STRUCTURE GEOTECHNICAL REPORT

Proposed SN 091-0077 (NB)
Proposed SN 091-0078 (SB)

Existing SNs 091-0005 & 091-0006

I-57 over Big Creek
FAI Route 57
Section (91-3)B-2
Union County

PTB 178 - Item 19
Contract No. 78504
Job No. D-99-003-16

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Project Description and Scope

This project involves the complete replacement of dual bridges carrying I-57 over Big Creek in Union County. The project site is located in Section 7, Range 1E, Township 13S, in the 3rd Principal Meridian about 2 miles north of Dongola. A *Location Map* is presented in Exhibit A.

There are existing dual bridges at this location, SN 091-0005 and SN 091-0006, which were constructed in 1958. They are three span structures with concrete T-beam superstructures supported on wall piers and open abutments. The piers are supported on spread footings while the abutments are supported on steel piles. The existing plans call for 40 ton capacity of the steel piles with estimated lengths of 25 feet at the north abutment and 30 feet at the south abutment. See *Existing Structure Pile Data* in Exhibit E for as-built information. Concrete slope walls are present from top to toe of slopes of both bridges. The NB bridge measures 195'-0" back to back abutments and 36'-10" out to out, with a 45° left ahead skew. The SB bridge measures 167'-3" back to back abutments and 36'-10" out to out, with a 43°-53' left ahead skew.

Per the preliminary Type, Size & Location Plan (TSL), the proposed dual structures are 3 span bridges with W33 rolled beams supported on integral abutments and multi-column drilled shaft piers. The proposed NB structure will have a back-to-back abutment length of 207'-3", while the proposed SB structure will measure 179'-4". Both bridges will have out-to-out widths of 44'-10" and a 45° left ahead skew. The roadway will be on a horizontal tangent alignment and on a sag vertical curve. The proposed abutments will be constructed on existing embankments behind existing abutments. The proposed profiles will roughly match the existing profiles for both structures. Traffic will be maintained utilizing cross overs during construction. The new structures are to be designed following LRFD Bridge Design Specifications.

See *Preliminary TSL* attached in Exhibit B for further information about the proposed structures.

Field Exploration

Subsurface Exploration and Testing

The site is located in a rural area north of Dongola with woods located immediately to the east and to the west of the bridges. The structures cross over Big Creek, which has a channel width of approximately 22 feet. A grassy median separates the two structures. There are no known utilities near the bridges.

The subsurface investigation consisted of six borings (1-S, 2-S, 3-S, 4-S, 5-S and 6-S) drilled by IDOT District 9 personnel in November/December of 2008 and April of 2009. Two additional rock cores (1-S and 2-S) were drilled by IDOT District 9 personnel in August 2018. 1-S was drilled along the east edge of SN 091-0005 just north of the bridge; 2-S was drilled in the east shoulder of the south approach of SN 091-0005; 3-S was drilled along the east edge of SN 091-0005 in the center span; 4-S was drilled in the west lane of the north approach of SN-091-0006; 5-S was drilled along the west edge of SN 091-0006 in the center span; 6-S was drilled along the west edge of SN 091-0006 just south of the bridge. Rock core 1-S was taken east of the SN 091-0077 north abutment, while rock core 2-S was taken east of the SN 091-0078 south abutment. Boring locations can be found in Exhibit B.

For the 2008/2009 borings, standard penetration tests (SPT) were conducted every 2.5 feet below the ground surface according to AASHTO T 206, using a Hollow Stem Auger. All borings were drilled until auger refusal, where rock cores into the limestone layers were then retrieved. The 2018 rock cores did not sample any soils between the ground surface and limestone, but retrieved samples from the limestone in order to determine unconfined compressive strengths.

Subsurface Conditions

While drilling the 2008/2009 borings, groundwater was encountered at elevations between 377.7 and 380.3 for the borings within the existing bridge embankments, while groundwater was encountered at elevations between 382.7 and 386.3 for the borings taken within the channel. While drilling the 2018 rock cores, groundwater was encountered at an elevation between 369.5 and 370.3. Rock was encountered between elevations 369.7 and 373.3.

