STRUCTURE GEOTECHNICAL REPORT

Farmington Road over Kickapoo Creek
Existing S.N. 072-0063
Proposed S.N. 072-0245

FAU 6659
SECTION 11BR-1
PEORIA COUNTY, ILLINOIS
JOB NO. P-94-011-01
PTB 148/015
CONTRACT NO. 68185
KEG NO. 08-0053.00

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EXECUTIVE SUMMARY

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FAU 6659
Section 11BR-1
Peoria County, Illinois
Job No. P-94-011-01
Contract No. 68185
PTB 148/015
Proposed Structure No. 072-0245

The new structure is a four-span bridge located east of the intersection of Farmington Road and Kickapoo Creek Road in Peoria County, Illinois. The purpose of this report is to present design and construction recommendations for the proposed structure.

The results of the slope stability analysis, as provided in Table 3.1, indicate an unacceptable factor of safety will exist at the West Abutment under all but the circular seismic case. Due to the stability concerns at the West Abutment location, stability improvement measures are recommended.

The proposed structure will widen the existing roadway approximately 28 ft. The resulting new roadbed and embankments will place an additional load on the soil profile. Due to the nature of the soils encountered in the borings and approximately 7 ft. of new fill proposed, anticipated settlement is approximately 2.5 in. It is anticipated that a majority of the settlement will coincide with new embankment and bridge cone construction. The majority of the settlement is anticipated to occur in the upper 25 ft. of the soil profile and coincide with the construction of the new embankments. Therefore, the 2.5 in. of calculated settlement is not included as down drag in the pile length estimates or anticipated to influence the bearing capacity of the approach slabs. Due to the lack of consolidation data to estimate the time rate for consolidation, settlement monitoring with settlement plates could be used to assess the required assumptions.

Drilled shafts and driven H-piles are feasible options for foundation support at this bridge location. If the lateral stability analysis shows that necessary embedment depths are greater than those required by the axial load analysis (driven installation), then the pile locations should be pre-drilled to the required depths (minimum of 3 ft. below the scour elevation), grouted in place, and driven to Maximum Nominal Required Bearing. If the H-piles are driven prior to filling the hole with grout, there is a potential for cave-ins to occur into the annulus around the piles, potentially restricting the flow of grout to the lower portions of the pile. Alternatively, the pile locations can be pre-drilled and the piles set on rock, developing capacity from side or end-bearing resistances.

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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 four-span bridge located east of the intersection of Farmington Road and Kickapoo Creek Road in Peoria 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 total replacement of the existing two-lane bridge (SN 072-0063) over Kickapoo Creek with a new, four-span structure (SN 072-0245). The project is located in the western portion of Peoria, Illinois. The general location is shown on the USGS Topographic Location Map, Exhibit A. The site lies in the Galesburg Plain of the Till Plains Section of the Central Lowland Province. The project site is located in Limestone Township (T. 8N R. 7E Section 1).

1.3 Proposed Bridge Information

The proposed four-span structure (SN 072-0245) located at Farmington Road and Kickapoo Creek will consist of a single, four-span structure built with no skew. The structure will have a width of 60 ft.-8 in. out-to-out. The centerline of the structure will vary from 267+40.50 at the East Abutment to 270+26.00 at the West Abutment. The proposed structure will measure 285 ft.-6 in. back-to-back abutments.

The proposed structure will support two, 12-ft. driving lanes, with 7-ft. inside and 6-ft. outside shoulders. The westbound lane will include a 7-ft. wide bicycle lane. Further substructure details will be based on the findings of this SGR.

1.4 Existing Bridge Information

The existing structure (SN 072-0063) was originally built in 1922 as a two-span through truss structure. In 1972, the bridge was widened and reconstructed to include stub abutments on steel H-piles. Two new pile bent piers on H-piles were added, and the existing piers were widened. The resulting four-span superstructure measures 238 ft. back-to-back abutments, with a 33 ft. out-to-out width.

Many of the beams are delaminating and spalling, with exposed stirrups and strands. The substructure shows areas of map cracking and spalling with exposed rebar on the piers and pier caps. The piers in the creek show some signs of scour, and the substructure has been shown to be scour critical. The most current damage inspection by BBS personnel was completed on June 05, 2007.

The Bridge Condition Report (BCR) concluded that the only way to take into consideration the dangerous intersection and the expense of costly scour countermeasures was with complete replacement of the existing structure.

2.0 Site Investigation, Subsurface Exploration and Generalized Subsurface Conditions

The site investigation plan was developed by Kaskaskia Engineering Group, LLC (KEG) in coordination with the Illinois Department of Transportation (IDOT). A representative of KEG conducted a site visit, observed the drilling operations, and logged the subsurface conditions. The boring locations were surveyed after completion by a representative of WHKS.

Four standard penetration test (SPT) borings, designated B-1, B-2, B-3, and B-4, were drilled on December 7 and 8, 2010. Due to limited access, the steep creek banks, and the weather conditions at the time of drilling, three out of the four borings were taken on the south side of the existing and proposed structures. The stations and offsets of the borings are listed in Table 2.1. The boring locations are shown on the Type, Size, and Location Plan (TS&L), Exhibit B, as provided by WHKS. 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 can be found under Subsurface Profile, Exhibit D.

Table 2.1 – Boring Stations and Offsets

Designation	Stationing	Offset from Proposed Centerline	Surface Elevation (ft.)
B-1	267+50	36 ft. Left	474.5
B-2	268+17	36 ft. Left	470.6
B-3	268+65	39 ft. Left	469.6
B-4	270+19	26 ft. Right	479.3

2.1 Subsurface Conditions

The stratigraphy of the borings exhibited layers of silty loams, clay loams, sandy loams, fine to coarse sands, and clayey shale. In general, the lithologic succession beneath the ground surface is as follows:

a) Fill (Clay/Silty/Sandy Loams) – Three of the borings, all except Boring B-3, encountered fill material ranging from approximately 3 to 13 ft. The fill contains variable amounts of sand and gravel. The driving resistances (N-values) ranged from 3 to 9 blows per foot (bpf), with unconfined compressive strengths (Q_u) of 0.1 to 2.8 tons per square foot (tsf). The moisture content of the fill varied from 3 to 26 percent.

b) Natural Loams – Below the fill material, a layer of loamy soil was encountered ranging from 10 to 23 ft. thick. The soil contains variable amounts of silts, clays, and sands. The N-values ranged from weight-of-hammer (WH) to 16 bpf, with Q_u values from less than 0.25 to 2.5 tsf. The moisture content varied from 13 to 34 percent. In Boring B-3, an interbedded layer of medium to coarse gray sand was encountered from El. 454.1 to El. 451.6. The N-value was 1 bpf, with a moisture content of 21 percent.

c) Sand – Below the layer of naturally deposited loams, the borings encountered a layer of sand, 7.5 to 21 ft. thick. The N-values ranged from 3 to 52 bpf, with moisture contents of 17 to 20 percent. The sand varies from fine to coarse with trace amounts of gravel. In Boring B-2, a layer of coarse gravel was encountered from El. 445.1 to El. 434.6. The N-values ranged from 24 to 109 bpf, with moisture contents from 15 to 17 percent. The sand layer was not encountered in Boring B-4.

c) Clayey Shale – Greenish-gray clayey shale was encountered below the sand layer at depths of 23 to 41.5 ft., corresponding to El. 456 to El. 433. The borings were advanced approximately 5 to 16 ft. into the clayey shale. The N-values ranged from 53 to 100+ bpf, with moisture contents between 13 and 20 percent. The borings were terminated after three consecutive samples of 100+ blow count material were encountered. An exception occurred in Boring B-1, where auger refusal was encountered at El. 428.3 after advancing approximately 5 ft. into the shale.

2.2 Bedrock

Table 2.2 shows the elevation of auger refusal on apparent bedrock for Boring B-1 and the top elevation of the shale at Borings B-2, B-3, and B-4. Auger refusal is a designation applied to any material that cannot be further penetrated by the power auger without extraordinary effort and is indicative of a very hard or very dense material, usually bedrock.

Table 2.2 – Top of Shale Elevations

Boring	Auger Refusal Elevation (ft.)	Top of Shale Elevation (ft.)
B-1	428.3	433.0
B-2	N/A	434.1
B-3	N/A	439.1
B-4	N/A	456.3

2.3 Groundwater

Groundwater was encountered during drilling in Boring B-1 at El. 451.5, B-2 at El. 455.1, B-3 at El. 454.1, and B-4 at El. 466.3. All groundwater elevations were taken upon completion of the boring. 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. Due to the steep slope of the creek bank and the snowy and icy conditions at the time of drilling, the surface water elevation was not measured.

3.0 Geotechnical Evaluations

3.1 Settlement

The proposed structure will widen the existing roadway approximately 28 ft. The resulting new roadbed and embankments will place an additional load on the soil profile. Due to the nature of the soils encountered in the borings and approximately 7 ft. of new fill proposed, settlement calculations were necessary.

A settlement analysis was performed using Boring B-1, soil parameters from laboratory and empirical correlations to available data, and the dimensions of the proposed structure (TS&L, Exhibit B) to calculate the applied loads on the soil profile. The subsurface profile generally consisted of cohesive, silty clay/loam, sandy clays, and coarse sand and gravels. According to the settlement calculations performed, approximately 2.5 in. of settlement could occur under the proposed approach embankments.

3.2 Slope Stability

The proposed construction of the new structure results in new endslopes at the abutment locations. The proposed endslopes are at 2 horizontal to 1 vertical (2H:1V) for both the East Abutment and 2H:1V for the West Abutment, to the toe in the streambed.

Slope stability of the endslopes was analyzed using STABL for Windows 3.0, the soil properties as indicated from Borings B-1 and B-4, and the endslope geometrics. Three conditions were modeled: end-of-construction (E-O-C), long-term (L-T), 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 E-O-C and L-T slope stability and 1.0 for the design seismic event.

In order to model the E-O-C 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 L-T and seismic cases 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.

Two methods were used to calculate critical failure surfaces. The Modified Bishop Method was used to calculate circular-arc failure surfaces, and the Janbu Method was used to analyze a wedge-type failure. As indicated by the Boring Logs, Exhibit C, an approximate 1-ft. layer of weathered shale is present at the proposed bridge location. The weathered zone appears to be inclined at an approximate 7 degree slope downwards to the east. Consequently, there is a downward slope into the creek along this surface at the western endslope. The Janbu Method, which generates block failure surfaces, was used to calculate the critical failure surfaces and FOS along the weathered shale for the West Abutment.

The FOS obtained in all of the analyses are shown in Table 3.1. STABL program output from the analyses can be found in STABL Slope Stability Analysis, Exhibit E.

The results of the analyses, as provided in Table 3.1, indicate that the minimum IDOT FOS are achieved for all three conditions for the East Abutment.

For the West Abutment, the minimum IDOT FOS was achieved only for the seismic case for the Bishop Method, but not for the E-O-C and L-T cases. With the Janbu Method, the minimum IDOT FOS were not achieved for any of the three cases.

After discussions with the IDOT Foundations Unit, stability improvements were added to the models for the West Abutment. Previously, a concrete shear key and concrete drilled shafts had been discussed; and while a shear key approach could achieve the minimum required FOS, constructability of the key was an issue, so this option is no longer provided. Driven piles were also considered, but not pursued due to the cost of the steel, the potential difficulty in achieving sufficient embedment of the piles into the shale, and the potential disturbance (fracturing) of the shale surface. Ground improvement options, such as stone columns, were not considered. From discussions with contractors on previous slope repairs, it does not appear that such an approach is cost effective for addressing wedge failures on shale. Ultimately, concrete drilled shafts were chosen as the stability improvement system.

Initially, a 2.5H:1V and a 2H:1V slope geometry were analyzed utilizing the drilled shafts to stabilize the slope. After extensive discussions with IDOT personnel, it was determined that a 2H:1V slope configuration was required at the West Abutment location.

Two types of concrete drilled shafts were considered: unreinforced and reinforced. In both conditions, the concrete was assumed to have a minimum 28-day unconfined compressive strength of 3,500 psi; and the shafts were assumed to be embedded 4 ft. into the shale. For the unreinforced condition, we modeled a material having a composite cohesion of 3,000 psf and for the reinforced condition, a composite cohesion of 5,000 psf. The width of the composite zone was equal to the width of the shafts. Shafts in the same row were modeled as being spaced 5 ft., center-to-center. The results of the analyses with the concrete shafts are summarized in Table 3.1. The distance from the toe of the slope to the centerline of the row of shafts is also included in the table. When multiple rows of shafts were modeled, the distance from the toe of the slope to the bottom row of shafts is included. With multiple rows, the rows were modeled as being 5 ft. apart, center-to-center; and shafts in adjacent rows were offset from the shafts in the adjoining row(s). Details of the concrete shaft installation are included in Section 5.5, Concrete Shaft Construction.

For the unreinforced case, a maximum FOS of 1.3 was calculated for the L-T condition; and a minimum FOS of 1.5 is required. Accordingly, reinforced shafts will be required to achieve the required FOS. For the case with a single row of 36-inch diameter reinforced shafts, a FOS of 1.4 was calculated for the E-O-C and a FOS of 1.3 was calculated for the L-T case, so this option should not be considered.

The lateral loads that were calculated for the reinforced concrete shafts are 6 kips per shaft for the 1.5-ft. diameter shafts, and 17 kips per shaft for the 2-ft. diameter shafts.

Table 3.1 – Slope Stability Critical FOS (Modified Bishop and Janbu Methods)

Critical FOS						
	Modified Bishop (Circular)			Janbu (Wedge)		
	E-O-C	L-T	Seismic	E-O-C	L-T	Seismic
East Abutment 267+50 (B-1)	5.9	3.6	2.9	N/A	N/A	N/A
West Abutment 270+19 (B-4)	1.4	1.4	1.1	2.1	1.0	0.8

2H:1V West Abutment with Improvements								
Janbu (Wedge)			E-O-C FOS		L-T FOS		Seismic FOS	
Pier Dia. (inches)	Number of Rows	Location* (feet)	Unreinforced	Reinforced	Unreinforced	Reinforced	Unreinforced	Reinforced
18	3	4.5	1.4	1.6	1.3	1.5	1.1	1.2
24	2	10	---	1.5	---	1.5	---	1.3
36	1	15	---	1.4	---	1.3	---	1.1

*Note: Location of the center of the first row of piles from the toe of the 2H:1V slope.
Piles spaced 5 ft. on center.
Rows spaced 5ft. on center.
Piers in adjacent rows are offset from piers in adjoining rows.

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 site class for this project is Soil Site Class C.

Additional seismic parameters were calculated for use in design of the structure. 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 the Soil Site Class C, are summarized in Table 3.2.

Table 3.2 – Summary of Seismic Parameters

Parameter	Value
Soil Site Class	C
Spectral Response Acceleration, 0.2 Sec, S_{DS}	0.131g(Site Class C)
Spectral Response Acceleration, 1.0 Sec, S_{D1}	0.079g (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 design scour elevations are shown in Table 3.3. Class A5 stone riprap will be placed on the surface of the proposed east and west endslopes from top to toe, as well as the intermediate piers, to reduce the potential for future scour.

Table 3.3 – Design Scour Elevations

Design Scour Elevations (ft.)					
	East Abutment	Pier #1	Pier #2	Pier #3	West Abutment
Q100	473.91	450.5	439.8	446.3	476.8
Q500	473.91	450.5	439.8	446.30	476.80

3.5 Mining Activity

The Illinois State Geological Survey (ISGS) website indicates that coal mining has occurred in Peoria County. According to the Peoria County, Illinois Coal Mines and Underground Industrial Mines Map, dated July 20, 2011, obtained from the Illinois Geological Survey (ISGS) website (http://www.isgs.illinois.edu/maps-data-pub/coal-maps.shtml), the project site was not undermined.

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 indication of subsurface mining activities was evident at the site. Our site observations did not detect any apparent depressions that could be due to mine subsidence or shafts beneath the site area.

3.6 Liquefaction

A liquefaction analysis is not required to be performed since the project is in Seismic Performance Zone 1 in accordance with IDOT Bridge Manual and AGMU Memo 10.1 – Liquefaction Analysis.

The low risk of liquefaction was not considered to require reduction for the pile design capacity or other foundation considerations included herein.

3.7 Approach Slab

In accordance with the IDOT Bridge Manual, KEG evaluated the foundation soils at the approach slabs for bearing capacity and excessive settlement. With proper compaction of the abutment wall backfill, the bearing capacity and settlement requirements of the IDOT Bridge Manual should be satisfied.

4.0 Foundation Evaluations and Design Recommendations

4.1 General Feasibility

According to the Bridge Manual, Section 3.8.4 on Open Abutments: Semi-Integral, the foundation may be supported by piles, drilled shafts, or shallow foundations.

Drilled shafts and driven H-piles are feasible options for foundation support at this bridge location. It should be noted that if the designer chooses H-piles to support the foundation, lateral stability concerns resulting from inadequate embedment depths at the piers may require pre-drilling at the pile locations. If the lateral stability analysis shows that necessary embedment depths are greater than those required by the axial load analysis (driven installation), then the pile locations should be pre-drilled to the required depths grouted in place, and driven to Maximum Nominal Required Bearing. If the H-piles are driven prior to filling the hole with grout, there is a potential for cave-ins to occur into the annulus around the piles, potentially restricting the flow of grout to the lower portions of the pile. Alternatively, the pile locations may be pre-drilled and the H-piles set in rock. The boring logs indicated a substantial zone of weathered shale present throughout the footprint of the proposed structure. Since the weathered shale is highly susceptible to scour, the H-piles should be driven or set a minimum of 3 ft. into the shale to ensure the H-piles penetrate into competent shale.

Spread footings are not a feasible option for foundation support at this location. The loads indicated will not allow for spread footings to be founded on the existing site soils and will result in oversized footings that are unreasonable and cost prohibitive.

4.2 Pile Supported Foundations

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. Based on the boring logs, the depth to bedrock, and the results of the pile design analysis, H-piles are a feasible option. However, due to the limited amount of overburden and relatively shallow depth of the clayey shale bedrock, lateral stability may be a concern.

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 a feasible option 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).

The Strength 1 factored loads were 1,225.0 and 1,043.1 kips at the East and West Abutments respectively; 2,675.6 kips at Pier 1; 2,604.1 kips at Pier 2; and 2,465.3 kips at Pier 3. The loads were provided by WHKS. 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 encounter during driving. These values 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.

Based on the pile cutoff elevations shown in the TS&L provided by WHKS, the maximum pile lengths for a 12x53 H-pile loaded to its maximum allowable capacity range from 43 to 47 ft. and 48 ft. for a 14x89 H-pile.

As shown in Pile Length/Pile Type, Exhibit F, downdrag, scour, and liquefaction have not been considered at the abutment locations. Scour was considered for the intermediate pier substructures.

Table 4.1 – Pile Types and Estimated Length for Abutments and Piers

	Pile Designation	R_n Nominal Required Bearing (kips) (Pile)	R_F Factored Resistance Available (kips)	Estimated Pile Length (ft.)	Assumed Pile Top El.
East Abutment	Steel HP 10X42	335	184	47	475.91
	Steel HP 12X53	418	230	47	475.91
	Steel HP 12X63	497	273	48	475.91
	Steel HP 14X73	578	318	48	475.91
	Steel HP 14X89	705	388	48	475.91
West Abutment	Steel HP 10X42	335	173	28	478.80
	Steel HP 12X53	418	219	28	478.80
	Steel HP 12X63	497	249	29	478.80
	Steel HP 14X73	578	308	29	478.80
	Steel HP 14X89	705	375	31	478.80
Pier 1	Steel HP 10X42	335	47	44	477.00
	Steel HP 12X53	418	67	44	477.00
	Steel HP 12X63	497	69	45	477.00
	Steel HP 14X73	578	94	45	477.00
	Steel HP 14X89	705	97	47	477.00
Pier 2	Steel HP 10X42	335	47	43	477.00
	Steel HP 12X53	418	67	43	477.00
	Steel HP 12X63	497	69	45	477.00
	Steel HP 14X73	578	94	44	477.00
	Steel HP 14X89	705	97	46	477.00
Pier 3	Steel HP 10X42	335	47	33	477.00
	Steel HP 12X53	418	67	31	477.00
	Steel HP 12X63	497	69	33	477.00
	Steel HP 14X73	578	94	32	477.00
	Steel HP 14X89	705	97	34	477.00

If H-piles are chosen to support the substructures, KEG recommends a test pile be installed at one of the abutment locations. A test pile is installed 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.

If the H-piles are pre-drilled and set on rock, recommendations for developing capacity from side or end-bearing resistance are provided for support for the abutment and piers. A Factored Unit Side Resistance of 2.6 ksf and a Factored Unit Tip Resistance of 54 ksf is recommended in the shale material. The construction of the rock sockets must adhere to the same construction practices used during the construction of a drilled shaft. This should include that water should be sealed from entering the socket by whatever means, including the advance of temporary casing. As previously mentioned, the piles must extend a minimum of 3 ft. into the shale in order to be certain the H-piles are set on/in competent shale.

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 4.2 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. It is emphasized that due to the significant estimated scour depths, there is a potential for loss of lateral capacity; and an increase in embedment depths may be required.

Table 4.2 – Soil Parameters for Lateral Pile Load Analysis

Boring	Elev. at Bottom of Layer	γ (pcf)	Φ (degrees)	K (pci)	N	Assumed % fines < #200	c (psf)	ε50
B-1	471.5	115	30	100	6	25	1000	0.010
	469.0	105	26	1000	3	80	2500	0.005
	464.0	110	26	100	5	65	750	0.010
	461.5	120	30	1000	9	25	2800	0.005
	456.5	110	26	30	5	65	200	0.020
	451.5	105	28	30	3	60	250	0.020
	446.5	120	34	20	6	3	N/A	N/A
	441.5	120	34	60	20	3	N/A	N/A
	437.5	120	34	125	52	3	N/A	N/A
	433.0	110	34	60	27	3	N/A	N/A
	428.3	125	12	2000	88	N/A	8000	0.004
B-2	467.6	105	28	100	4	60	800	0.010
	465.1	105	26	100	6	80	700	0.010
	460.1	105	28	30	6	60	400	0.020
	457.6	115	30	100	5	30	500	0.010
	455.1	120	30	30	2	25	400	0.020
	452.6	110	34	20	7	3	N/A	N/A
	445.1	120	34	20	9	3	N/A	N/A
	442.6	120	34	60	24	3	N/A	N/A
	437.1	120	34	90	43	3	N/A	N/A
	434.1	120	34	90	109	3	N/A	N/A
	421.4	125	12	2000	100	N/A	8000	0.004
B-3	465.6	105	28	500	5	60	1500	0.005
	464.1	115	30	1000	16	25	2000	0.007
	461.6	110	26	1000	6	65	2500	0.005
	456.6	105	28	100	2	60	650	0.010
	454.1	110	26	30	3	65	400	0.020
	451.6	110	34	20	1	3	N/A	N/A
	449.1	105	28	30	3	60	300	0.020
	446.6	115	30	30	3	25	500	0.020
	441.6	110	34	60	18	3	N/A	N/A
	439.1	110	34	60	17	3	N/A	N/A

	423.0	125	12	2000	100+	N/A	8000	0.004
B-4	475.3	110	34	25	6	3	N/A	N/A
	471.3	115	30	100	7	25	1000	0.010
	468.8	105	26	30	3	80	100	0.020
	466.3	115	30	500	9	25	1300	0.007
	463.8	105	26	30	3	80	200	0.020
	458.8	110	26	100	5	65	500	0.010
	456.3	105	26	30	7	80	300	0.020
	454.3	125	12	2000	53	N/A	8000	0.004
	440.2	125	12	2000	100+	N/A	8000	0.004

4.4 Foundations on Drilled Shafts

Due to the relatively shallow bedrock, drilled shafts are an alternative foundation choice for the substructures. Recommendations for drilled shafts with sockets extending one shaft diameter into the underlying shale, developing capacity from end bearing resistance, are provided for support for the abutment and piers. Also, included is the available side resistance if the shafts extend greater than one shaft diameter into the shale. Combined effects of end bearing and side resistances may be considered. The total loads to be resisted at each bent range from 1,046 to 2,675 kips, as detailed in Section 4.2.

In the 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 and side resistance calculations were based on a nominal Q_u of 14.4 ksf and the clayey shale was treated as a cohesive material. Due to the limited amount of overburden present, the side resistance in the overlying soils has been ignored. A Factored Unit Side Resistance of 2.6 ksf (AASHTO LRFD 10.8.3.5.1b-1) and a Factored Unit Tip Resistance of 54 ksf (AASHTO LRFD 10.8.3.5.1c) is recommended in the clayey shale material. Based on the results of the exploration, competent shale is encountered below El. 433 in Boring B-1, El. 434 in Boring B-2, and El. 439 in Boring B-3; whereas in Boring B-4, competent shale is encountered at El. 450.8 ft. Table 4.3 – LRFD Drilled Shaft Design below contains a summary of Factored Tip Resistance available for various pier diameters and the available Side Resistance per foot of embedment for piers extending more than one pier diameter into competent shale.

Table 4.3 - LRFD Drilled Shaft Design

Pier Diameter (ft.)	Factored Tip Resistance (kips)	Factored Side Resistance (kips/ft_p)*
2.5	265	20
3	382	25
4	679	33
5	1060	41
6	1527	49
7	2078	57
8	2714	65

* ft_p …foot of penetration… See discussion below for limitations to use of side resistance values in Table 4.3

Settlement of drilled shaft foundations bearing on competent shale generally can be estimated to be less than 0.5 in. 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.

A minimum center-to-center shaft spacing of five times the shaft diameter is recommended. The FHWA publication Drilled Shafts: Construction Procedures and LRFD Design Methods (FHWA-NHI-10-016, May 2010) states on Section 14.3, page 14-3, that group effects must be considered at center-to-center spacing of less than 4 diameters for axial resistance and less than 5 diameters for lateral resistance. Shafts will need to be evaluated for lateral resistance, which may control socket embedment lengths, using the L-Pile factors given in Table 4.2.

Temporary smooth steel pipe casing is recommended from the top of shaft to the top of the shale during excavation. The contractor must be prepared to core the drilled shaft in case limestone stringers or other zones of more competent rock are encountered during installation.

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 embankment, as staged construction is anticipated for this project. The average unconfined compressive strength for the assumed embedment depth of 17.5 ft. is 1.0 tsf. The IDOT Temporary Sheet Piling Design Guide and Charts indicate that a Cantilevered Sheet Piling System would be feasible for retained heights up to 15 ft. However, if the retained height exceeds 15 ft., the design charts will no longer be feasible.

While the IDOT method shows that a maximum retained height of 15 ft. is feasible, KEG typically recommends a minimum of 2 ft. embedment per 1 ft. retained height. In KEG's opinion, sheeting can be installed with standard vibratory methods to approximate El. 445 ft. at the East Abutment and El. 455 ft. at the West Abutment; beyond these elevations, the sheeting may require a driven installation method. If the required embedment depths extend below these elevations and the contractor determines that a driven method is not feasible, 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 review whether 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. Protective tips should be provided for the piles.

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.

5.5 Concrete Shaft Construction

Due to the stability concerns at the West Abutment as previously discussed in this report, installation of reinforced concrete shafts are recommended to increase the FOS to the minimum IDOT values. In the slope stability analysis, we modeled three rows of 18-inch diameter shafts, two rows of 24-inch diameter shafts, and one row of 36-inch diameter shafts. The shafts should extend the full width of the abutment plus an additional 10 ft. on each side for a total length of 80 ft. - 8 in.

The concrete was assumed to have a minimum 28-day unconfined compressive strength of 3,500 psi; and the shafts were assumed to be embedded 4 ft. into the shale. The shaft excavations should be backfilled with concrete to within 2 ft. of the final ground surface. Soil fill should be used to fill the upper 2 ft. of the shaft excavations. Shafts in the same row should be spaced 5 ft. apart, center-to-center. The distance from the toe of the slope to the centerline of the row of shafts is shown in Table 3.1. For multiple rows of shafts, the distance from the toe of the slope to the bottom row of shafts is shown. With multiple rows, the rows should be spaced 5 ft. apart, center-to-center; and shafts in adjacent rows should be offset from the shafts in the adjoining row(s).

It is critical that the concrete shafts be installed prior to grading of the slope. Our stability analysis indicated an unacceptable FOS at the final geometry. If the slope is graded prior to installing the shafts, then a failure could occur before the shafts are in place.

The drilled shafts must be embedded a minimum of 4 ft. into the shale. The Boring logs indicated that the shale is sloping at approximately 7 percent from an elevation of 456.3 ft. at the West Abutment to approximately 439 ft. at the location of Pier 2. Accordingly, KEG anticipates that shale may be first encountered between elevation 445 and 440. However, a qualified inspector should be present during construction to verify the top elevation of rock at each location and ensure that the minimum embedment depth is achieved.

Individual shaft excavations should be backfilled with concrete as soon as possible, but in no case should any portion of the excavation be left open for more than four hours. If multiple drilled shaft excavations are open at the same time, then they need to be maintained at least 20 feet from each other. The concrete backfill shall have achieved an unconfined compressive strength of at least 2,000 psi before any additional drilled shaft excavations are made within 20 ft. of an existing shaft. This may require the use of high early concrete, depending upon the construction schedule.

KEG recommends a temporary casing construction method for the stability shafts to ensure the stability of the excavated hole and control the effects of groundwater. The temporary casing should be removed while the concrete remains workable. As the casing is withdrawn, maintain a 5 ft. minimum head of fresh concrete in the casing so that all the fluid trapped behind the casing is displaced upward without contaminating the shaft concrete. It may be necessary to increase the required minimum concrete head to counteract groundwater head inside the casing. Alternatively, a slurry (mineral or polymer) may be used to contain seepage and groundwater movement. If a slurry construction method is used, a temporary surface casing may be used to aid shaft alignment and position and to prevent sloughing of the top of the shaft excavation. The surface casing should be extended to a point in the shaft where sloughing of the surrounding soils does not occur.

5.6 Cofferdam Construction/Permanent Casing

Cofferdams will be required at the proposed pier 2 and 3 locations. The estimated water surface elevation is greater than 6 ft. above the bottom elevation of the substructure. Therefore, a Type 2 cofferdam will be required. All cofferdams are required to be dewatered. Sand and sandy loam materials are present at the site of the cofferdams requiring the use of a seal coat. A seal coat will reduce the potential for water from seeping beneath the sheet piling in the dewatered cofferdam. As per the 2012 IDOT Bridge Manual, if a seal coat is specified, General Note 26 shall be added to the plans.

It is KEG's understanding, that WHKS would prefer to utilize permanent casing at pier 2 and 3 in-lieu of cofferdams. The permanent casing should be extended into the shale, as needed, to provide both a positive seal from the inflow of water and stabilize the shaft excavation against collapse. The permanent casing should extend from at least 18 in. above the water elevation to the bottom of the casing elevation to protect the concrete during placement and curing. After filling the permanent casing with concrete, pressure grout the voids between the shaft excavation and the casing with cement grout. The pressure grouting is required to ensure intimate contact between the permanent casing and the overburden soils, which is used for the lateral support. It should be noted that side resistance can be developed only in the rock socket that extends below the bottom elevation of the permanent casing.

It should be noted, that the designers should make a cost comparison between using drilled shafts with permanent casing, relying only on factored tip resistance, and the cost of using a cofferdam and designing the drilled shafts for both factored side and tip resistance and choose the most feasible option from both the economic and design standpoints.

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

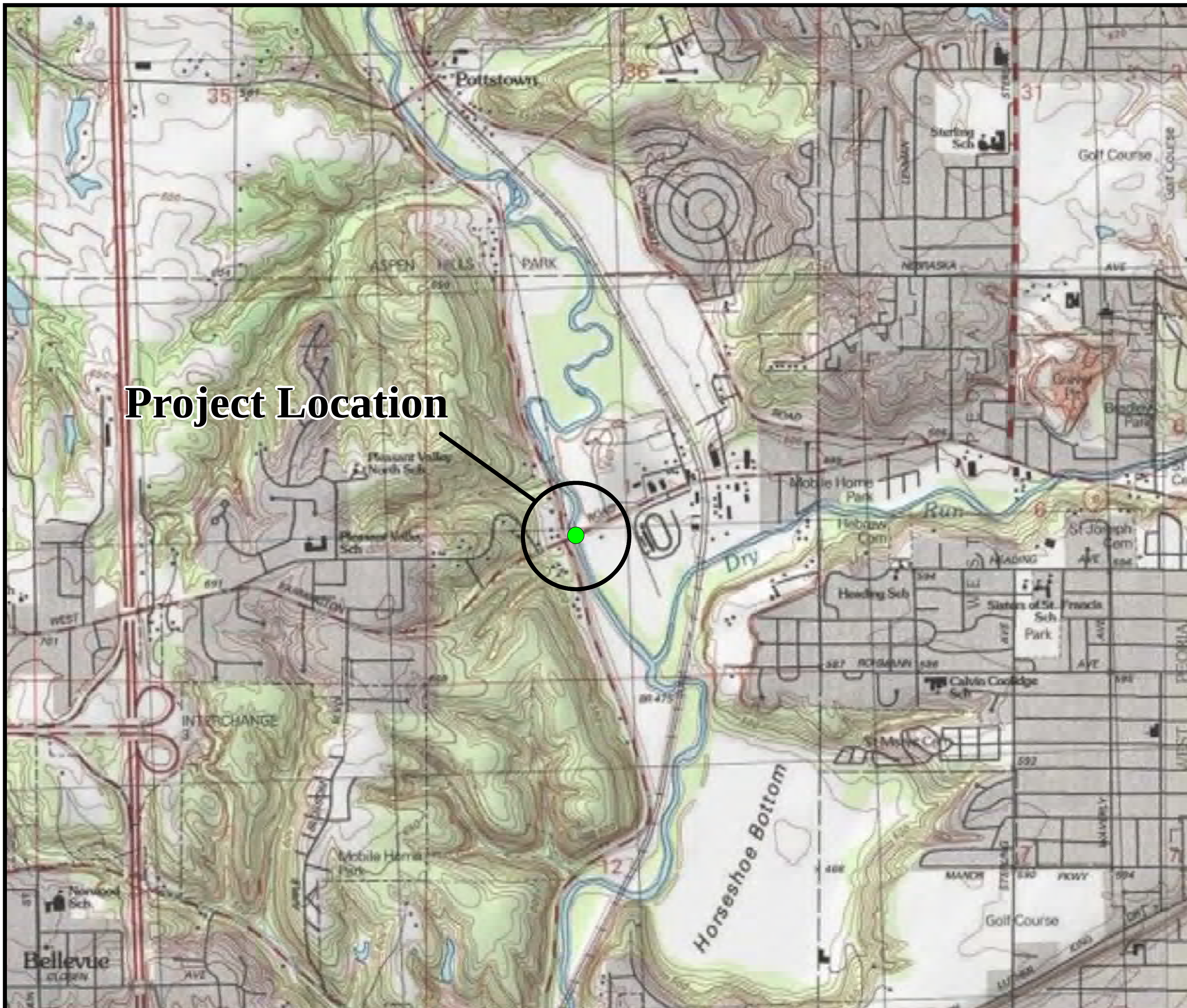
Soil boring logs can be found in Exhibit C. The Subsurface Profile can be found in Exhibit D.

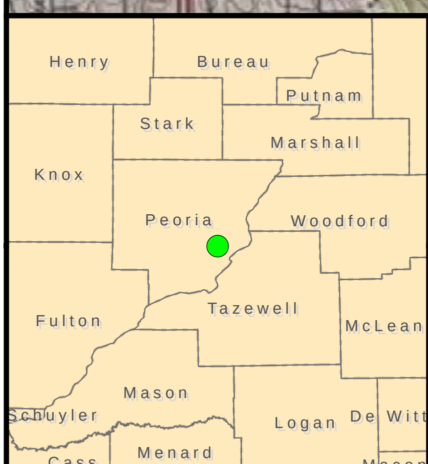
8.0 Limitations

The recommendations provided herein are for the exclusive use of WHKS and IDOT. They are specific only to the project described and are based on the subsurface information obtained at four boring locations within the bridge area in 2010, 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





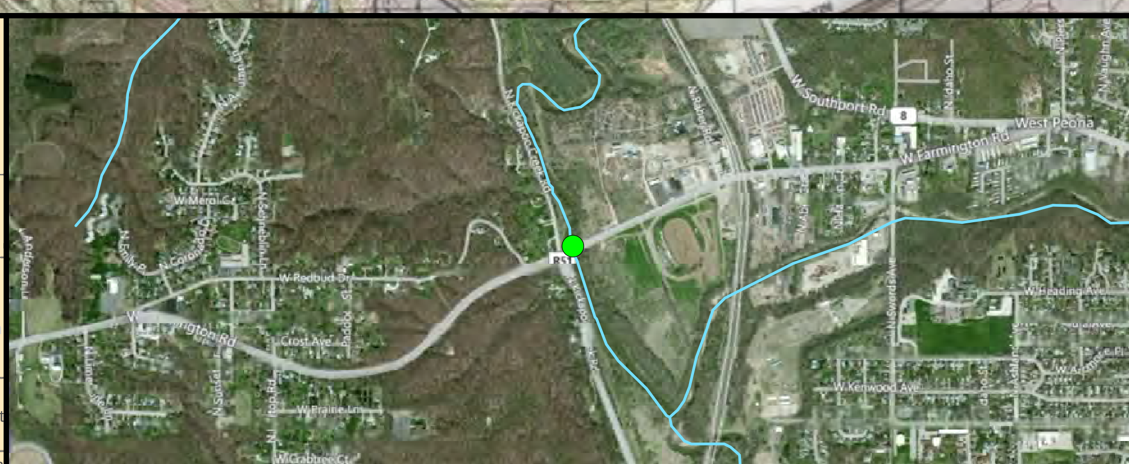


Exhibit A
Location Map
Farmington Road over Kickapoo Creek
Peoria County, Illinois

N

0 500 1,000
Feet

Designed By: MMJ
Drawn By: MMJ
Checked By: CRG
Date: 1/23/2012
Project #: 08-0053

Kaskaskia
Engineering Group, LLC
23 Public Square Suite 404
Belleville, Illinois 62220
618.233.5877 phone
618.233.5977 fax
www.kaskaskiaeng.com

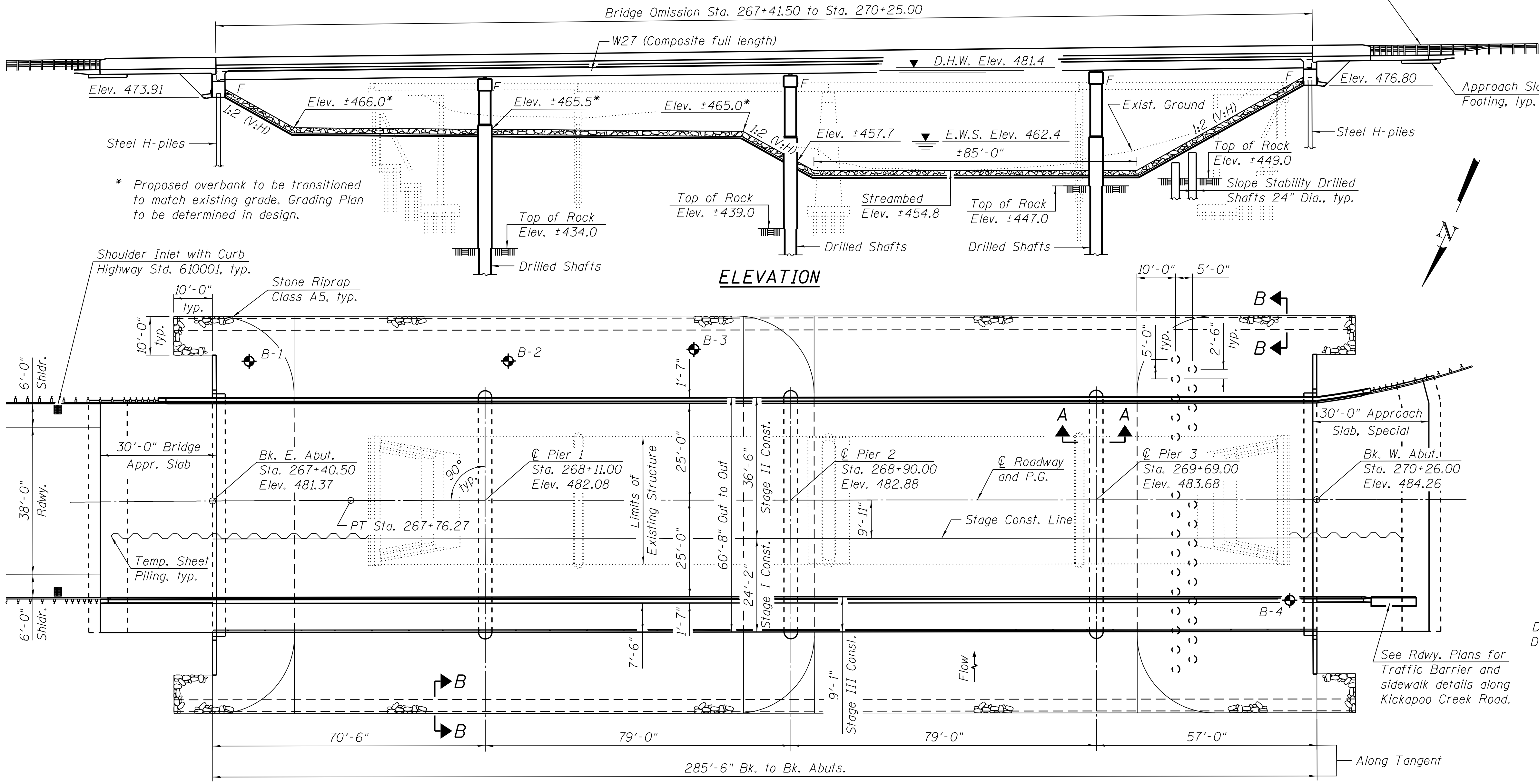
EXHIBIT B

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

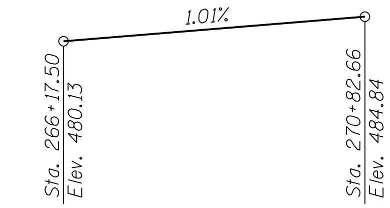
Benchmark: Chisled "□" North end of East abutment of S.N. 072-0063, Elev. 478.42.

Existing Structure: S.N. 072-0063. Originally built in 1922 as S.B.I. Route 8, Section 11B as a two-span through truss structure. In 1972, the bridge was widened and reconstructed as S.B.I. Route 8, Section 11BR. The existing trusses were removed, the existing closed abutments were abandoned and new stub abutments on steel H-piles were added, two new pile bent piers on H-piles were added and the existing pier was widened. The resulting four-span superstructure consists of 11 - 21" & 27" deep PPC Deck Beams. 238'-0" Bk. to Bk. abutments, 33'-0" out to out. Structure to be removed and replaced. Traffic to be maintained utilizing stage construction.

No salvage



PLAN



PROPOSED PROFILE GRADE

HIGHWAY CLASSIFICATION

F.A.U. 6659 (Farmington Road)
Functional Class: Collector (Urban)
ADT: 12,653 (2014) / 14,730 (2034)
ADTT: 468 (2014) / 777 (2023)
DHV: 1,473 (2034)
Design Speed: 45 m.p.h.
Posted Speed: 45 m.p.h.
2-Way Traffic
Directional Distribution: 50/50

LOADING HL-93

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

DESIGN SPECIFICATIONS

2012 AASHTO LRFD Bridge Design Specifications, 6th Edition

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}) = 0.109g
Design Spectral Acceleration at 0.2 sec. (S_{DS}) = 0.175g
Soil Site Class D

CURVE DATA

Δ = 3° 04' 56" (RT)
D = 0° 52' 46"
R = 6,515.60'
T = 175.29'
L = 350.50'
E = 2.36'
P.C. STA. = 264+25.77
PI STA. = 266+01.06
P.T. STA. = 267+76.27
S.E. - None

DESIGN SCOUR ELEVATION TABLE **

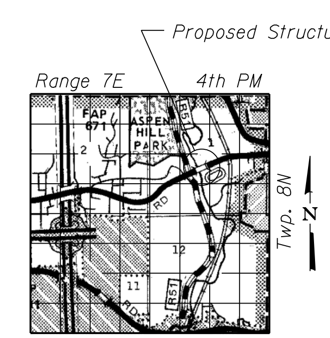
	E. Abut.	Pier 1	Pier 2	Pier 3	W. Abut.
Q100	473.91	430.60	435.12	451.75	476.80
Q500	473.91	430.65	435.14	451.77	476.80

** Scour elevations are preliminary pending completion of final Hydraulic Report.

WATERWAY INFORMATION TABLE

Drainage Area = 290 sq. mi.
Exist. Low Grade Elev. 475.16 at Sta. 3+64
Prop. Low Grade Elev. 475.36 at Sta. 3+72

Flood	Freq. Yr.	Q C.F.S.	Opening Sq. Ft. Exist.	Opening Sq. Ft. Prop.	Nat. H.W.E.	Head - Ft. Exist.	Head - Ft. Prop.	Headwater El. Exist.	Headwater El. Prop.
Overtopping	<10							476.50	476.50
Overtopping	10	17,560	2,577	3,670	476.98	0.40	0.32	477.38	477.30
Design	50	29,360	2,577	4,141	481.40	0.12	0.12	481.52	481.52
Base	100	35,600	2,577	4,141	483.17	0.17	0.14	483.34	483.31
Max. Calc.	500	51,560	2,577	4,141	485.41	0.18	0.17	485.59	485.58



LOCATION SKETCH

GENERAL PLAN
FARMINGTION ROAD OVER KICKAPOO CREEK
FAU 6659 - SECTION 11BR-1
PEORIA COUNTY
STATION 268+90
STRUCTURE NO. 072-0245

design firm no. 184001036
whks engineers + planners + land surveyors

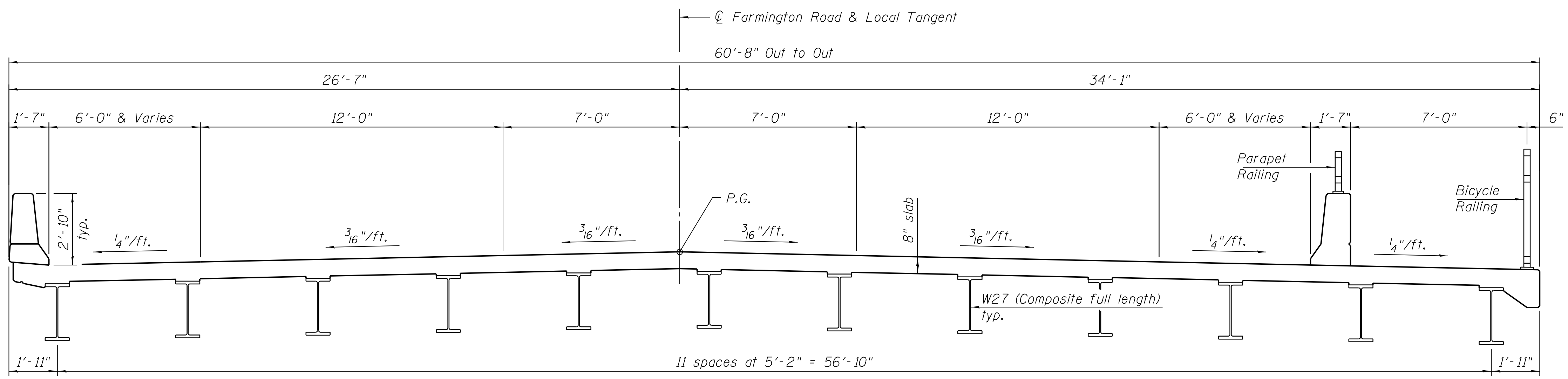
USER NAME = $OPERATOR$	DESIGNED - SDS	REVISED	
FILE NAME = 0720245-68185.dgn	CHECKED - CWC	REVISED	
PLOT SCALE = 0:2 ':' / in.	DRAWN - DLH	REVISED	
PLOT DATE = 6/26/2013	CHECKED - SDS/CWC	REVISED	

STATE OF ILLINOIS
DEPARTMENT OF TRANSPORTATION

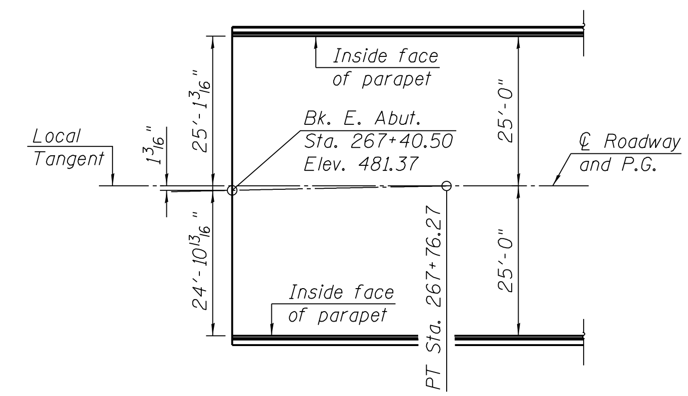
SHEET NO. 1 OF 3 SHEETS

F.A.U. RTE.	SECTION	COUNTY	TOTAL SHEETS	SHEET NO.
6659	11BR-1	PEORIA	3	1

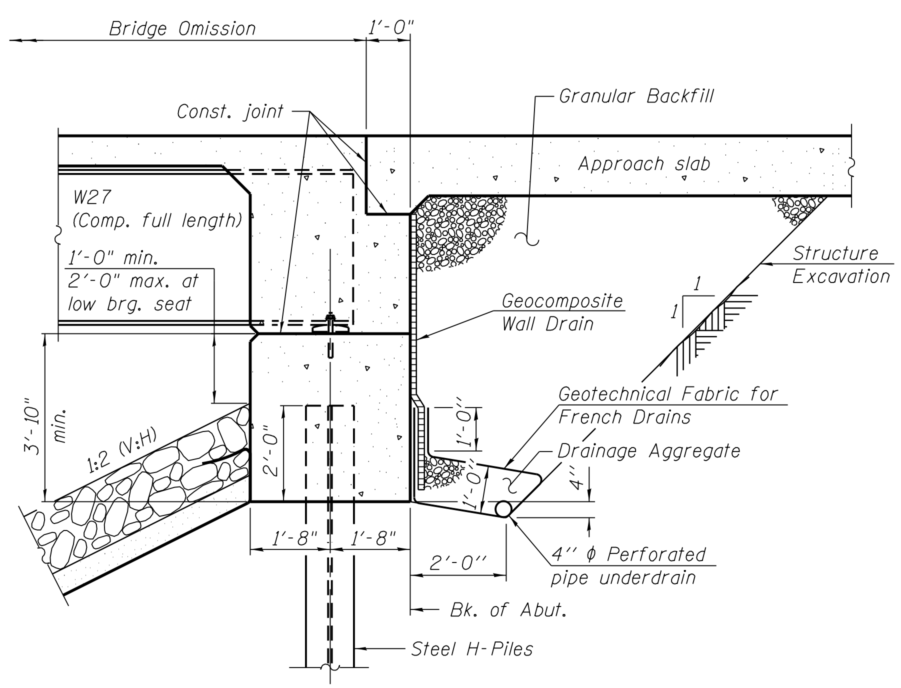
CONTRACT NO. 68185
ILLINOIS FED. AID PROJECT



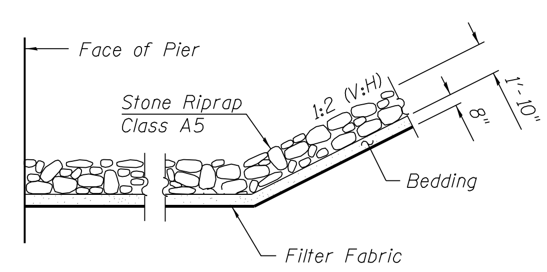
CROSS SECTION
(Looking West)



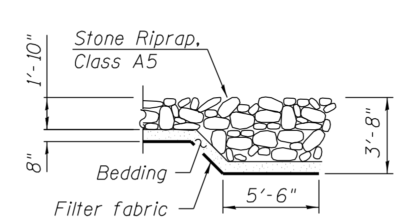
OFFSET SKETCH



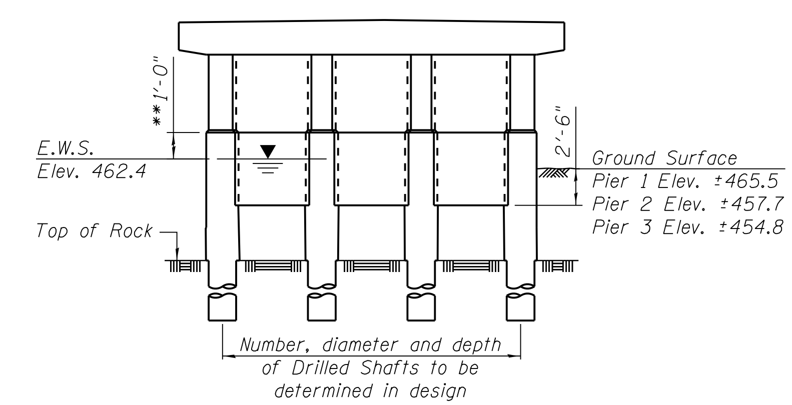
SECTION THRU ABUTMENT



SECTION A-A



SECTION B-B

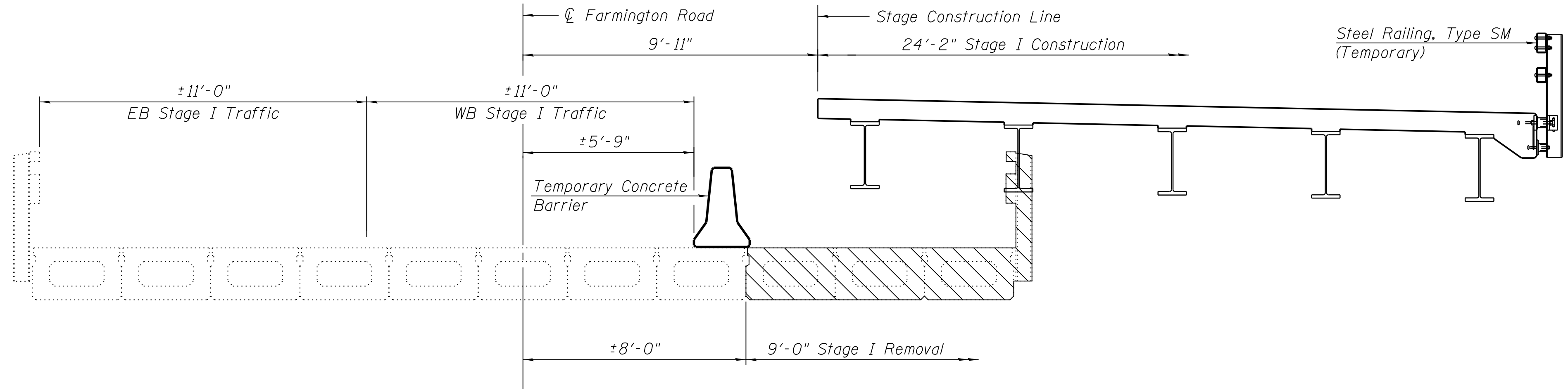


PIER SKETCH

** 1'-0" above E.W.S.E., typ. at Piers 2 and 3.
Use 1'-0" above Ground Surface at Pier 1.

design firm no. 184001036 whks engineers + planners + land surveyors	USER NAME = $OPERATOR$	DESIGNED - SDS	REVISED	STATE OF ILLINOIS DEPARTMENT OF TRANSPORTATION	DETAILS STRUCTURE NO. 072-0245
	FILE NAME = 0720245-68185.dgn	CHECKED - CWC	REVISED		
	PLOT SCALE = 0:2 ':' / in.	DRAWN - DLH	REVISED		
	PLOT DATE = 6/26/2013	CHECKED - SDS/CWC	REVISED		SHEET NO. 2 OF 3 SHEETS

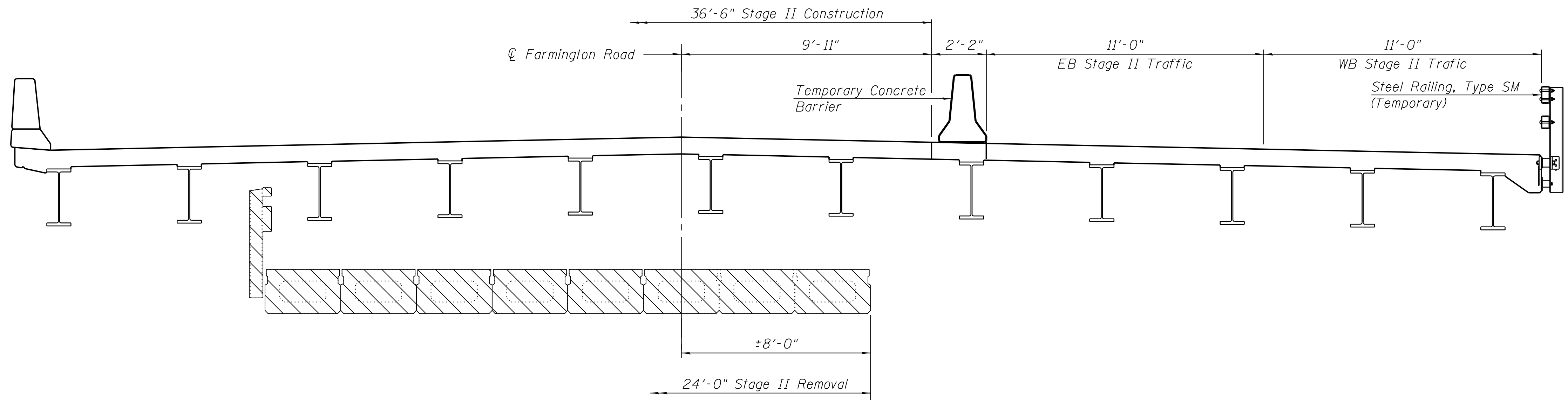
F.A.U. RTE.	SECTION	COUNTY	TOTAL SHEETS	SHEET NO.
6659	11BR-1	PEORIA	3	2
		CONTRACT NO. 68185		
	ILLINOIS FED. AID PROJECT			



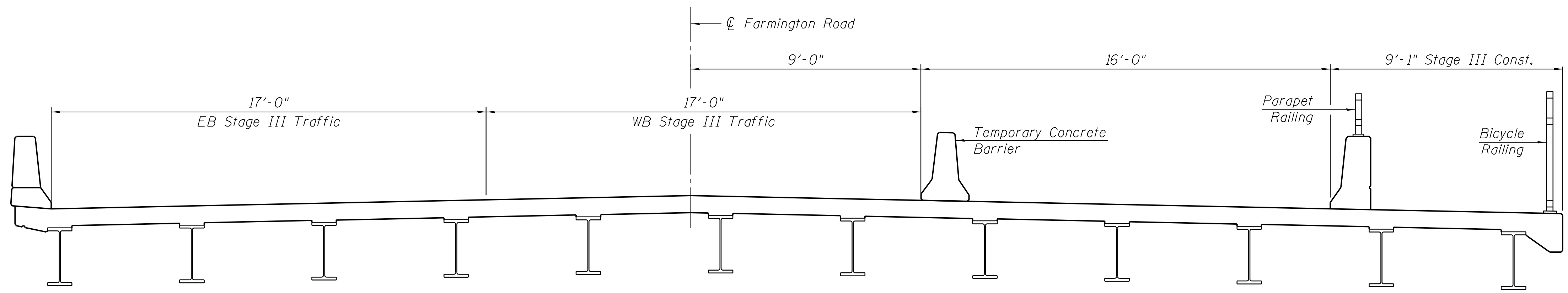
Note:
All Cross Sections are looking West.

