STRUCTURE GEOTECHNICAL REPORT

F.A.P. 332 (IL Route 1) over CSX RAILROAD

Existing S.N. 012-0014
Proposed S.N 012-0074

F.A.P. ROUTE 332 (IL 1)
SECTION (FX-VBR)B-1
CLARK COUNTY, ILLINOIS
JOB NO. P97-043-09
PTB 152/29
CONTRACT NO. 74433
KEG NO. 09-1049.10

Authored By:
Matthew D. Masterson, P.E.
Kaskaskia Engineering Group, LLC
208 East Main Street, Suite 100
Belleville, IL 62220
mmasterson@kaskaskiaeng.com
618.233.5877

LICENSED PROFESSIONAL ENGINEER
MATTHEW DENNIS MASTERSON
062-061885
STATE OF ILLINOIS

01/16/2014
Exp. 11/30/2015

Prepared for:
Allen Henderson & Associates
907 South 4th Street
Springfield Illinois, 62703

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Kaskaskia
Engineering Group, LLC

EXECUTIVE SUMMARY

IL 1 over CSX Railroad
F.A.P. Route 332 (IL 1)
Section (FX-VBR) B-1
Clark County, Illinois
Job No. P97-043-09
PTB 152/29
Contract No. 74433
Proposed Structure No. 012-0074

The new bridge is currently proposed as a single, three-span structure carrying Illinois Route 1 over the CSX Railroad in Clark County, Illinois. This report summarizes the geotechnical analysis of the proposed structure.

Slope stability and settlement are not anticipated to be an issue at the north or south abutment locations.

According to the Bridge Manual, Section 3.8.3 on Open Abutments: Integral, the foundation may consist of H-piles or Metal Shell piles. The proposed back-to-back abutment length exceeds 200 ft. Therefore, the north and south abutments are required to use steel H-piles. Kaskaskia Engineering Group, LLC (KEG) has reviewed the applicability of integral abutments for this structure with respect to All Bridge Designers (ABD) Memo 12.3, dated July 25, 2012 by IDOT. Based on our analysis, the average strength values (Qu_{avg}) within the critical depth at both abutment locations is less than 1.5 tsf. According to the IDOT Integral Abutment Pile Selection Chart, available piles sizes are HP 10X42 and larger. Please see ABD Memo 12.3 for additional information.

Due to the shallow sandstone bedrock, at the intermediate pier locations, drilled shaft support is recommended.

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EXHIBITS

1.0 Project Description and Proposed Structure Information

1.1 Introduction

The geotechnical study summarized in this report was performed for the proposed structure at IL 1 over CSX Railroad in Clark County, Illinois. The purpose of this report is to present design and construction recommendations for the proposed structure.

1.2 Project Description

The project consists of a complete replacement of an existing three-span structure (SN 012-0014) with a new three-span structure (SN 012-0074) located at IL 1 over the CSX Railroad. The general location of the structure is shown on a USGS Topographic Location Map, Exhibit A. The site lies within the limits of the Second Principal Meridian, (T. 11N R. 12W Section 12) within the Springfield Plain of the Till Plains section of the Central Lowland Province.

1.3 Existing Structure

The existing structure was built in 1940. In 1973, the bridge deck was replaced. The existing structure is a three-span continuous, wide flange bridge. The back-to-back abutment length is 182 ft. - 1½ in., with an out-to-out bridge width of 35 ft. The superstructure consists of a composite reinforced concrete deck supported by continuous WF 30 x 108 steel beams. The reinforced deck is in poor condition, and the expansion joints have failed. The substructure consists of reinforced concrete pile bent abutments and multi-column piers. According to the Bridge Condition Report (BCR), dated February 2012, the abutment caps are in good condition with small areas of map cracking and delamination observed. However, the wing-wall and back walls were in poor condition with heavy map cracking, delamination, and leaching. The abutments are supported on concrete piles; while the piers are supported on concrete spread footings. The current slope protection does not meet current IDOT Standards. The BCR recommends complete replacement.

1.4 Proposed Bridge Information

The proposed three-span structure (SN 012-0074) located at IL 1 over CSX Railroad will be built on a 45º – 48' skew, from the centerline of the railroad tracks. The structure will have an out-to-out width of 58 ft. - 2 in. The centerline of the structure will lie at Station 169+05.72 of the roadway and Station 6+17.66 of the railroad. Integral abutments and piers are proposed for the structure. The slope wall will include a bituminous coated aggregate layer for protection.

The structure will measure 230 ft. back-to-back abutments and will support two, 12-ft. driving lanes with 10-ft. shoulders. The southbound side will include a 10-ft.-wide bike lane. 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 District personnel. A site visit by a KEG representative to observe all or part of the borings, or to make site observations, was not included in the scope of services. Therefore, no site observations have been made relative to current conditions of the structure or immediate surroundings, including the soil samples retained during drilling.

Three standard penetration test (SPT) borings, designated 1, 2, and 3, were drilled December 13, 2012, through December 18, 2012. A 10-ft. rock core was obtained from the South Abutment (1) boring, and a 15-ft. core was obtained from the South Pier (2) boring. The boring locations are shown on the Type, Size, and Location Plan (TS&L), Exhibit B, as provided by Allen Henderson & Associates. Detailed information regarding the nature and thickness of the soils and rock encountered and the results of the field sampling and laboratory testing are shown on the Boring Logs, Exhibit C. A soil profile, prepared by the District, can be found under Subsurface Profile, Exhibit D.

Table 2.1 – Boring Summary

Boring Location	Station	Offset	Ground Surface Elevation
South Abutment (1)	167+89	11 ft. LT	649.91
South Pier (2)	168+84	43 ft. RT	632.72
North Abutment (3)	170+52	12 ft. RT	650.81

2.1 Subsurface Conditions

The subsurface conditions at all three borings exhibited similar lithologic profiles. Generally, the first 30 ft. below ground surface (bgs), approximate El. 630.0 to El. 600.0, consisted of moist clay loams and clays with unconfined compressive strength (Q_u) values ranging from 0.5 to 3.0 tons per square foot (tsf), with average Standard Penetration Test (SPT) N-values of 3 to 7. The moisture contents varied from 13 to 35 percent. This material was followed by clay loam/ sandy clay till which exhibited Q_u values greater than 1.5 tsf. Sandstone bedrock was encountered in all borings at approximate El 616.0 to 612.0, approximately 34 to 35 feet bgs. An interbedded layer of sandy clay shale was encountered in Borings 1 and 2. In Borings 1 and 2, 10- and 15-ft. rock cores were performed, respectively. Unconfined compressive strength tests were performed on samples of the bedrock. The unweathered sandstone had an average Q_u of 140 tsf and an average RQD of 76 percent, and the sandy clay shale had an average Q_u of 6.7 tsf and an RQD of 80 percent. It should be noted that at the south pier boring location, sandstone was first encountered approximately 15 ft. bgs.

2.2 Bedrock

Table 2.2 shows the elevations of top of rock and boring termination depths for Borings 1, 2, and 3.

Table 2.2 – Top of Rock Elevations

Boring	Top of Rock Elevation (ft.)	Boring Termination Elevation (ft.)
1	614.0	593.9*
2	615.7	596.7*
3	616.3	610.8

*Termination depth includes rock core

2.3 Groundwater

Groundwater was encountered in all of the borings. Table 2.3 shows the elevations and the time of the readings. Without extended periods of observation, measurement of true groundwater levels may not be possible. It should be further noted that the groundwater level is subject to seasonal and climatic variations.

Table 2.3 – Groundwater

Boring	Upon Completion Elevation (ft.)	Extended Reading Elevation (ft.)
1	624.9	625.9 (96 hrs.)
2	624.4	619.2 (24 hrs.)
3	616.7	616.8 (24 hrs.)

3.0 Geotechnical Evaluations

3.1 Settlement

Since no significant grading or changes to the existing embankments are expected at the proposed structure, it is estimated that the existing embankments will experience settlements of less than 0.5 in. Therefore, no settlement calculations were performed for the proposed structure.

3.2 Slope Stability

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

The proposed abutments are integral abutments with endslopes at 1 Vertical to 2 Horizontal (1V:2H), to the toe. Slope stability of the endslopes was analyzed using SLOPE-W; the soil properties at the site, including those in Borings 1 and 3; and 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 standard of practice, the target FOS is 1.5 for end-of-construction and long-term slope stability, and 1.0 for the design seismic event.

In order to model the end-of-construction condition, undrained soil parameters were used with a friction angle of 0 degrees assumed for cohesive soils. Drained soil parameters with assumed friction angles ranging from 26 to 30 degrees were used to model the long-term and seismic conditions to analyze the condition where excess pore water pressure from construction has dissipated. For clay and silty clay materials, a nominal cohesion value of 100 psf was included in the drained strength parameters.

The Modified Bishop Method, which generates circular-arc failure surfaces, was used to calculate the critical failure surfaces and FOS for the analyzed conditions. The FOS obtained in the analysis is shown in Table 3.1. SLOPE-W program output from this analysis can be found in Slope Stability Analysis, Exhibit E.

Table 3.1 – Slope Stability Critical FOS

Location	Slope	Calculated Critical FOS		
		End-of-Construction	Long-Term	Seismic
North Abutment	1V:2H	2.4	1.5	1.3
South Abutment	1V:2H	2.9	1.6	1.4

The results of the analysis, as provided in Table 3.1, indicate an acceptable FOS at the north and south abutments under all three modeled conditions.

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 C.

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 C, are summarized below.

Table 3.2 – Summary of Seismic Parameters

Parameter	Value
Soil Site Class	C
Spectral Response Acceleration, 0.2 Sec, S_{DS}	0.266g (Site Class C)
Spectral Response Acceleration, 1.0 Sec, S_{D1}	0.122g (Site Class C)
Seismic Performance Zone	1

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

3.4 Scour

The proposed structure will not cross a river or other tributary; therefore, scour is not an issue.

3.5 Mining Activity

According to the Illinois State Geological Survey (ISGS) website, coal mining has occurred in Clark County. However, as of March 2013, an Illinois Coal Mines and Underground Industrial Mines Map was not available from Illinois Geological Survey (ISGS) website (http://www.isgs.illinois.edu/maps-data-pub/coal-maps.shtml).

No visual indication of subsurface mining activities were brought to our attention prior to issuance of this report.

3.6 Liquefaction

A liquefaction analysis is not required to be performed since the project is in a Seismic Performance Zone 1 as per IDOT Bridge Manual and AGMU Memo 10.1 - Liquefaction Analysis. However, due to the possible variations in the soil profile that could affect the soil site class designation and the increased potential for seismic activity in IDOT District 7, a liquefaction analysis was performed for reference.

The Peak Horizontal Ground Surface Acceleration value used in the analysis was set equivalent to the PGA (0.053 for NMSZ and 0.061 for CEUS), as determined based on deaggregation information from the USGS website and the liquefaction worksheet provided by IDOT BBS Central Geotechnical Unit (Mod. 5/24/2010). The PGA was calculated for both GMPE models. The Design Earthquake Mean Magnitudes (7.7 for NMSZ and 8.0 for CEUS) were determined using the USGS data and deaggregation methods provided at http://earthquake.usgs.gov/. The soil profiles for Borings 1, 2, and 3 were analyzed.

The results for the soil profile encountered in all three borings indicated no concern for liquefaction. Therefore, liquefaction was not considered as a reduction for the pile design capacity or other foundation considerations included herein.

3.7 Approach Slab

In accordance with the IDOT Bridge Manual, KEG has evaluated the foundation soils at the approach slabs for bearing capacity and excessive settlement. With proper compaction of the new approach embankment fills, the bearing capacity and settlement requirements of the IDOT Bridge Manual should be satisfied. Backfill placed directly behind the abutments should be in accordance with Guide Bridge Special Provision #76.

4.0 Foundation Evaluations and Design Recommendations

4.1 General Feasibility

According to the Bridge Manual, Section 3.8.3 on Open Abutments: Integral, the foundation may consist of H-piles or Metal Shell piles. KEG has reviewed the applicability of integral abutments for this structure with respect to All Bridge Designers (ABD) Memo 12.3, dated July 25, 2012 by IDOT. Based on our analysis, the average strength values (Qu_{avg}) within the critical depth at both abutment locations is less than 1.5 tsf. According to the IDOT Integral Abutment Pile Selection Chart, available piles sizes are HP 10X42 and larger. Please see ABD Memo 12.3 for additional information.

Based on the boring logs, the depth to bedrock, and the results of the pile design analysis, H-piles appear to be the most feasible option for abutment support. 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. Drilled shafts are recommended at the intermediate pier locations, versus piles or shallow foundations due to the proximity of the piers to the railroad and the depth to competent bedrock.

4.2 Pile Supported Foundations

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

The Strength 1 factored loads were 1,400 kips at the abutments and 3,534 kips at the intermediate piers. The loads were provided by Allen Henderson & Associates. The estimated pile lengths for the pile types considered are shown in Pile Length/Pile Type, Exhibit F. The Nominal Required Bearing (R_N) represents the resistance the pile will experience during driving, and it assists 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.

Based on the pile cutoff elevations shown in the TS&L provided by Allen Henderson & Associates, the maximum pile lengths for a 12x53 H-pile range from 34 to 35 ft. and 35 to 36 ft. for a 14x73 H-pile.

As shown in Pile Length/Pile Type, Exhibit F, downdrag, scour, and liquefaction have not been considered at the abutment locations.

Due to the consistency of the soil profile, KEG recommends a test pile be performed at the south abutment. 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.

Pile shoes are not anticipated to be necessary. As indicated by the subsurface exploration, there does not appear to be any stratigraphic layers or hard rock (limestone or dolomite) present that could potentially damage the piles during driving.

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 4.1 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 4.1 – Soil Parameters for Lateral Pile Load Analysis

Boring	Elev. At Bottom of Layer	γ (pcf)	Short Term		Long Term		K (pci)	N	% fines < #200	ε_{50}
			c' (psf)	Φ (degrees)	c' (psf)	Φ (degrees)				
B-1 (South Abutment)	640.41	125	1600	0	50	26	500	6	80	0.007
	632.91	120	930	0	50	26	100	3	80	0.010
	630.41	125	1700	0	50	26	500	5	80	0.007
	620.41	125	1700	0	50	26	500	7	80	0.007
	615.41	115	1800	0	50	30	500	8	25	0.007
	614.01	115	100	0	50	30	30	2	25	0.020
	605.41	145	600	38	600	38	125	50	n/a	0.004
	603.91	120	2500	12	2500	12	2000	50	n/a	0.004

B-1 WK Rock	Elev. At Bottom of Layer	γ (pci)	Φ (degrees)	E_r (psi)	Comp. Strength (psi)	RQD (%)	K_{rm}
Sandstone	598.91	0.084	45	1.35 x10^6	1,500	66	0.0005
Sandstone	593.91**	0.084	45	1.35 x10^6	1,780	83	0.0005

Boring	Elev. At Bottom of Layer	γ (pcf)	Short Term		Long Term		K (pci)	N	% fines < #200	ε_{50}
			c' (psf)	Φ (degrees)	c' (psf)	Φ (degrees)				
B-2 (South Pier)	628.22	125	2500	0	50	26	1000	14	80	0.005
	620.72	120	3800	0	50	26	1000	15	25	0.005
	618.22	115	300	0	50	30	30	2	25	0.020
	615.72	120	1600	0	50	30	500	11	25	0.007
	611.72	145	2500	38	2500	38	125	50	n/a	0.004

B-2 Wk Rock	**Elev. At Bottom of Layer**	**γ (pcf)**	**Φ (degrees)**	**E_r (psi)**	**Comp. Strength (psi)**	**RQD (%)**	**K_{rm}**
Sandstone	606.72	0.084	45	1.35 x10^6	832	21	0.00005
Clay Shale	602.72	0.072	12	1000	93	80	0.004
Sandstone	596.72**	0.084	45	1.35 x10^6	1,589	79	0.0005

Boring	**Elev. At Bottom of Layer**	**γ (pcf)**	**Short Term**		**Long Term**		**K (pci)**	**N**	**% fine < #200**	**ε_{50}**
			c' (psf)	**Φ (degrees)**	**c' (psf)**	**Φ (degrees)**				
B-3 (North Abutment)	641.81	120	2550	0	50	26	1000	5	80	0.005
	638.81	120	500	0	50	26	30	2	80	0.020
	634.81	125	900	0	50	26	100	5	80	0.010
	631.31	120	800	0	50	26	100	3	80	0.010
	627.81	120	1700	0	50	26	500	8	80	0.007
	626.31	115	1200	0	50	28	500	4	60	0.007
	621.31	120	1000	0	50	26	100	7	80	0.007
	616.31	125	3800	0	50	26	1000	10	80	0.005
	610.81	145	2500	38	2500	38	125	50	n/a	0.004

**** Use the weak rock values in this interval, if additional depth is required for analysis.**

4.4 Foundations on Drilled Shafts

Recommendations are provided for drilled shafts with sockets in the underlying sandstone, developing capacity from side or end-bearing resistance. As per the IDOT Bridge Manual Section 3.10.2.1, shafts extending into rock shall be designed utilizing only side resistance or end bearing, not a combination of both. The top of drilled shaft elevation is anticipated to be approximately 622.00 at the piers, as shown on the TS&L, Exhibit B.

Our calculations include the geotechnical resistance factors for drilled shafts in side resistance and end bearing. Side resistance in the overlying soils and underlying sandy clay shale has been ignored. Side resistance should only be considered for portions of the shafts in competent sandstone bedrock. The resistance factor used for side resistance in rock is 0.55. The resistance factor for end bearing in rock is 0.50. A Factored Unit Side Resistance of 7 ksf and a Factored Unit Tip Resistance of 80 ksf is recommended in the competent sandstone. In order to use the Factored Unit Tip Resistance value of 80 ksf, the sandstone must be verified at the bearing surface elevation and to a depth equal to one shaft diameter below the bearing surface. Based on the results of the exploration, competent rock begins at or below El. 602.0 for drilled shafts. Table 4.2 - LRFD Drilled Shaft Design below contains a summary of Factored Side and Tip Resistance available for various pier diameters.

