REVISED
STRUCTURE GEOTECHNICAL REPORT

BRIDGE REPLACEMENT
IL 1 OVER SUGAR CREEK

F.A.P. ROUTE 332 (IL1)
SECTION (21Y-NHR-BY) B-1
CRAWFORD COUNTY, ILLINOIS
JOB NO P-97-029-05
PTB 152 ITEM 28
EXISTING STRUCTURE NO. 017-0004
PROPOSED STRUCTURE NO. 017-0032

Prepared by:

Kaskaskia Engineering Group, LLC
23 Public Square, Suite 404
Belleville, Illinois 62220
Phone: 618-233-5877   Fax: 618-233-5977
KEG No. 09-1049 WO # 1

Authored By:
Matthew D. Masterson, PE

Prepared for:

Allen Henderson & Associates, Inc
907 South 4th Street
Springfield, Illinois 62703
Phone: 217.544.8033

May 2010

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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 bridge on Illinois 1 over Sugar Creek in Crawford County, Illinois. The purpose of this report is to present design and construction recommendations for the proposed structure.

1.2 Project Description

The project entails the replacement of the existing single-span structure (017-0004) to carry Illinois 1 over Sugar Creek in Crawford County, Illinois. The project is located 0.34 miles north of Gordon Junction in Crawford County, Illinois. The general location of the bridge is shown on a USGS Topographic Location Map, Exhibit A. The site lies within the limits of the Second Principal Meridian, Section 36, Township 7N, Range 12W, in the Till Plains Section, specifically in the Springfield Physiographic region.

1.3 Proposed Bridge Information

The proposed structure (S.N. 017-0032) will consist of a single-span, 54-in. PPC I-beam structure with a 36 ft. and 0 in. horizontal clear width, with two, 12-ft. driving lanes and two, 4-ft. aggregate shoulders, as shown on the Preliminary Type, Size and Location (TS&L) Plan, Exhibit E, as provided by Allen Henderson & Associates, Inc. The proposed bridge centerline station will be at Station 209+37 over Illinois Route 1. The proposed substructure will consist of pile-supported integral abutments skewed 27 degrees right forward and have an approximate overall length of 90 ft. and 8 in. as measured from back to back of the abutments. Further substructure details will be based on the Structure Geotechnical Report (SGR). Pile foundations are anticipated to be used for supporting the new single-span bridge. The proposed improvements are shown on the Plan and Profile with Boring Locations, Exhibit B and the Preliminary Type Size & Location (TS&L) Plan, Exhibit E.

According to the Hydraulic Report dated January 27, 2009 prepared by IDOT District 7, a sufficient amount of grading is anticipated. The proposed roadway profile will be raised approximately 3 ft. over the existing profile to accommodate the proposed deeper superstructure. The flow line elevation is 454.95 ft., the proposed clear line elevation is 467.6 ft, and the stream flows from west to east. Stage construction will be considered for this project to maintain one-lane of traffic during construction.

2.0 EXISTING BRIDGE INFORMATION

The original structure (017-0004), constructed in 1935 as SBI-1, Section 21X-NRH-BY, at Station 209+35 as a single-span, reinforced tee beam structure on pile-supported closed abutments consists of a superstructure composed of four concrete tee beams providing a 24 ft. and 0 in. roadway width. The bridge was rehabilitated in 1958. The structure was widened to a 30 ft. roadway width. The parapet was removed, and the abutments were widened. Two tee beams were placed over the widened portion of the abutments, and new curb and rail were placed over the new constructed tee beams. The existing structure is skewed 27 degrees 10 minutes right forward. The existing superstructure has a length of 48 ft. and 4 in. from back to back of the abutments, and a width of 36 ft. and 4 in. from outside parapet to outside parapet.

The concrete deck has been given a poor NBIS rating due to the map cracking with leaching noted in the deck soffit located towards the ends of the deck. The entire wearing surface is map cracked. Potholes located at the deck ends and in the approach pavement can be seen forming through the bituminous wearing surface. The curb and steel bridge rail configuration are in fair condition, but does not meet today’s standards. The superstructure is in fair condition due to the map cracking and efflorescence on exterior side of the original fascia beams. The bituminous is cracked and spalled at the joints. Four cast iron rocker bearings used for expansion on the original structure located at the north abutment are corroding. Two of the bearings are tilted back toward the abutment.

The substructure has been given a poor NBIS rating due to the amounts of map cracking and efflorescence while the majority of the map cracking and efflorescence is located around the construction joints.

In accordance with the Bridge Condition Report, dated September 8, 2008, the entire structure is recommended to be removed and replaced due to the extent of deterioration noted to the deck and the concrete tee beams, the age of the existing substructure, the fact that the substructure units are being founded on untreated timber piling, the deterioration of the abutments, and the evidence of scour.

3.0 SITE INVESTIGATION, SUBSURFACE EXPLORATION, AND GENERALIZED SUBSURFACE CONDITIONS

The site investigation was conducted by IDOT. A site visit by a representative of Kaskaskia Engineering Group, LLC (KEG) to observe all or part of the borings or to make site observations was not performed. Therefore, no site observations have been made by KEG relative to existing conditions of the structure, stream, roadway, or of subsurface sample condition.

Two standard penetration test (SPT) borings, designated 1 N Abut and 2 S Abut, were drilled between the proposed north and south abutments of the bridge on August 25-26, 2009 by IDOT. The locations of the borings are shown on the Preliminary Type, Size, and Location (TS&L) Plan, Exhibit E, as well as having stations and offsets shown on the logs.

Boring 1 N Abut extended to El. 391.06 (80 ft. below ground surface) where rock coring continued to El. 381.06. Boring 2 S Abut extended to El. 390.84 (80 ft. below ground surface). Detailed information regarding the nature and thickness of the soils and rock encountered and the results of the field sampling are shown on the Boring Logs, Exhibit C. The subsurface profiles are included in Subsurface Data Profile, Exhibit D.

Both borings exhibited similar lithology. Generally, from the ground surface to approximate El. 435, layers of clay and silty clay were encountered for both borings with some exceptions for Boring 1 N Abut where layers of fine sand were interbedded from approximate El. 435 to approximate El. 421. Both borings encountered till materials at approximate El. 421 and El. 436, respectively, followed by intermittent layers of sandy clay until at approximate El. 401 where silty and sandy clay shale continued to termination depths. Boring 1 N Abut was extended an additional 10 ft. using rock coring techniques. The rock core information indicates recoveries of 83% and 81% for the two 5 ft. long core runs. The RQD values were 0% and 23%, respectively. The recovered cores were defined as silty clay shale.

Materials were generally cohesive in the upper 36 ft. of the profile, exhibiting N-values from 1 to 26. Unconfined compressive strengths ranged from 0.1 to 4.5 tons per square foot (tsf) and moisture contents ranged from 22% to 36%. The granular and bedrock material encountered exhibited N-values ranging from 3 to 100 and moisture contents ranging from 9% to 36%. Detailed information on the nature and thickness of the materials in each boring are shown on the Subsurface Data Profile, Exhibit D.

Groundwater was encountered at Boring 1 N Abut at El. 435.5 during drilling, at El. 457.3 upon completion, and at El. 461.1 after 576 hours. At Boring 2 S Abut, groundwater was encountered at El. 456.1 during drilling, at El. 445.1 upon completion, and at El. 454.1 after 552 hours. It should be noted that the groundwater level is subject to seasonal and climatic variations and other factors and may be present at different depths in the future. In addition, without extended periods of observation, measurement of the true groundwater levels may not be possible

Table 3.1 summarizes the estimated top of bedrock elevations based on the data from Borings 1 N Abut and 2 S Abut.

Table 3.1 – Estimated Bedrock Elevations

Boring	Estimated Bedrock Elevation
1 N Abut	El. 391.06
2 S Abut	El. 390.84

4.0 GEOTECHNICAL EVALUATIONS

4.1 Settlement

KEG understands that during replacement of the existing structures at this site, the existing concrete abutments in the vicinity of Sugar Creek will be removed and replaced with 2H:1V backslopes covered with riprap. In KEG's opinion, settlements below and within the embankment for the existing loads have occurred long ago and re-grading these slopes as described above will not induce any additional settlements. In addition, with the approach slabs structurally supported by the integral abutments on one end and supported by the existing embankment subgrades at the other, settlement is not a concern, provided compaction utilizing static or vibratory methods is performed during placement of the porous granular embankment backfill adjacent to the integral abutments. In general, recommended pile units for the new structure should only experience settlements of less than 0.5 in.

4.2 Slope Stability

The proposed construction does not result in significant changes in roadway embankment sideslopes, but does result in changes to the backslopes at the abutments. Currently, the abutments are monolithic concrete abutments. When these abutments are replaced by open abutments supported by deep pile foundations, the existing vertical concrete wall face will be replaced with 2:1 (H:V) backslopes.

Slope stability was checked for the proposed backslopes using STABL for Windows 3.0, the soil properties at the site, and the geometrics of the embankments. Similar subsurface soil conditions were assumed along all the abutments, based on the conditions reported from Borings 1N Abut and 2S Abut. Three conditions were modeled: end-of-construction, long-term stability, and a design seismic event. A circular failure surface was assumed, and a critical factor of safety (FOS) was calculated for each condition. According to current standard of practice, the target FOS is 1.5 for end-of-construction and long-term slope stability and 1.0 for a design seismic event.

In order to model the end-of-construction condition, full cohesion was used with no friction angle assumed. Nominal values for cohesion were used to model the long term and seismic conditions to analyze the theoretical condition where pore water pressure has dissipated. For the new clay fill, cohesion of 250 was utilized. Friction angles ranged from 12 to 34 degrees.

The Bishop Circular Method, which generates circular-shaped failure surfaces, was used to calculate the critical failure surfaces and FOS for the proposed conditions. The FOS obtained in the analysis is shown in Table 4.1. Based on the assumptions used in the analysis, all FOS calculated exceed the minimum requirements. STABL program output from this analysis can be found in STABL Analyses, Exhibit F.

Table 4.1 – Slope Stability Critical FOS

	Calculated Critical FOS		
	End of Construction	Long Term	Seismic
North Abutment Back slope	1.67	1.66	1.19
South Abutment Back slope	1.52	1.59	1.04

4.3 Seismic Considerations

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

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

Table 4.2 – Summary of Seismic Parameters

Parameter	**Value**
Soil Site Class	D
Spectral Acceleration Coefficient at Period of 0.2 Sec, Ss	0.290g (Site Class B)
Spectral Acceleration Coefficient at Period of 1.0 Sec, S1	0.084g (Site Class B)
Site Factor, Zero Period, Fpga	1.52 (Site Class D)
Site Factor, Short Period, Fa	1.57 (Site Class D)
Site Factor, Long Period, Fv	2.40 (Site Class D)
Spectral Response Acceleration, 0.2 Sec, S_{DS}	0.445g (Site Class D)
Spectral Response Acceleration, 1.0 Sec, S_{D1}	0.202g (Site Class D)
Seismic Performance Zone	2

As indicated in Table 4.2, the Seismic Performance Zone is 2, based on S_{D1} and Table 3.15.2-1- *LRFD Seismic Performance Zones* in the IDOT Bridge Manual.

4.4 Scour

The approved Hydraulic Report anticipates channel contraction scour of 3 ft. using the 100-year flood design event. Scour countermeasures proposed include protecting the abutment slopes with stone riprap to accommodate the predicted scour. As shown on the Preliminary Type, Size, and Location (TS&L) Plan, Exhibit E, the integral abutments proposed for the bridge are positioned behind a 2:1 (H:V) embankment and lined with Class A5 stone riprap. This is considered an armored embankment and is deemed to be an adequate level of scour protection according to the Bridge Manual.

Table 4.3 shows the Design Scour Elevations. No reduction in the scour elevations was applied. The near surface soil profile anticipated clay material, which would not be considered more scour prone than the default properties assumed in the hydraulic analysis.

Table 4.3 - Design Scour Elevations

	N. Abut	S. Abut
Design Scour Elevation (ft)	464.79	464.78

4.5 Mining Activity

No visual indication of subsurface mining activities is evident at the site. According to the Coal Mines of Crawford County dated August 17, 2009, which was obtained from the Illinois State Geological Survey (ISGS) website, (http://www.isgs.illinois.edu/maps-data-pub/coal-maps.shtml), the project site was not undermined.

4.6 Lateral Pile/Pier Response

Generally, the geotechnical engineer provides soil parameters to the structural engineer so that an L-Pile program, or other approved program, can be used for the lateral or displacement analysis of the foundations. In Table 4.4, Soil Parameters for Lateral Pile Load Analysis, KEG has included the assumed soil parameters needed to perform a displacement or lateral pile analysis, if deemed necessary by the structural engineer.

Table 4.4 – Soil Parameters for Lateral Pile Load Analysis

	Depth	Elev. at Bottom of Layer	γ (pcf)	Φ (degrees)	K (pci)	N	% fines < #200	c (psf)	ε_{50}
Boring 1 North Abut	0-12.0	459.26	105	26	200	4	80	1400	0.007
	12.0-14.5	456.76	95	19	400	5	85	2400	0.005
	14.5-17.0	454.26	110	26	30	4	65	500	0.020
	17.0-22.0	449.26	105	26	200	6	85	1450	0.007
	22.0-24.5	446.76	105	26	200	9	80	1500	0.007
	24.5-34.5	436.76	105	26	200	7	80	1370	0.007
	34.5-39.5	431.76	120	34	30	1	10	N/A	N/A
	39.5-44.5	426.76	110	26	30	0	65	100	0.020
	44.5-49.5	421.76	120	34	60	26	3	N/A	N/A
	49.5-59.5	411.76	110	26	800	28	26	5400	0.004
	59.5-69.5	401.76	105	26	20	3	80	N/A	N/A
	69.5-79.5	391.76	125	12	200	16	N/A	1900	0.005
	79.5-80.2	391.06	125	12	N/A	100/3”	N/A	N/A	0.0005
Boring 2 South Abut	0-9.5	461.64	105	26	800	15	80	3000	0.004
	9.5-14.5	456.64	90	19	400	9	85	2400	0.005
	14.5-17.0	454.14	110	26	100	7	65	1000	0.010
	17.0-27.0	444.14	110	26	100	4	65	975	0.010
	27.0-29.5	441.64	105	26	30	1	80	500	0.020
	29.5-34.5	436.64	110	26	400	11	65	2600	0.005
	34.5-49.5	421.64	110	26	800	33	65	4900	0.004
	49.5-59.5	411.64	120	19	200	34	85	2000	0.005
	59.5-69.5	401.64	120	19	200	14	25	1200	0.005
	69.5-80.3	390.84	125	12	200	100	N/A	1700	0.0005

4.7 Liquefaction

A liquefaction analysis was performed using the liquefaction worksheet provided by IDOT BBS Central Geotechnical Unit. The Maximum Horizontal Ground Surface Acceleration value in the spreadsheet was set equivalent to the PGA (0.118g), according the USGS seismic hazard deaggregation for the location. The Design Earthquake Mean Magnitude (6.35) was determined using the USGS data and deaggregation methods provided at http://earthquake.usgs.gov/., using the 2008 update.

The soil profiles for borings 1 N Abut and 2-S Abut were analyzed. At boring 1-N Abut, a 5 ft. thick layer of fine sand at approximate El. 435.46 was calculated to be a potentially liquefiable layer. However, this layer is confined above and below by cohesive soils which are not considered susceptible to liquefaction and is a fine grained mixture of sand with silty loam. The silty loam within the sand will act as a bonding agent to increase the cohesiveness of the soil. The results for the soil profile encountered in Boring 2-S Abut indicated no liquefiable layers.

Based on the generally cohesive nature of clay and silty clay subsurface materials (that will support structural elements) and their generally stiff consistency, it is not expected that liquefaction will occur during a seismic event for these materials. Therefore, liquefaction was not considered as a reduction for the pile design capacity or other foundation considerations.

5.0 FOUNDATION EVALUATIONS AND DESIGN RECOMMENDATIONS

5.1 General Feasibility

In accordance with the Bridge Manual Section 3.8.3 on Open Abutments: Integral, a single row of H-piles or 12 in. and 14 in. metal shell piles are permitted for the foundation of a bridge having this type of abutment with lengths up to 90 ft. The Modified IDOT Static Method of Estimating Pile Length provided by IDOT BBS Foundations and Geotechnical Unit was used to determine the design length of the piles. Based on the subsurface conditions encountered, the depth to bedrock and the results of the pile design analysis, metal shell piles and H-piles are both considered for the support of the proposed structure. The pile design analysis also revealed that for the south abutment, the 12 in. and 14 in. metal shell piles with 0.25 in. walls would develop significant frictional as well as end bearing resistance at tip elevations before reaching the silty clay shale. The likelihood of pile damage occurring in the layer of stiff clay till material at El. 421, coupled with the risk of pile installation damage and the concern for inadequate penetration to develop lateral fixity, deters recommendation of these pile types. At the south abutment, H-piles are also deriving a majority of support due to friction before reaching the silty clay shale. However, H-piles deriving support primarily from friction, and limited end bearing, have shown unpredictable performance in practice. Therefore, there is potential risk if H-piles are not supported primarily in end bearing, i.e., driven to refusal in the silty or sandy clay shale material.

The Modified IDOT Static Method of Estimating Pile Length spreadsheet in accordance with AGMU 10.2 – Geotechnical Pile Design was used to calculate the pile lengths. Pile capacities were calculated versus increasing embedment up to the Maximum Nominal Required Bearing ($R_{N\ MAX}$) for a given pile type. The results of this analysis are summarized for each structure location on the Pile Design Tables, Exhibit G.

The structure may benefit from the use of shallow foundations or drilled shafts. These types of foundations are not used with integral abutments, as indicated in the TS&L, however, the Structural engineer may consider a semi-integral abutment type which can be used with spread footings and drilled shafts.

The depth to competent bearing material capable of economically supporting the design loads makes the spread footings unfeasible. In accordance with the Geotechnical Manual, the maximum depth at which spread footings are considered economical, as compared to pile foundations, is 10 ft. below the normal depth of a footing.

Based on soil conditions, drilled shafts could be considered as a support system at both abutments. However, the use of drilled shafts is estimated to be cost prohibitive versus driven piles due to the depths required to penetrate the overburden soils and bear in the silty or sandy clay shale. In addition, the occurrence of very soft zones below the water table, especially at the north abutment, could present problems requiring casing of the piers. The use of drilled shafts also is accompanied by significantly more complex detailing for seismic considerations. For these reasons, drilled shafts are not deemed as a support foundation alternative for this structure.

5.2 Pile Supported Foundations

The foundations supporting the proposed bridge must provide sufficient support to resist dead and live loads, including seismic loadings. Based on the subsurface conditions encountered, depth to the hard bedrock material, and the design information available to date, H-pile foundations driven to refusal on the shale bedrock are preferred. The Modified IDOT Static Method of Estimating Pile Length provided by IDOT BBS Foundations and Geotechnical Unit was used to estimate the pile lengths. Table 5.1 LRFD Pile Design shows the estimated pile lengths and corresponding pile tip elevations, based on the pile cutoff elevations as provided by Allen Henderson & Associates, at the abutment locations. The H-pile lengths identified in Table 5.1 assume a 3 ft. penetration into the sandy clay shale at the north abutment and a 6 ft. penetration into the silty clay shale at the south abutment.

The Nominal Required Bearing (R_N) represents the resistance the pile will experience during driving as well as 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 pile to support factored structure loadings. The potential influences of: (a) negative skin friction (down drag) from settlement of compressible layers, (b) loss of support from liquefaction, and (c) loss of support due to material removal (scour) were analyzed. The liquefaction analysis showed no potentially liquefiable layers, and significant additional settlement of the embankment and the foundation units is not anticipated since the subsurface materials mainly consist of cohesive material which are not susceptible to liquefaction and only minor grading is anticipated; hence, down drag forces should be negligible, and liquefaction values were not applied to obtain the R_F according to the Bridge Manual. Scour elevations were not applied during the pile design analyses to account for scour, since the design scour elevation for both abutments, according to the TS&L, is at the bottom of abutment caps.

The factored design loads provided by Allen Henderson & Associates are 1,525 kips at the abutments. In accordance with the Bridge Manual, when determining the final pile size, normally the lowest weight section necessary, which provides the factored or allowable resistance required, should be selected; however, utilizing the pile sections such as the HP 8x36, HP 10x57, HP 12x74, HP 12x84, HP 14x102, and HP 14x117 that have a limited supply compared to other piling, can cause construction delays and increase the cost of the project. Based on these restrictions and based on the factored design loads provided by Allen Henderson and Associates, Inc., the likely pile types to be considered in the pile design analysis were Steel HP 10x42 with an $R_{N\ MAX}$ of 335 kips, Steel HP 12x53 with an $R_{N\ MAX}$ of 419 kips, Steel HP 12x63 with an $R_{N\ MAX}$ of 497 kips, Steel HP 14x73 with an RN MAX of 578 kips, and Metal Shell 14 in. with 0.312 in. walls with an RN MAX of 516 kips. The LRFD Pile Design Guide Procedure (3.10.1) was used to estimate pile capacity at tip elevations for the pile types and sizes being considered.