STAGE I CONSTRUCTION

Note:
Portions of the original closed abutment and existing pile bent abutment to be removed shall not be completed in Stage I Removal operation. Removal of abutment portions shall occur during Stage II Removal operation.



STAGE II CONSTRUCTION



STAGE III CONSTRUCTION

design firm
no. 184001036

whks
engineers + planners + land surveyors

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FILE NAME = 0720245-68185.dgn	CHECKED - CWC	REVISED				
PLOT SCALE = 0.2 ' / in.	DRAWN - DLH	REVISED				
PLOT DATE = 6/26/2013	CHECKED - SDS/CWC	REVISED		SHEET NO. 3 OF 3 SHEETS		

F.A.U. RTE.	SECTION	COUNTY	TOTAL SHEETS	SHEET NO.
6659	11BR-1	PEORIA	3	3
		CONTRACT NO. 68185		
	ILLINOIS FED. AID PROJECT			

EXHIBIT C

BORING LOGS

Illinois Department of Transportation

Division of Highways
SCI Engineering

SOIL BORING LOG

Date 12/07/10

ROUTE FAU 6659 **DESCRIPTION** Structure Replacment - Farmington Road over Kickapoo Creek **LOGGED BY** KEG

SECTION 11I, 11BR-1 **LOCATION** Limestone Township; SW1/4, **SEC.** 1, **TWP.** 8N, **RNG.** 7E

COUNTY Peoria **DRILLING METHOD** CME 55LC w/HSA **HAMMER TYPE** Automatic

STRUCT. NO. 072-0063 (ex.); 072-00XX (prop.)
Station

BORING NO. B-1 (E. Abut)
Station 267+50
Offset 36 ft Lt
Ground Surface Elev. 474.53 ft

Surface Water Elev. ft
Stream Bed Elev. ft

Groundwater Elev.:
First Encounter 451.5 ft ▼
Upon Completion 451.5 ft ▽
After - **Hrs.** - ft

Description	Elev. (ft)	DEPTH (ft)	BLOWS (/6")	UCS Qu (tsf)	MOIST (%)
FILL: Brown, sandy loam, fine grain (A-2)			5 3 3	-	3
	471.5				
FILL: Brown, clay loam, trace fine gravel (A-6)		-5	3 2 1	2.5 P	13
	469.0				
FILL: Gray, silty clay (A-6)			2 2 3	0.7 S/10	24
LL-40, PL-24, PI-16		-10	2 2 4	0.8 P	26
	464.0				
FILL: Brown, sandy clay loam (A-6) Becomes dark brown			5 4 5	2.8 P	16
	461.5				
SILTY CLAY LOAM: Brown (A-6)		-15	2 2 4	0.3 S/10	25
			2 2 2	0.1 S/10	21
	456.5				
LOAM: Brown (A-4)		-20	WH WH 1	-	19
LOAM: Brown (A-4) *(continued)*			1 4 2	<0.25 P	21
	451.5 ▼				
SAND: Brown, fine to coarse, trace fine gravel (A-1) Mud rotary drilling started at 23 feet. Hollow stem augers advanced after coarse gravel encountered.		-25	2 1 2		
			3 3 6		
		-30	6 10 10		
No recovery		-35	27 27 25		
	437.5				
SAND: Brown, fine to medium (A-3)		-40	10 12 15		

The Unconfined Compressive Strength (UCS) Failure Mode is indicated by (B-Bulge, S-Shear, P-Penetrometer)
AASHTO Classifications are based on visual classifications unless otherwise noted BBS, form 137 (Rev. 8-99)

Illinois Department of Transportation

Division of Highways
SCI Engineering

SOIL BORING LOG

Date 12/07/10

ROUTE FAU 6659 DESCRIPTION Structure Replacment - Farmington Road over Kickapoo Creek LOGGED BY KEG

SECTION 11I, 11BR-1 LOCATION Limestone Township; SW1/4, **SEC.** 1, **TWP.** 8N, **RNG.** 7E

COUNTY Peoria DRILLING METHOD CME 55LC w/HSA HAMMER TYPE Automatic

STRUCT. NO. 072-0063 (ex.); 072-00XX (prop.)
Station

BORING NO. B-1 (E. Abut)
Station 267+50
Offset 36 ft Lt
Ground Surface Elev. 474.53 ft

Surface Water Elev. ft
Stream Bed Elev. ft

Groundwater Elev.:
First Encounter 451.5 ft ▼
Upon Completion 451.5 ft ▽
After - Hrs. - ft

Description	Elev.	DEPTH (ft)	BLOWS (/6")	UCS Qu (tsf)	MOIST (%)
SAND: Brown, fine to medium (A-3) *(continued)*					
Becomes organish brown	433.0		4 22 50	-	20
CLAYEY SHALE: Gray					
			24 40 50/2"	-	15
		-45			
	428.3				
Auger refusal at 46.2 feet.					
		-50			
		-55			
		-60			

The Unconfined Compressive Strength (UCS) Failure Mode is indicated by (B-Bulge, S-Shear, P-Penetrometer)
AASHTO Classifications are based on visual classifications unless otherwise noted BBS, form 137 (Rev. 8-99)

Illinois Department of Transportation

Division of Highways
SCI Engineering

SOIL BORING LOG

Date 12/08/10

ROUTE FAU 6659 **DESCRIPTION** Structure Replacment - Farmington Road over Kickapoo Creek **LOGGED BY** KEG

SECTION 11I, 11BR-1 **LOCATION** Limestone Township; SW1/4, **SEC.** 1, **TWP.** 8N, **RNG.** 7E

COUNTY Peoria **DRILLING METHOD** CME 55LC w/HSA **HAMMER TYPE** Automatic

STRUCT. NO. 072-0063 (ex.); 072-00XX (prop.)
Station

BORING NO. B-2 (Pier 1)
Station 268+17
Offset 36 ft Lt
Ground Surface Elev. 470.60 ft

Surface Water Elev. ft
Stream Bed Elev. ft

Groundwater Elev.:
First Encounter 455.1 ft ▼
Upon Completion 455.1 ft ▽
After - **Hrs.** - ft

Description	DEPTH (ft)	BLOWS (/6")	UCS Qu (tsf)	MOIST (%)
FILL: Brown, silty loam (A-4)		3 2 2	0.8 P	21
467.6				
CLAY LOAM: Brown, trace fine gravel (A-7) LL-42, PL-23, PI-19	-5	3 3 3	0.7 B	23
465.1				
SILTY LOAM: Brown (A-4)		1 2 2	0.4 S/15	23
	-10	2 3 6	0.4 S/10	22
460.1				
SANDY LOAM: Brown (A-4)		3 2 3	0.5 S/15	17
457.6				
SANDY CLAY LOAM: Brown (A-4)	-15	1 1 1	0.4 B	23
455.1 ▼				
SAND: Brown, fine (A-3)		WH 3 4		20
452.6				
SAND: Brown, fine to coarse, trace fine gravel (A-1)	-20	1 3 4		

Description	DEPTH (ft)	BLOWS (/6")	UCS Qu (tsf)	MOIST (%)
SAND: Brown, fine to coarse, trace fine gravel (A-1) *(continued)* Added mud to HSA Becomes dark brown and medium to coarse		3 3 5		18
Becomes brown and fine to coarse	-25	5 9 5		
445.1				
GRAVEL: Coarse (A-1) Poor recovery		10 10 14		
Poor recovery	-30	21 20 23		17
	-35	20 63 46		15
434.6				
SAND: Brown, fine to medium, trace fine and coarse gravel (A-1) 434.1 CLAYEY SHALE: Gray		50/3" 23 50/3"		16
	-40	31 50/6"		16

Illinois Department of Transportation

Division of Highways
SCI Engineering

SOIL BORING LOG

Date 12/08/10

ROUTE FAU 6659 **DESCRIPTION** Structure Replacment - Farmington Road over Kickapoo Creek **LOGGED BY** KEG

SECTION 11I, 11BR-1 **LOCATION** Limestone Township; SW1/4, **SEC.** 1, **TWP.** 8N, **RNG.** 7E

COUNTY Peoria **DRILLING METHOD** CME 55LC w/HSA **HAMMER TYPE** Automatic

STRUCT. NO. 072-0063 (ex.); 072-00XX (prop.)
Station

BORING NO. B-2 (Pier 1)
Station 268+17
Offset 36 ft Lt
Ground Surface Elev. 470.60 ft

Surface Water Elev. ft
Stream Bed Elev. ft

Groundwater Elev.:
First Encounter 455.1 ft ▼
Upon Completion 455.1 ft ▽
After - **Hrs.** - ft

Description	Elev.	DEPTH (ft)	BLOWS (/6")	UCS Qu (tsf)	MOIST (%)
CLAYEY SHALE: Gray *(continued)*					
			40 50/4"		14
			35 50/3"		14
		-45			
			40 50/2"		16
			50		
	421.4				
Boring terminated at 49.2 ft.			50/2"		14
		-50			
		-55			
		-60			

The Unconfined Compressive Strength (UCS) Failure Mode is indicated by (B-Bulge, S-Shear, P-Penetrometer)
AASHTO Classifications are based on visual classifications unless otherwise noted BBS, form 137 (Rev. 8-99)

Illinois Department of Transportation

Division of Highways
SCI Engineering

SOIL BORING LOG

Date 12/7, 8/2010

ROUTE FAU 6659 **DESCRIPTION** Structure Replacment - Farmington Road over Kickapoo Creek **LOGGED BY** KEG

SECTION 11I, 11BR-1 **LOCATION** Limestone Township; SW1/4, **SEC.** 1, **TWP.** 8N, **RNG.** 7E

COUNTY Peoria **DRILLING METHOD** CME 55LC w/HSA **HAMMER TYPE** Automatic

STRUCT. NO. 072-0063 (ex.); 072-00XX (prop.)
Station

BORING NO. B-3 (Pier 2)
Station 268+65
Offset 39 ft Lt
Ground Surface Elev. 469.56 ft

Surface Water Elev. ft
Stream Bed Elev. ft

Groundwater Elev.:
First Encounter 454.1 ft ▼
Upon Completion 454.1 ft ▽
After - **Hrs.** - ft

Description	DEPTH (ft)	BLOWS (/6")	UCS Qu (tsf)	MOIST (%)
SILTY LOAM: Brown (A-4) LL-30, PL-21, PI-9		2 2 3	1.5 P	23
465.6 SANDY LOAM: Brown, trace fine gravel (A-4)	-5	5 8 8	2.0 P	13
464.1 SILTY CLAY: Brown (A-6)		3 3 3	2.5 P	25
461.6 SILTY LOAM: Gray (A-4)	-10	2 2 1	1.0 P	28
		WH WH WH	0.3 P	34
456.6 SILTY CLAY LOAM: Gray (A-6)	-15	WH 1 2	0.4 B	33
454.1 ▼ SAND: Dark gray, medium to coarse, trace fine gravel (A-1)		WR WH 1		21
451.6 SILTY LOAM: Gray (A-4)	-20	1 1 2	0.3 P	35

Description	DEPTH (ft)	BLOWS (/6")	UCS Qu (tsf)	MOIST (%)
449.1 SANDY LOAM: Gray (A-4) Added mud to HSA		2 1 2	0.5 B	21
446.6 SAND: Gray, fine to coarse, trace fine gravel (A-1)	-25	6 6 7		17
Becomes brown and some fine to coarse gravel		7 13 11		
441.6 SAND: Brown, fine (A-3)	-30	7 8 9		
439.1 CLAYEY SHALE: Gray	-35	25 50/3" 50/1"		18
		50 50/2"		14
	-40	50 50/4"		15

The Unconfined Compressive Strength (UCS) Failure Mode is indicated by (B-Bulge, S-Shear, P-Penetrometer)
AASHTO Classifications are based on visual classifications unless otherwise noted BBS, form 137 (Rev. 8-99)

Illinois Department of Transportation

Division of Highways
SCI Engineering

SOIL BORING LOG

Date 12/7, 8/2010

ROUTE FAU 6659 **DESCRIPTION** Structure Replacment - Farmington Road over Kickapoo Creek **LOGGED BY** KEG

SECTION 11I, 11BR-1 **LOCATION** Limestone Township; SW1/4, **SEC.** 1, **TWP.** 8N, **RNG.** 7E

COUNTY Peoria **DRILLING METHOD** CME 55LC w/HSA **HAMMER TYPE** Automatic

STRUCT. NO. 072-0063 (ex.); 072-00XX (prop.)
Station

BORING NO. B-3 (Pier 2)
Station 268+65
Offset 39 ft Lt
Ground Surface Elev. 469.56 ft

Surface Water Elev. ft
Stream Bed Elev. ft

Groundwater Elev.:
First Encounter 454.1 ft ▼
Upon Completion 454.1 ft ▽
After - **Hrs.** - ft

Description	DEPTH (ft)	BLOWS (/6")	UCS Qu (tsf)	MOIST (%)
CLAYEY SHALE: Gray *(continued)*				
		38 50/4"		15
		50 50/2"		13
	-45			
423.0		50/5" 50/2"		17
Boring terminated at 46.6 ft.				
	-50			
	-55			
	-60			

The Unconfined Compressive Strength (UCS) Failure Mode is indicated by (B-Bulge, S-Shear, P-Penetrometer)
AASHTO Classifications are based on visual classifications unless otherwise noted BBS, form 137 (Rev. 8-99)

Illinois Department of Transportation

Division of Highways
SCI Engineering

SOIL BORING LOG

Date 12/08/10

ROUTE FAU 6659 **DESCRIPTION** Structure Replacment - Farmington Road over Kickapoo Creek **LOGGED BY** KEG

SECTION 11I, 11BR-1 **LOCATION** Limestone Township; SW1/4, **SEC.** 1, **TWP.** 8N, **RNG.** 7E

COUNTY Peoria **DRILLING METHOD** CME 55LC w/HSA **HAMMER TYPE** Automatic

STRUCT. NO. 072-0063 (ex.); 072-00XX (prop.)
Station

BORING NO. B-4 (W. Abut)
Station 270+19
Offset 26 ft Rt
Ground Surface Elev. 479.30 ft

Surface Water Elev. ft
Stream Bed Elev. ft

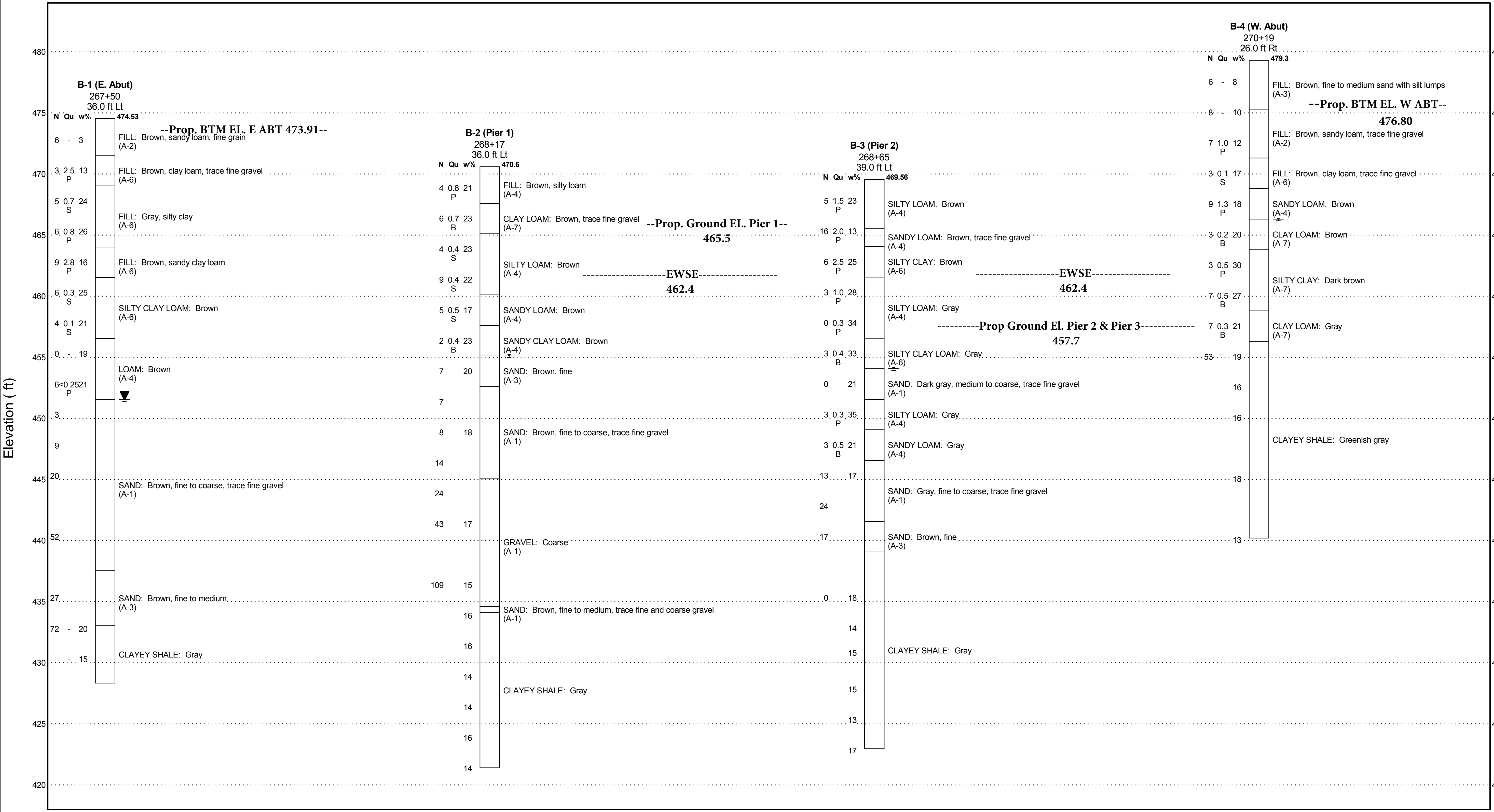
Groundwater Elev.:
First Encounter 466.3 ft ▼
Upper Completion 466.3 ft ▽
After - **Hrs.** - ft

Description	Elev.	DEPTH (ft)	BLOWS (/6")	UCS Qu (tsf)	MOIST (%)
FILL: Brown, fine to medium sand with silt lumps (A-3)			3 3 3	-	8
FILL: Brown, sandy loam, trace fine gravel (A-2)	475.3	-5	4 4 4	-	10
Trace coarse gravel			4 3 4	1.0 P	12
FILL: Brown, clay loam, trace fine gravel (A-6)	471.3	-10	2 2 1	0.1 S/10	17
SANDY LOAM: Brown (A-4)	468.8		5 4 5	1.3 P	18
CLAY LOAM: Brown (A-7)	466.3 ▼	-15	2 1 2	0.2 B	20
SILTY CLAY: Dark brown (A-7) LL-49, PL-29, PI-20	463.8		WH 1 2	0.5 P	30
Becomes brown		-20	3 3 4	0.5 B	27
CLAY LOAM: Gray (A-7)	458.8		WH 2 5	0.3 B	21
CLAYEY SHALE: Greenish gray	456.3	-25	7 19 34		19
			26 43 50/3"		16
Becomes gray		-30	50/2" 50		16
		-35	50 50/3"		18
Boring terminated at 39.1 ft.	440.2	-40	50 50/1"		13

The Unconfined Compressive Strength (UCS) Failure Mode is indicated by (B-Bulge, S-Shear, P-Penetrometer)
AASHTO Classifications are based on visual classifications unless otherwise noted BBS, form 137 (Rev. 8-99)

EXHIBIT D

SUBSURFACE PROFILE



Kaskaskia Engineering Group, LLC

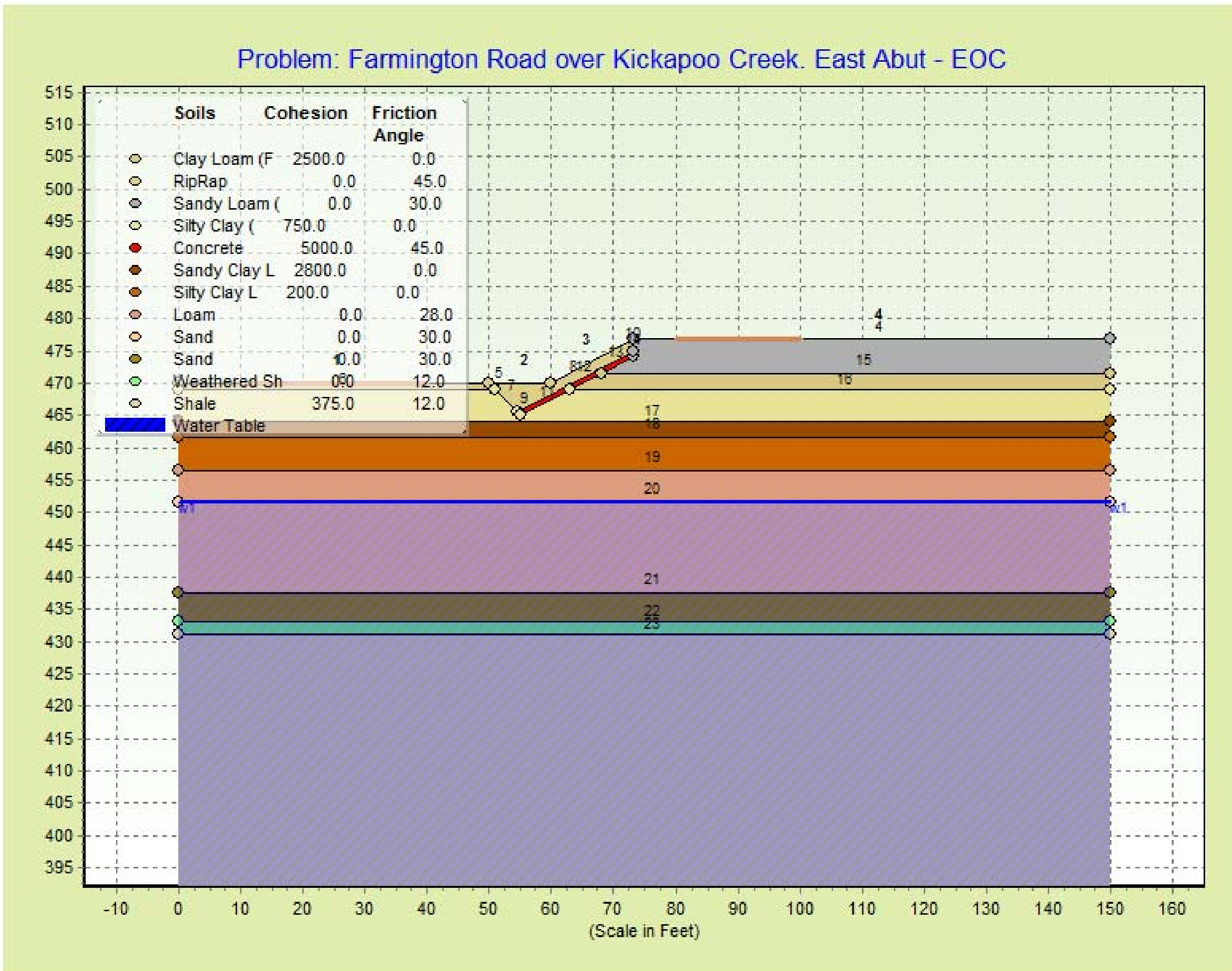
SUBSURFACE PROFILE

Route: FAU 6659
Section: 11I, 11BR-1
County: Peoria

EXHIBIT E

STABL SLOPE STABILITY ANALYSIS

================= DATA SUMMARY ===================



Profile Data

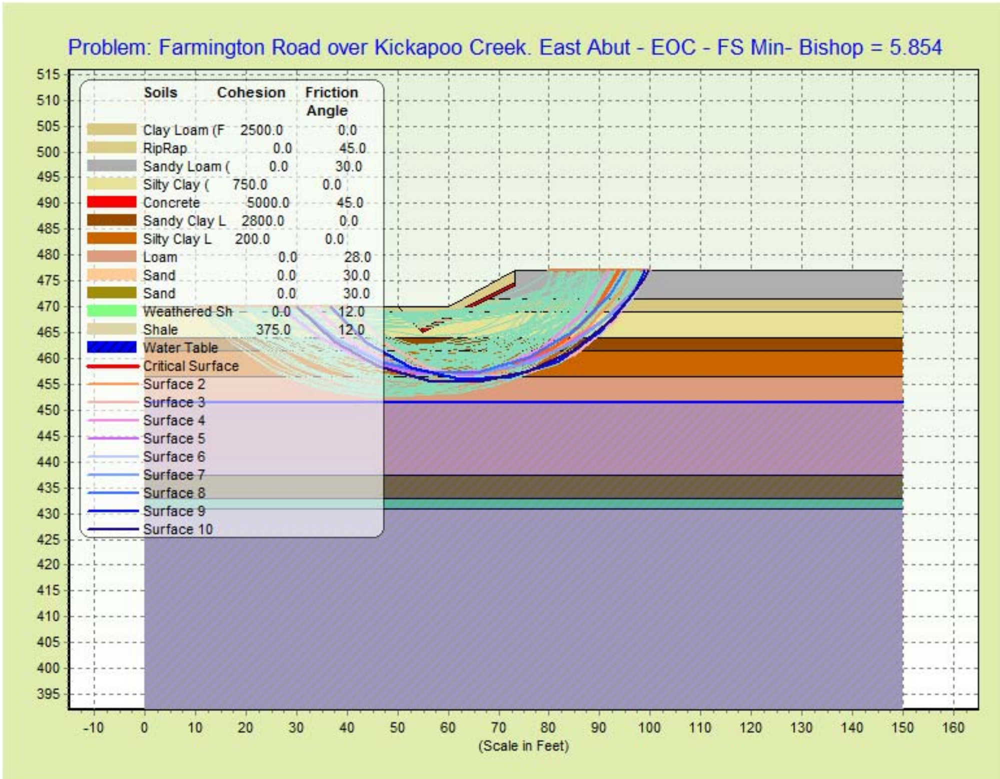
Segment Number	Left Extreme X	Left Extreme Y	Right Extreme X	Right Extreme Y	Soil Under Segment
1	0	470	50	470	2
2	50	470	60	470	11
3	60	470	73.32	476.96	11
4	73.32	476.96	150	476.96	1
5	50	470	51	469	2
6	0	469	51	469	3
7	51	469	54.5	465.5	3
8	54.5	465.5	73.32	474.91	10
9	54.5	465.5	55	465	3
10	73.32	474.91	73.32	476.96	1

Segment Number	Left Extreme X	Left Extreme Y	Right Extreme X	Right Extreme Y	Soil Under Segment
11	55	465	63	469	3
12	63	469	68	471.5	2
13	68	471.5	73.32	474.16	1
14	73.32	474.16	73.32	474.91	1
15	68	471.5	150	471.5	2
16	63	469	150	469	3
17	0	464	150	464	4
18	0	461.5	150	461.5	5
19	0	456.5	150	456.5	6
20	0	451.5	150	451.5	7
21	0	437.5	150	437.5	8
22	0	433	150	433	9
23	0	431	150	431	12

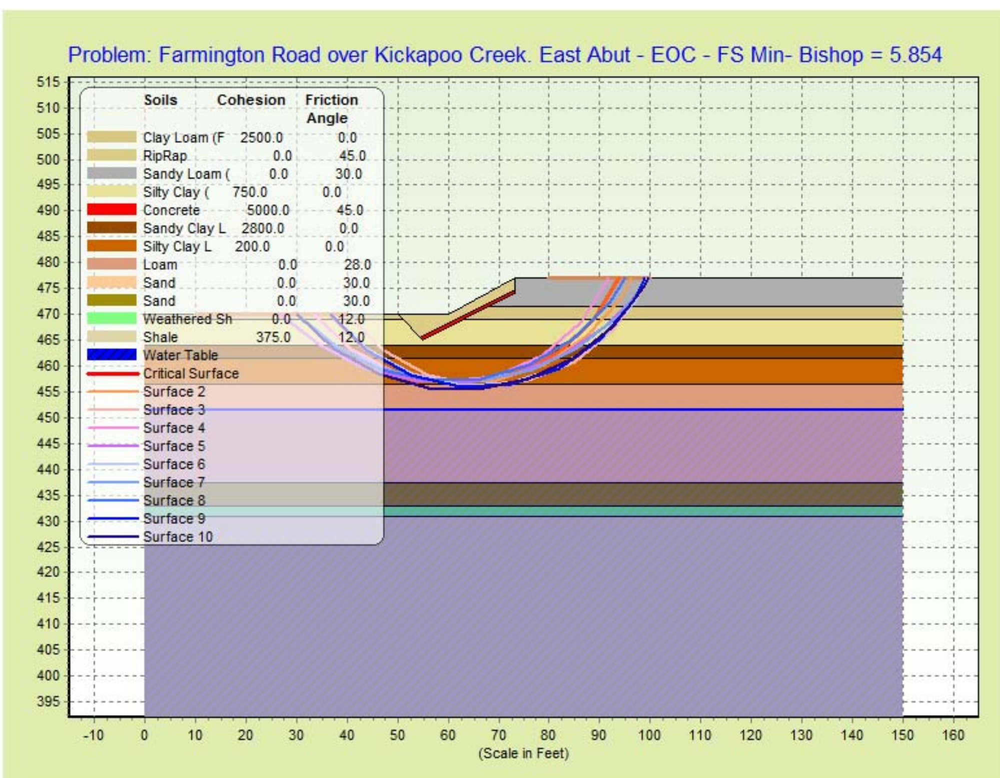
Soil Properties

Soil Number	Wet Unit Weight	Saturated Unit Weight	Cohesive Intercept	Friction Angle	Ru	Pressure Head	Water Table	Soil Name
1	115	115	0	30	0	0	1	Sandy Loam
2	125	125	2500	0	0	0	1	Clay Loam (Fill)
3	125	125	750	0	0	0	1	Silty Clay (Fill)
4	120	120	2800	0	0	0	1	Sandy Clay
5	120	120	200	0	0	0	1	Silty Clay Loam
6	125	125	0	28	0	0	1	Loam
7	115	115	0	30	0	0	1	Sand
8	115	115	0	30	0	0	1	Sand
9	130	135	0	12	0	0	1	Weathered
10	150	150	5000	45	0	0	0	Concrete
11	145	145	0	45	0	0	1	RipRap
12	130	130	375	12	0	0	1	Shale

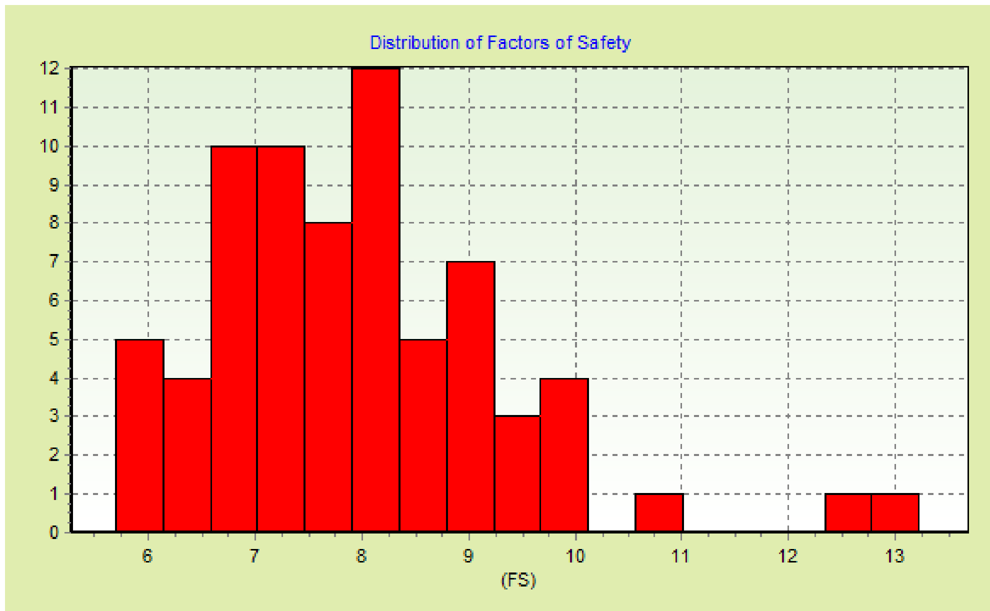
=============== All Surfaces Generated =============



=============== 10 Most Critical Surfaces ===============



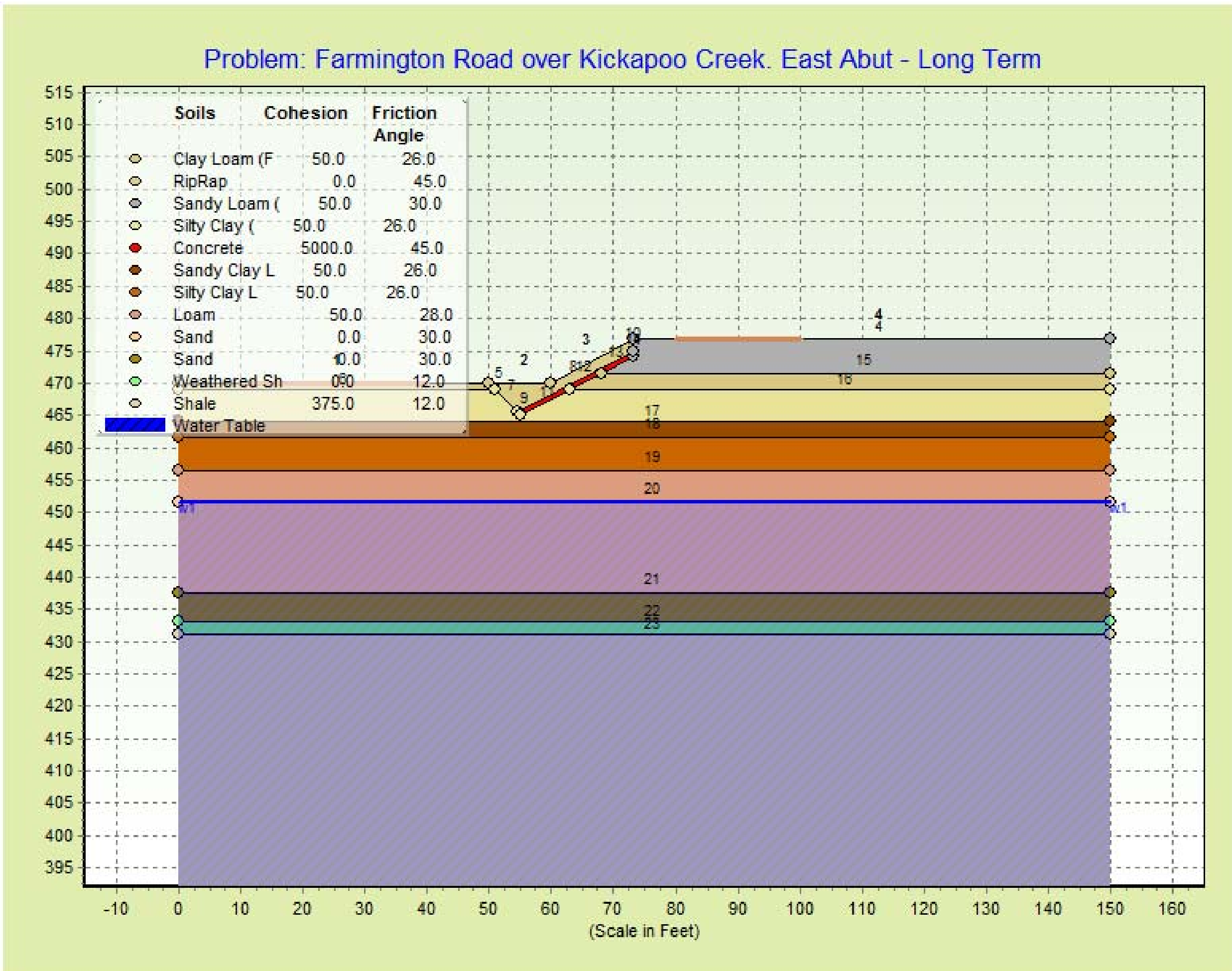
============= Factor of Safety Histogram ============



======== Factors of Safety of 10 Most Critical Surfaces =======

Surface Number	Factor of Safety
1	5.854
2	5.882
3	5.945
4	5.985
5	6.103
6	6.155
7	6.256
8	6.325
9	6.586
10	6.642

================== DATA SUMMARY ====================



Profile Data

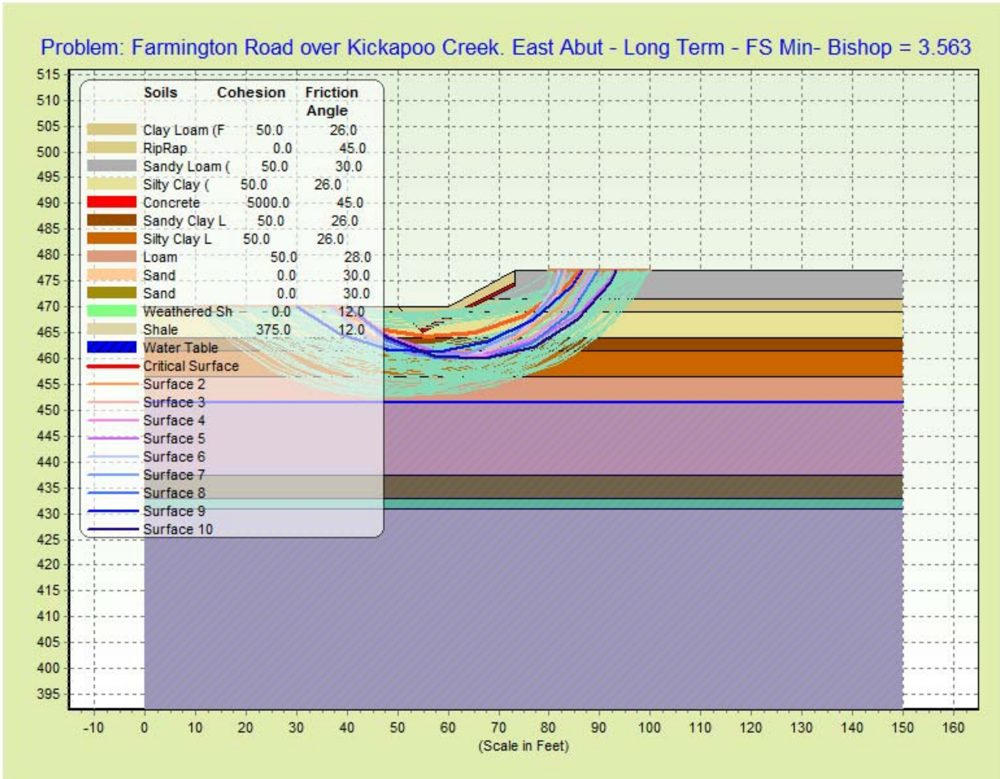
Segment Number	Left Extreme X	Left Extreme Y	Right Extreme X	Right Extreme Y	Soil Under Segment
1	0	470	50	470	2
2	50	470	60	470	11
3	60	470	73.32	476.96	11
4	73.32	476.96	150	476.96	1
5	50	470	51	469	2
6	0	469	51	469	3
7	51	469	54.5	465.5	3
8	54.5	465.5	73.32	474.91	10
9	54.5	465.5	55	465	3
10	73.32	474.91	73.32	476.96	1

Segment Number	Left Extreme X	Left Extreme Y	Right Extreme X	Right Extreme Y	Soil Under Segment
11	55	465	63	469	3
12	63	469	68	471.5	2
13	68	471.5	73.32	474.16	1
14	73.32	474.16	73.32	474.91	1
15	68	471.5	150	471.5	2
16	63	469	150	469	3
17	0	464	150	464	4
18	0	461.5	150	461.5	5
19	0	456.5	150	456.5	6
20	0	451.5	150	451.5	7
21	0	437.5	150	437.5	8
22	0	433	150	433	9
23	0	431	150	431	12

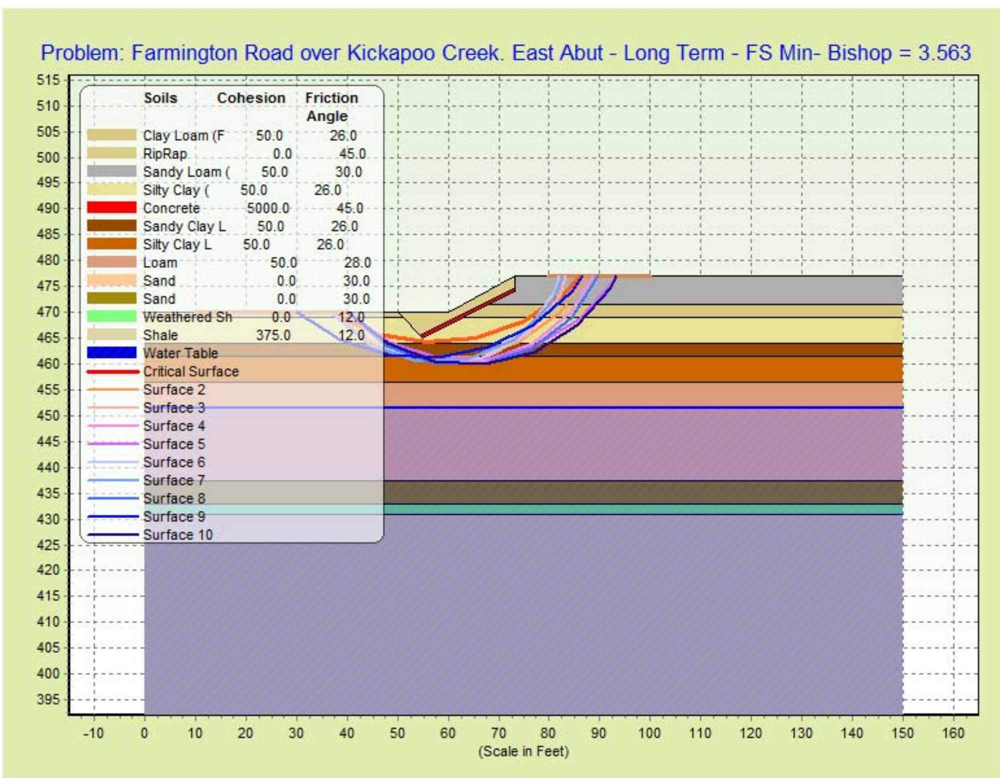
Soil Properties

Soil Number	Wet Unit Weight	Saturated Unit Weight	Cohesive Intercept	Friction Angle	Ru	Pressure Head	Water Table	Soil Name
1	115	115	50	30	0	0	1	Sandy Loam
2	125	125	50	26	0	0	1	Clay Loam (Fill)
3	125	125	50	26	0	0	1	Silty Clay (Fill)
4	120	120	50	26	0	0	1	Sandy Clay
5	120	120	50	26	0	0	1	Silty Clay Loam
6	125	125	50	28	0	0	1	Loam
7	115	115	0	30	0	0	1	Sand
8	115	115	0	30	0	0	1	Sand
9	130	130	0	12	0	0	1	Weathered
10	150	150	5000	45	0	0	0	Concrete
11	145	145	0	45	0	0	1	RipRap
12	130	130	375	12	0	0	1	Shale

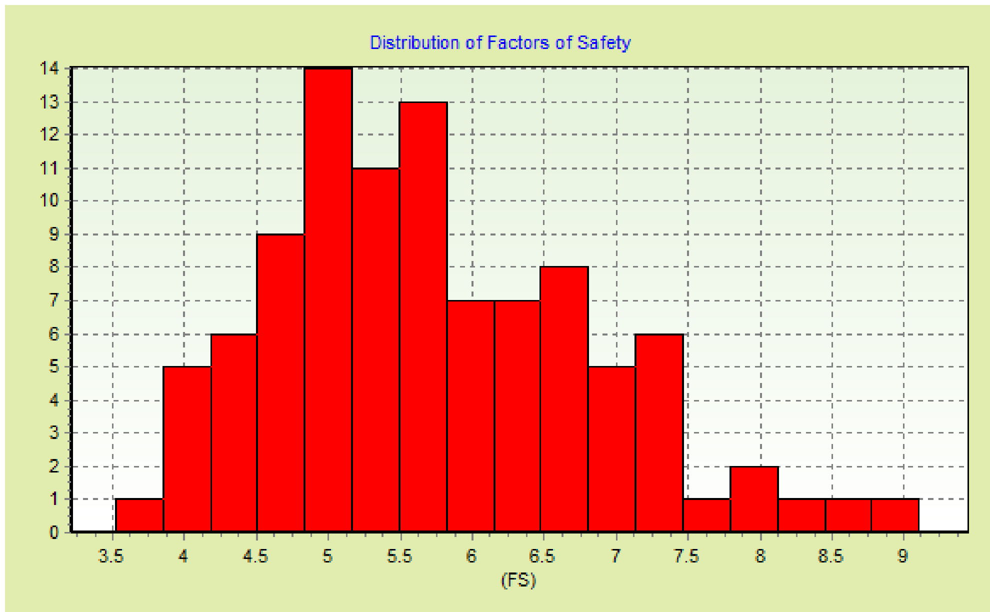
=============== All Surfaces Generated =============