Table 4.2 – LRFD Drilled Shaft Design

Pier Diameter (ft.)	Factored Side Resistance (kips/ft$_p$)	Factored Tip Resistance (kips)	At or Below Elevation (ft.)
2.0	44	251	602.0
2.5	55	393	602.0
3.0	66	565	602.0
3.5	77	770	602.0
4.0	88	1005	602.0

*kips/ft$_p$…kips per foot embedment…See discussion below for limitations to use of side resistance values in Table 4.2

To use the Factored Side Resistance values in Table 4.2, the shaft penetration to be used in the resistance calculations should ignore at least 1 foot of the surface of the sandstone bedrock to account for weathering, and ignore one shaft diameter to account for reversed strains occurring as a result of mobilizing tip resistance.

Settlement of drilled shaft foundations bearing in competent sandstone generally can be estimated to be less than 0.5 in. in addition to any calculated shaft compression.

A minimum center-to-center shaft spacing of three times the shaft diameter is recommended. There is no reduction in Factored Resistances 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 socket embedment lengths.

Temporary smooth steel pipe casing is recommended from the top of shaft to the top of the sandstone 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

Temporary shoring may be required at the substructure units during construction, as well as along the proposed roadway embankment, as staged construction is anticipated for this project. The native soils indicate inadequate unconfined compressive strengths and densities between approximate El. 639 to El. 634 at the abutments and between approximate El. 621 to El. 618 at the piers. These elevations are between 12 to 15 ft. bgs. If the temporary shoring is designed to terminate in these zones, low strength native soils with unconfined compressive strengths of 0.5 tsf or below may be encountered. In this case, IDOT Temporary Sheet Piling Design Guide and Charts show that a Cantilevered Sheet Piling System would not be feasible; and a Temporary 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.

Soils with high moisture content could complicate construction activities. Soft or disturbed areas should be undercut (typically 1 to 2 ft.); and crushed rock, such as CA-6, can be used to provide a working platform.

5.4 Foundation Construction

Conventional pile driving equipment and methodologies should be assumed.

It is recommended that drilled shaft construction be performed by an experienced, knowledgeable contractor familiar with the subsurface conditions in the area of the project site. The contractor should be prepared to address water seepage into the shaft excavations and the potential for sloughing or caving of the shaft side walls.

The base of each shaft shall be cleared of loose or softened material and should be pumped as necessary to prevent the accumulation of water. A full-time, qualified geotechnical engineer or geologist who has knowledge of the design and soil conditions shall observe the bearing material and condition of the bearing surface of each shaft and verify that competent sandstone extends a minimum of one shaft diameter below the bearing surface of each shaft during construction.

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

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

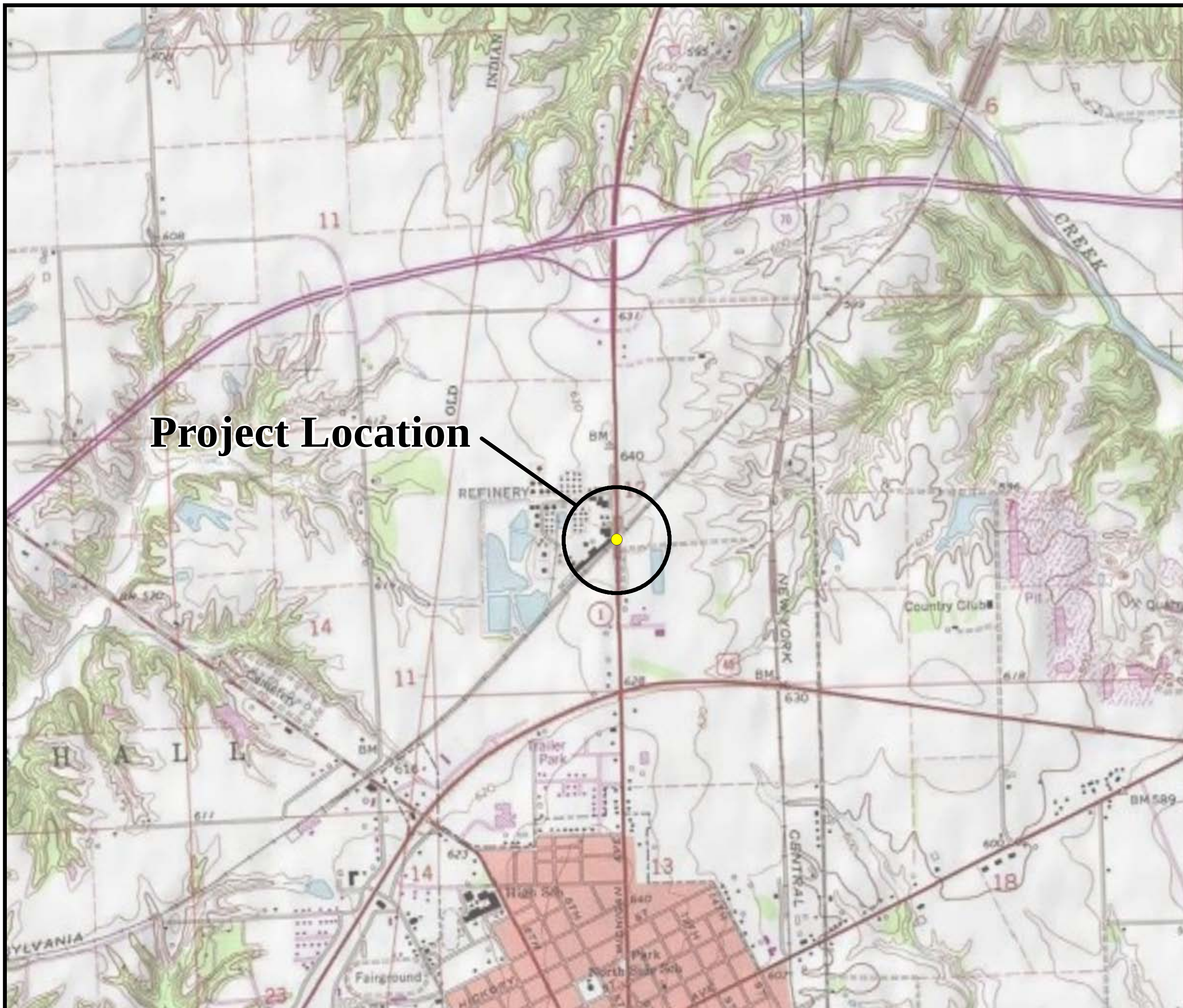
Soil boring logs can be found in Exhibit C. The Subsurface Profile can be found in Exhibit D.

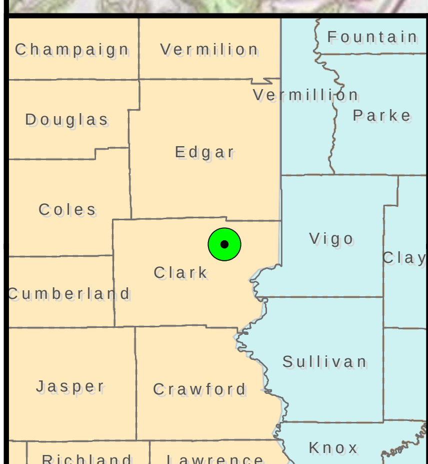
8.0 Limitations

The recommendations provided herein are for the exclusive use of Allen Henderson & Associates and IDOT. Recommendations are specific only to the project described and are based on the subsurface information obtained by IDOT at three boring locations within the bridge area in 2012; 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





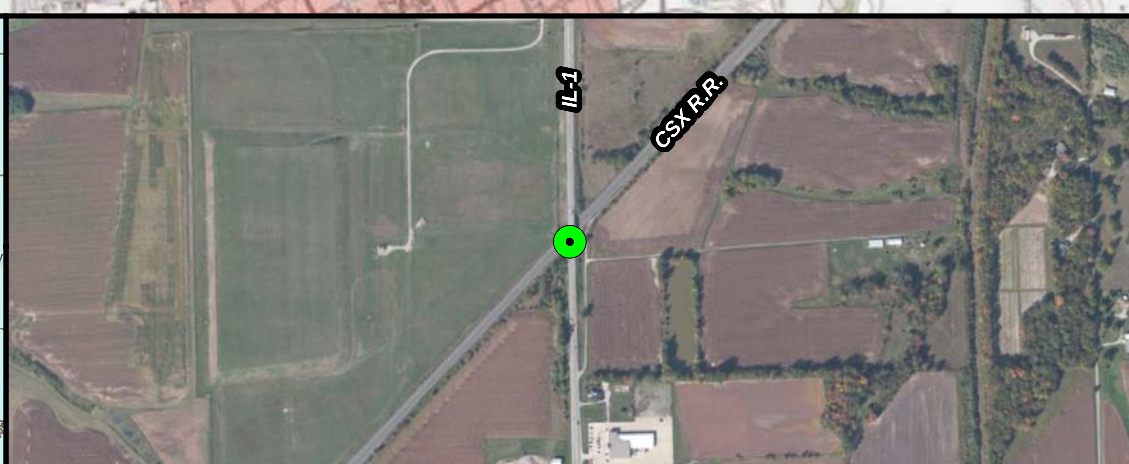


Exhibit A
Location Map
IL-1 Over CSX R.R.
Clark County, Illinois

N

0 500 1,000
Feet

Designed By: CRG
Drawn By: ASC
Checked By: CRG
Date: 3/4/13
Project #: 09-1049.10

Kaskaskia Engineering Group, LLC

EXHIBIT B

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

Bench Mark: BM#401 - Chiseled "□" on the top of curb at the S.E. corner of S.N. 012-0014. Elev. 650.96

BM#402 - Chiseled "□" on the top of curb at the N.W. corner of S.N. 012-0014. Elev. 651.65

Existing Structure: S.N. 012-0014 was originally built in 1940 as SBI 1, Sec. FX-VB. In 1973 the bridge deck was replaced under FA 1, Sec. FX-VBR. The existing structure is a three span continuous wide flange bridge. The back to back abutment length is 182'-1½" and the out to out bridge width is 35'-0". The structure is to be removed and replaced. Traffic to be maintained utilizing stage construction.

No Salvage.

HIGHWAY CLASSIFICATION

F.A.P. Rte. 332 - IL Rte. 1
Functional Class: Other Principal Arterial
ADT: 9200 (2011); 13050 (2039)
ADTT: 552 (2011); 783 (2039)
DHV: 1305 (2039)
Design Speed: 45 m.p.h.
Posted Speed: 45 m.p.h.
Two-Way Traffic
Directional Distribution: 51:49

LOADING HL-93

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

DESIGN SPECIFICATIONS

2012 AASHTO LRFD Bridge Design Specifications, 6th Edition, with 2012 Interims.

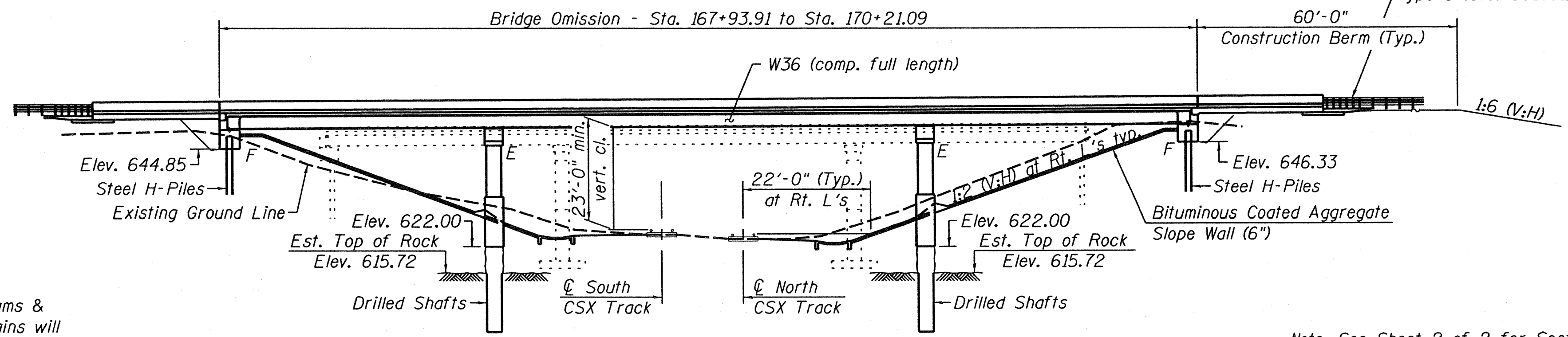
DESIGN STRESSES

FIELD UNITS

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

SEISMIC DATA

Seismic Performance Zone (SPZ) = 1
Design Spectral Acceleration at 1.0 sec. (S_{D1}) = 0.122g
Design Spectral Acceleration at 0.2 sec. (S_{DS}) = 0.266g
Soil Site Class = C

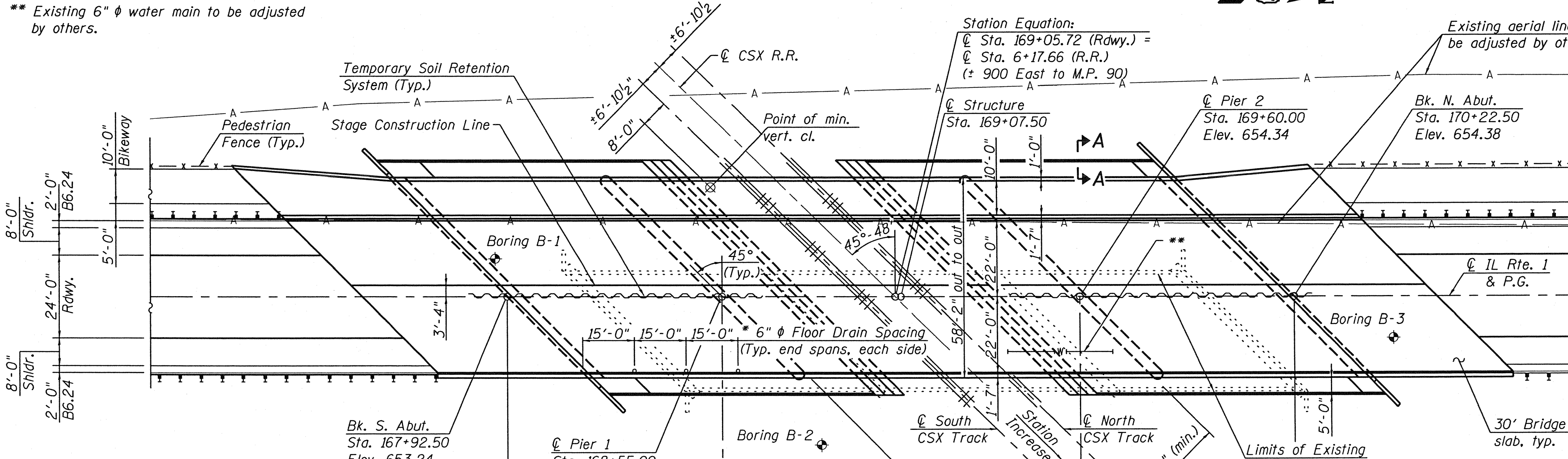


Note: See Sheet 2 of 2 for Section A-A

ELEVATION

* Drains shall be located clear of all diaphragms & 10' clear of substructure units. No deck drains will be permitted in the span over track or within 10' of cross arms of a railroad pole line.

