0.80			6.0	11.5	***126.4***	8.7	1.7	169.3	126	0	0	70	56
326.10	2.50	0.80			6.0	11.5	***126.6***	8.7	1.7	177.2	127	0	0	70	58
324.60	1.50	0.40			1.9	5.7	***128.5***	2.8	0.8	180.0	129	0	0	71	60
323.10	1.50	0.40			1.9	5.7	252.4	2.8	0.8	***200.8***	201	0	0	110	61
322.90	0.20			Shale	10.1	127.7	262.5	14.7	18.9	***215.5***	216	0	0	119	61.2
322.70	0.20			Shale	10.1	127.7	272.6	14.7	18.9	***230.2***	230	0	0	127	61.4
322.50	0.20			Shale	10.1	127.7	282.7	14.7	18.9	***245.0***	245	0	0	135	61.6
321.50	1.00			Shale	50.5	127.7	333.1	73.6	18.9	***318.6***	319	0	0	175	62.6
320.50	1.00			Shale	50.5	127.7	***383.6***	73.6	18.9	392.2	384	0	0	211	63.6
319.50	1.00			Shale	50.5	127.7	***434.0***	73.6	18.9	465.8	434	0	0	239	64.6
318.50	1.00			Shale	50.5	127.7	***484.5***	73.6	18.9	539.4	484	0	0	266	65.6
317.50	1.00			Shale	50.5	127.7	***534.9***	73.6	18.9	613.0	535	0	0	294	66.6
316.50	1.00			Shale	50.5	127.7	***585.4***	73.6	18.9	686.6	585	0	0	322	67.6
315.50	1.00			Shale	50.5	127.7	***635.8***	73.6	18.9	760.2	~~636~~	~~0~~	~~0~~	~~350~~	~~68.6~~
314.50	1.00			Shale	50.5	127.7	***686.3***	73.6	18.9	833.8	~~686~~	~~0~~	~~0~~	~~377~~	~~69.6~~
313.50	1.00			Shale	50.5	127.7	***736.7***	73.6	18.9	907.4	~~737~~	~~0~~	~~0~~	~~405~~	~~70.6~~
312.50	1.00			Shale	50.5	127.7	***787.2***	73.6	18.9	981.0	~~787~~	~~0~~	~~0~~	~~433~~	~~71.6~~
311.50	1.00			Shale		127.7			18.9						

I D O T   S T A T I C   M E T H O D   O F   E S T I M A T I N G   P I L E   L E N G T H

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. ============================ 384.00 ft
GROUND SURFACE ELEV. AGAINST PILE DURING DRI 355.40 ft
GEOTECHNICAL LOSS TYPE (None, Scour, Liquef., DD) Scour
BOTTOM ELEV. OF SCOUR, LIQUEF., or DD ======== 339.61 ft
TOP ELEV. OF LIQUEF. (so layers above apply DD) ============ ft