The four borings taken within the existing embankments (1-S, 2-S, 4-S and 6-S) all encountered similar soil layers, starting with 19'-24' thick layers of medium to very stiff silty clay or silt loam near the ground surface, followed by 4'-10' thick layers of very soft to medium silt loam to silty clay loam. 3'-7' thick layers of loose to medium dense sand and broken gravel were then present above the limestone.

The two borings taken within the channel (3-S and 5-S) showed approximately 12 feet of very loose to medium dense sand and broken gravel present just above the limestone.

At Rock Core 1-S, limestone was encountered at elevation 372.5 and the rock cores displayed RQD values between 78% and 87% with sample recovery of 100%. At Rock Core 2-S, limestone was encountered at elevation 372.3 and the rock cores displayed RQD values between 88% and 97% with sample recovery of 100%.

Further descriptions of the soil conditions encountered in the borings are presented in the *Soil Borings* attached in Exhibit D and the *Subsurface Data Profile* in Exhibit C.

Geotechnical Evaluations

Settlement

Per the preliminary TSL, it is estimated the proposed profiles will approximately match existing. The proposed abutments will be located behind the existing abutments on existing embankments, resulting in calculated settlement of less than 0.4 inches. Since the settlement is negligible, downdrag forces are not significant and no pre-coring will be required.

Slope Stability

Preliminary stability analyses using Bishop's method were performed for both abutments on SN 091-0077 and SN 091-0078. According to AASHTO LRFD 11.6.2.3, the required resistance factor for slope stability is 0.65 which is equivalent to factor of safety of 1.54. For SN 091-0077, the north abutment used 27'-9" high 2H:1V (at right angles) end slope model with rendered factor of safety of 1.87. The south abutment used 28'-6" high 2H:1V (at right angles) end slope model which rendered factor of safety of 1.76. The Seismic slope stability was also analyzed and yielded factors of safety of 0.68 and 0.73

at north and south abutments respectively. For SN 091-0078, the north abutment is 22'-11" high 2H:1V (at right angles) end slope model with rendered factor of safety 1.85. The south abutment used 24'-0" high 2H:1V (at right angles) end slope model which rendered factor of safety of 1.78. The Seismic slope stability was also analyzed and yielded factors of safety of 0.65 and 0.79 at north and south abutments respectively. The horizontal coefficient was calculated according to FHWA-NHI-11-032. The horizontal coefficient for the NB abutments is 0.31g while the coefficient for the SB abutments is 0.32g. As per AASHTO LRFD 11.6.5.3, minimum required factor of safety under the effect of seismic loads is 1. Per IDOT Geotechnical Manual Section 6.12.4.1, if the seismic slope stability factor of safety falls below 1.0, the vertical deformation at the back of slope shall be estimated using the Newmark procedure. IDOT considers a settlement of 6 inches or less at the bridge approach resulting from the design earthquake to be acceptable without corrective measures. Preliminary calculations per FHWA-NHI-11-032, section 6.2.3 yield an estimated displacement near or over 6 inches at both north abutments. Remediation with drilled shafts is recommended at Pier 1 of both structures, given likely nominal variations in the soils relative to the borings. Preliminary analyses for improvement of slope stability during a seismic event incorporated the existing pier foundations to be left in place, removed to 1 ft below grade per the Standard Specifications; in combination with drilled shafts utilized for the proposed pier foundations. It is anticipated that a minimum of two additional drilled shafts will be required adjacent to each end of Pier 1 of each structure, in an attempt to maintain the integrity of the slope in front of the abutments. The Seismic slope stability was re-analyzed accounting for the benefits realized from the existing pier foundations to be left in place and the proposed drilled shafts, and yielded factors of safety of 1.02 and 1.05 at the north and south abutments respectively of SN 091-0077, and 1.13 and 1.21 at the north and south abutments respectively of SN 091-0078. The foundations were modelled as a column of soil with a cohesive strength of 11,000 psf. Assigning soil properties to represent a combination of the foundations and soils within the slope effectively allowed for the failure surface within the slope to flow through the location of the proposed shafts, rather than being completely stopped and/or diverted by them. Per AGMU 12.0, a Geotechnical Design Memorandum will be required for the drilled shafts during the design phase. Slope stability analyses are presented in Exhibit H.

Scour

With integral abutments protected by riprap, the design scour elevation is set at the bottom of abutment cap per IDOT Bridge Manual 2.3.6.3.2. See Table 1 for Scour Elevation Table.