** Existing 6" φ water main to be adjusted by others.



PLAN

STA.	Elev.
5+60.08	626.09
5+92.80	625.99
6+49.35	625.89
7+16.18	625.76

EXISTING TOP OF RAIL ELEVATIONS
(South Rail Along South CSX Track)

STA.	Elev.
5+60.27	626.06
5+99.75	626.00
6+54.30	625.88
7+17.68	625.77

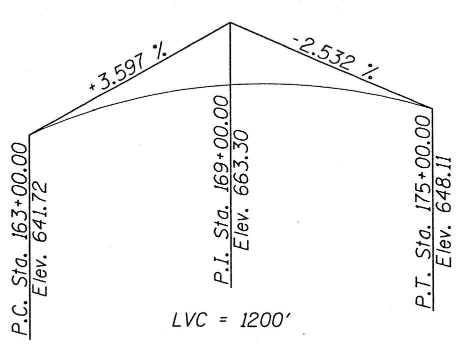
EXISTING TOP OF RAIL ELEVATIONS
(North Rail Along South CSX Track)

STA.	Elev.
5+63.48	625.33
6+08.66	625.25
6+63.39	625.17
7+21.32	625.11

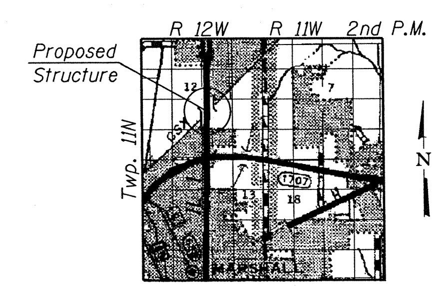
EXISTING TOP OF RAIL ELEVATIONS
(South Rail Along North CSX Track)

STA.	Elev.
5+64.14	625.35
6+13.29	625.24
6+67.78	625.19
7+22.93	625.10

EXISTING TOP OF RAIL ELEVATIONS
(North Rail Along North CSX Track)



PROFILE GRADE
(along ℄ roadway)



LOCATION SKETCH

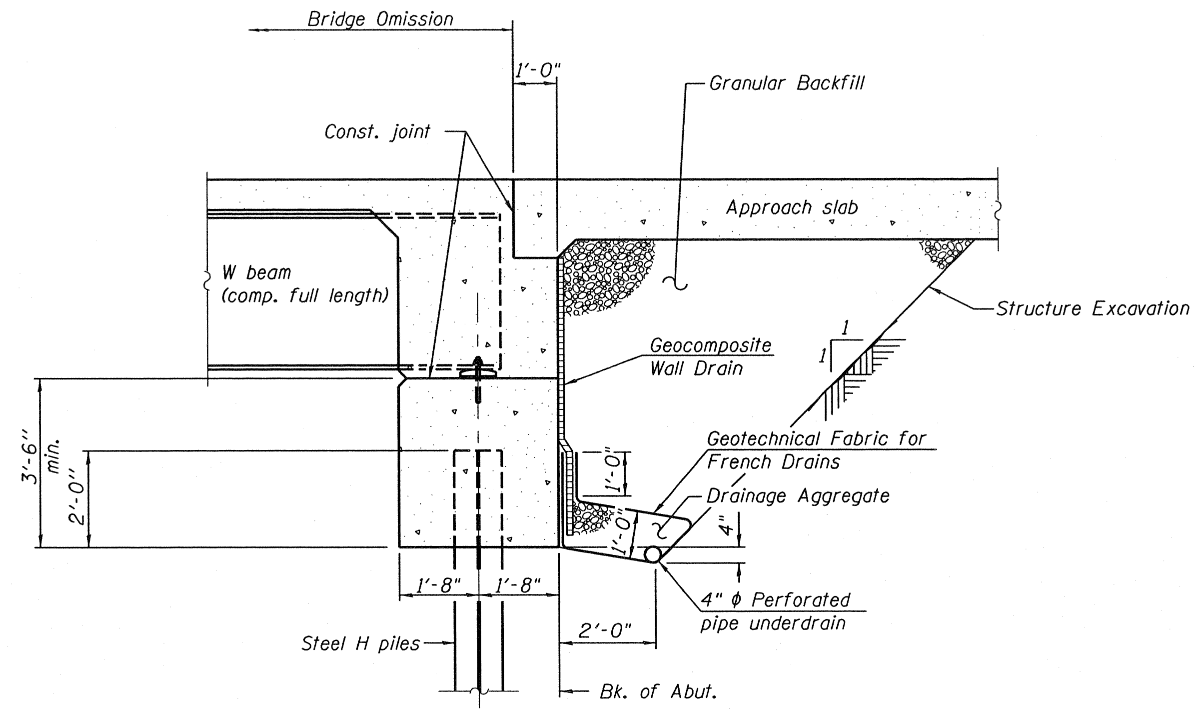
GENERAL PLAN AND ELEVATION
IL ROUTE 1 OVER CSX RAILROAD
F.A.P. RT. 332 - SEC. (FX-VBR)B-1
CLARK COUNTY
STA. 169+07.50
STRUCTURE NO. 012-0074

FILE NAME =	USER NAME =	DESIGNED -	REVISED -
		CHECKED -	REVISED -
	PLOT SCALE =	DRAWN -	REVISED -
	PLOT DATE =	CHECKED -	REVISED -

Allen Henderson & Associates, Inc.
Civil and Structural Engineers Springfield, IL. 62703 Phone: (217)544-8033 IL. Design Firm No. 184-001907

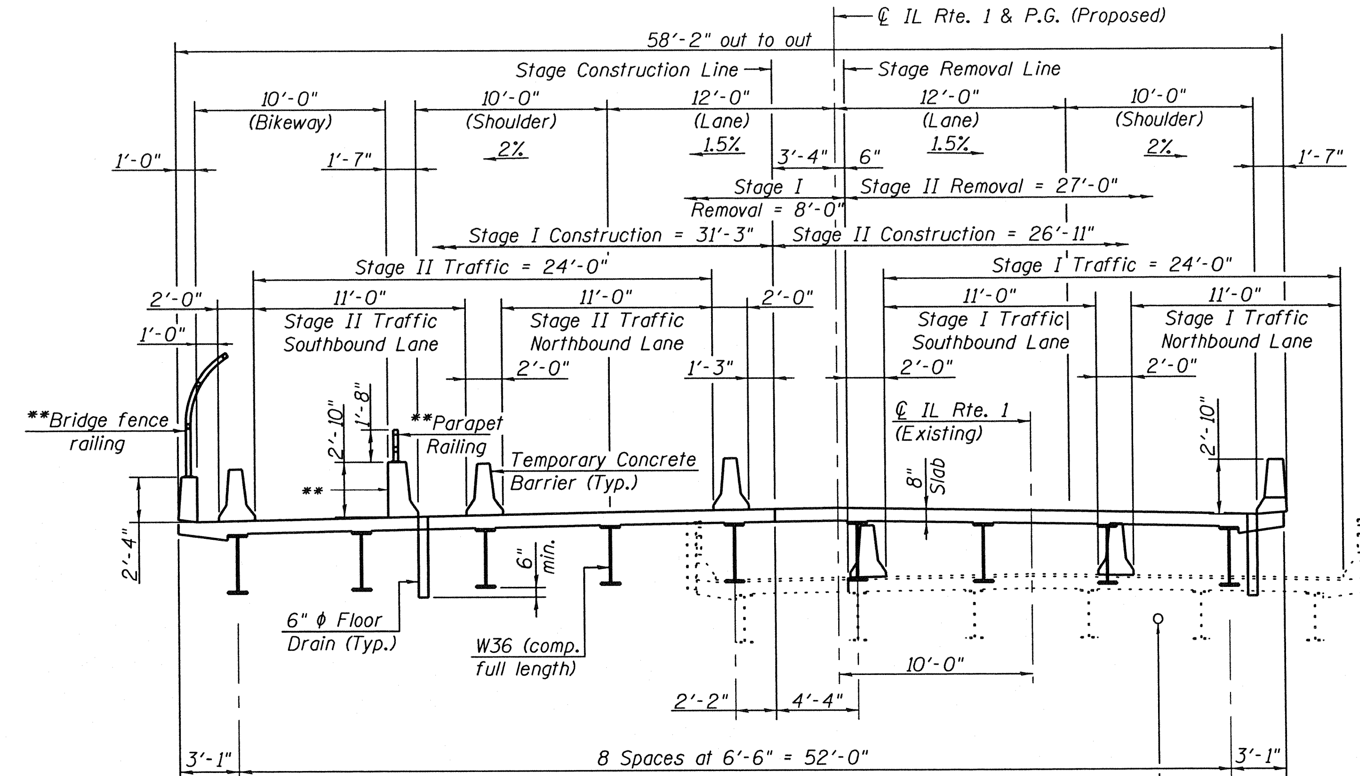
SHEET NO. 1 OF 2 SHEETS

F.A.P. RTE.	SECTION	COUNTY	TOTAL SHEETS	SHEET NO.
332	(FX-VBR)B-1	CLARK		
		CONTRACT NO. 74433		
	ILLINOIS FED. AID PROJECT			



SECTION THRU INTEGRAL ABUTMENT

(Horiz. dim. @ Rt. L's)

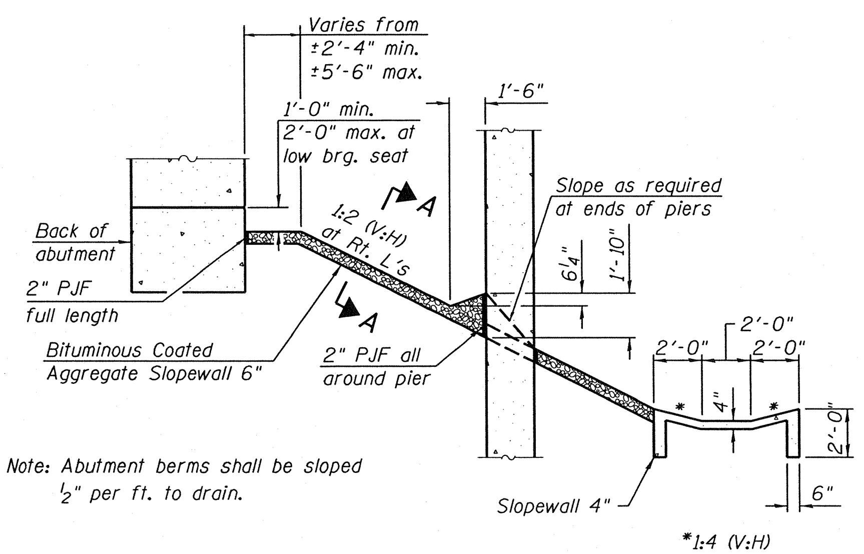


** - Items to be constructed during Stage III

CROSS SECTION

(Looking North)

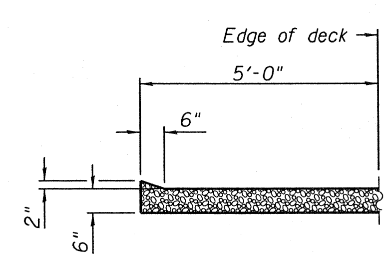
Existing 6" ϕ water main to be adjusted by others



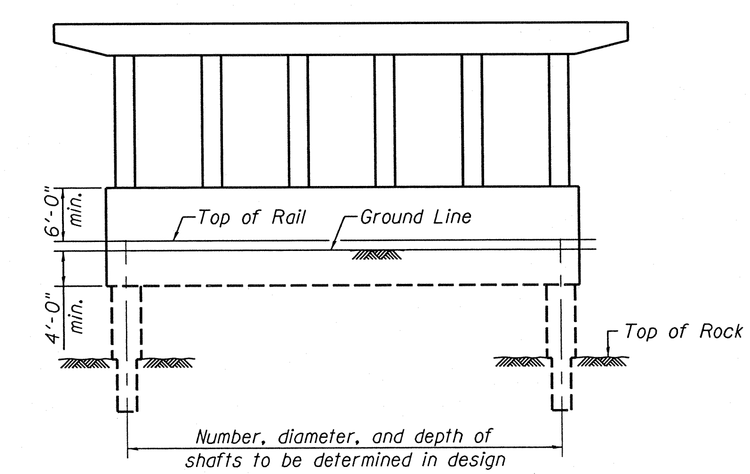
Note: Abutment berms shall be sloped ½" per ft. to drain.

SECTION THRU BITUMINOUS COATED AGGREGATE SLOPEWALL

(Horz. dim at Rt. L's)



SECTION A-A



PIER SKETCH

DETAILS
IL ROUTE 1 OVER CSX RAILROAD
F.A.P. RT. 332 - SEC. (FX-VBR)B-1
CLARK COUNTY
STA. 169+07.50
STRUCTURE NO. 012-0074

FILE NAME =	USER NAME =	DESIGNED -	REVISED -	Allen Henderson & Associates, Inc. Civil and Structural Engineers Springfield, IL. 62703 Phone: (217)544-8033 IL. Design Firm No. 184-001907		F.A. RTE.	SECTION	COUNTY	TOTAL SHEETS	SHEET NO.
		CHECKED -	REVISED -			332	(FX-VBR)B-1	CLARK		
	PLOT SCALE =	DRAWN -	REVISED -					CONTRACT NO. 74433		
	PLOT DATE =	CHECKED -	REVISED -		SHEET NO. 2 OF 2 SHEETS		ILLINOIS FED. AID PROJECT			

EXHIBIT C

BORING LOGS

Illinois Department of Transportation
Division of Highways
IDOT

SOIL BORING LOG

Date 9/13/12

ROUTE FAP 332 (IL 1) DESCRIPTION IL 1 over the CSX Railroad LOGGED BY E. Sandschafer

SECTION (FX-VBR)B-1 LOCATION , SEC. 12, TWP. 11 N, RNG. 12 W, 3 PM

COUNTY Clark DRILLING METHOD Hollow stem auger & split spoon HAMMER TYPE Auto 140#

STRUCT. NO. 012-0074
Station 169+18.17

BORING NO. 1 (South Abut)
Station 167+89
Offset 11.0ft Lt
Ground Surface Elev. 649.91 ft

Surface Water Elev. N/A ft
Stream Bed Elev. N/A ft

Groundwater Elev.:
First Encounter Dry ft
Upon Completion 624.9 ft
After 96 Hrs. 625.9 ft

Description	Elev. (ft)	DEPTH (ft)	BLOWS (/6")	UCS Qu (tsf)	MOIST (%)
6.5" asphalt on 9" concrete pavement.	648.61				
Stiff, damp, brown, CLAY LOAM. (Embankment)			1		
Brown marbled gray w/ black specks.			1	1.1	21
			2	B	
		-5	1		
			3	1.7	17
			3	B	
			2		
			3	2.0	13
	640.41		5	B	
Stiff, damp, brown marbled gray, CLAY w/ Silt. (Embankment)		-10	1		
			2	1.2	23
	637.91		2	B	
Medium, damp, brown, SANDY CLAY LOAM. (Embankment)			1		
			1	0.9	23
	635.41		1	B	
Medium, damp, brown marbled gray, LOAM. (Embankment)		-15	1		
			1	0.7	23
	632.91		2	B	
Stiff, damp, brown marbled gray, CLAY LOAM. (Embankment)			2		
			3	1.7	14
	630.41		2	B	
		-20	1		
Stiff, damp, gray, CLAY.			2	1.4	15
			4	B	
			2		
Brown marbled gray.			3	1.8	25
			3	S	
		-25	2		
Brown marbled gray.			3	1.9	18
			4	B	
			2		
Brown marbled gray. (continued)			3	1.7	17
	620.41		4	B	
Stiff, damp, brown marbled gray, SANDY CLAY.		-30	1		
			3	1.8	16
	615.41		5	S	
Very soft, wet, brown, SANDY LOAM.		-35	1		
			1	0.1	23
	614.01		1	B	
Medium, damp, gray and brown layered, SANDSTONE.		-40	29		

The Unconfined Compressive Strength (UCS) Failure Mode is indicated by (B-Bulge, S-Shear, P-Penetrometer, E-Estimated)
Abbreviations W.O.H - Sampler Advanced By Weight of Hammer, W.O.P - Advanced by Weight of Pipe, B.S. - Before Seating
The SPT (N value) is the sum of the last two blow values in each sampling zone (AASHTO T206) BBS, from 137 (Rev. 8-99)

File Name S:\NEW GEOTECHNICAL\GINTDATA\PROJECTS\CLARK CO (012)\012-0074 SOIL ROCK 2012.GPJ Data Template D6TEMPLT.GDT Date Printed 9/25/12
Latitude W 39 deg 24 min 35.2677 sec Longitude N 87 deg 41 min 37.2807 sec Datum Job Number

Illinois Department of Transportation
Division of Highways
IDOT

SOIL BORING LOG

Date 9/13/12

ROUTE FAP 332 (IL 1) DESCRIPTION IL 1 over the CSX Railroad LOGGED BY E. Sandschafer

SECTION (FX-VBR)B-1 LOCATION , SEC. 12, TWP. 11 N, RNG. 12 W, 3 PM

COUNTY Clark DRILLING METHOD Hollow stem auger & split spoon HAMMER TYPE Auto 140#

STRUCT. NO. 012-0074
Station 169+18.17

BORING NO. 1 (South Abut)
Station 167+89
Offset 11.0ft Lt
Ground Surface Elev. 649.91 ft

Surface Water Elev. N/A ft
Stream Bed Elev. N/A ft

Groundwater Elev.:
First Encounter Dry ft
Upon Completion 624.9 ft
After 96 Hrs. 625.9 ft

Description	Elev.	DEPTH (ft)	BLOWS (/6")	UCS Qu (tsf)	MOIST (%)
Medium, damp, gray and brown layered, SANDSTONE. (continued)			50/5"	0.6	21
			50/2"	S	
	605.41				
Very dense, moist, brown, SANDY CLAY SHALE. Sample broken, unable to test.		-45	49		
			41		12
	603.91		50/3"		
Borehole continued with rock coring.		-50			
		-55			
		-60			

The Unconfined Compressive Strength (UCS) Failure Mode is indicated by (B-Bulge, S-Shear, P-Penetrometer, E-Estimated)
Abbreviations W.O.H – Sampler Advanced By Weight of Hammer, W.O.P – Advanced by Weight of Pipe, B.S. – Before Seating
The SPT (N value) is the sum of the last two blow values in each sampling zone (AASHTO T206) BBS, from 137 (Rev. 8-99)

File Name S:\NEW GEOTECHNICAL\GINTDATA\PROJECTS\CLARK CO (012)\012-0074 SOIL ROCK 2012.GPJ Data Template D6TEMPLT.GDT Date Printed 9/25/12
Latitude W 39 deg 24 min 35.2677 sec Longitude N 87 deg 41 min 37.2807 sec Datum Job Number

Illinois Department of Transportation
Division of Highways
IDOT

ROCK CORE LOG

Date 9/13/12

ROUTE FAP 332 (IL 1) DESCRIPTION IL 1 over the CSX Railroad LOGGED BY E. Sandschafer

SECTION (FX-VBR)B-1 LOCATION , SEC. 12, TWP. 11 N, RNG. 12 W, 3 PM

COUNTY Clark CORING METHOD Rotary, surf set diamond bit

STRUCT. NO. 012-0074
Station 169+18.17

CORING BARREL TYPE & SIZE NW, conv dbl bbl, split inner
Core Diameter 2.06 in
Top of Rock Elev. 614.01 ft
Begin Core Elev. 603.91 ft

BORING NO. 1 (South Abut)
Station 167+89
Offset 11.0ft Lt
Ground Surface Elev. 649.91 ft

Description	Elev.	DEPTH (ft)	CORE (#)	RECOVERY (%)	R.Q.D. (%)	CORE TIME (min/ft)	STRENGTH (tsf)
Brown, slightly weathered, SANDSTONE.	603.91		B1C1	70	66	0.6	
Core B1C1 from 48.9' to 49.5' depth, Qu = 108.4 tsf.		-50					
			B1C2	99	83	0.6	
		-55					
Core B1C2 from 55.5' to 56.0' depth, Qu = 128.5 tsf.	593.91						
Extent of exploration.							
Benchmark: BM402 Sta 169+94, 17' Lt, chiseled square on top of curb on NW corner of existing bridge = 651.65' elevation.							
(B1 Location: 39' S of existing South Abutment, 11' West of IL 1 Centerline.)		-60					
		-65					