At the north abutment, the Maximum Required Bearing (RNMAX) for each type of H-pile considered is attained when reaching the silty clay shale bedrock unit.

At the south abutment, the RNMAX for each type of H-pile considered is exceeded before reaching the silty clay shale bedrock unit. KEG recommends driving H-piles to bedrock. The higher available resistance can allow the number of piles to be reduced, resulting in a net savings despite the increased pile length. The potential for driving damage is minimized with H-pile type foundations, and fewer test piles are necessary when H-pile are driven to the shale. Although there is always a risk of damage to metal shell piles during driving, this risk can be minimized by selection of the thicker wall thicknesses. Metal shell would have less inherent risk than friction H-piles; however, it is recognized that IDOT is generally comfortable with H-piles in friction, and length estimates based on the current method of analysis. Therefore, the selection of pile types is left to the collective discretion of the designer and the owner.

If Metal Shell piles are to be used, pile shoes are recommended to reduce damage during driving through the dense layers encountered in the boring logs.

Pile groups were determined by taking the total factored loads for each substructure unit and dividing by the factored resistance available for each type of pile considered. The Minimum Pile Groups represent the minimum number of pile needed to support the factored structural loads provided by the structural engineer. Larger pile groups may be necessary to meet maximum spacing requirements at each substructure unit. The results are shown in Table 5.1 below.

Table 5.1 – LRFD Pile Design

	Pile Designation	R_n Nominal Required Bearing (kips)	R_F Factored Resistance Available (kips)	Total Factored Load (kips)	Estimated Pile Length (ft)	Pile Tip Elevation	Min. Pile Group
North Abutment	HP10x42	323	178	1525	70	397.76	9
	HP12x53	394	217	1525	70	397.76	7
	HP12x63	432	238	1525	72	395.26	7
	HP 14x73	514	283	1525	72	395.26	6
	Metal Shell 14”Ø w/.312 walls	365	201	1525	72	395.26	8
South Abutment	HP10x42	328	180	1525	47	420.14	9
	HP12x53	412	227	1525	50	417.64	7
	HP12x63	491	270	1525	60	407.64	6
	HP 14x73	555	305	1525	57	410.14	5
	Metal Shell 14”Ø w/.312 walls	426	234	1525	65	402.64	7

Although all of the above pile types are considerable options for foundation support, the structural engineer is responsible to determine what pile best suits the design. Some of the pile options may not be suitable alternatives due to spacing requirements or constructability concerns. It is recommended that if an H-pile is recommended for construction and the elevation noted above is within driving distance to sandy or silty clay shale, piles be driven 2 to 6 ft. into the shale.

At least one test pile at each abutment is recommended in the vicinity of the proposed structure, if metal shell piles are to be used. If H-piles are chosen as a foundation type, one test pile is recommended in the vicinity of the north abutment. A test pile is performed prior to production driving so that actual, on-site, field data can be gathered to determine 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.

6.0 CONSTRUCTION CONSIDERATIONS

6.1 Construction Activities

The 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.

6.2 Temporary Sheeting and Soil Retention

KEG understands that temporary shoring will be required for this project. The soils from the boring logs indicate adequate unconfined compressive strengths. If the maximum retained height is 17.5 ft and temporary shoring depths do not exceed the embedment depths in Table 6.1, then IDOT temporary sheet piling design charts should be feasible for this project. The temporary sheet piling should extend from the start of the existing abutments to the end of the proposed abutments. The assumptions for these recommendations are summarized in Table 6.1- Temporary Sheet Piling Design Parameters.

The assumption on which the recommendations at both abutments are based upon, are shown in Table 6.1, below.

Table 6.1 – Temporary Sheet Piling Design Parameters

Structure Unit	Retained Height H (ft)	Embedment Depth D_{req} (ft)	Dredge Line Elevation (ft)	Average Q_u of Embedment (tsf)	Average Q_u in the Upper 1/3 of Embedment (ft)
North Abutment	17.5	17.7	453.6	1.17	1.20
South Abutment	17.5	25.2	453.6	1.02	0.99

If the retained height will exceed 17.5 feet, then further analysis will be required to evaluate whether a Soil Retention System will be required. An Illinois-licensed Structural engineer is required to seal the design of the soil retention system, if deemed necessary.

6.3 Site and Soil Conditions

The soil profile underlying the near surface soils reported in the boring logs, as provided by IDOT, are mostly stiff, cohesive soils which are not at high risk for deformation under loading. However, should any bridge or embankment design considerations assumed by either IDOT or KEG in the analysis stated in this report change, KEG should be contacted to determine if these recommendations 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.

6.4 Foundation Construction

Conventional pile driving equipment and methodologies should be assumed.

7.0 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.

8.0 GEOTECHNICAL DATA

Soil borings can be found in Boring Logs, Exhibit C. The Subsurface Data Profile can be found in Exhibit D.

9.0 LIMITATIONS

The recommendations provided herein are for the exclusive use of Allen Henderson & Associates, Inc. and IDOT. They are specific only to the project described and are based on subsurface information obtained at two boring locations within the bridge area, KEG's understanding of the project as described herein, and geotechnical engineering practice consistent with the standard of care. No other warranty is expressed or implied. KEG should be contacted if conditions encountered during construction are not consistent with those described.

EXHIBIT A

LOCATION MAP

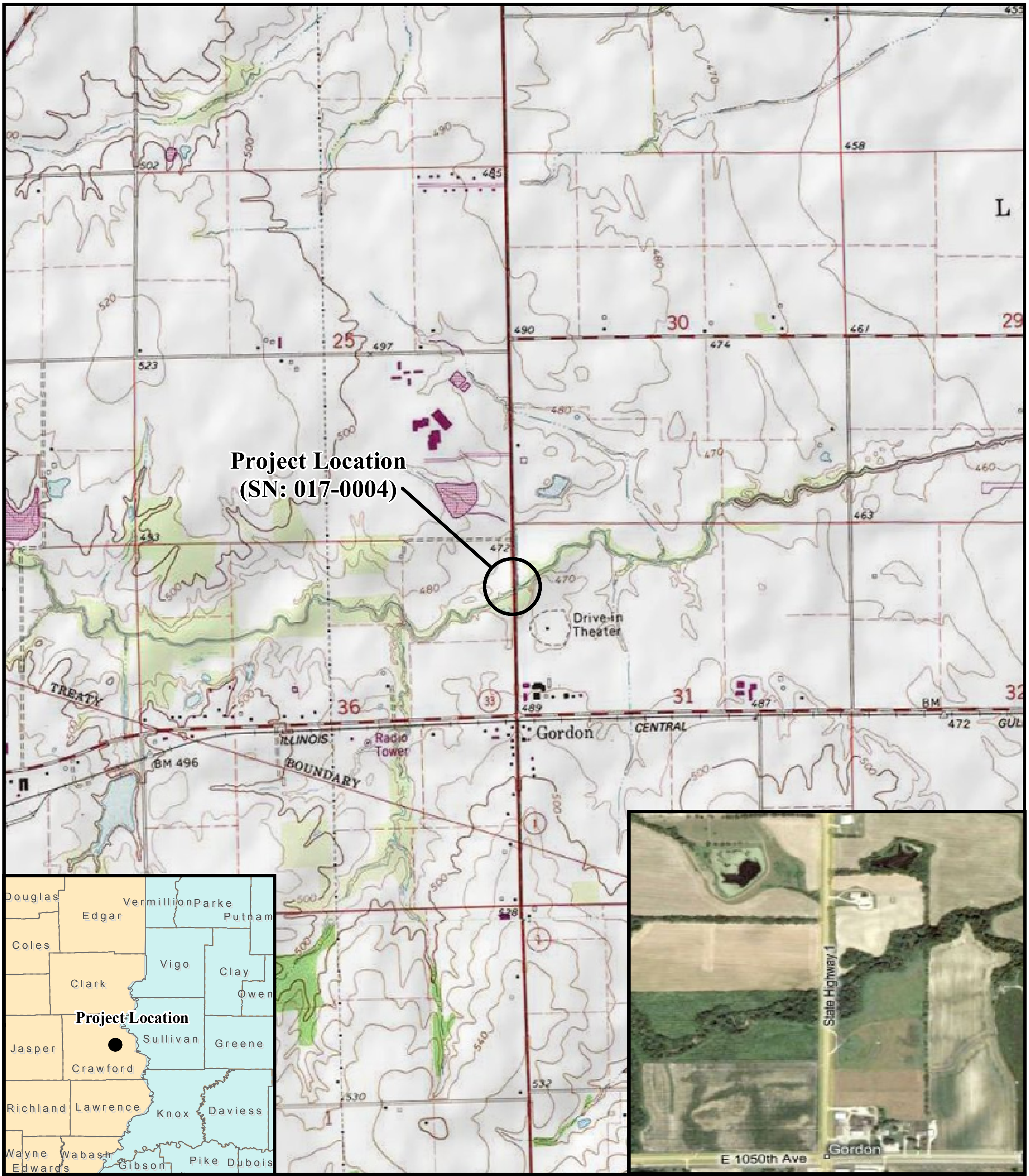

Exhibit A
Location Map
IL 1 over Sugar Creek
Crawford County, Illinois

N

0 500 1,000
Feet

Designed By: TSR
Drawn By: TDW
Checked By: MGM
Date: 1/12/10
Project #: 09_1049.01

Kaskaskia Engineering Group L.L.C.
23 Public Square Suite 404
Belleville, Illinois 62220
Phone: (618)-233-5877 Fax: (618)-233-5977
www.kaskaskiaeng.com
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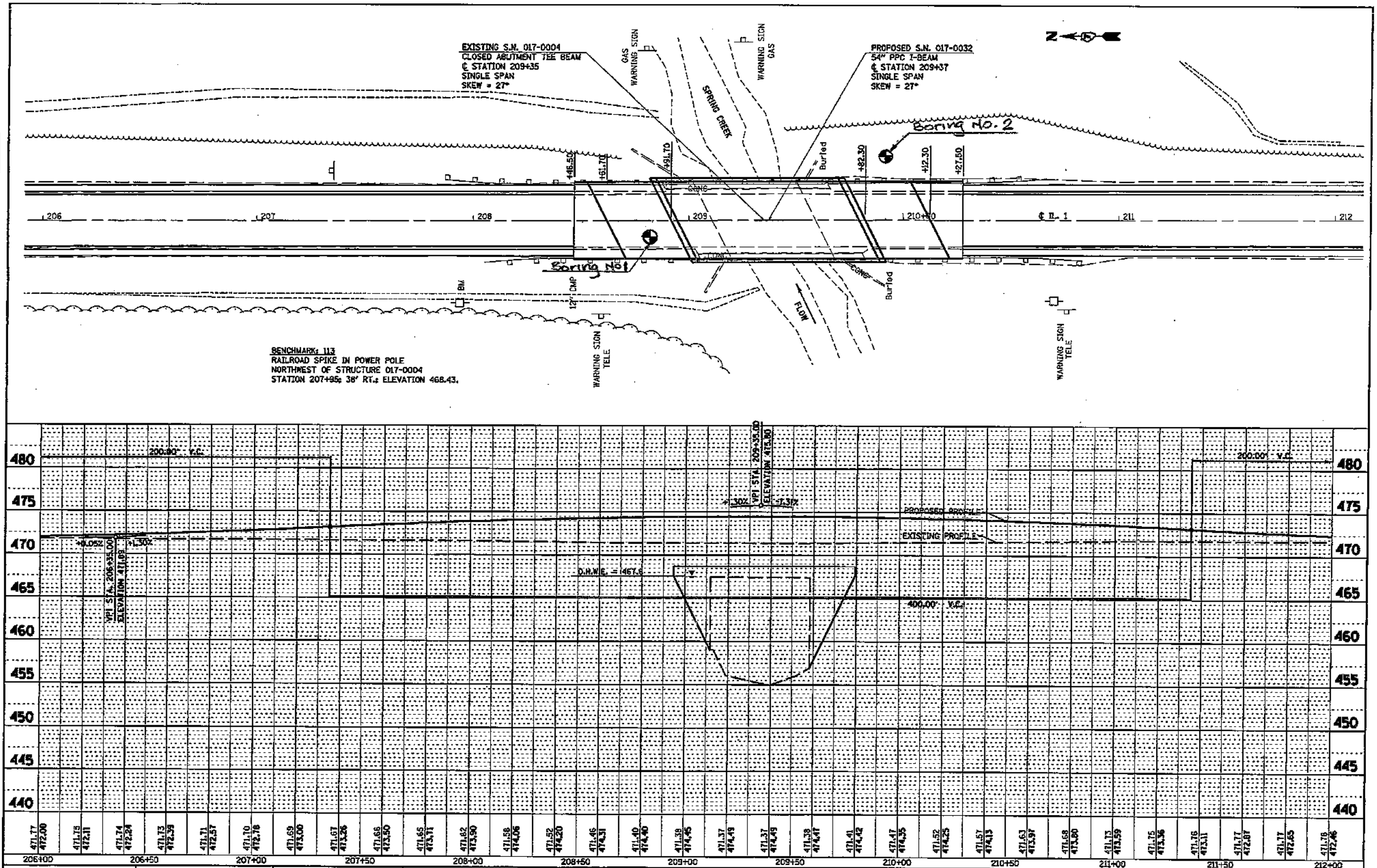
Y:\Projects\Henderson_09_1049_01_IL1overSugarCreek\a_MXD\ExhibitA.mxd

EXHIBIT B

PLAN & PROFILE WITH BORING LOCATIONS

PLAN
NOTE BOOK
NO.
SURVEYED
PLOTTED
ALIGNMENT CHECKED
R/W OF WAY CHECKED
CADD FILE NAME
BY
DATE

PROFILE
NOTE BOOK
NO.
SURVEYED
PLOTTED
GRADES CHECKED
B.M. NOTED
STRUCTURE NOTATNS CHKD
BY
DATE



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PLOT SCALE = 40.0000 '/ IN.
PLOT DATE = 7/16/2008

DESIGNED -
DRAWN -
CHECKED -
DATE -

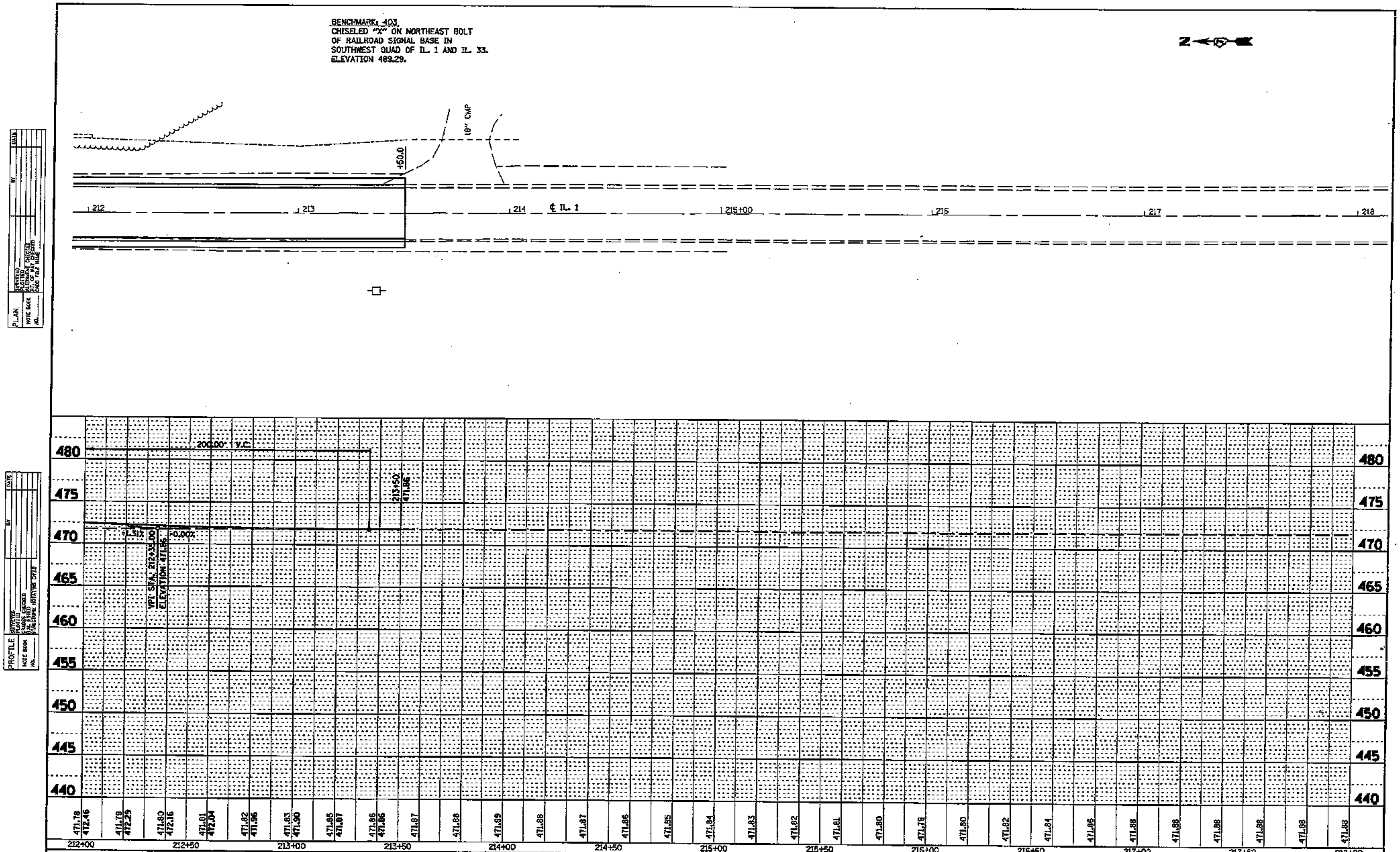
REVISED -
REVISED -
REVISED -
REVISED -

STATE OF ILLINOIS
DEPARTMENT OF TRANSPORTATION

STRUCTURE PLAN AND PROFILE

SCALE: 20
SHEET NO. OF SHEETS
STA. TO STA.

F.A.P. RTE.	SECTION	COUNTY	TOTAL SHEETS	SHEET NO.
332	(21-Y-NRH-BY)B-1	CRAWFORD		
		CONTRACT NO. 74109		
FED. ROAD DIST. NO.	ILLINOIS FED. AID PROJECT			



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		DRAWN -	REVISED -
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	PLOT DATE = 7/16/2008	DATE -	REVISED -

STATE OF ILLINOIS
DEPARTMENT OF TRANSPORTATION

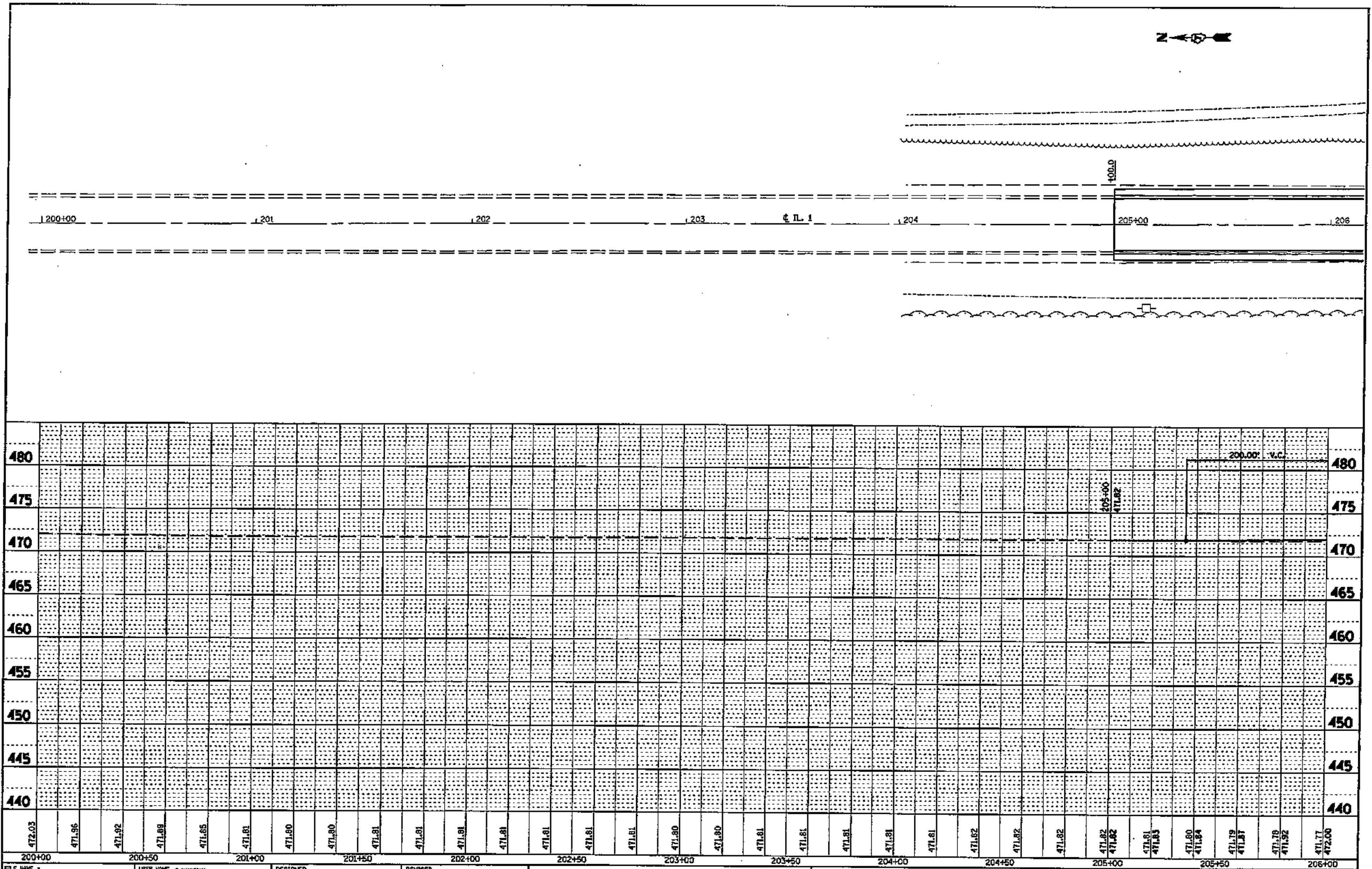
STRUCTURE PLAN AND PROFILE

SCALE: 20 | SHEET NO. OF SHEETS | STA. TO STA.