=============== 10 Most Critical Surfaces ===============



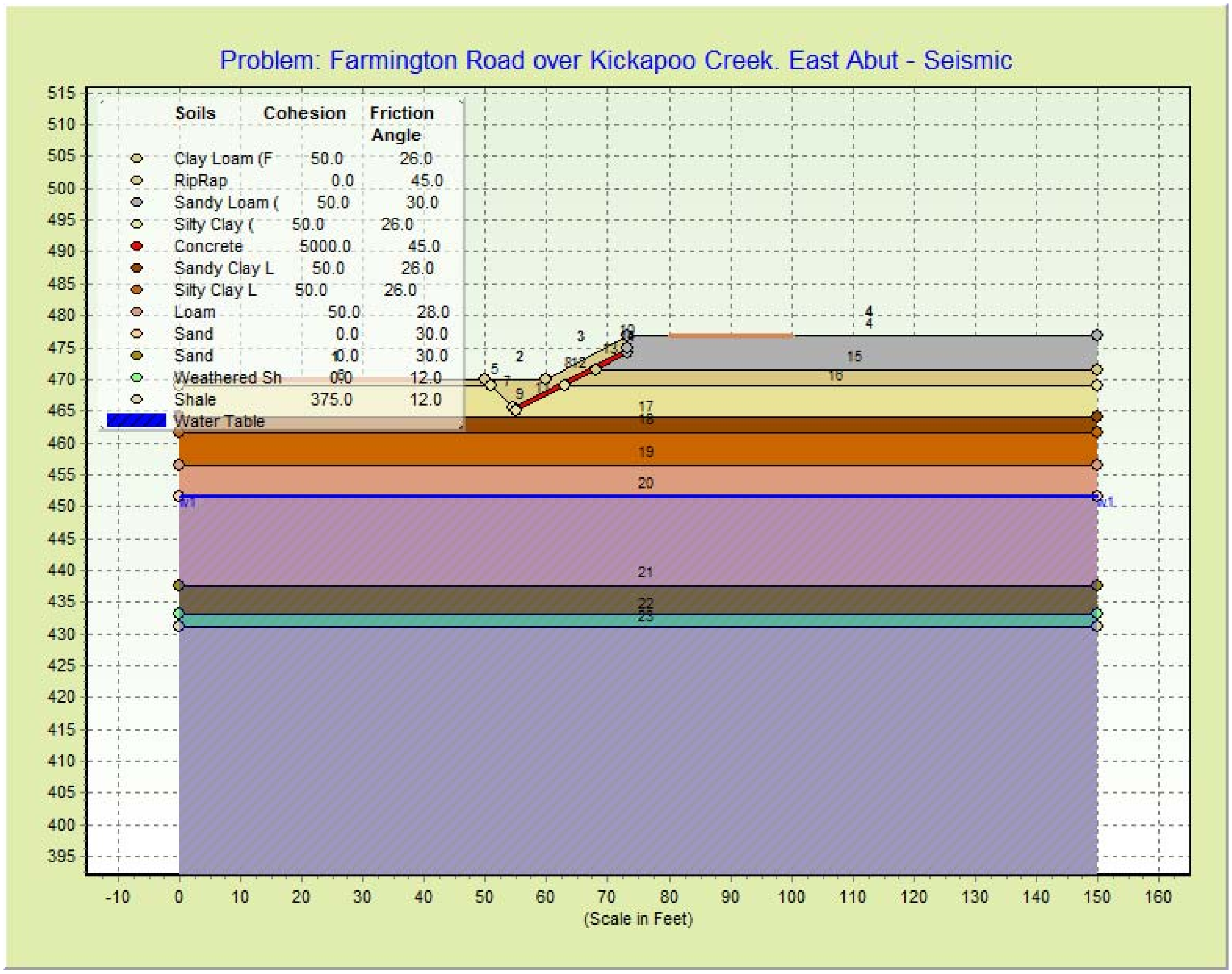
============= Factor of Safety Histogram ============



======== Factors of Safety of 10 Most Critical Surfaces =======

Surface Number	Factor of Safety
1	3.563
2	4.03
3	4.129
4	4.152
5	4.165
6	4.166
7	4.169
8	4.269
9	4.279
10	4.349

================= DATA SUMMARY ===================



Profile Data

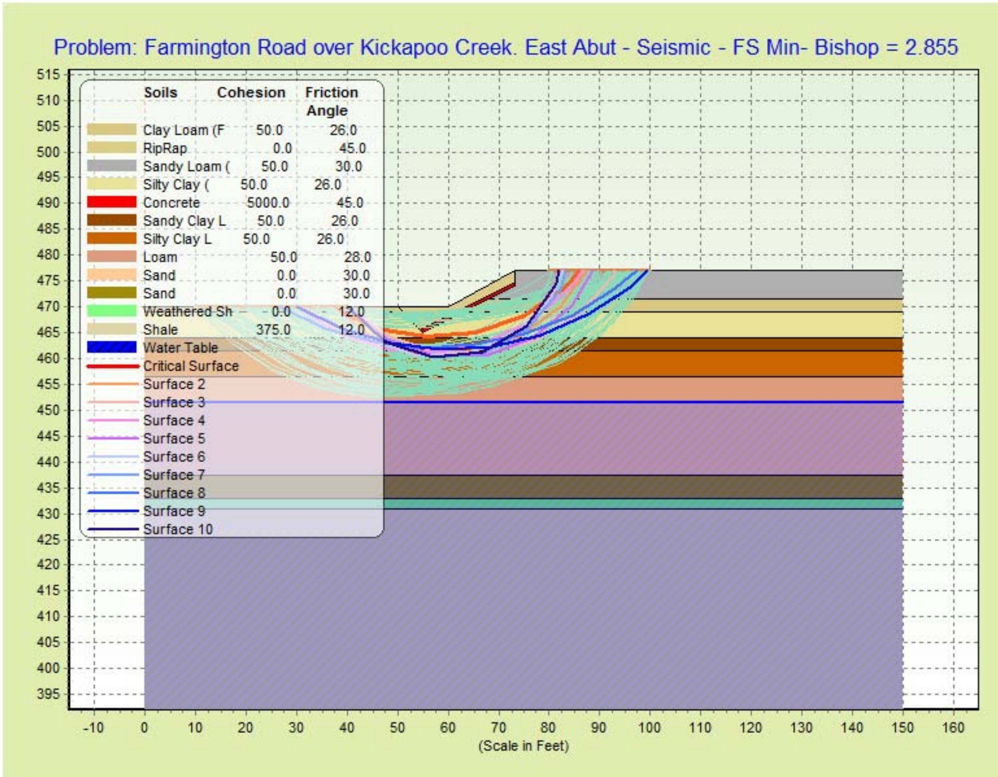
Segment Number	Left Extreme X	Left Extreme Y	Right Extreme X	Right Extreme Y	Soil Under Segment
1	0	470	50	470	2
2	50	470	60	470	11
3	60	470	73.32	476.96	11
4	73.32	476.96	150	476.96	1
5	50	470	51	469	2
6	0	469	51	469	3
7	51	469	54.5	465.5	3
8	54.5	465.5	73.32	474.91	10
9	54.5	465.5	55	465	3
10	73.32	474.91	73.32	476.96	1

Segment Number	Left Extreme X	Left Extreme Y	Right Extreme X	Right Extreme Y	Soil Under Segment
11	55	465	63	469	3
12	63	469	68	471.5	2
13	68	471.5	73.32	474.16	1
14	73.32	474.16	73.32	474.91	1
15	68	471.5	150	471.5	2
16	63	469	150	469	3
17	0	464	150	464	4
18	0	461.5	150	461.5	5
19	0	456.5	150	456.5	6
20	0	451.5	150	451.5	7
21	0	437.5	150	437.5	8
22	0	433	150	433	9
23	0	431	150	431	12

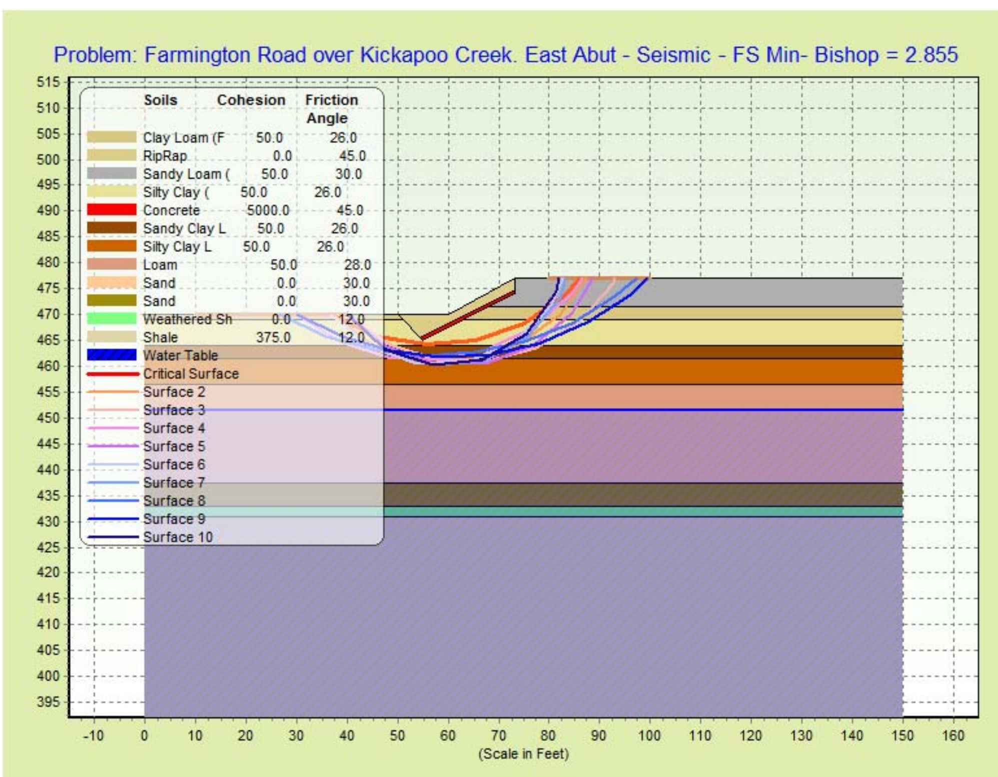
Soil Properties

Soil Number	Wet Unit Weight	Saturated Unit Weight	Cohesive Intercept	Friction Angle	Ru	Pressure Head	Water Table	Soil Name
1	115	115	50	30	0	0	1	Sandy Loam
2	125	125	50	26	0	0	1	Clay Loam (Fill)
3	125	125	50	26	0	0	1	Silty Clay (Fill)
4	120	120	50	26	0	0	1	Sandy Clay
5	120	120	50	26	0	0	1	Silty Clay Loam
6	125	125	50	28	0	0	1	Loam
7	115	115	0	30	0	0	1	Sand
8	115	115	0	30	0	0	1	Sand
9	130	135	0	12	0	0	1	Weathered
10	150	150	5000	45	0	0	0	Concrete
11	145	145	0	45	0	0	1	RipRap
12	130	130	375	12	0	0	1	Shale

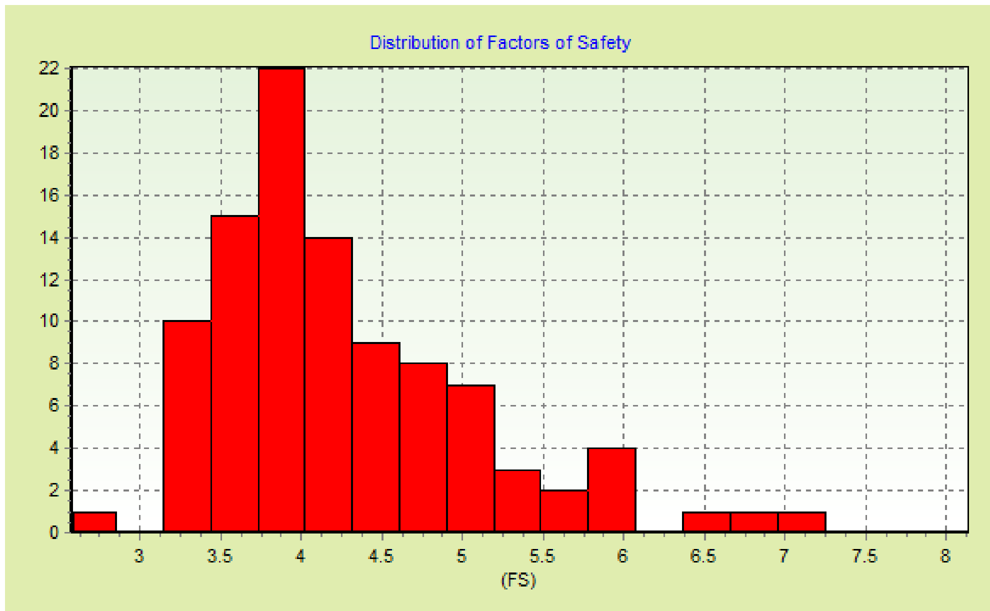
=============== All Surfaces Generated =============



=============== 10 Most Critical Surfaces ===============



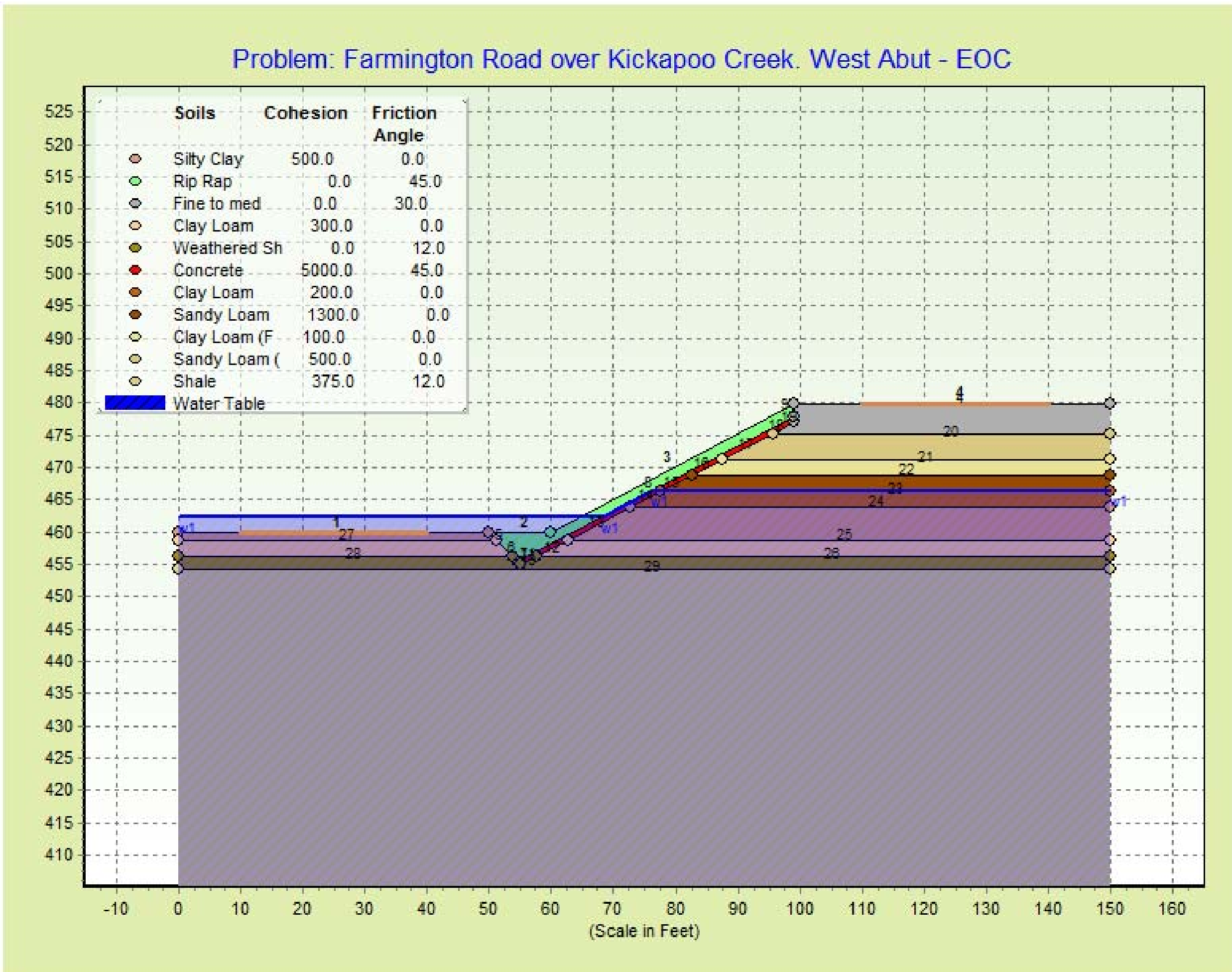
============= Factor of Safety Histogram ============



======== Factors of Safety of 10 Most Critical Surfaces =======

Surface Number	Factor of Safety
1	2.855
2	3.208
3	3.28
4	3.316
5	3.327
6	3.353
7	3.364
8	3.404
9	3.404
10	3.408

================== DATA SUMMARY ====================



Profile Data

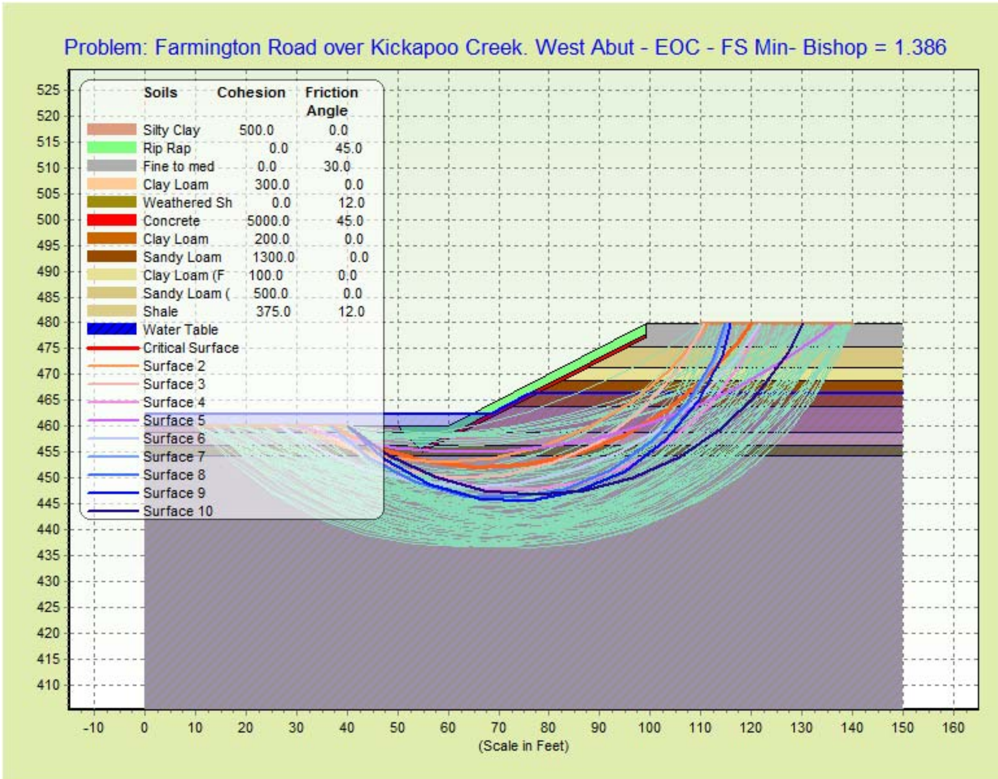
Segment Number	Left Extreme X	Left Extreme Y	Right Extreme X	Right Extreme Y	Soil Under Segment
1	0	460	50	460	6
2	50	460	60	460	9
3	60	460	99.1	479.85	9
4	99.1	479.85	150	479.85	1
5	50	460	51.2	458.8	6
6	51.2	458.8	53.7	456.3	7
7	53.7	456.3	54.5	455.5	8
8	54.5	455.5	99.1	477.8	10
9	99.1	477.8	99.1	479.85	1
10	54.5	455.5	55	455	8

Segment Number	Left Extreme X	Left Extreme Y	Right Extreme X	Right Extreme Y	Soil Under Segment
11	55	455	57.6	456.3	8
12	57.6	456.3	62.6	458.8	7
13	62.6	458.8	72.6	463.8	6
14	72.6	463.8	77.6	466.3	5
15	77.6	466.3	82.6	468.8	4
16	82.6	468.8	87.6	471.3	3
17	87.6	471.3	95.6	475.3	2
18	95.6	475.3	99.1	477.05	1
19	99.1	477.05	99.1	477.8	1
20	95.6	475.3	150	475.3	2
21	87.6	471.3	150	471.3	3
22	82.6	468.8	150	468.8	4
23	77.6	466.3	150	466.3	5
24	72.6	463.8	150	463.8	6
25	62.6	458.8	150	458.8	7
26	57.6	456.3	150	456.3	8
27	0	458.8	51.2	458.8	7
28	0	456.3	53.7	456.3	8
29	0	454.3	150	454.3	11

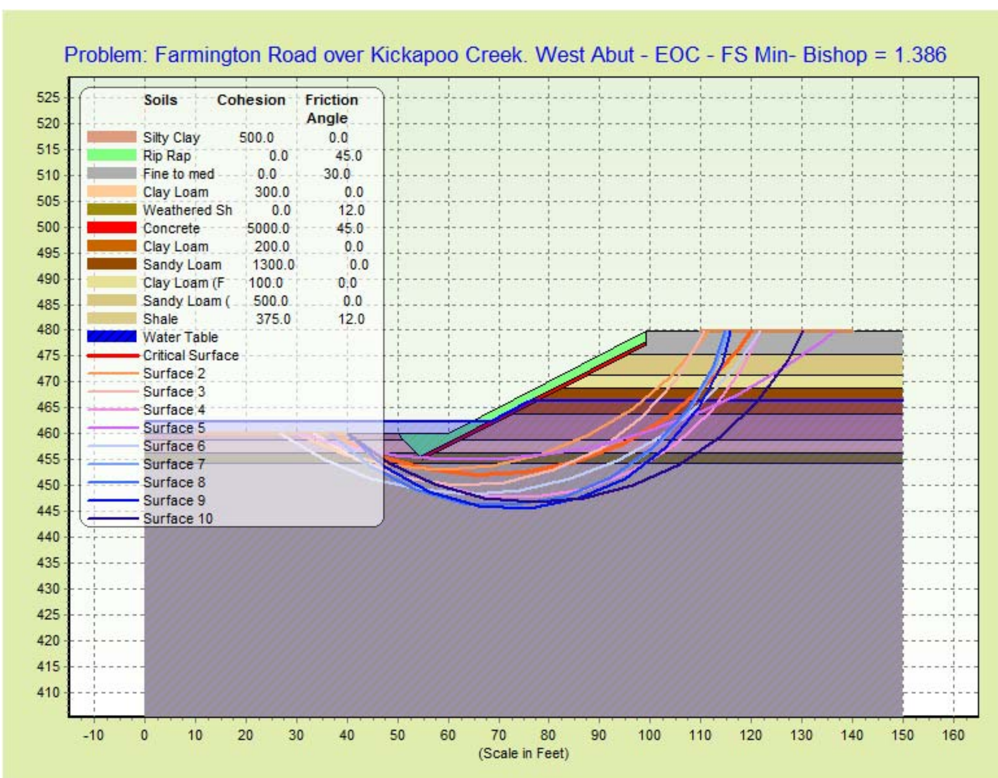
Soil Properties

Soil Number	Wet Unit Weight	Saturated Unit Weight	Cohesive Intercept	Friction Angle	Ru	Pressure Head	Water Table	Soil Name
1	115	115	0	30	0	0	1	Fine to med
2	115	115	500	0	0	0	1	Sandy Loam
3	125	125	100	0	0	0	1	Clay Loam (Fill)
4	115	115	1300	0	0	0	1	Sandy Loam
5	125	125	200	0	0	0	1	Clay Loam
6	125	125	500	0	0	0	1	Silty Clay
7	125	125	300	0	0	0	1	Clay Loam
8	130	130	0	12	0	0	1	Weathered
9	150	150	0	45	0	0	1	Rip Rap
10	150	150	5000	45	0	0	0	Concrete
11	130	130	375	12	0	0	1	Shale

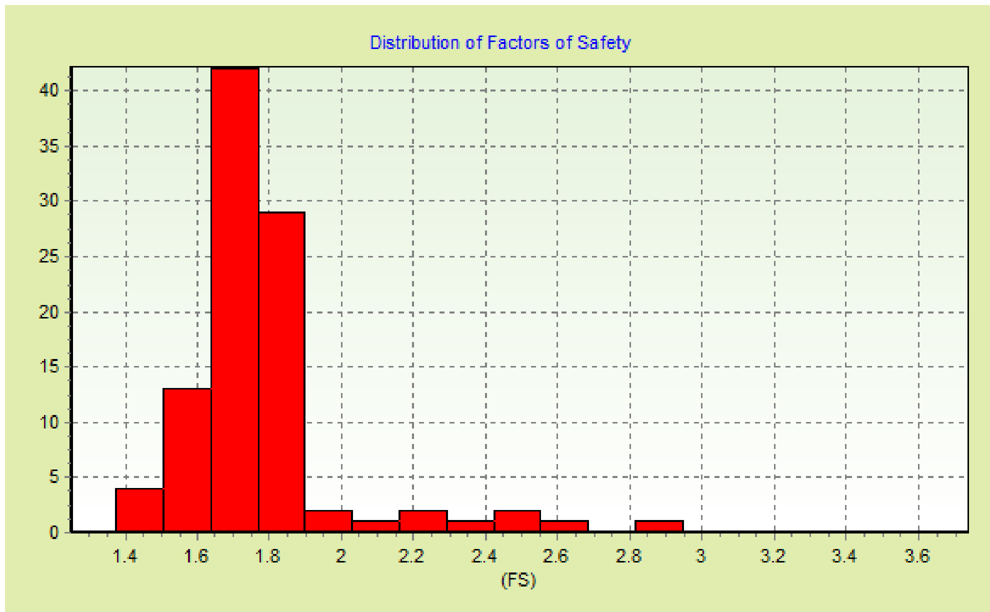
=============== All Surfaces Generated =============



=============== 10 Most Critical Surfaces ===============



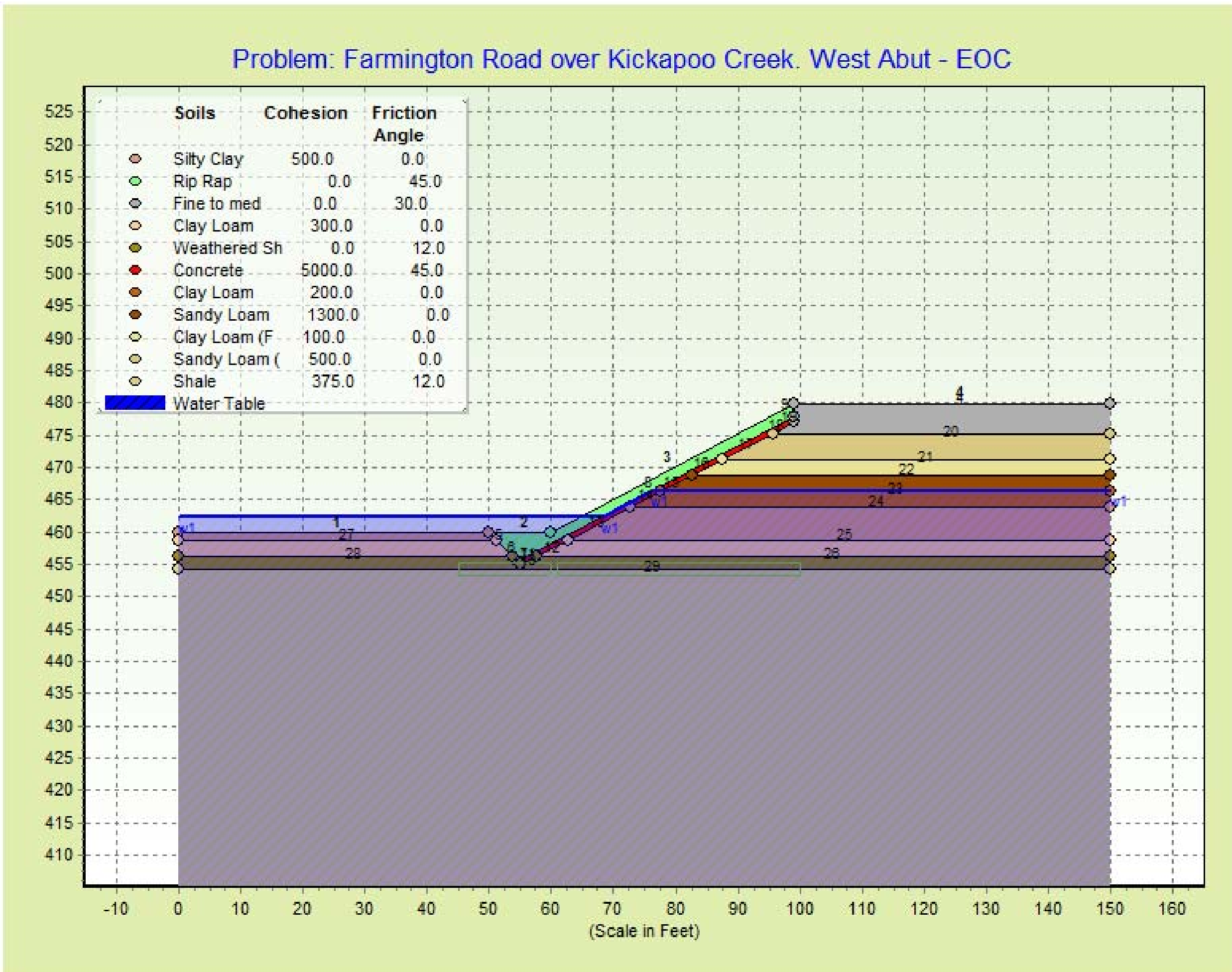
============= Factor of Safety Histogram ============



======== Factors of Safety of 10 Most Critical Surfaces =======

Surface Number	Factor of Safety
1	1.386
2	1.467
3	1.505
4	1.506
5	1.53
6	1.552
7	1.553
8	1.553
9	1.57
10	1.571

================== DATA SUMMARY ====================



Profile Data

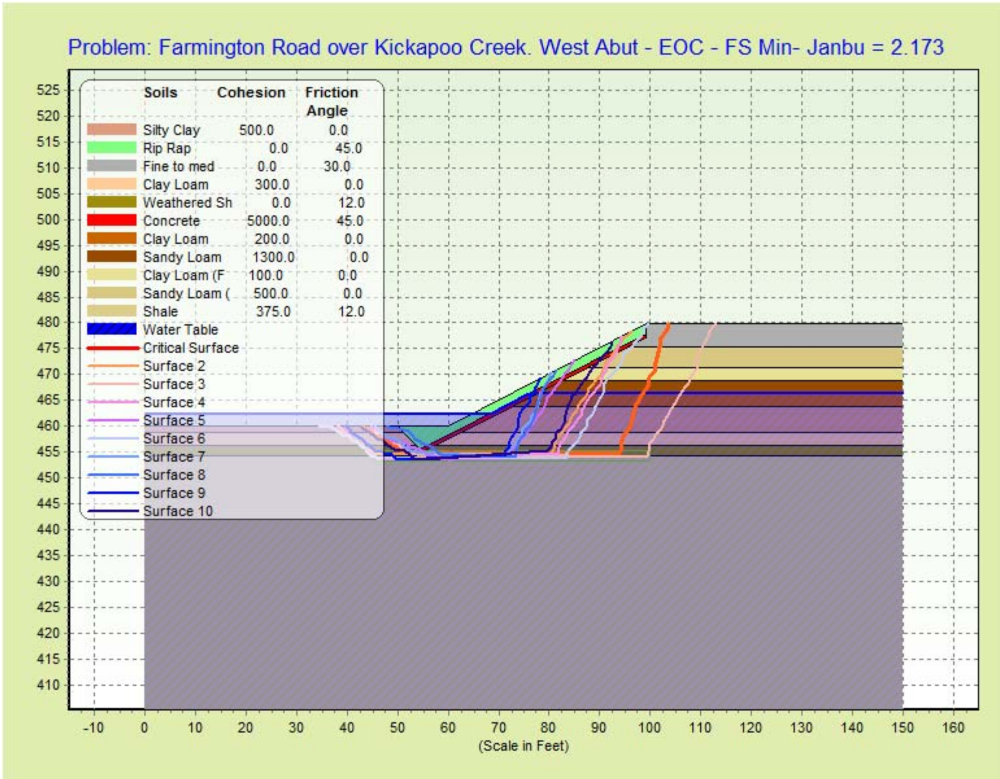
Segment Number	Left Extreme X	Left Extreme Y	Right Extreme X	Right Extreme Y	Soil Under Segment
1	0	460	50	460	6
2	50	460	60	460	9
3	60	460	99.1	479.85	9
4	99.1	479.85	150	479.85	1
5	50	460	51.2	458.8	6
6	51.2	458.8	53.7	456.3	7
7	53.7	456.3	54.5	455.5	8
8	54.5	455.5	99.1	477.8	10
9	99.1	477.8	99.1	479.85	1
10	54.5	455.5	55	455	8

Segment Number	Left Extreme X	Left Extreme Y	Right Extreme X	Right Extreme Y	Soil Under Segment
11	55	455	57.6	456.3	8
12	57.6	456.3	62.6	458.8	7
13	62.6	458.8	72.6	463.8	6
14	72.6	463.8	77.6	466.3	5
15	77.6	466.3	82.6	468.8	4
16	82.6	468.8	87.6	471.3	3
17	87.6	471.3	95.6	475.3	2
18	95.6	475.3	99.1	477.05	1
19	99.1	477.05	99.1	477.8	1
20	95.6	475.3	150	475.3	2
21	87.6	471.3	150	471.3	3
22	82.6	468.8	150	468.8	4
23	77.6	466.3	150	466.3	5
24	72.6	463.8	150	463.8	6
25	62.6	458.8	150	458.8	7
26	57.6	456.3	150	456.3	8
27	0	458.8	51.2	458.8	7
28	0	456.3	53.7	456.3	8
29	0	454.3	150	454.3	11

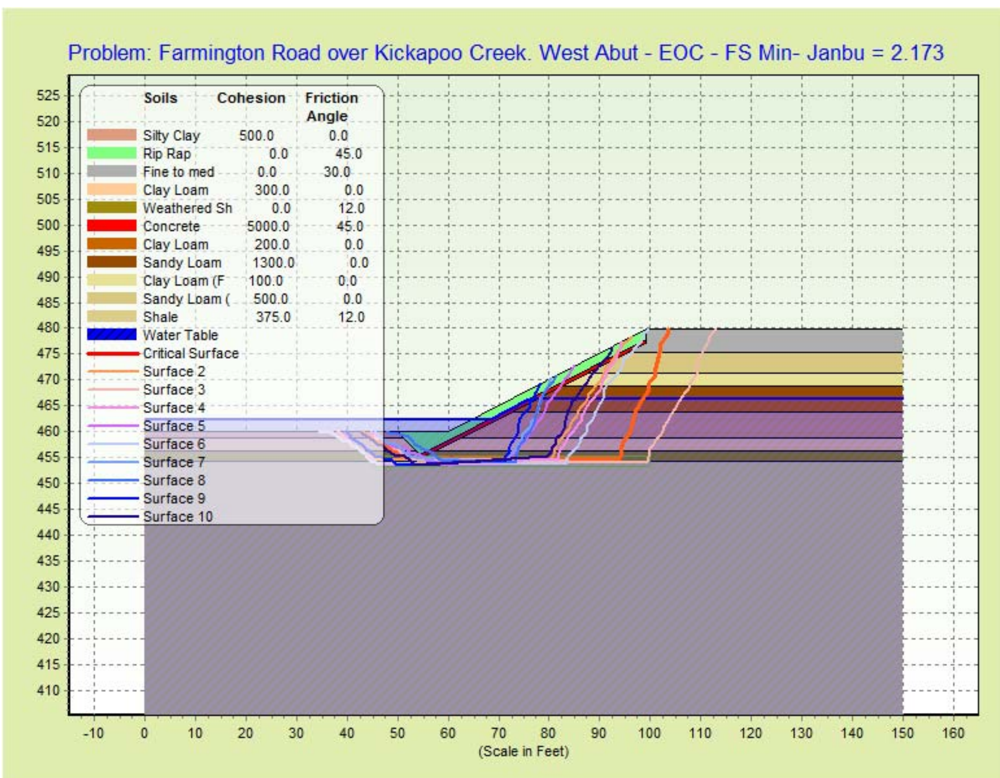
Soil Properties

Soil Number	Wet Unit Weight	Saturated Unit Weight	Cohesive Intercept	Friction Angle	Ru	Pressure Head	Water Table	Soil Name
1	115	115	0	30	0	0	1	Fine to med
2	115	115	500	0	0	0	1	Sandy Loam
3	125	125	100	0	0	0	1	Clay Loam (Fill)
4	115	115	1300	0	0	0	1	Sandy Loam
5	125	125	200	0	0	0	1	Clay Loam
6	125	125	500	0	0	0	1	Silty Clay
7	125	125	300	0	0	0	1	Clay Loam
8	130	130	0	12	0	0	1	Weathered
9	150	150	0	45	0	0	1	Rip Rap
10	150	150	5000	45	0	0	0	Concrete
11	130	130	375	12	0	0	1	Shale

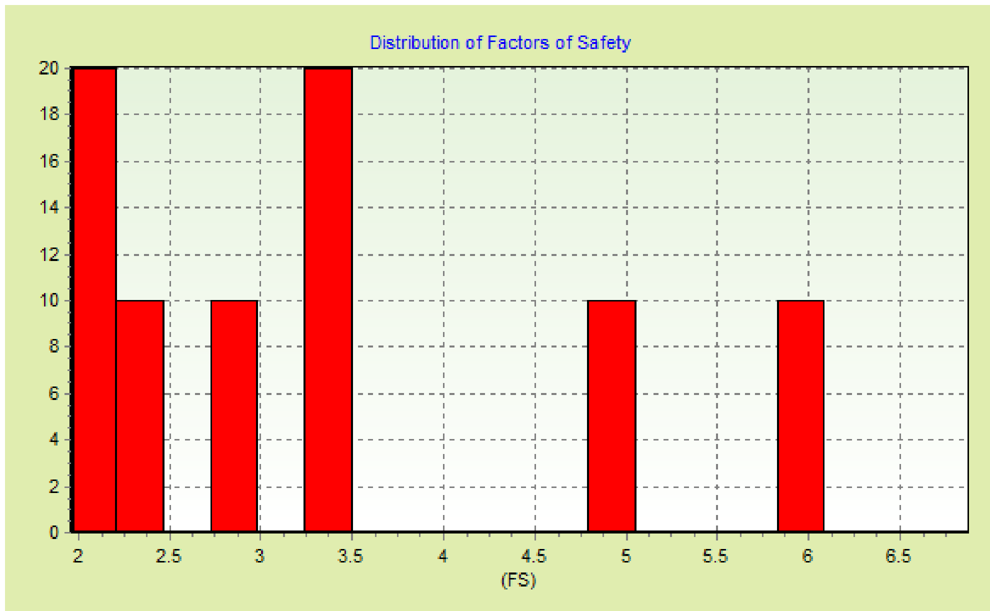
=============== All Surfaces Generated =============



=============== 10 Most Critical Surfaces ===============



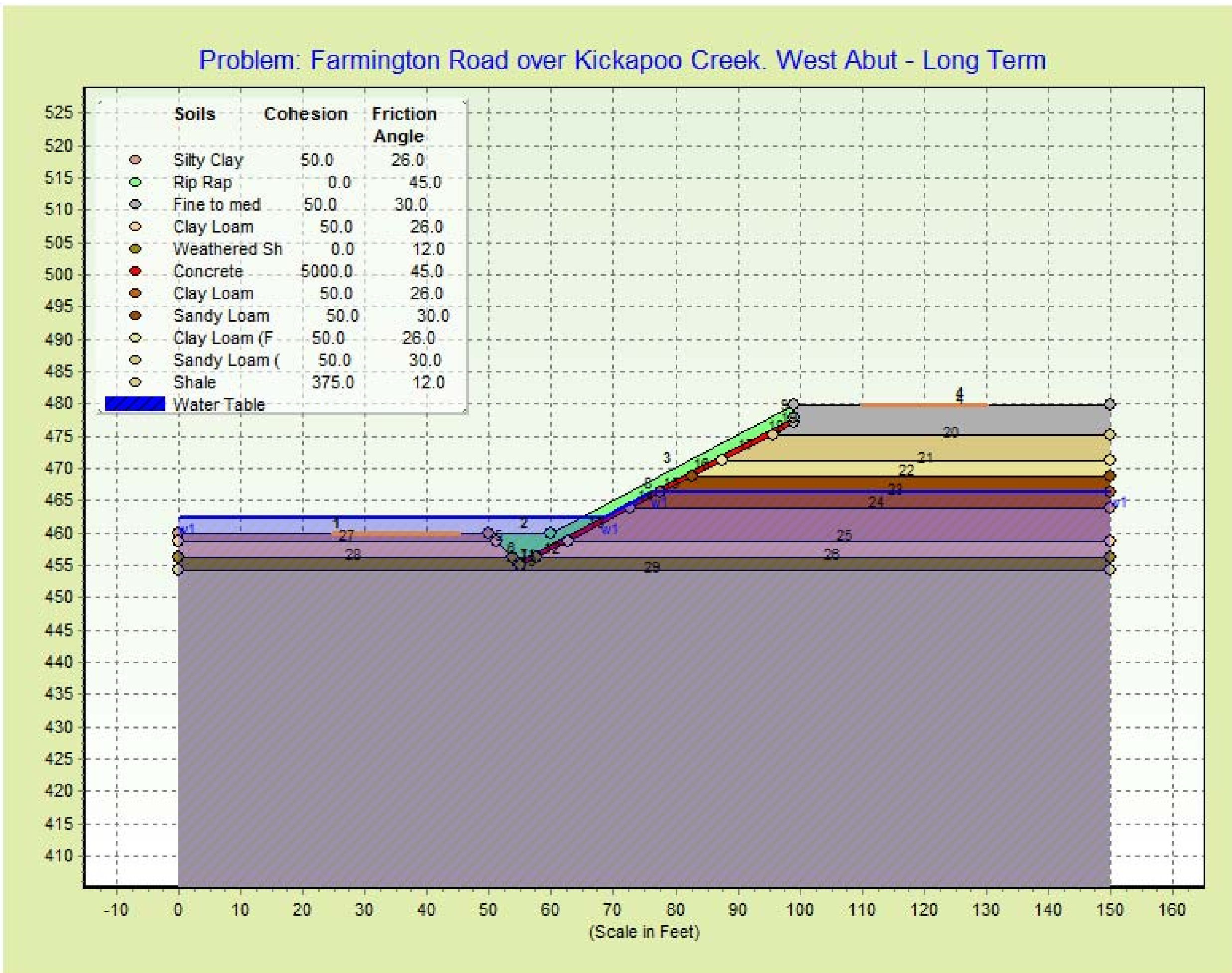
============= Factor of Safety Histogram ============



======== Factors of Safety of 10 Most Critical Surfaces =======

Surface Number	Factor of Safety
1	2.173
2	2.179
3	2.354
4	2.789
5	3.385
6	3.497
7	3.552
8	4.972
9	5.852
10	7.766

================== DATA SUMMARY ====================



Profile Data

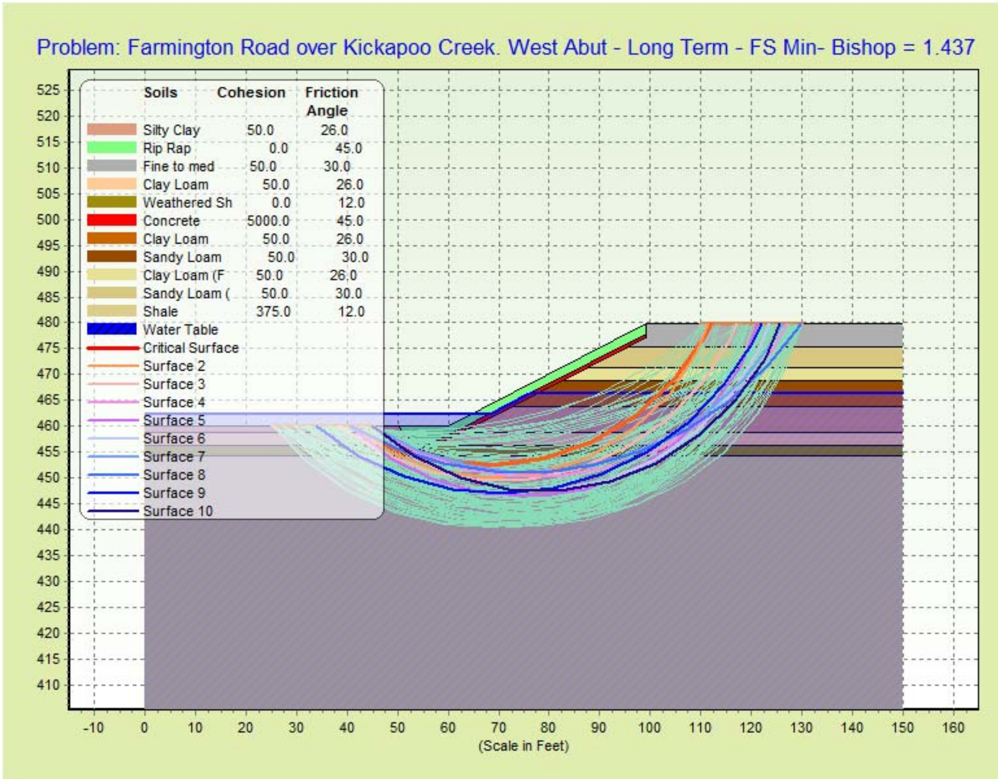
Segment Number	Left Extreme X	Left Extreme Y	Right Extreme X	Right Extreme Y	Soil Under Segment
1	0	460	50	460	6
2	50	460	60	460	9
3	60	460	99.1	479.85	9
4	99.1	479.85	150	479.85	1
5	50	460	51.2	458.8	6
6	51.2	458.8	53.7	456.3	7
7	53.7	456.3	54.5	455.5	8
8	54.5	455.5	99.1	477.8	10
9	99.1	477.8	99.1	479.85	1
10	54.5	455.5	55	455	8

Segment Number	Left Extreme X	Left Extreme Y	Right Extreme X	Right Extreme Y	Soil Under Segment
11	55	455	57.6	456.3	8
12	57.6	456.3	62.6	458.8	7
13	62.6	458.8	72.6	463.8	6
14	72.6	463.8	77.6	466.3	5
15	77.6	466.3	82.6	468.8	4
16	82.6	468.8	87.6	471.3	3
17	87.6	471.3	95.6	475.3	2
18	95.6	475.3	99.1	477.05	1
19	99.1	477.05	99.1	477.8	1
20	95.6	475.3	150	475.3	2
21	87.6	471.3	150	471.3	3
22	82.6	468.8	150	468.8	4
23	77.6	466.3	150	466.3	5
24	72.6	463.8	150	463.8	6
25	62.6	458.8	150	458.8	7
26	57.6	456.3	150	456.3	8
27	0	458.8	51.2	458.8	7
28	0	456.3	53.7	456.3	8
29	0	454.3	150	454.3	11

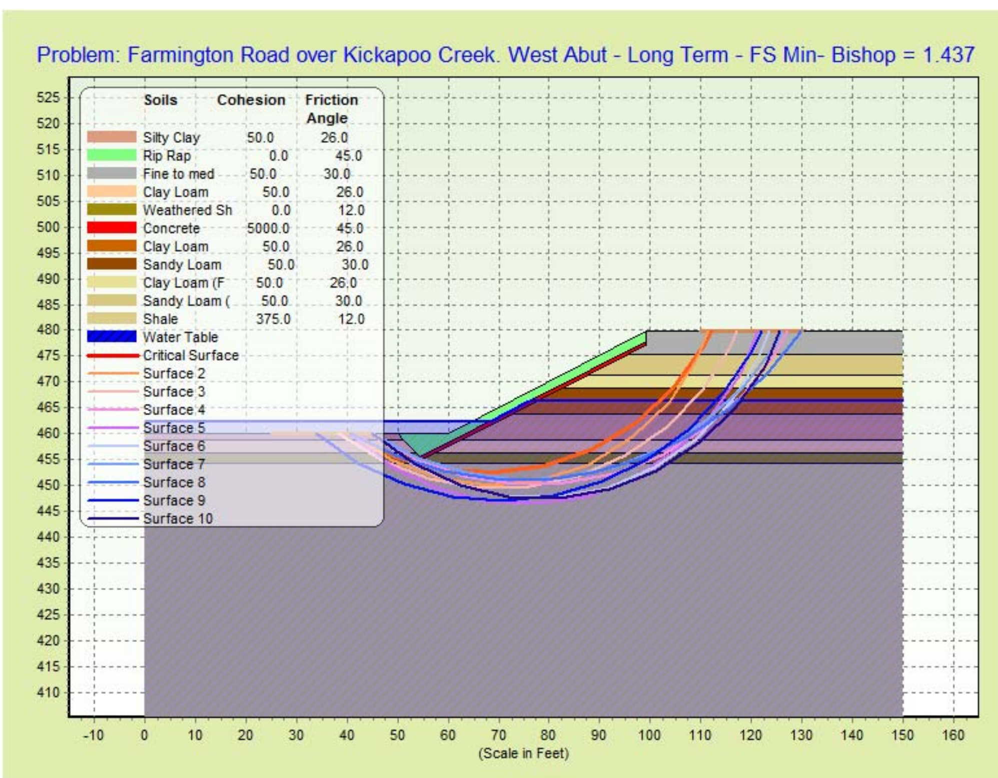
Soil Properties

Soil Number	Wet Unit Weight	Saturated Unit Weight	Cohesive Intercept	Friction Angle	Ru	Pressure Head	Water Table	Soil Name
1	115	115	50	30	0	0	1	Fine to med
2	115	115	50	30	0	0	1	Sandy Loam
3	125	125	50	26	0	0	1	Clay Loam (Fill)
4	115	115	50	30	0	0	1	Sandy Loam
5	125	125	50	26	0	0	1	Clay Loam
6	125	125	50	26	0	0	1	Silty Clay
7	125	125	50	26	0	0	1	Clay Loam
8	130	130	0	12	0	0	1	Weathered
9	150	150	0	45	0	0	1	Rip Rap
10	150	150	5000	45	0	0	0	Concrete
11	130	130	375	12	0	0	1	Shale

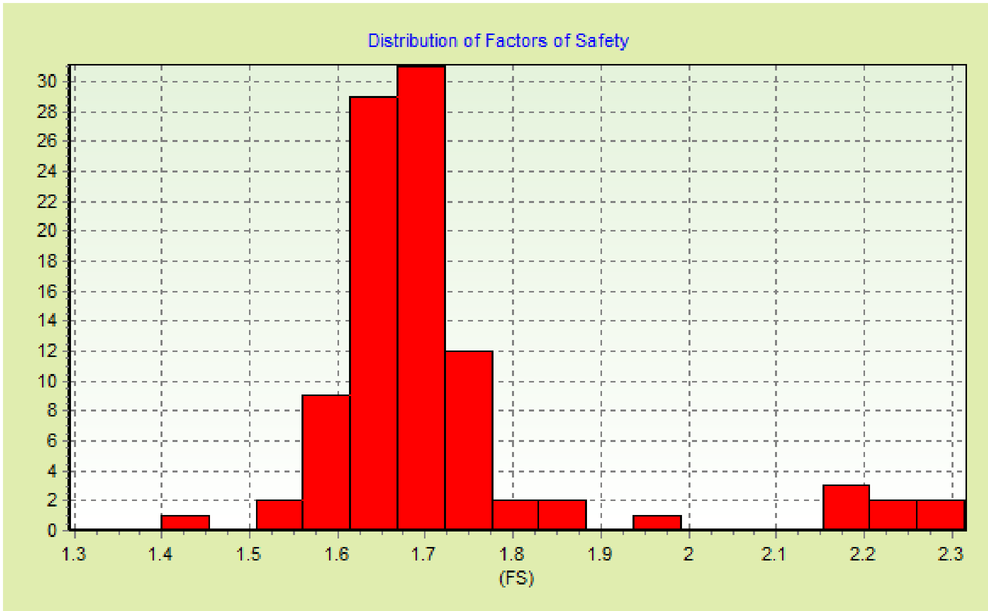
=============== All Surfaces Generated =============