TOTAL FACTORED SUBSTRUCTURE LOAD ======== 4016 kips
TOTAL LENGTH OF SUBSTRUCTURE (along skew)==== 52.00 ft
NUMBER OF ROWS OF PILES PER SUBSTRUCTURE = 1
Approx. Factored Loading Applied per pile at 8 ft. Cts ===== 617.85 KIPS
Approx. Factored Loading Applied per pile at 3 ft. Cts ===== 231.69 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	**581** KIPS	**298** KIPS	**68** 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.)
353.40	2.00	1.50			7.8		33.7	11.4		***15.2***	15	4	0	4	31
350.90	2.50	1.80			11.0	25.9	31.3	16.1	3.8	***29.3***	29	10	0	6	33
348.40	2.50		7	Hard Till	0.8	12.5	33.0	1.1	1.8	***30.5***	31	11	0	6	36
345.90	2.50		7	Hard Till	0.8	13.4	41.9	1.1	2.0	***32.9***	33	11	0	7	38
343.40	2.50	1.50			9.7	21.5	51.6	14.2	3.2	***47.1***	47	17	0	9	41
340.90	2.50	1.50			9.7	21.5	***51.3***	14.2	3.2	59.8	51	22	0	6	43
338.40	2.50	0.80			6.0	11.5	***57.3***	8.7	1.7	68.5	57	22	0	10	46
335.90	2.50	0.80			6.0	11.5	***57.5***	8.7	1.7	76.4	58	22	0	10	48
333.40	2.50	0.40			3.2	5.7	***60.7***	4.7	0.8	81.1	61	22	0	12	51
330.90	2.50	0.40			3.2	5.7	***65.9***	4.7	0.8	86.1	66	22	0	14	53
328.40	2.50		3	Medium Sand	0.6	7.7	***66.4***	0.8	1.1	86.9	66	22	0	15	56
325.90	2.50		3	Medium Sand	0.6	7.7	***85.2***	0.8	1.1	90.4	85	22	0	25	58
323.40	2.50	1.80			11.0	25.9	198.0	16.1	3.8	***121.5***	121	22	0	45	61
323.20	0.20			Shale	10.1	127.7	208.1	14.7	18.9	***136.2***	136	22	0	53	60.8
323.00	0.20			Shale	10.1	127.7	218.2	14.7	18.9	***150.9***	151	22	0	61	61
322.80	0.20			Shale	10.1	127.7	228.3	14.7	18.9	***165.6***	166	22	0	69	61.2
322.60	0.20			Shale	10.1	127.7	238.4	14.7	18.9	***180.3***	180	22	0	77	61.4
322.40	0.20			Shale	10.1	127.7	248.5	14.7	18.9	***195.1***	195	22	0	85	61.6
322.20	0.20			Shale	10.1	127.7	258.6	14.7	18.9	***209.8***	210	22	0	93	61.8
322.00	0.20			Shale	10.1	127.7	268.7	14.7	18.9	***224.5***	224	22	0	102	62
321.80	0.20			Shale	10.1	127.7	278.8	14.7	18.9	***239.2***	239	22	0	110	62.2
321.30	0.50			Shale	25.2	127.7	304.0	36.8	18.9	***276.0***	276	22	0	130	62.7
320.80	0.50			Shale	25.2	127.7	329.2	36.8	18.9	***312.8***	313	22	0	150	63.2
319.80	1.00			Shale	50.5	127.7	***379.7***	73.6	18.9	386.4	380	22	0	187	64.2
318.80	1.00			Shale	50.5	127.7	***430.1***	73.6	18.9	460.0	430	22	0	215	65.2
317.80	1.00			Shale	50.5	127.7	***480.6***	73.6	18.9	533.6	481	22	0	242	66.2
316.80	1.00			Shale	50.5	127.7	***531.0***	73.6	18.9	607.2	531	22	0	270	67.2
315.80	1.00			Shale	50.5	127.7	***581.5***	73.6	18.9	680.8	581	22	0	298	68.2
314.80	1.00			Shale	50.5	127.7	***631.9***	73.6	18.9	754.4	~~632~~	~~22~~	~~0~~	~~326~~	~~69.2~~
313.80	1.00			Shale	50.5	127.7	***682.4***	73.6	18.9	828.0	~~682~~	~~22~~	~~0~~	~~353~~	~~70.2~~
312.80	1.00			Shale	50.5	127.7	***732.8***	73.6	18.9	901.6	~~733~~	~~22~~	~~0~~	~~381~~	~~71.2~~
311.80	1.00			Shale	50.5	127.7	***783.3***	73.6	18.9	975.2	~~783~~	~~22~~	~~0~~	~~409~~	~~72.2~~
310.80	1.00			Shale	50.5	127.7	***833.7***	73.6	18.9	1048.8	~~834~~	~~22~~	~~0~~	~~437~~	~~73.2~~
309.80	1.00			Shale	50.5	127.7	***884.2***	73.6	18.9	1122.4	~~884~~	~~22~~	~~0~~	~~464~~	~~74.2~~
308.80	1.00			Shale	50.5	127.7	***934.6***	73.6	18.9	1196.0	~~935~~	~~22~~	~~0~~	~~492~~	~~75.2~~
307.80	1.00			Shale	50.5	127.7	***985.1***	73.6	18.9	1269.6	~~985~~	~~22~~	~~0~~	~~520~~	~~76.2~~
306.80	1.00			Shale	50.5	127.7	***1035.5***	73.6	18.9	1343.2	~~1036~~	~~22~~	~~0~~	~~548~~	~~77.2~~
305.80	1.00			Shale		127.7			18.9						

I D O T   S T A T I C   M E T H O D   O F   E S T I M A T I N G   P I L E   L E N G T H

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. ============================ 384.10 ft
GROUND SURFACE ELEV. AGAINST PILE DURING DRI 366.40 ft
GEOTECHNICAL LOSS TYPE (None, Scour, Liquef., DD) Scour
BOTTOM ELEV. OF SCOUR, LIQUEF., or DD ======== 350.07 ft
TOP ELEV. OF LIQUEF. (so layers above apply DD) ============ ft