F.A.P. RTE.	SECTION	COUNTY	TOTAL SHEETS	SHEET NO.
332	(21-Y-NRH-BY)B-1	CRAWFORD		
		CONTRACT NO. 74109		
FED. ROAD DIST. NO.	ILLINOIS FED. AID PROJECT			

PLAN
NOTE BOOK
NO.
SURVEYED
PLOTTED
ALIGNMENT CHECKED
RT. OF WAY CHECKED
CADD FILE NAME
BY
DATE

PROFILE
NOTE BOOK
NO.
SURVEYED
PLOTTED
GRADES CHECKED
B.M. NOTED
STRUCTURE NOTATIONS CHKD
BY
DATE



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	PLOT DATE = 7/16/2008	DATE -	REVISED -

STATE OF ILLINOIS
DEPARTMENT OF TRANSPORTATION

STRUCTURE PLAN AND PROFILE

SCALE: 20 | SHEET NO. OF SHEETS | STA. TO STA.

F.A.P. RTE.	SECTION	COUNTY	TOTAL SHEETS	SHEET NO.
332	(21-Y-NRH-BYDB-1	CRAWFORD		
		CONTRACT NO. 74109		

FED. ROAD DIST. NO. | ILLINOIS | FED. AID PROJECT

EXHIBIT C

BORING LOGS

Illinois Department of Transportation

Memorandum

To: Tim Jackson   Attn: Mike Allen

From: Terry Hoekstra   By: David Miller

Subject: Foundation Boring Logs*

Date: October 2, 2009

---

* Route: FAP 332 (IL 1)
Section: (21Y-NRH-BY)B-1
Structure No.: 017-0004
County: Crawford
Location: Spring Creek, 0.5 mile North of
IL 33, East of Robinson.

Attached is one (1) copy of the foundation boring logs, and fence diagram, for the above captioned section.

If you have any questions, or require any additional information, please contact David Miller, District Geotechnical Engineer, at (217) 342-8233.

By

Terry Hoekstra, P.E.
District Materials Engineer

DKM

Attachments

Illinois Department of Transportation
Division of Highways
Illinois Department of Transportation

SOIL BORING LOG

Page 1 **of** 4

Date 8/25/09

ROUTE FAP 332 (IL 1) **DESCRIPTION** Spring Creek **LOGGED BY** E. Sandschafer

SECTION (21Y-NRH-BY)B-1 **LOCATION** NE 1/4, Sec 35, R12W & NW 1/4, Sec 31, R11W, **SEC.** , **TWP.** 7 N, **RNG.** , 3 **PM**

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

STRUCT. NO. 017-0004
Station 209+35

BORING NO. 1 N Abut
Station 208+84
Offset 8.50ft Rt
Ground Surface Elev. 471.26 **ft**

Surface Water Elev. 455.88 **ft**
Stream Bed Elev. 455.17 **ft**

Groundwater Elev.:
First Encounter 435.5 **ft**
Upon Completion 457.3 **ft**
After 576 **Hrs.** 461.1 **ft**

	DEPTH (ft)	BLOWS (/6")	UCS Qu (tsf)	MOIST (%)
3 1/2" asphalt on 17" concrete pavement.				
469.56				
	-5	1		
Stiff, damp, gray, SILTY CLAY.		2	1.4	22
		3	B	
		5		
No recovery.		2		
		2		
	-10	4		
No recovery.		1		
		2		
459.26				
Very stiff, damp, gray marbled brown, CLAY.		0		
		2	2.4	24
		3	B	
456.76				
Soft to medium, damp, gray, SILTY LOAM.	-15	2		
		2	0.5	24
		2	B	
454.26				
Stiff, damp, gray, CLAY.		1		
		3	1.7	24
		4	B	
	-20	1		

	DEPTH (ft)	BLOWS (/6")	UCS Qu (tsf)	MOIST (%)
Stiff, damp, gray, CLAY. *(continued)*		2	1.2	28
		3	B	
449.26				
Medium, damp, gray, SILTY CLAY.		2		
		4	0.7	25
		5	B	
446.76				
Stiff to medium, damp, gray, CLAY w/ some wood splinters.	-25	1		
		3	1.6	27
		4	B	
		1		
		2	1.5	28
		5	B	
	-30	1		
		2	1.0	32
		3	B	
436.76				
Very soft, very damp, gray, SILTY LOAM.	-35	0		
		0	0.1	36
435.46		1	B	
Gray, fine grained, SAND.				
431.76				
	-40	0		

Latitude W 87 deg 41.077 min, Longitude N 39 deg 00.786 min, Map Datum WGS 84

The Unconfined Compressive Strength (UCS) Failure Mode is indicated by (B-Bulge, S-Shear, P-Penetrometer)
The SPT (N value) is the sum of the last two blow values in each sampling zone (AASHTO T206)

BBS, from 137 (Rev. 8-99)

Illinois Department of Transportation

Division of Highways
Illinois Department of Transportation

SOIL BORING LOG

Page 2 **of** 4

Date 8/25/09

ROUTE FAP 332 (IL 1) **DESCRIPTION** Spring Creek **LOGGED BY** E. Sandschafer

SECTION (21Y-NRH-BY)B-1 **LOCATION** NE 1/4, Sec 35, R12W & NW 1/4, Sec 31, R11W, **SEC.** , **TWP.** 7 N, **RNG.** , 3 **PM**

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

STRUCT. NO. 017-0004
Station 209+35

BORING NO. 1 N Abut
Station 208+84
Offset 8.50ft Rt
Ground Surface Elev. 471.26 **ft**

Surface Water Elev. 455.88 **ft**
Stream Bed Elev. 455.17 **ft**

Groundwater Elev.:
First Encounter 435.5 **ft**
Upon Completion 457.3 **ft**
After 576 **Hrs.** 461.1 **ft**

	DEPTH (ft)	BLOWS (/6")	UCS Qu (tsf)	MOIST (%)
Very soft, very damp, gray, SILTY LOAM. *(continued)*		0	0.1	24
		0	B	
426.76				
Medium, wet, gray, fine grained, SAND.	-45	6		
		11		15
		15		
421.76				
Hard, damp, gray, CLAY LOAM TILL.	-50	6		
		11	5.4	12
		17	B	
	-55			
411.76				
	-60	0		

	DEPTH (ft)	BLOWS (/6")	UCS Qu (tsf)	MOIST (%)
Very loose, wet, gray, fine grained, SAND. *(continued)*		1		21
410.56		2		
Soft, wet, gray, SILTY CLAY.				
	-65			
401.76				
Stiff, damp, gray, SILTY CLAY SHALE.	-70	5		
400.76		7	1.9	16
Gray, SANDY CLAY SHALE.		9	S	
	-75			
391.76				
	-80	50/5"		

Latitude W 87 deg 41.077 min, Longitude N 39 deg 00.786 min, Map Datum WGS 84

The Unconfined Compressive Strength (UCS) Failure Mode is indicated by (B-Bulge, S-Shear, P-Penetrometer)
The SPT (N value) is the sum of the last two blow values in each sampling zone (AASHTO T206)

Illinois Department of Transportation
Division of Highways
Illinois Department of Transportation

SOIL BORING LOG

Date 8/25/09

ROUTE FAP 332 (IL 1) **DESCRIPTION** Spring Creek **LOGGED BY** E. Sandschafer

SECTION (21Y-NRH-BY)B-1 **LOCATION** NE 1/4, Sec 35, R12W & NW 1/4, Sec 31, R11W, **SEC.** , **TWP.** 7 N, **RNG.** , 3 **PM**

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

STRUCT. NO. 017-0004
Station 209+35

BORING NO. 1 N Abut
Station 208+84
Offset 8.50ft Rt
Ground Surface Elev. 471.26 ft

Surface Water Elev. 455.88 **ft**
Stream Bed Elev. 455.17 **ft**

Groundwater Elev.:
First Encounter 435.5 **ft**
Upon Completion 457.3 **ft**
After 576 **Hrs.** 461.1 **ft**

	DEPTH (ft)	BLOWS (/6")	UCS Qu (tsf)	MOIST (%)
Very dense, moist, gray, SILTY CLAY SHALE. *(continued)* 391.06		50/2" 50/1"		9
Borehole continued with rock coring.				
	-85			
	-90			
	-95			
	-100			

Latitude W 87 deg 41.077 min, Longitude N 39 deg 00.786 min, Map Datum WGS 84

The Unconfined Compressive Strength (UCS) Failure Mode is indicated by (B-Bulge, S-Shear, P-Penetrometer)
The SPT (N value) is the sum of the last two blow values in each sampling zone (AASHTO T206)

ROCK CORE LOG

Date 8/25/09

ROUTE FAP 332 (IL 1) **DESCRIPTION** Spring Creek **LOGGED BY** E. Sandschafer

SECTION (21Y-NRH-BY)B-1 **LOCATION** NE 1/4, Sec 35, R12W & NW 1/4, Sec 31, R11W, **SEC.** , **TWP.** 7 N, **RNG.** , 3 **PM**

COUNTY Crawford **CORING METHOD** Rotary, surf set diamond bit

STRUCT. NO. 017-0004
Station 209+35

CORING BARREL TYPE & SIZE NW, conv dbl bbl, split inner

Core Diameter 2.06 **in**
Top of Rock Elev. 401.76 **ft**
Begin Core Elev. 391.06 **ft**

BORING NO. 1 N Abut
Station 208+84
Offset 8.50ft Rt
Ground Surface Elev. 471.26 **ft**

		DEPTH (ft)	CORE (#)	RECOVERY (%)	R.Q.D. (%)	CORE TIME (min/ft)	STRENGTH (tsf)
Gray, moderate to severe weathered, SILTY CLAY SHALE. *Unable to test for Qu due to numerous fractures.*	391.06		B1C1	83	0	1.8	
		-85					
			B1C2	81	23	2	
	381.06	-90					
Extent of exploration. Benchmark: BM 113 RR spike in PP NW of existing structure, Sta 207+95, 38' Rt = 468.43' elevation. Provided by Program Development.							
		-95					
		-100					

Color pictures of the cores Available on request
Cores will be stored for examination until 08/25/2014
The "Strength" column represents the uniaxial compressive strength of the core sample (ASTM D-2938)

Field Rock Core Log

Date: 8-25-09

Structure #: 017-0004

Boring #: B1 N Abut

Rock Core #: B1C1

Depth: 80²

Grey Silty Clay Shale mod - severe weathering

OJ

0.25
0.34
0.37
0.40

-0.24 OJ
-0.58 OJ
-0.72 OJ
-0.80 OJ
-1.07 OJ

0.82 OJ
0.84 OJ
0.88 OJ
0.90 OJ
0.93 OJ
0.97 OJ

-1.85 OJ
-1.90 OJ
-2.00 OJ
-2.04 OJ
-2.31 OJ
-2.60 OJ
-2.70 OJ
-2.75 OJ
-2.80 OJ
-2.95 OJ
-2.98 OJ
-3.20 OJ
-3.29 OJ
-3.43 OJ
-3.47 OJ
-3.79 OJ
-3.95 OJ
-4.15

1.12 OJ
1.14 OJ
1.15 OJ
1.25 OJ
1.32 OJ
1.37 OJ
1.42 OJ
1.47 OJ
1.50 OJ
1.52 OJ
1.55 OJ
1.59 OJ
1.62 OJ
1.65 OJ

①
②
③
④

NO Test Sample

RQD
0

Depth: 85.2'

Core Time: 8:57

Recovery: 82.8%

RQD: 0%

Rock Core #: B1C2

Depth: 85²

Grey Silty Clay Shale w/mod to severe weathering

-0.17 OJ
-0.35 OJ
-0.70 OJ
-0.99 OJ
-1.34 OJ
-1.54 OJ
-1.68 OJ
-1.96 OJ
-2.27 OJ
-2.50 OJ
-2.64 OJ
-2.82 OJ
-3.14 OJ
-3.50 OJ
-3.60 OJ
-3.84 OJ
-3.90 OJ
-4.06 OJ

①
②
③
④

NO TEST Sample

RQD
0.35
0.35
0.45

Depth: 90.2'

Core Time: 9:47

Recovery: 81% → saw core fall down into augers.

RQD: 23%

Logged By: Eric Sandschafer

Illinois Department of Transportation
Division of Highways
Illinois Department of Transportation

SOIL BORING LOG

Page 1 **of** 3

Date 8/26/09

ROUTE FAP 332 (IL 1) **DESCRIPTION** Spring Creek **LOGGED BY** E. Sandschafer

SECTION (21Y-NRH-BY)B-1 **LOCATION** NE 1/4, Sec 35, R12W & NW 1/4, Sec 31, R11W, **SEC.** , **TWP.** 7 N, **RNG.** , 3 **PM**

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

STRUCT. NO. 017-0004
Station 209+35

BORING NO. 2 S Abut
Station 209+92
Offset 30.00ft Lt
Ground Surface Elev. 471.14 **ft**

Surface Water Elev. 455.88 **ft**
Stream Bed Elev. 455.17 **ft**

Groundwater Elev.:
First Encounter 456.1 **ft**
Upon Completion 445.1 **ft**
After 552 **Hrs.** 454.1 **ft**

	DEPTH (ft)	BLOWS (/6")	UCS Qu (tsf)	MOIST (%)
8" shoulderstone and cold millings. 470.44				
Hard, very moist, brown/gray/red, CLAY LOAM.		4		
		5 7	+4.5 PP	
	-5	13		
		16 10	+4.5 PP	22
		3		
		4 5	3.1 S	
461.64				
Stiff, damp, brown/gray, CLAY w/ trace Silt.	-10	3		
		3 5	1.9 B	
		1		
		4 5	2.8 B	24
456.64				
Brown, very damp, SILTY LOAM. 456.14	-15	1		
Medium, damp, gray, SANDY LOAM.		4 3	0.8 S	24
454.14				
Medium to stiff, damp, gray, SILTY CLAY.		0		
		1 1	0.7 B	24
	-20	1		

	DEPTH (ft)	BLOWS (/6")	UCS Qu (tsf)	MOIST (%)
Medium to stiff, damp, gray, SILTY CLAY. *(continued)*		2 5	1.3 B	28
		0		
		1 1	1.1 B	25
	-25	1		
		2 2	0.8 B	27
444.14				
Soft, damp, gray, SILTY CLAY.		0		
		0 1	0.5 B	28
441.64				
Very stiff, damp, gray mottled brown, SILTY CLAY.	-30	3		
		5 6	2.6 B	32
436.64				
Hard, damp, gray, CLAY LOAM TILL.	-35	9		
		14 28	5.5 B	36
	-40	7		

Latitude W 87 deg 41.077 min, Longitude N 39 deg 00.786 min, Map Datum WGS 84

The Unconfined Compressive Strength (UCS) Failure Mode is indicated by (B-Bulge, S-Shear, P-Penetrometer)
The SPT (N value) is the sum of the last two blow values in each sampling zone (AASHTO T206)

BBS, from 137 (Rev. 8-99)

SOIL BORING LOG

Page 2 **of** 3

Date 8/26/09

ROUTE FAP 332 (IL 1) **DESCRIPTION** Spring Creek **LOGGED BY** E. Sandschafer

SECTION (21Y-NRH-BY)B-1 **LOCATION** NE 1/4, Sec 35, R12W & NW 1/4, Sec 31, R11W, **SEC.** , **TWP.** 7 N, **RNG.** , 3 **PM**

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

STRUCT. NO. 017-0004
Station 209+35

BORING NO. 2 S Abut
Station 209+92
Offset 30.00ft Lt
Ground Surface Elev. 471.14 **ft**

Surface Water Elev. 455.88 **ft**
Stream Bed Elev. 455.17 **ft**

Groundwater Elev.:
First Encounter 456.1 **ft**
Upon Completion 445.1 **ft**
After 552 **Hrs.** 454.1 **ft**

	DEPTH (ft)	BLOWS (/6")	UCS Qu (tsf)	MOIST (%)
Hard, damp, gray, CLAY LOAM TILL. *(continued)*		11 16	4.7 B	24
	-45	7		
		13 17	4.6 B	15
421.64				
Stiff to very stiff, damp, gray, CLAY TILL.	-50	2		
		5 29	2.0 B	12
	-55			
411.64				
Stiff, damp, gray, SANDY CLAY.	-60	1		

	DEPTH (ft)	BLOWS (/6")	UCS Qu (tsf)	MOIST (%)
Stiff, damp, gray, SANDY CLAY. *(continued)*		6 8	1.2 B	21
	-65			
401.64				
Stiff, damp, blue, SILTY CLAY SHALE.	-70	1		
		4 9	1.7 BS	16
	-75			
391.64				
	-80	50		

Latitude W 87 deg 41.077 min, Longitude N 39 deg 00.786 min, Map Datum WGS 84

The Unconfined Compressive Strength (UCS) Failure Mode is indicated by (B-Bulge, S-Shear, P-Penetrometer)
The SPT (N value) is the sum of the last two blow values in each sampling zone (AASHTO T206)

Illinois Department of Transportation
Division of Highways
Illinois Department of Transportation

SOIL BORING LOG

Page 3 **of** 3

Date 8/26/09

ROUTE FAP 332 (IL 1) **DESCRIPTION** Spring Creek **LOGGED BY** E. Sandschafer

SECTION (21Y-NRH-BY)B-1 **LOCATION** NE 1/4, Sec 35, R12W & NW 1/4, Sec 31, R11W, **SEC.** , **TWP.** 7 N, **RNG.** , 3 **PM**

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

STRUCT. NO. 017-0004
Station 209+35

BORING NO. 2 S Abut
Station 209+92
Offset 30.00ft Lt
Ground Surface Elev. 471.14 ft

Surface Water Elev. 455.88 ft
Stream Bed Elev. 455.17 ft

Groundwater Elev.:
First Encounter 456.1 ft
Upon Completion 445.1 ft
After 552 **Hrs.** 454.1 ft

		DEPTH (ft)	**BLOWS** (/6")	**UCS** Qu (tsf)	**MOIST** (%)
Very dense, moist, gray, SILTY CLAY SHALE. *(continued)*	390.84		50/2" 50/2"		9
Extent of exploration.					
Benchmark: BM 113 RR spike in PP NW of existing structure, Sta 207+95, 38' Rt = 468.43' elevation. Provided by Program Development.		-85			
		-90			
		-95			
		-100			

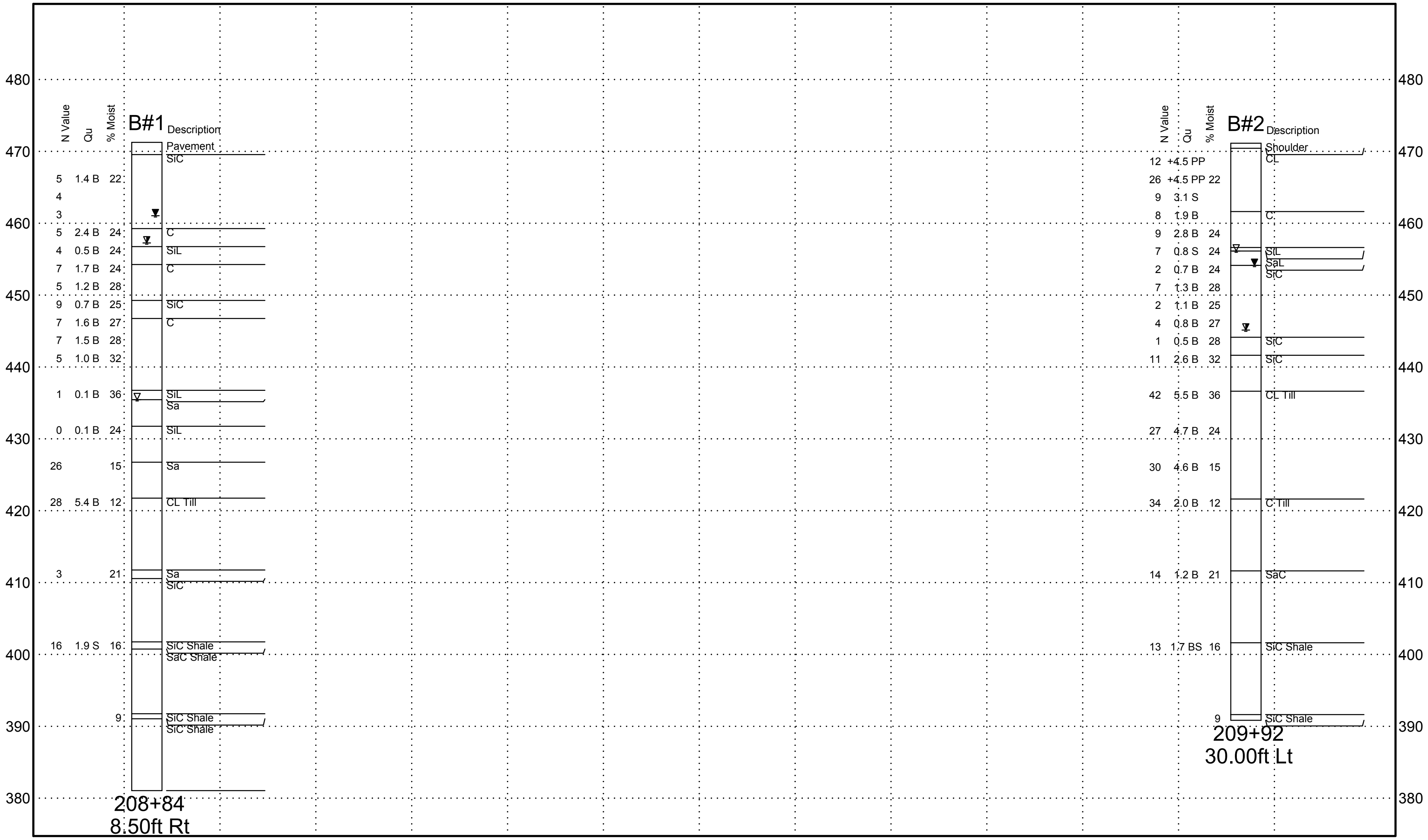
Latitude W 87 deg 41.077 min, Longitude N 39 deg 00.786 min, Map Datum WGS 84

The Unconfined Compressive Strength (UCS) Failure Mode is indicated by (B-Bulge, S-Shear, P-Penetrometer)
The SPT (N value) is the sum of the last two blow values in each sampling zone (AASHTO T206)

EXHIBIT D

SUBSUFRACE DATA PROFILE

Structure Number 017-0004 Spring Creek
Located in the NE 1/4, Sec 35, R12W & NW 1/4, Sec 31, R11W of Section , Township 7 N, Range of the 3 P.M.