=============== 10 Most Critical Surfaces ===============



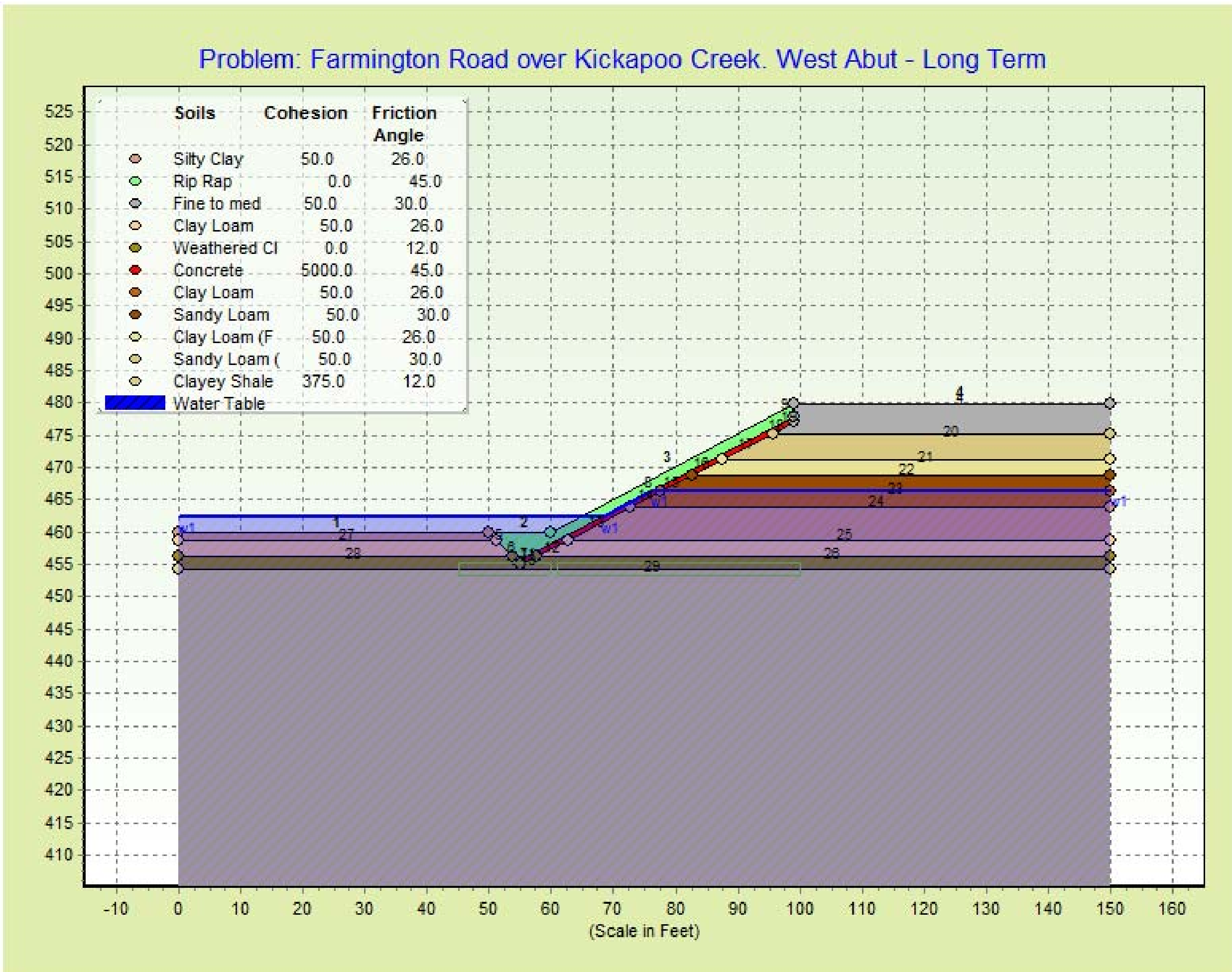
============= Factor of Safety Histogram ============



======== Factors of Safety of 10 Most Critical Surfaces =======

Surface Number	Factor of Safety
1	1.437
2	1.518
3	1.543
4	1.58
5	1.591
6	1.598
7	1.604
8	1.61
9	1.613
10	1.614

================== DATA SUMMARY ====================



Profile Data

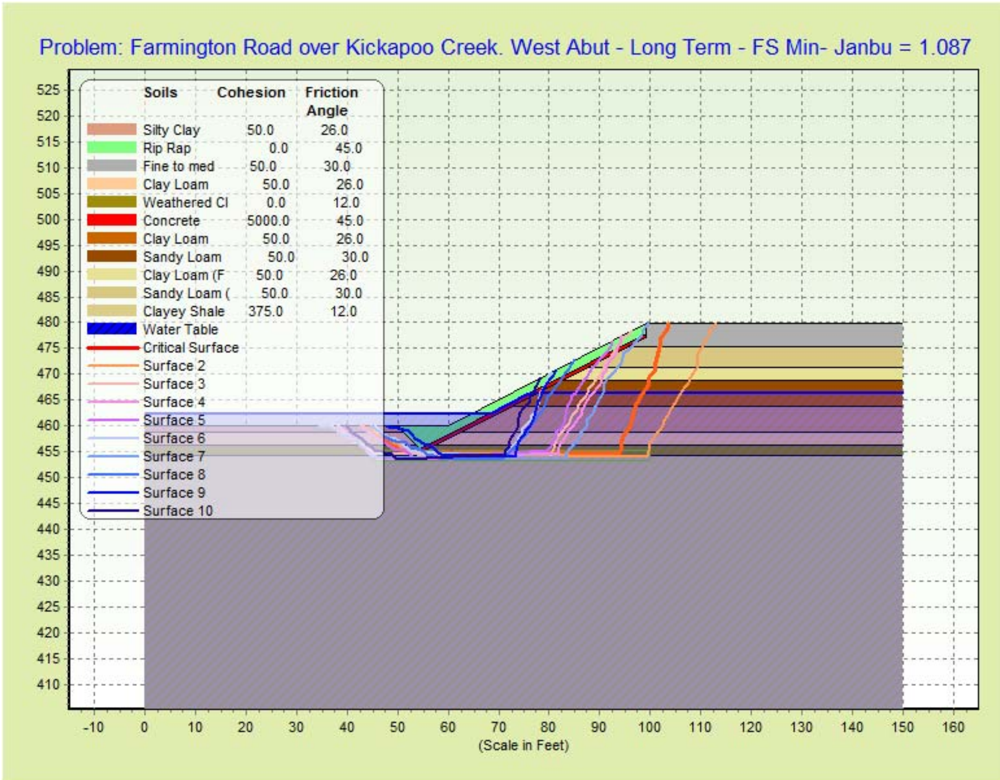
Segment Number	Left Extreme X	Left Extreme Y	Right Extreme X	Right Extreme Y	Soil Under Segment
1	0	460	50	460	6
2	50	460	60	460	9
3	60	460	99.1	479.85	9
4	99.1	479.85	150	479.85	1
5	50	460	51.2	458.8	6
6	51.2	458.8	53.7	456.3	7
7	53.7	456.3	54.5	455.5	8
8	54.5	455.5	99.1	477.8	10
9	99.1	477.8	99.1	479.85	1
10	54.5	455.5	55	455	8

Segment Number	Left Extreme X	Left Extreme Y	Right Extreme X	Right Extreme Y	Soil Under Segment
11	55	455	57.6	456.3	8
12	57.6	456.3	62.6	458.8	7
13	62.6	458.8	72.6	463.8	6
14	72.6	463.8	77.6	466.3	5
15	77.6	466.3	82.6	468.8	4
16	82.6	468.8	87.6	471.3	3
17	87.6	471.3	95.6	475.3	2
18	95.6	475.3	99.1	477.05	1
19	99.1	477.05	99.1	477.8	1
20	95.6	475.3	150	475.3	2
21	87.6	471.3	150	471.3	3
22	82.6	468.8	150	468.8	4
23	77.6	466.3	150	466.3	5
24	72.6	463.8	150	463.8	6
25	62.6	458.8	150	458.8	7
26	57.6	456.3	150	456.3	8
27	0	458.8	51.2	458.8	7
28	0	456.3	53.7	456.3	8
29	0	454.3	150	454.3	11

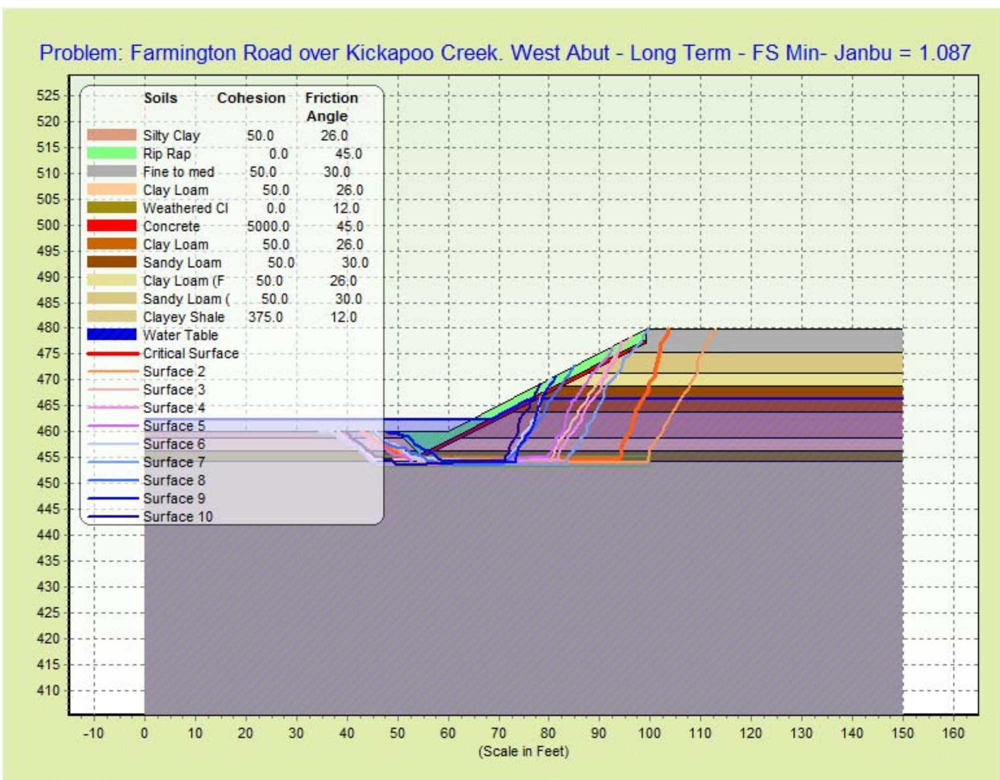
Soil Properties

Soil Number	Wet Unit Weight	Saturated Unit Weight	Cohesive Intercept	Friction Angle	Ru	Pressure Head	Water Table	Soil Name
1	115	115	50	30	0	0	1	Fine to med
2	115	115	50	30	0	0	1	Sandy Loam
3	125	125	50	26	0	0	1	Clay Loam (Fill)
4	115	115	50	30	0	0	1	Sandy Loam
5	125	125	50	26	0	0	1	Clay Loam
6	125	125	50	26	0	0	1	Silty Clay
7	125	125	50	26	0	0	1	Clay Loam
8	130	130	0	12	0	0	1	Weathered
9	150	150	0	45	0	0	1	Rip Rap
10	150	150	5000	45	0	0	0	Concrete
11	130	130	375	12	0	0	1	Clayey Shale

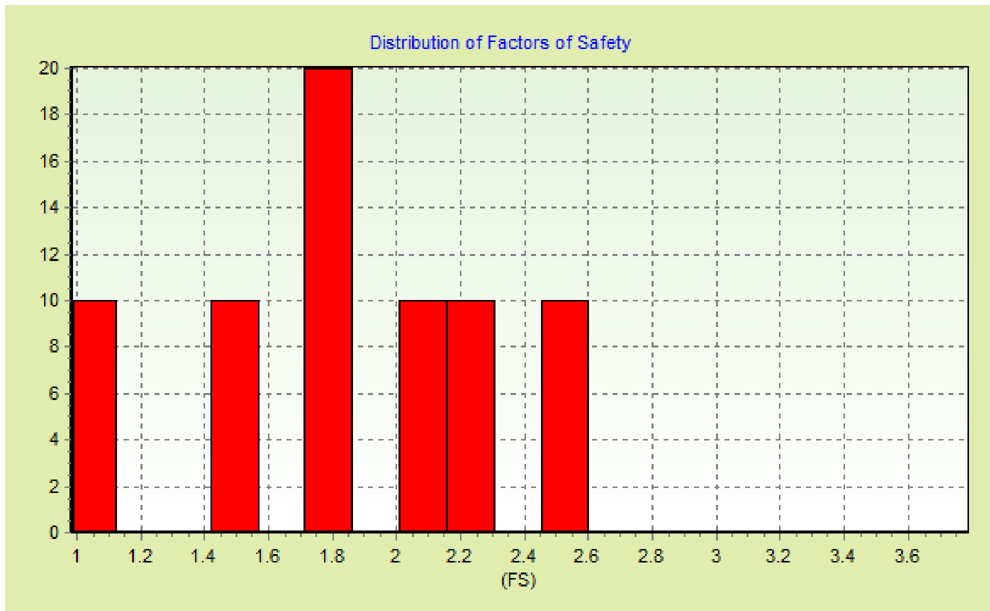
=============== All Surfaces Generated =============



=============== 10 Most Critical Surfaces ===============



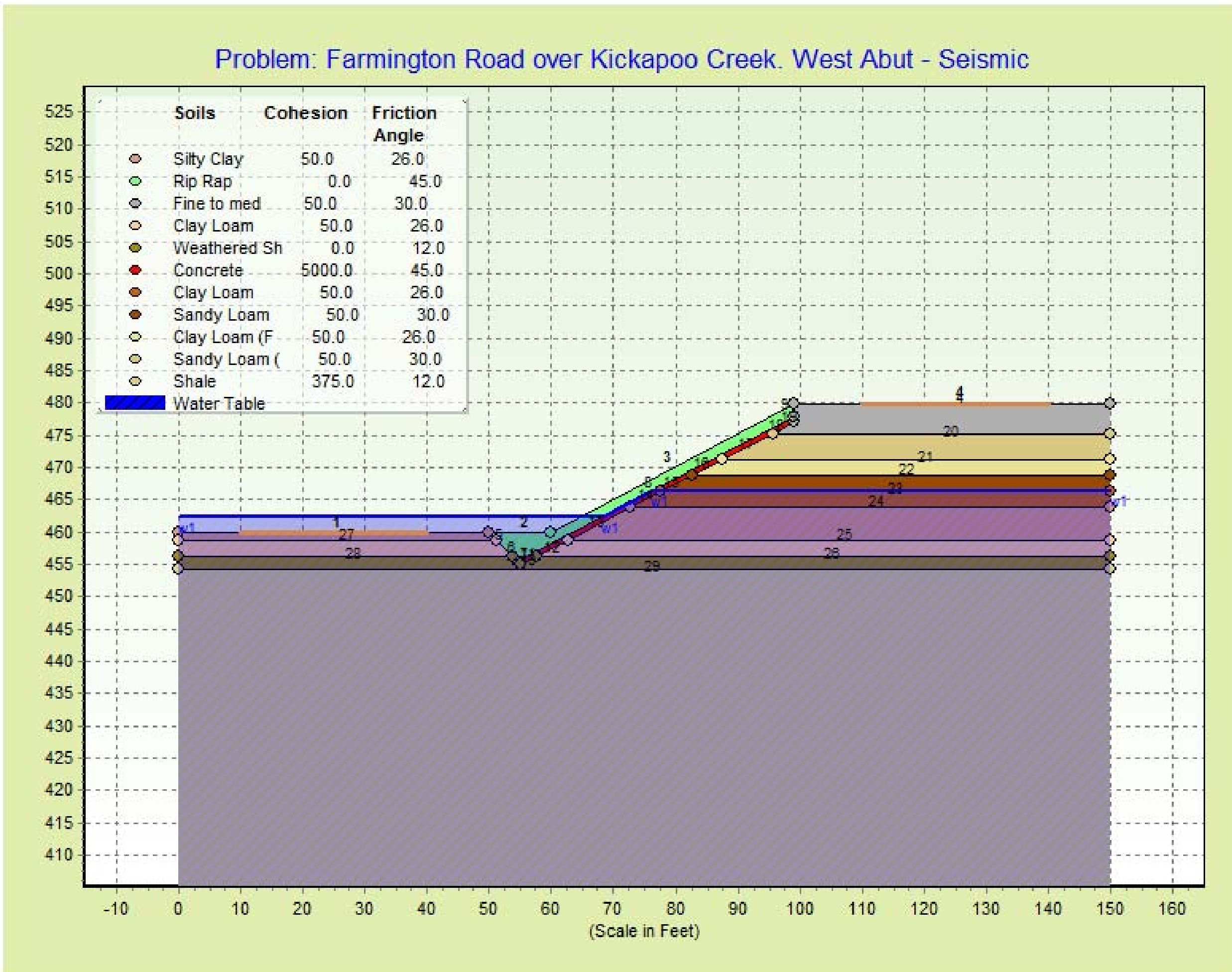
============= Factor of Safety Histogram ============



======== Factors of Safety of 10 Most Critical Surfaces =======

Surface Number	Factor of Safety
1	1.087
2	1.47
3	1.768
4	1.857
5	2.069
6	2.227
7	2.247
8	2.552
9	4.002
10	4.043

================== DATA SUMMARY ====================



Profile Data

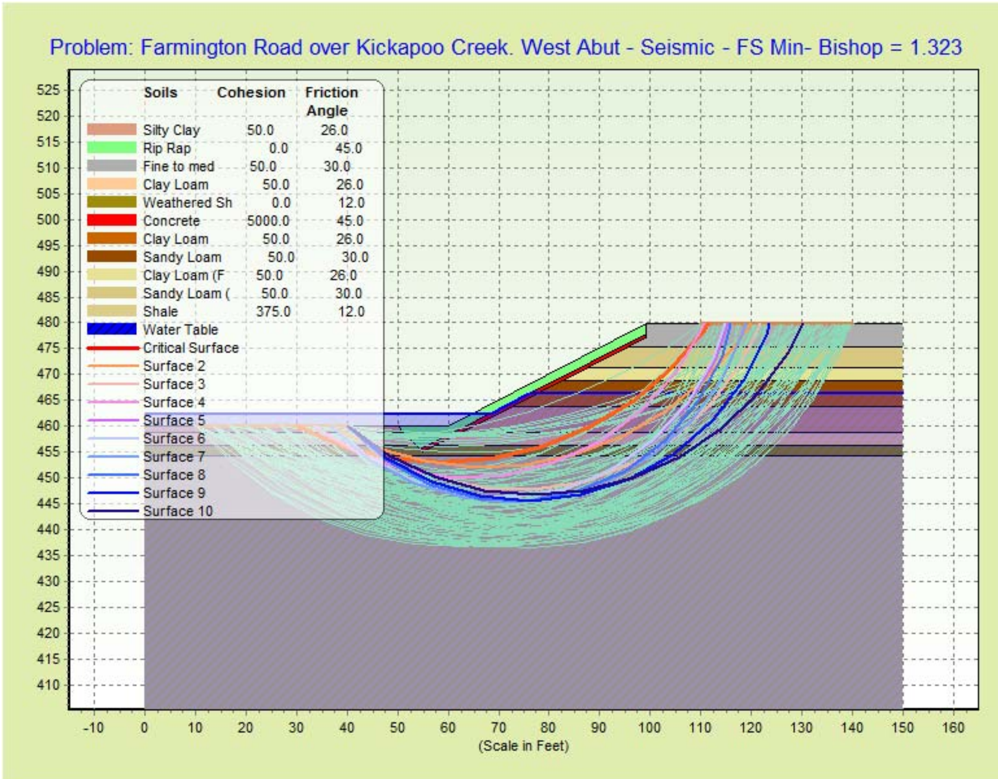
Segment Number	Left Extreme X	Left Extreme Y	Right Extreme X	Right Extreme Y	Soil Under Segment
1	0	460	50	460	6
2	50	460	60	460	9
3	60	460	99.1	479.85	9
4	99.1	479.85	150	479.85	1
5	50	460	51.2	458.8	6
6	51.2	458.8	53.7	456.3	7
7	53.7	456.3	54.5	455.5	8
8	54.5	455.5	99.1	477.8	10
9	99.1	477.8	99.1	479.85	1
10	54.5	455.5	55	455	8

Segment Number	Left Extreme X	Left Extreme Y	Right Extreme X	Right Extreme Y	Soil Under Segment
11	55	455	57.6	456.3	8
12	57.6	456.3	62.6	458.8	7
13	62.6	458.8	72.6	463.8	6
14	72.6	463.8	77.6	466.3	5
15	77.6	466.3	82.6	468.8	4
16	82.6	468.8	87.6	471.3	3
17	87.6	471.3	95.6	475.3	2
18	95.6	475.3	99.1	477.05	1
19	99.1	477.05	99.1	477.8	1
20	95.6	475.3	150	475.3	2
21	87.6	471.3	150	471.3	3
22	82.6	468.8	150	468.8	4
23	77.6	466.3	150	466.3	5
24	72.6	463.8	150	463.8	6
25	62.6	458.8	150	458.8	7
26	57.6	456.3	150	456.3	8
27	0	458.8	51.2	458.8	7
28	0	456.3	53.7	456.3	8
29	0	454.3	150	454.3	11

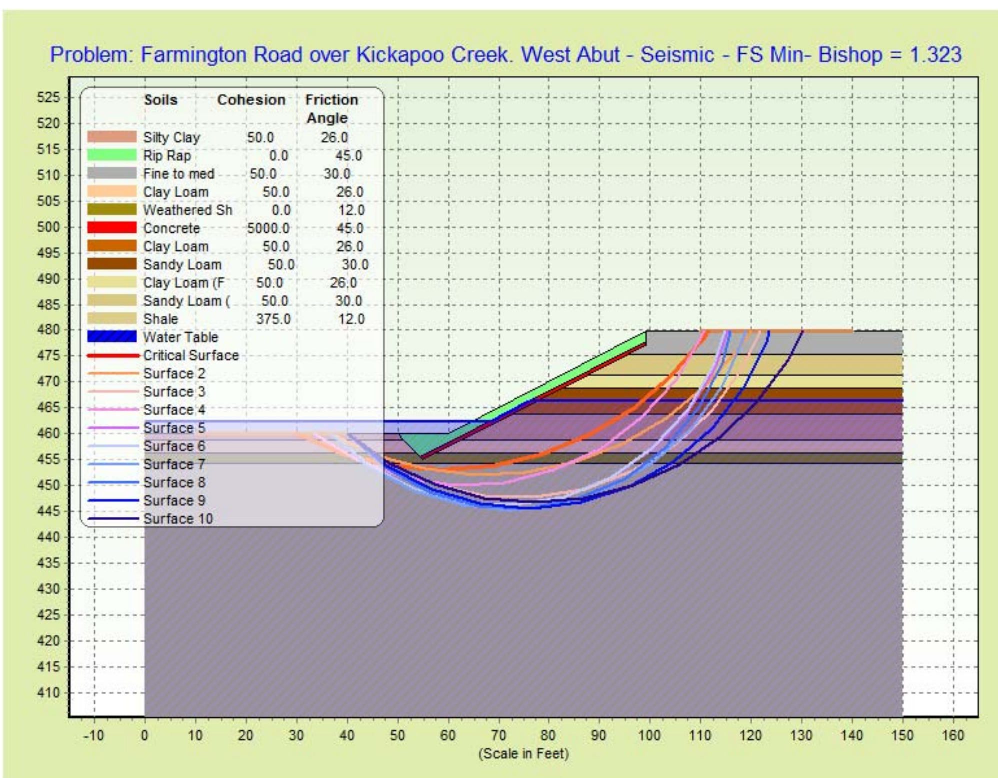
Soil Properties

Soil Number	Wet Unit Weight	Saturated Unit Weight	Cohesive Intercept	Friction Angle	Ru	Pressure Head	Water Table	Soil Name
1	115	115	50	30	0	0	1	Fine to med
2	115	115	50	30	0	0	1	Sandy Loam
3	125	125	50	26	0	0	1	Clay Loam (Fill)
4	115	115	50	30	0	0	1	Sandy Loam
5	125	125	50	26	0	0	1	Clay Loam
6	125	125	50	26	0	0	1	Silty Clay
7	125	125	50	26	0	0	1	Clay Loam
8	130	130	0	12	0	0	1	Weathered
9	150	150	0	45	0	0	1	Rip Rap
10	150	150	5000	45	0	0	0	Concrete
11	130	130	375	12	0	0	1	Shale

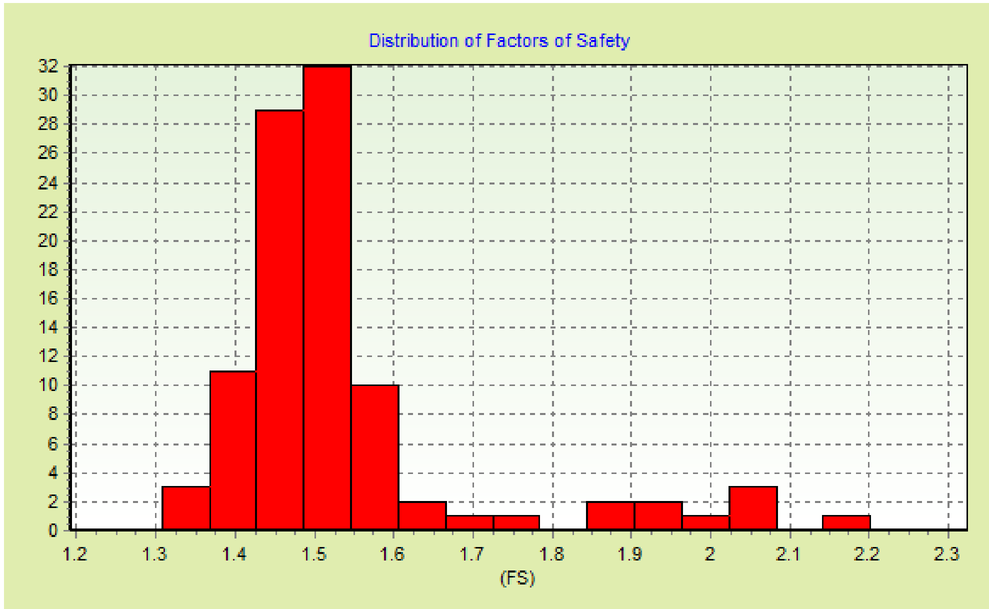
=============== All Surfaces Generated =============



=============== 10 Most Critical Surfaces ===============



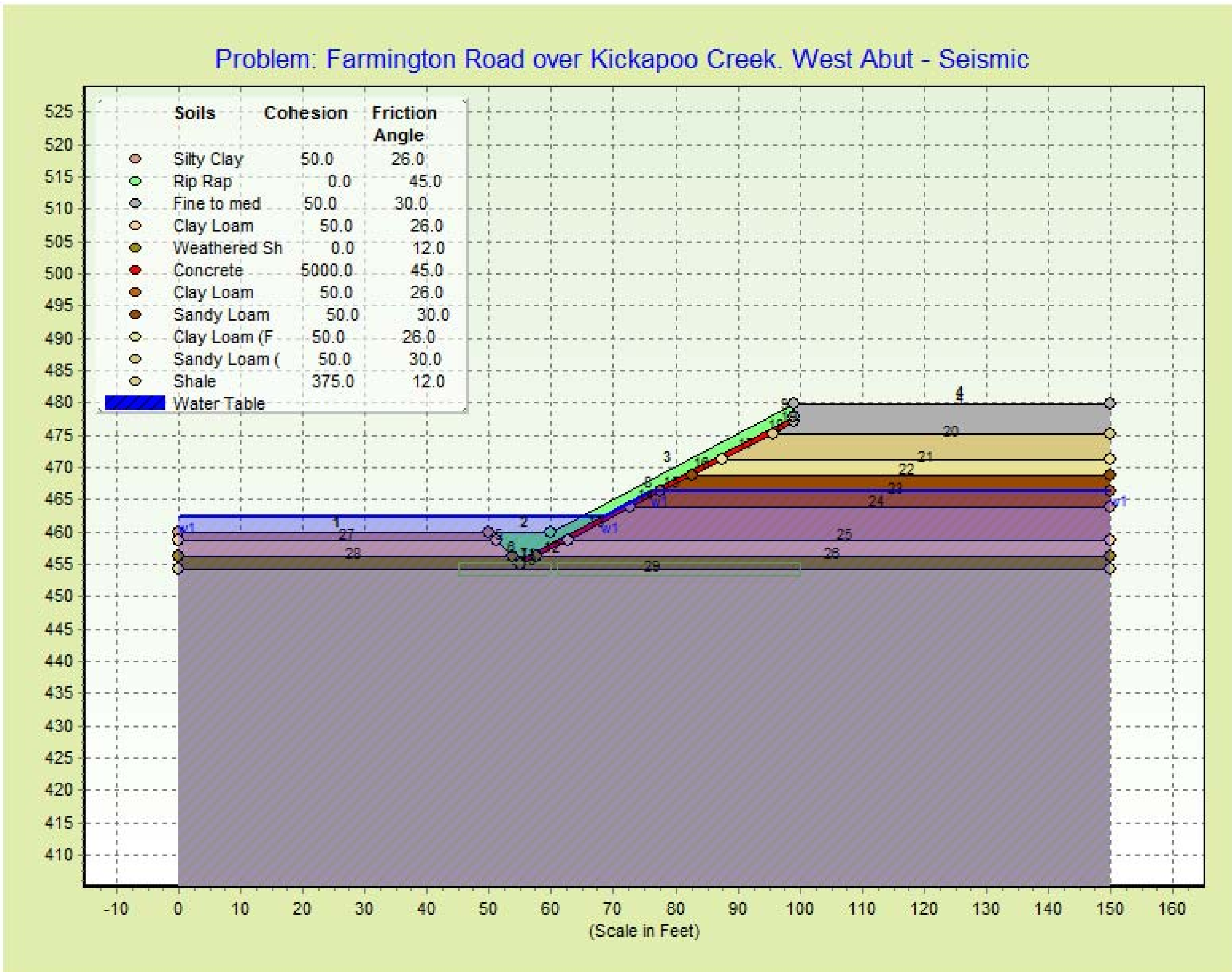
============= Factor of Safety Histogram ============



======== Factors of Safety of 10 Most Critical Surfaces =======

Surface Number	Factor of Safety
1	1.323
2	1.326
3	1.36
4	1.374
5	1.384
6	1.386
7	1.392
8	1.392
9	1.392
10	1.401

================== DATA SUMMARY ====================



Profile Data

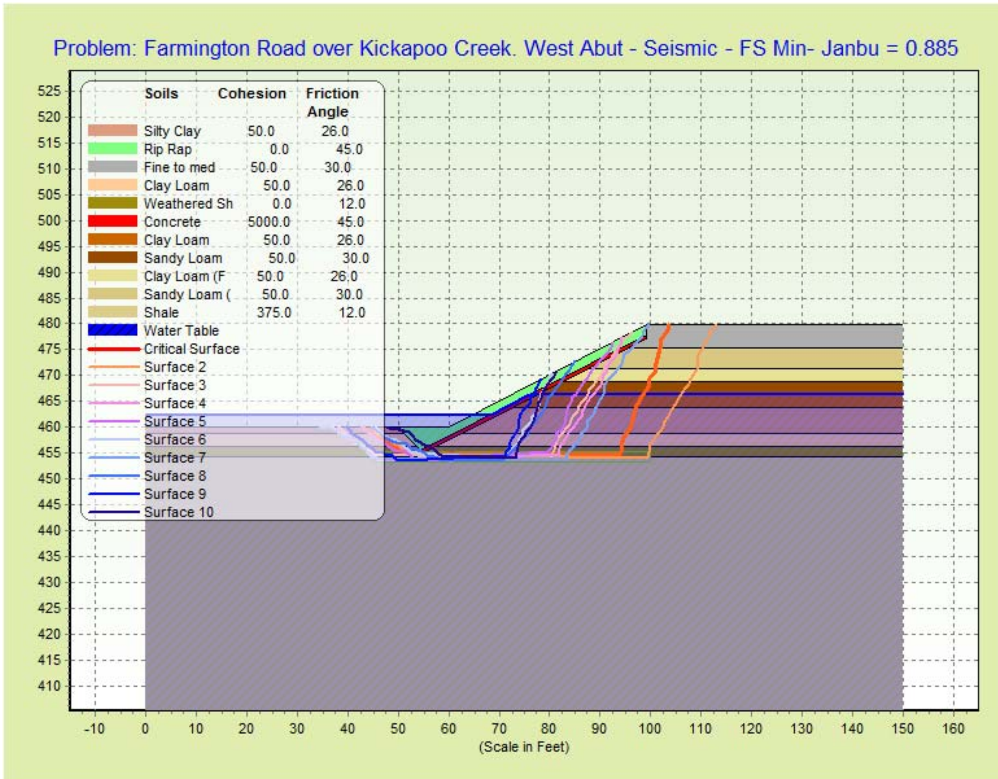
Segment Number	Left Extreme X	Left Extreme Y	Right Extreme X	Right Extreme Y	Soil Under Segment
1	0	460	50	460	6
2	50	460	60	460	9
3	60	460	99.1	479.85	9
4	99.1	479.85	150	479.85	1
5	50	460	51.2	458.8	6
6	51.2	458.8	53.7	456.3	7
7	53.7	456.3	54.5	455.5	8
8	54.5	455.5	99.1	477.8	10
9	99.1	477.8	99.1	479.85	1
10	54.5	455.5	55	455	8

Segment Number	Left Extreme X	Left Extreme Y	Right Extreme X	Right Extreme Y	Soil Under Segment
11	55	455	57.6	456.3	8
12	57.6	456.3	62.6	458.8	7
13	62.6	458.8	72.6	463.8	6
14	72.6	463.8	77.6	466.3	5
15	77.6	466.3	82.6	468.8	4
16	82.6	468.8	87.6	471.3	3
17	87.6	471.3	95.6	475.3	2
18	95.6	475.3	99.1	477.05	1
19	99.1	477.05	99.1	477.8	1
20	95.6	475.3	150	475.3	2
21	87.6	471.3	150	471.3	3
22	82.6	468.8	150	468.8	4
23	77.6	466.3	150	466.3	5
24	72.6	463.8	150	463.8	6
25	62.6	458.8	150	458.8	7
26	57.6	456.3	150	456.3	8
27	0	458.8	51.2	458.8	7
28	0	456.3	53.7	456.3	8
29	0	454.3	150	454.3	11

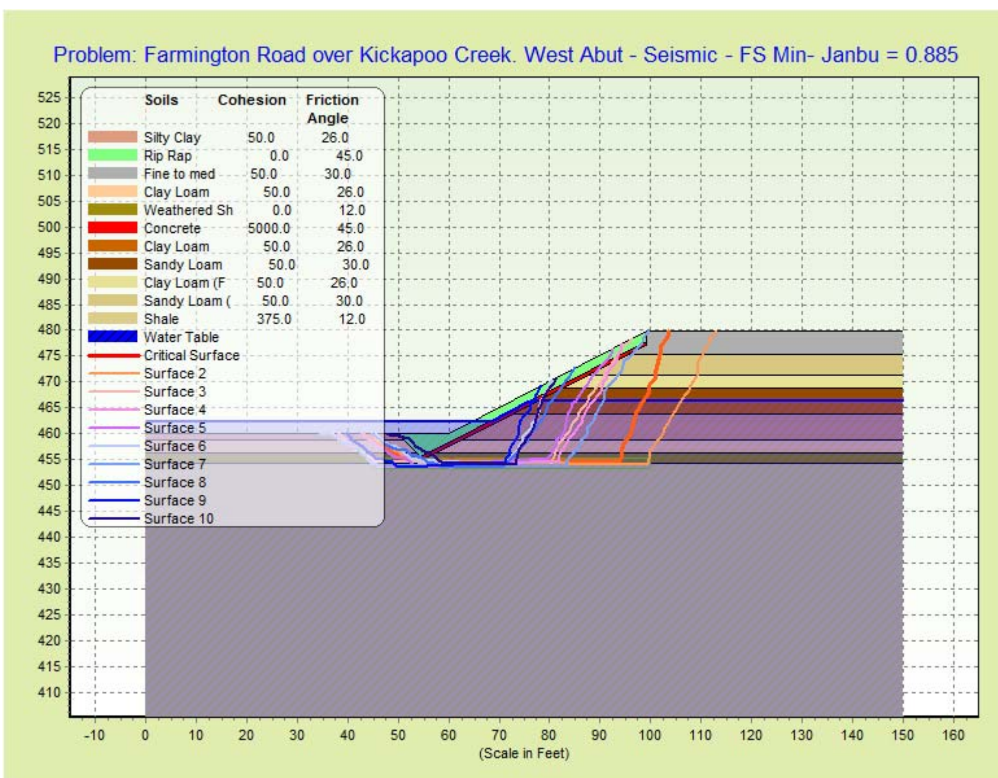
Soil Properties

Soil Number	Wet Unit Weight	Saturated Unit Weight	Cohesive Intercept	Friction Angle	Ru	Pressure Head	Water Table	Soil Name
1	115	115	50	30	0	0	1	Fine to med
2	115	115	50	30	0	0	1	Sandy Loam
3	125	125	50	26	0	0	1	Clay Loam (Fill)
4	115	115	50	30	0	0	1	Sandy Loam
5	125	125	50	26	0	0	1	Clay Loam
6	125	125	50	26	0	0	1	Silty Clay
7	125	125	50	26	0	0	1	Clay Loam
8	130	130	0	12	0	0	1	Weathered
9	150	150	0	45	0	0	1	Rip Rap
10	150	150	5000	45	0	0	0	Concrete
11	130	130	375	12	0	0	1	Shale

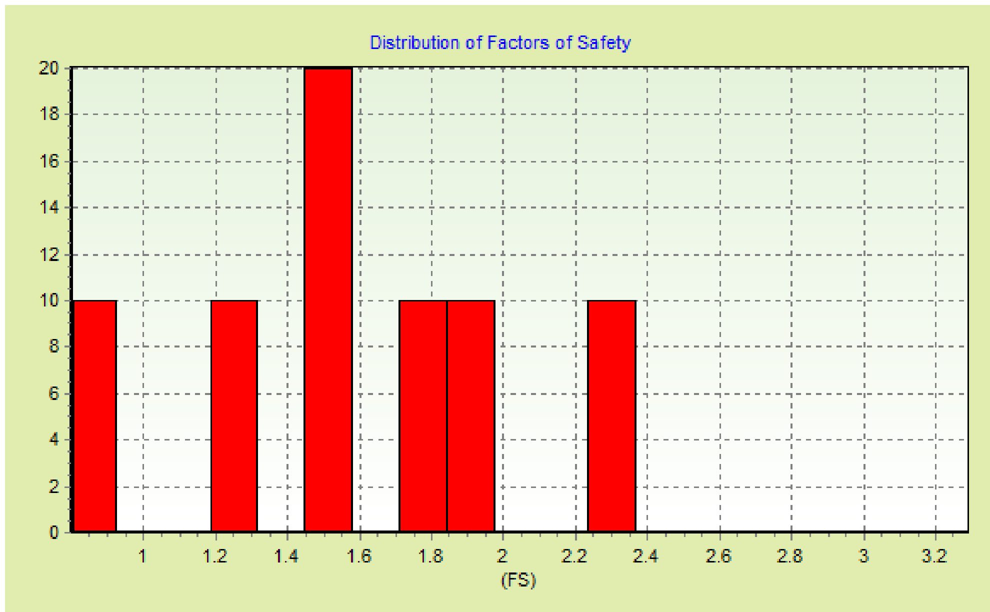
=============== All Surfaces Generated =============



=============== 10 Most Critical Surfaces ===============



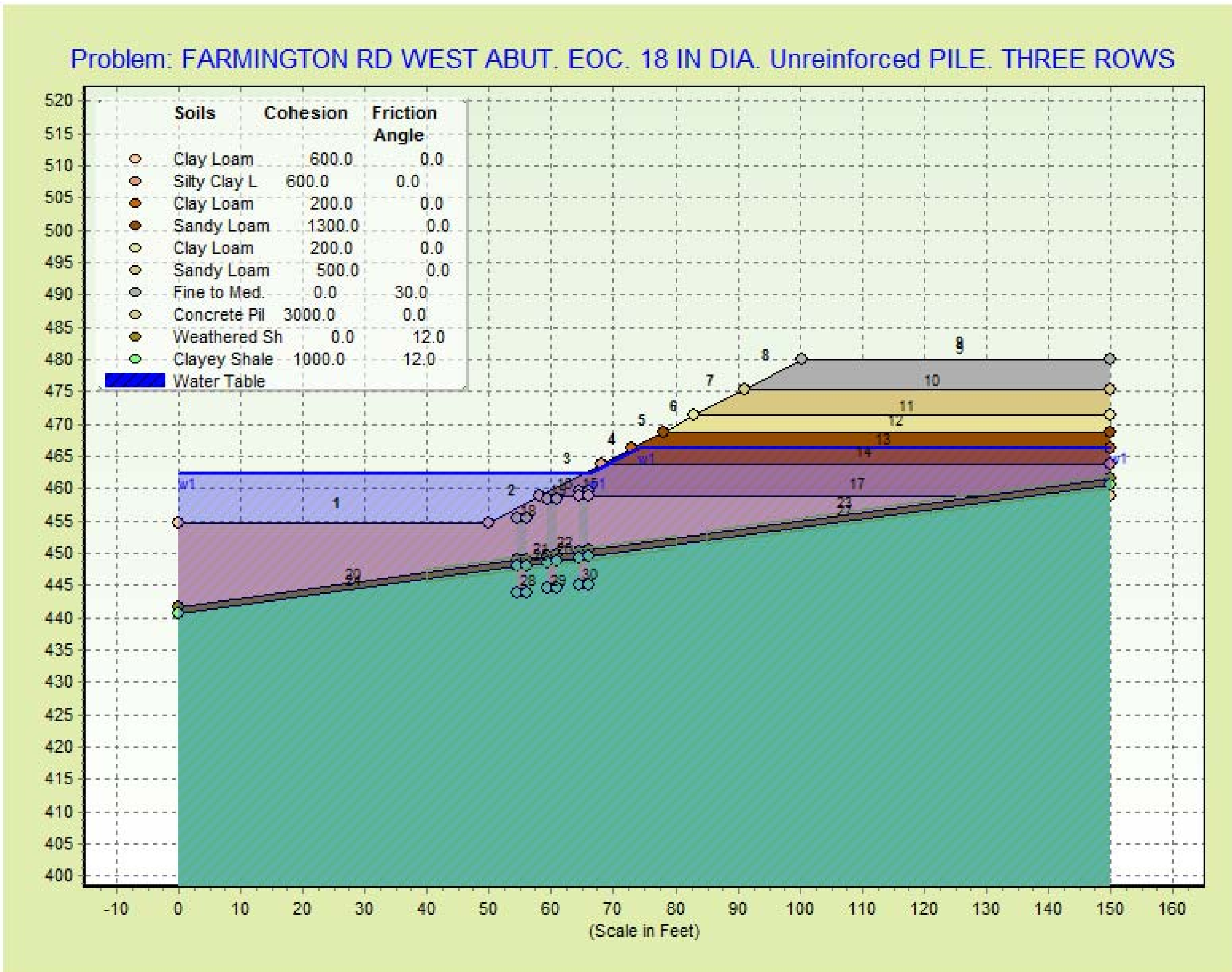
============= Factor of Safety Histogram ============



======== Factors of Safety of 10 Most Critical Surfaces =======

Surface Number	Factor of Safety
1	.885
2	1.213
3	1.533
4	1.577
5	1.777
6	1.883
7	1.966
8	2.246
9	3.336
10	3.508

================== DATA SUMMARY ====================



Profile Data

Segment Number	Left Extreme X	Left Extreme Y	Right Extreme X	Right Extreme Y	Soil Under Segment
1	0	454.8	50	454.8	7
2	50	454.8	58	458.8	7
3	58	458.8	68	463.8	6
4	68	463.8	73	466.3	5
5	73	466.3	78	468.8	4
6	78	468.8	83	471.3	3
7	83	471.3	91	475.3	2
8	91	475.3	100.4	480	1
9	100.4	480	150	480	1
10	91	475.3	150	475.3	2

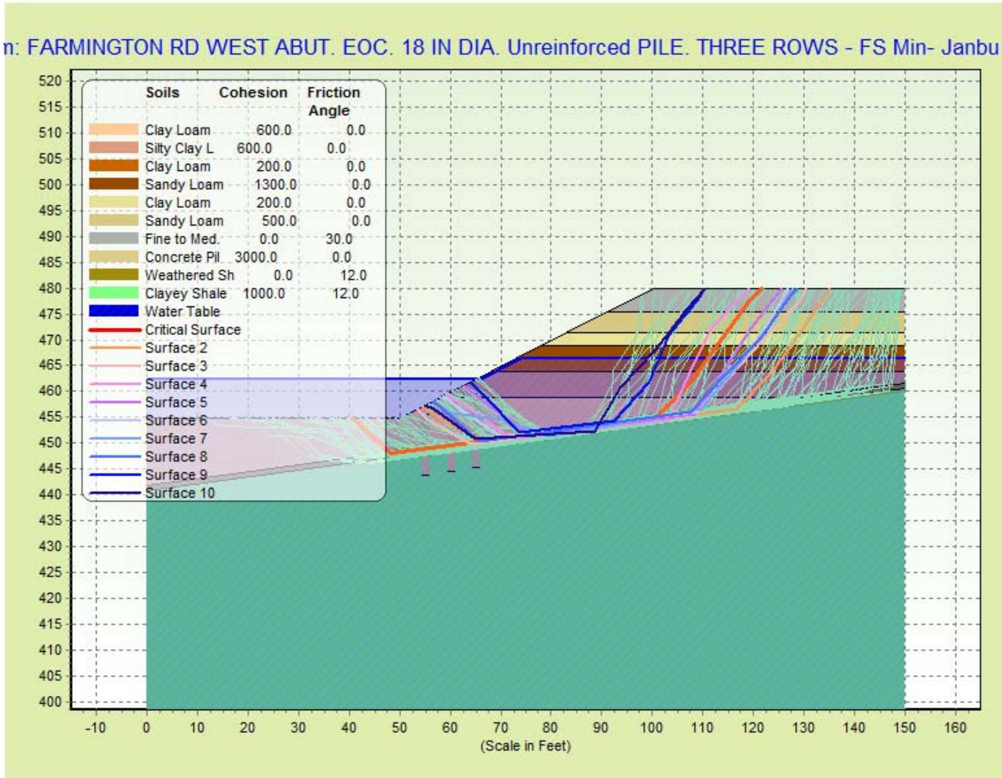
Segment Number	Left Extreme X	Left Extreme Y	Right Extreme X	Right Extreme Y	Soil Under Segment
11	83	471.3	150	471.3	3
12	78	468.8	150	468.8	4
13	73	466.3	150	466.3	5
14	68	463.8	150	463.8	6
15	64.5	459.5	66	459.5	11
16	58	458.8	64.5	458.8	7
17	66	458.8	150	458.8	7
18	54.5	455.5	56	455.5	11
19	59.5	458.5	61	458.5	11
20	0	441.7	54.5	448.95	8
21	56	449.15	59.5	449.61	8
22	61	449.81	64.5	450.28	8
23	66	450.48	150	461.65	8
24	0	440.7	54.5	447.95	9
25	56	448.15	59.5	448.61	9
26	61	448.81	64.5	449.28	9
27	66	449.48	150	460.65	9
28	54.5	443.9	56	443.9	9
29	59.5	444.6	61	444.6	9
30	64.5	445.2	66	445.2	9

Soil Properties

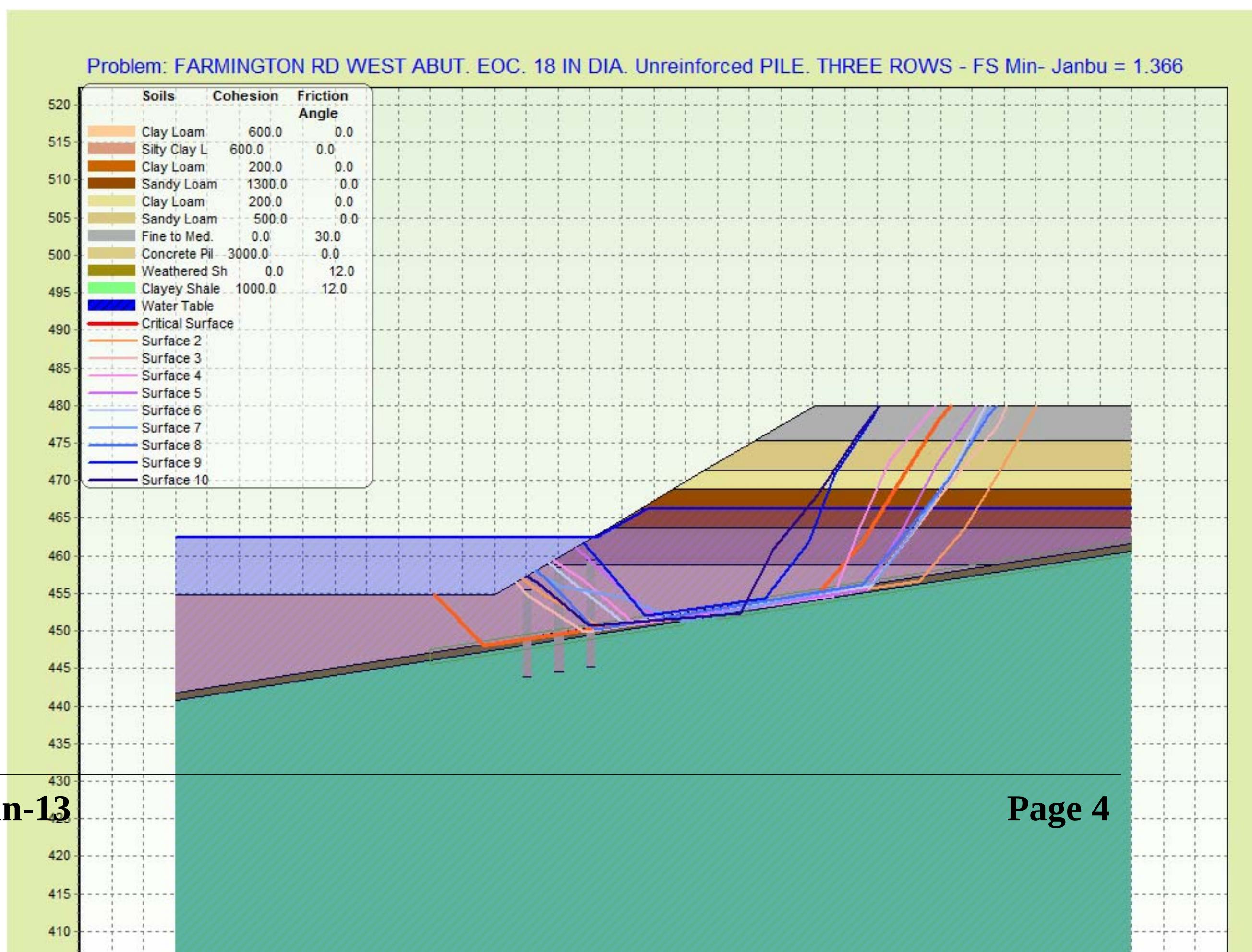
Soil Number	Wet Unit Weight	Saturated Unit Weight	Cohesive Intercept	Friction Angle	Ru	Pressure Head	Water Table	Soil Name
1	115	115	0	30	0	0	1	Fine to Med.
2	115	115	500	0	0	0	1	Sandy Loam
3	125	125	200	0	0	0	1	Clay Loam
4	115	115	1300	0	0	0	1	Sandy Loam
5	125	125	200	0	0	0	1	Clay Loam
6	125	125	600	0	0	0	1	Silty Clay Loam
7	125	125	600	0	0	0	1	Clay Loam
8	130	130	0	12	0	0	1	Weathered
9	130	130	1000	12	0	0	1	Clayey Shale
10	35	35	1500	0	0	0	1	Timber Pile

Soil Number	Wet Unit Weight	Saturated Unit Weight	Cohesive Intercept	Friction Angle	Ru	Pressure Head	Water Table	Soil Name
11	145	145	3000	0	0	0	1	Concrete Pile