TOTAL FACTORED SUBSTRUCTURE LOAD ======== 4016 kips
TOTAL LENGTH OF SUBSTRUCTURE (along skew)==== 52.00 ft
NUMBER OF ROWS OF PILES PER SUBSTRUCTURE = 1
Approx. Factored Loading Applied per pile at 8 ft. Cts ===== 617.85 KIPS
Approx. Factored Loading Applied per pile at 3 ft. Cts ===== 231.69 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	**575** KIPS	**306** KIPS	**68** 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.)
366.10	0.30	0.10			0.1		1.5	0.1		***0.4***	0	0	0	0	18
363.60	2.50	0.10			0.8	1.4	3.8	1.2	0.2	***1.8***	2	1	0	0	21
361.10	2.50	0.20			1.7	2.9	6.9	2.4	0.4	***4.4***	4	1	0	1	23
358.60	2.50	0.30			2.5	4.3	12.2	3.6	0.6	***8.4***	8	3	0	2	26
356.10	2.50	0.50			3.9	7.2	17.6	5.8	1.1	***14.4***	14	5	0	3	28
353.60	2.50	0.60			4.7	8.6	22.3	6.8	1.3	***21.2***	21	8	0	4	31
351.10	2.50	0.60			4.7	8.6	54.2	6.8	1.3	***32.0***	32	10	0	8	33
348.60	2.50	2.50			13.6	35.9	67.9	19.9	5.3	***51.9***	52	10	0	18	36
346.10	2.50	2.50			13.6	35.9	71.4	19.9	5.3	***70.3***	70	10	0	29	38
343.60	2.50	1.80			11.0	25.9	***82.5***	16.1	3.8	86.4	82	10	0	35	41
341.10	2.50	1.80			11.0	25.9	***76.2***	16.1	3.8	99.9	76	10	0	32	43
338.60	2.50	0.60			4.7	8.6	***80.9***	6.8	1.3	106.7	81	10	0	34	46
336.60	2.00	0.60			3.7	8.6	***88.8***	5.4	1.3	112.7	89	10	0	39	48
336.10	0.50		5	Fine Sand	0.2	12.8	***88.9***	0.3	1.9	113.0	89	10	0	39	48
333.60	2.50		5	Fine Sand	0.9	12.8	***89.8***	1.3	1.9	114.3	90	10	0	39	51
331.10	2.50		5	Fine Sand	0.9	12.8	***89.4***	1.3	1.9	115.3	89	10	0	39	53
328.60	2.50	0.80			6.0	11.5	***95.4***	8.7	1.7	124.1	95	10	0	42	56
326.10	2.50	0.80			6.0	11.5	***95.6***	8.7	1.7	131.9	96	10	0	43	58
324.60	1.50	0.40			1.9	5.7	***97.5***	2.8	0.8	134.7	98	10	0	44	60