NOT TO HORIZONTAL SCALE

Illinois Department of Transportation

Division of Highways
Illinois Department of Transportation

VARIATIONS IN SUBSURFACE CONDITIONS MAY EXIST BETWEEN BORINGS

Groundwater
▽ First Encounter
▼ Completion
▼ after (refer to log) hours

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

SUBSURFACE DATA PROFILE

Route: FAP 332 (IL 1)

Section: (21Y-NRH-BY)B-1

County: Crawford

SUBSURFACE DATA PROFILE 017-0004.GPJ D6TEMPLT.GDT 09/10/02

SUBSURFACE DATA PROFILE 017-0004.GPJ D6TEMPLT.GDT 09/10/02

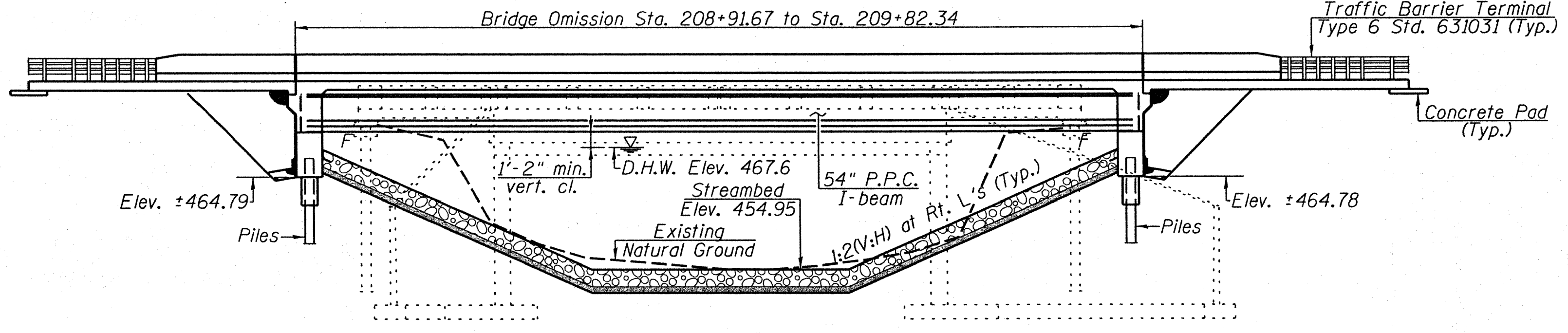
EXHIBIT E

PRELIMINARY TYPE, SIZE, AND LOCATION PLAN

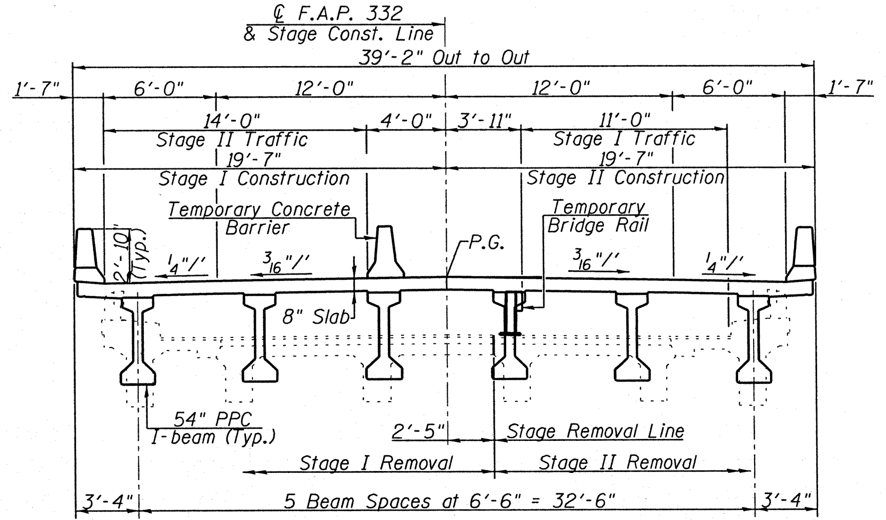
Benchmark: Railroad spike in power pole northwest of structure 017-0004
Station 207+95, 38' Rt., Elevation 468.43

Existing Structure: S.N. 017-0004 was built in 1935 as part of SBI-1 Sec. 21-X-NRH at Sta. 209+35. In 1959, under SBI-1 Section 21X-NRH-By, the superstructure was widened. Existing structure is a single span concrete T-Beam on closed abutments, 48'-4½" bk. to bk. abutments, 36'-4" out to out with a 27°-10' right forward skew. Existing structure is to be removed and replaced utilizing stage construction to maintain one lane of traffic during construction.

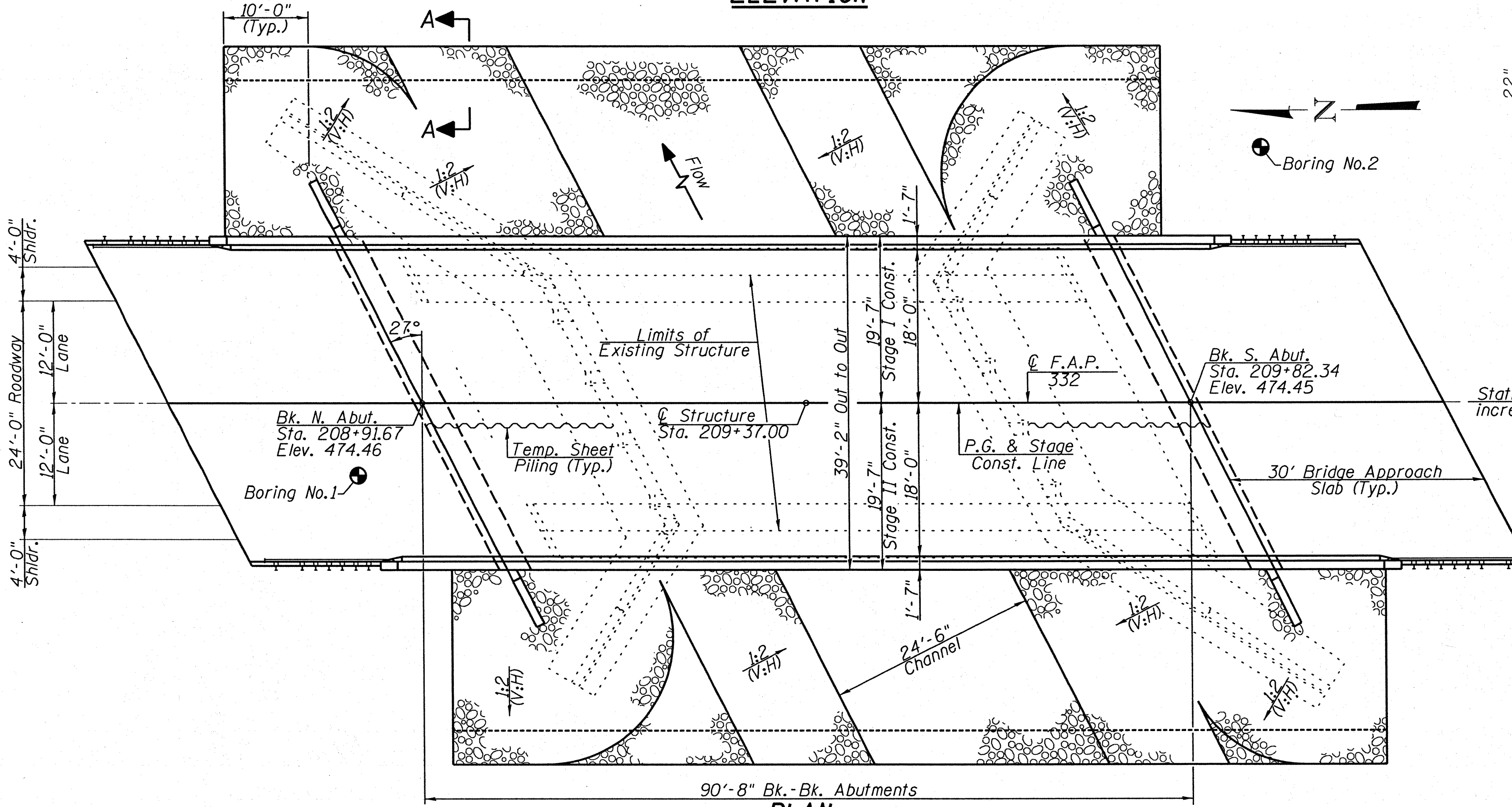
No salvage.



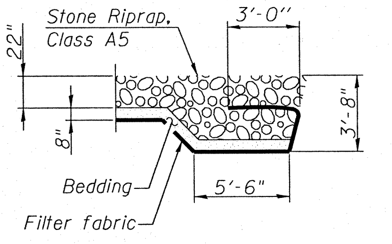
ELEVATION



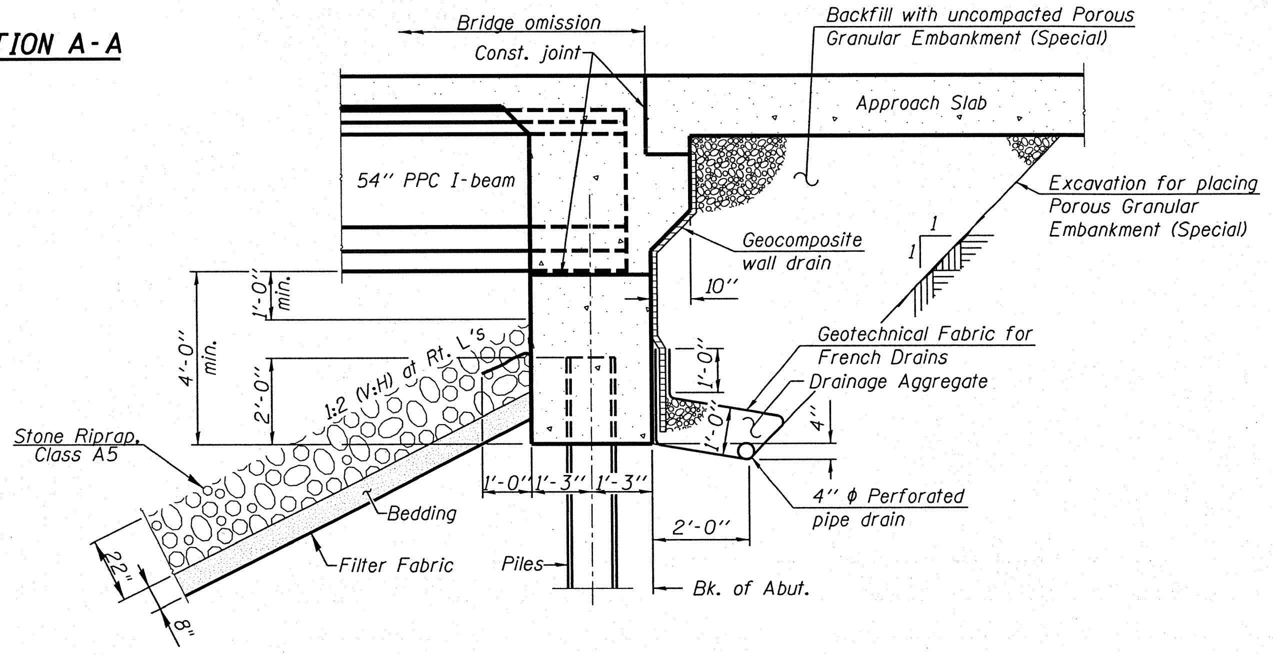
CROSS SECTION
(Looking South)



PLAN



SECTION A-A



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

LOADING HL-93
Allow 50#/sq. ft. for future wearing surface.

DESIGN SPECIFICATIONS
2007 AASHTO LRFD Bridge Design Specifications with 2008 and 2009 Interims.

DESIGN STRESSES

FIELD UNITS
f'_c = 3,500 psi
f_y = 60,000 psi (reinforcement)

PRECAST PRESTRESSED UNITS
f'_c = 6,000 psi
f'_{ci} = 5,000 psi
f_{pu} = 270,000 psi (½" ϕ low lax. strands)
f_{pbt} = 201,960 psi (½" ϕ low lax. strands)

SEISMIC DATA
Seismic Performance Zone (SPZ) =
Design Spectral Acceleration at 1.0 sec. (S_{D1}) =
Design Spectral Acceleration at 0.2 sec. (S_{DS}) =
Soil Site Class =

HIGHWAY CLASSIFICATION
F.A.P. Route 332 - IL Rte. 1
Functional Class: Other Principal Arterial
ADT: 2,700 (2007); 5,698 (2031)
ADTT: 494 (2007); 1043 (2031)
DHV: 684
Design Speed: 60 m.p.h. (posted); 55 m.p.h. (design)
Two way traffic Directional Dist. 52:48

DESIGN SCOUR ELEVATION TABLE

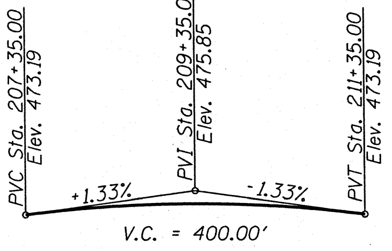
Design Scour Elevation (ft.)	N. Abut.	S. Abut.
	464.79	464.78

WATERWAY INFORMATION

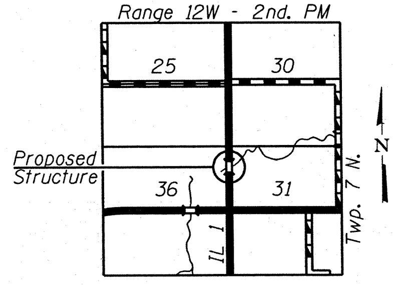
Drainage Area = 10.5 mi²
Exist. Low Grade Elev. 471.80 @ Sta. 203+06
Prop. Low Grade Elev. 471.37 @ Sta. 209+31

Flood	Freq. Yr.	Q C.F.S.	Opening Sq. Ft.		Nat. H.W.E.	Head - Ft.		Headwater El.	
			Exist.	Prop.		Exist.	Prop.	Exist.	Prop.
	10	2136	385	515	465.8	0.2	0.2	466.0	466.0
Design	50	3471	452	652	467.6	1.1	0.4	468.7	468.0
Base	100	4076	452	690	468.0	1.6	1.3	469.6	469.3
Overtopping Exist.	340	5160	452		468.6	2.8		471.4	
Overtopping Prop.									
Max. Calc.	500	5570	452	728	468.8	3.1	1.7	471.9	470.5

10 year velocity through existing bridge = 5.55 fps
10 year velocity through prop. bridge = 4.15 fps



PROFILE GRADE
(Along ℄ Roadway)



LOCATION SKETCH

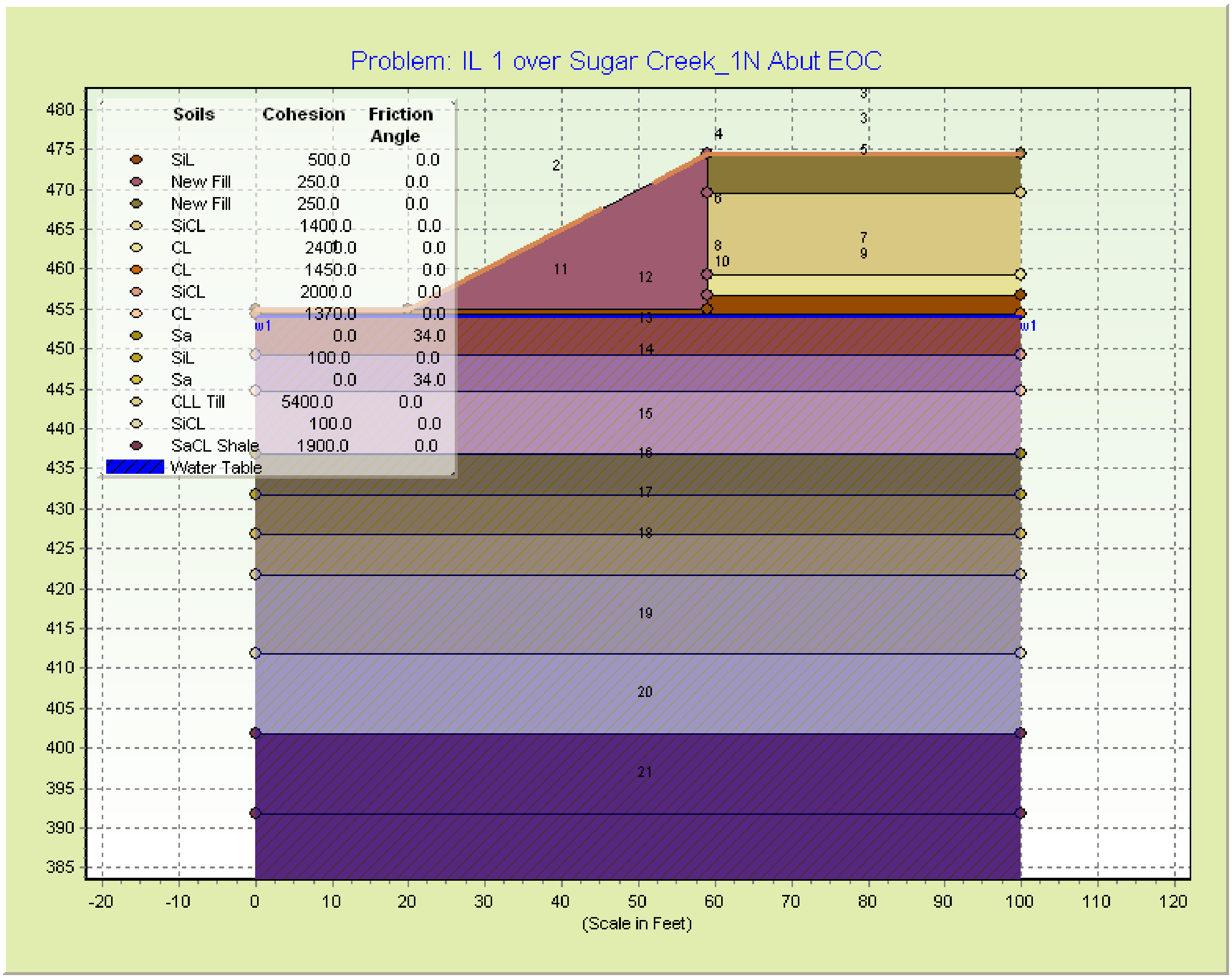
GENERAL PLAN
ILLINOIS ROUTE 1 OVER SUGAR CREEK
F.A.P. RTE 332 - SEC. (21-Y-NHR-BY)B-1
CRAWFORD COUNTY
STATION 209+37.00
STRUCTURE NO. 017-0032