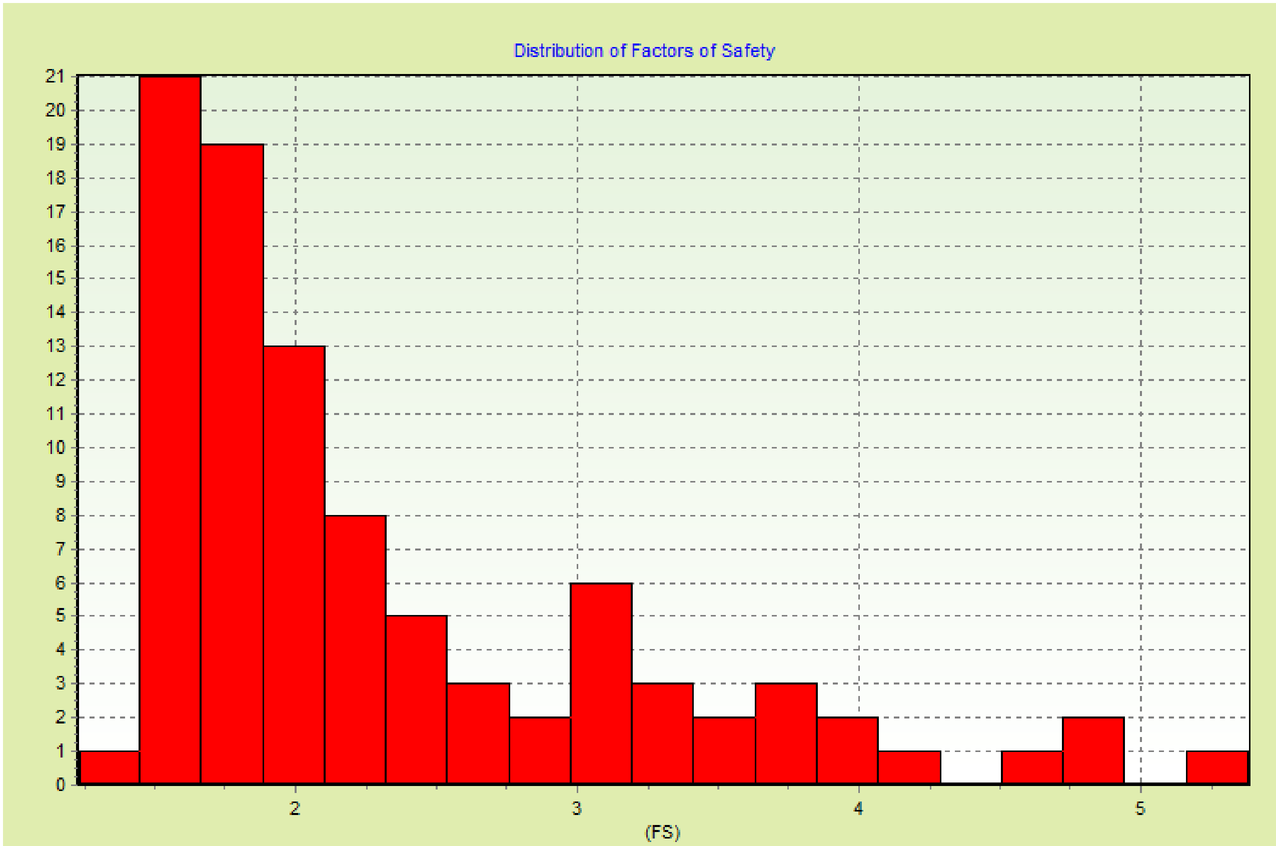
=============== All Surfaces Generated =============



=============== 10 Most Critical Surfaces ===============



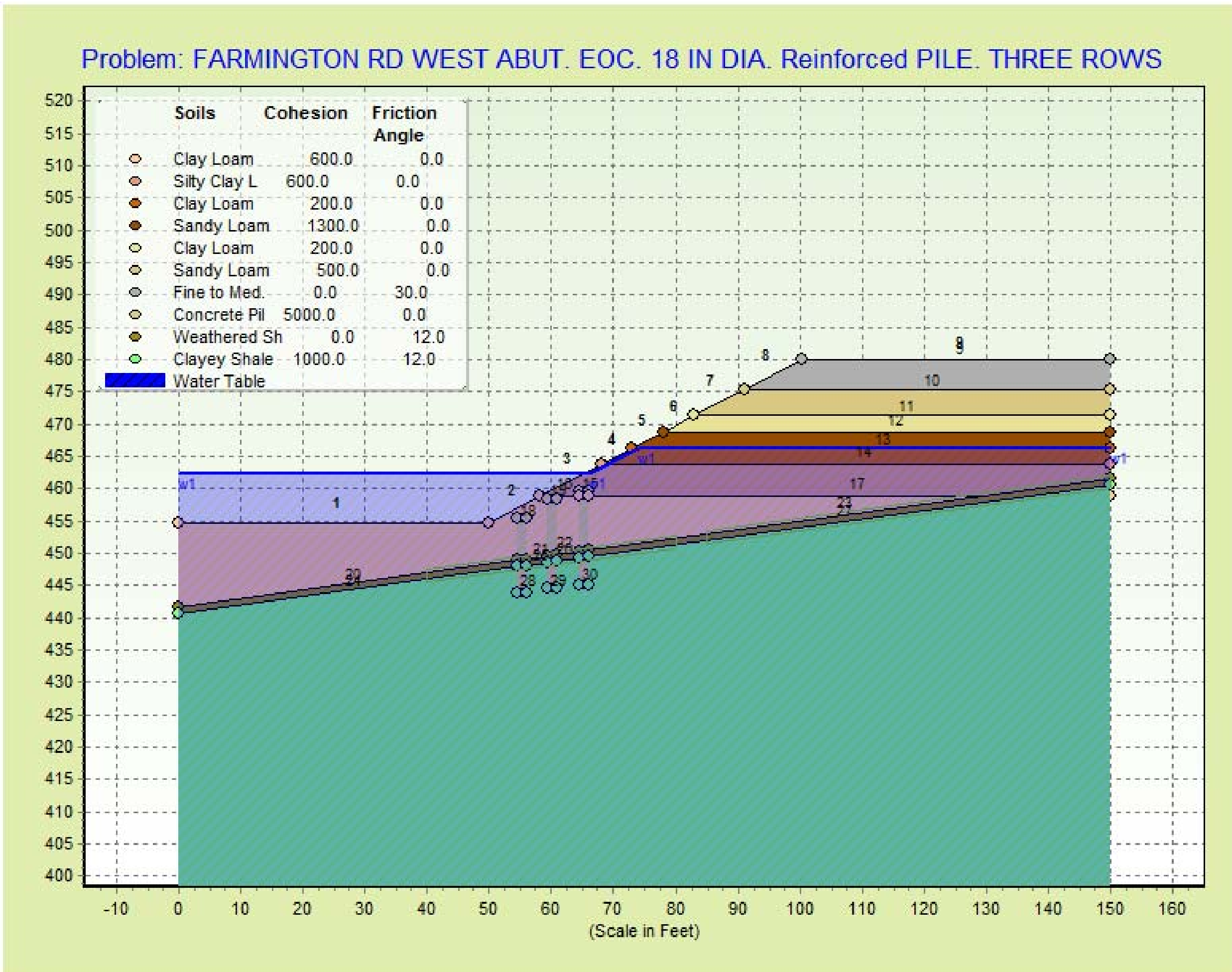
============= Factor of Safety Histogram ============



======== Factors of Safety of 10 Most Critical Surfaces =======

Surface Number	Factor of Safety
1	1.366
2	1.457
3	1.483
4	1.493
5	1.501
6	1.522
7	1.539
8	1.558
9	1.566
10	1.567

================== DATA SUMMARY ====================



Profile Data

Segment Number	Left Extreme X	Left Extreme Y	Right Extreme X	Right Extreme Y	Soil Under Segment
1	0	454.8	50	454.8	7
2	50	454.8	58	458.8	7
3	58	458.8	68	463.8	6
4	68	463.8	73	466.3	5
5	73	466.3	78	468.8	4
6	78	468.8	83	471.3	3
7	83	471.3	91	475.3	2
8	91	475.3	100.4	480	1
9	100.4	480	150	480	1
10	91	475.3	150	475.3	2

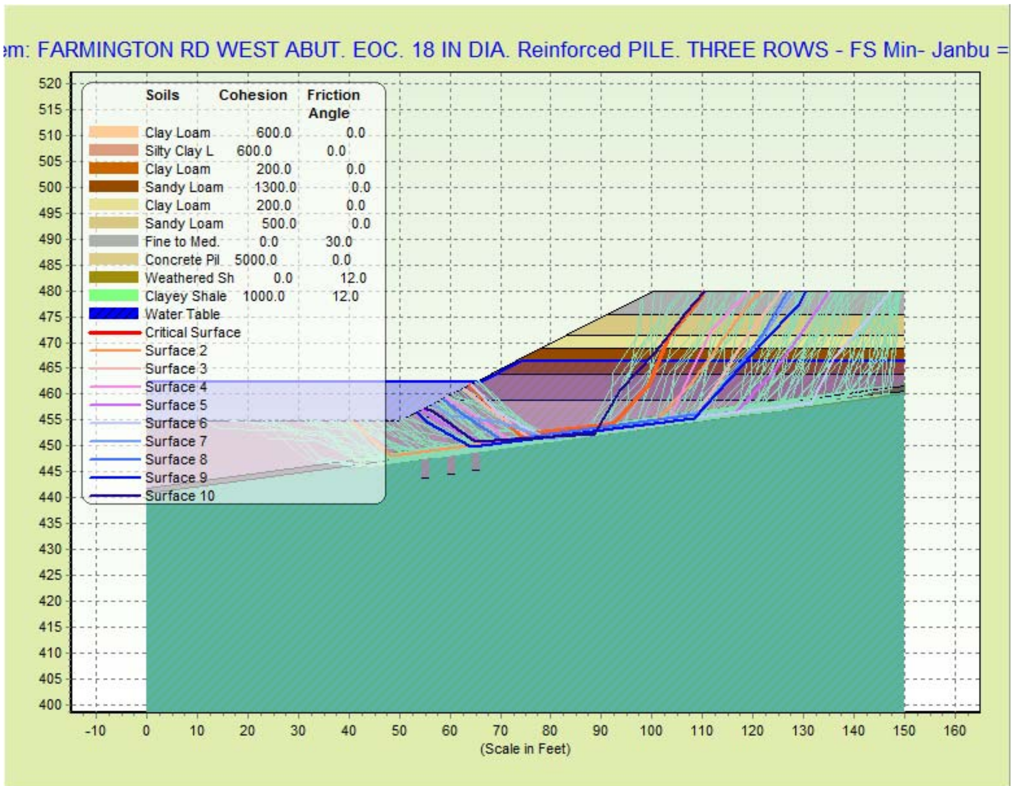
Segment Number	Left Extreme X	Left Extreme Y	Right Extreme X	Right Extreme Y	Soil Under Segment
11	83	471.3	150	471.3	3
12	78	468.8	150	468.8	4
13	73	466.3	150	466.3	5
14	68	463.8	150	463.8	6
15	64.5	459.5	66	459.5	11
16	58	458.8	64.5	458.8	7
17	66	458.8	150	458.8	7
18	54.5	455.5	56	455.5	11
19	59.5	458.5	61	458.5	11
20	0	441.7	54.5	448.95	8
21	56	449.15	59.5	449.61	8
22	61	449.81	64.5	450.28	8
23	66	450.48	150	461.65	8
24	0	440.7	54.5	447.95	9
25	56	448.15	59.5	448.61	9
26	61	448.81	64.5	449.28	9
27	66	449.48	150	460.65	9
28	54.5	443.9	56	443.9	9
29	59.5	444.6	61	444.6	9
30	64.5	445.2	66	445.2	9

Soil Properties

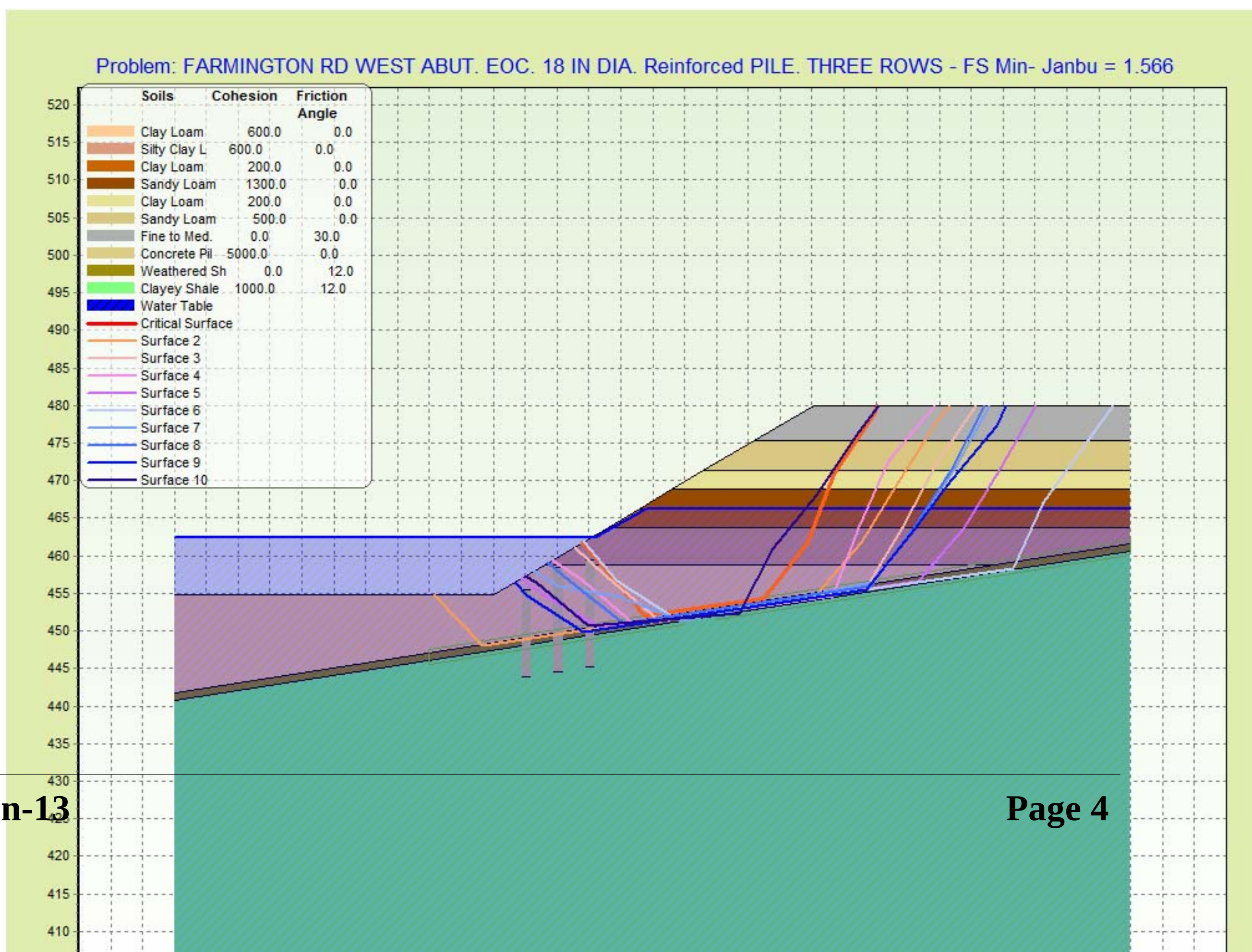
Soil Number	Wet Unit Weight	Saturated Unit Weight	Cohesive Intercept	Friction Angle	Ru	Pressure Head	Water Table	Soil Name
1	115	115	0	30	0	0	1	Fine to Med.
2	115	115	500	0	0	0	1	Sandy Loam
3	125	125	200	0	0	0	1	Clay Loam
4	115	115	1300	0	0	0	1	Sandy Loam
5	125	125	200	0	0	0	1	Clay Loam
6	125	125	600	0	0	0	1	Silty Clay Loam
7	125	125	600	0	0	0	1	Clay Loam
8	130	130	0	12	0	0	1	Weathered
9	130	130	1000	12	0	0	1	Clayey Shale
10	35	35	1500	0	0	0	1	Timber Pile

Soil Number	Wet Unit Weight	Saturated Unit Weight	Cohesive Intercept	Friction Angle	Ru	Pressure Head	Water Table	Soil Name
11	145	145	5000	0	0	0	1	Concrete Pile

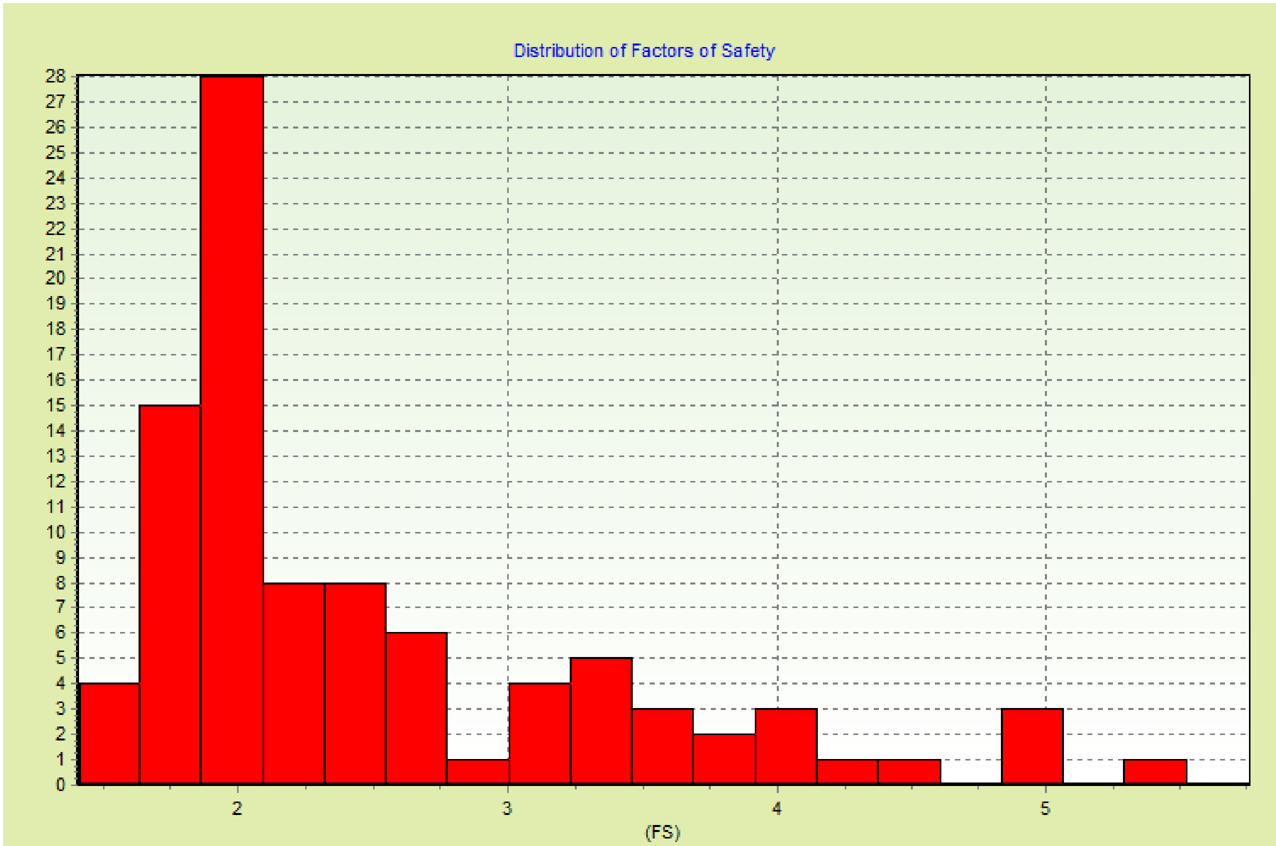
=============== All Surfaces Generated =============



=============== 10 Most Critical Surfaces ===============



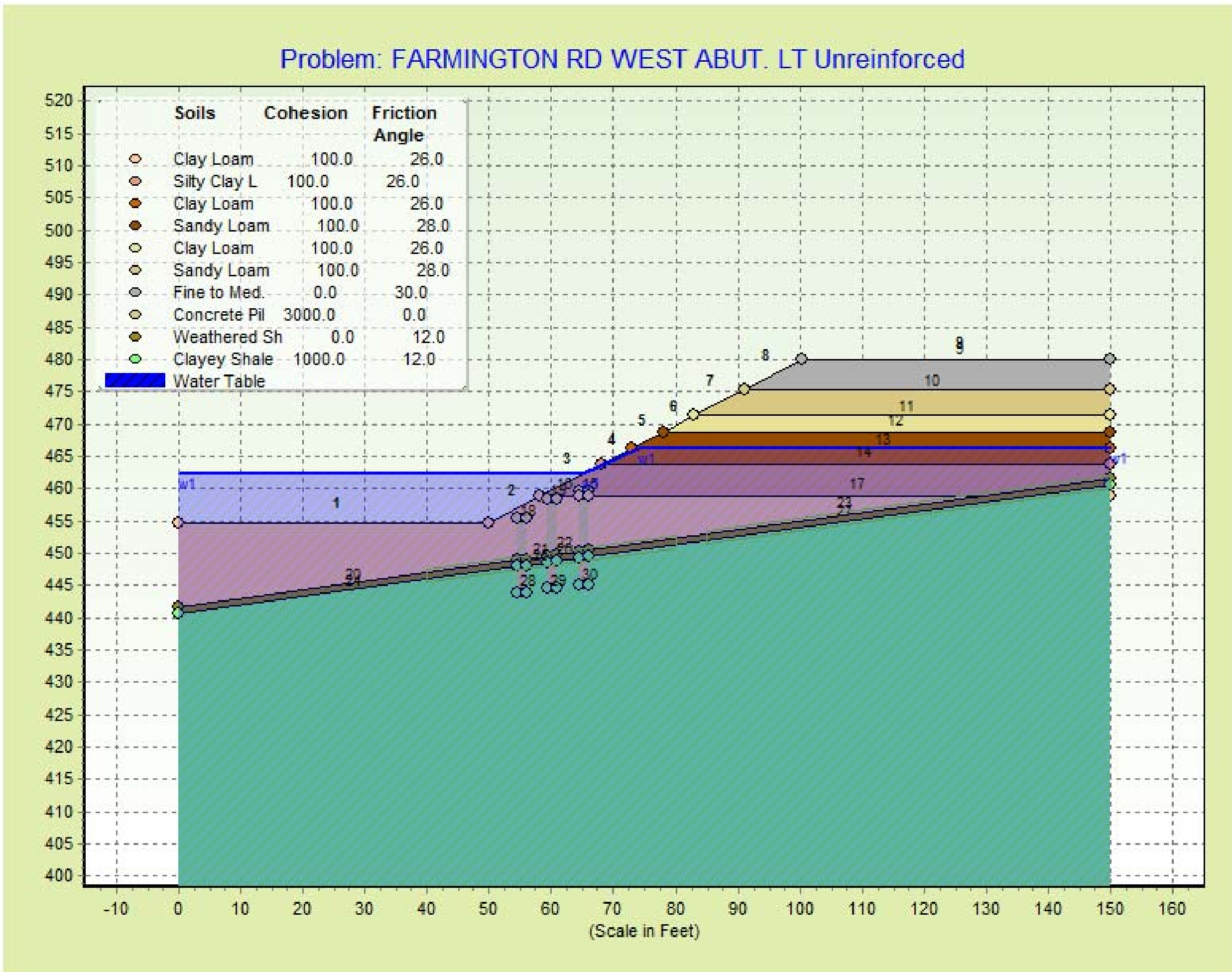
============= Factor of Safety Histogram ============



======== Factors of Safety of 10 Most Critical Surfaces =======

Surface Number	Factor of Safety
1	1.566
2	1.578
3	1.608
4	1.626
5	1.638
6	1.641
7	1.711
8	1.751
9	1.765
10	1.788

================== DATA SUMMARY =====================



Profile Data

Segment Number	Left Extreme X	Left Extreme Y	Right Extreme X	Right Extreme Y	Soil Under Segment
1	0	454.8	50	454.8	7
2	50	454.8	58	458.8	7
3	58	458.8	68	463.8	6
4	68	463.8	73	466.3	5
5	73	466.3	78	468.8	4
6	78	468.8	83	471.3	3
7	83	471.3	91	475.3	2
8	91	475.3	100.4	480	1
9	100.4	480	150	480	1
10	91	475.3	150	475.3	2

Unreinforced

Segment Number	Left Extreme X	Left Extreme Y	Right Extreme X	Right Extreme Y	Soil Under Segment
11	83	471.3	150	471.3	3
12	78	468.8	150	468.8	4
13	73	466.3	150	466.3	5
14	68	463.8	150	463.8	6
15	64.5	459.5	66	459.5	11
16	58	458.8	64.5	458.8	7
17	66	458.8	150	458.8	7
18	54.5	455.5	56	455.5	11
19	59.5	458.5	61	458.5	11
20	0	441.7	54.5	448.95	8
21	56	449.15	59.5	449.61	8
22	61	449.81	64.5	450.28	8
23	66	450.48	150	461.65	8
24	0	440.7	54.5	447.95	9
25	56	448.15	59.5	448.61	9
26	61	448.81	64.5	449.28	9
27	66	449.48	150	460.65	9
28	54.5	443.9	56	443.9	9
29	59.5	444.6	61	444.6	9
30	64.5	445.2	66	445.2	9

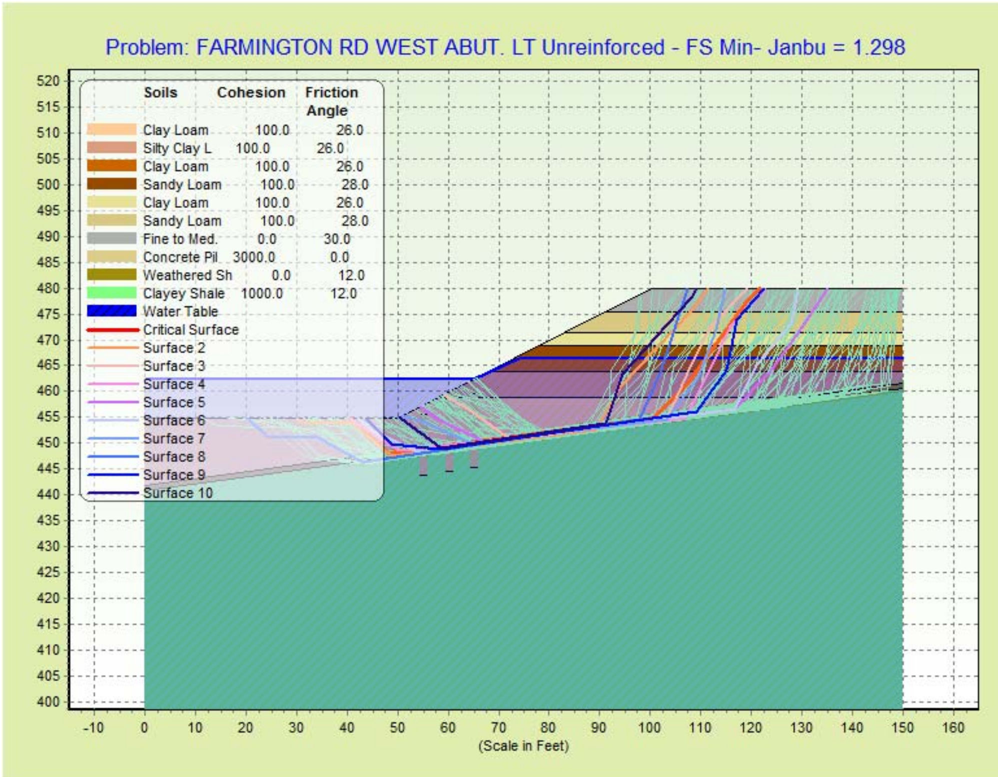
Soil Properties

Soil Number	Wet Unit Weight	Saturated Unit Weight	Cohesive Intercept	Friction Angle	Ru	Pressure Head	Water Table	Soil Name
1	115	115	0	30	0	0	1	Fine to Med.
2	115	115	100	28	0	0	1	Sandy Loam
3	125	125	100	26	0	0	1	Clay Loam
4	115	115	100	28	0	0	1	Sandy Loam
5	125	125	100	26	0	0	1	Clay Loam
6	125	125	100	26	0	0	1	Silty Clay Loam
7	125	125	100	26	0	0	1	Clay Loam
8	130	130	0	12	0	0	1	Weathered
9	130	130	1000	12	0	0	1	Clayey Shale
10	35	35	1500	0	0	0	1	Timber Pile

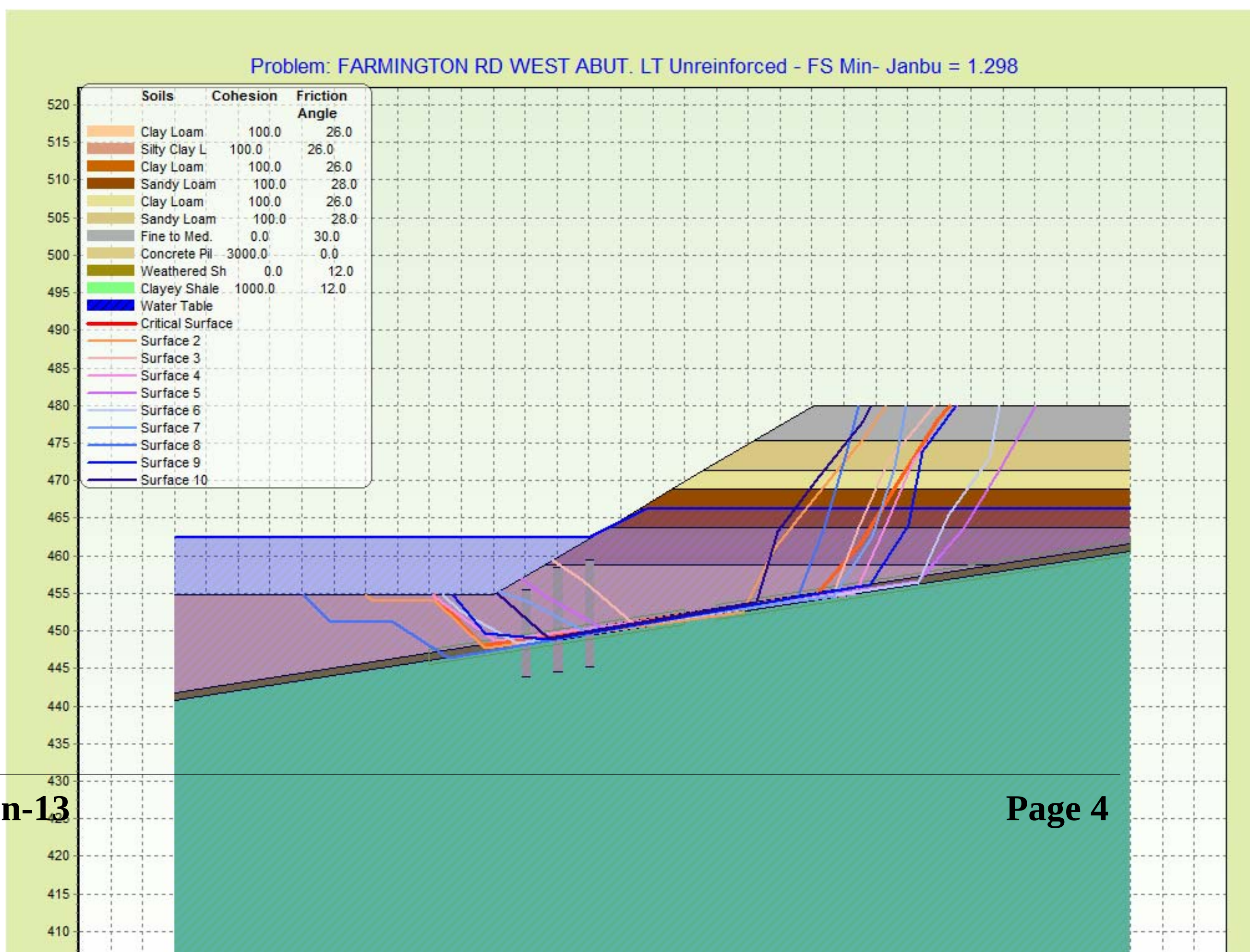
Unreinforced

Soil Number	Wet Unit Weight	Saturated Unit Weight	Cohesive Intercept	Friction Angle	Ru	Pressure Head	Water Table	Soil Name
11	145	145	3000	0	0	0	1	Concrete Pile

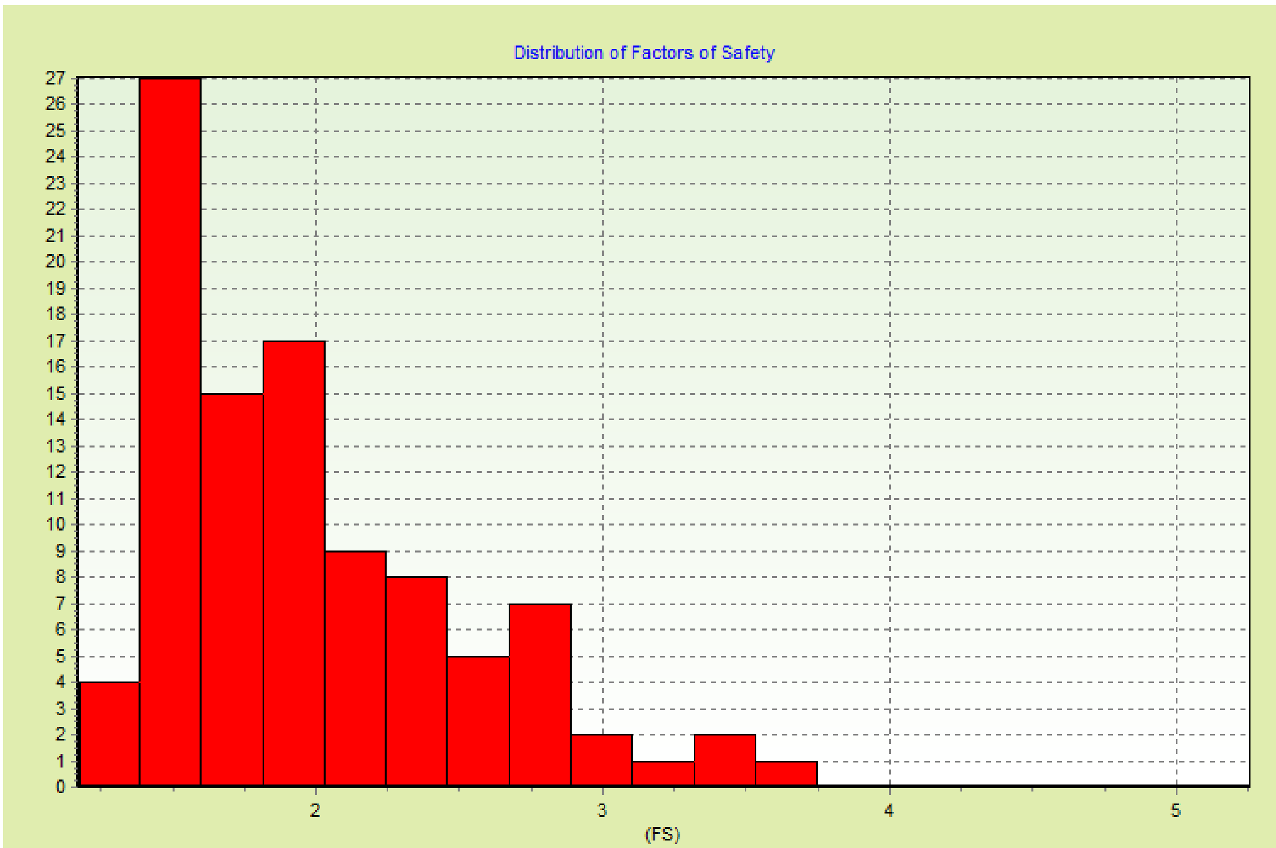
=============== All Surfaces Generated =============



=============== 10 Most Critical Surfaces ===============



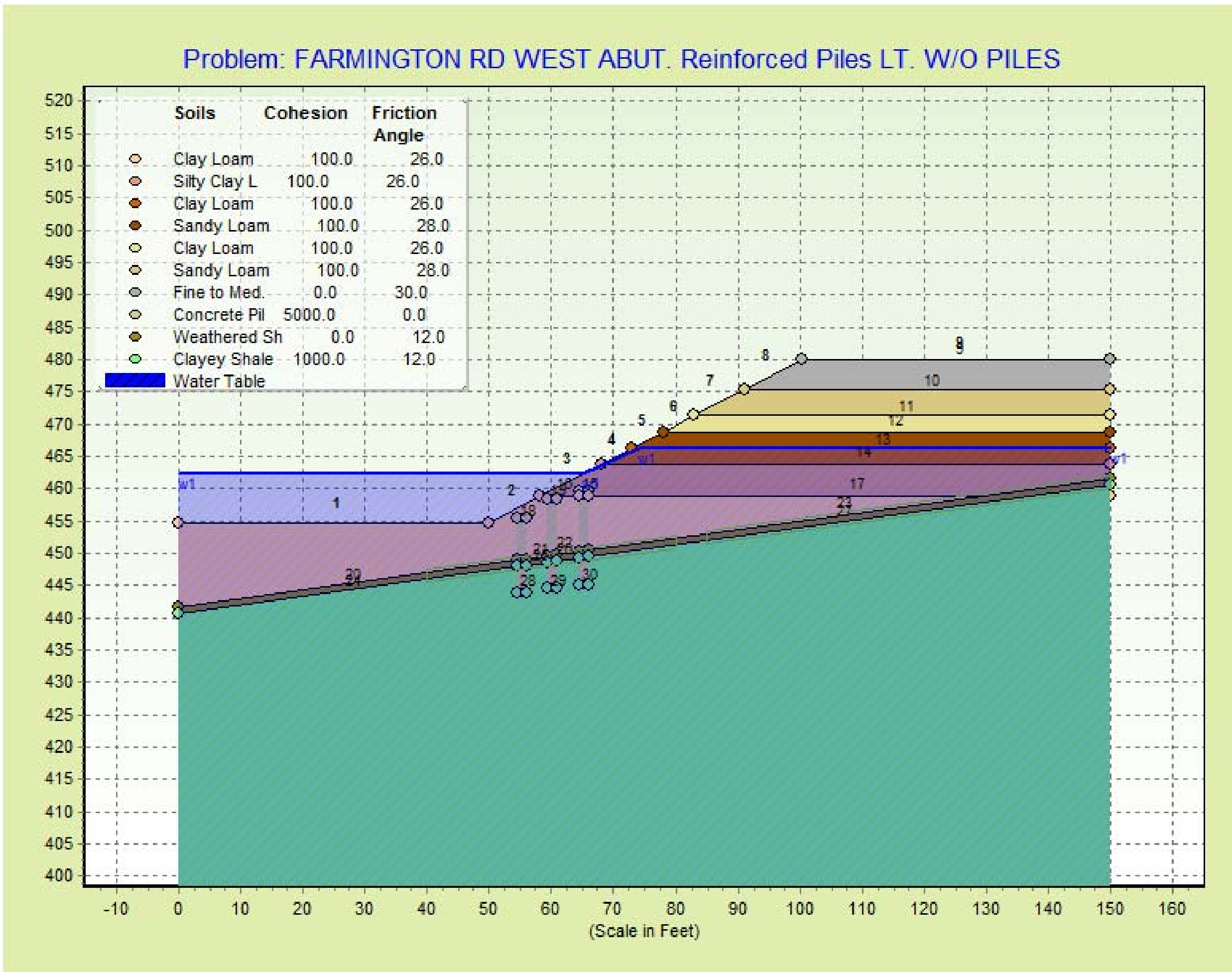
============= Factor of Safety Histogram ============



======== Factors of Safety of 10 Most Critical Surfaces =======

Surface Number	Factor of Safety
1	1.298
2	1.321
3	1.363
4	1.38
5	1.389
6	1.393
7	1.408
8	1.415
9	1.416
10	1.426

================== DATA SUMMARY ====================



Profile Data

Segment Number	Left Extreme X	Left Extreme Y	Right Extreme X	Right Extreme Y	Soil Under Segment
1	0	454.8	50	454.8	7
2	50	454.8	58	458.8	7
3	58	458.8	68	463.8	6
4	68	463.8	73	466.3	5
5	73	466.3	78	468.8	4
6	78	468.8	83	471.3	3
7	83	471.3	91	475.3	2
8	91	475.3	100.4	480	1
9	100.4	480	150	480	1
10	91	475.3	150	475.3	2

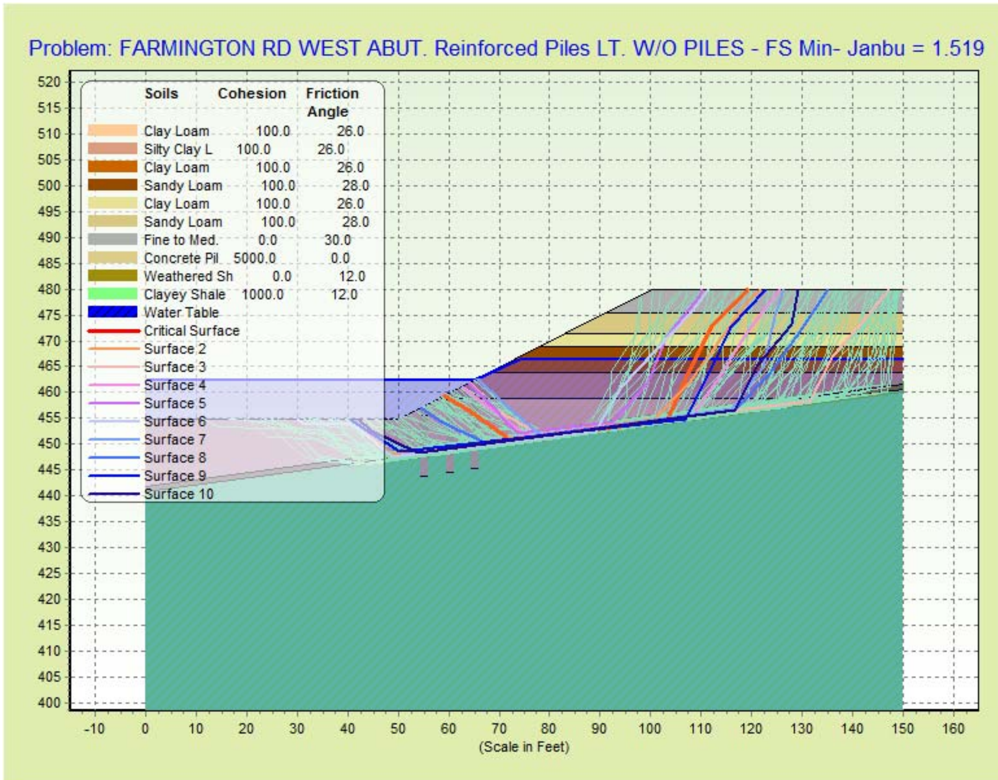
Segment Number	Left Extreme X	Left Extreme Y	Right Extreme X	Right Extreme Y	Soil Under Segment
11	83	471.3	150	471.3	3
12	78	468.8	150	468.8	4
13	73	466.3	150	466.3	5
14	68	463.8	150	463.8	6
15	64.5	459.5	66	459.5	11
16	58	458.8	64.5	458.8	7
17	66	458.8	150	458.8	7
18	54.5	455.5	56	455.5	11
19	59.5	458.5	61	458.5	11
20	0	441.7	54.5	448.95	8
21	56	449.15	59.5	449.61	8
22	61	449.81	64.5	450.28	8
23	66	450.48	150	461.65	8
24	0	440.7	54.5	447.95	9
25	56	448.15	59.5	448.61	9
26	61	448.81	64.5	449.28	9
27	66	449.48	150	460.65	9
28	54.5	443.9	56	443.9	9
29	59.5	444.6	61	444.6	9
30	64.5	445.2	66	445.2	9

Soil Properties

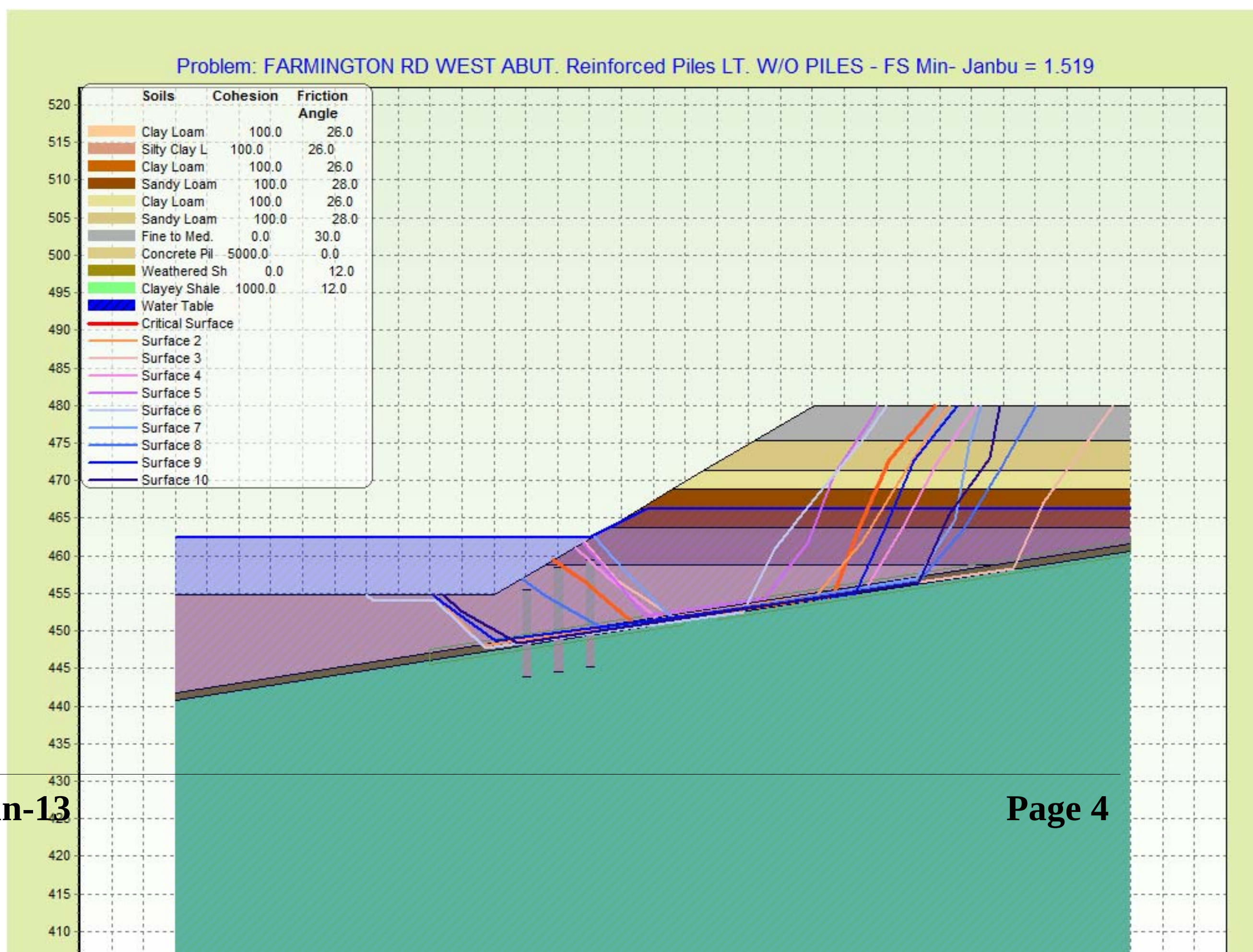
Soil Number	Wet Unit Weight	Saturated Unit Weight	Cohesive Intercept	Friction Angle	Ru	Pressure Head	Water Table	Soil Name
1	115	115	0	30	0	0	1	Fine to Med.
2	115	115	100	28	0	0	1	Sandy Loam
3	125	125	100	26	0	0	1	Clay Loam
4	115	115	100	28	0	0	1	Sandy Loam
5	125	125	100	26	0	0	1	Clay Loam
6	125	125	100	26	0	0	1	Silty Clay Loam
7	125	125	100	26	0	0	1	Clay Loam
8	130	130	0	12	0	0	1	Weathered
9	130	130	1000	12	0	0	1	Clayey Shale
10	35	35	1500	0	0	0	1	Timber Pile

Soil Number	Wet Unit Weight	Saturated Unit Weight	Cohesive Intercept	Friction Angle	Ru	Pressure Head	Water Table	Soil Name
11	145	145	5000	0	0	0	1	Concrete Pile

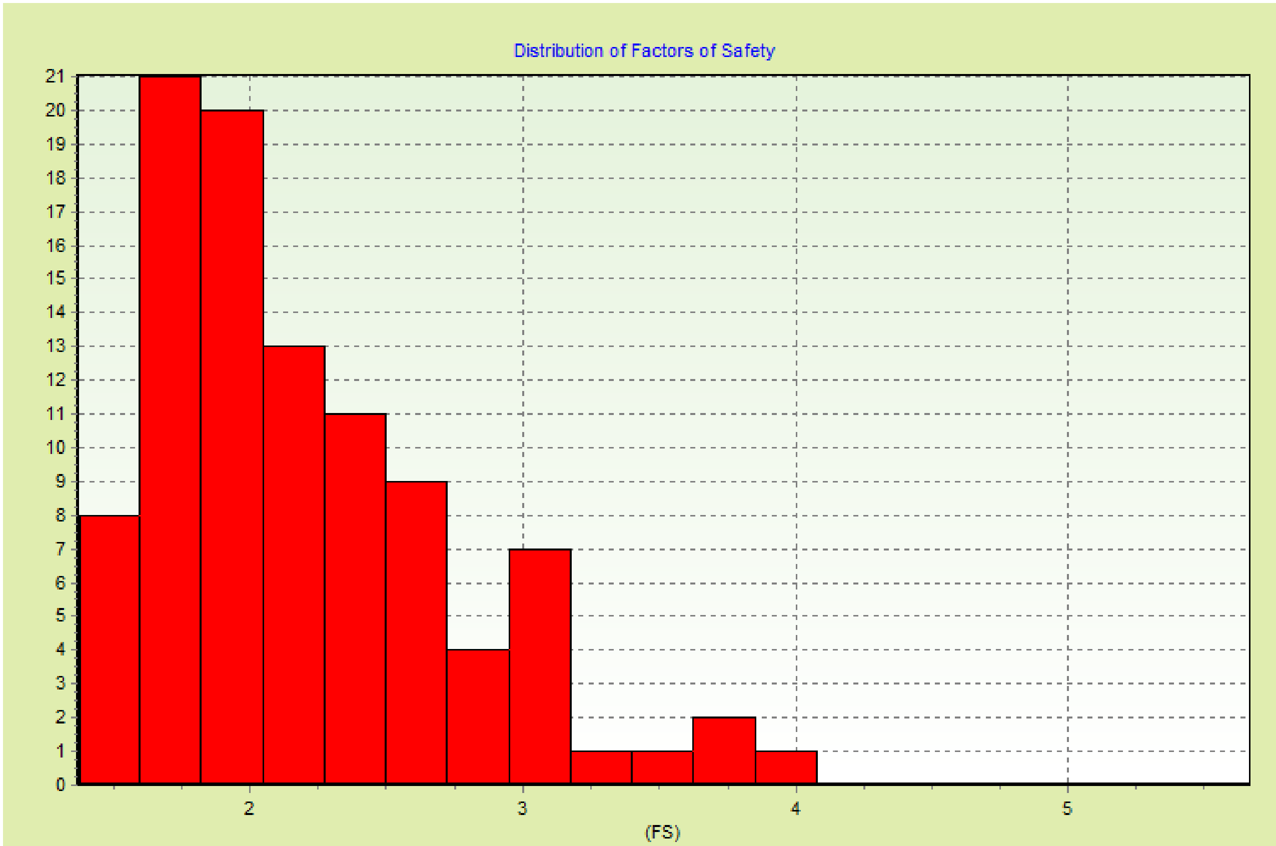
=============== All Surfaces Generated =============