Event/Limit State	Design Scour Elevations (ft)								
	SN 091-0077				SN 091-0078				
	N. Abut.	Pier 1	Pier 2	S. Abut.	N. Abut.	Pier 1	Pier 2	S. Abut.	Item 113
Q100	402.3	369.7	369.7	403.0	397.2	370.3	370.3	398.2	5
Q200	402.3	369.7	369.7	403.0	397.2	370.3	370.3	398.2	
Design	402.3	369.7	369.7	403.0	397.2	370.3	370.3	398.2	
Check	402.3	369.7	369.7	403.0	397.2	370.3	370.3	398.2	

Table 1

Seismic Considerations

Based on the method described in the IDOT Design Guide LRFD Soil Site Class Definition, Soil Site Class C controls. The Design Spectral Acceleration at 1.0 sec (S_{D1}) is 0.460g and at 0.2 sec (S_{Ds}) is 1.213g. These values are based on a 1000 year design return period earthquake. According to AASHTO LRFD 3.10.6 the Seismic Performance Zone is 3 based on the 1.0 second Design Spectral Acceleration.

Liquefaction analysis was performed using the IDOT Liquefaction Analysis spreadsheet for each boring at the proposed bridge locations. All boring locations were found to contain potentially liquefiable layers just above the limestone. Effects of liquefaction should be accounted for at all substructure locations. Liquefaction calculations are presented in Exhibit F.

Mining Activity

A review of the Illinois State Geological Survey (ISGS) "Directory of Coal Mines in Illinois" for Union County indicates that no mining activity has been present at the project location. The nearest underground coal mine is located 8.3 miles southwest of the bridge location.

Foundation Recommendations

Following is the summary of preliminary factored vertical loads for the AASHTO LRFD Strength I load combination provided by ESCA Consultants, Inc., for both bridges. The Extreme Event I load combination was estimated to be 75% of Strength I.

Strength I Load Combination

NB Abutments	820 kips	SB Abutments	770 kips
NB Piers	2120 kips	SB Piers	1900 kips

Abutments

Due to IDOT's strong desire for a jointless structure, integral abutments will be provided for both of these bridges. Per IDOT ABD Memoranda 12.3, all pile types above HP8 are permissible for an effective expansion length of 117.86' determined for northbound SN 091-0077, or for an effective expansion length of 90.44' determined for southbound SN 091-0078. Unless the abutment type is changed, spread footings and drilled shafts are not allowed for integral abutments as per the IDOT Bridge Manual.

Driven pile foundation design includes seismic design, which accounts for the effects of liquefiable soil layers at each abutment. Analyses have been performed using the Modified IDOT Static Method for estimating nominal pile resistance. Pile size calculations are presented in Exhibit G and summarized in Tables 2 thru 9. Tables include strength limit state and extreme event including liquefaction. The estimated lengths include a 2 foot embedment into the abutment cap and are based on top of pile elevations of 404.31 at the north abutment and 405.04 at the south abutment for SN 091-0077, and 399.27 at the north abutment and 400.23 at the south abutment for SN 091-0078. R_n values in tables represent the maximum nominal required bearing. Results from the seismic case show the piles need to be driven to rock to achieve required capacity. For this reason, the following tables only include pile data for H-piles

driven to rock with a minimum 2 ft penetration into the limestone for determining pile length and tip elevations. Per IDOT Bridge Manual 3.10.1.6, the suggested upper limit for pile length is 75 ft for HP 10's and 100 ft for HP 12's. Metal shell piles are not feasible, as they do not provide sufficient resistance during a seismic event.

Location	Pile Size	R_n Nominal Required Bearing (kips)	R_F Factored Resistance Available (kips)	Estimated Pile Length (ft)	Pile Tip Elev.	Estimated Embedment into rock (ft)
North Abutment SN 091-0077 Strength Limit State	HP 10x42	335	184	35	369.3	2.6
	HP 12x53	419	230	35	369.3	2.6
	HP 12x63	497	273	36	368.3	3.6
	HP 14x73	578	318	36	368.3	3.6
	HP 14x89	705	388	36	368.3	3.6
	HP 14x102	810	445	37	367.3	4.6
	HP 14x117	929	511	37	367.3	4.6