SHEET NO. 1 1 SHEETS	F.A.P. RTE.	SECTION	COUNTY	TOTAL SHEETS	SHEET NO.
	332	(21-Y-NHR-BY)B-1	CRAWFORD	1	1
			CONTRACT NO. 74109		
	FED. ROAD DIST. NO. _	ILLINOIS	FED. AID PROJECT		

EXHIBIT F

STABL ANALYSES

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



Profile Data

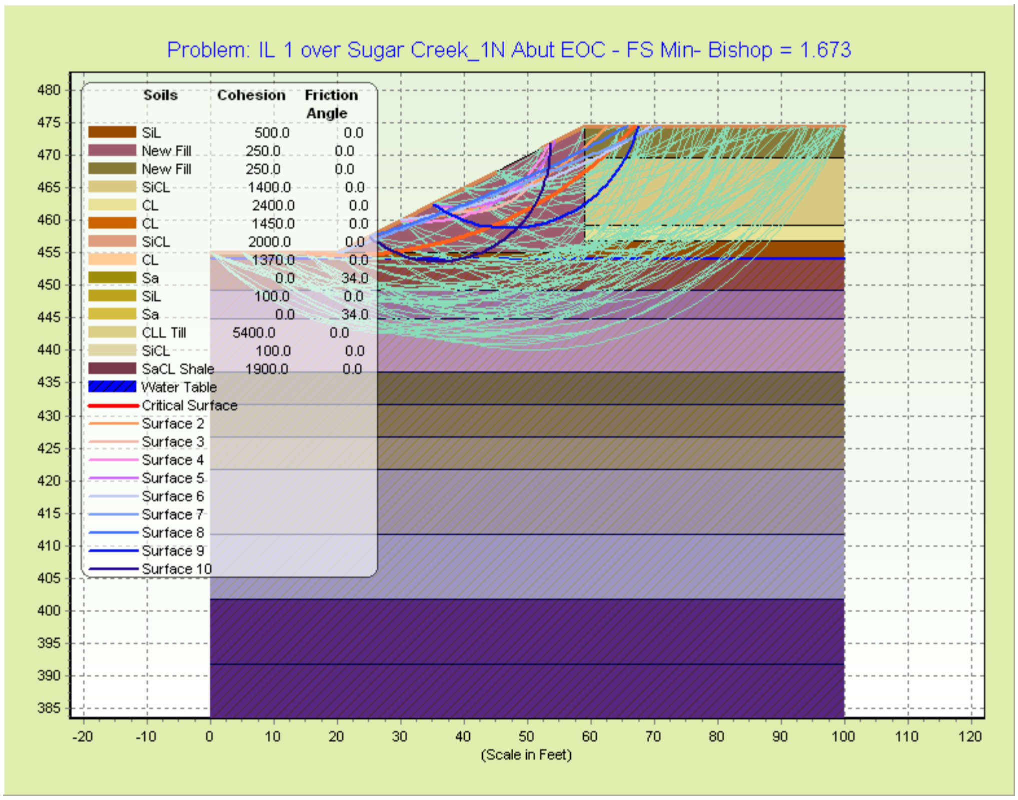
Segment Number	Left Extreme X	Left Extreme Y	Right Extreme X	Right Extreme Y	Soil Under Segment
1	0	454.95	20	454.95	4
2	20	454.95	58.96	474.43	14
3	58.96	474.43	100	474.43	1
4	58.96	474.43	58.96	469.56	14
5	58.96	469.56	100	469.56	2
6	58.96	469.56	58.96	459.26	14
7	58.96	459.26	100	459.26	3
8	58.96	459.26	58.96	456.76	14
9	58.96	456.76	100	456.76	4
10	58.96	456.76	58.96	454.95	14

Segment Number	Left Extreme X	Left Extreme Y	Right Extreme X	Right Extreme Y	Soil Under Segment
11	20	454.95	58.96	454.95	4
12	0	454.26	100	454.26	5
13	0	449.26	100	449.26	6
14	0	444.76	100	444.76	7
15	0	436.76	100	436.76	8
16	0	431.76	100	431.76	9
17	0	426.76	100	426.76	10
18	0	421.76	100	421.76	11
19	0	411.76	100	411.76	12
20	0	401.76	100	401.76	13
21	0	391.76	100	391.76	13

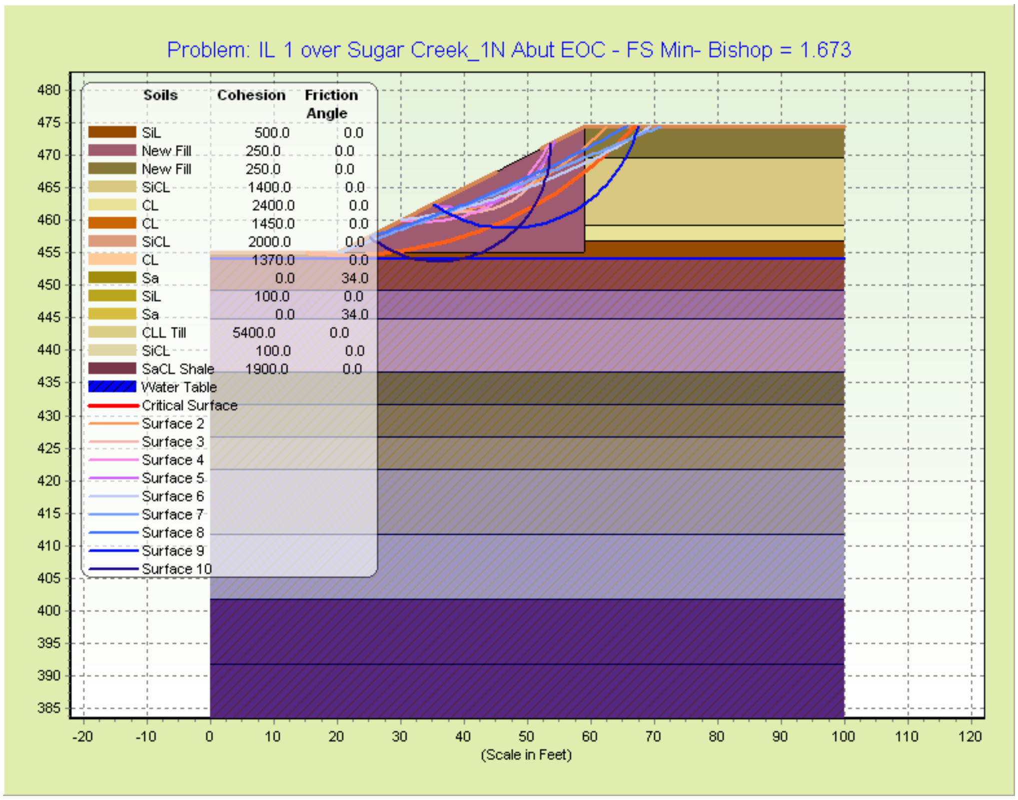
Soil Properties

Soil Number	Wet Unit Weight	Saturated Unit Weight	Cohesive Intercept	Friction Angle	Ru	Pressure Head	Water Table	Soil Name
1	125	0	250	0	0	0	1	New Fill
2	105	0	1400	0	0	0	1	SiCL
3	95	0	2400	0	0	0	1	CL
4	110	0	500	0	0	0	1	SiL
5	105	105	1450	0	0	0	1	CL
6	0	105	2000	0	0	0	0	SiCL
7	0	105	1370	0	0	0	0	CL
8	0	120	0	34	0	0	0	Sa
9	0	110	100	0	0	0	0	SiL
10	0	120	0	34	0	0	0	Sa
11	0	110	5400	0	0	0	0	CLL Till
12	0	105	100	0	0	0	0	SiCL
13	0	125	1900	0	0	0	0	SaCL Shale
14	125	0	250	0	0	0	1	New Fill

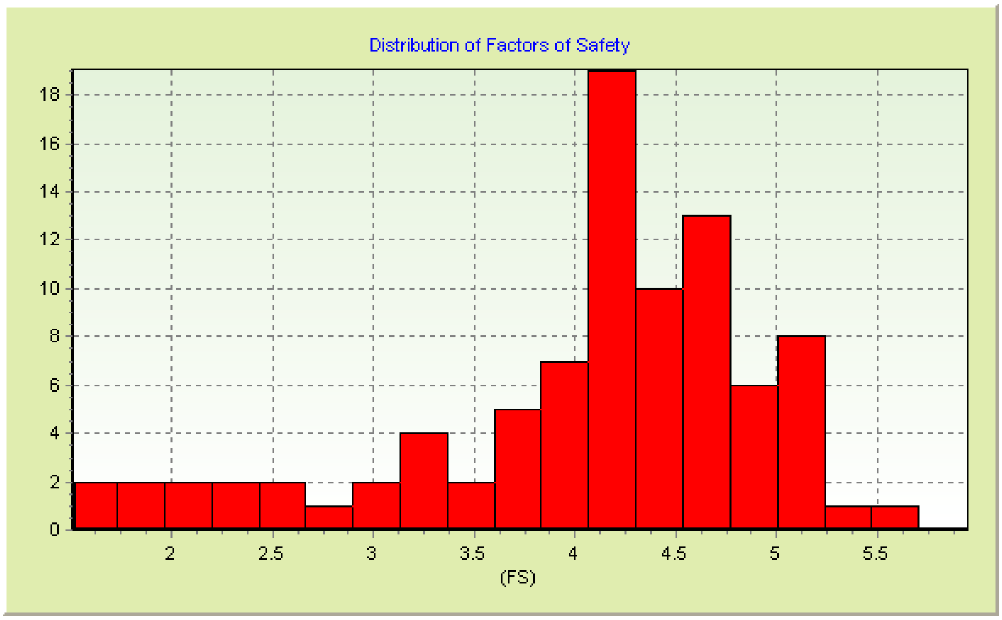
=============== All Surfaces Generated =============



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



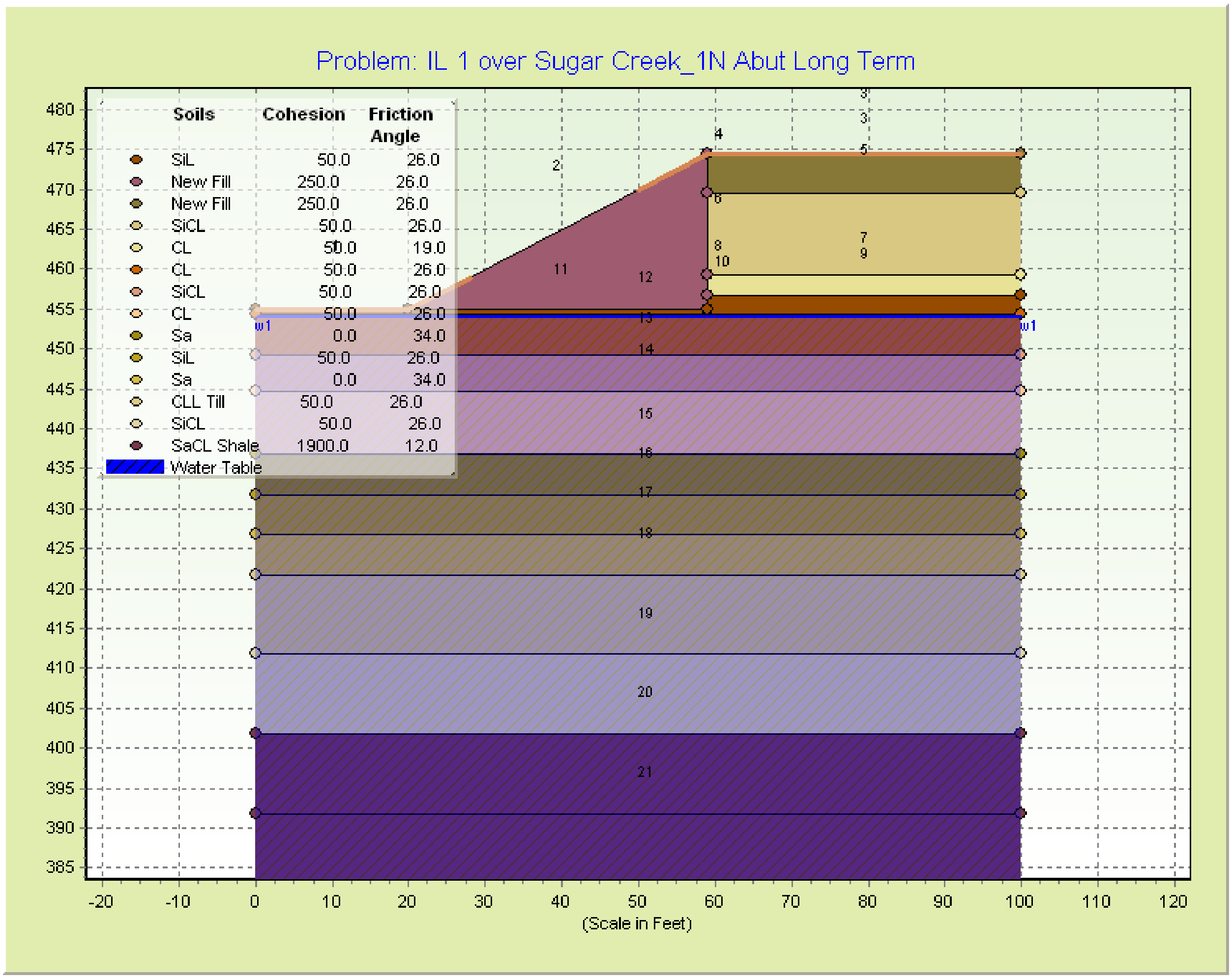
============= Factor of Safety Histogram ============



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

Surface Number	Factor of Safety
1	1.673
2	1.677
3	1.881
4	1.887
5	2.05
6	2.117
7	2.319
8	2.322
9	2.442
10	2.569

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



Profile Data

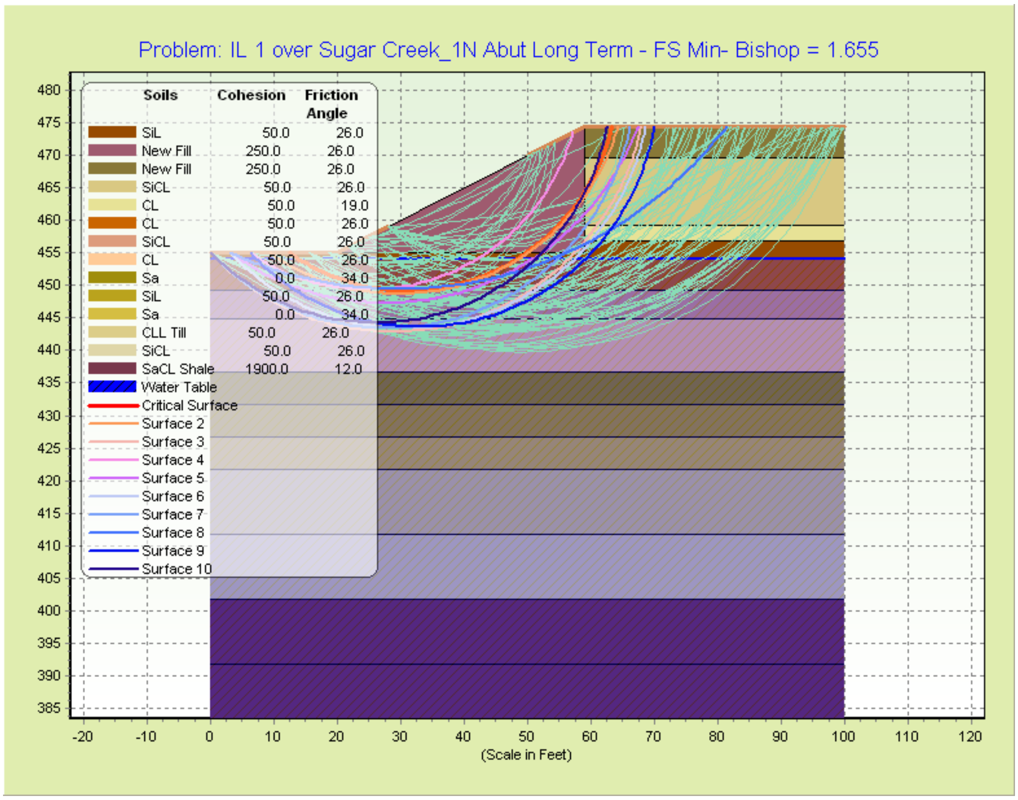
Segment Number	Left Extreme X	Left Extreme Y	Right Extreme X	Right Extreme Y	Soil Under Segment
1	0	454.95	20	454.95	4
2	20	454.95	58.96	474.43	14
3	58.96	474.43	100	474.43	1
4	58.96	474.43	58.96	469.56	14
5	58.96	469.56	100	469.56	2
6	58.96	469.56	58.96	459.26	14
7	58.96	459.26	100	459.26	3
8	58.96	459.26	58.96	456.76	14
9	58.96	456.76	100	456.76	4
10	58.96	456.76	58.96	454.95	14

Segment Number	Left Extreme X	Left Extreme Y	Right Extreme X	Right Extreme Y	Soil Under Segment
11	20	454.95	58.96	454.95	4
12	0	454.26	100	454.26	5
13	0	449.26	100	449.26	6
14	0	444.76	100	444.76	7
15	0	436.76	100	436.76	8
16	0	431.76	100	431.76	9
17	0	426.76	100	426.76	10
18	0	421.76	100	421.76	11
19	0	411.76	100	411.76	12
20	0	401.76	100	401.76	13
21	0	391.76	100	391.76	13

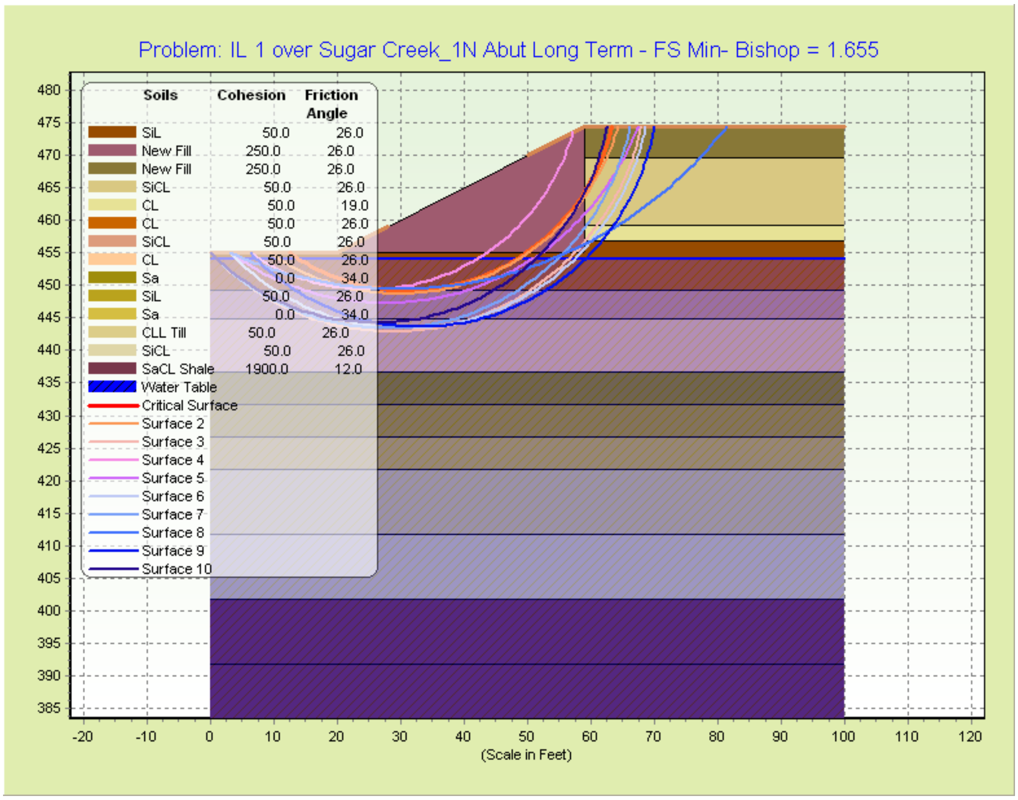
Soil Properties

Soil Number	Wet Unit Weight	Saturated Unit Weight	Cohesive Intercept	Friction Angle	Ru	Pressure Head	Water Table	Soil Name
1	125	0	250	26	0	0	1	New Fill
2	105	0	50	26	0	0	1	SiCL
3	95	0	50	19	0	0	1	CL
4	110	0	50	26	0	0	1	SiL
5	105	105	50	26	0	0	1	CL
6	0	105	50	26	0	0	0	SiCL
7	0	105	50	26	0	0	0	CL
8	0	120	0	34	0	0	0	Sa
9	0	110	50	26	0	0	0	SiL
10	0	120	0	34	0	0	0	Sa
11	0	110	50	26	0	0	0	CLL Till
12	0	105	50	26	0	0	0	SiCL
13	0	125	1900	12	0	0	0	SaCL Shale
14	125	0	250	26	0	0	1	New Fill