=============== 10 Most Critical Surfaces ===============



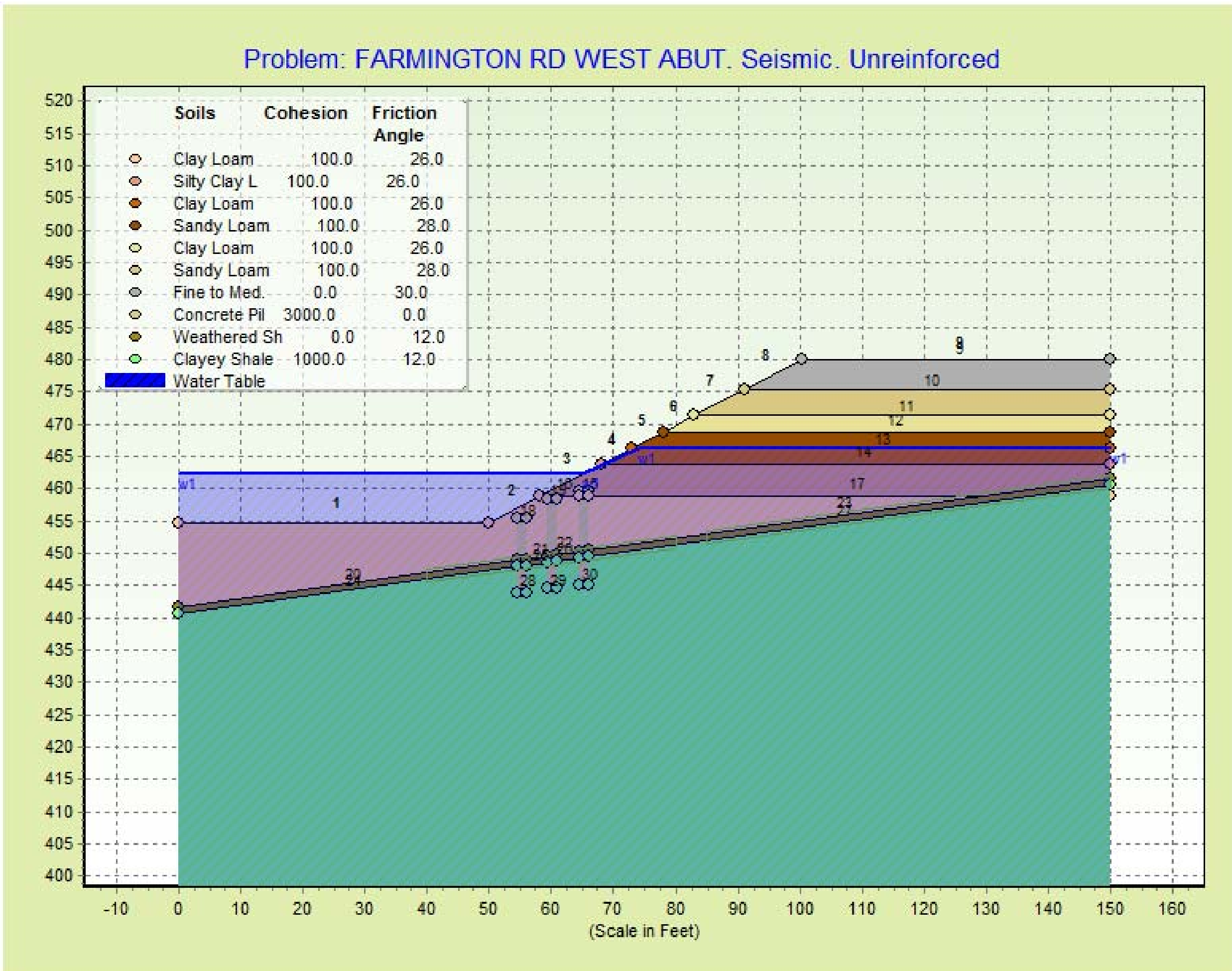
============= Factor of Safety Histogram ============



======== Factors of Safety of 10 Most Critical Surfaces =======

Surface Number	Factor of Safety
1	1.519
2	1.533
3	1.551
4	1.569
5	1.574
6	1.579
7	1.585
8	1.588
9	1.623
10	1.632

================= DATA SUMMARY ===================



Profile Data

Segment Number	Left Extreme X	Left Extreme Y	Right Extreme X	Right Extreme Y	Soil Under Segment
1	0	454.8	50	454.8	7
2	50	454.8	58	458.8	7
3	58	458.8	68	463.8	6
4	68	463.8	73	466.3	5
5	73	466.3	78	468.8	4
6	78	468.8	83	471.3	3
7	83	471.3	91	475.3	2
8	91	475.3	100.4	480	1
9	100.4	480	150	480	1
10	91	475.3	150	475.3	2

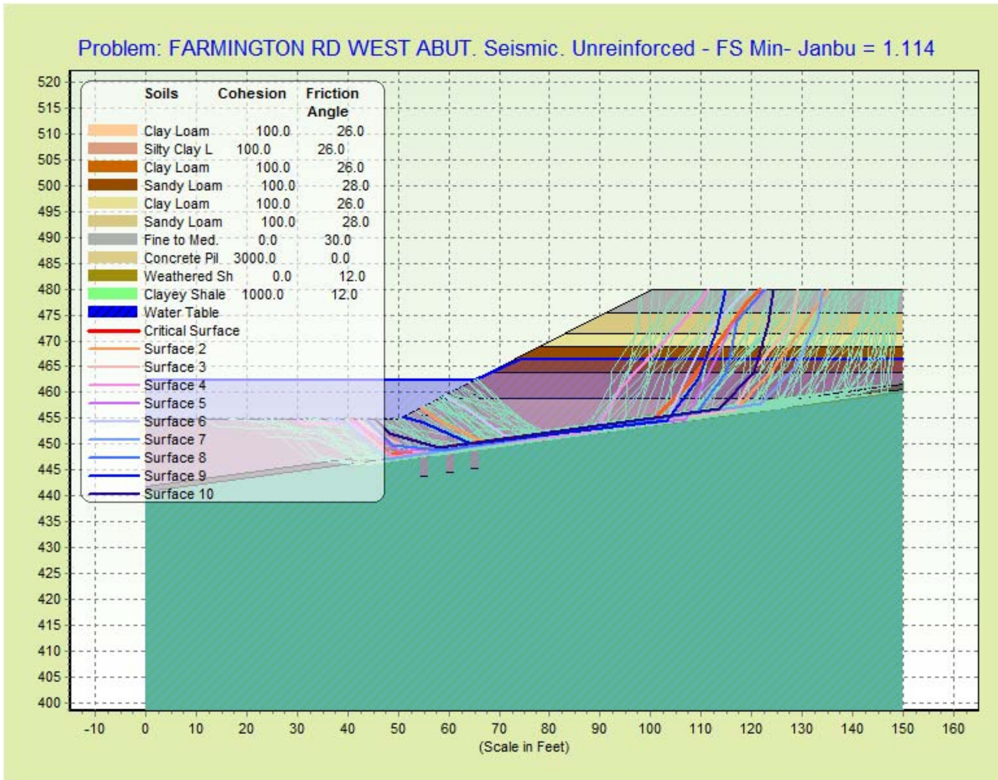
Segment Number	Left Extreme X	Left Extreme Y	Right Extreme X	Right Extreme Y	Soil Under Segment
11	83	471.3	150	471.3	3
12	78	468.8	150	468.8	4
13	73	466.3	150	466.3	5
14	68	463.8	150	463.8	6
15	64.5	459.5	66	459.5	11
16	58	458.8	64.5	458.8	7
17	66	458.8	150	458.8	7
18	54.5	455.5	56	455.5	11
19	59.5	458.5	61	458.5	11
20	0	441.7	54.5	448.95	8
21	56	449.15	59.5	449.61	8
22	61	449.81	64.5	450.28	8
23	66	450.48	150	461.65	8
24	0	440.7	54.5	447.95	9
25	56	448.15	59.5	448.61	9
26	61	448.81	64.5	449.28	9
27	66	449.48	150	460.65	9
28	54.5	443.9	56	443.9	9
29	59.5	444.6	61	444.6	9
30	64.5	445.2	66	445.2	9

Soil Properties

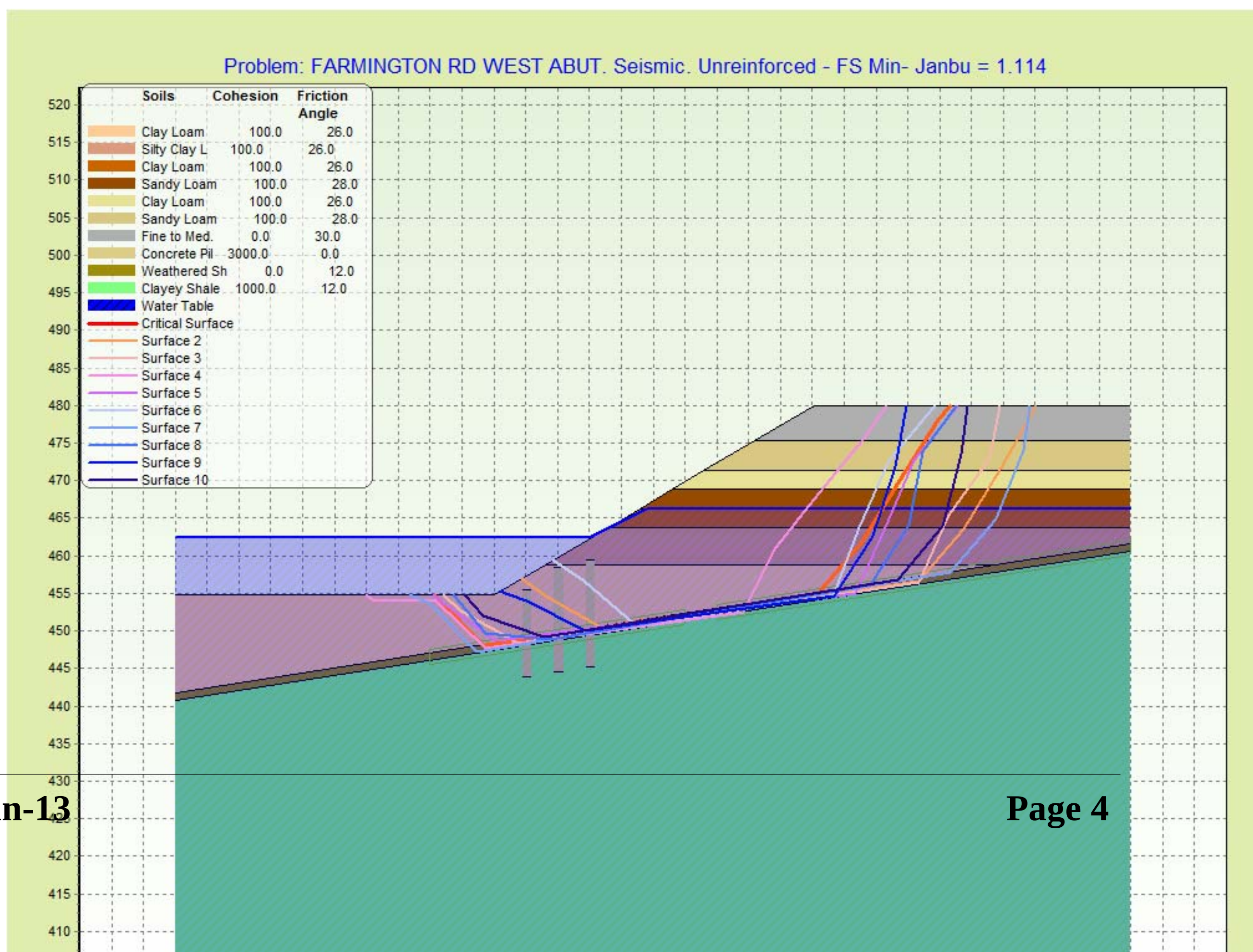
Soil Number	Wet Unit Weight	Saturated Unit Weight	Cohesive Intercept	Friction Angle	Ru	Pressure Head	Water Table	Soil Name
1	115	115	0	30	0	0	1	Fine to Med.
2	115	115	100	28	0	0	1	Sandy Loam
3	125	125	100	26	0	0	1	Clay Loam
4	115	115	100	28	0	0	1	Sandy Loam
5	125	125	100	26	0	0	1	Clay Loam
6	125	125	100	26	0	0	1	Silty Clay Loam
7	125	125	100	26	0	0	1	Clay Loam
8	130	130	0	12	0	0	1	Weathered
9	130	130	1000	12	0	0	1	Clayey Shale
10	35	35	1500	0	0	0	1	Timber Pile

Soil Number	Wet Unit Weight	Saturated Unit Weight	Cohesive Intercept	Friction Angle	Ru	Pressure Head	Water Table	Soil Name
11	145	145	3000	0	0	0	1	Concrete Pile

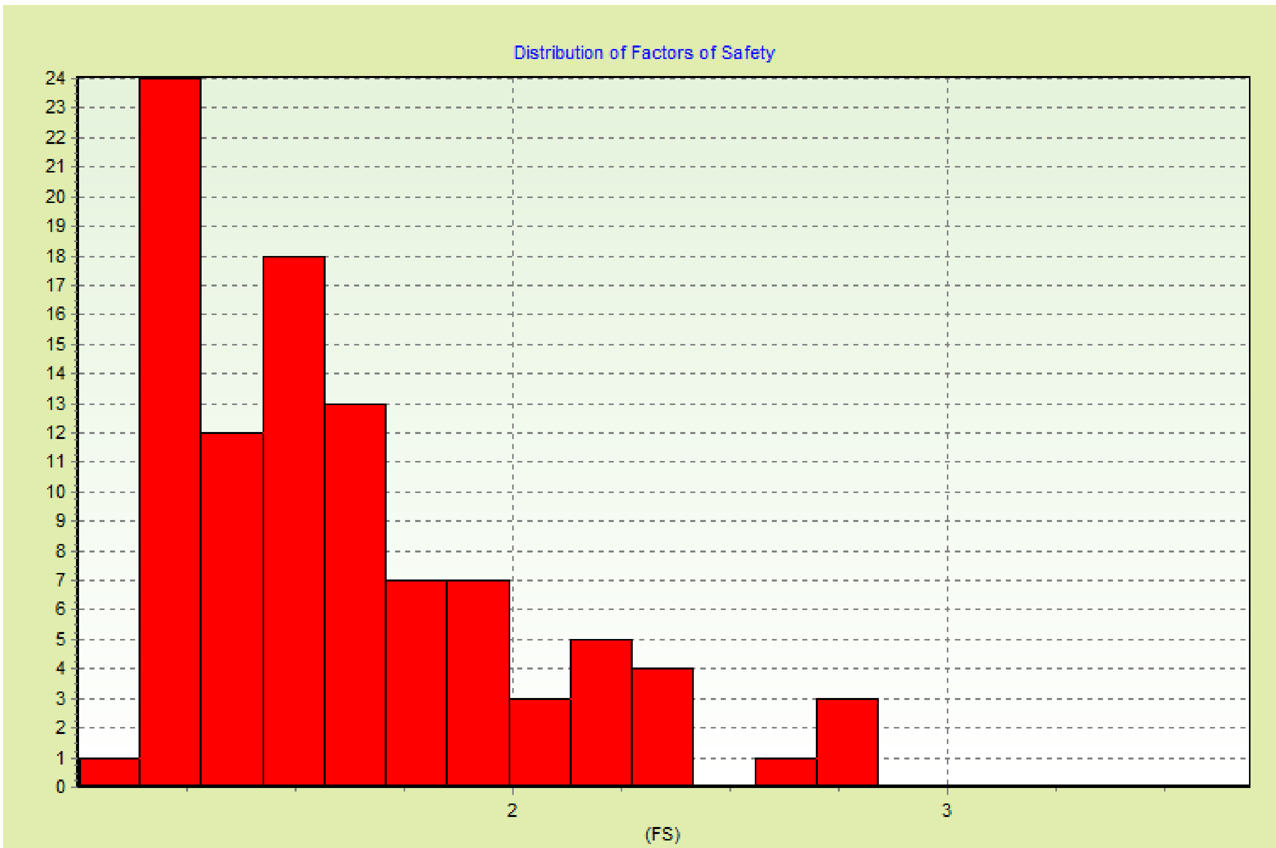
=============== All Surfaces Generated =============



=============== 10 Most Critical Surfaces ===============



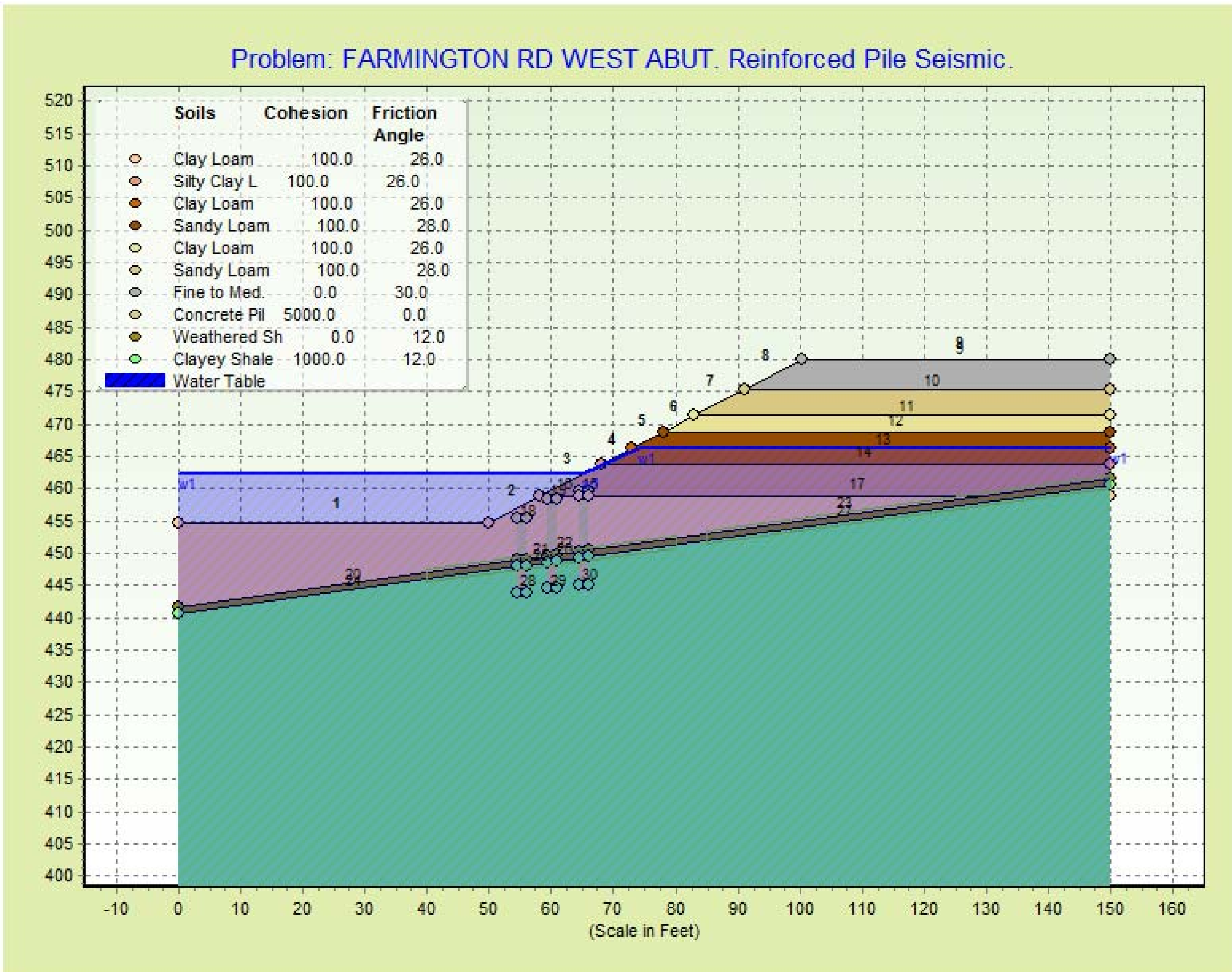
============= Factor of Safety Histogram ============



======== Factors of Safety of 10 Most Critical Surfaces =======

Surface Number	Factor of Safety
1	1.114
2	1.145
3	1.149
4	1.156
5	1.167
6	1.175
7	1.178
8	1.186
9	1.201
10	1.203

================== DATA SUMMARY =====================



Profile Data

Segment Number	Left Extreme X	Left Extreme Y	Right Extreme X	Right Extreme Y	Soil Under Segment
1	0	454.8	50	454.8	7
2	50	454.8	58	458.8	7
3	58	458.8	68	463.8	6
4	68	463.8	73	466.3	5
5	73	466.3	78	468.8	4
6	78	468.8	83	471.3	3
7	83	471.3	91	475.3	2
8	91	475.3	100.4	480	1
9	100.4	480	150	480	1
10	91	475.3	150	475.3	2

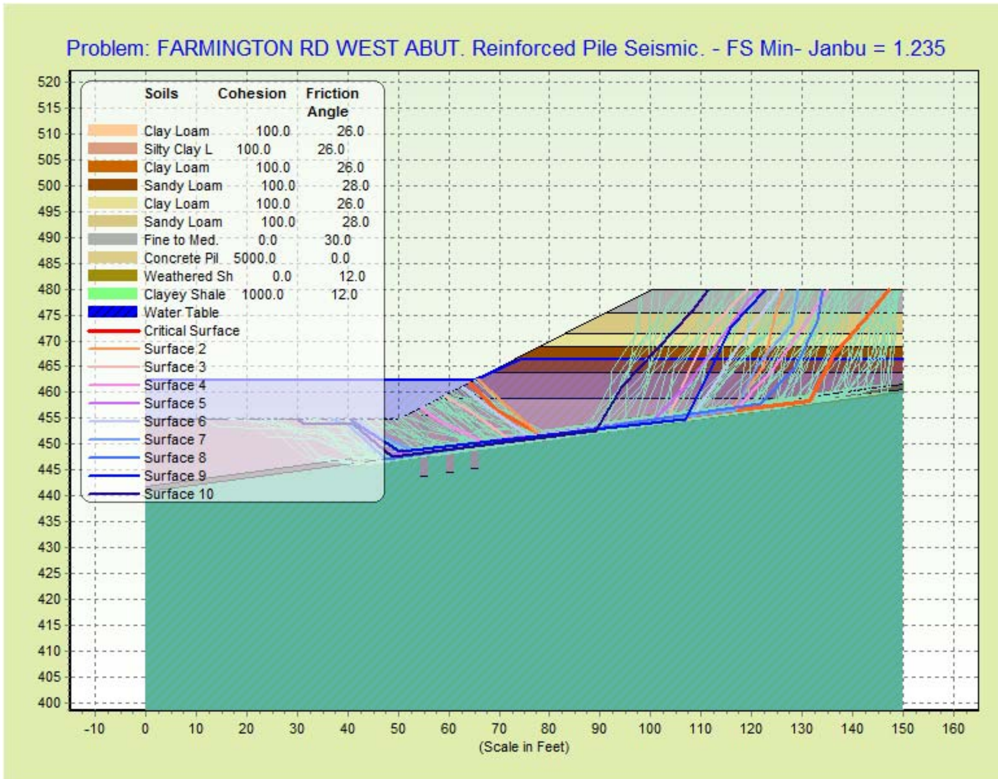
Segment Number	Left Extreme X	Left Extreme Y	Right Extreme X	Right Extreme Y	Soil Under Segment
11	83	471.3	150	471.3	3
12	78	468.8	150	468.8	4
13	73	466.3	150	466.3	5
14	68	463.8	150	463.8	6
15	64.5	459.5	66	459.5	11
16	58	458.8	64.5	458.8	7
17	66	458.8	150	458.8	7
18	54.5	455.5	56	455.5	11
19	59.5	458.5	61	458.5	11
20	0	441.7	54.5	448.95	8
21	56	449.15	59.5	449.61	8
22	61	449.81	64.5	450.28	8
23	66	450.48	150	461.65	8
24	0	440.7	54.5	447.95	9
25	56	448.15	59.5	448.61	9
26	61	448.81	64.5	449.28	9
27	66	449.48	150	460.65	9
28	54.5	443.9	56	443.9	9
29	59.5	444.6	61	444.6	9
30	64.5	445.2	66	445.2	9

Soil Properties

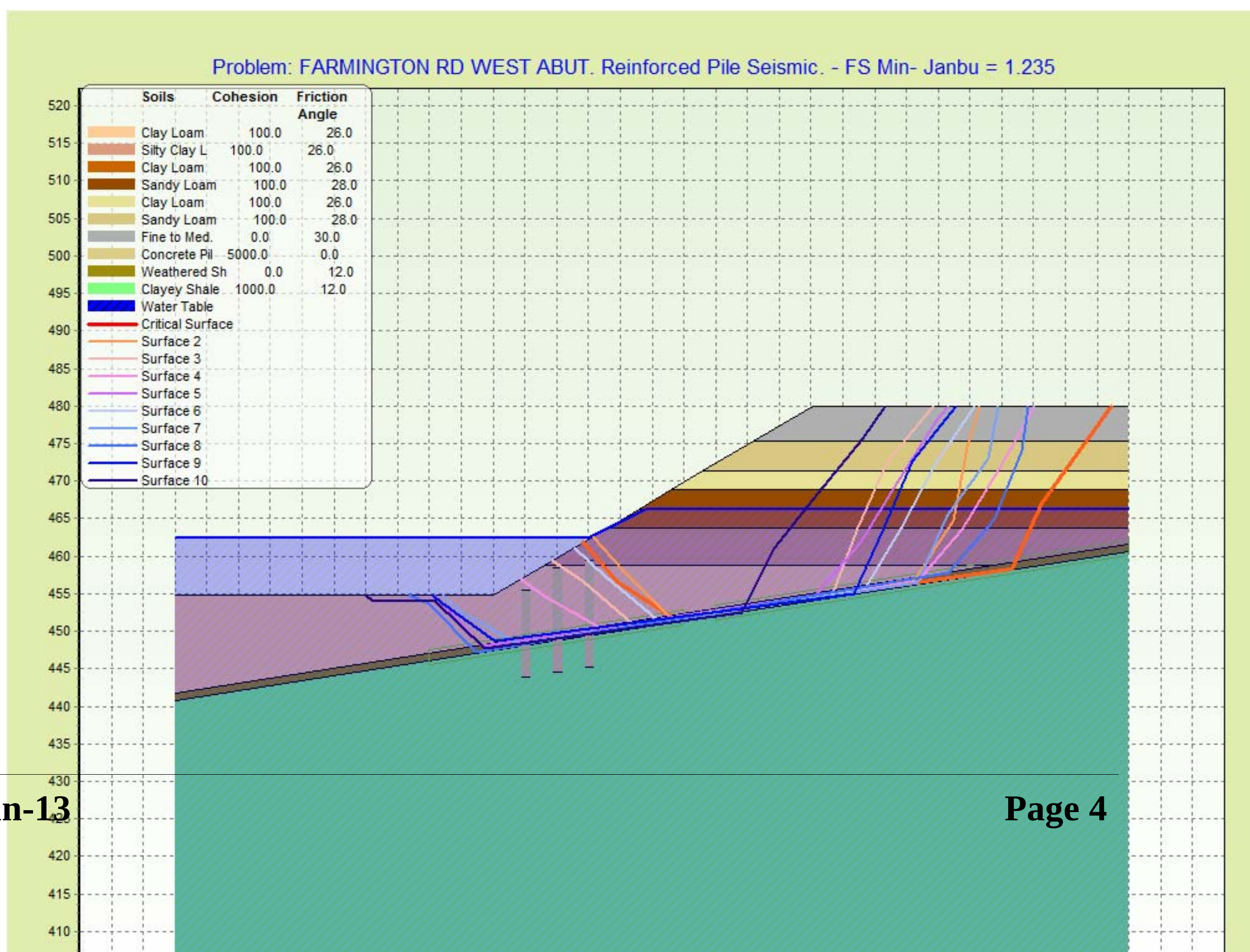
Soil Number	Wet Unit Weight	Saturated Unit Weight	Cohesive Intercept	Friction Angle	Ru	Pressure Head	Water Table	Soil Name
1	115	115	0	30	0	0	1	Fine to Med.
2	115	115	100	28	0	0	1	Sandy Loam
3	125	125	100	26	0	0	1	Clay Loam
4	115	115	100	28	0	0	1	Sandy Loam
5	125	125	100	26	0	0	1	Clay Loam
6	125	125	100	26	0	0	1	Silty Clay Loam
7	125	125	100	26	0	0	1	Clay Loam
8	130	130	0	12	0	0	1	Weathered
9	130	130	1000	12	0	0	1	Clayey Shale
10	35	35	1500	0	0	0	1	Timber Pile

Soil Number	Wet Unit Weight	Saturated Unit Weight	Cohesive Intercept	Friction Angle	Ru	Pressure Head	Water Table	Soil Name
11	145	145	5000	0	0	0	1	Concrete Pile

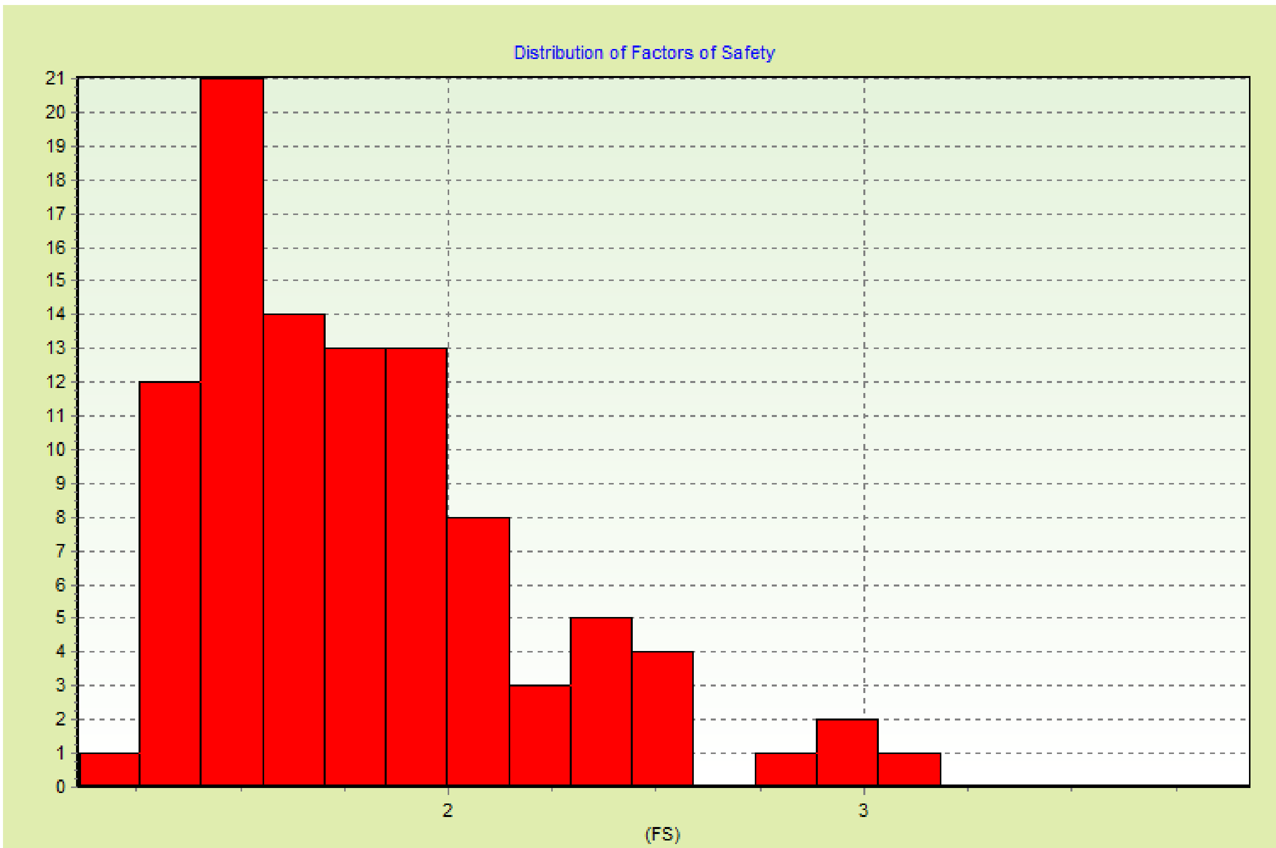
=============== All Surfaces Generated =============



=============== 10 Most Critical Surfaces ===============



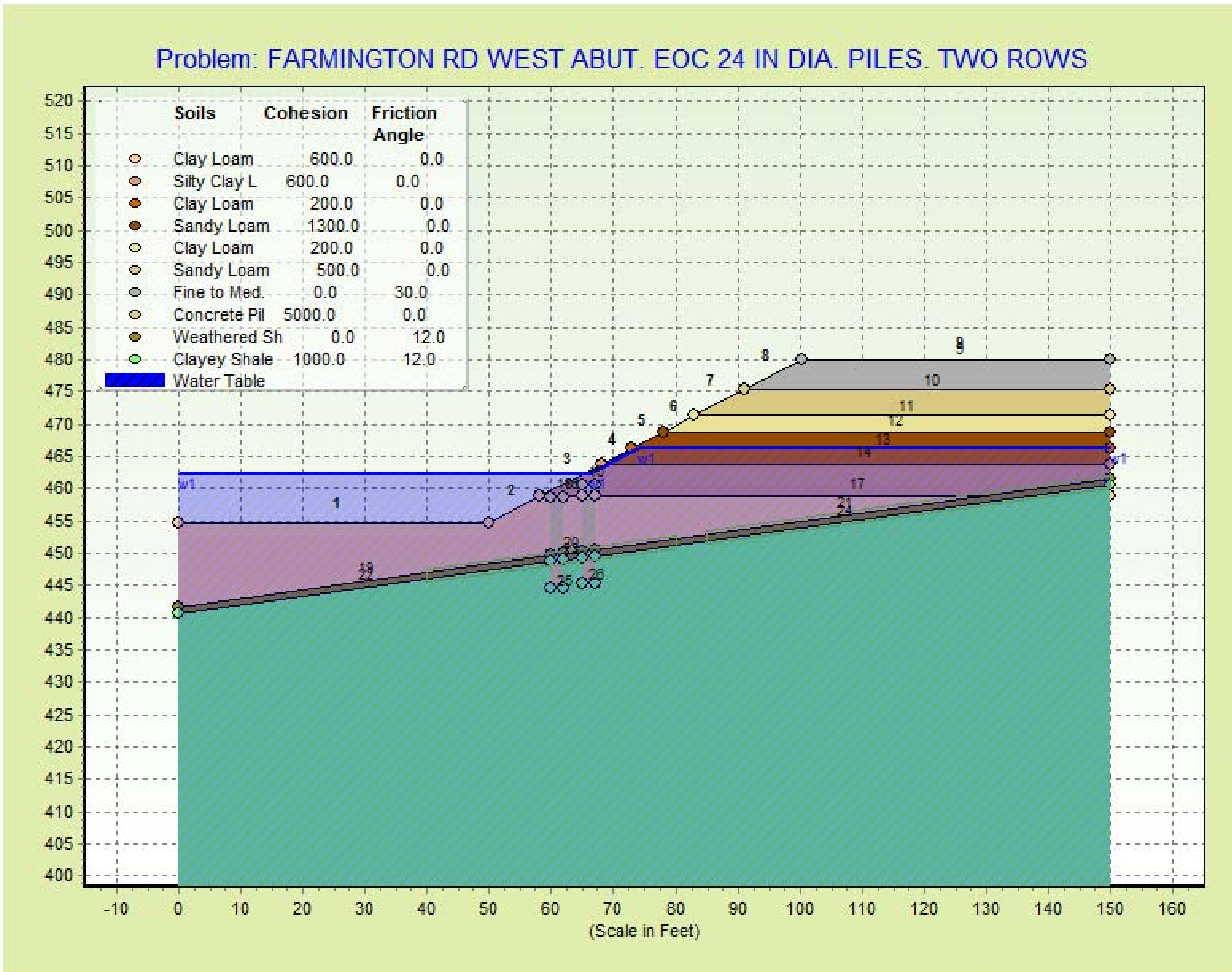
============= Factor of Safety Histogram ============



======== Factors of Safety of 10 Most Critical Surfaces =======

Surface Number	Factor of Safety
1	1.235
2	1.305
3	1.313
4	1.314
5	1.319
6	1.333
7	1.353
8	1.372
9	1.379
10	1.386

================== DATA SUMMARY ====================



Profile Data

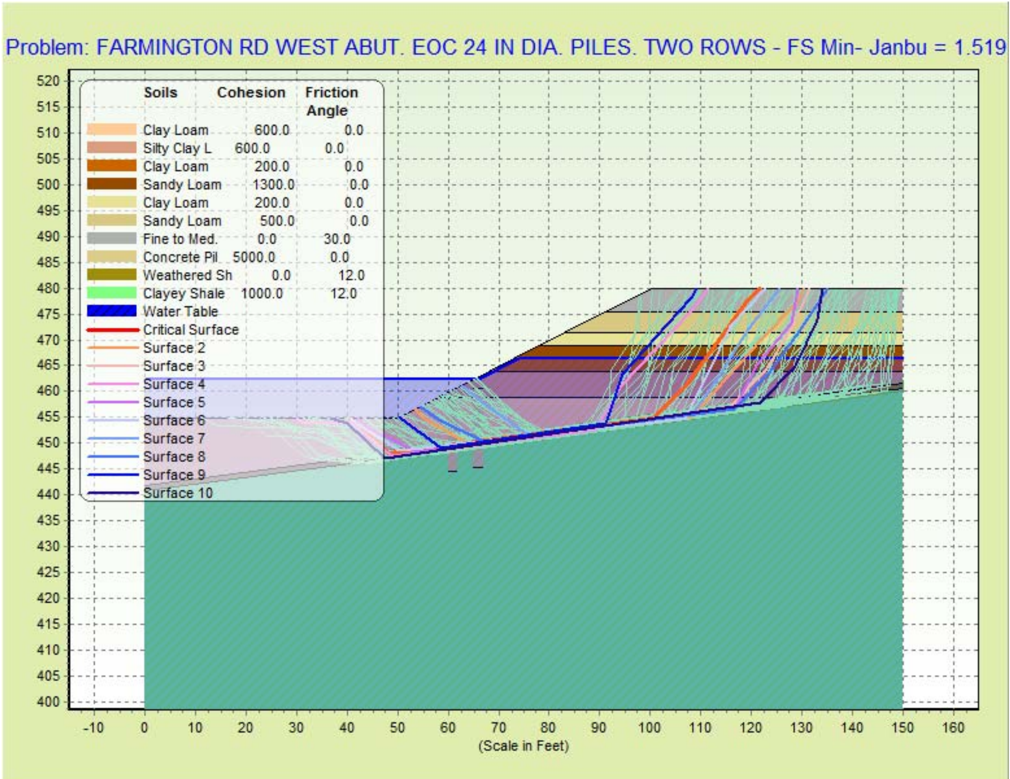
Segment Number	Left Extreme X	Left Extreme Y	Right Extreme X	Right Extreme Y	Soil Under Segment
1	0	454.8	50	454.8	7
2	50	454.8	58	458.8	7
3	58	458.8	68	463.8	6
4	68	463.8	73	466.3	5
5	73	466.3	78	468.8	4
6	78	468.8	83	471.3	3
7	83	471.3	91	475.3	2
8	91	475.3	100.4	480	1
9	100.4	480	150	480	1
10	91	475.3	150	475.3	2

Segment Number	Left Extreme X	Left Extreme Y	Right Extreme X	Right Extreme Y	Soil Under Segment
11	83	471.3	150	471.3	3
12	78	468.8	150	468.8	4
13	73	466.3	150	466.3	5
14	68	463.8	150	463.8	6
15	65	460.7	67	460.7	11
16	58	458.8	65	458.8	7
17	67	458.8	150	458.8	7
18	60	458.7	62	458.7	11
19	0	441.7	60	449.68	8
20	62	449.95	65	450.35	8
21	67	450.61	150	461.65	8
22	0	440.7	60	448.68	9
23	62	448.95	65	449.35	9
24	67	449.61	150	460.65	9
25	60	444.6	62	444.6	9
26	65	445.3	67	445.3	9

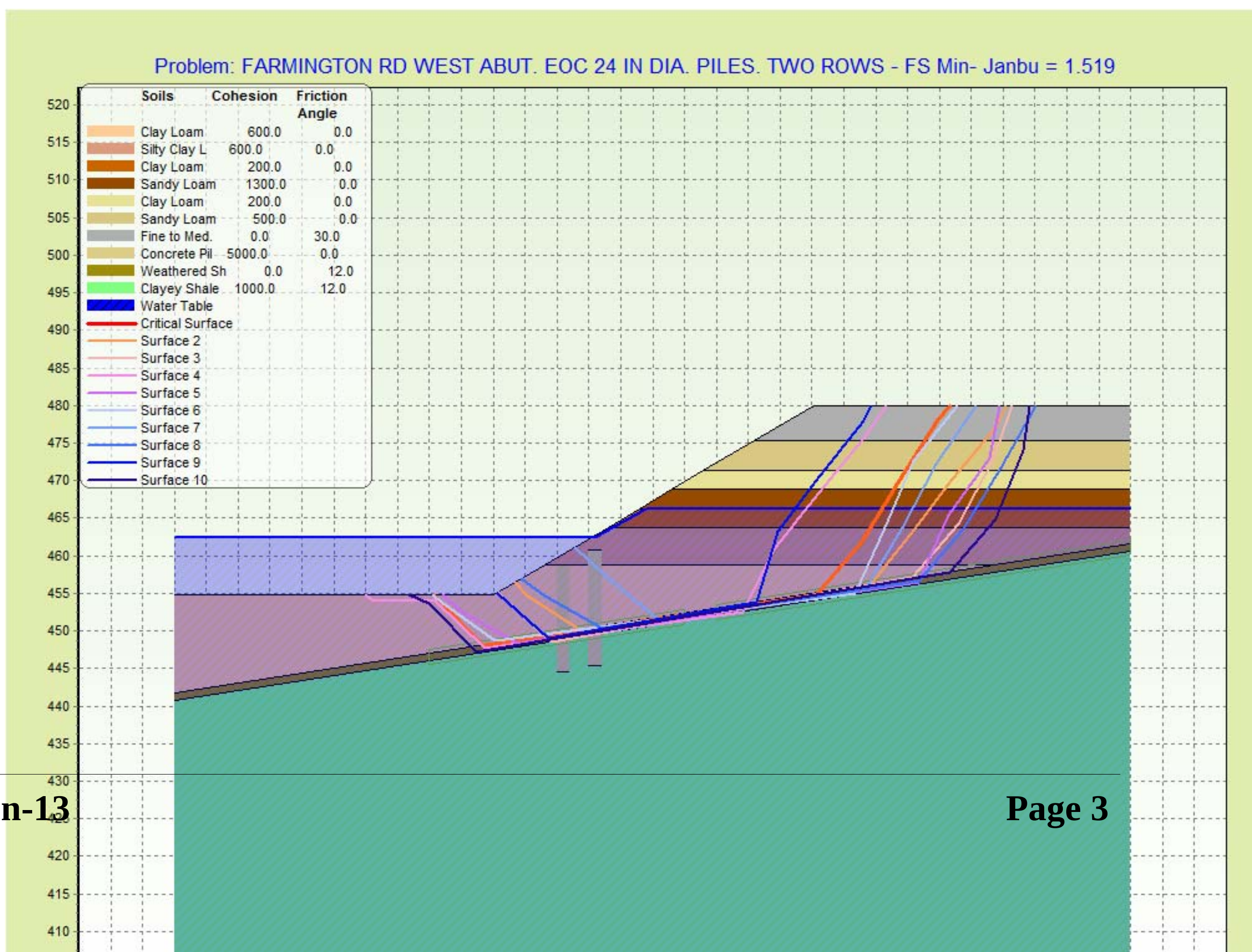
Soil Properties

Soil Number	Wet Unit Weight	Saturated Unit Weight	Cohesive Intercept	Friction Angle	Ru	Pressure Head	Water Table	Soil Name
1	115	115	0	30	0	0	1	Fine to Med.
2	115	115	500	0	0	0	1	Sandy Loam
3	125	125	200	0	0	0	1	Clay Loam
4	115	115	1300	0	0	0	1	Sandy Loam
5	125	125	200	0	0	0	1	Clay Loam
6	125	125	600	0	0	0	1	Silty Clay Loam
7	125	125	600	0	0	0	1	Clay Loam
8	130	130	0	12	0	0	1	Weathered
9	130	130	1000	12	0	0	1	Clayey Shale
10	35	35	1500	0	0	0	1	Timber Pile
11	145	145	5000	0	0	0	1	Concrete Pile

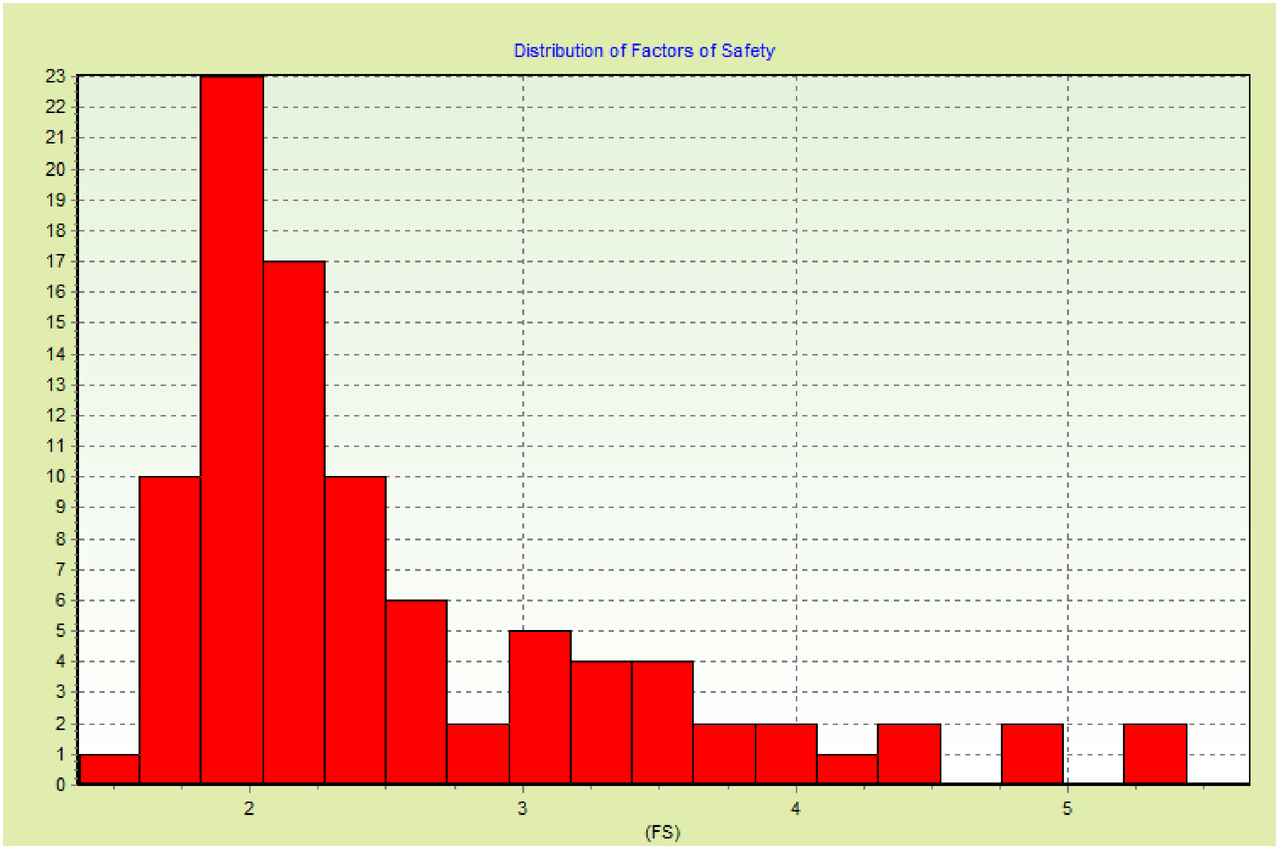
=============== All Surfaces Generated =============



=============== 10 Most Critical Surfaces ===============



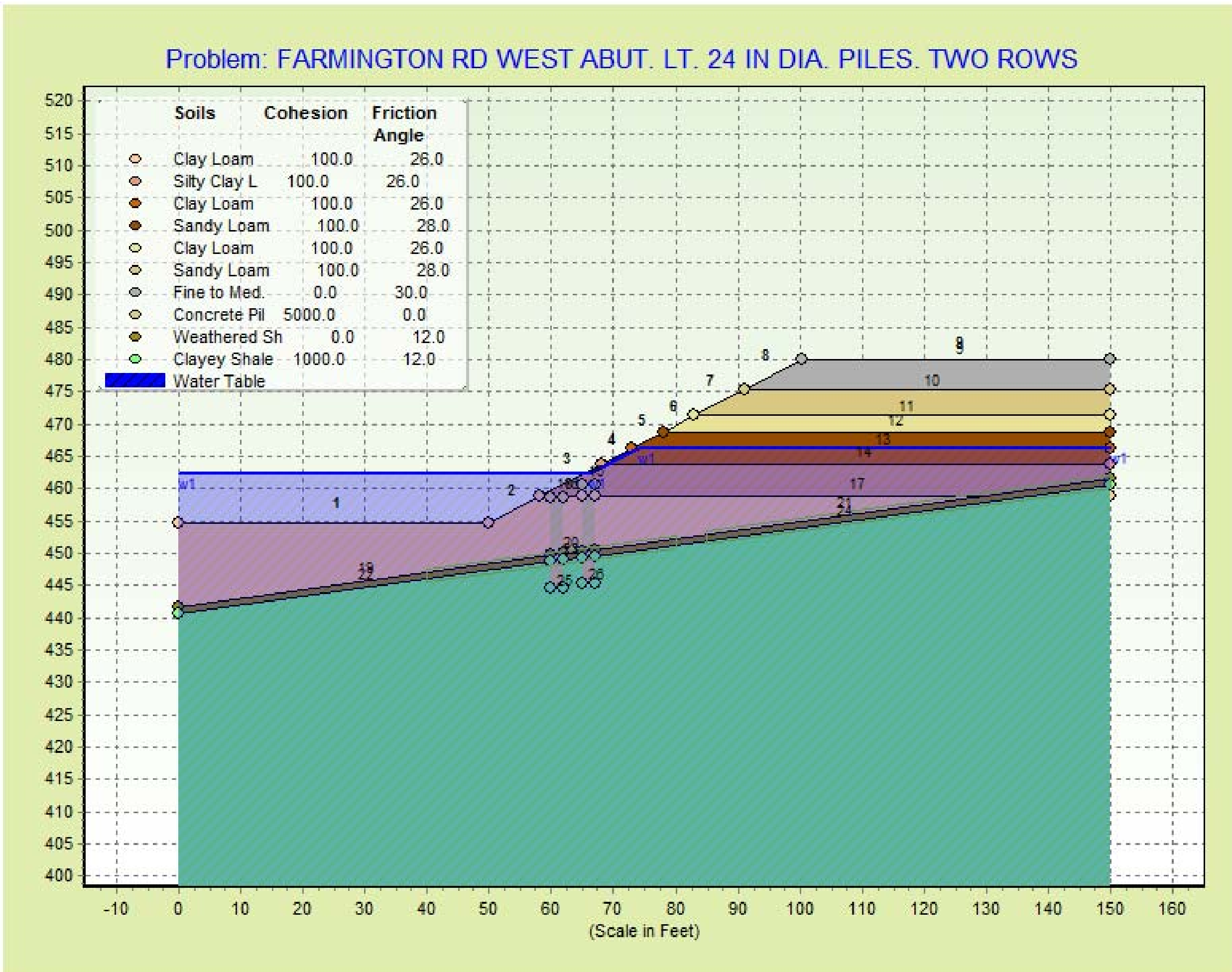
============= Factor of Safety Histogram ============



======== Factors of Safety of 10 Most Critical Surfaces =======

Surface Number	Factor of Safety
1	1.519
2	1.643
3	1.685
4	1.743
5	1.745
6	1.765
7	1.777
8	1.78
9	1.793
10	1.803

================== DATA SUMMARY ====================



Profile Data

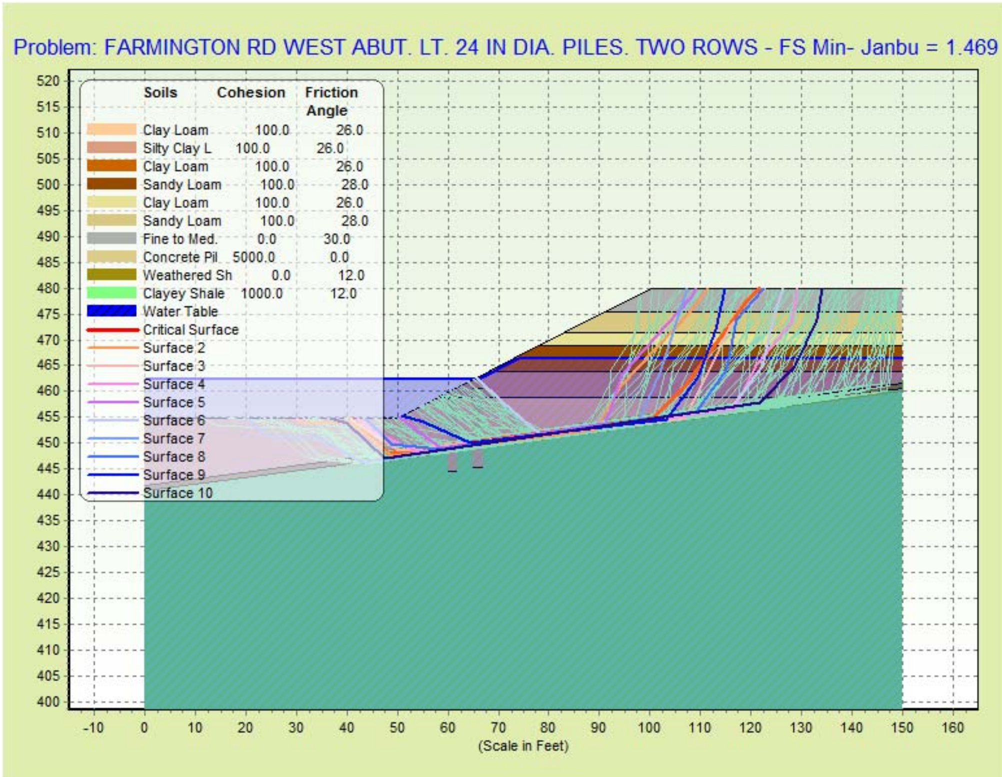
Segment Number	Left Extreme X	Left Extreme Y	Right Extreme X	Right Extreme Y	Soil Under Segment
1	0	454.8	50	454.8	7
2	50	454.8	58	458.8	7
3	58	458.8	68	463.8	6
4	68	463.8	73	466.3	5
5	73	466.3	78	468.8	4
6	78	468.8	83	471.3	3
7	83	471.3	91	475.3	2
8	91	475.3	100.4	480	1
9	100.4	480	150	480	1
10	91	475.3	150	475.3	2