Table 2

Location	Pile Size	R_n Nominal Required Bearing (kips)	R_F Factored Resistance Available (kips)	Estimated Pile Length (ft)	Pile Tip Elev.	Estimated Embedment into rock (ft)
North Abutment SN 091-0077 Extreme Event (Liquefaction)	HP 10x42	335	273	35	369.3	2.6
	HP 12x53	419	344	35	369.3	2.6
	HP 12x63	497	422	36	368.3	3.6
	HP 14x73	578	489	36	368.3	3.6
	HP 14x89	705	616	36	368.3	3.6
	HP 14x102	810	720	37	367.3	4.6
	HP 14x117	929	838	37	367.3	4.6

Table 3

Location	Pile Size	R_n Nominal Required Bearing (kips)	R_F Factored Resistance Available (kips)	Estimated Pile Length (ft)	Pile Tip Elev.	Estimated Embedment into rock (ft)
South Abutment SN 091-0077 Strength Limit State	HP 10x42	335	184	35	370.0	2.7
	HP 12x53	419	230	35	370.0	2.7
	HP 12x63	497	273	35	370.0	2.7
	HP 14x73	578	318	35	370.0	2.7
	HP 14x89	705	388	36	369.0	3.7
	HP 14x102	810	445	37	368.0	4.7
	HP 14x117	929	511	37	368.0	4.7

Table 4

Location	Pile Size	R_n Nominal Required Bearing (kips)	R_F Factored Resistance Available (kips)	Estimated Pile Length (ft)	Pile Tip Elev.	Estimated Embedment into rock (ft)
South Abutment SN 091-0077 Extreme Event (Liquefaction)	HP 10x42	335	209	35	370.0	2.7
	HP 12x53	419	267	35	370.0	2.7
	HP 12x63	497	344	35	370.0	2.7
	HP 14x73	578	398	35	370.0	2.7
	HP 14x89	705	524	36	369.0	3.7
	HP 14x102	810	627	37	368.0	4.7
	HP 14x117	929	744	37	368.0	4.7

Table 5

Location	Pile Size	R_n Nominal Required Bearing (kips)	R_F Factored Resistance Available (kips)	Estimated Pile Length (ft)	Pile Tip Elev.	Estimated Embedment into rock (ft)
North Abutment SN 091-0078 Strength Limit State	HP 10x42	335	184	29	370.3	3.0
	HP 12x53	419	230	29	370.3	3.0
	HP 12x63	497	273	29	370.3	3.0
	HP 14x73	578	318	29	370.3	3.0
	HP 14x89	705	388	30	369.3	4.0
	HP 14x102	810	445	31	368.3	5.0
	HP 14x117	929	511	31	368.3	5.0

Table 6

Location	Pile Size	R_n Nominal Required Bearing (kips)	R_F Factored Resistance Available (kips)	Estimated Pile Length (ft)	Pile Tip Elev.	Estimated Embedment into rock (ft)
North Abutment SN 091-0078 Extreme Event (Liquefaction)	HP 10x42	335	263	29	370.3	3.0
	HP 12x53	419	332	29	370.3	3.0
	HP 12x63	497	410	29	370.3	3.0
	HP 14x73	578	476	29	370.3	3.0
	HP 14x89	705	602	30	369.3	4.0
	HP 14x102	810	706	31	368.3	5.0
	HP 14x117	929	824	31	368.3	5.0

Table 7

Location	Pile Size	R_n Nominal Required Bearing (kips)	R_F Factored Resistance Available (kips)	Estimated Pile Length (ft)	Pile Tip Elev.	Estimated Embedment into rock (ft)
South Abutment SN 091-0078 Strength Limit State	HP 10x42	335	184	30	370.2	2.0
	HP 12x53	419	230	31	369.2	3.0
	HP 12x63	497	273	31	369.2	3.0
	HP 14x73	578	318	31	369.2	3.0
	HP 14x89	705	388	32	368.2	4.0
	HP 14x102	810	445	32	368.2	4.0
	HP 14x117	929	511	32	368.2	4.0

Table 8

Location	Pile Size	R_n Nominal Required Bearing (kips)	R_F Factored Resistance Available (kips)	Estimated Pile Length (ft)	Pile Tip Elev.	Estimated Embedment into rock (ft)
South Abutment SN 091-0078 Extreme Event (Liquefaction)	HP 10x42	335	243	30	370.2	2.0
	HP 12x53	419	308	31	369.2	3.0
	HP 12x63	497	386	31	369.2	3.0
	HP 14x73	578	448	31	369.2	3.0
	HP 14x89	705	573	32	368.2	4.0
	HP 14x102	810	677	32	368.2	4.0
	HP 14x117	929	795	32	368.2	4.0

Table 9

Piers

There are multiple options for the type of foundation at the piers: Spread footing bearing on rock, pile-supported foundation, or drilled shaft foundation.