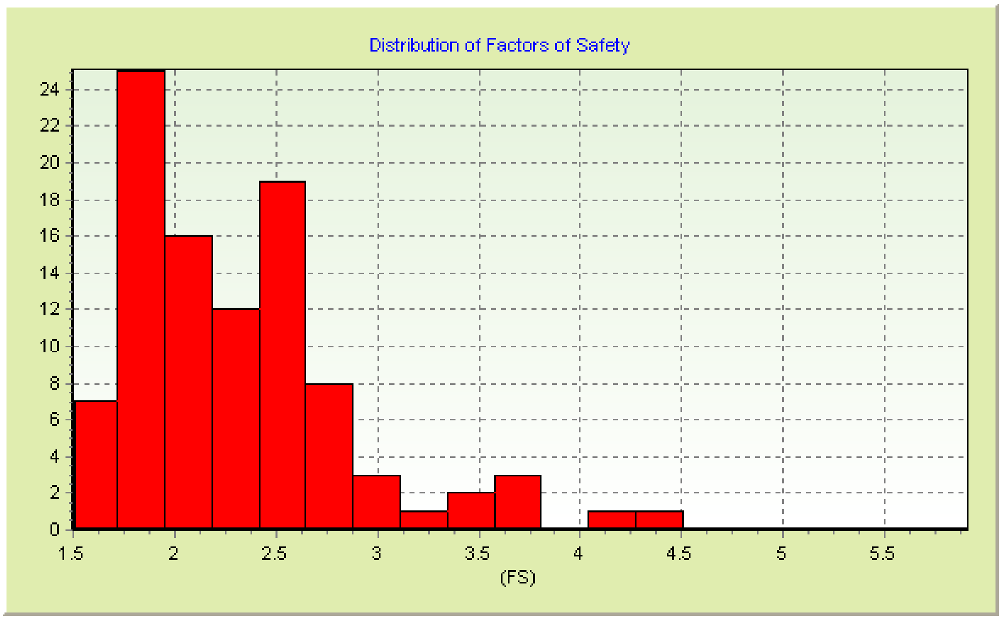
=============== All Surfaces Generated =============



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



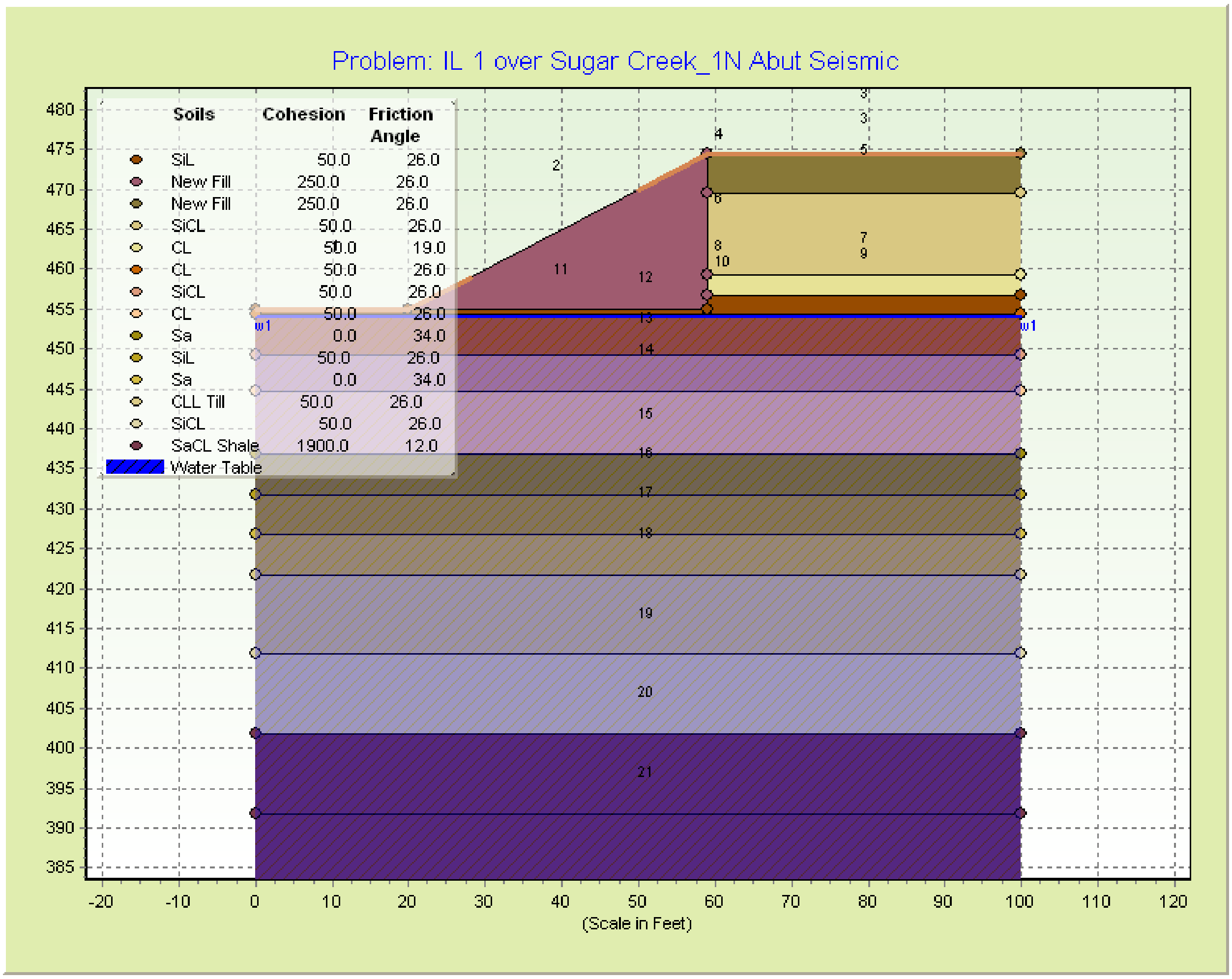
============= Factor of Safety Histogram ============



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

Surface Number	Factor of Safety
1	1.655
2	1.683
3	1.697
4	1.701
5	1.71
6	1.71
7	1.716
8	1.724
9	1.753
10	1.761

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



Profile Data

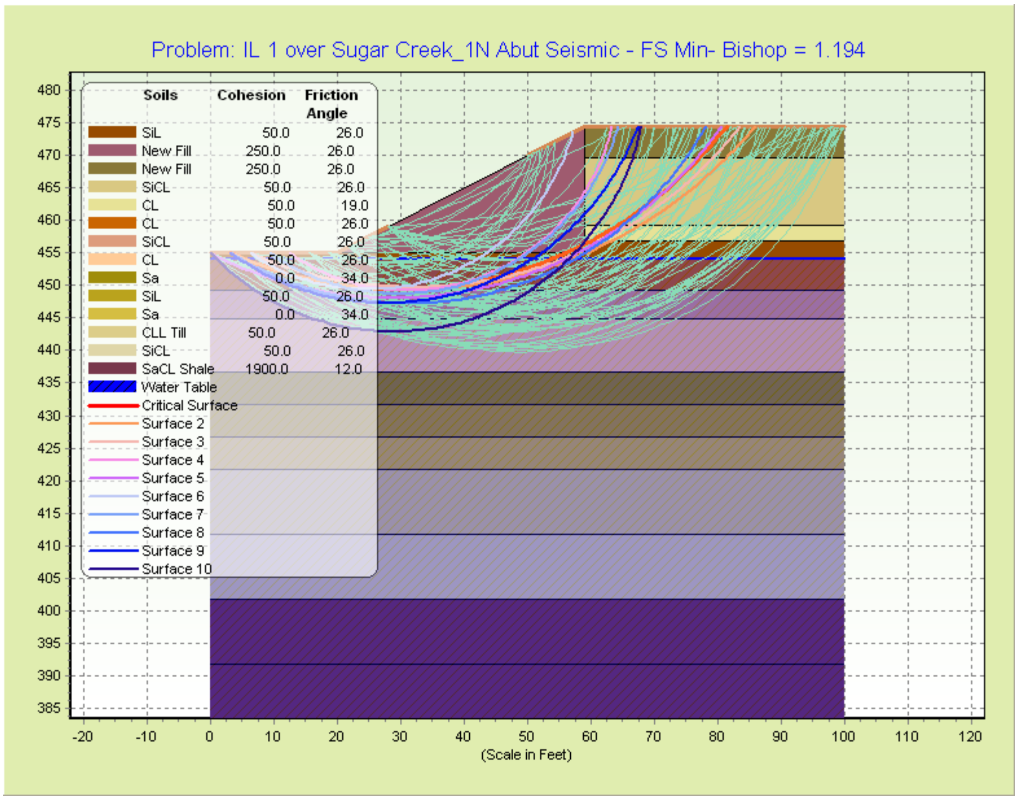
Segment Number	Left Extreme X	Left Extreme Y	Right Extreme X	Right Extreme Y	Soil Under Segment
1	0	454.95	20	454.95	4
2	20	454.95	58.96	474.43	14
3	58.96	474.43	100	474.43	1
4	58.96	474.43	58.96	469.56	14
5	58.96	469.56	100	469.56	2
6	58.96	469.56	58.96	459.26	14
7	58.96	459.26	100	459.26	3
8	58.96	459.26	58.96	456.76	14
9	58.96	456.76	100	456.76	4
10	58.96	456.76	58.96	454.95	14

Segment Number	Left Extreme X	Left Extreme Y	Right Extreme X	Right Extreme Y	Soil Under Segment
11	20	454.95	58.96	454.95	4
12	0	454.26	100	454.26	5
13	0	449.26	100	449.26	6
14	0	444.76	100	444.76	7
15	0	436.76	100	436.76	8
16	0	431.76	100	431.76	9
17	0	426.76	100	426.76	10
18	0	421.76	100	421.76	11
19	0	411.76	100	411.76	12
20	0	401.76	100	401.76	13
21	0	391.76	100	391.76	13

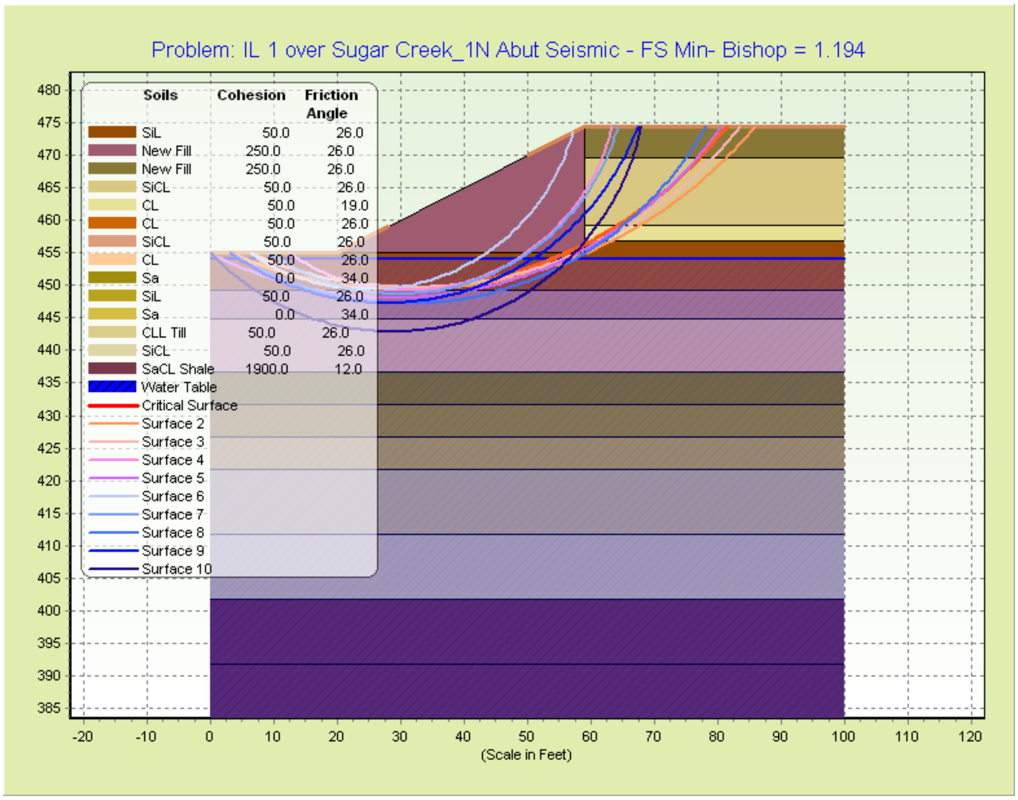
Soil Properties

Soil Number	Wet Unit Weight	Saturated Unit Weight	Cohesive Intercept	Friction Angle	Ru	Pressure Head	Water Table	Soil Name
1	125	0	250	26	0	0	1	New Fill
2	105	0	50	26	0	0	1	SiCL
3	95	0	50	19	0	0	1	CL
4	110	0	50	26	0	0	1	SiL
5	105	105	50	26	0	0	1	CL
6	0	105	50	26	0	0	0	SiCL
7	0	105	50	26	0	0	0	CL
8	0	120	0	34	0	0	0	Sa
9	0	110	50	26	0	0	0	SiL
10	0	120	0	34	0	0	0	Sa
11	0	110	50	26	0	0	0	CLL Till
12	0	105	50	26	0	0	0	SiCL
13	0	125	1900	12	0	0	0	SaCL Shale
14	125	0	250	26	0	0	1	New Fill

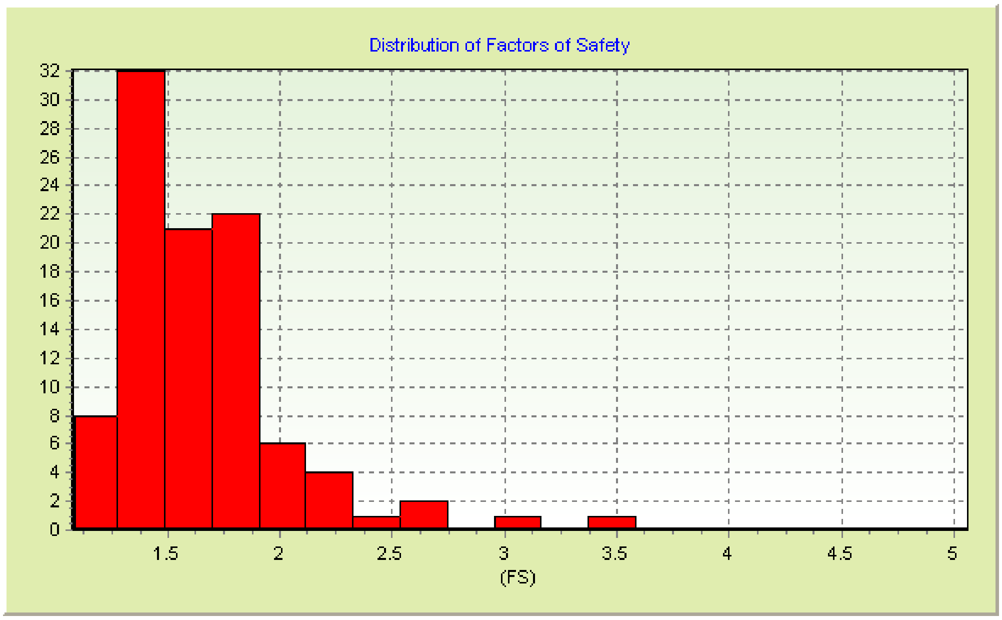
=============== All Surfaces Generated =============



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



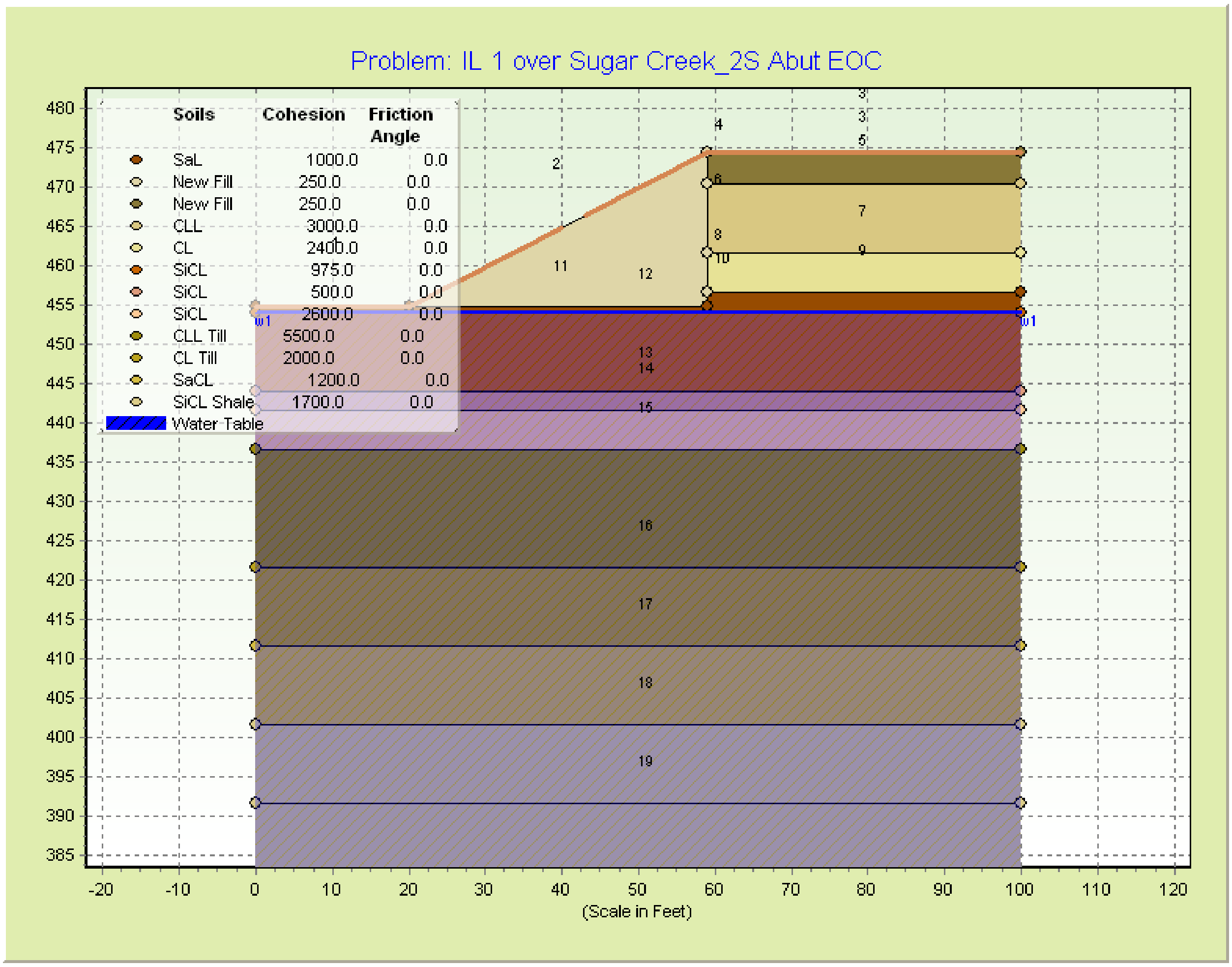
============= Factor of Safety Histogram ============



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

Surface Number	Factor of Safety
1	1.194
2	1.223
3	1.224
4	1.259
5	1.272
6	1.274
7	1.28
8	1.282
9	1.292
10	1.344