Segment Number	Left Extreme X	Left Extreme Y	Right Extreme X	Right Extreme Y	Soil Under Segment
11	83	471.3	150	471.3	3
12	78	468.8	150	468.8	4
13	73	466.3	150	466.3	5
14	68	463.8	150	463.8	6
15	65	460.7	67	460.7	11
16	58	458.8	65	458.8	7
17	67	458.8	150	458.8	7
18	60	458.7	62	458.7	11
19	0	441.7	60	449.68	8
20	62	449.95	65	450.35	8
21	67	450.61	150	461.65	8
22	0	440.7	60	448.68	9
23	62	448.95	65	449.35	9
24	67	449.61	150	460.65	9
25	60	444.6	62	444.6	9
26	65	445.3	67	445.3	9

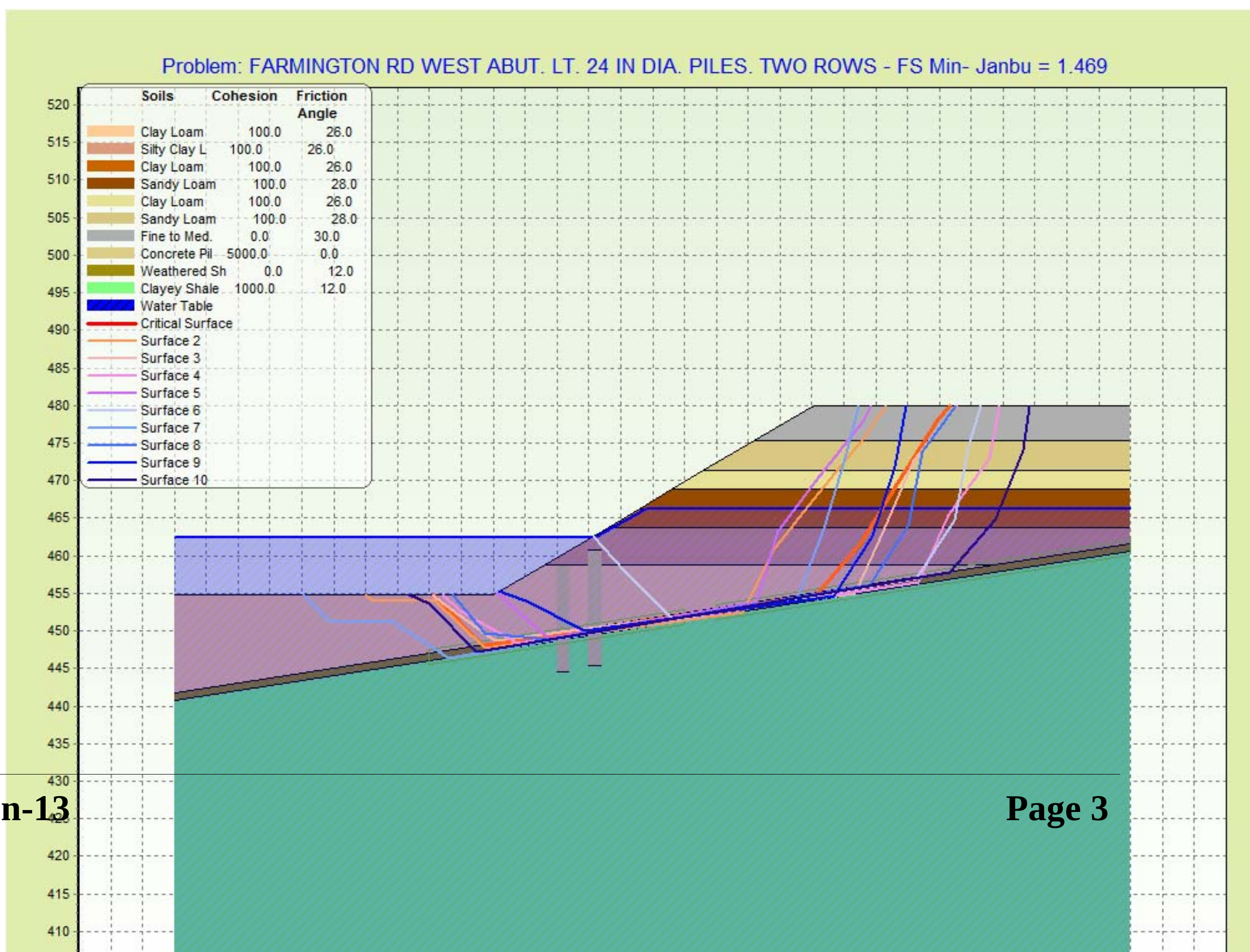
Soil Properties

Soil Number	Wet Unit Weight	Saturated Unit Weight	Cohesive Intercept	Friction Angle	Ru	Pressure Head	Water Table	Soil Name
1	115	115	0	30	0	0	1	Fine to Med.
2	115	115	100	28	0	0	1	Sandy Loam
3	125	125	100	26	0	0	1	Clay Loam
4	115	115	100	28	0	0	1	Sandy Loam
5	125	125	100	26	0	0	1	Clay Loam
6	125	125	100	26	0	0	1	Silty Clay Loam
7	125	125	100	26	0	0	1	Clay Loam
8	130	130	0	12	0	0	1	Weathered
9	130	130	1000	12	0	0	1	Clayey Shale
10	35	35	1500	0	0	0	1	Timber Pile
11	145	145	5000	0	0	0	1	Concrete Pile

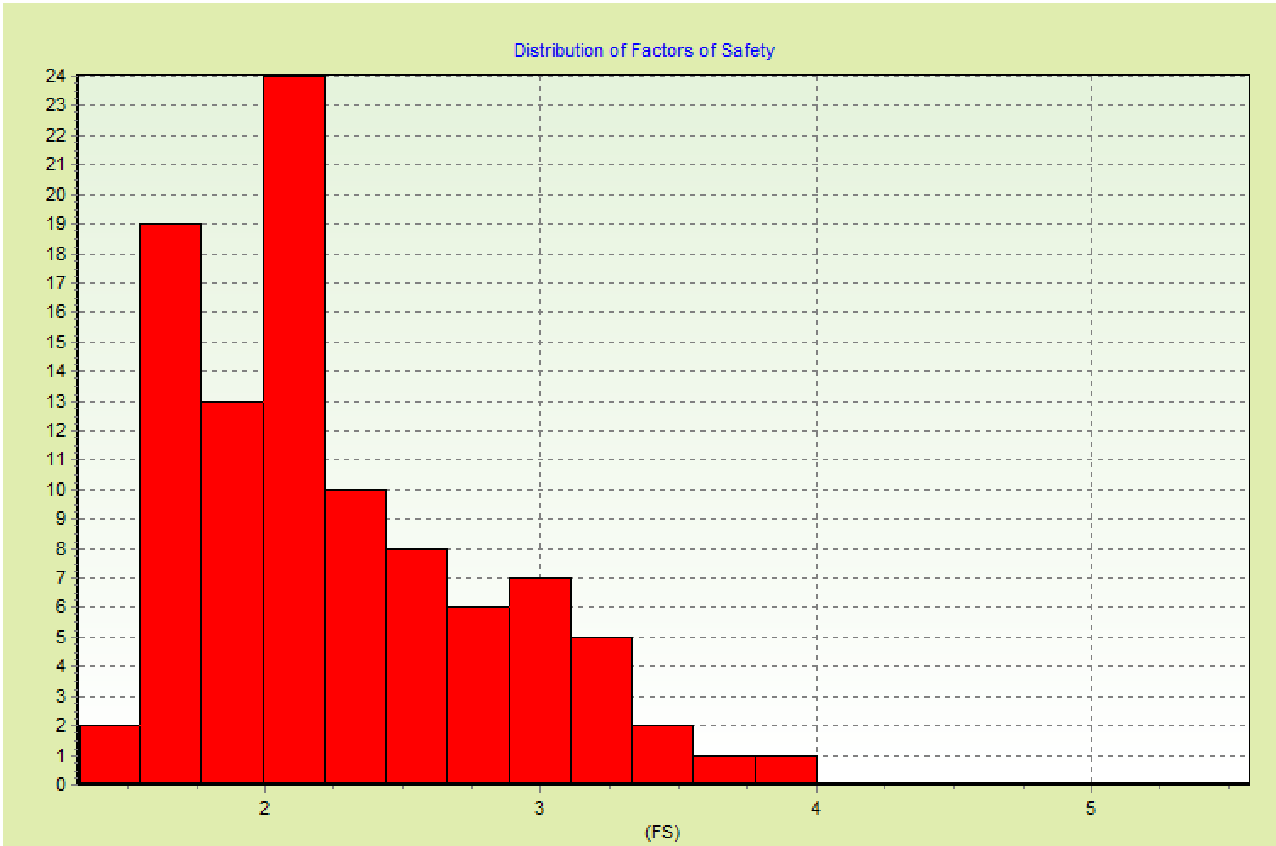
=============== All Surfaces Generated =============



=============== 10 Most Critical Surfaces ===============



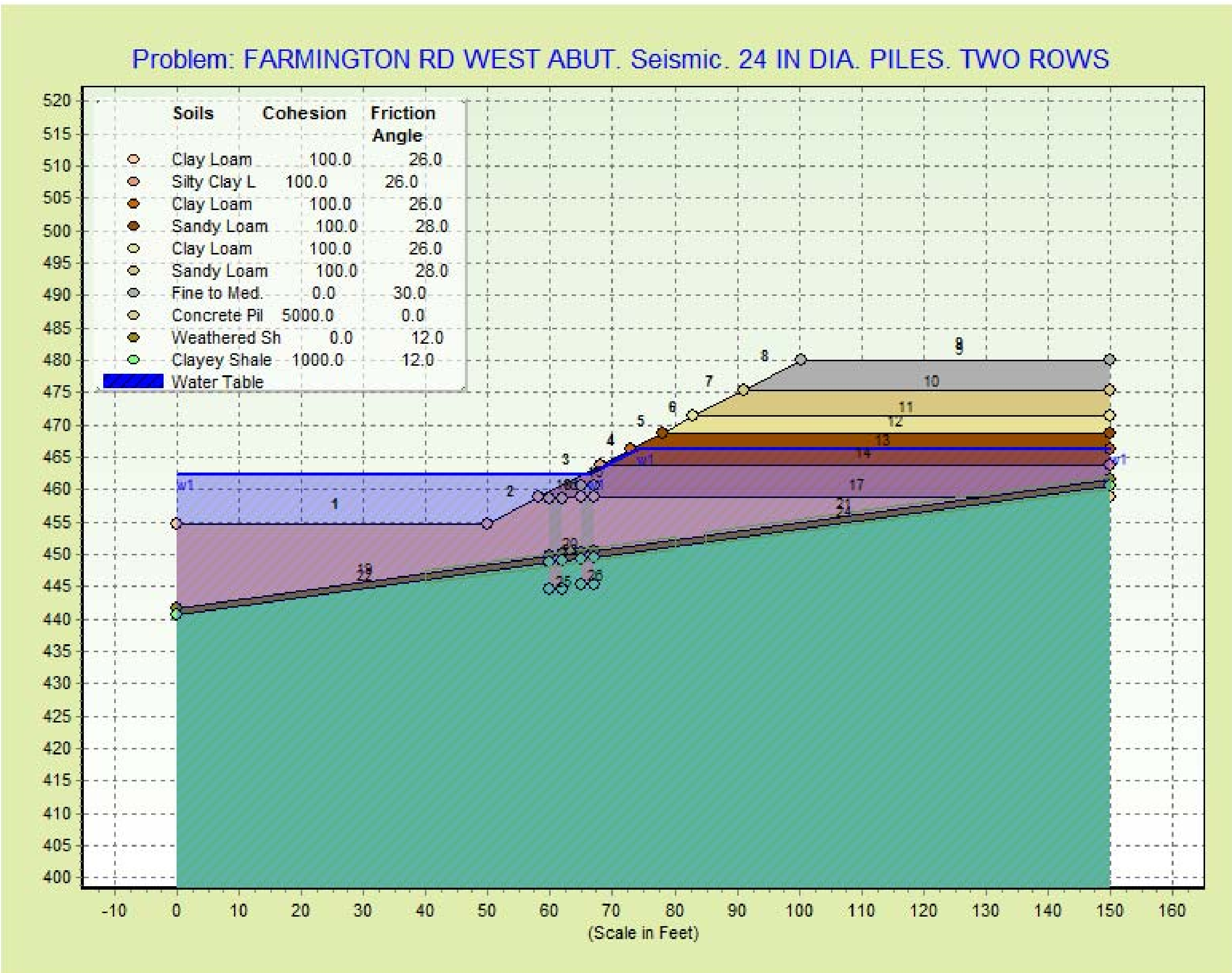
============= Factor of Safety Histogram ============



======== Factors of Safety of 10 Most Critical Surfaces =======

Surface Number	Factor of Safety
1	1.469
2	1.503
3	1.567
4	1.567
5	1.582
6	1.592
7	1.603
8	1.61
9	1.612
10	1.614

================== DATA SUMMARY =====================



Profile Data

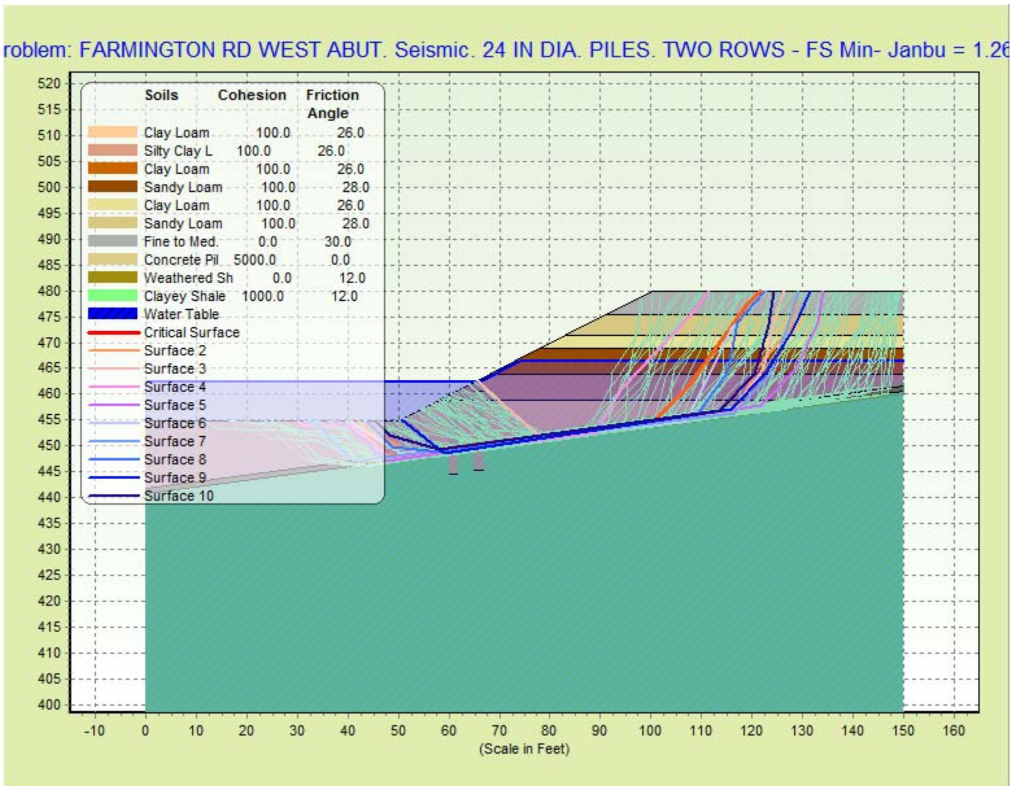
Segment Number	Left Extreme X	Left Extreme Y	Right Extreme X	Right Extreme Y	Soil Under Segment
1	0	454.8	50	454.8	7
2	50	454.8	58	458.8	7
3	58	458.8	68	463.8	6
4	68	463.8	73	466.3	5
5	73	466.3	78	468.8	4
6	78	468.8	83	471.3	3
7	83	471.3	91	475.3	2
8	91	475.3	100.4	480	1
9	100.4	480	150	480	1
10	91	475.3	150	475.3	2

Segment Number	Left Extreme X	Left Extreme Y	Right Extreme X	Right Extreme Y	Soil Under Segment
11	83	471.3	150	471.3	3
12	78	468.8	150	468.8	4
13	73	466.3	150	466.3	5
14	68	463.8	150	463.8	6
15	65	460.7	67	460.7	11
16	58	458.8	65	458.8	7
17	67	458.8	150	458.8	7
18	60	458.7	62	458.7	11
19	0	441.7	60	449.68	8
20	62	449.95	65	450.35	8
21	67	450.61	150	461.65	8
22	0	440.7	60	448.68	9
23	62	448.95	65	449.35	9
24	67	449.61	150	460.65	9
25	60	444.6	62	444.6	9
26	65	445.3	67	445.3	9

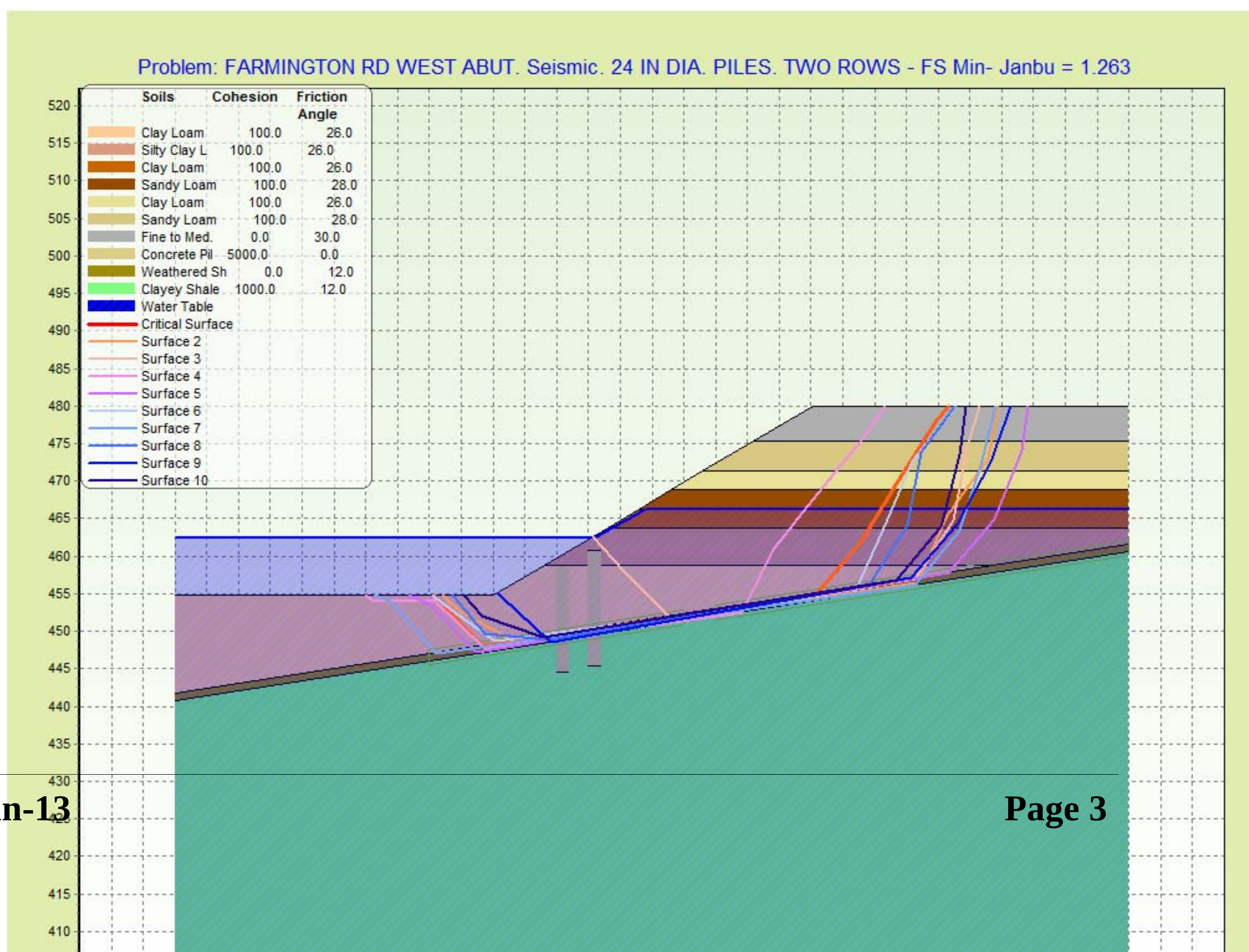
Soil Properties

Soil Number	Wet Unit Weight	Saturated Unit Weight	Cohesive Intercept	Friction Angle	Ru	Pressure Head	Water Table	Soil Name
1	115	115	0	30	0	0	1	Fine to Med.
2	115	115	100	28	0	0	1	Sandy Loam
3	125	125	100	26	0	0	1	Clay Loam
4	115	115	100	28	0	0	1	Sandy Loam
5	125	125	100	26	0	0	1	Clay Loam
6	125	125	100	26	0	0	1	Silty Clay Loam
7	125	125	100	26	0	0	1	Clay Loam
8	130	130	0	12	0	0	1	Weathered
9	130	130	1000	12	0	0	1	Clayey Shale
10	35	35	1500	0	0	0	1	Timber Pile
11	145	145	5000	0	0	0	1	Concrete Pile

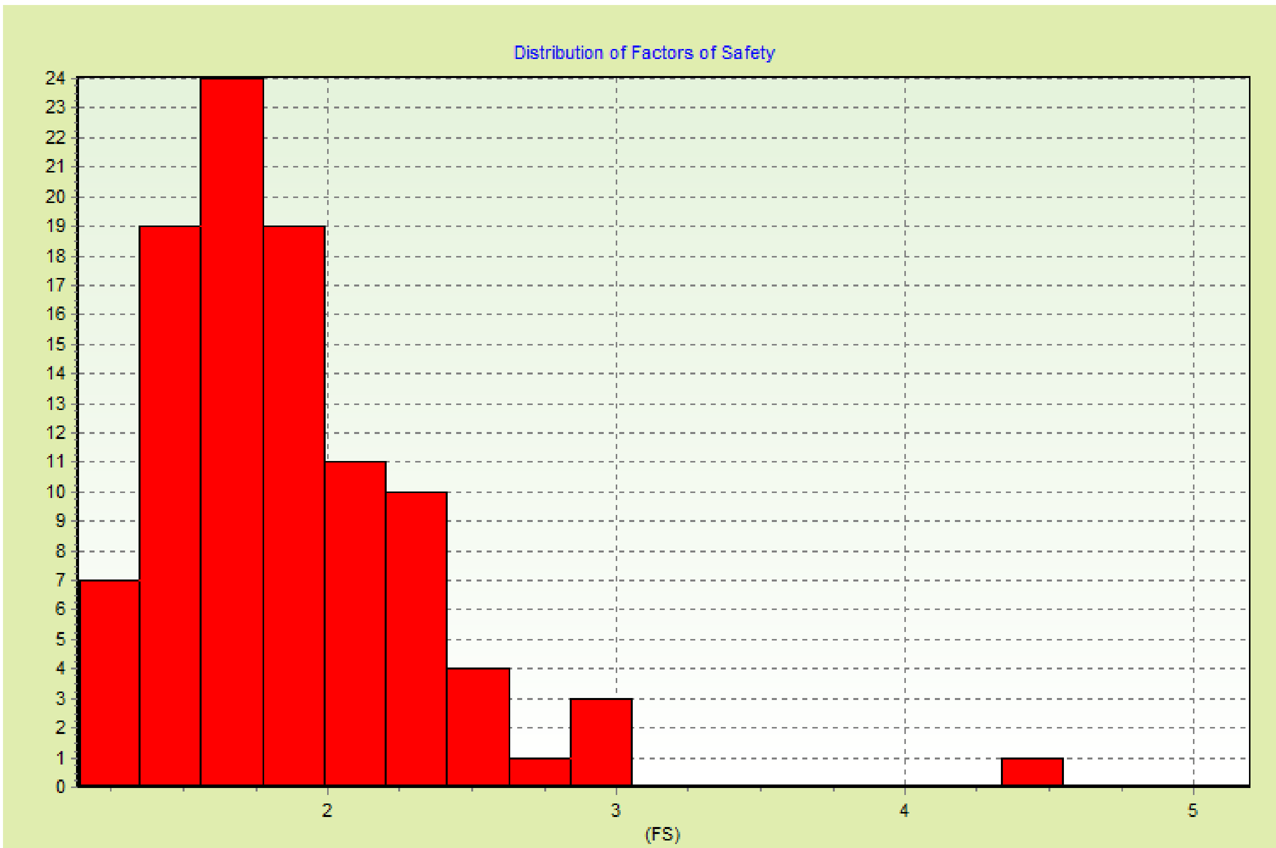
=============== All Surfaces Generated =============



=============== 10 Most Critical Surfaces ===============



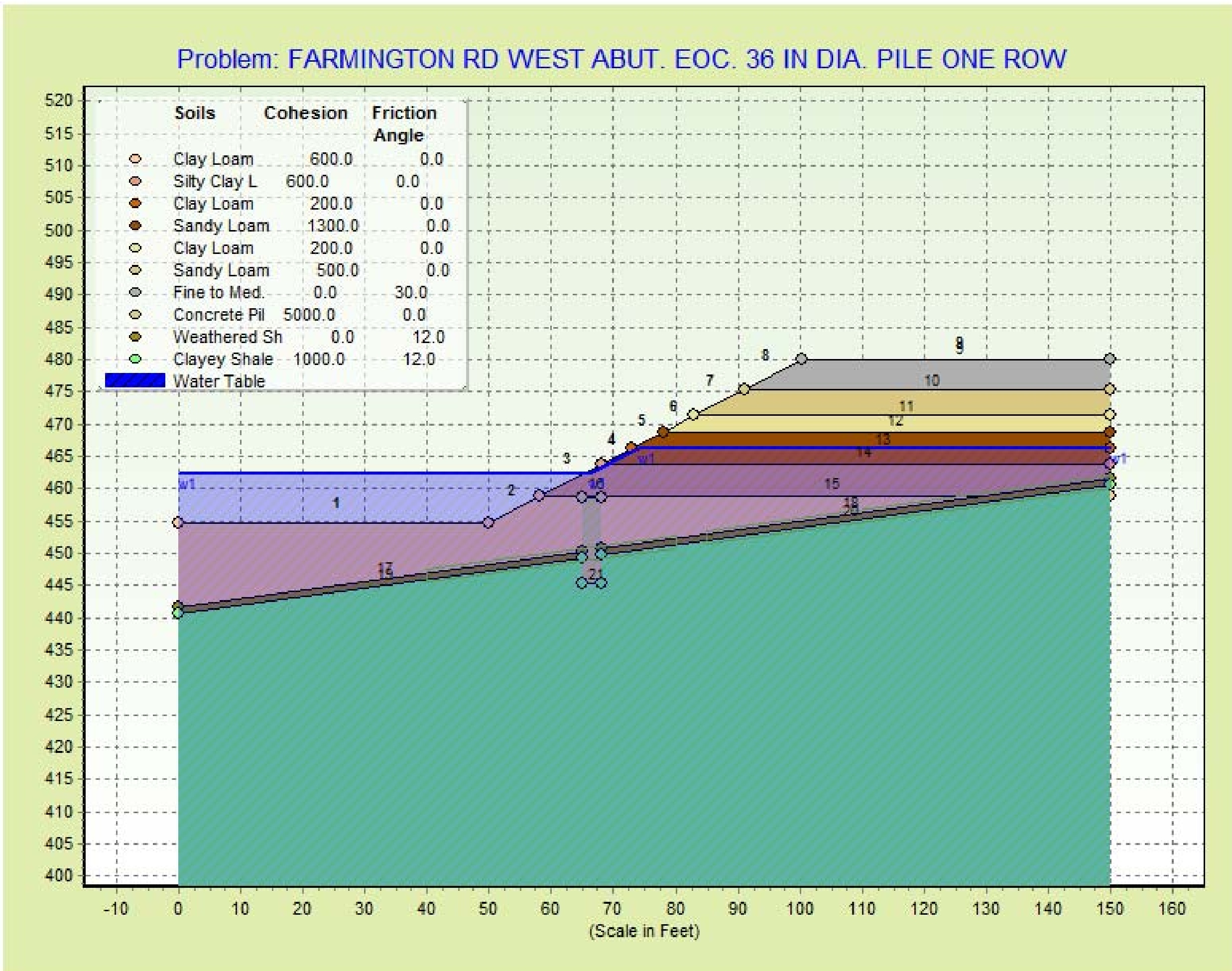
============= Factor of Safety Histogram ============



======== Factors of Safety of 10 Most Critical Surfaces =======

Surface Number	Factor of Safety
1	1.263
2	1.297
3	1.311
4	1.318
5	1.319
6	1.33
7	1.347
8	1.354
9	1.356
10	1.364

================== DATA SUMMARY ====================



Profile Data

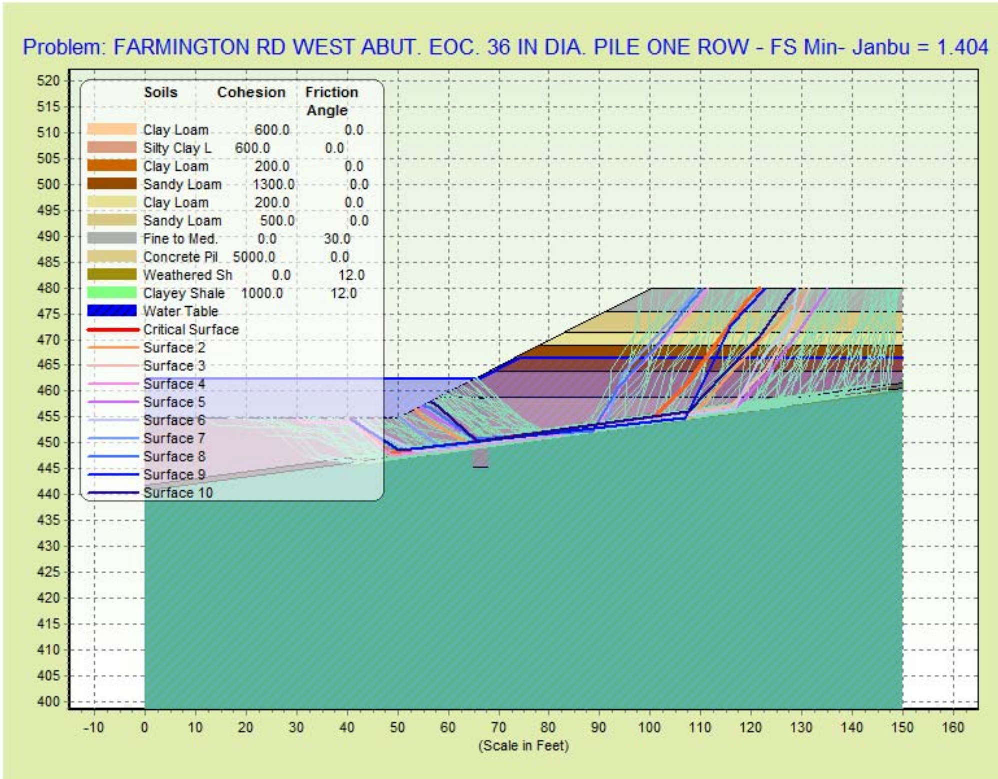
Segment Number	Left Extreme X	Left Extreme Y	Right Extreme X	Right Extreme Y	Soil Under Segment
1	0	454.8	50	454.8	7
2	50	454.8	58	458.8	7
3	58	458.8	68	463.8	6
4	68	463.8	73	466.3	5
5	73	466.3	78	468.8	4
6	78	468.8	83	471.3	3
7	83	471.3	91	475.3	2
8	91	475.3	100.4	480	1
9	100.4	480	150	480	1
10	91	475.3	150	475.3	2

Segment Number	Left Extreme X	Left Extreme Y	Right Extreme X	Right Extreme Y	Soil Under Segment
11	83	471.3	150	471.3	3
12	78	468.8	150	468.8	4
13	73	466.3	150	466.3	5
14	68	463.8	150	463.8	6
15	58	458.8	150	458.8	7
16	65	458.7	68	458.7	11
17	0	441.7	65	450.35	8
18	68	450.74	150	461.65	8
19	0	440.7	65	449.35	9
20	68	449.74	150	460.65	9
21	65	445.3	68	445.3	9

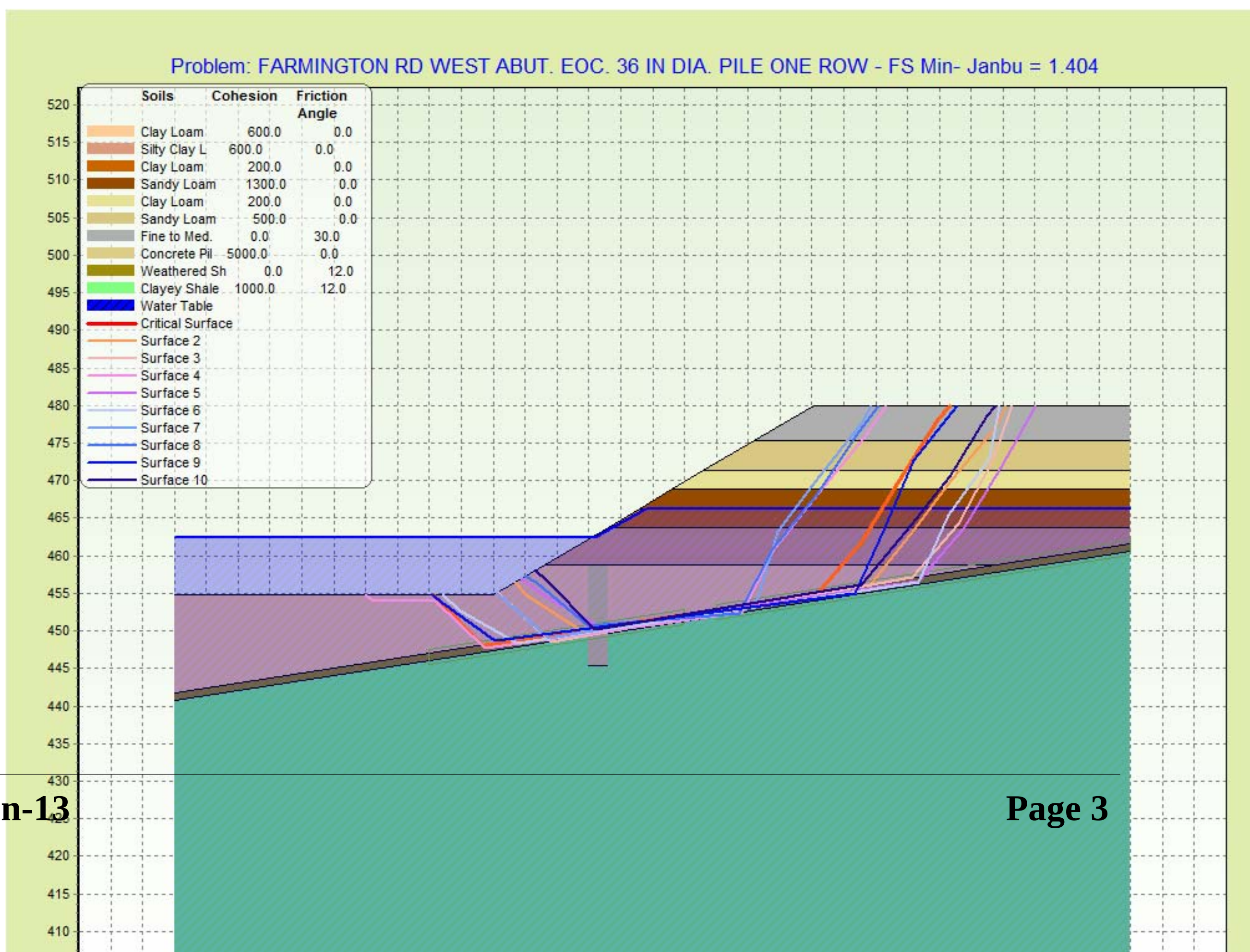
Soil Properties

Soil Number	Wet Unit Weight	Saturated Unit Weight	Cohesive Intercept	Friction Angle	Ru	Pressure Head	Water Table	Soil Name
1	115	115	0	30	0	0	1	Fine to Med.
2	115	115	500	0	0	0	1	Sandy Loam
3	125	125	200	0	0	0	1	Clay Loam
4	115	115	1300	0	0	0	1	Sandy Loam
5	125	125	200	0	0	0	1	Clay Loam
6	125	125	600	0	0	0	1	Silty Clay Loam
7	125	125	600	0	0	0	1	Clay Loam
8	130	130	0	12	0	0	1	Weathered
9	130	130	1000	12	0	0	1	Clayey Shale
10	35	35	1500	0	0	0	1	Timber Pile
11	145	145	5000	0	0	0	1	Concrete Pile

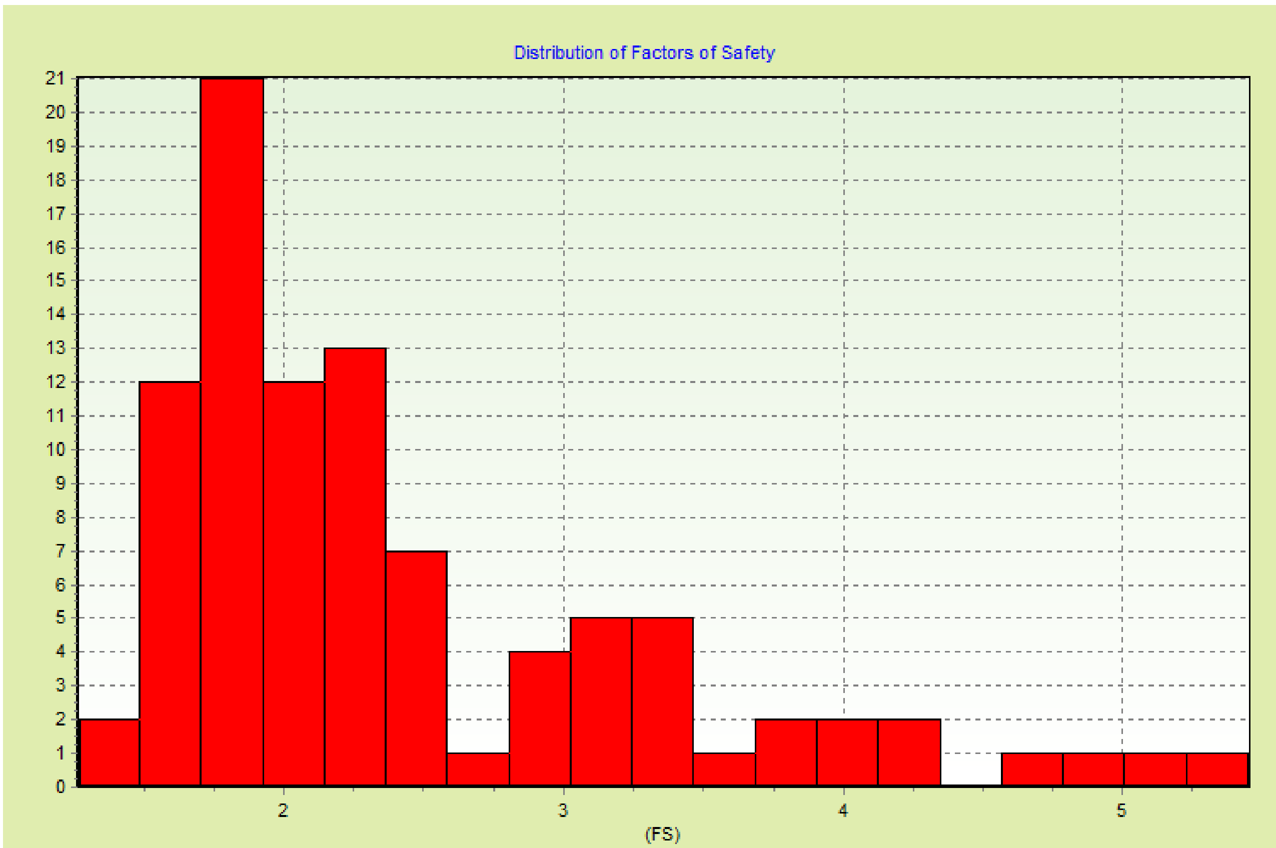
=============== All Surfaces Generated =============



=============== 10 Most Critical Surfaces ===============



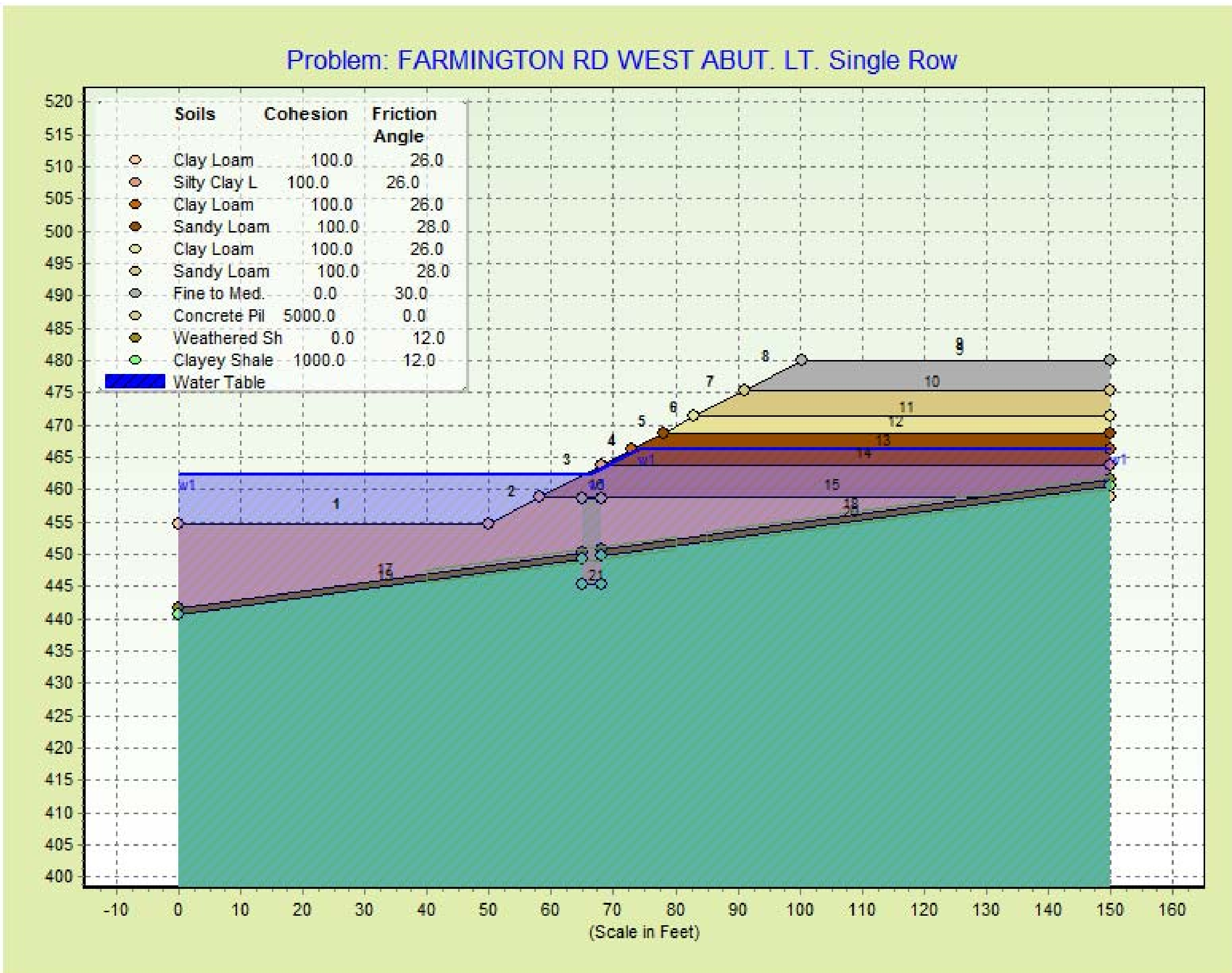
============= Factor of Safety Histogram ============



======== Factors of Safety of 10 Most Critical Surfaces =======

Surface Number	Factor of Safety
1	1.404
2	1.476
3	1.617
4	1.619
5	1.631
6	1.632
7	1.662
8	1.662
9	1.663
10	1.67

================= DATA SUMMARY ===================



Profile Data

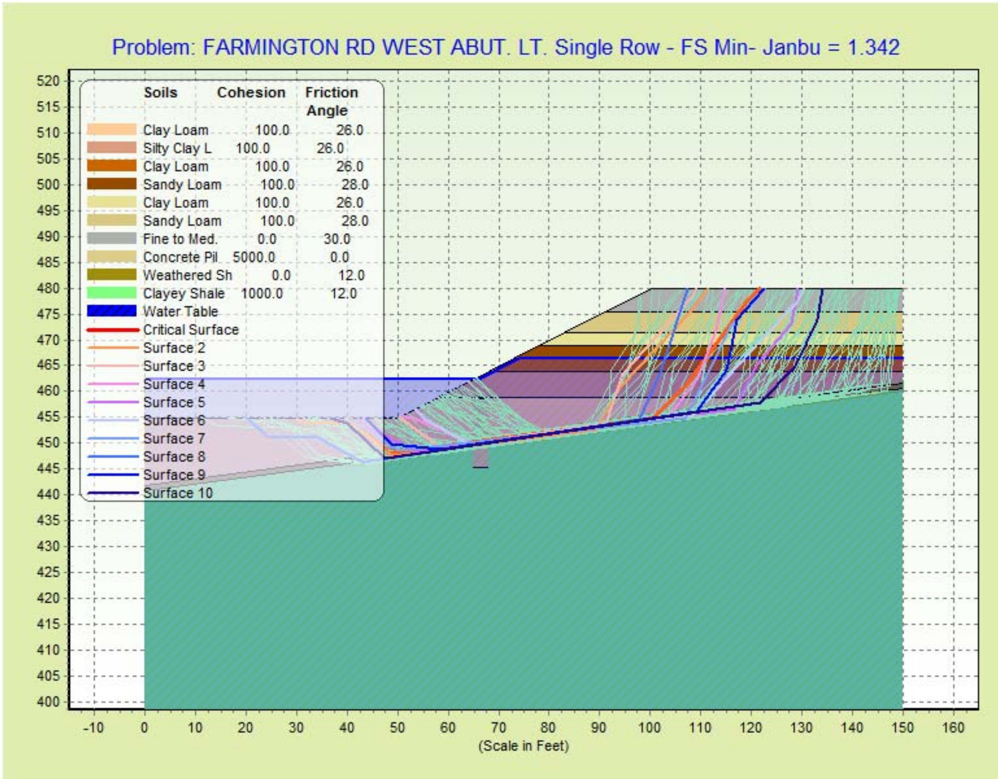
Segment Number	Left Extreme X	Left Extreme Y	Right Extreme X	Right Extreme Y	Soil Under Segment
1	0	454.8	50	454.8	7
2	50	454.8	58	458.8	7
3	58	458.8	68	463.8	6
4	68	463.8	73	466.3	5
5	73	466.3	78	468.8	4
6	78	468.8	83	471.3	3
7	83	471.3	91	475.3	2
8	91	475.3	100.4	480	1
9	100.4	480	150	480	1
10	91	475.3	150	475.3	2

Segment Number	Left Extreme X	Left Extreme Y	Right Extreme X	Right Extreme Y	Soil Under Segment
11	83	471.3	150	471.3	3
12	78	468.8	150	468.8	4
13	73	466.3	150	466.3	5
14	68	463.8	150	463.8	6
15	58	458.8	150	458.8	7
16	65	458.7	68	458.7	11
17	0	441.7	65	450.35	8
18	68	450.74	150	461.65	8
19	0	440.7	65	449.35	9
20	68	449.74	150	460.65	9
21	65	445.3	68	445.3	9

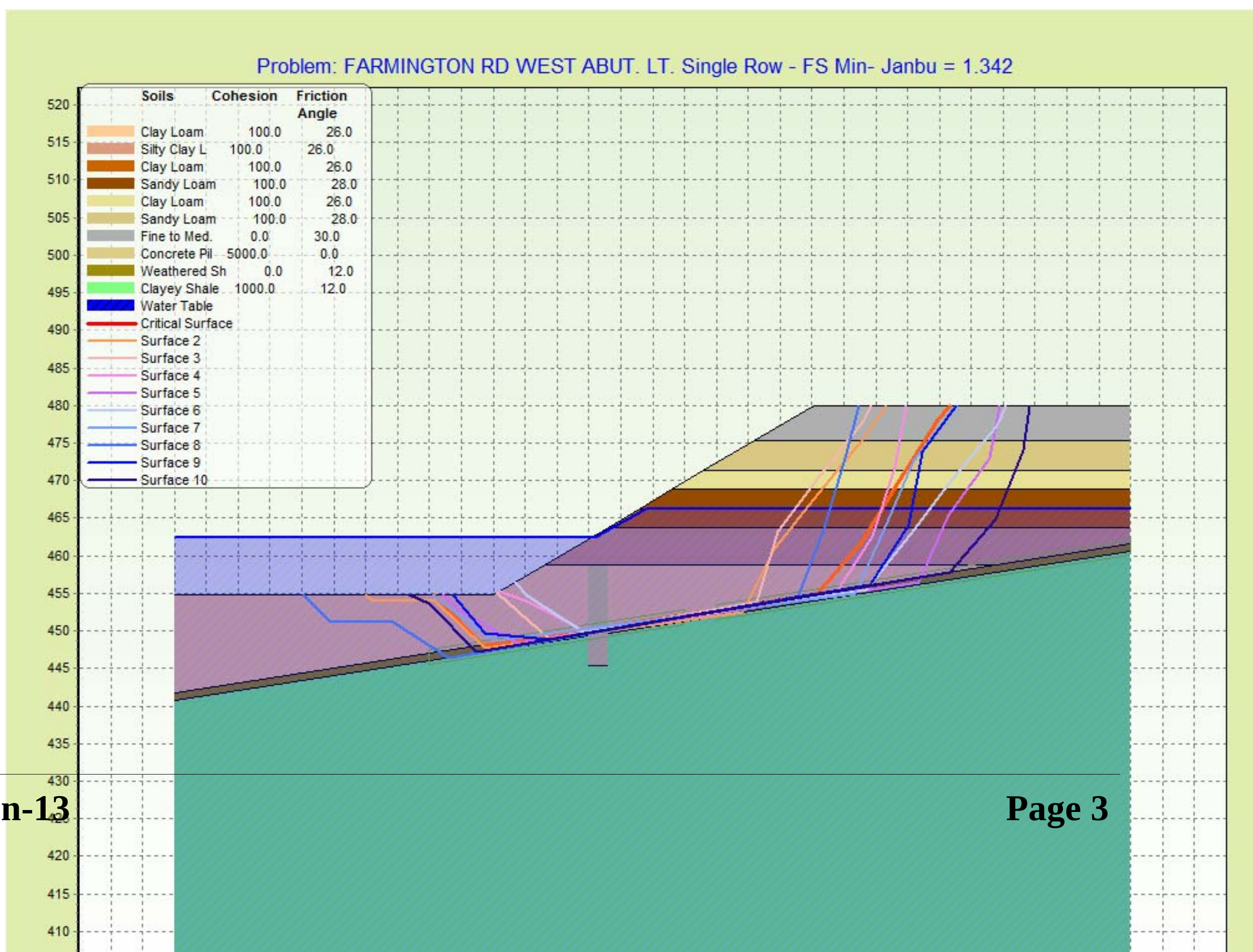
Soil Properties

Soil Number	Wet Unit Weight	Saturated Unit Weight	Cohesive Intercept	Friction Angle	Ru	Pressure Head	Water Table	Soil Name
1	115	115	0	30	0	0	1	Fine to Med.
2	115	115	100	28	0	0	1	Sandy Loam
3	125	125	100	26	0	0	1	Clay Loam
4	115	115	100	28	0	0	1	Sandy Loam
5	125	125	100	26	0	0	1	Clay Loam
6	125	125	100	26	0	0	1	Silty Clay Loam
7	125	125	100	26	0	0	1	Clay Loam
8	130	130	0	12	0	0	1	Weathered
9	130	130	1000	12	0	0	1	Clayey Shale
10	35	35	1500	0	0	0	1	Timber Pile
11	145	145	5000	0	0	0	1	Concrete Pile