Spread Footing on Rock: The pier footings would need to be founded on rock due to the low scour elevations. Estimated top of rock elevations are provided in Table 10. Soil excavation of approximately 20 feet would be required. The minimum available nominal bearing resistance available from limestone (without cavities) is 40 ksf according to AASHTO LRFD Table C10.6.2.6.1-1. However, 2008 Boring 1-S shows a 6" void within the first limestone core, while 2009 boring 5-S shows a 12" void within the first limestone core. The available nominal bearing resistance from limestone with cavities should be reduced to 20 ksf. A coefficient of friction of 0.70 can be used to determine resistance against sliding for mass concrete poured against clean sound rock per AASHTO LRFD Table C3.11.5.3-1. The following note would be required on the plans per section 3.10.3.2 of the Bridge Manual: *The bottom of footing elevation(s) shall be adjusted to ensure a minimum embedment of 6 inches in non-weathered rock. The rock excavation shall be made with near-vertical sides at the plan dimensions to allow the sides and base of the embedded portion of the footing to be cast against undisturbed rock surfaces.*

Pile Supported: With the shallow depth to estimated rock, the piles would not be able to develop sufficient fixity above the rock line. The piles could be drilled and set into the rock to develop fixity, but with the number of piles required this would not be economical.

Drilled Shafts: The drilled shafts will need to be socketed into the rock layers in order to develop required fixity and appropriate axial resistance. Per IDOT Bridge Manual 3.10.2.1, shafts extending into rock shall be designed utilizing either end bearing or side resistance in rock, whichever is larger, and neglect the overburden side resistance in soil. Preliminary analysis shows the limestone layers will provide a nominal unit side resistance (qs) of 32 ksf and a nominal unit tip resistance (qp) of 2000 ksf. Per AASHTO 10.8.3.5.4b, the side resistance is controlled by the compressive strength of the concrete shaft. A resistance factor of 0.50 shall be used for the tip and side resistances respectively when calculating the factored resistances for Strength. The geotechnical losses due to liquefaction are to be accounted for due to liquefiable layers defined in Exhibit F. The maximum center to center drilled shaft spacing at and adjacent to Pier 1 of both structures shall be limited to 2.0 times the shaft diameter, in order to ensure soil arching between adjacent shafts and minimize the flow of soil between the shafts during a seismic event. The maximum center to center drilled shaft spacing at Pier 2 of both structures may be increased beyond 2.0 times the shaft diameter, at the discretion of the structural engineer and as dictated by the structural design. Per AGMU 12.0, a Geotechnical Design Memorandum will be required for the drilled shafts during the design phase.

Estimated Top of Rock Elevations			
Pier 1 (NB)	Pier 2 (NB)	Pier 1 (SB)	Pier 2 (SB)
369.7	369.7	370.3	370.3

Table 10

Lateral Loading Analysis

Tables 11 thru 16 provide soil parameters for the LPile program (or other approved programs) for the structural engineer to perform the lateral analysis of the foundations. The effective unit weights provided are based on groundwater elevations defined in the soil borings.

Preliminary analysis has determined that adequate lateral resistance can be provided for the piles before they reach the rock strata. Per Bridge Manual 3.10.1.10, if the lateral load on a pile exceeds 3 kips then a detailed soil structure interaction analysis shall be performed.