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



Profile Data

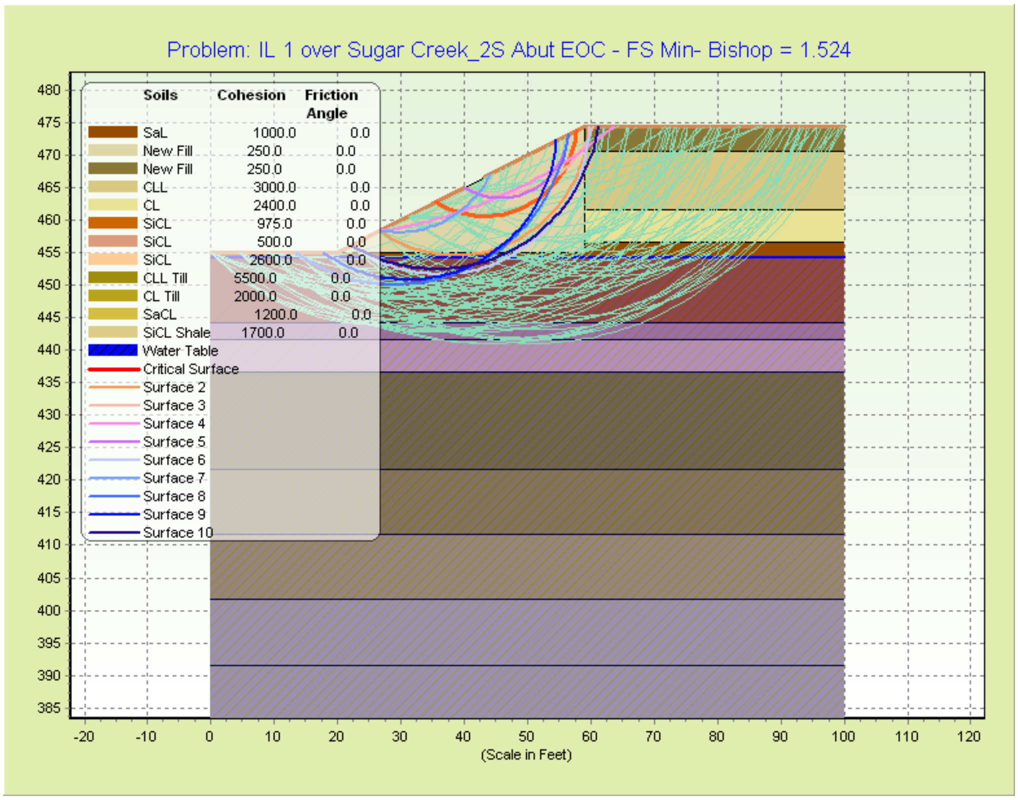
Segment Number	Left Extreme X	Left Extreme Y	Right Extreme X	Right Extreme Y	Soil Under Segment
1	0	454.95	20	454.95	4
2	20	454.95	58.94	474.42	12
3	58.94	474.42	100	474.42	1
4	58.94	474.42	58.94	470.44	12
5	58.94	470.44	100	470.44	2
6	58.94	470.44	58.94	461.64	12
7	58.94	461.64	100	461.64	3
8	58.94	461.64	58.94	456.64	12
9	58.94	456.64	100	456.64	4
10	58.94	456.64	58.94	454.95	12

Segment Number	Left Extreme X	Left Extreme Y	Right Extreme X	Right Extreme Y	Soil Under Segment
11	20	454.95	58.94	454.95	4
12	0	454.14	100	454.14	5
13	0	444.14	100	444.14	6
14	0	441.64	100	441.64	7
15	0	436.64	100	436.64	8
16	0	421.64	100	421.64	9
17	0	411.64	100	411.64	10
18	0	401.64	100	401.64	11
19	0	391.64	100	391.64	11

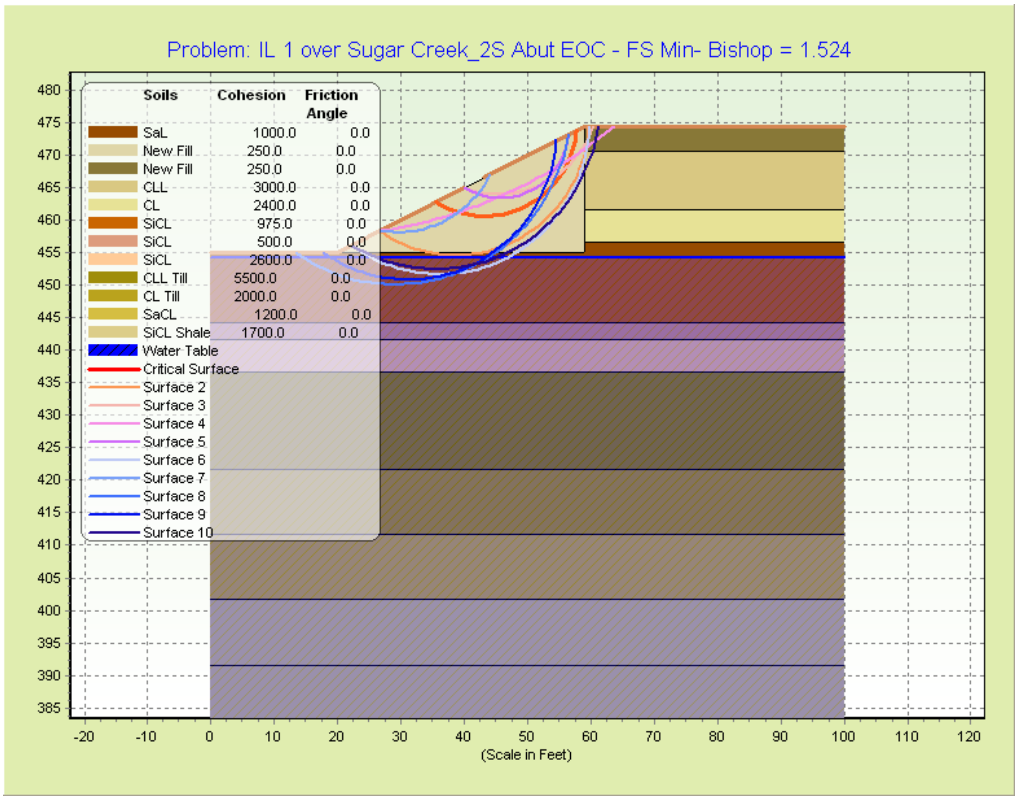
Soil Properties

Soil Number	Wet Unit Weight	Saturated Unit Weight	Cohesive Intercept	Friction Angle	Ru	Pressure Head	Water Table	Soil Name
1	125	0	250	0	0	0	1	New Fill
2	105	0	3000	0	0	0	1	CLL
3	90	0	2400	0	0	0	1	CL
4	110	0	1000	0	0	0	1	SaL
5	0	110	975	0	0	0	0	SiCL
6	0	105	500	0	0	0	0	SiCL
7	0	110	2600	0	0	0	0	SiCL
8	0	110	5500	0	0	0	0	CLL Till
9	0	120	2000	0	0	0	0	CL Till
10	0	120	1200	0	0	0	0	SaCL
11	0	125	1700	0	0	0	0	SiCL Shale
12	125	0	250	0	0	0	1	New Fill

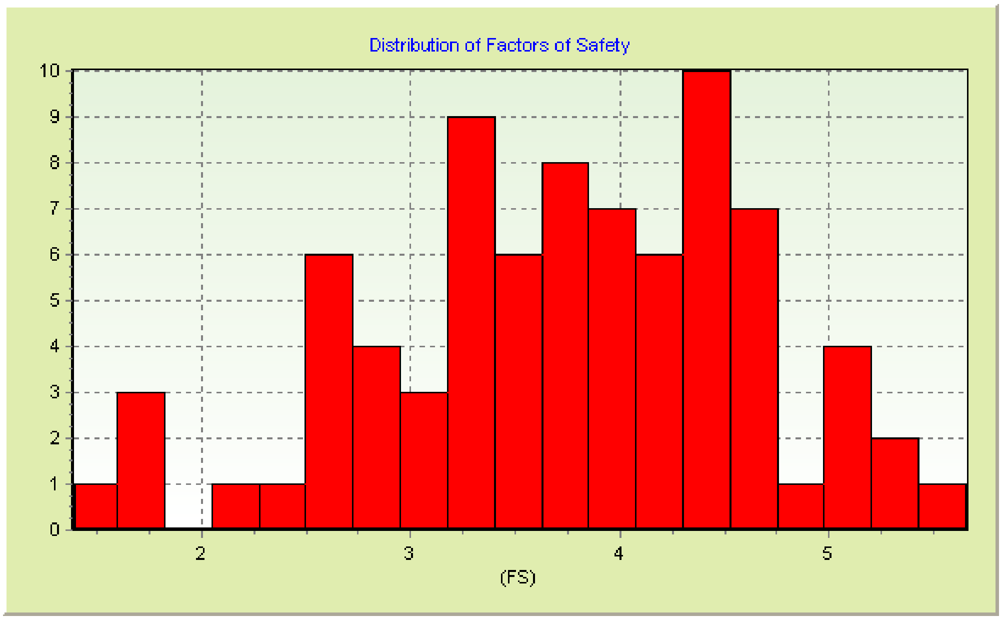
=============== All Surfaces Generated =============



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



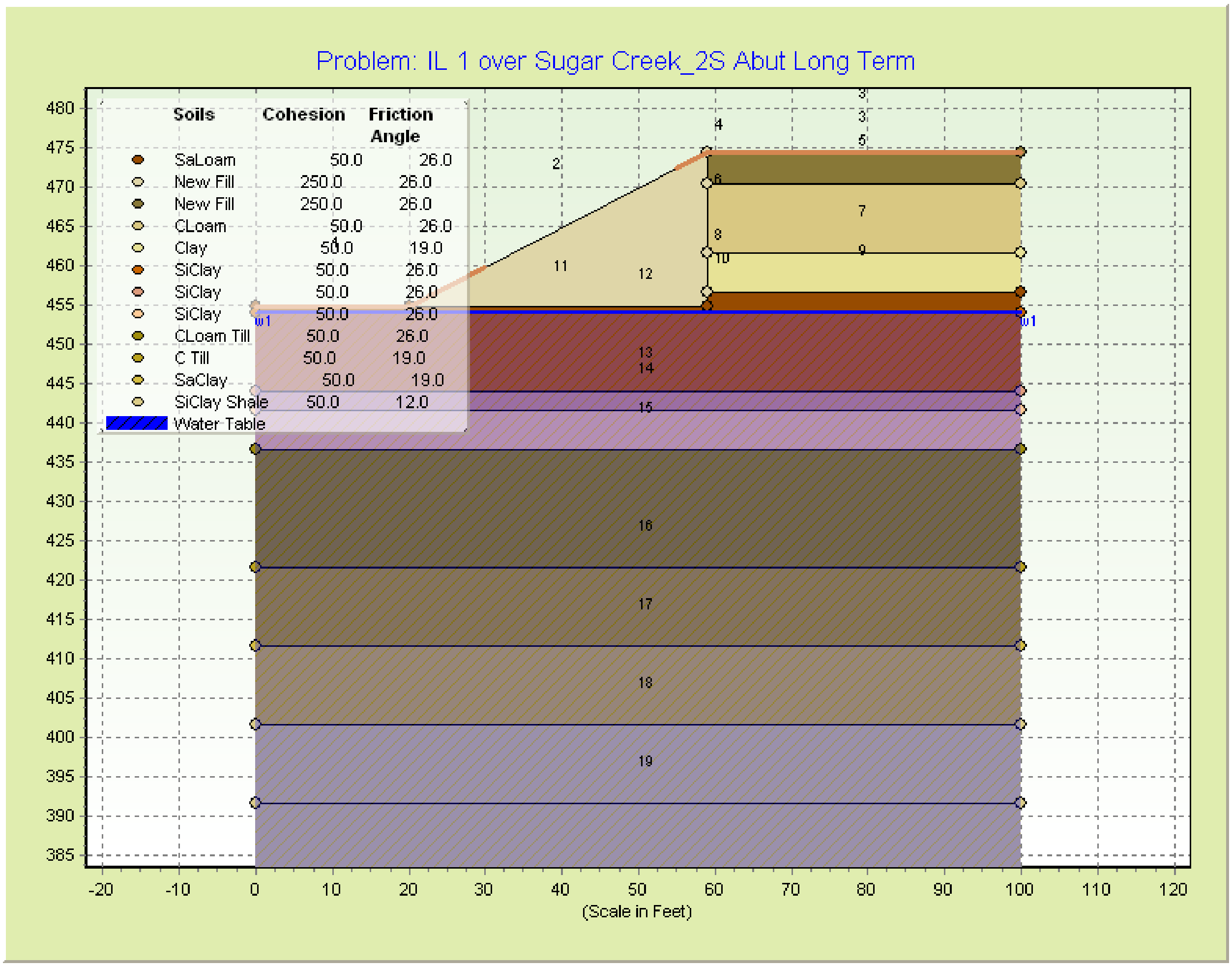
============= Factor of Safety Histogram ============



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

Surface Number	Factor of Safety
1	1.524
2	1.64
3	1.754
4	1.788
5	2.06
6	2.436
7	2.511
8	2.591
9	2.598
10	2.652

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



Profile Data

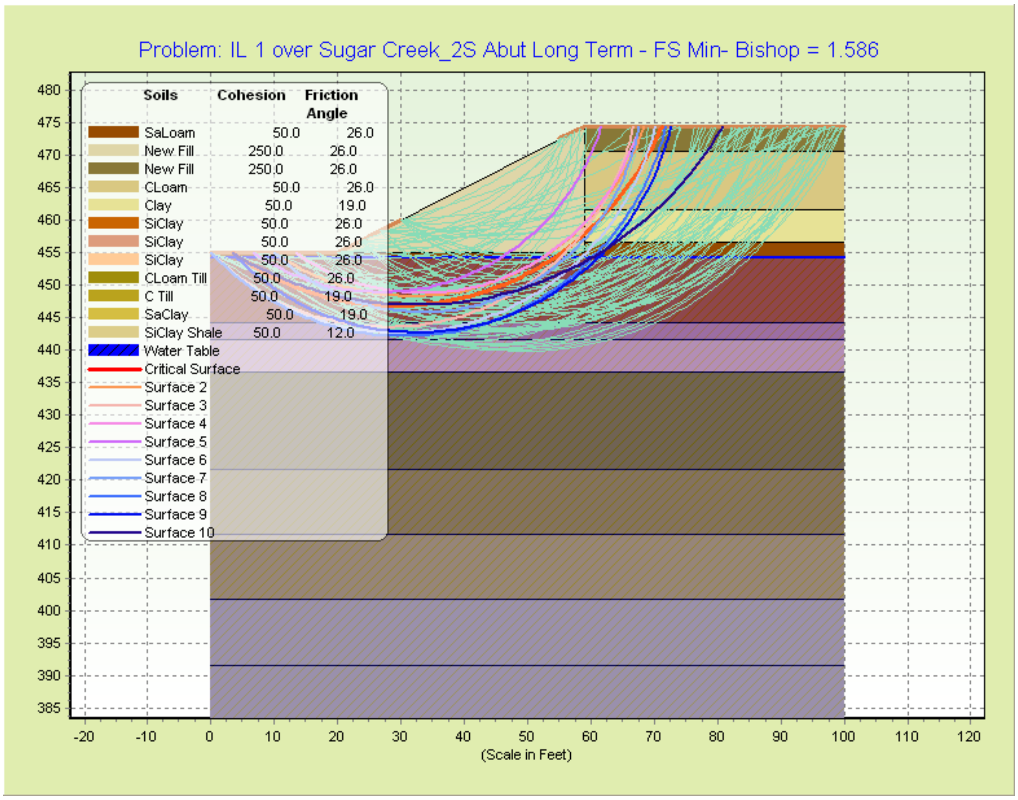
Segment Number	Left Extreme X	Left Extreme Y	Right Extreme X	Right Extreme Y	Soil Under Segment
1	0	454.95	20	454.95	4
2	20	454.95	58.94	474.42	12
3	58.94	474.42	100	474.42	1
4	58.94	474.42	58.94	470.44	12
5	58.94	470.44	100	470.44	2
6	58.94	470.44	58.94	461.64	12
7	58.94	461.64	100	461.64	3
8	58.94	461.64	58.94	456.64	12
9	58.94	456.64	100	456.64	4
10	58.94	456.64	58.94	454.95	12

Segment Number	Left Extreme X	Left Extreme Y	Right Extreme X	Right Extreme Y	Soil Under Segment
11	20	454.95	58.94	454.95	4
12	0	454.14	100	454.14	5
13	0	444.14	100	444.14	6
14	0	441.64	100	441.64	7
15	0	436.64	100	436.64	8
16	0	421.64	100	421.64	9
17	0	411.64	100	411.64	10
18	0	401.64	100	401.64	11
19	0	391.64	100	391.64	11

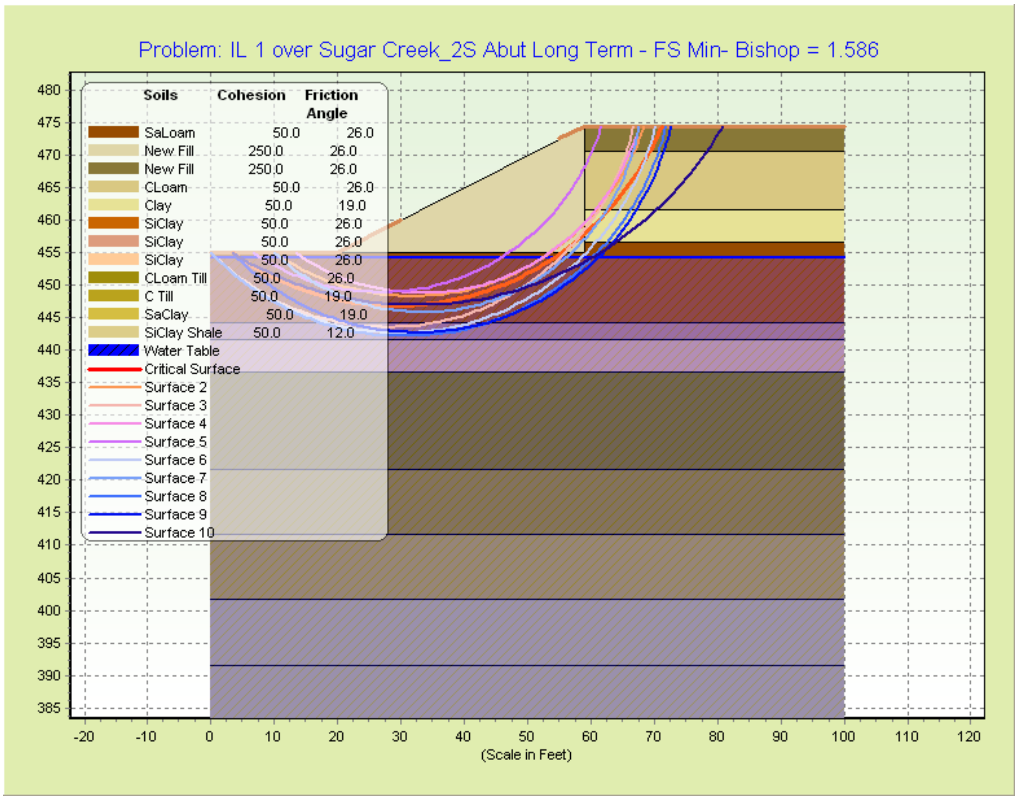
Soil Properties

Soil Number	Wet Unit Weight	Saturated Unit Weight	Cohesive Intercept	Friction Angle	Ru	Pressure Head	Water Table	Soil Name
1	125	0	250	26	0	0	1	New Fill
2	105	0	50	26	0	0	1	CLoam
3	90	0	50	19	0	0	1	Clay
4	110	0	50	26	0	0	1	SaLoam
5	50	110	50	26	0	0	0	SiClay
6	0	105	50	26	0	0	0	SiClay
7	0	110	50	26	0	0	0	SiClay
8	0	110	50	26	0	0	0	CLoam Till
9	0	120	50	19	0	0	0	C Till
10	0	120	50	19	0	0	0	SaClay
11	0	125	50	12	0	0	0	SiClay Shale
12	125	0	250	26	0	0	1	New Fill

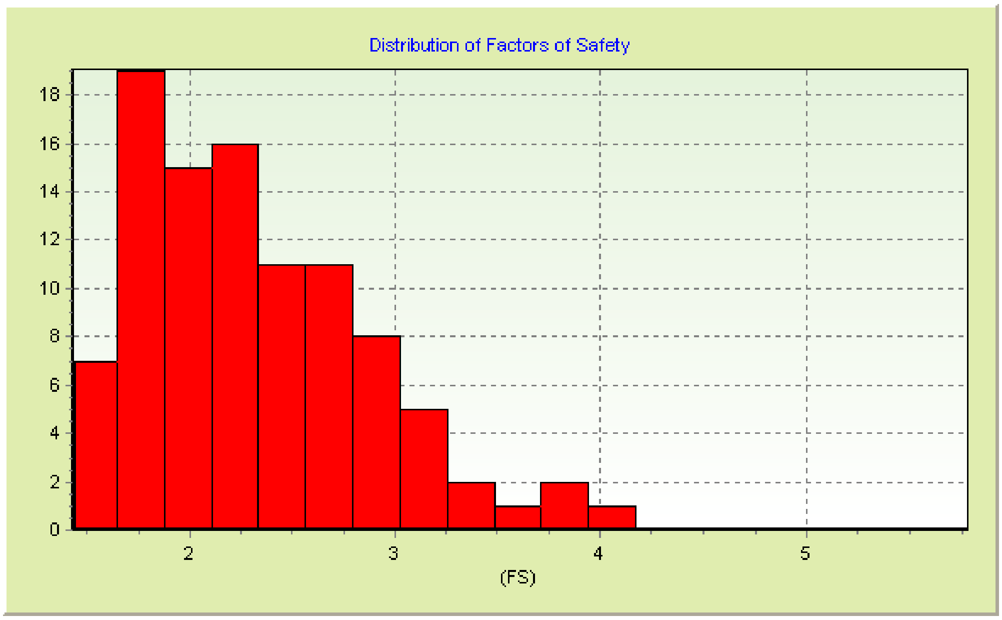
=============== All Surfaces Generated =============