Color pictures of the cores Available on request
Cores will be stored for examination until 09/13/17
The "Strength" column represents the uniaxial compressive strength of the core sample (ASTM D-2938)
RQD is the ratio of the total length of sound core specimens >4" to total length of core run

BBS, form 138 (Rev. 8-99)

ROCK CORE 012-0074 SOIL ROCK 2012.GPJ D6TEMPLT.GDT 9/25/12

Illinois Department of Transportation
Division of Highways
IDOT

SOIL BORING LOG

Date 9/18/12

ROUTE FAP 332 (IL 1) DESCRIPTION IL 1 over the CSX Railroad LOGGED BY E. Sandschafer

SECTION (FX-VBR)B-1 LOCATION , SEC. 12, TWP. 11 N, RNG. 12 W, 3 PM

COUNTY Clark DRILLING METHOD Hollow stem auger & split spoon HAMMER TYPE Auto 140#

STRUCT. NO. 012-0074
Station 169+18.17

BORING NO. 2 (South Pier)
Station 168+84
Offset 43.0ft Rt
Ground Surface Elev. 632.72 ft

Surface Water Elev. N/A ft
Stream Bed Elev. N/A ft

Groundwater Elev.:
∇ First Encounter Dry ft
∇ Upon Completion 624.4 ft
▼ After 24 Hrs. 619.2 ft

Description	DEPTH (ft)	BLOWS (/6")	UCS Qu (tsf)	MOIST (%)
Very stiff, very moist, gray, SILTY CLAY. (Embankment)		14		
		6	2.5	9
		8	PP	
628.22				
Hard to very stiff, damp, brown, SANDY CLAY LOAM. (Embankment)	-5	5		
		7	4.4	11
		11	S	
		4		
		6	4.0	10
∇		8	S	
	-10	4		
		6	3.0	14
Brown marbled gray.		8	S	
620.72				
Soft, very damp, brown, SANDY LOAM. (Embankment)		1		
		1	0.3	23
▼		1	B	
618.22				
Stiff, damp, brown, SANDY CLAY LOAM to SANDSTONE. (Embankment)	-15	11		
		41	1.6	13
		50/3"	S	
615.72				
Very dense, damp, brown, SANDSTONE.		50/5"		
		50/2"		14
		50/1"		
612.72	-20	44		

Description	DEPTH (ft)	BLOWS (/6")	UCS Qu (tsf)	MOIST (%)
Very dense, moist, gray, SANDY CLAY SHALE.		44		10
611.72		50/5"		
Borehole continued with rock coring.				
	-25			
	-30			
	-35			
	-40			

The Unconfined Compressive Strength (UCS) Failure Mode is indicated by (B-Bulge, S-Shear, P-Penetrometer, E-Estimated)
Abbreviations W.O.H - Sampler Advanced By Weight of Hammer, W.O.P - Advanced by Weight of Pipe, B.S. - Before Seating
The SPT (N value) is the sum of the last two blow values in each sampling zone (AASHTO T206) BBS, from 137 (Rev. 8-99)

File Name S:\NEW GEOTECHNICAL\GINTDATA\PROJECTS\CLARK CO (012)\012-0074 SOIL ROCK 2012.GPJ Data Template D6TEMPLT.GDT Date Printed 9/25/12
Latitude W 39 deg 24 min 36.2127 sec Longitude N 87 deg 41 min 36.6003 sec Datum Job Number

Illinois Department of Transportation
Division of Highways
IDOT

ROCK CORE LOG

Date 9/18/12

ROUTE FAP 332 (IL 1) DESCRIPTION IL 1 over the CSX Railroad LOGGED BY E. Sandschafer

SECTION (FX-VBR)B-1 LOCATION , SEC. 12, TWP. 11 N, RNG. 12 W, 3 PM

COUNTY Clark CORING METHOD Rotary, surf set diamond bit

STRUCT. NO. 012-0074 CORING BARREL TYPE & SIZE NW, conv dbl bbl, split inner
Station 169+18.17

Core Diameter 2.06 in
Top of Rock Elev. 615.72 ft
Begin Core Elev. 611.72 ft

BORING NO. 2 (South Pier)
Station 168+84
Offset 43.0ft Rt
Ground Surface Elev. 632.72 ft

Description	Elev.	DEPTH (ft)	CORE (#)	RECOVERY (%)	R.Q.D. (%)	CORE TIME (min/ft)	STRENGTH (tsf)
Brown, slightly weathered, SANDSTONE. Rock Core B2C1 from 22.8' to 23.2' depth, Qu = 59.9 tsf.	611.72	-25	B2C1	63	21	0.6	
Gray, slightly to moderately weathered, soft, SANDY CLAY SHALE. Rock Core B2C2 from 26.6' to 27.1' depth, Qu = 6.7 tsf.	606.72		B2C2	93	80	1	
Brown, slightly weathered, SANDSTONE.	602.72	-30					
Rock Core B2C3 from 33.5' to 34.0' depth, Qu = 114.4 tsf.		-35	B2C3	100	79	0.4	
Extent of exploration. Benchmark: BM402 Sta 169+94, 17' Lt, chiseled square on top of curb on NW corner of existing bridge = 651.65' elevation. (B2 Location: 57' N of existing South Abutment, 43' East of IL 1 Centerline.)	596.72	-40					

Color pictures of the cores Available on request
Cores will be stored for examination until 09/18/17
The "Strength" column represents the uniaxial compressive strength of the core sample (ASTM D-2938)
RQD is the ratio of the total length of sound core specimens >4" to total length of core run

Illinois Department of Transportation
Division of Highways
IDOT

SOIL BORING LOG

Date 9/17/12

ROUTE FAP 332 (IL 1) DESCRIPTION IL 1 over the CSX Railroad LOGGED BY E. Sandschafer

SECTION (FX-VBR)B-1 LOCATION , SEC. 12, TWP. 11 N, RNG. 12 W, 3 PM

COUNTY Clark DRILLING METHOD Hollow stem auger & split spoon HAMMER TYPE Auto 140#

STRUCT. NO. 012-0074
Station 169+18.17

BORING NO. 3 (North Abut)
Station 170+52
Offset 12.0ft Rt
Ground Surface Elev. 650.81 ft

Surface Water Elev. N/A ft
Stream Bed Elev. N/A ft

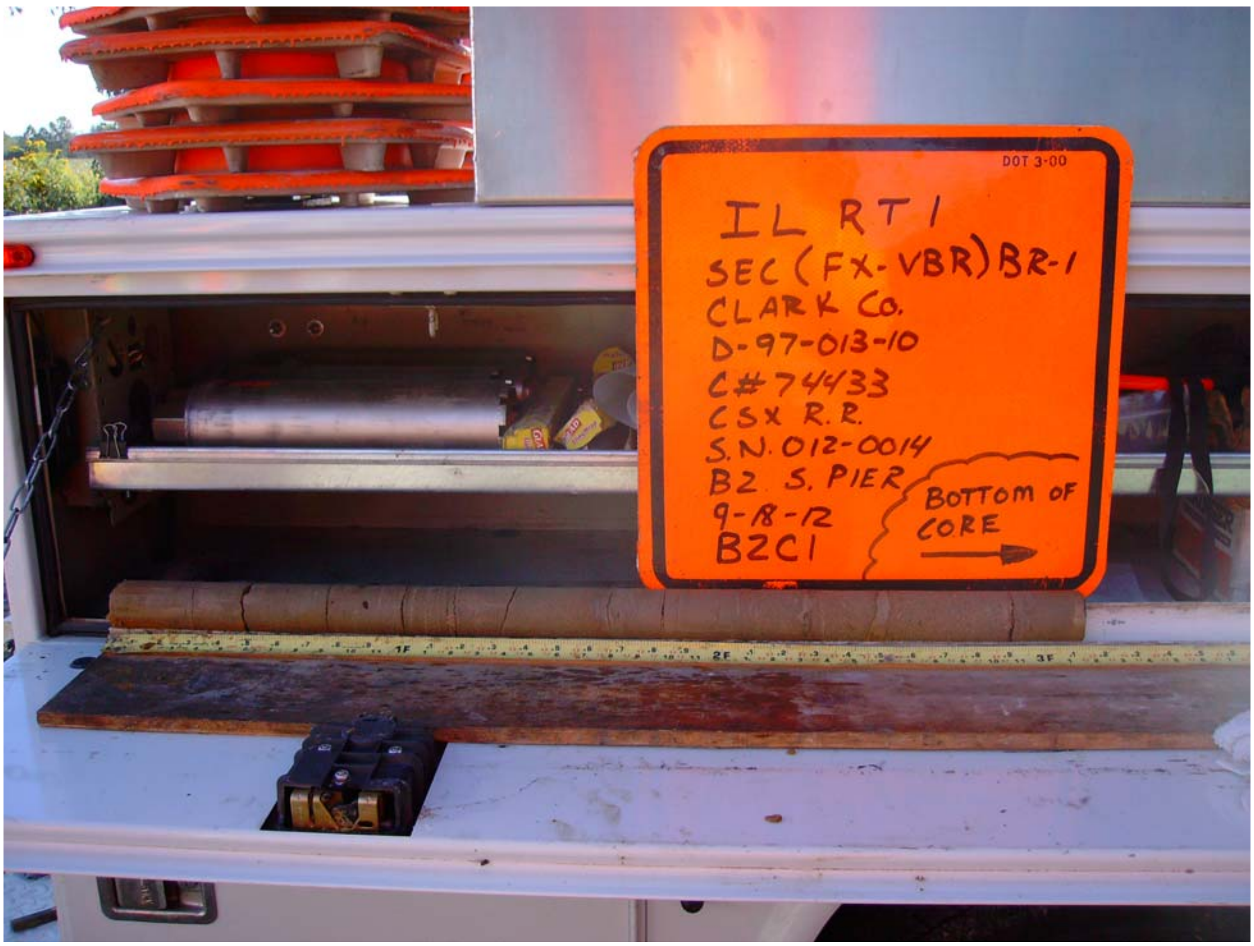
Groundwater Elev.:
▽First Encounter Dry ft
▽Upon Completion 616.7 ft
▼After 24 Hrs. 616.8 ft

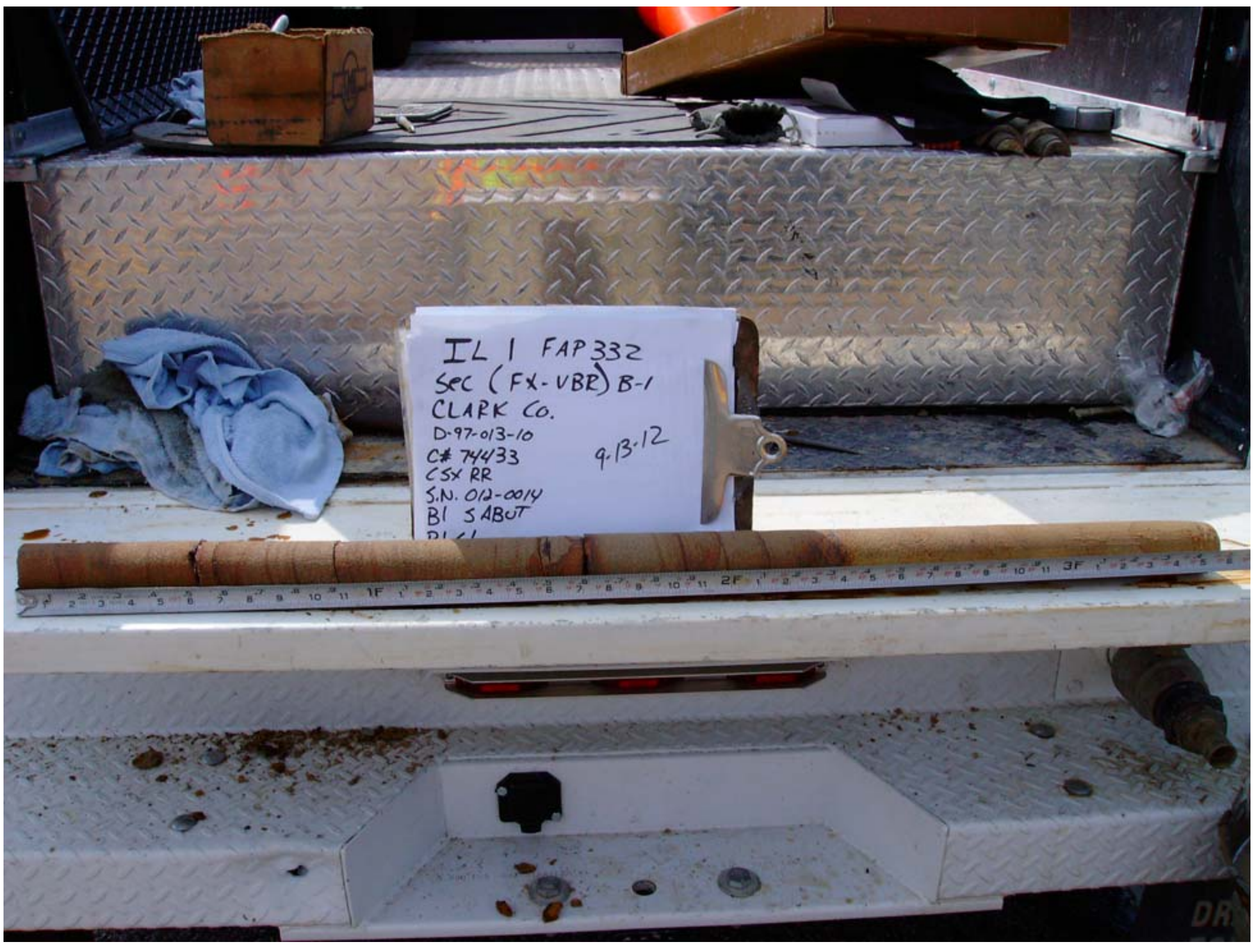
Description	Elev.	DEPTH (ft)	BLOWS (/6")	UCS Qu (tsf)	MOIST (%)
5" asphalt on 9" concrete pavement.	649.61				
Very stiff, damp, brown/gray, CLAY LOAM.			2		
			3	3.0	14
			4	B	
		-5	2		
			2	2.1	21
			3	B	
6" thick concrete layer, bored through, skipped this sample,			3		
			2		
			2		
		-10	1		
Soft to medium.			1	0.5	23
	638.81		1	B	
Stiff, damp, brown mottled gray, CLAY.			1		
			1	1.2	28
			2	B	
		-15	1		
			1	0.6	35
	634.91		6	B	
Black, CINDERS.	634.81				
Medium, damp, gray mottled brown, CLAY w/ Silt.			0		
			1	0.8	20
	631.31		2	B	
		-20	2		

Description	Elev.	DEPTH (ft)	BLOWS (/6")	UCS Qu (tsf)	MOIST (%)
Stiff, damp, brown mottled gray, CLAY LOAM. (continued)			3	1.7	24
			5	B	
			1		
	627.81		2	1.2	19
Very soft, gray, very damp, SILTY LOAM.	627.31		2	B	
Stiff, damp, brown, LOAM.	626.31				
Stiff, damp, brown, CLAY LOAM.		-25	2		
			3	1.2	17
			4	B	
			2		
			3	0.8	19
			4	PP	
	621.31				
Very stiff, damp, brown, CLAY LOAM TILL.		-30	0		
			2	3.8	12
			8	B	
(B3 Location: 43' N of existing North Abutment, 12' East of IL 1 Centerline.) ▽▼	616.31				
Very dense, moist, brown, SANDSTONE.		-35	50/2"		
			50/4"		18
Benchmark: BM402 Sta 169+94, 17' Lt, chiseled square on top of curb on NW corner of existing bridge = 651.65' elevation.			50/1"		
* 50/2", 50/2", 50/2"					
Extent of exploration.	610.81	-40	*		19

The Unconfined Compressive Strength (UCS) Failure Mode is indicated by (B-Bulge, S-Shear, P-Penetrometer, E-Estimated)
Abbreviations W.O.H - Sampler Advanced By Weight of Hammer, W.O.P - Advanced by Weight of Pipe, B.S. - Before Seating
The SPT (N value) is the sum of the last two blow values in each sampling zone (AASHTO T206) BBS, from 137 (Rev. 8-99)


DOT 3-00
IL RT 1
SEC (FX-VBR) BR-1
CLARK Co.
D-97-013-10
C#74433
CSX R.R.
S.N. 012-0014
B2 S. PIER
9-18-12
B2C3
BOTTOM OF CORE
GRAINGER


DOT 3-00
IL RT 1
SEC (FX-VBR) BR-1
CLARK Co.
D-97-013-10
C#74433
CSX R.R.
S.N. 012-0014
B2 S. PIER
9-18-12
B2C1
BOTTOM OF CORE