Soil Type	Elev. At Bottom of Layer	Effective Unit Wt. (pci)	Friction Angle (deg)	k (pci)	c (psi)	E50
Very Stiff Silty Clay	402.4	0.079	-	1000	23	0.005
Stiff Silty Clay Loam	399.9	0.072	-	500	9	0.007
Medium Silt Loam	397.4	0.070	-	100	6	0.010
Soft Silty Clay Loam	392.4	0.064	-	30	3	0.020
Med. Silt Loam to Silty Clay Loam	389.9	0.067	-	100	4	0.010
Soft Silt Loam to Silty Clay Loam	387.4	0.063	-	30	2	0.020
Very Soft Silt Loam to Silty Clay Loam	382.4	0.058	-	30	1	0.020
Med. Silt Loam to Silty Clay Loam	379.9	0.067	-	100	4	0.010
Med. Dense Broken Gravel & Sand	377.4	0.037	33	60	-	-
Loose Broken Gravel & Sand	374.9	0.032	29	20	-	-
Medium Broken Gravel & Sand	371.9	0.036	32	60	-	-
Limestone	361.9	0.048	44	-	-	-

Table 11 – Northbound, North Abutment

Soil Type	Elev. At Bottom of Layer	Effective Unit Wt. (pci)	Friction Angle (deg)	k (pci)	c (psi)	E50
Very Loose Sand with Silt Layers	377.7	0.028	26	20	-	-
Loose Broken Gravel with Sand & Silt Layers	375.2	0.033	29	20	-	-
Med. Broken Gravel with Sand	372.7	0.036	32	60	-	-
Very Loose Broken Gravel with Sand	369.7	0.028	26	20	-	-
Limestone	359.7	0.048	44	-	-	-

Table 12 – Northbound, Piers

Soil Type	Elev. At Bottom of Layer	Effective Unit Wt. (pci)	Friction Angle (deg)	k (pci)	c (psi)	E50
Very Stiff Silty Clay	405.7	0.077	-	1000	17	0.005
Stiff Silty Clay	403.2	0.073	-	500	10	0.007
Very Stiff Silty Clay	400.7	0.079	-	1000	24	0.005
Stiff Silty Clay Loam	395.7	0.073	-	500	10	0.007
Stiff Silt Loam	393.2	0.071	-	500	8	0.007
Medium Silt Loam	385.7	0.068	-	100	5	0.010
Soft Silt Loam to Silty Clay Loam	380.7	0.065	-	30	3	0.020
Soft Silty Clay Loam	378.2	0.066	-	30	3	0.020
Medium Silty Clay Loam	375.7	0.034	-	100	6	0.010
Loose Broken Gravel & Sand	372.7	0.034	30	20	-	-
Limestone	362.7	0.048	44	-	-	-

Table 13 – Northbound, South Abutment

Soil Type	Elev. At Bottom of Layer	Effective Unit Wt. (pci)	Friction Angle (deg)	k (pci)	c (psi)	E50
Stiff Silty Clay	395.3	0.071	-	500	8	0.007
Medium Silty Clay Loam	392.8	0.068	-	100	5	0.010
Stiff Silty Clay	387.8	0.072	-	500	9	0.007
Med. Silty Clay to Silty Clay Loam	382.8	0.067	-	100	4	0.010
Soft Silty Clay Loam	380.3	0.027	-	30	2	0.020
Loose Sandy Gravel with Clay Layers	373.3	0.033	30	20	-	-
Limestone	363.3	0.048	44	-	-	-

Table 14 – Southbound, North Abutment

Soil Type	Elev. At Bottom of Layer	Effective Unit Wt. (pci)	Friction Angle (deg)	k (pci)	c (psi)	E50
Very Loose Sand & Gravel with Clay Layers	378.3	0.025	25	20	-	-
Loose Sand & Gravel with Clay Layers	375.8	0.034	30	20	-	-
Loose Gravel with Sand	370.3	0.036	32	20	-	-
Limestone	360.3	0.048	44	-	-	-

Table 15 – Southbound, Piers

Soil Type	Elev. At Bottom of Layer	Effective Unit Wt. (pci)	Friction Angle (deg)	k (pci)	c (psi)	E50
Very Stiff Silty Clay	401.7	0.076	-	1000	16	0.005
Stiff Silt Loam	399.2	0.073	-	500	10	0.007
Stiff Silty Clay	396.7	0.074	-	500	11	0.007
Stiff Silt Loam	391.7	0.071	-	500	8	0.007
Soft Silt Loam	389.2	0.064	-	30	3	0.020
Medium Silt Loam	386.7	0.068	-	100	5	0.010
Med. Silty Clay Loam to Silt Loam	381.7	0.064	-	100	3	0.010
Stiff Silty Clay Loam	379.2	0.074	-	500	13	0.007
Stiff Silty Clay Loam with Sand Seams	376.7	0.035	-	500	8	0.007
Loose Sand & Gravel with Clay Seams	374.2	0.032	29	20	-	-
Very Soft Clay	372.2	0.024	-	30	1	0.020
Limestone	362.2	0.048	44	-	-	-