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



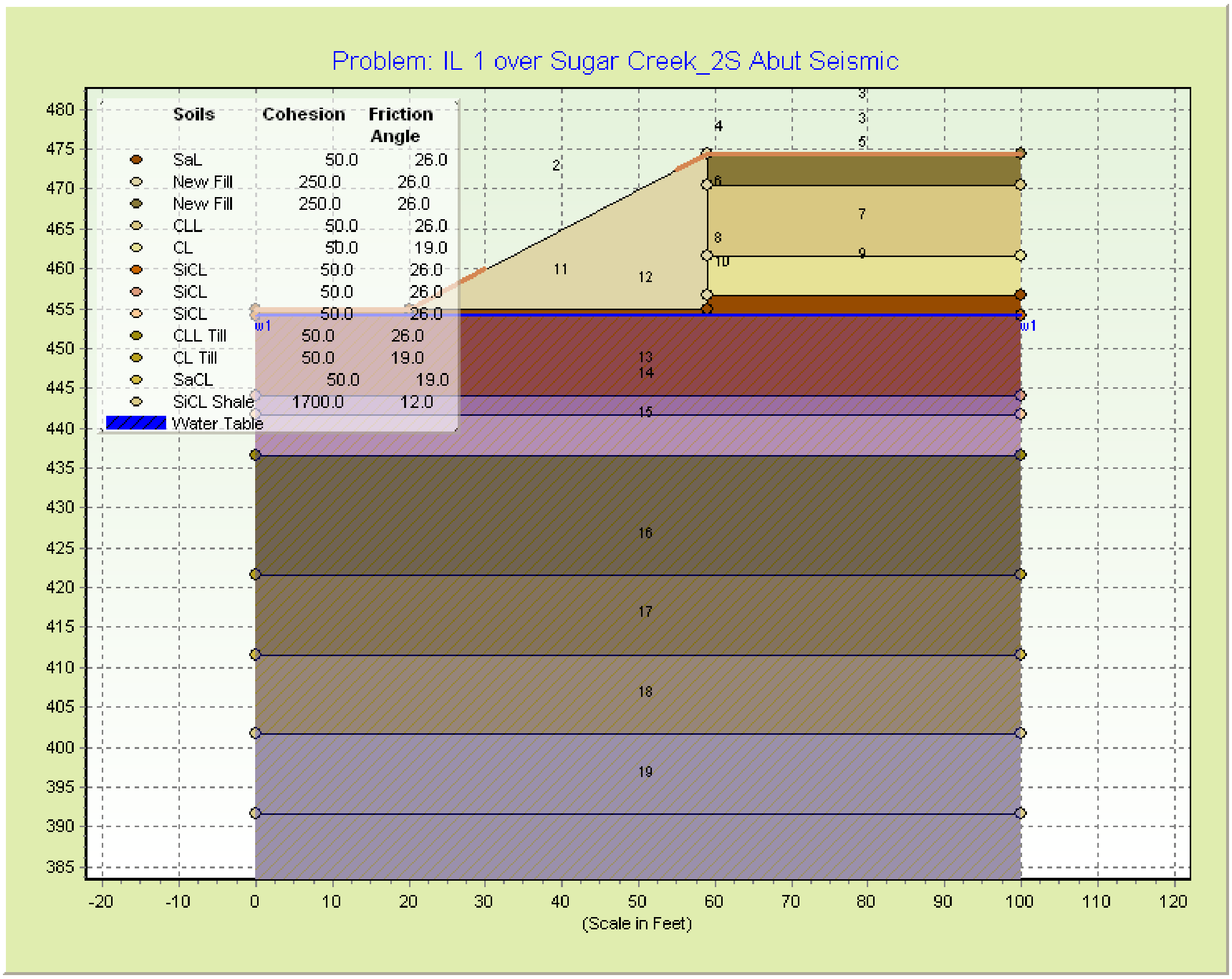
============= Factor of Safety Histogram ============



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

Surface Number	Factor of Safety
1	1.586
2	1.602
3	1.63
4	1.634
5	1.634
6	1.639
7	1.641
8	1.667
9	1.7
10	1.717

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



Profile Data

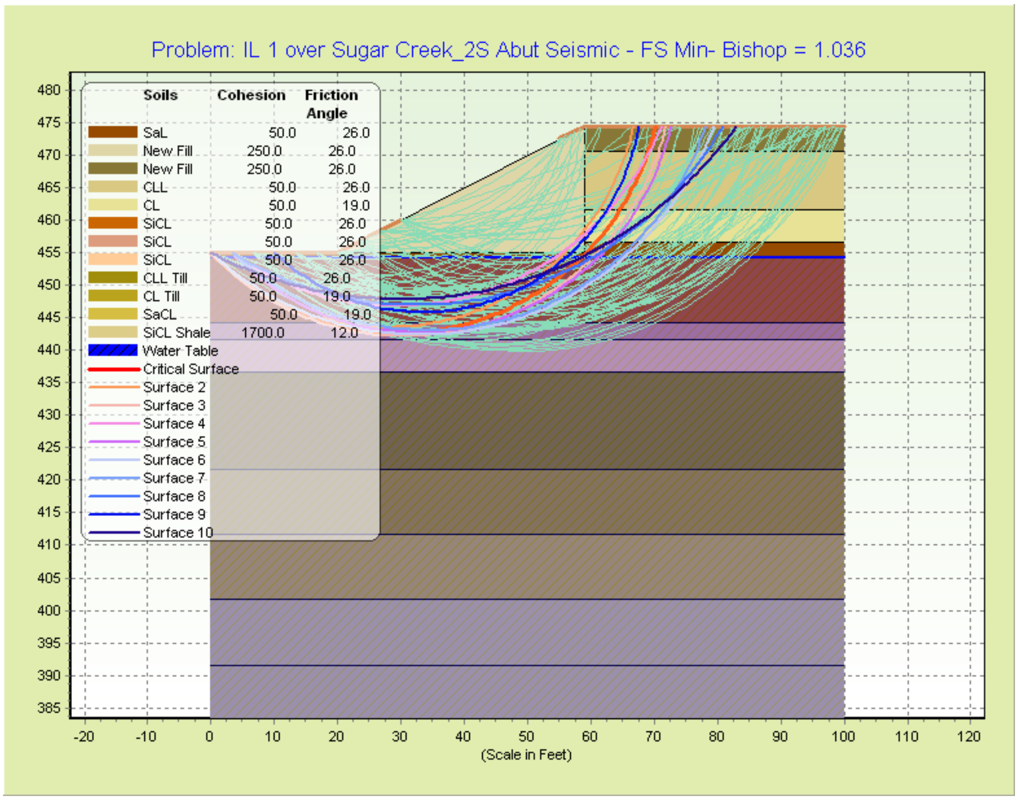
Segment Number	Left Extreme X	Left Extreme Y	Right Extreme X	Right Extreme Y	Soil Under Segment
1	0	454.95	20	454.95	4
2	20	454.95	58.94	474.42	12
3	58.94	474.42	100	474.42	1
4	58.94	474.42	58.94	470.44	12
5	58.94	470.44	100	470.44	2
6	58.94	470.44	58.94	461.64	12
7	58.94	461.64	100	461.64	3
8	58.94	461.64	58.94	456.64	12
9	58.94	456.64	100	456.64	4
10	58.94	456.64	58.94	454.95	12

Segment Number	Left Extreme X	Left Extreme Y	Right Extreme X	Right Extreme Y	Soil Under Segment
11	20	454.95	58.94	454.95	4
12	0	454.14	100	454.14	5
13	0	444.14	100	444.14	6
14	0	441.64	100	441.64	7
15	0	436.64	100	436.64	8
16	0	421.64	100	421.64	9
17	0	411.64	100	411.64	10
18	0	401.64	100	401.64	11
19	0	391.64	100	391.64	11

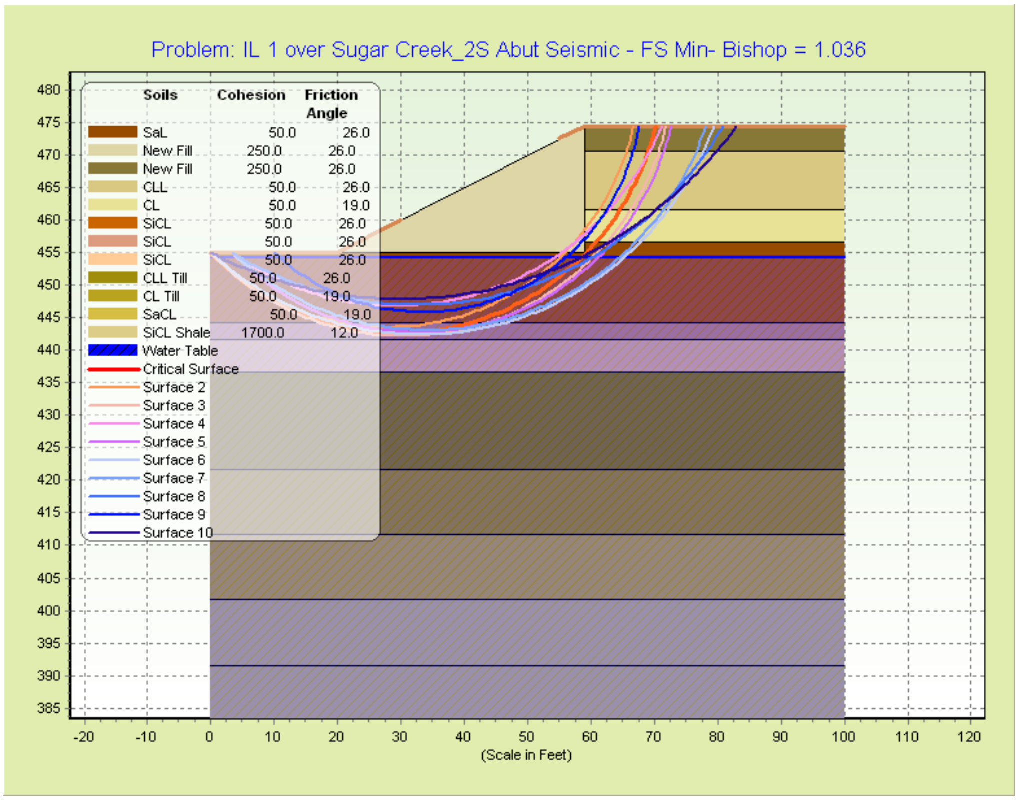
Soil Properties

Soil Number	Wet Unit Weight	Saturated Unit Weight	Cohesive Intercept	Friction Angle	Ru	Pressure Head	Water Table	Soil Name
1	125	0	250	26	0	0	1	New Fill
2	105	0	50	26	0	0	1	CLL
3	90	0	50	19	0	0	1	CL
4	110	0	50	26	0	0	1	SaL
5	0	110	50	26	0	0	0	SiCL
6	0	105	50	26	0	0	0	SiCL
7	0	110	50	26	0	0	0	SiCL
8	0	110	50	26	0	0	0	CLL Till
9	0	120	50	19	0	0	0	CL Till
10	0	120	50	19	0	0	0	SaCL
11	0	125	1700	12	0	0	0	SiCL Shale
12	125	0	250	26	0	0	1	New Fill

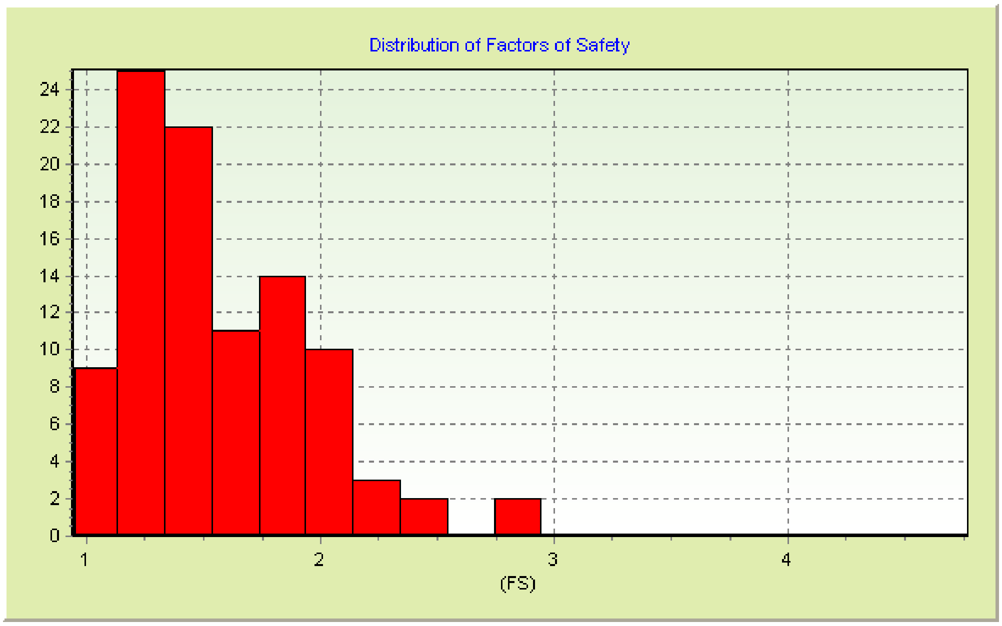
=============== All Surfaces Generated =============



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



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



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

Surface Number	Factor of Safety
1	1.036
2	1.04
3	1.054
4	1.074
5	1.095
6	1.109
7	1.134
8	1.134
9	1.134
10	1.137

EXHIBIT G

PILE DESING TABLES

Pile Design Table for North abut. utilizing Boring #1

	Nominal Required Bearing (Kips)	Factored Resistance Available (Kips)	Estimated Pile Length (Ft.)
Metal Shell 12"Φ w/.179" walls			
	190	104	47
	215	118	50
	223	123	55
	224	123	57
	226	124	60
	227	125	62
	245	135	65
Metal Shell 12"Φ w/.25" walls			
	190	104	47
	215	118	50
	223	123	55
	224	123	57
	226	124	60
	227	125	62
	245	135	65
	267	147	67
	288	158	70
	309	170	72
Metal Shell 14"Φ w/.25" walls			
	229	126	47
	259	142	50
	262	144	55
	263	145	57
	265	146	60
	267	147	62
	291	160	65
	316	174	67
	341	187	70
	365	201	72
Metal Shell 14"Φ w/.312" walls			
	229	126	47
	259	142	50
	262	144	55
	263	145	57
	265	146	60
	267	147	62
	291	160	65
	316	174	67
	341	187	70
	365	201	72
Steel HP 8 X 36			
	200	110	55
	201	110	57
	201	111	60
	202	111	62
	215	118	65
	238	131	67
	261	143	70
	284	156	72
Steel HP 10 X 42			
	236	130	50
	246	135	55
	246	135	57
	247	136	60
	247	136	62
	267	147	65
	295	162	67
	323	178	70

	Nominal Required Bearing (Kips)	Factored Resistance Available (Kips)	Estimated Pile Length (Ft.)
Steel HP 10 X 57			
	242	133	50
	251	138	55
	251	138	57
	252	138	60
	252	139	62
	273	150	65
	301	166	67
	330	182	70
	359	198	72
Steel HP 12 X 53			
	241	132	40
	248	136	42
	251	138	47
	293	161	50
	296	163	55
	297	163	57
	298	164	60
	298	164	62
	326	179	65
	360	198	67
	394	217	70
Steel HP 12 X 63			
	243	134	40
	251	138	42
	254	140	47
	295	162	50
	299	164	55
	299	165	57
	300	165	60
	301	165	62
	329	181	65
	364	200	67
	398	219	70
	432	238	72
Steel HP 12 X 74			
	247	136	40
	254	140	42
	258	142	47
	300	165	50
	302	166	55
	303	167	57
	304	167	60
	305	168	62
	334	184	65
	368	203	67
	403	222	70
	438	241	72
Steel HP 12 X 84			
	250	138	40
	258	142	42
	261	144	47
	304	167	50
	306	168	55
	307	169	57
	308	169	60
	308	170	62
	338	186	65
	373	205	67
	409	225	70
	444	244	72

	Nominal Required Bearing (Kips)	Factored Resistance Available (Kips)	Estimated Pile Length (Ft.)
Steel HP 14 X 73			
	212	117	27
	218	120	35
	220	121	37
	297	163	40
	306	168	42
	308	170	47
	352	194	55
	353	194	57
	354	194	60
	354	195	62
	394	216	65
	434	239	67
	474	261	70
	514	283	72
Steel HP 14 X 89			
	215	118	27
	221	121	35
	223	122	37
	301	165	40
	310	170	42
	312	172	47
	356	196	55
	357	196	57
	357	197	60
	358	197	62
	398	219	65
	439	241	67
	480	264	70
	520	286	72
Steel HP 14 X 102			
	217	119	27
	223	123	35
	225	124	37
	305	168	40
	314	173	42
	317	174	47
	360	198	55
	360	198	57
	361	199	60
	362	199	62
	403	222	65
	444	244	67
	485	267	70
	526	290	72
Steel HP 14 X 117			
	220	121	27
	225	124	35
	227	125	37
	309	170	40
	318	175	42
	321	176	47
	363	200	55
	364	200	57
	365	201	60
	366	201	62
	408	224	65
	449	247	67
	491	270	70
	532	293	72

Pile Design Table for South abut. utilizing Boring #2

	Nominal Required Bearing (Kips)	Factored Resistance Available (Kips)	Estimated Pile Length (Ft.)
Metal Shell 12"Φ w/.179" walls			
	191	105	32
	217	119	35
	242	133	37
Metal Shell 12"Φ w/.25" walls			
	191	105	32
	217	119	35
	242	133	37
	267	147	40
	272	150	42
	280	154	47
	290	160	50
	300	165	52
	310	171	55
	324	178	57
	337	186	60
	350	193	62
Metal Shell 14"Φ w/.25" walls			
	230	126	32
	260	143	35
	288	159	37
	318	175	40
	320	176	42
	328	181	47
	340	187	50
	352	194	52
	364	200	55
	381	210	57
	396	218	60
	411	226	62
Metal Shell 14"Φ w/.312" walls			
	230	126	32
	260	143	35
	288	159	37
	318	175	40
	320	176	42
	328	181	47
	340	187	50
	352	194	52
	364	200	55
	381	210	57
	396	218	60
	411	226	62
	426	234	65
Steel HP 8 X 36			
	237	131	40
	254	140	42
	267	147	47
	278	153	50
Steel HP 10 X 42			
	228	125	35
	262	144	37
	296	163	40
	314	173	42
	328	180	47

	Nominal Required Bearing (Kips)	Factored Resistance Available (Kips)	Estimated Pile Length (Ft.)
Steel HP 10 X 57			
	198	109	32
	233	128	35
	267	147	37
	303	166	40
	320	176	42
	335	184	47
	348	192	50
	362	199	52
	376	207	55
	393	216	57
	411	226	60
	429	236	62
	446	245	65
Steel HP 12 X 53			
	240	132	32
	281	155	35
	322	177	37
	363	200	40
	380	209	42
	396	218	47
	412	227	50
Steel HP 12 X 63			
	242	133	32
	284	156	35
	325	179	37
	366	202	40
	384	211	42
	400	220	47
	416	229	50
	432	238	52
	449	247	55
	470	258	57
	491	270	60
Steel HP 12 X 74			
	246	135	32
	288	158	35
	329	181	37
	372	204	40
	389	214	42
	405	223	47
	421	232	50
	438	241	52
	455	250	55
	476	262	57
	497	273	60
	518	285	62
	540	297	65
Steel HP 12 X 84			
	250	137	32
	292	161	35
	334	184	37
	377	207	40
	394	217	42
	410	225	47
	427	235	50
	444	244	52
	460	253	55
	482	265	57
	504	277	60
	525	289	62
	547	301	65

	Nominal Required Bearing (Kips)	Factored Resistance Available (Kips)	Estimated Pile Length (Ft.)
Steel HP 14 X 73			
	294	162	32
	343	189	35
	390	215	37
	439	242	40
	455	250	42
	472	259	47
	491	270	50
	510	281	52
	530	291	55
	555	305	57
Steel HP 14 X 89			
	298	164	32
	347	191	35
	395	217	37
	445	245	40
	460	253	42
	477	262	47
	496	273	50
	516	284	52
	535	295	55
	562	309	57
	586	323	60
	611	336	62
	636	350	65
Steel HP 14 X 102			
	215	118	25
	301	166	32
	351	193	35
	400	220	37
	450	248	40
	465	256	42
	482	265	47
	502	276	50
	522	287	52
	541	298	55
	568	312	57
	593	326	60
	618	340	62
	643	354	65
Steel HP 14 X 117			
	218	120	25
	305	168	32
	356	196	35
	405	223	37
	455	250	40
	470	259	42
	487	268	47
	507	279	50
	527	290	52
	547	301	55
	574	316	57
	599	330	60
	625	344	62
	650	358	65
	867	477	67
	897	493	70
	924	508	72