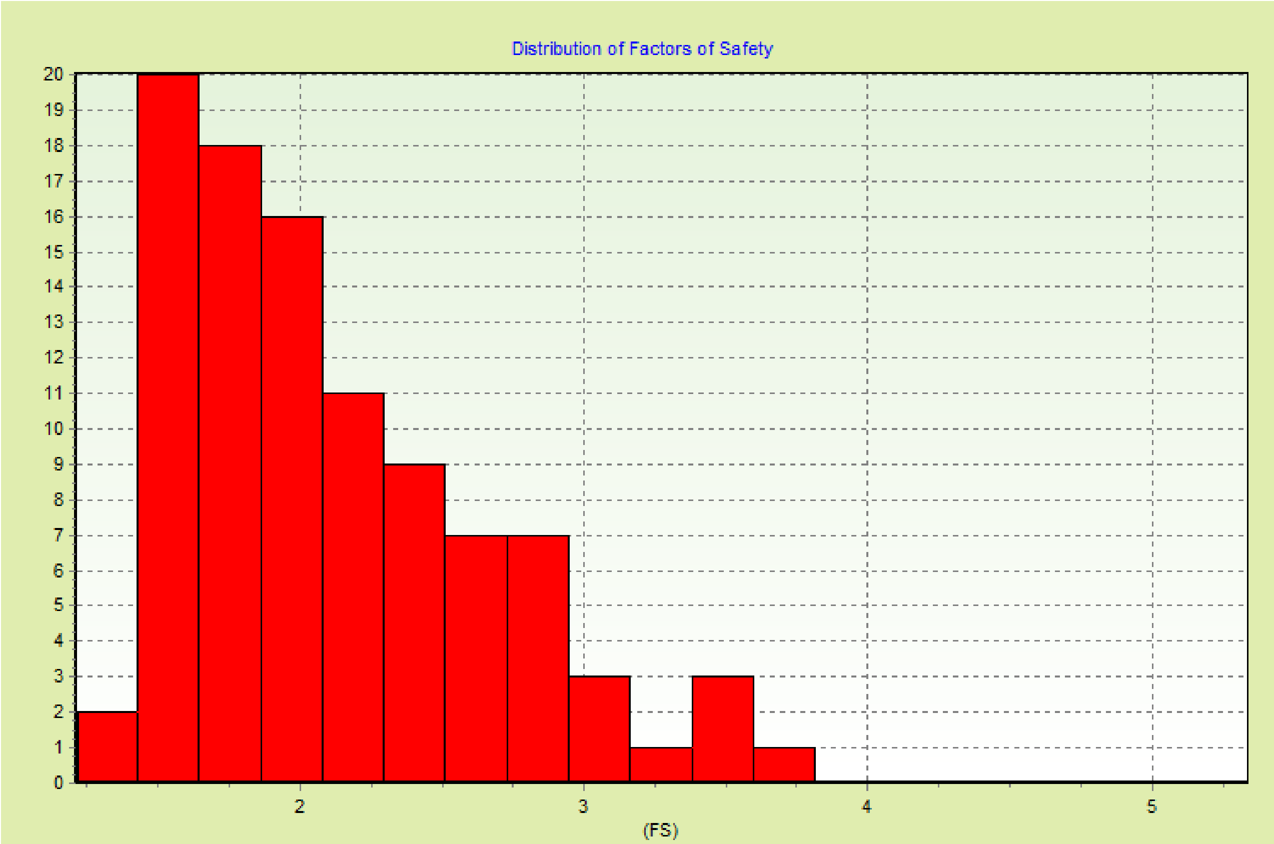
=============== All Surfaces Generated =============



=============== 10 Most Critical Surfaces ===============



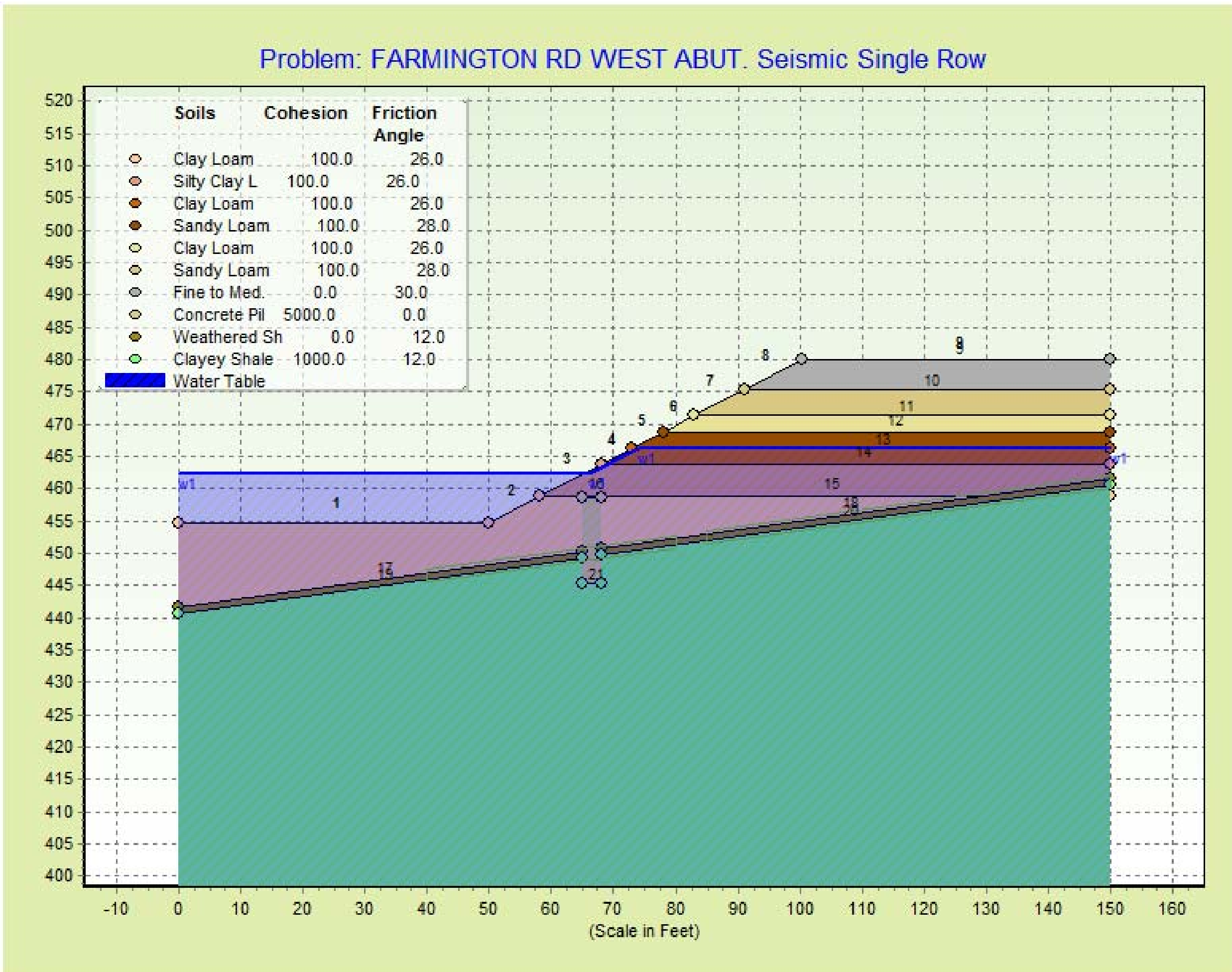
============= Factor of Safety Histogram ============



======== Factors of Safety of 10 Most Critical Surfaces =======

Surface Number	Factor of Safety
1	1.342
2	1.363
3	1.427
4	1.434
5	1.438
6	1.44
7	1.443
8	1.464
9	1.473
10	1.489

================= DATA SUMMARY ===================



Profile Data

Segment Number	Left Extreme X	Left Extreme Y	Right Extreme X	Right Extreme Y	Soil Under Segment
1	0	454.8	50	454.8	7
2	50	454.8	58	458.8	7
3	58	458.8	68	463.8	6
4	68	463.8	73	466.3	5
5	73	466.3	78	468.8	4
6	78	468.8	83	471.3	3
7	83	471.3	91	475.3	2
8	91	475.3	100.4	480	1
9	100.4	480	150	480	1
10	91	475.3	150	475.3	2

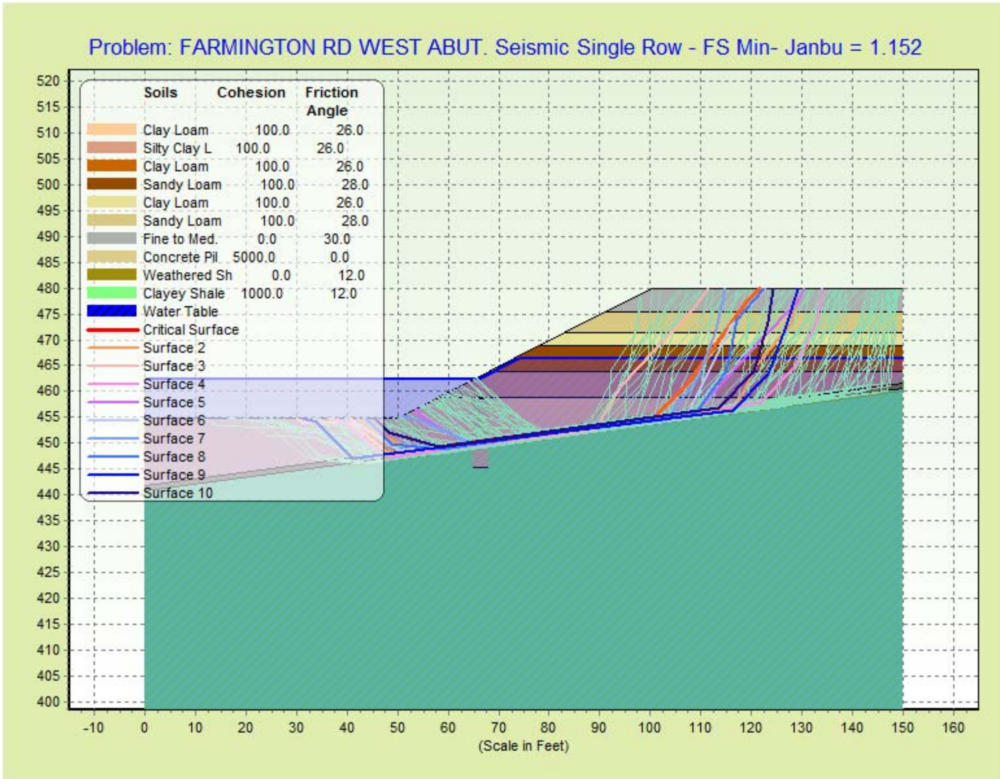
Single Row

Segment Number	Left Extreme X	Left Extreme Y	Right Extreme X	Right Extreme Y	Soil Under Segment
11	83	471.3	150	471.3	3
12	78	468.8	150	468.8	4
13	73	466.3	150	466.3	5
14	68	463.8	150	463.8	6
15	58	458.8	150	458.8	7
16	65	458.7	68	458.7	11
17	0	441.7	65	450.35	8
18	68	450.74	150	461.65	8
19	0	440.7	65	449.35	9
20	68	449.74	150	460.65	9
21	65	445.3	68	445.3	9

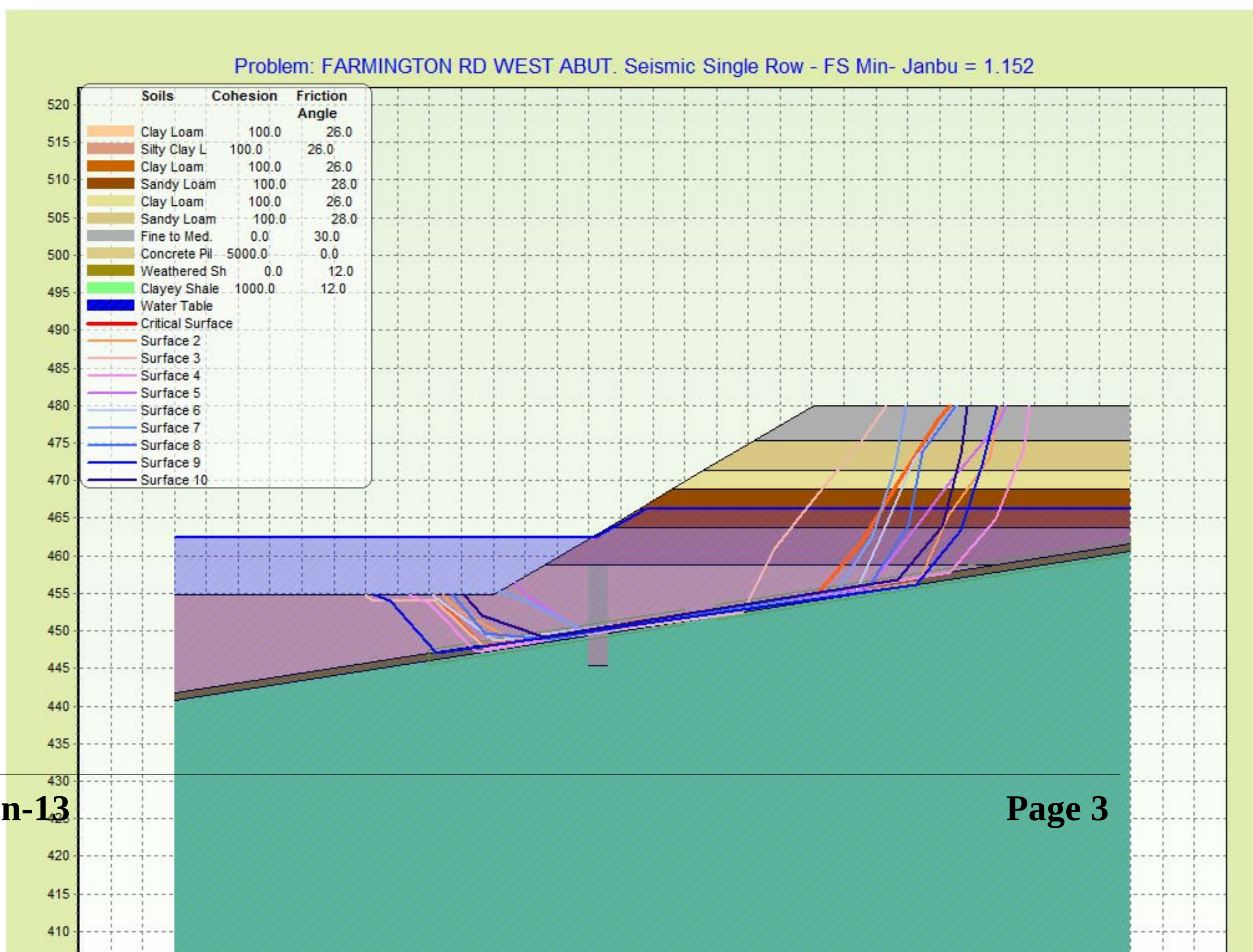
Soil Properties

Soil Number	Wet Unit Weight	Saturated Unit Weight	Cohesive Intercept	Friction Angle	Ru	Pressure Head	Water Table	Soil Name
1	115	115	0	30	0	0	1	Fine to Med.
2	115	115	100	28	0	0	1	Sandy Loam
3	125	125	100	26	0	0	1	Clay Loam
4	115	115	100	28	0	0	1	Sandy Loam
5	125	125	100	26	0	0	1	Clay Loam
6	125	125	100	26	0	0	1	Silty Clay Loam
7	125	125	100	26	0	0	1	Clay Loam
8	130	130	0	12	0	0	1	Weathered
9	130	130	1000	12	0	0	1	Clayey Shale
10	35	35	1500	0	0	0	1	Timber Pile
11	145	145	5000	0	0	0	1	Concrete Pile

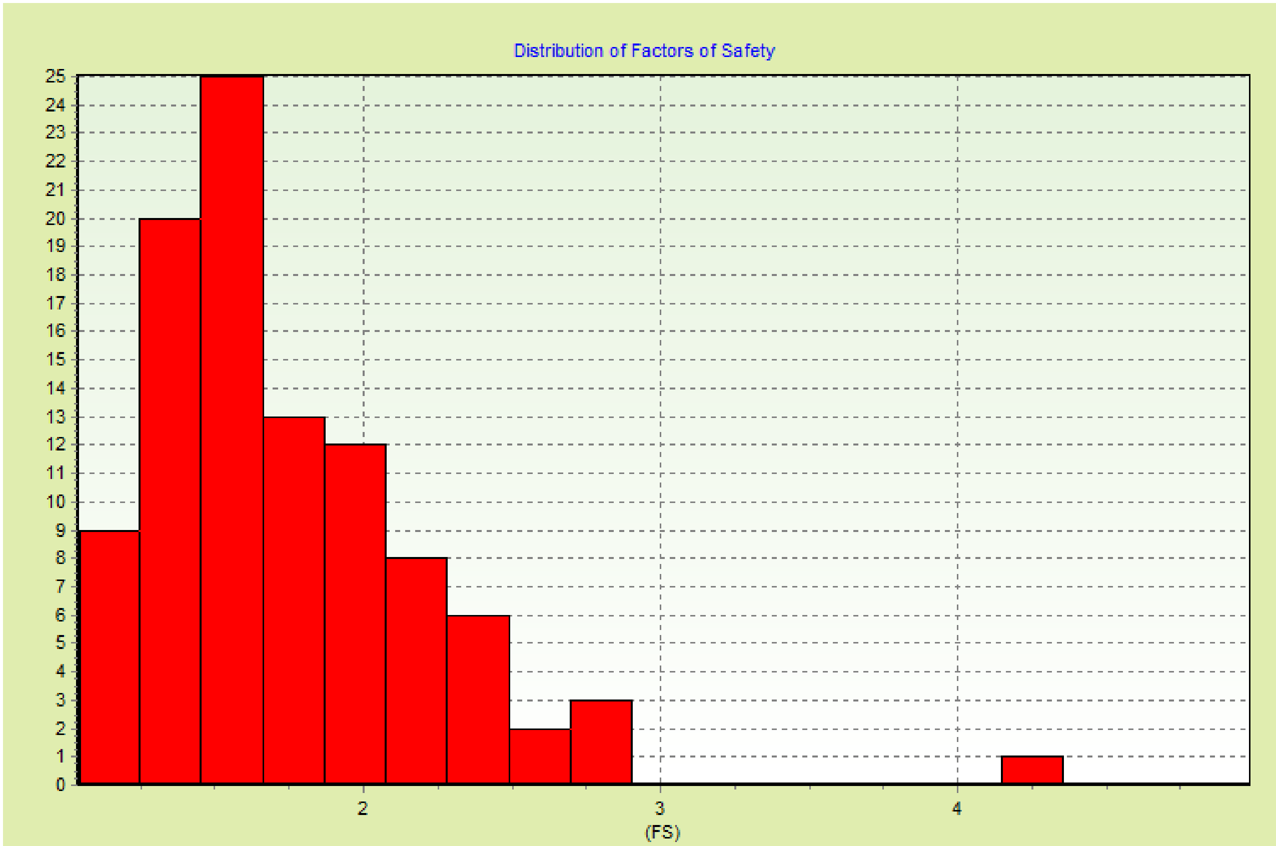
=============== All Surfaces Generated =============



=============== 10 Most Critical Surfaces ===============



============= Factor of Safety Histogram ============



======== Factors of Safety of 10 Most Critical Surfaces =======

Surface Number	Factor of Safety
1	1.152
2	1.187
3	1.194
4	1.215
5	1.216
6	1.222
7	1.225
8	1.235
9	1.242
10	1.245

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============================== East Abutment
REFERENCE BORING ========================== B-1
LRFD or ASD or SEISMIC ======================== LRFD
PILE CUTOFF ELEV. =========================== 475.91 ft
GROUND SURFACE ELEV. AGAINST PILE DURING DRI 470.91 ft
GEOTECHNICAL LOSS TYPE (None, Scour, Liquef., DD) Scour
BOTTOM ELEV. OF SCOUR, LIQUEF., or DD ========= 473.91 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
418 KIPS	**418** KIPS	**230** KIPS	**47** FT.

TOTAL FACTORED SUBSTRUCTURE LOAD ========= 1225 kips
TOTAL LENGTH OF SUBSTRUCTURE (along skew)==== 60.60 ft
NUMBER OF ROWS OF PILES PER SUBSTRUCTURE = 1

Approx. Factored Loading Applied per pile at 8 ft. Cts ===== 161.72 KIPS
Approx. Factored Loading Applied per pile at 3 ft. Cts ===== 60.64 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.

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.)
469.00	1.91	2.50	3		10.2		20.5	14.9		**16.1**	16	0	0	9	7
464.00	5.00	0.75	5		11.1	10.3	59.9	16.2	1.1	**35.3**	35	0	0	19	12
461.50	2.50	2.80	9		14.4	38.6	**38.5**	21.1	4.2	52.6	38	0	0	21	14
456.50	5.00	0.20	5		3.3	2.8	**40.4**	4.8	0.3	57.2	40	0	0	22	19
451.50	5.00	0.10	3		1.7	1.4	**48.0**	2.4	0.2	60.2	48	0	0	26	24
449.00	2.50		3	Medium Sand	0.5	7.3	63.2	0.8	0.8	**62.6**	63	0	0	34	27
446.50	2.50		9	Medium Sand	1.6	22.0	91.8	2.4	2.4	**68.0**	68	0	0	37	29
444.00	2.50		20	Medium Sand	3.6	49.0	173.8	5.3	5.4	**81.8**	82	0	0	45	32
437.50	6.50		52	Medium Sand	37.9	127.4	150.4	55.4	13.9	**130.5**	130	0	0	72	38
433.00	4.50		27	Medium Sand	8.9	66.1	215.7	13.0	7.2	**149.6**	150	0	0	82	43
432.50	0.50			Shale	24.7	122.5	240.4	36.1	13.4	**185.8**	186	0	0	102	43.4
432.00	0.50			Shale	24.7	122.5	265.1	36.1	13.4	**221.9**	222	0	0	122	43.9
431.50	0.50			Shale	24.7	122.5	289.8	36.1	13.4	**258.0**	258	0	0	142	44.4
431.00	0.50			Shale	24.7	122.5	314.5	36.1	13.4	**294.1**	294	0	0	162	44.9
430.50	0.50			Shale	24.7	122.5	339.2	36.1	13.4	**330.3**	330	0	0	182	45.4
430.00	0.50			Shale	24.7	122.5	**363.9**	36.1	13.4	366.4	364	0	0	200	45.9
429.50	0.50			Shale	24.7	122.5	**388.6**	36.1	13.4	402.5	389	0	0	214	46.4
429.00	0.50			Shale	24.7	122.5	**413.3**	36.1	13.4	438.6	413	0	0	227	46.9
428.50	0.50			Shale	24.7	122.5	**438.0**	36.1	13.4	474.8	438	*0*	*0*	*241*	*47.4*
428.30	0.20			Shale		122.5			13.4						

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

	Nominal Required Bearing (Kips)	Factored Resistance Available (Kips)	Estimated Pile Length (Ft.)
Metal Shell 12"Φ w/.179" walls			
	97	53	27
	158	87	29
Metal Shell 12"Φ w/.25" walls			
	97	53	27
	158	87	29
	331	182	32
Metal Shell 14"Φ w/.25" walls			
	79	43	24
	122	67	27
	204	112	29
Metal Shell 14"Φ w/.312" walls			
	79	43	24
	122	67	27
	204	112	29
	436	240	32
	444	244	38
Steel HP 8 X 36			
	271	149	47
Steel HP 10 X 42			
	109	60	38
	125	69	43
	335	184	47

	Nominal Required Bearing (Kips)	Factored Resistance Available (Kips)	Estimated Pile Length (Ft.)
Steel HP 10 X 57			
	72	40	32
	112	61	38
	129	71	43
	454	250	48
Steel HP 12 X 53			
	82	45	32
	130	72	38
	150	82	43
	418	230	47
Steel HP 12 X 63			
	85	47	32
	134	73	38
	154	85	43
	497	273	48
Steel HP 12 X 74			
	89	49	32
	136	75	38
	158	87	43
	589	324	48
Steel HP 12 X 84			
	92	50	32
	138	76	38
	161	88	43
	664	365	48

	Nominal Required Bearing (Kips)	Factored Resistance Available (Kips)	Estimated Pile Length (Ft.)
Steel HP 14 X 73			
	101	55	32
	158	87	38
	182	100	43
	578	318	48
Steel HP 14 X 89			
	106	58	32
	162	89	38
	188	103	43
	705	388	48
Steel HP 14 X 102			
	110	60	32
	164	90	38
	192	105	43
	810	445	48
Steel HP 14 X 117			
	89	49	29
	114	63	32
	167	92	38
	197	108	43
	929	511	48
Precast 14"x 14"			
	101	55	24
	155	85	27
	259	143	29
Timber Pile			
	93	51	29

IDOT STATIC METHOD OF ESTIMATING PILE LENGTH

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

Modified 10/18/2011

SUBSTRUCTURE================================ Pier 1
REFERENCE BORING ========================== B-2
LRFD or ASD or SEISMIC ======================= LRFD
PILE CUTOFF ELEV. =========================== 477.00 ft
GROUND SURFACE ELEV. AGAINST PILE DURING DRI 465.00 ft
GEOTECHNICAL LOSS TYPE (None, Scour, Liquef., DD) Scour
BOTTOM ELEV. OF SCOUR, LIQUEF., or DD ======== 426.20 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
418 KIPS	403 KIPS	67 KIPS	44 FT.

TOTAL FACTORED SUBSTRUCTURE LOAD ========= 2676 kips
TOTAL LENGTH OF SUBSTRUCTURE (along skew)==== 60.60 ft
NUMBER OF ROWS OF PILES PER SUBSTRUCTURE = 1
Approx. Factored Loading Applied per pile at 8 ft. Cts ===== 353.21 KIPS
Approx. Factored Loading Applied per pile at 3 ft. Cts ===== 132.46 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.

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.)
460.10	4.90	0.40	6		6.2		13.1	9.0		9.8	10	3	0	2	17
457.60	2.50	0.50	5		3.9	6.9	15.5	5.7	0.8	15.3	15	6	0	3	19
455.10	2.50	0.40	2		3.1	5.5	30.3	4.6	0.6	21.2	21	7	0	4	22
452.60	2.50		7	Fine Sand	1.2	17.1	31.5	1.7	1.9	22.9	23	8	0	5	24
450.10	2.50		7	Medium Sand	1.3	17.1	35.2	1.8	1.9	25.0	25	9	0	5	27
447.60	2.50		8	Medium Sand	1.4	19.6	51.4	2.1	2.1	28.7	29	9	0	6	29
445.10	2.50		14	Medium Sand	2.5	34.3	78.4	3.7	3.8	35.1	35	11	0	9	32
442.60	2.50		24	Sandy Gravel	5.7	58.8	130.6	8.3	6.4	48.5	48	14	0	13	34
440.10	2.50		43	Sandy Gravel	16.7	105.3	309.0	24.4	11.5	90.5	91	23	0	27	37
434.60	5.50		109	Sandy Gravel	171.2	267.0	514.5	250.4	29.2	344.7	345	117	0	72	42
434.10	0.50		123	Sandy Gravel	18.2	301.3	353.8	26.6	33.0	351.6	352	127	0	66	43
433.10	1.00			Shale	49.4	122.5	403.2	72.3	13.4	423.9	403	154	0	67	43.9
432.10	1.00			Shale	49.4	122.5	452.6	72.3	13.4	496.1	453	~~182~~	~~0~~	~~67~~	~~44.9~~
431.10	1.00			Shale	49.4	122.5	502.1	72.3	13.4	568.4	~~502~~	~~209~~	~~0~~	~~67~~	~~45.9~~
430.10	1.00			Shale	49.4	122.5	551.5	72.3	13.4	640.6	~~551~~	~~236~~	~~0~~	~~67~~	~~46.9~~
429.10	1.00			Shale	49.4	122.5	600.9	72.3	13.4	712.9	~~601~~	~~263~~	~~0~~	~~67~~	~~47.9~~
428.10	1.00			Shale	49.4	122.5	650.3	72.3	13.4	785.1	~~650~~	~~290~~	~~0~~	~~67~~	~~48.9~~
427.10	1.00			Shale	49.4	122.5	699.7	72.3	13.4	857.4	~~700~~	~~317~~	~~0~~	~~67~~	~~49.9~~
426.10	1.00			Shale	49.4	122.5	749.1	72.3	13.4	929.6	~~749~~	~~317~~	~~0~~	~~95~~	~~50.9~~
425.10	1.00			Shale	49.4	122.5	798.5	72.3	13.4	1001.9	~~799~~	~~317~~	~~0~~	~~122~~	~~51.9~~
424.10	1.00			Shale	49.4	122.5	847.9	72.3	13.4	1074.1	~~848~~	~~317~~	~~0~~	~~149~~	~~52.9~~
423.10	1.00			Shale	49.4	122.5	897.4	72.3	13.4	1146.4	~~897~~	~~317~~	~~0~~	~~176~~	~~53.9~~
422.10	1.00			Shale	49.4	122.5	946.8	72.3	13.4	1218.7	~~947~~	~~317~~	~~0~~	~~203~~	~~54.9~~
421.40	0.70			Shale		122.5			13.4						

Pile Design Table for Pier 1 utilizing Boring #B-2

	Nominal Required Bearing (Kips)	Factored Resistance Available (Kips)	Estimated Pile Length (Ft.)
Metal Shell 12"Φ w/.179" walls			
	161	65	32
Metal Shell 12"Φ w/.25" walls			
	277	117	34
Metal Shell 14"Φ w/.25" walls			
	211	89	32
	365	159	34
Metal Shell 14"Φ w/.312" walls			
	211	89	32
	365	159	34
Steel HP 8 X 36			
	281	31	45
Steel HP 10 X 42			
	318	47	44

	Nominal Required Bearing (Kips)	Factored Resistance Available (Kips)	Estimated Pile Length (Ft.)
Steel HP 10 X 57			
	452	48	47
Steel HP 12 X 53			
	403	67	44
Steel HP 12 X 63			
	457	69	45
Steel HP 12 X 74			
	566	70	47
Steel HP 12 X 84			
	625	72	48

	Nominal Required Bearing (Kips)	Factored Resistance Available (Kips)	Estimated Pile Length (Ft.)
Steel HP 14 X 73			
	563	94	45
Steel HP 14 X 89			
	689	97	47
Steel HP 14 X 102			
	758	99	48
Steel HP 14 X 117			
	889	101	50
Precast 14"x 14"			
	167	66	29
Timber Pile			
	137	40	34

IDOT STATIC METHOD OF ESTIMATING PILE LENGTH

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

Modified 10/18/2011

SUBSTRUCTURE=============================== Pier 1
REFERENCE BORING ========================== B-2
LRFD or ASD or SEISMIC ======================== LRFD
PILE CUTOFF ELEV. ============================ 477.00 ft
GROUND SURFACE ELEV. AGAINST PILE DURING DRI 465.00 ft
GEOTECHNICAL LOSS TYPE (None, Scour, Liquef., DD) Scour
BOTTOM ELEV. OF SCOUR, LIQUEF., or DD ========= 426.20 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
418 KIPS	**418** KIPS	**49** KIPS	**45** FT.

TOTAL FACTORED SUBSTRUCTURE LOAD ========= 2676 kips
TOTAL LENGTH OF SUBSTRUCTURE (along skew)==== 60.60 ft
NUMBER OF ROWS OF PILES PER SUBSTRUCTURE = 2

Approx. Factored Loading Applied per pile at 8 ft. Cts ===== 176.61 KIPS
Approx. Factored Loading Applied per pile at 3 ft. Cts ===== 66.23 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.

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.)
460.10	4.90	0.40	6		6.2		13.1	9.0		***9.8***	10	3	0	2	17
457.60	2.50	0.50	5		3.9	6.9	15.5	5.7	0.8	***15.3***	15	6	0	3	19
455.10	2.50	0.40	2		3.1	5.5	30.3	4.6	0.6	***21.2***	21	7	0	4	22
452.60	2.50		7	Fine Sand	1.2	17.1	31.5	1.7	1.9	***22.9***	23	8	0	5	24
450.10	2.50		7	Medium Sand	1.3	17.1	35.2	1.8	1.9	***25.0***	25	9	0	5	27
447.60	2.50		8	Medium Sand	1.4	19.6	51.4	2.1	2.1	***28.7***	29	9	0	6	29
445.10	2.50		14	Medium Sand	2.5	34.3	78.4	3.7	3.8	***35.1***	35	11	0	9	32
442.60	2.50		24	Sandy Gravel	5.7	58.8	130.6	8.3	6.4	***48.5***	48	14	0	13	34
440.10	2.50		43	Sandy Gravel	16.7	105.3	309.0	24.4	11.5	***90.5***	91	23	0	27	37
434.60	5.50		109	Sandy Gravel	171.2	267.0	514.5	250.4	29.2	***344.7***	345	117	0	72	42
434.10	0.50		123	Sandy Gravel	18.2	301.3	353.8	26.6	33.0	***351.6***	352	127	0	66	43
433.10	1.00			Shale	49.4	122.5	***403.2***	72.3	13.4	423.9	403	154	0	67	43.9
432.10	1.00			Shale	49.4	122.5	***452.6***	72.3	13.4	496.1	~~453~~	~~182~~	~~0~~	~~67~~	~~44.9~~
431.10	1.00			Shale	49.4	122.5	***502.1***	72.3	13.4	568.4	~~502~~	~~209~~	~~0~~	~~67~~	~~45.9~~
430.10	1.00			Shale	49.4	122.5	***551.5***	72.3	13.4	640.6	~~551~~	~~236~~	~~0~~	~~67~~	~~46.9~~
429.10	1.00			Shale	49.4	122.5	***600.9***	72.3	13.4	712.9	~~601~~	~~263~~	~~0~~	~~67~~	~~47.9~~
428.10	1.00			Shale	49.4	122.5	***650.3***	72.3	13.4	785.1	~~650~~	~~290~~	~~0~~	~~67~~	~~48.9~~
427.10	1.00			Shale	49.4	122.5	***699.7***	72.3	13.4	857.4	~~700~~	~~317~~	~~0~~	~~67~~	~~49.9~~
426.10	1.00			Shale	49.4	122.5	***749.1***	72.3	13.4	929.6	~~749~~	~~317~~	~~0~~	~~95~~	~~50.9~~
425.10	1.00			Shale	49.4	122.5	***798.5***	72.3	13.4	1001.9	~~799~~	~~317~~	~~0~~	~~122~~	~~51.9~~
424.10	1.00			Shale	49.4	122.5	***847.9***	72.3	13.4	1074.1	~~848~~	~~317~~	~~0~~	~~149~~	~~52.9~~
423.10	1.00			Shale	49.4	122.5	***897.4***	72.3	13.4	1146.4	~~897~~	~~317~~	~~0~~	~~176~~	~~53.9~~
422.10	1.00			Shale	49.4	122.5	***946.8***	72.3	13.4	1218.7	~~947~~	~~317~~	~~0~~	~~203~~	~~54.9~~
421.40	0.70			Shale		122.5			13.4						

Pile Design Table for Pier 1 utilizing Boring #B-2

	Nominal Required Bearing (Kips)	Factored Resistance Available (Kips)	Estimated Pile Length (Ft.)
Metal Shell 12"Φ w/.179" walls			
	161	65	32
Metal Shell 12"Φ w/.25" walls			
	161	65	32
	277	117	34
Metal Shell 14"Φ w/.25" walls			
	131	52	29
	211	89	32
	365	159	34
Metal Shell 14"Φ w/.312" walls			
	131	52	29
	211	89	32
	365	159	34
Steel HP 8 X 36			
	281	31	45
Steel HP 10 X 42			
	318	47	44

	Nominal Required Bearing (Kips)	Factored Resistance Available (Kips)	Estimated Pile Length (Ft.)
Steel HP 10 X 57			
	452	48	47
Steel HP 12 X 53			
	91	27	37
	345	72	42
	418	49	45
Steel HP 12 X 63			
	97	30	37
	355	77	42
	358	69	43
	497	63	46
Steel HP 12 X 74			
	104	33	37
	363	70	43
	589	55	48
Steel HP 12 X 84			
	109	36	37
	368	71	43
	664	65	49

	Nominal Required Bearing (Kips)	Factored Resistance Available (Kips)	Estimated Pile Length (Ft.)
Steel HP 14 X 73			
	114	35	37
	420	92	42
	425	83	43
	578	70	46
Steel HP 14 X 89			
	124	40	37
	433	86	43
	705	73	48
Steel HP 14 X 102			
	131	44	37
	438	87	43
	810	94	49
Steel HP 14 X 117			
	140	49	37
	445	89	43
	929	123	51
Precast 14"x 14"			
	167	66	29
Timber Pile			
	137	40	34

IDOT STATIC METHOD OF ESTIMATING PILE LENGTH

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

Modified 10/18/2011

SUBSTRUCTURE================================ Pier 2
REFERENCE BORING =========================== B-3
LRFD or ASD or SEISMIC ======================== LRFD
PILE CUTOFF ELEV. ============================ 477.00 ft
GROUND SURFACE ELEV. AGAINST PILE DURING DRI 459.40 ft
GEOTECHNICAL LOSS TYPE (None, Scour, Liquef., DD) Scour
BOTTOM ELEV. OF SCOUR, LIQUEF., or DD ========= 426.30 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
418 KIPS	392 KIPS	67 KIPS	43 FT.

TOTAL FACTORED SUBSTRUCTURE LOAD ========= 2604 kips
TOTAL LENGTH OF SUBSTRUCTURE (along skew)==== 60.60 ft
NUMBER OF ROWS OF PILES PER SUBSTRUCTURE = 1
Approx. Factored Loading Applied per pile at 8 ft. Cts ===== 343.78 KIPS
Approx. Factored Loading Applied per pile at 3 ft. Cts ===== 128.92 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.

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.)
456.60	2.80	0.40	1		3.5		9.0	5.2		**5.8**	6	2	0	1	20
454.10	2.50	0.40	3		3.1	5.5	**8.6**	4.6	0.6	10.0	9	4	0	1	23
451.60	2.50		1	Medium Sand	0.2	1.9	11.0	0.3	0.2	**10.5**	10	4	0	2	25
449.10	2.50	0.30	3		2.4	4.1	16.1	3.5	0.5	**14.3**	14	5	0	3	28
446.60	2.50	0.50	3		3.9	6.9	45.0	5.7	0.8	**22.7**	23	7	0	5	30
444.10	2.50		13	Medium Sand	2.3	31.8	74.3	3.4	3.5	**29.1**	29	9	0	7	33
441.60	2.50		24	Medium Sand	4.3	58.8	61.5	6.3	6.4	**33.5**	34	11	0	8	35
439.10	2.50		17	Fine Sand	2.9	41.6	145.2	4.2	4.6	**46.6**	47	12	0	13	38
438.10	1.00			Shale	49.4	122.5	194.6	72.3	13.4	**118.8**	119	40	0	26	38.9
437.10	1.00			Shale	49.4	122.5	244.0	72.3	13.4	**191.1**	191	67	0	38	39.9
436.10	1.00			Shale	49.4	122.5	293.4	72.3	13.4	**263.3**	263	94	0	51	40.9
435.10	1.00			Shale	49.4	122.5	342.8	72.3	13.4	**335.6**	336	121	0	63	41.9
434.10	1.00			Shale	49.4	122.5	**392.3**	72.3	13.4	407.8	392	148	0	67	42.9
433.10	1.00			Shale	49.4	122.5	**441.7**	72.3	13.4	480.1	~~442~~	~~176~~	~~0~~	~~67~~	~~43.9~~
432.10	1.00			Shale	49.4	122.5	**491.1**	72.3	13.4	552.3	~~491~~	~~203~~	~~0~~	~~67~~	~~44.9~~
431.10	1.00			Shale	49.4	122.5	**540.5**	72.3	13.4	624.6	~~540~~	~~230~~	~~0~~	~~67~~	~~45.9~~
430.10	1.00			Shale	49.4	122.5	**589.9**	72.3	13.4	696.8	~~590~~	~~257~~	~~0~~	~~67~~	~~46.9~~
429.10	1.00			Shale	49.4	122.5	**639.3**	72.3	13.4	769.1	~~639~~	~~284~~	~~0~~	~~67~~	~~47.9~~
428.10	1.00			Shale	49.4	122.5	**688.7**	72.3	13.4	841.4	~~689~~	~~311~~	~~0~~	~~67~~	~~48.9~~
427.10	1.00			Shale	49.4	122.5	**738.1**	72.3	13.4	913.6	~~738~~	~~339~~	~~0~~	~~67~~	~~49.9~~
426.10	1.00			Shale	49.4	122.5	**787.6**	72.3	13.4	985.9	~~788~~	~~339~~	~~0~~	~~95~~	~~50.9~~
425.10	1.00			Shale	49.4	122.5	**837.0**	72.3	13.4	1058.1	~~837~~	~~339~~	~~0~~	~~122~~	~~51.9~~
424.10	1.00			Shale	49.4	122.5	**886.4**	72.3	13.4	1130.4	~~886~~	~~339~~	~~0~~	~~149~~	~~52.9~~
423.10	1.00			Shale	49.4	122.5	**813.3**	72.3	13.4	1189.2	~~813~~	~~339~~	~~0~~	~~109~~	~~53.9~~
423.00	0.10					0.0			0.0						

Pile Design Table for Pier 2 utilizing Boring #B-3

	Nominal Required Bearing (Kips)	Factored Resistance Available (Kips)	Estimated Pile Length (Ft.)
Metal Shell 12"Φ w/.179" walls			
	128	46	35
Metal Shell 12"Φ w/.25" walls			
	128	46	35
	302	136	38
Metal Shell 14"Φ w/.25" walls			
	165	63	35
	401	185	38
Metal Shell 14"Φ w/.312" walls			
	165	63	35
	401	185	38
Steel HP 8 X 36			
	273	31	44
Steel HP 10 X 42			
	309	47	43

	Nominal Required Bearing (Kips)	Factored Resistance Available (Kips)	Estimated Pile Length (Ft.)
Steel HP 10 X 57			
	443	48	46
Steel HP 12 X 53			
	392	67	43
Steel HP 12 X 63			
	496	69	45
Steel HP 12 X 74			
	554	70	46
Steel HP 12 X 84			
	614	72	47

	Nominal Required Bearing (Kips)	Factored Resistance Available (Kips)	Estimated Pile Length (Ft.)
Steel HP 14 X 73			
	550	94	44
Steel HP 14 X 89			
	676	97	46
Steel HP 14 X 102			
	805	99	48
Steel HP 14 X 117			
	875	101	49
Precast 14"x 14"			
	210	80	35
Timber Pile			
	139	46	38

IDOT STATIC METHOD OF ESTIMATING PILE LENGTH

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

Modified 10/18/2011

SUBSTRUCTURE=============================== Pier 3
REFERENCE BORING ========================== B-4
LRFD or ASD or SEISMIC ======================== LRFD
PILE CUTOFF ELEV. ============================ 477.00 ft
GROUND SURFACE ELEV. AGAINST PILE DURING DRI 450.60 ft
GEOTECHNICAL LOSS TYPE (None, Scour, Liquef., DD) Scour
BOTTOM ELEV. OF SCOUR, LIQUEF., or DD ========= 440.50 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
418 KIPS	**370** KIPS	**67** KIPS	**31** FT.

TOTAL FACTORED SUBSTRUCTURE LOAD ========= 2465 kips
TOTAL LENGTH OF SUBSTRUCTURE (along skew)==== 60.60 ft
NUMBER OF ROWS OF PILES PER SUBSTRUCTURE = 1

Approx. Factored Loading Applied per pile at 8 ft. Cts ===== 325.45 KIPS
Approx. Factored Loading Applied per pile at 3 ft. Cts ===== 122.04 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.

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.)
449.60	1.00			Shale	49.4		171.9	72.3		***85.7***	86	27	0	20	27.4
448.60	1.00			Shale	49.4	122.5	221.3	72.3	13.4	***157.9***	158	54	0	32	28.4
447.60	1.00			Shale	49.4	122.5	270.7	72.3	13.4	***230.2***	230	82	0	45	29.4
446.60	1.00			Shale	49.4	122.5	320.1	72.3	13.4	***302.4***	302	109	0	58	30.4
445.60	1.00			Shale	49.4	122.5	***369.6***	72.3	13.4	374.7	370	136	0	67	31.4
444.60	1.00			Shale	49.4	122.5	***419.0***	72.3	13.4	446.9	~~419~~	~~163~~	~~0~~	~~67~~	~~32.4~~
443.60	1.00			Shale	49.4	122.5	***468.4***	72.3	13.4	519.2	~~468~~	~~190~~	~~0~~	~~67~~	~~33.4~~
442.60	1.00			Shale	49.4	122.5	***517.8***	72.3	13.4	591.4	~~518~~	~~217~~	~~0~~	~~67~~	~~34.4~~
441.60	1.00			Shale	49.4	122.5	***567.2***	72.3	13.4	663.7	~~567~~	~~245~~	~~0~~	~~67~~	~~35.4~~
440.60	1.00			Shale	49.4	122.5	***616.6***	72.3	13.4	735.9	~~617~~	~~272~~	~~0~~	~~67~~	~~36.4~~
440.20	0.40			Shale		122.5			13.4						

Pile Design Table for Pier 3 utilizing Boring #B-4

	Nominal Required Bearing (Kips)	Factored Resistance Available (Kips)	Estimated Pile Length (Ft.)
Steel HP 8 X 36			
	258	31	32
Steel HP 10 X 42			
	331	47	32

	Nominal Required Bearing (Kips)	Factored Resistance Available (Kips)	Estimated Pile Length (Ft.)
Steel HP 10 X 57			
	423	48	34
Steel HP 12 X 53			
	370	67	31
Steel HP 12 X 63			
	473	69	33
Steel HP 12 X 74			
	582	70	35
Steel HP 12 X 84			
	642	72	36

	Nominal Required Bearing (Kips)	Factored Resistance Available (Kips)	Estimated Pile Length (Ft.)
Steel HP 14 X 73			
	523	94	32
Steel HP 14 X 89			
	649	97	34
Steel HP 14 X 102			
	777	99	36
Steel HP 14 X 117			
	787	101	36

IDOT STATIC METHOD OF ESTIMATING PILE LENGTH

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

Modified 10/18/2011

SUBSTRUCTURE================================ West Abutment
REFERENCE BORING ============================ B-4
LRFD or ASD or SEISMIC ========================= LRFD
PILE CUTOFF ELEV. ============================ 478.80 ft
GROUND SURFACE ELEV. AGAINST PILE DURING DRI 473.80 ft
GEOTECHNICAL LOSS TYPE (None, Scour, Liquef., DD) Scour
BOTTOM ELEV. OF SCOUR, LIQUEF., or DD ========= 476.80 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
418 KIPS	**398** KIPS	**219** KIPS	**28** FT.

TOTAL FACTORED SUBSTRUCTURE LOAD ========= 1043 kips
TOTAL LENGTH OF SUBSTRUCTURE (along skew)==== 60.60 ft
NUMBER OF ROWS OF PILES PER SUBSTRUCTURE = 1
Approx. Factored Loading Applied per pile at 8 ft. Cts ===== 137.70 KIPS
Approx. Factored Loading Applied per pile at 3 ft. Cts ===== 51.64 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.

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.)
471.30	2.50	1.00	7		7.0		***8.4***	10.3		10.5	8	0	0	5	8
468.80	2.50	0.10	3		0.8	1.4	25.8	1.2	0.2	***13.5***	13	0	0	7	10
466.30	2.50	1.30	9		8.6	17.9	***19.3***	12.6	2.0	24.4	19	0	0	11	13
463.80	2.50	0.20	3		1.6	2.8	***25.0***	2.4	0.3	27.3	25	0	0	14	15
461.30	2.50	0.50	3		3.9	6.9	***28.9***	5.7	0.8	32.9	29	0	0	16	18
458.80	2.50	0.50	7		3.9	6.9	***30.0***	5.7	0.8	38.3	30	0	0	16	20
456.30	2.50	0.30	7		2.4	4.1	150.8	3.5	0.5	. ***54.7***	55	0	0	30	23
455.30	1.00			Shale	49.4	122.5	200.2	72.3	13.4	***127.0***	127	0	0	70	23.5
454.30	1.00			Shale	49.4	122.5	249.6	72.3	13.4	***199.2***	199	0	0	110	24.5
453.30	1.00			Shale	49.4	122.5	299.0	72.3	13.4	***271.5***	271	0	0	149	25.5
452.30	1.00			Shale	49.4	122.5	348.4	72.3	13.4	***343.7***	344	0	0	189	26.5
451.30	1.00			Shale	49.4	122.5	***397.8***	72.3	13.4	416.0	398	0	0	219	27.5
450.30	1.00			Shale	49.4	122.5	***447.2***	72.3	13.4	488.2	~~447~~	~~0~~	~~0~~	~~246~~	~~28.5~~
449.30	1.00			Shale	49.4	122.5	***496.6***	72.3	13.4	560.5	~~497~~	~~0~~	~~0~~	~~273~~	~~29.5~~
448.30	1.00			Shale	49.4	122.5	***546.1***	72.3	13.4	632.7	~~546~~	~~0~~	~~0~~	~~300~~	~~30.5~~
447.30	1.00			Shale	49.4	122.5	***595.5***	72.3	13.4	705.0	~~595~~	~~0~~	~~0~~	~~328~~	~~31.5~~
446.30	1.00			Shale	49.4	122.5	***644.9***	72.3	13.4	777.2	~~645~~	~~0~~	~~0~~	~~355~~	~~32.5~~
445.30	1.00			Shale	49.4	122.5	***694.3***	72.3	13.4	849.5	~~694~~	~~0~~	~~0~~	~~382~~	~~33.5~~
444.30	1.00			Shale	49.4	122.5	***743.7***	72.3	13.4	921.7	~~744~~	~~0~~	~~0~~	~~409~~	~~34.5~~
443.30	1.00			Shale	49.4	122.5	***793.1***	72.3	13.4	994.0	~~793~~	~~0~~	~~0~~	~~436~~	~~35.5~~
442.30	1.00			Shale	49.4	122.5	***842.5***	72.3	13.4	1066.2	~~843~~	~~0~~	~~0~~	~~463~~	~~36.5~~
441.30	1.00			Shale	49.4	122.5	***892.0***	72.3	13.4	1138.5	~~892~~	~~0~~	~~0~~	~~491~~	~~37.5~~
440.30	1.00			Shale	49.4	122.5	***818.9***	72.3	13.4	1197.3	~~819~~	~~0~~	~~0~~	~~450~~	~~38.5~~
440.20	0.10					0.0			0.0						

Pile Design Table for West Abutment utilizing Boring #B-4

	Nominal Required Bearing (Kips)	Factored Resistance Available (Kips)	Estimated Pile Length (Ft.)
Metal Shell 12"Φ w/.179" walls			
	35	19	20
Metal Shell 12"Φ w/.25" walls			
	35	19	20
	282	155	23
Metal Shell 14"Φ w/.25" walls			
	41	23	20
	377	208	23
Metal Shell 14"Φ w/.312" walls			
	41	23	20
	377	208	23
Steel HP 8 X 36			
	277	152	29
Steel HP 10 X 42			
	314	173	28

	Nominal Required Bearing (Kips)	Factored Resistance Available (Kips)	Estimated Pile Length (Ft.)
Steel HP 10 X 57			
	447	246	31
Steel HP 12 X 53			
	398	219	28
Steel HP 12 X 63			
	452	249	29
Steel HP 12 X 74			
	560	308	31
Steel HP 12 X 84			
	620	341	32

	Nominal Required Bearing (Kips)	Factored Resistance Available (Kips)	Estimated Pile Length (Ft.)
Steel HP 14 X 73			
	557	306	29
Steel HP 14 X 89			
	683	375	31
Steel HP 14 X 102			
	752	413	32
Steel HP 14 X 117			
	882	485	34
Precast 14"x 14"			
	52	29	20
Timber Pile			
	33	18	20
	119	66	23