323.10	1.50	0.40			1.9	5.7	221.4	2.8	0.8	***155.6***	156	10	0	75	61
322.90	0.20			Shale	10.1	127.7	231.5	14.7	18.9	***170.3***	170	10	0	84	61.2
322.70	0.20			Shale	10.1	127.7	241.6	14.7	18.9	***185.0***	185	10	0	92	61.4
322.50	0.20			Shale	10.1	127.7	251.7	14.7	18.9	***199.7***	200	10	0	100	61.6
322.30	0.20			Shale	10.1	127.7	261.8	14.7	18.9	***214.4***	214	10	0	108	61.8
322.10	0.20			Shale	10.1	127.7	271.9	14.7	18.9	***229.2***	229	10	0	116	62
321.10	1.00			Shale	50.5	127.7	322.3	73.6	18.9	***302.8***	303	10	0	156	63
320.10	1.00			Shale	50.5	127.7	***372.8***	73.6	18.9	376.4	373	10	0	195	64
319.10	1.00			Shale	50.5	127.7	***423.2***	73.6	18.9	450.0	423	10	0	223	65
318.10	1.00			Shale	50.5	127.7	***473.7***	73.6	18.9	523.6	474	10	0	250	66
317.10	1.00			Shale	50.5	127.7	***524.1***	73.6	18.9	597.2	524	10	0	278	67
316.10	1.00			Shale	50.5	127.7	***574.6***	73.6	18.9	670.8	575	10	0	306	68
315.10	1.00			Shale	50.5	127.7	***625.0***	73.6	18.9	744.4	~~625~~	~~10~~	~~0~~	~~334~~	~~69~~
314.10	1.00			Shale	50.5	127.7	***675.5***	73.6	18.9	818.0	~~675~~	~~10~~	~~0~~	~~361~~	~~70~~
313.10	1.00			Shale	50.5	127.7	***725.9***	73.6	18.9	891.6	~~726~~	~~10~~	~~0~~	~~389~~	~~71~~
312.10	1.00			Shale	50.5	127.7	***776.4***	73.6	18.9	965.2	~~776~~	~~10~~	~~0~~	~~417~~	~~72~~
311.10	1.00			Shale	50.5	127.7	***826.8***	73.6	18.9	1038.8	~~827~~	~~10~~	~~0~~	~~445~~	~~73~~
310.10	1.00			Shale	50.5	127.7	***877.3***	73.6	18.9	1112.4	~~877~~	~~10~~	~~0~~	~~472~~	~~74~~
309.10	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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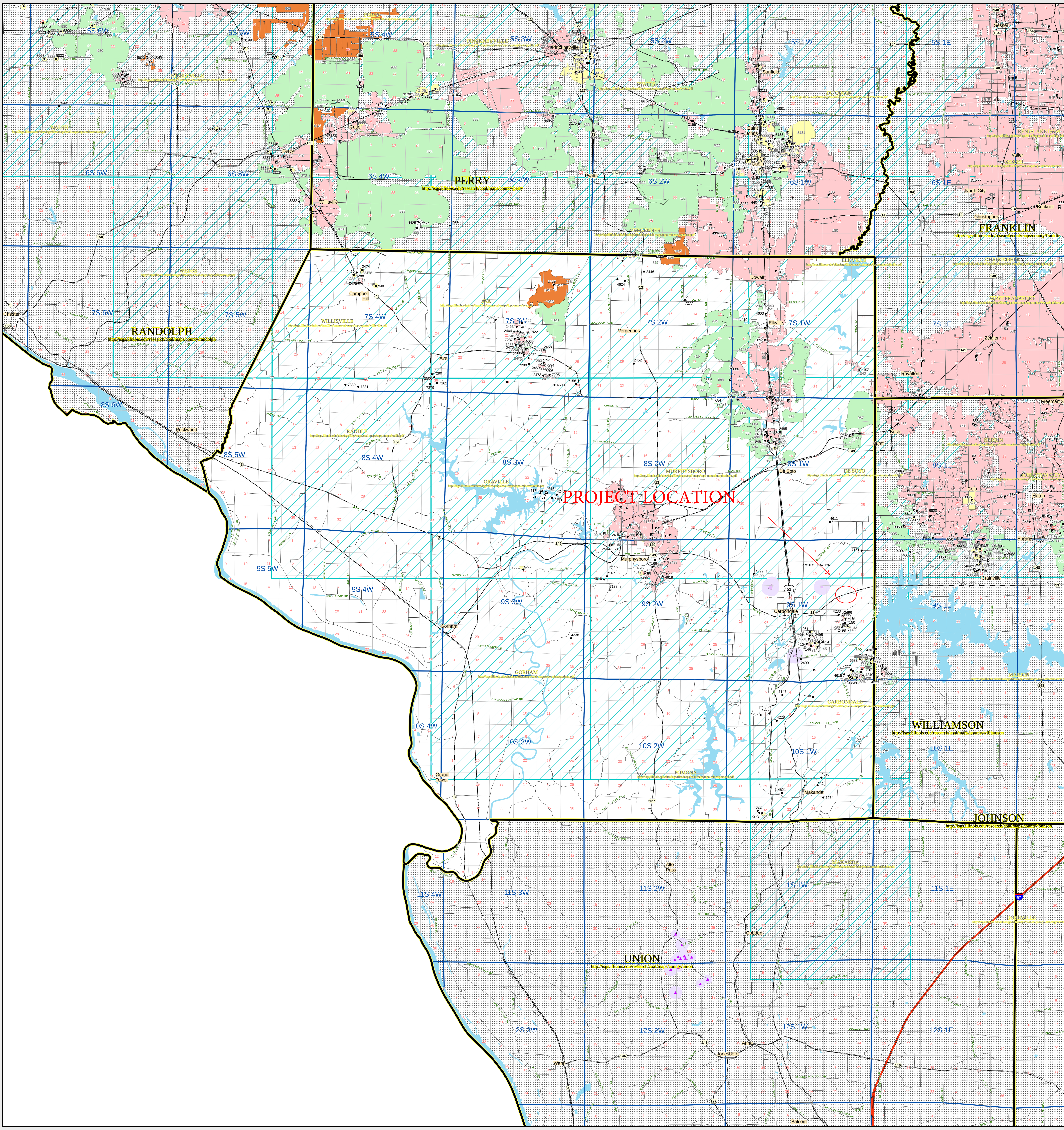
Coal Mines and Underground Industrial Mines
JACKSON
County