IL 1 FAP 332
Sec (FX-VBR) B-1
CLARK Co.
D-97-013-10
C# 74433
CSX RR
S.N. 012-0014
B1 S ABUT
9.13.12

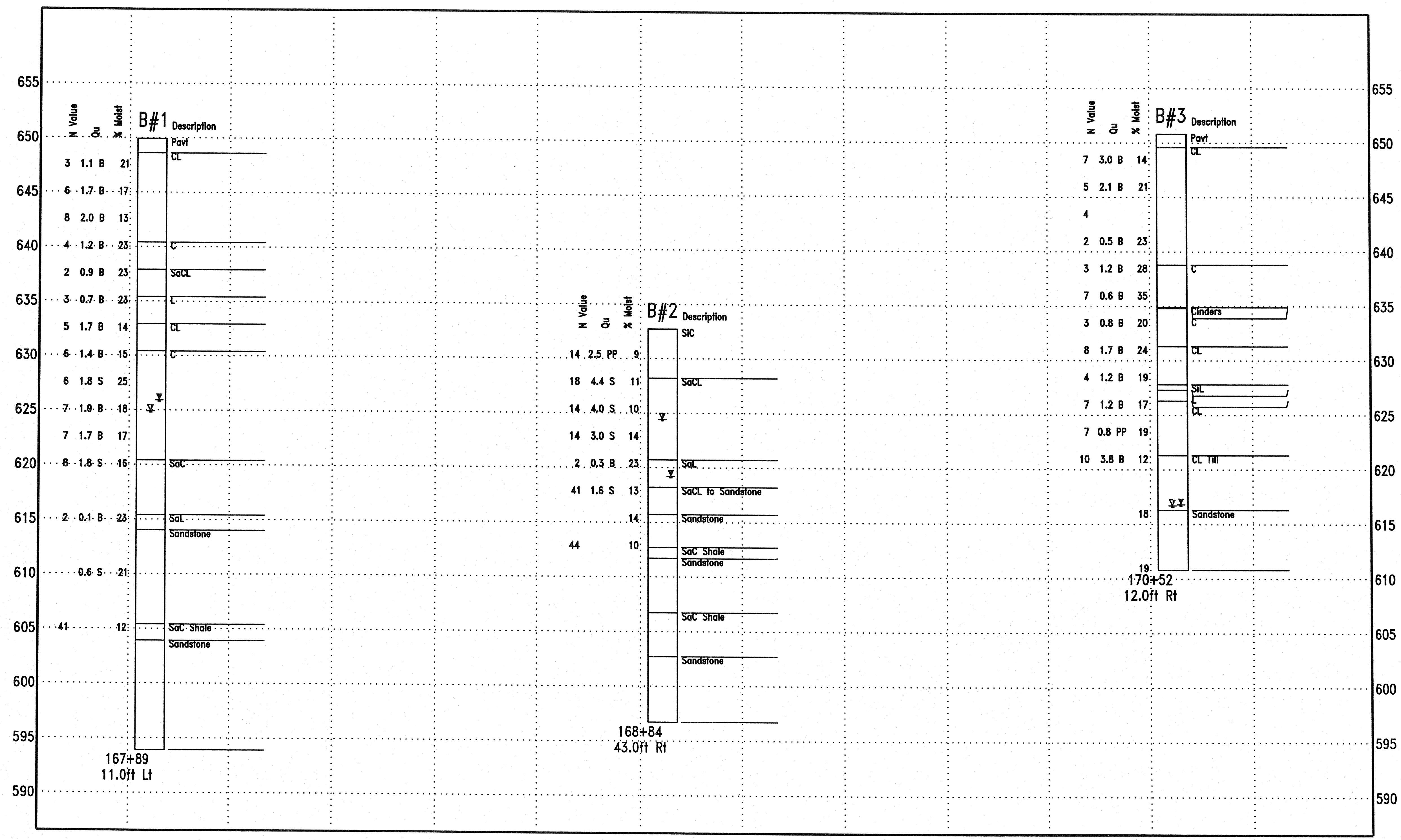

DOT 3-00
IL RT 1
SEC (FX-VBR) BR-1
CLARK Co.
D-97-013-10
C#74433
CSX R.R.
S.N. 012-0014
B2 S. PIER
9-18-12
B2C2
BOTTOM OF CORE
GRAINGER


IL 1 FAP 332
Sec (FX-VBR) B-1
CLARK Co.
D-97-013-10
C# 74433
CSX RR
S.N. 012-0014
B1 S ABUT
B2C1
9.13.12
3982
ILLINOIS
DRAKE-SCRUGGS
EQUIPMENT INC.
drake-scruggs.com

EXHIBIT D

SUBSURFACE PROFILE

Structure Number 012-0074 IL 1 over the CSX Railroad
Located in the of Section 12, Township 11 N, Range 12 W of the 3 P.M.



NOT TO HORIZONTAL SCALE

Illinois Department of Transportation

Division of Highways
IDOT

VARIATIONS IN SUBSURFACE CONDITIONS MAY EXIST BETWEEN BORINGS

Groundwater
First Encounter
Completion
after (refer to log) hours

Abbreviations
WOH – Sampler Advanced by Weight of Hammer, WOP – Weight of Pipe
B.S. – Before Seating

SUBSURFACE DATA PROFILE

Route: FAP 332 (IL 1)

Section: (FX-VBR)B-1

County: Clark

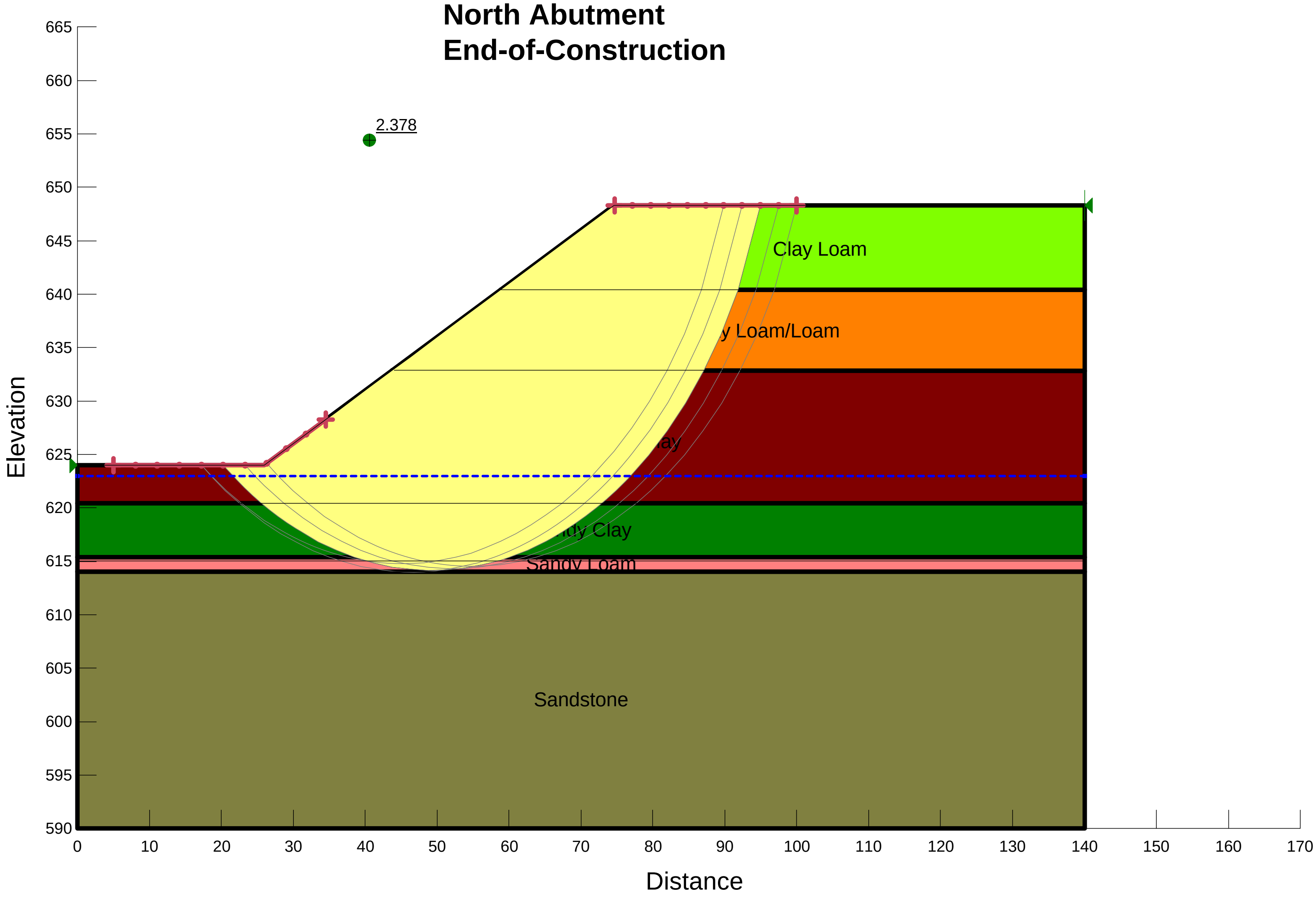
TEST FENCE 2 012-0074 SOIL ROCK 2012.GPJ D6TEMPLT.GDT 9/25/12

TEST FENCE 2 012-0074 SOIL ROCK 2012.GPJ D6TEMPLT.GDT 9/25/12

EXHIBIT E

SLOPE/W SLOPE STABILITY ANALYSIS

IL Rt 1 over CSX Railroad
North Abutment
End-of-Construction



SLOPE/W Analysis

Project Settings

Length(L) Units: feet
Time(t) Units: Seconds
Force(F) Units: lbf
Pressure(p) Units: psf
Strength Units: psf
Unit Weight of Water: 62.4 pcf
View: 2D

Analysis Settings

SLOPE/W Analysis

Description: IL 1 over CSX RR Clark County, IL North Abutment
Kind: SLOPE/W
Method: Bishop, Ordinary and Janbu
Settings
- Apply Phreatic Correction: No
- PWP Conditions Source: Piezometric Line
- Use Staged Rapid Drawdown: No

SlipSurface
- Direction of movement: Right to Left
- Use Passive Mode: No
- Slip Surface Option: Entry and Exit
- Critical slip surfaces saved: 1
- Optimize Critical Slip Surface Location: No
- Tension Crack
  - Tension Crack Option: (none)

FOS Distribution
- FOS Calculation Option: Constant

Advanced
- Number of Slices: 30
- Optimization Tolerance: 0.01
- Minimum Slip Surface Depth: 0.1 ft
- Optimization Maximum Iterations: 2000
- Optimization Convergence Tolerance: 1e-007
- Starting Optimization Points: 8
- Ending Optimization Points: 16
- Complete Passes per Insertion: 1
- Driving Side Maximum Convex Angle: 5 °
- Resisting Side Maximum Convex Angle: 1 °

Materials

Clay Loam

Model: Mohr-Coulomb
Unit Weight: 120 pcf
Cohesion: 1600 psf
Phi: 0 °
Phi-B: 0 °
Pore Water Pressure
Piezometric Line: 1

Clay Loam/Loam

Model: Mohr-Coulomb
Unit Weight: 125 pcf
Cohesion: 930 psf
Phi: 0 °
Phi-B: 0 °
Pore Water Pressure
Piezometric Line: 1

Clay

Model: Mohr-Coulomb
Unit Weight: 125 pcf
Cohesion: 1700 psf
Phi: 0 °
Phi-B: 0 °
Pore Water Pressure
Piezometric Line: 1

Sandy Clay

Model: Mohr-Coulomb
Unit Weight: 120 pcf
Cohesion: 1800 psf
Phi: 0 °
Phi-B: 0 °
Pore Water Pressure
Piezometric Line: 1

Sandy Loam

Model: Mohr-Coulomb
Unit Weight: 115 pcf
Cohesion: 100 psf
Phi: 0 °
Phi-B: 0 °
Pore Water Pressure
Piezometric Line: 1

Sandstone

Model: Mohr-Coulomb
Unit Weight: 145 pcf
Cohesion: 0 psf
Phi: 45 °
Phi-B: 0 °
Pore Water Pressure
Piezometric Line: 1

Slip Surface Entry and Exit

Left Projection: Range
Left-Zone Left Coordinate: (5, 624.00962) ft
Left-Zone Right Coordinate: (34.49545, 628.25) ft
Left-Zone Increment: 10
Right Projection: Range
Right-Zone Left Coordinate: (74.6424, 648.30769) ft
Right-Zone Right Coordinate: (100, 648.30769) ft
Right-Zone Increment: 10
Radius Increments: 4

Slip Surface Limits

Left Coordinate: (0, 624.00962) ft
Right Coordinate: (140, 648.30769) ft

Piezometric Lines

Piezometric Line 1

Coordinates

	X (ft)	Y (ft)
	0	623
	140	623

Seismic Loads

Horz Seismic Load: 0.061
Ignore seismic load in strength: No

Regions

	Material	Points	Area (ft²)
Region 1	Clay Loam	1,2,3,4	577.2375
Region 2	Clay Loam/Loam	4,3,5,6	671.89901
Region 3	Clay	6,5,7,8,9,10	1429.9583
Region 4	Sandy Clay	8,7,11,12	706.7312
Region 5	Sandy Loam	12,11,13,14	188.461
Region 6	Sandstone	14,13,15,16	3364.039

Points

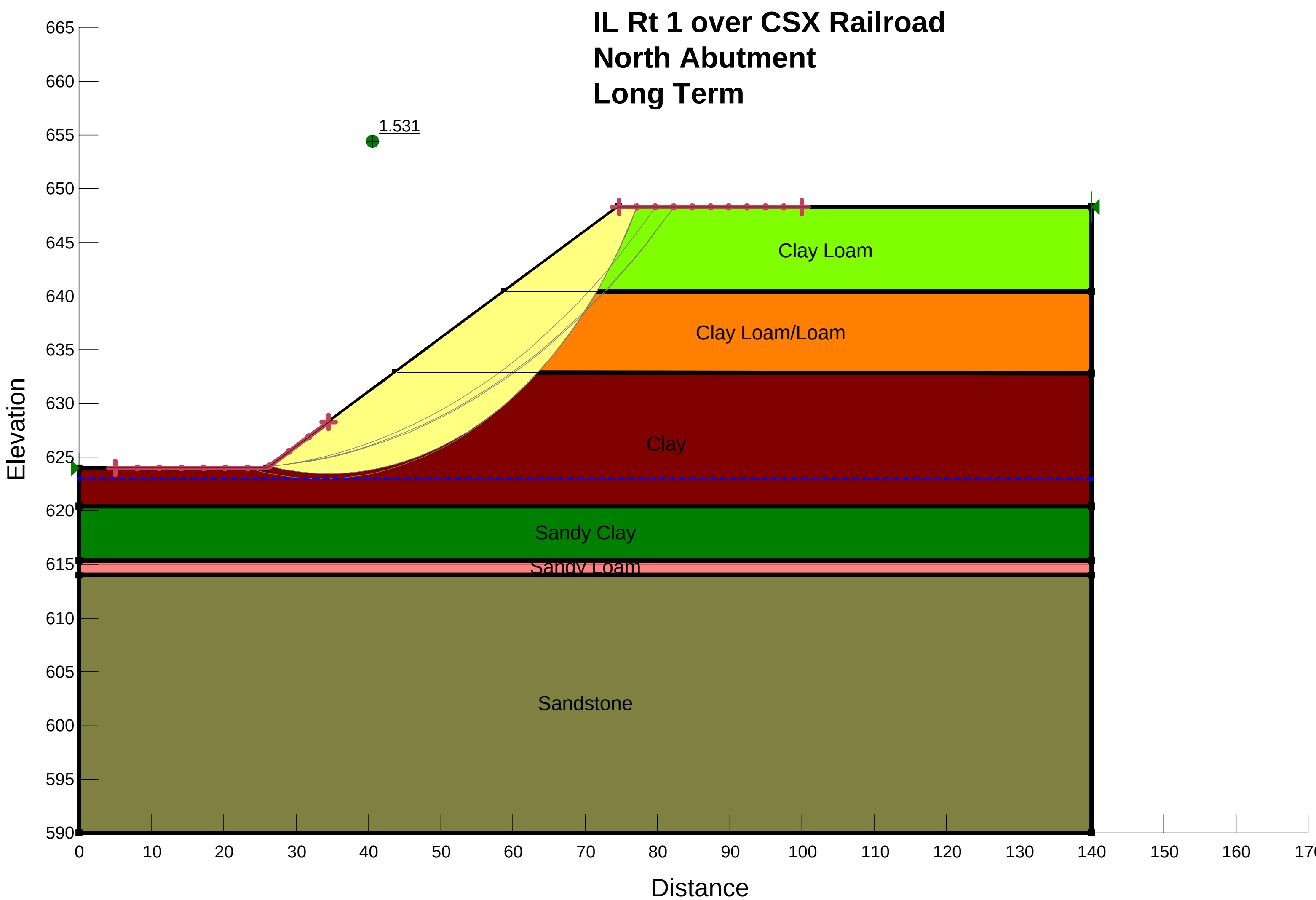
	X (ft)	Y (ft)
Point 1	74.6	648.30769
Point 2	140	648.30769
Point 3	140	640.43269
Point 4	58.8	640.43269
Point 5	140	632.82692
Point 6	43.8	632.89423
Point 7	140	620.44231
Point 8	0	620.44231
Point 9	0	624.00962
Point 10	26	624.00962
Point 11	140	615.39423
Point 12	0	615.39423
Point 13	140	614.04808
Point 14	0	614.04808
Point 15	140	590.01923
Point 16	0	590.01923

Critical Slip Surfaces

	Slip Surface	FOS	Center (ft)	Radius (ft)	Entry (ft)	Exit (ft)
1	319	2.378	(49.249, 661.788)	47.627	(94.9285, 648.308)	(20.2475, 624.01)