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



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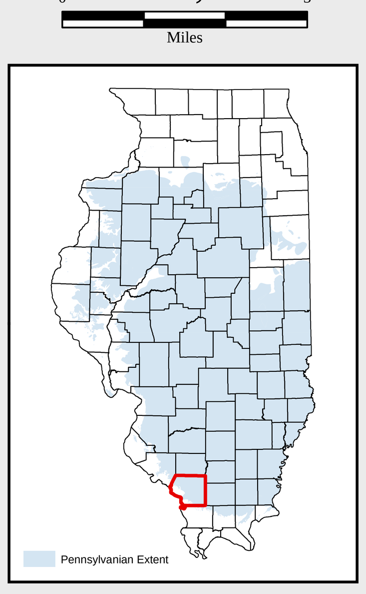
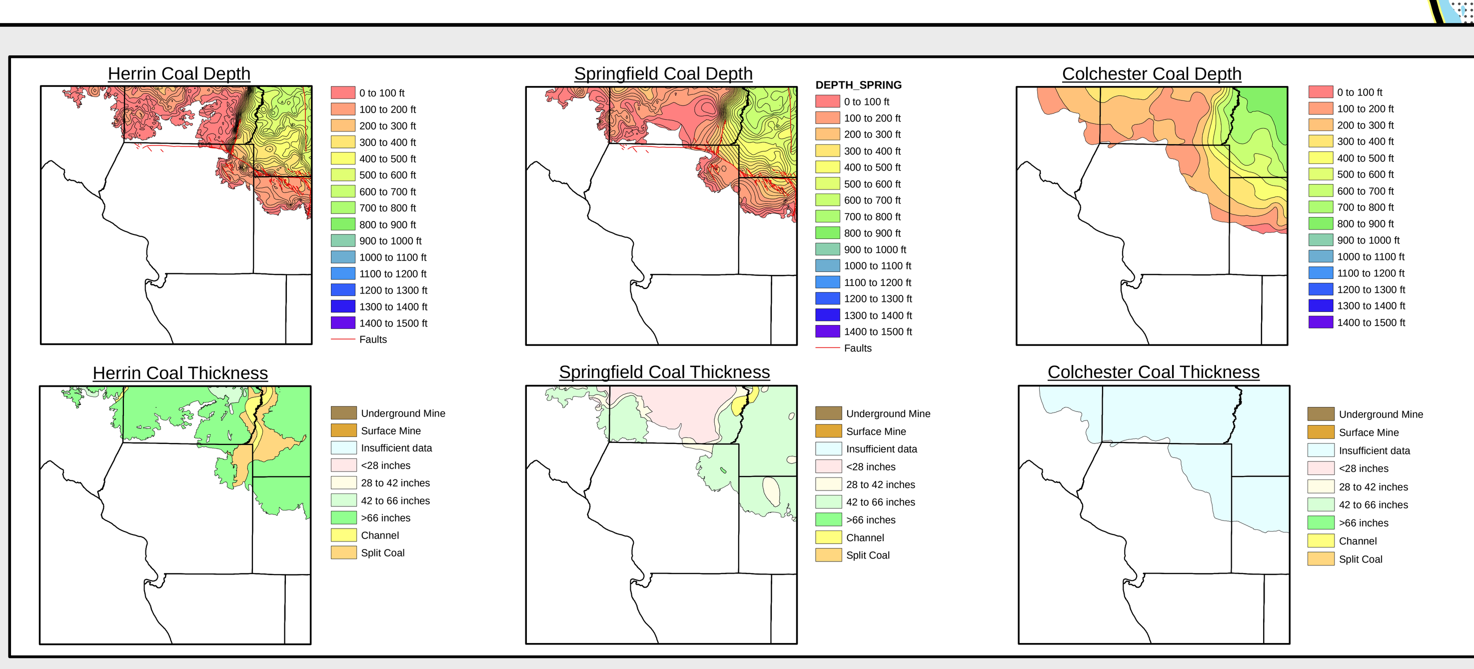
Miles





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

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.