Slices of Slip Surface: 319

	Slip Surface	X (ft)	Y (ft)	PWP (psf)	Base Normal Stress (psf)	Frictional Strength (psf)	Cohesive Strength (psf)
1	319	20.929875	623.5048	-31.500158	591.86864	0	1700
2	319	22.61155	622.3255	42.090778	693.01104	0	1700
3	319	24.61007	621.04665	121.88856	802.67138	0	1700
4	319	25.804665	620.33185	166.49381	887.19012	0	1800
5	319	27.248195	619.5709	213.97791	1022.7857	0	1800
6	319	29.74459	618.3598	289.55083	1269.377	0	1800
7	319	32.240985	617.32175	354.32343	1499.2607	0	1800
8	319	34.73738	616.4448	409.0599	1712.9622	0	1800
9	319	37.233775	615.71975	454.27941	1910.9194	0	1800
10	319	39.81148	615.1253	491.36408	1952.8497	0	100
11	319	42.470495	614.66515	520.10396	2169.1968	0	100
12	319	45.05	614.3632	538.93127	2363.0738	0	100
13	319	47.55	614.2079	548.61021	2535.7832	0	100
14	319	50.05	614.1843	550.08211	2693.3386	0	100
15	319	52.55	614.29215	543.36939	2835.7601	0	100
16	319	55.05	614.53245	528.35417	2962.9203	0	100
17	319	57.55	614.90725	504.98546	3074.6174	0	100
18	319	59.40834	615.2614	482.88782	3147.0095	0	100
19	319	61.30394	615.73115	453.58333	3015.7974	0	1800
20	319	63.878465	616.48375	406.62712	3033.1626	0	1800
21	319	66.452995	617.3983	349.54643	3028.4801	0	1800
22	319	69.027525	618.48515	281.72731	2999.688	0	1800
23	319	71.602055	619.7577	202.31984	2944.1247	0	1800
24	319	73.74466	620.9554	127.58116	2899.7131	0	1700
25	319	75.74318	622.23425	47.782054	2741.0088	0	1700
26	319	78.16147	623.97495	-60.838949	2455.6744	0	1700
27	319	80.711695	626.0732	-191.77015	2110.2484	0	1700
28	319	83.26192	628.49935	-343.17013	1706.3334	0	1700
29	319	85.812145	631.33305	-519.99092	1224.3126	0	1700
30	319	88.27043	634.55955	-721.31539	1118.7547	0	930
31	319	90.636775	638.34395	-957.45512	515.77065	0	930
32	319	93.374215	644.3702	-1333.519	-1231.8219	0	1600


IL Rt 1 over CSX Railroad
North Abutment
Long Term
1.531
Clay Loam
Clay Loam/Loam
Clay
Sandy Clay
Sandy Loam
Sandstone
Elevation
Distance
665
660
655
650
645
640
635
630
625
620
615
610
605
600
595
590
0
10
20
30
40
50
60
70
80
90
100
110
120
130
140
150
160
170

SLOPE/W Analysis

Project Settings

Length(L) Units: feet
Time(t) Units: Seconds
Force(F) Units: lbf
Pressure(p) Units: psf
Strength Units: psf
Unit Weight of Water: 62.4 pcf
View: 2D

Analysis Settings

SLOPE/W Analysis

Description: IL 1 over CSX RR Clark County, IL North Abutment
Kind: SLOPE/W
Method: Bishop, Ordinary and Janbu
Settings
- Apply Phreatic Correction: No
- PWP Conditions Source: Piezometric Line
- Use Staged Rapid Drawdown: No

SlipSurface
- Direction of movement: Right to Left
- Use Passive Mode: No
- Slip Surface Option: Entry and Exit
- Critical slip surfaces saved: 1
- Optimize Critical Slip Surface Location: No
- Tension Crack
  - Tension Crack Option: (none)

FOS Distribution
- FOS Calculation Option: Constant

Advanced
- Number of Slices: 30
- Optimization Tolerance: 0.01
- Minimum Slip Surface Depth: 0.1 ft
- Optimization Maximum Iterations: 2000
- Optimization Convergence Tolerance: 1e-007
- Starting Optimization Points: 8
- Ending Optimization Points: 16
- Complete Passes per Insertion: 1
- Driving Side Maximum Convex Angle: 5 °
- Resisting Side Maximum Convex Angle: 1 °

Materials

Clay Loam

Model: Mohr-Coulomb
Unit Weight: 120 pcf
Cohesion: 100 psf
Phi: 26 °
Phi-B: 0 °
Pore Water Pressure
Piezometric Line: 1

Clay Loam/Loam

Model: Mohr-Coulomb
Unit Weight: 125 pcf
Cohesion: 100 psf
Phi: 26 °
Phi-B: 0 °
Pore Water Pressure
Piezometric Line: 1

Clay

Model: Mohr-Coulomb
Unit Weight: 125 pcf
Cohesion: 100 psf
Phi: 26 °
Phi-B: 0 °
Pore Water Pressure
Piezometric Line: 1

Sandy Clay

Model: Mohr-Coulomb
Unit Weight: 120 pcf
Cohesion: 100 psf
Phi: 30 °
Phi-B: 0 °
Pore Water Pressure
Piezometric Line: 1

Sandy Loam

Model: Mohr-Coulomb
Unit Weight: 115 pcf
Cohesion: 100 psf
Phi: 30 °
Phi-B: 0 °
Pore Water Pressure
Piezometric Line: 1

Sandstone

Model: Mohr-Coulomb
Unit Weight: 145 pcf
Cohesion: 0 psf
Phi: 45 °
Phi-B: 0 °
Pore Water Pressure
Piezometric Line: 1

Slip Surface Entry and Exit

Left Projection: Range
Left-Zone Left Coordinate: (5, 624.00962) ft
Left-Zone Right Coordinate: (34.49545, 628.25) ft
Left-Zone Increment: 10
Right Projection: Range
Right-Zone Left Coordinate: (74.6424, 648.30769) ft
Right-Zone Right Coordinate: (100, 648.30769) ft
Right-Zone Increment: 10
Radius Increments: 4

Slip Surface Limits

Left Coordinate: (0, 624.00962) ft
Right Coordinate: (140, 648.30769) ft

Piezometric Lines

Piezometric Line 1

Coordinates

	X (ft)	Y (ft)
	0	623
	140	623

Regions

	Material	Points	Area (ft²)
Region 1	Clay Loam	1,2,3,4	577.2375
Region 2	Clay Loam/Loam	4,3,5,6	671.89901
Region 3	Clay	6,5,7,8,9,10	1429.9583

Region 4	Sandy Clay	8,7,11,12	706.7312
Region 5	Sandy Loam	12,11,13,14	188.461
Region 6	Sandstone	14,13,15,16	3364.039

Points

	X (ft)	Y (ft)
Point 1	74.6	648.30769
Point 2	140	648.30769
Point 3	140	640.43269
Point 4	58.8	640.43269
Point 5	140	632.82692
Point 6	43.8	632.89423
Point 7	140	620.44231
Point 8	0	620.44231
Point 9	0	624.00962
Point 10	26	624.00962
Point 11	140	615.39423
Point 12	0	615.39423
Point 13	140	614.04808
Point 14	0	614.04808
Point 15	140	590.01923
Point 16	0	590.01923

Critical Slip Surfaces

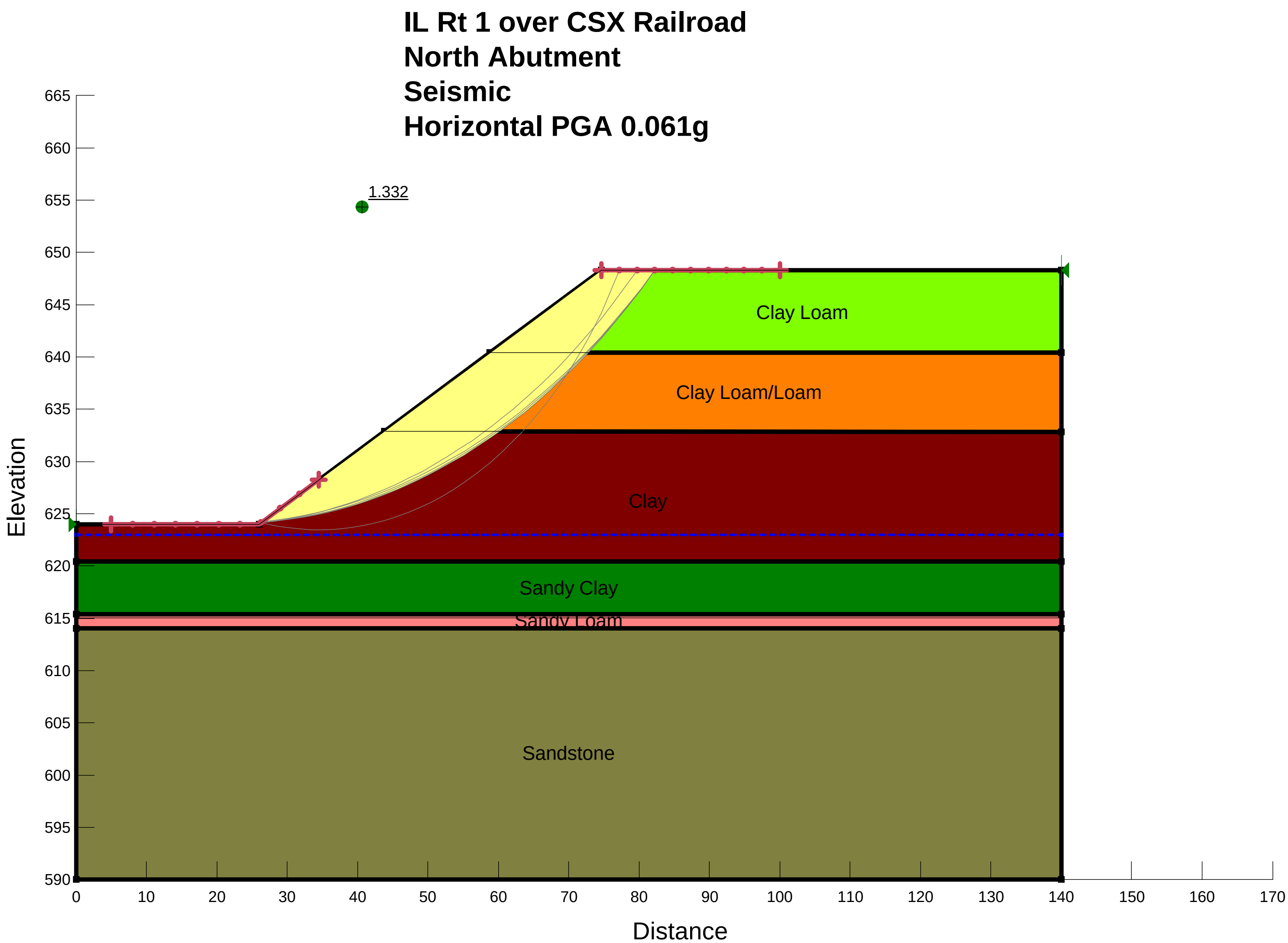
	Slip Surface	FOS	Center (ft)	Radius (ft)	Entry (ft)	Exit (ft)
1	393	1.531	(34.56, 672.441)	48.976	(77.1782, 648.308)	(26.31, 624.164)

Slices of Slip Surface: 393

	Slip Surface	X (ft)	Y (ft)	PWP (psf)	Base Normal Stress (psf)	Frictional Strength (psf)	Cohesive Strength (psf)
1	393	27.18448	624.0311	-64.340287	85.293414	41.600378	100

2	393	28.93348	623.7967	-49.713603	225.48299	109.9754	100
3	393	30.68248	623.62605	-39.066681	354.22935	172.7692	100
4	393	32.431485	623.51855	-32.356977	472.03394	230.22634	100
5	393	34.18049	623.4737	-29.558819	579.34142	282.56369	100
6	393	35.92949	623.49135	-30.662073	676.46423	329.93365	100
7	393	37.67849	623.5716	-35.670126	763.74034	372.50105	100
8	393	39.427495	623.71475	-44.602453	841.38075	410.36881	100
9	393	41.1765	623.92135	-57.495292	909.5915	443.63742	100
10	393	42.9255	624.19225	-74.396018	968.45521	472.34717	100
11	393	44.633335	624.51905	-94.786702	1017.5053	496.27048	100
12	393	46.3	624.9	-118.55679	1057.1843	515.62323	100
13	393	47.966665	625.343	-146.20237	1088.5397	530.91629	100
14	393	49.633335	625.8498	-177.82563	1111.4815	542.10577	100
15	393	51.3	626.4225	-213.56519	1126.072	549.22202	100
16	393	52.966665	627.06365	-253.56938	1132.1273	552.17538	100
17	393	54.633335	627.7762	-298.0337	1129.5159	550.90171	100
18	393	56.3	628.5636	-347.16775	1118.0507	545.30976	100
19	393	57.966665	629.43	-401.23301	1097.4579	535.26598	100
20	393	59.57228	630.3423	-458.16062	1067.0173	520.41909	100
21	393	61.116835	631.2996	-517.8991	1027.1493	500.97419	100

22	393	62.66139	632.3393	-582.75726	978.72043	477.35385	100
23	393	64.25331	633.5056	-655.56102	919.24061	448.3436	100
24	393	65.892595	634.8132	-737.15476	847.73969	413.47027	100
25	393	67.531885	636.24225	-826.3367	764.95788	373.09488	100
26	393	69.171175	637.80795	-924.02938	670.14244	326.85031	100
27	393	70.81046	639.5299	-1031.4706	562.29603	274.2501	100
28	393	72.372575	641.33525	-1144.1237	450.11128	219.53394	100
29	393	73.857525	643.2369	-1262.768	333.52467	162.67085	100
30	393	75.24454	645.19855	-1385.1842	186.88096	91.147932	100
31	393	76.53362	647.2344	-1512.2088	13.185499	6.4309976	100


IL Rt 1 over CSX Railroad
North Abutment
Seismic
Horizontal PGA 0.061g
1.332
Clay Loam
Clay Loam/Loam
Clay
Sandy Clay
Sandy Loam
Sandstone
Elevation
Distance
665
660
655
650
645
640
635
630
625
620
615
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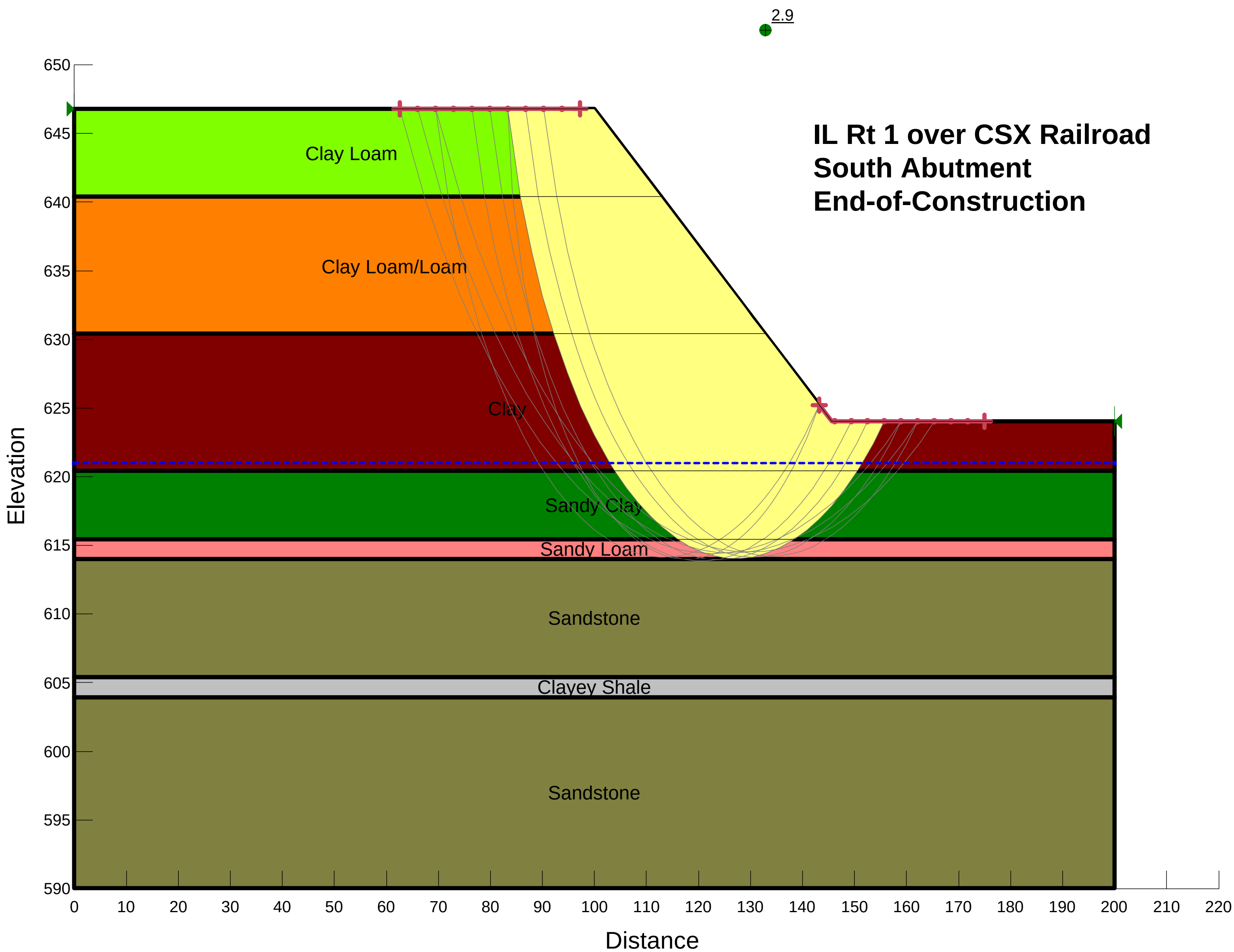

2.9
IL Rt 1 over CSX Railroad
South Abutment
End-of-Construction
Clay Loam
Clay Loam/Loam
Clay
Sandy Clay
Sandy Loam
Sandstone
Clayey Shale
Sandstone
Elevation
Distance
650
645
640
635
630
625
620
615
610
605
600
595
590
0 10 20 30 40 50 60 70 80 90 100 110 120 130 140 150 160 170 180 190 200 210 220

SLOPE/W Analysis

Project Settings

Length(L) Units: feet
Time(t) Units: Seconds
Force(F) Units: lbf
Pressure(p) Units: psf
Strength Units: psf
Unit Weight of Water: 62.4 pcf
View: 2D

Analysis Settings

SLOPE/W Analysis

Description: IL Rte 1 over CSX Railraod South Abutment
Kind: SLOPE/W
Method: Bishop, Ordinary and Janbu
Settings
- Apply Phreatic Correction: No
- PWP Conditions Source: Piezometric Line
- Use Staged Rapid Drawdown: No

SlipSurface
- Direction of movement: Left to Right
- Use Passive Mode: No
- Slip Surface Option: Entry and Exit
- Critical slip surfaces saved: 1
- Optimize Critical Slip Surface Location: No
- Tension Crack
  - Tension Crack Option: (none)

FOS Distribution
- FOS Calculation Option: Constant

Advanced
- Number of Slices: 30
- Optimization Tolerance: 0.01
- Minimum Slip Surface Depth: 0.1 ft
- Optimization Maximum Iterations: 2000
- Optimization Convergence Tolerance: 1e-007
- Starting Optimization Points: 8
- Ending Optimization Points: 16
- Complete Passes per Insertion: 1
- Driving Side Maximum Convex Angle: 5 °
- Resisting Side Maximum Convex Angle: 1 °

Materials

Clay Loam

Model: Mohr-Coulomb
Unit Weight: 120 pcf
Cohesion: 1600 psf
Phi: 0 °
Phi-B: 0 °
Pore Water Pressure
    Piezometric Line: 1

Clay Loam/Loam

Model: Mohr-Coulomb
Unit Weight: 120 pcf
Cohesion: 1125 psf
Phi: 0 °
Phi-B: 0 °
Pore Water Pressure
    Piezometric Line: 1

Clay

Model: Mohr-Coulomb
Unit Weight: 125 pcf
Cohesion: 1700 psf
Phi: 0 °
Phi-B: 0 °
Pore Water Pressure
    Piezometric Line: 1

Sandy Clay

Model: Mohr-Coulomb
Unit Weight: 115 pcf
Cohesion: 1800 psf
Phi: 0 °
Phi-B: 0 °
Pore Water Pressure
    Piezometric Line: 1

Sandy Loam

Model: Mohr-Coulomb
Unit Weight: 115 pcf
Cohesion: 100 psf
Phi: 0 °
Phi-B: 0 °
Pore Water Pressure
    Piezometric Line: 1

Sandstone

Model: Mohr-Coulomb
Unit Weight: 145 pcf
Cohesion: 0 psf
Phi: 45 °
Phi-B: 0 °
Pore Water Pressure
Piezometric Line: 1

Clayey Shale

Model: Mohr-Coulomb
Unit Weight: 125 pcf
Cohesion: 300 psf
Phi: 12 °
Phi-B: 0 °
Pore Water Pressure
Piezometric Line: 1

Slip Surface Entry and Exit

Left Projection: Range
Left-Zone Left Coordinate: (62.5373, 646.8101) ft
Left-Zone Right Coordinate: (97.2, 646.8101) ft
Left-Zone Increment: 10
Right Projection: Range
Right-Zone Left Coordinate: (143.21059, 625.21244) ft
Right-Zone Right Coordinate: (175, 624.01803) ft
Right-Zone Increment: 10
Radius Increments: 4

Slip Surface Limits

Left Coordinate: (0, 646.8101) ft
Right Coordinate: (200, 624.01803) ft

Piezometric Lines

Piezometric Line 1

Coordinates

	X (ft)	Y (ft)
	0	621
	200	621

Regions

	Material	Points	Area (ft²)
Region 1	Clay Loam	1,2,3,4	680.79402
Region 2	Clay Loam/Loam	4,3,5,6	1227.4093
Region 3	Clay	6,5,7,8,9,10	1610.0148
Region 4	Sandy Clay	10,9,11,12	999.518
Region 5	Sandy Loam	12,11,13,14	280.168
Region 6	Sandstone	14,13,15,16	1718.87
Region 7	Clayey Shale	16,15,17,18	302.886
Region 8	Sandstone	18,17,19,20	2778.966

Points

	X (ft)	Y (ft)
Point 1	0	646.8101
Point 2	100	646.8101
Point 3	112.8	640.41166
Point 4	0	640.41166
Point 5	132.8	630.41647
Point 6	0	630.41647
Point 7	145.6	624.01803
Point 8	200	624.01803
Point 9	200	620.42127
Point 10	0	620.42127
Point 11	200	615.42368
Point 12	0	615.42368
Point 13	200	614.02284
Point 14	0	614.02284
Point 15	200	605.42849
Point 16	0	605.42849
Point 17	200	603.91406
Point 18	0	603.91406
Point 19	200	590.01923
Point 20	0	590.01923

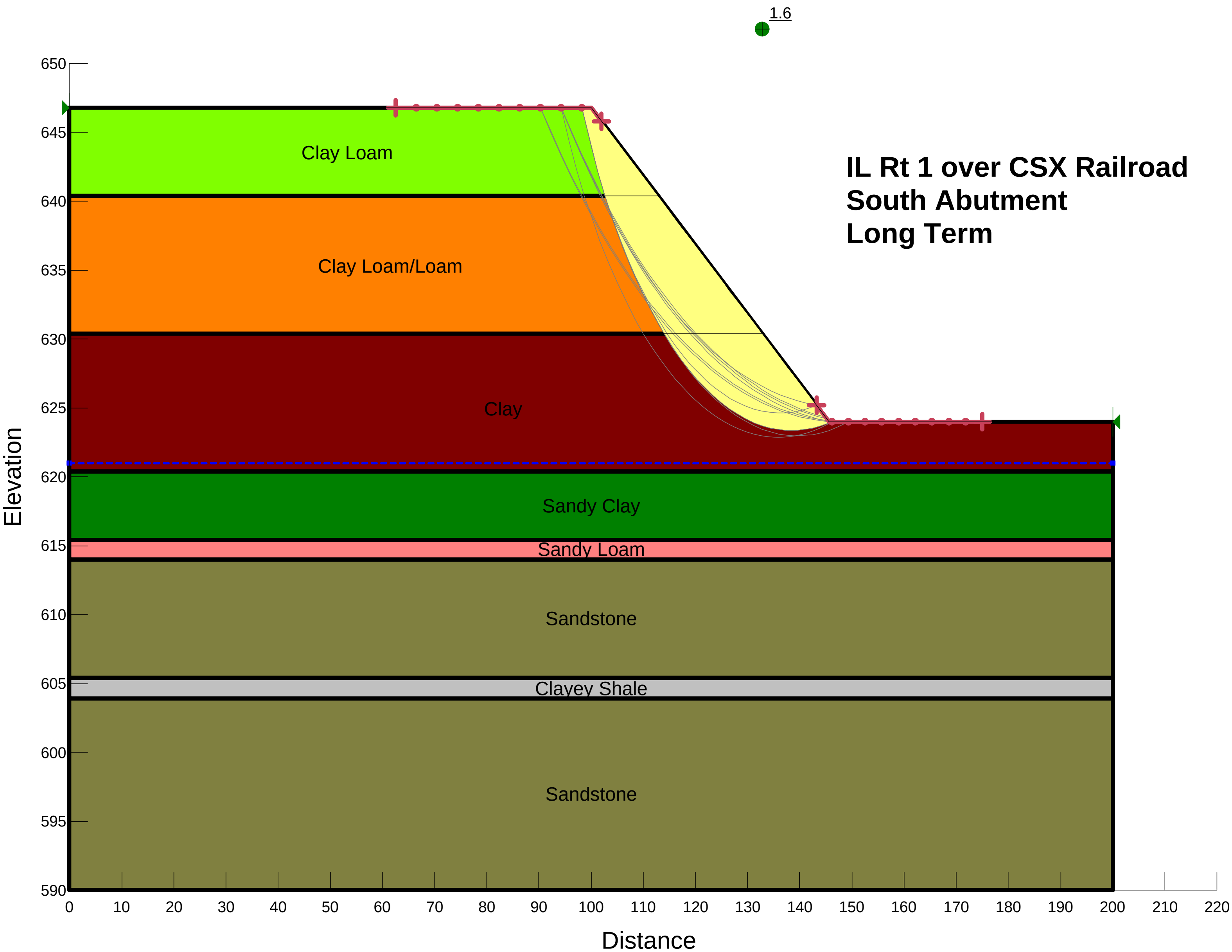
Critical Slip Surfaces

	Slip Surface	FOS	Center (ft)	Radius (ft)	Entry (ft)	Exit (ft)
1	354	2.9	(127.228, 659.824)	45.782	(83.3349, 646.81)	(155.757, 624.018)

Slices of Slip Surface: 354

	Slip Surface	X (ft)	Y (ft)	PWP (psf)	Base Normal Stress (psf)	Frictional Strength (psf)	Cohesive Strength (psf)
1	354	84.550285	643.6109	-1410.9235	-1054.1456	0	1600
2	354	86.82805	638.40755	-1086.2337	283.69307	0	1125
3	354	88.952845	634.77975	-859.86577	856.59318	0	1125
4	354	91.07764	631.7863	-673.05621	1307.5779	0	1125
5	354	93.45003	628.9818	-498.07236	1510.8684	0	1700
6	354	96.070015	626.3285	-332.50593	1938.2765	0	1700
7	354	98.690005	624.06445	-191.22357	2298.0002	0	1700
8	354	101.48275	622.0095	-62.992517	2533.9722	0	1700
9	354	103.4413	620.71065	18.05648	2621.0671	0	1700
10	354	105.02745	619.8053	74.548641	2644.9568	0	1800
11	354	107.2482	618.6505	146.61062	2687.2335	0	1800
12	354	109.46895	617.6442	209.40209	2709.2454	0	1800
13	354	111.68965	616.7759	263.58368	2712.7971	0	1800
14	354	114.43305	615.8994	318.29281	2691.8789	0	1800
15	354	117.2614	615.157	364.60464	2779.0366	0	100
16	354	119.65195	614.68965	393.76731	2691.3009	0	100
17	354	122.0425	614.3527	414.79274	2588.5218	0	100
18	354	124.43305	614.14325	427.84594	2471.0431	0	100
19	354	126.8236	614.05955	433.10505	2339.1187	0	100
20	354	129.21415	614.1009	430.49911	2192.783	0	100
21	354	131.6047	614.26765	420.10246	2032.0151	0	100
22	354	134.1975	614.59785	399.50015	1837.0359	0	100
23	354	136.99255	615.11845	367.01288	1604.7201	0	100
24	354	139.59175	615.76085	326.92339	1533.4199	0	1800
25	354	141.99505	616.50765	280.3212	1334.4371	0	1800
26	354	144.39835	617.4037	224.40963	1120.4475	0	1800

27	354	146.8348	618.4756	157.52292	964.7927	0	1800
28	354	149.30435	619.7412	78.550243	866.30143	0	1800
29	354	151.0149	620.71065	18.05648	766.42398	0	1700
30	354	152.55735	621.7088	-44.230892	674.37568	0	1700
31	354	154.6906	623.2178	-138.39277	535.5047	0	1700



1.6
IL Rt 1 over CSX Railroad
South Abutment
Long Term
Clay Loam
Clay Loam/Loam
Clay
Sandy Clay
Sandy Loam
Sandstone
Clayey Shale
Sandstone
Elevation
Distance
650
645
640
635
630
625
620
615
610
605
600
595
590
0
10
20
30
40
50
60
70
80
90
100
110
120
130
140
150
160
170
180
190
200
210
220

SLOPE/W Analysis

Project Settings

Length(L) Units: feet
Time(t) Units: Seconds
Force(F) Units: lbf
Pressure(p) Units: psf
Strength Units: psf
Unit Weight of Water: 62.4 pcf
View: 2D

Analysis Settings

SLOPE/W Analysis

Description: IL Rte 1 over CSX Railraod South Abutment
Kind: SLOPE/W
Method: Bishop, Ordinary and Janbu
Settings
- Apply Phreatic Correction: No
- PWP Conditions Source: Piezometric Line
- Use Staged Rapid Drawdown: No

SlipSurface
- Direction of movement: Left to Right
- Use Passive Mode: No
- Slip Surface Option: Entry and Exit
- Critical slip surfaces saved: 1
- Optimize Critical Slip Surface Location: No
- Tension Crack
  - Tension Crack Option: (none)

FOS Distribution
- FOS Calculation Option: Constant

Advanced
- Number of Slices: 30
- Optimization Tolerance: 0.01
- Minimum Slip Surface Depth: 0.1 ft
- Optimization Maximum Iterations: 2000
- Optimization Convergence Tolerance: 1e-007
- Starting Optimization Points: 8
- Ending Optimization Points: 16
- Complete Passes per Insertion: 1
- Driving Side Maximum Convex Angle: 5 °
- Resisting Side Maximum Convex Angle: 1 °

Materials

Clay Loam

Model: Mohr-Coulomb
Unit Weight: 120 pcf
Cohesion: 100 psf
Phi: 26 °
Phi-B: 0 °
Pore Water Pressure
Piezometric Line: 1

Clay Loam/Loam

Model: Mohr-Coulomb
Unit Weight: 120 pcf
Cohesion: 100 psf
Phi: 26 °
Phi-B: 0 °
Pore Water Pressure
Piezometric Line: 1

Clay

Model: Mohr-Coulomb
Unit Weight: 125 pcf
Cohesion: 100 psf
Phi: 26 °
Phi-B: 0 °
Pore Water Pressure
Piezometric Line: 1

Sandy Clay

Model: Mohr-Coulomb
Unit Weight: 115 pcf
Cohesion: 100 psf
Phi: 30 °
Phi-B: 0 °
Pore Water Pressure
Piezometric Line: 1

Sandy Loam

Model: Mohr-Coulomb
Unit Weight: 115 pcf
Cohesion: 50 psf
Phi: 30 °
Phi-B: 0 °
Pore Water Pressure
Piezometric Line: 1

Sandstone

Model: Mohr-Coulomb
Unit Weight: 145 pcf
Cohesion: 0 psf
Phi: 45 °
Phi-B: 0 °
Pore Water Pressure
Piezometric Line: 1

Clayey Shale

Model: Mohr-Coulomb
Unit Weight: 125 pcf
Cohesion: 300 psf
Phi: 12 °
Phi-B: 0 °
Pore Water Pressure
Piezometric Line: 1

Slip Surface Entry and Exit

Left Projection: Range
Left-Zone Left Coordinate: (62.5373, 646.8101) ft
Left-Zone Right Coordinate: (102, 645.81034) ft
Left-Zone Increment: 10
Right Projection: Range
Right-Zone Left Coordinate: (143.21059, 625.21244) ft
Right-Zone Right Coordinate: (175, 624.01803) ft
Right-Zone Increment: 10
Radius Increments: 4

Slip Surface Limits

Left Coordinate: (0, 646.8101) ft
Right Coordinate: (200, 624.01803) ft

Piezometric Lines

Piezometric Line 1

Coordinates

	X (ft)	Y (ft)
	0	621
	200	621

Regions

	Material	Points	Area (ft^2)
Region 1	Clay Loam	1,2,3,4	680.79402
Region 2	Clay Loam/Loam	4,3,5,6	1227.4093
Region 3	Clay	6,5,7,8,9,10	1610.0148
Region 4	Sandy Clay	10,9,11,12	999.518
Region 5	Sandy Loam	12,11,13,14	280.168
Region 6	Sandstone	14,13,15,16	1718.87
Region 7	Clayey Shale	16,15,17,18	302.886
Region 8	Sandstone	18,17,19,20	2778.966

Points

	X (ft)	Y (ft)
Point 1	0	646.8101
Point 2	100	646.8101
Point 3	112.8	640.41166
Point 4	0	640.41166
Point 5	132.8	630.41647
Point 6	0	630.41647
Point 7	145.6	624.01803
Point 8	200	624.01803
Point 9	200	620.42127
Point 10	0	620.42127
Point 11	200	615.42368
Point 12	0	615.42368
Point 13	200	614.02284
Point 14	0	614.02284
Point 15	200	605.42849
Point 16	0	605.42849
Point 17	200	603.91406
Point 18	0	603.91406
Point 19	200	590.01923
Point 20	0	590.01923

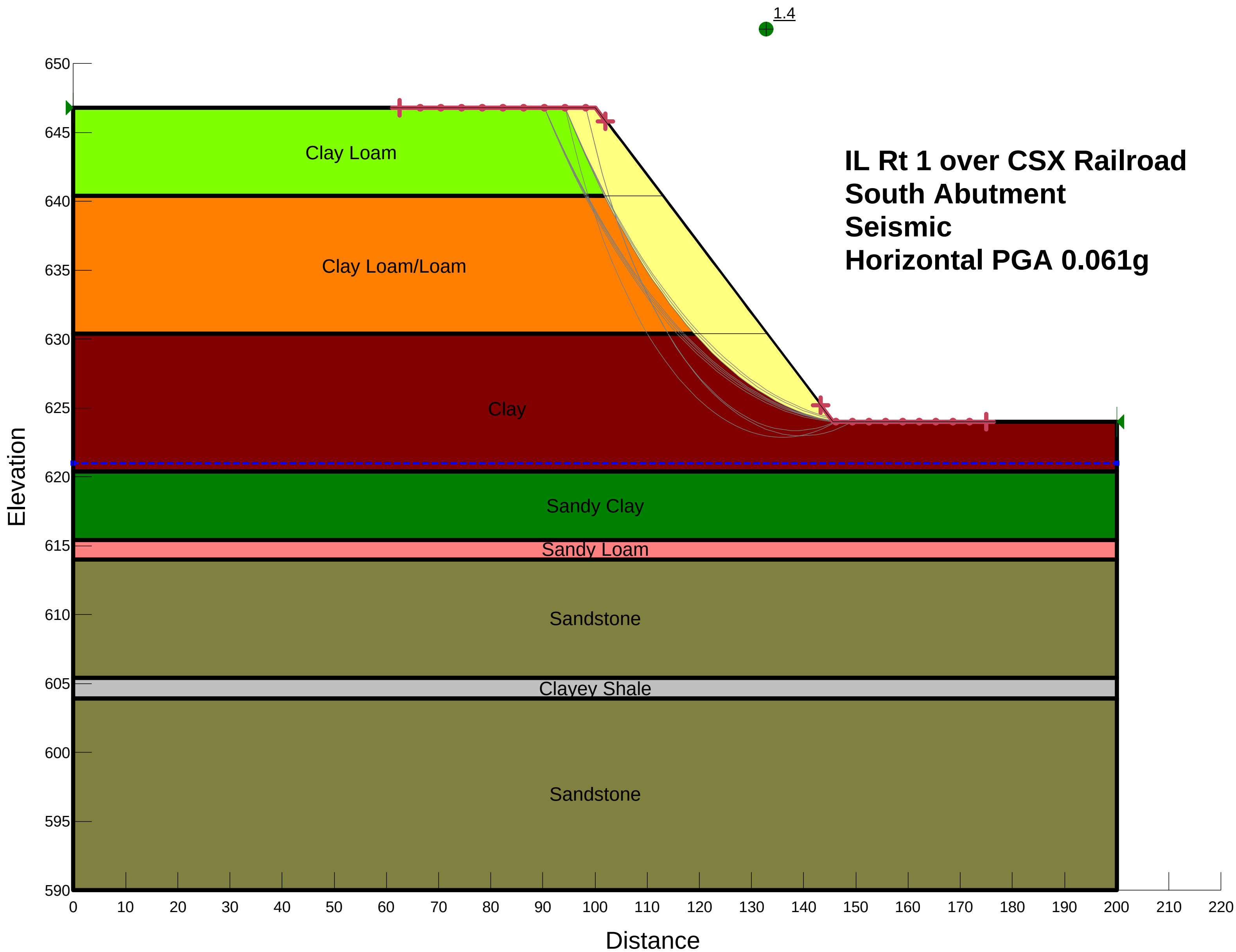
Critical Slip Surfaces

	Slip Surface	FOS	Center (ft)	Radius (ft)	Entry (ft)	Exit (ft)
1	503	1.6	(138.45, 669.541)	46.167	(98.2661, 646.81)	(146.136, 624.018)

Slices of Slip Surface: 503

	Slip Surface	X (ft)	Y (ft)	PWP (psf)	Base Normal Stress (psf)	Frictional Strength (psf)	Cohesive Strength (psf)
1	503	99.133045	645.39825	-1522.4512	43.624066	21.276879	100
2	503	100.65805	643.04775	-1375.762	222.53743	108.53876	100
3	503	101.97415	641.2604	-1264.2274	332.26359	162.05578	100
4	503	103.4795	639.4277	-1149.8812	443.272	216.1982	100
5	503	105.1741	637.56205	-1033.468	554.04516	270.22588	100
6	503	106.86875	635.8853	-928.83254	649.77398	316.91594	100
7	503	108.5634	634.3702	-834.27915	731.79857	356.92201	100
8	503	110.25805	632.99655	-748.58979	801.15274	390.7483	100
9	503	111.9527	631.7488	-670.73657	858.68969	418.81095	100
10	503	113.3704	630.7856	-610.62394	898.9915	438.46745	100
11	503	114.7266	629.9457	-558.21615	931.23358	454.19296	100
12	503	116.2982	629.04505	-502.01077	962.62273	469.50248	100
13	503	117.8698	628.2238	-450.76699	985.26965	480.54812	100
14	503	119.4414	627.4773	-404.18296	999.41146	487.44554	100
15	503	121.013	626.8016	-362.02123	1005.3265	490.3305	100

16	503	122.5846	626.1934	-324.0712	1003.1358	489.26204	100
17	503	124.1562	625.6499	-290.156	993.02108	484.32874	100
18	503	125.7278	625.1687	-260.12941	974.97304	475.52613	100
19	503	127.2994	624.7478	-233.86613	949.20901	462.96017	100
20	503	128.871	624.3855	-211.25779	915.61639	446.57595	100
21	503	130.4426	624.0804	-192.21827	874.3005	426.42485	100
22	503	132.0142	623.83135	-176.68096	825.21684	402.48515	100
23	503	133.6	623.6362	-164.50329	765.67651	373.44539	100
24	503	135.2	623.49525	-155.7002	695.45755	339.19731	100
25	503	136.8	623.4102	-150.39759	616.71819	300.79356	100
26	503	138.4	623.3807	-148.55616	529.31217	258.16279	100
27	503	140	623.4067	-150.17774	432.98688	211.18181	100
28	503	141.6	623.4883	-155.26841	327.466	159.71584	100
29	503	143.2	623.6258	-163.85045	212.40379	103.59625	100
30	503	144.8	623.8197	-175.94861	87.398583	42.627137	100
31	503	145.8679	623.9744	-185.60432	16.663864	8.1275094	100



1.4
IL Rt 1 over CSX Railroad
South Abutment
Seismic
Horizontal PGA 0.061g
Clay Loam
Clay Loam/Loam
Clay
Sandy Clay
Sandy Loam
Sandstone
Clayey Shale
Sandstone
Elevation
Distance
650
645
640
635
630
625
620
615
610
605
600
595
590
0
10
20
30
40
50
60
70
80
90
100
110
120
130
140
150
160
170
180
190
200
210
220

EXHIBIT F

PILE LENGTH/PILE TYPE

IDOT STATIC METHOD OF ESTIMATING PILE LENGTH

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

Modified 10/18/2011

SUBSTRUCTURE============================== North Abutment
REFERENCE BORING ========================== B-3
LRFD or ASD or SEISMIC ======================== LRFD
PILE CUTOFF ELEV. =========================== 648.33 ft
GROUND SURFACE ELEV. AGAINST PILE DURING DR 643.33 ft
GEOTECHNICAL LOSS TYPE (None, Scour, Liquef., DD None
BOTTOM ELEV. OF SCOUR, LIQUEF., or DD ======== 0.00 ft
TOP ELEV. OF LIQUEF. (so layers above apply DD) === 0.00 ft

TOTAL FACTORED SUBSTRUCTURE LOAD ======== 1400 kips
TOTAL LENGTH OF SUBSTRUCTURE (along skew)=== 58.16 ft
NUMBER OF ROWS OF PILES PER SUBSTRUCTURE = 1
Approx. Factored Loading Applied per pile at 8 ft. Cts ===== 192.57 KIPS
Approx. Factored Loading Applied per pile at 3 ft. Cts ===== 72.21 KIPS

PILE TYPE AND SIZE ========== Steel HP 12 X 53
Plugged Pile Perimeter==================== 3.967 FT. Unplugged Pile Perimeter=========== 5.800 FT.
Plugged Pile End Bearing Area============= 0.983 SQFT. Unplugged Pile End Bearing Area===== 0.108 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
418 KIPS	**418** KIPS	**230** KIPS	**34** 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.)
638.81	4.52	0.50	2		7.0		23.5	10.2		***12.0***	12	0	0	7	10
636.31	2.50	1.20	3		8.1	16.5	23.4	11.9	1.8	***23.0***	23	0	0	13	12
633.81	2.50	0.60	7		4.6	8.3	30.7	6.7	0.9	***30.0***	30	0	0	16	15
631.31	2.50	0.80	3		5.9	11.0	49.0	8.6	1.2	***39.9***	40	0	0	22	17
628.81	2.50	1.70	8		10.4	23.4	***52.4***	15.2	2.6	54.3	52	0	0	29	20
626.31	2.50	1.20	4		8.1	16.5	***60.6***	11.9	1.8	66.2	61	0	0	33	22
623.81	2.50	1.20	7		8.1	16.5	***63.2***	11.9	1.8	77.5	63	0	0	35	25
621.31	2.50	0.80	7		5.9	11.0	110.4	8.6	1.2	***90.6***	91	0	0	50	27
616.31	5.00	3.80	10		36.1	52.4	293.2	52.9	5.7	***159.5***	159	0	0	88	32
616.06	0.25			Sandstone	20.6	199.1	313.8	30.1	21.8	***189.6***	190	0	0	104	32.3
615.81	0.25			Sandstone	20.6	199.1	334.4	30.1	21.8	***219.7***	220	0	0	121	32.5
615.56	0.25			Sandstone	20.6	199.1	355.0	30.1	21.8	***249.8***	250	0	0	137	32.8
615.31	0.25			Sandstone	20.6	199.1	375.6	30.1	21.8	***279.9***	280	0	0	154	33
615.06	0.25			Sandstone	20.6	199.1	396.2	30.1	21.8	***310.0***	310	0	0	170	33.3
614.81	0.25			Sandstone	20.6	199.1	416.8	30.1	21.8	***340.1***	340	0	0	187	33.5
614.56	0.25			Sandstone	20.6	199.1	437.3	30.1	21.8	***370.2***	370	0	0	204	33.8
614.31	0.25			Sandstone	20.6	199.1	457.9	30.1	21.8	***400.3***	400	0	0	220	34
614.06	0.25			Sandstone	20.6	199.1	478.5	30.1	21.8	***430.4***	~~430~~	~~0~~	~~0~~	~~237~~	~~34.3~~
613.81	0.25			Sandstone	20.6	199.1	499.1	30.1	21.8	***460.5***	~~461~~	~~0~~	~~0~~	~~253~~	~~34.5~~
613.56	0.25			Sandstone	20.6	199.1	519.7	30.1	21.8	***490.6***	~~491~~	~~0~~	~~0~~	~~270~~	~~34.8~~
613.31	0.25			Sandstone	20.6	199.1	540.3	30.1	21.8	***520.7***	~~521~~	~~0~~	~~0~~	~~286~~	~~35~~
613.06	0.25			Sandstone	20.6	199.1	560.9	30.1	21.8	***550.8***	~~551~~	~~0~~	~~0~~	~~303~~	~~35.3~~
612.81	0.25			Sandstone		199.1			21.8						

Pile Design Table for North Abutment utilizing Boring #B-3

	Nominal Required Bearing (Kips)	Factored Resistance Available (Kips)	Estimated Pile Length (Ft.)
Metal Shell 12"Φ w/.179" walls			
	105	58	27
Metal Shell 12"Φ w/.25" walls			
	105	58	27
Metal Shell 14"Φ w/.25" walls			
	128	71	27
Metal Shell 14"Φ w/.312" walls			
	128	71	27
Steel HP 8 X 36			
	282	155	34
Steel HP 10 X 42			
	76	42	27
	133	73	32
	335	184	34

	Nominal Required Bearing (Kips)	Factored Resistance Available (Kips)	Estimated Pile Length (Ft.)
Steel HP 10 X 57			
	78	43	27
	140	77	32
	454	250	36
Steel HP 12 X 53			
	91	50	27
	159	88	32
	418	230	34
Steel HP 12 X 63			
	93	51	27
	166	91	32
	497	273	35
Steel HP 12 X 74			
	94	52	27
	171	94	32
	589	324	36
Steel HP 12 X 84			
	96	53	27
	176	97	32
	664	365	36

	Nominal Required Bearing (Kips)	Factored Resistance Available (Kips)	Estimated Pile Length (Ft.)
Steel HP 14 X 73			
	110	60	27
	196	108	32
	578	318	35
Steel HP 14 X 89			
	113	62	27
	204	112	32
	705	388	36
Steel HP 14 X 102			
	114	63	27
	210	115	32
	810	445	36
Steel HP 14 X 117			
	117	64	27
	217	120	32
	929	511	36
Precast 14"x 14"			
	108	59	25
	164	90	27
Timber Pile			
	83	46	27

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=============================== South Abutment
REFERENCE BORING ========================== B-1
LRFD or ASD or SEISMIC ======================== LRFD
PILE CUTOFF ELEV. =========================== 646.85 ft
GROUND SURFACE ELEV. AGAINST PILE DURING DR 641.85 ft
GEOTECHNICAL LOSS TYPE (None, Scour, Liquef., DD None
BOTTOM ELEV. OF SCOUR, LIQUEF., or DD ======== 0.00 ft
TOP ELEV. OF LIQUEF. (so layers above apply DD) === 0.00 ft

TOTAL FACTORED SUBSTRUCTURE LOAD ======== 1400 kips
TOTAL LENGTH OF SUBSTRUCTURE (along skew)=== 58.16 ft
NUMBER OF ROWS OF PILES PER SUBSTRUCTURE = 1
Approx. Factored Loading Applied per pile at 8 ft. Cts ===== 192.57 KIPS
Approx. Factored Loading Applied per pile at 3 ft. Cts ===== 72.21 KIPS

PILE TYPE AND SIZE ========== Steel HP 12 X 53
Plugged Pile Perimeter==================== 3.967 FT. Unplugged Pile Perimeter========== 5.800 FT.
Plugged Pile End Bearing Area============== 0.983 SQFT. Unplugged Pile End Bearing Area===== 0.108 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
418 KIPS	**418** KIPS	**230** KIPS	**35** 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.)
640.41	1.44	2.00	8		6.6		23.2	9.7		***11.5***	12	0	0	6	6
637.91	2.50	1.20	4		8.1	16.5	27.2	11.9	1.8	***23.0***	23	0	0	13	9
635.41	2.50	0.90	2		6.5	12.4	***30.9***	9.5	1.4	32.1	31	0	0	17	11
632.91	2.50	0.70	3		5.2	9.6	49.9	7.6	1.1	***41.3***	41	0	0	23	14
630.41	2.50	1.70	5		10.4	23.4	56.1	15.2	2.6	***56.0***	56	0	0	31	16
627.91	2.50	1.40	6		9.1	19.3	70.7	13.3	2.1	***69.9***	70	0	0	38	19
625.41	2.50	1.80	6		10.8	24.8	***82.9***	15.8	2.7	85.8	83	0	0	46	21
622.91	2.50	1.90	7		11.2	26.2	***91.3***	16.3	2.9	101.8	91	0	0	50	24
620.41	2.50	1.70	7		10.4	23.4	***103.1***	15.2	2.6	117.2	103	0	0	57	26
615.41	5.00	1.80	8		21.6	24.8	***101.2***	31.5	2.7	146.1	101	0	0	56	31
614.01	1.40	0.10	2		0.5	1.4	299.4	0.7	0.2	***168.5***	168	0	0	93	33
613.76	0.25			Sandstone	20.6	199.1	320.0	30.1	21.8	***198.6***	199	0	0	109	33.1
613.51	0.25			Sandstone	20.6	199.1	340.5	30.1	21.8	***228.7***	229	0	0	126	33.3
613.26	0.25			Sandstone	20.6	199.1	361.1	30.1	21.8	***258.8***	259	0	0	142	33.6
613.01	0.25			Sandstone	20.6	199.1	381.7	30.1	21.8	***288.9***	289	0	0	159	33.8
612.76	0.25			Sandstone	20.6	199.1	402.3	30.1	21.8	***319.0***	319	0	0	175	34.1
612.51	0.25			Sandstone	20.6	199.1	422.9	30.1	21.8	***349.1***	349	0	0	192	34.3
612.26	0.25			Sandstone	20.6	199.1	443.5	30.1	21.8	***379.2***	379	0	0	209	34.6
612.01	0.25			Sandstone	20.6	199.1	464.1	30.1	21.8	***409.3***	409	0	0	225	34.8
611.76	0.25			Sandstone	20.6	199.1	484.7	30.1	21.8	***439.4***	~~439~~	~~0~~	~~0~~	~~242~~	~~35.1~~
611.51	0.25			Sandstone	20.6	199.1	505.3	30.1	21.8	***469.5***	~~470~~	~~0~~	~~0~~	~~258~~	~~35.3~~
611.26	0.25			Sandstone	20.6	199.1	525.8	30.1	21.8	***499.6***	~~500~~	~~0~~	~~0~~	~~275~~	~~35.6~~
611.01	0.25			Sandstone	20.6	199.1	546.4	30.1	21.8	***529.7***	~~530~~	~~0~~	~~0~~	~~291~~	~~35.8~~
610.76	0.25			Sandstone	20.6	199.1	567.0	30.1	21.8	***559.8***	~~560~~	~~0~~	~~0~~	~~308~~	~~36.1~~
610.51	0.25			Sandstone	20.6	199.1	***587.6***	30.1	21.8	589.9	~~588~~	~~0~~	~~0~~	~~323~~	~~36.3~~
610.26	0.25			Sandstone		199.1			21.8						

Pile Design Table for South Abutment utilizing Boring #B-1

	Nominal Required Bearing (Kips)	Factored Resistance Available (Kips)	Estimated Pile Length (Ft.)
Metal Shell 12"Φ w/.179" walls			
	125	69	31
Metal Shell 12"Φ w/.25" walls			
	125	69	31
Metal Shell 14"Φ w/.25" walls			
	118	65	24
	134	74	26
	146	80	31
Metal Shell 14"Φ w/.312" walls			
	118	65	24
	134	74	26
	146	80	31
Steel HP 8 X 36			
	286	157	35
Steel HP 10 X 42			
	84	46	31
	140	77	33
	335	184	35

	Nominal Required Bearing (Kips)	Factored Resistance Available (Kips)	Estimated Pile Length (Ft.)
Steel HP 10 X 57			
	86	47	31
	147	81	33
	454	250	36
Steel HP 12 X 53			
	101	56	31
	168	93	33
	418	230	35
Steel HP 12 X 63			
	102	56	31
	175	96	33
	497	273	36
Steel HP 12 X 74			
	103	57	31
	180	99	33
	589	324	36
Steel HP 12 X 84			
	105	58	31
	185	102	33
	664	365	37

	Nominal Required Bearing (Kips)	Factored Resistance Available (Kips)	Estimated Pile Length (Ft.)
Steel HP 14 X 73			
	120	66	31
	206	114	33
	578	318	36
Steel HP 14 X 89			
	122	67	31
	215	118	33
	705	388	36
Steel HP 14 X 102			
	123	68	31
	221	121	33
	810	445	37
Steel HP 14 X 117			
	124	68	31
	228	126	33
	929	511	37
Precast 14"x 14"			
	111	61	19
	133	73	21
	150	83	24
	171	94	26
	185	102	31
Timber Pile			
	124	68	31