Table 16 – Southbound, South Abutment

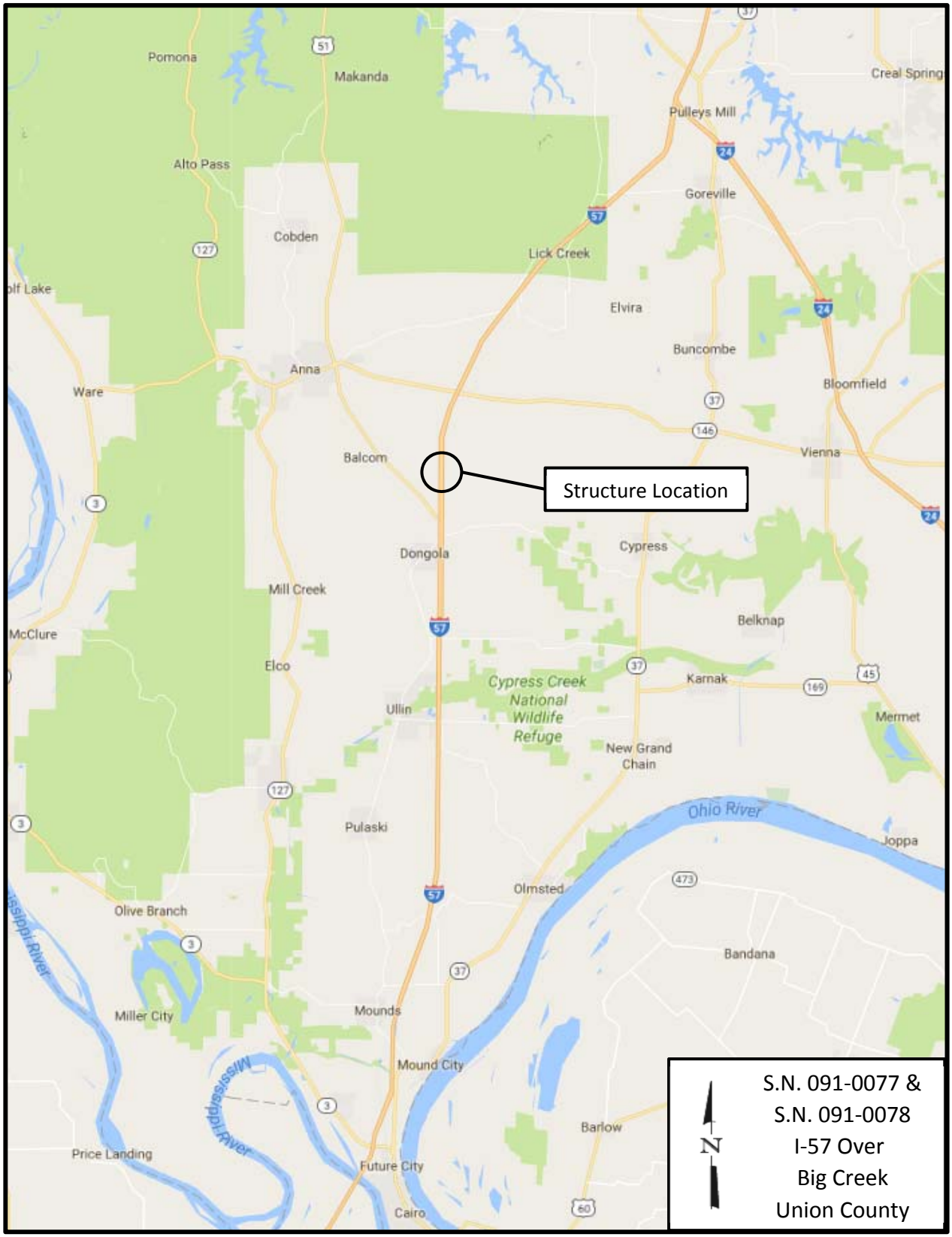
Construction Considerations

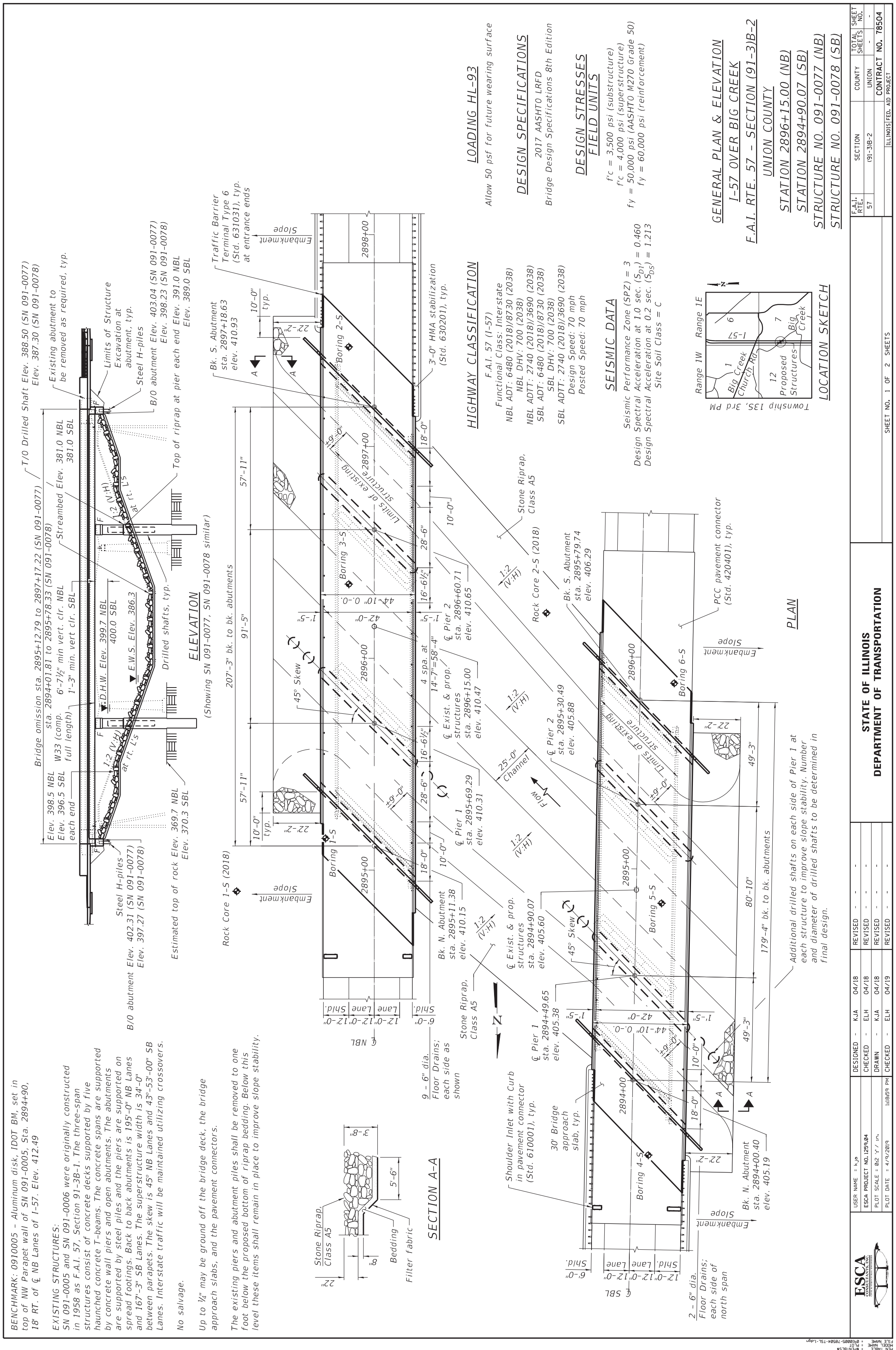
Stage Construction: Traffic is expected to be maintained on I-57 utilizing cross overs for the construction of both structures. No temporary soil support system will be required as each of the proposed bridges will be constructed in a single stage and there is adequate space between the structures to excavate without cutting into the other structure. It has been determined that the soil will generally be adequate for a 1V:1H excavation slope. However, if the intermittent very soft soil layers shown in the borings are encountered in the field, a 1V:1.5H excavation slope may be more appropriate.

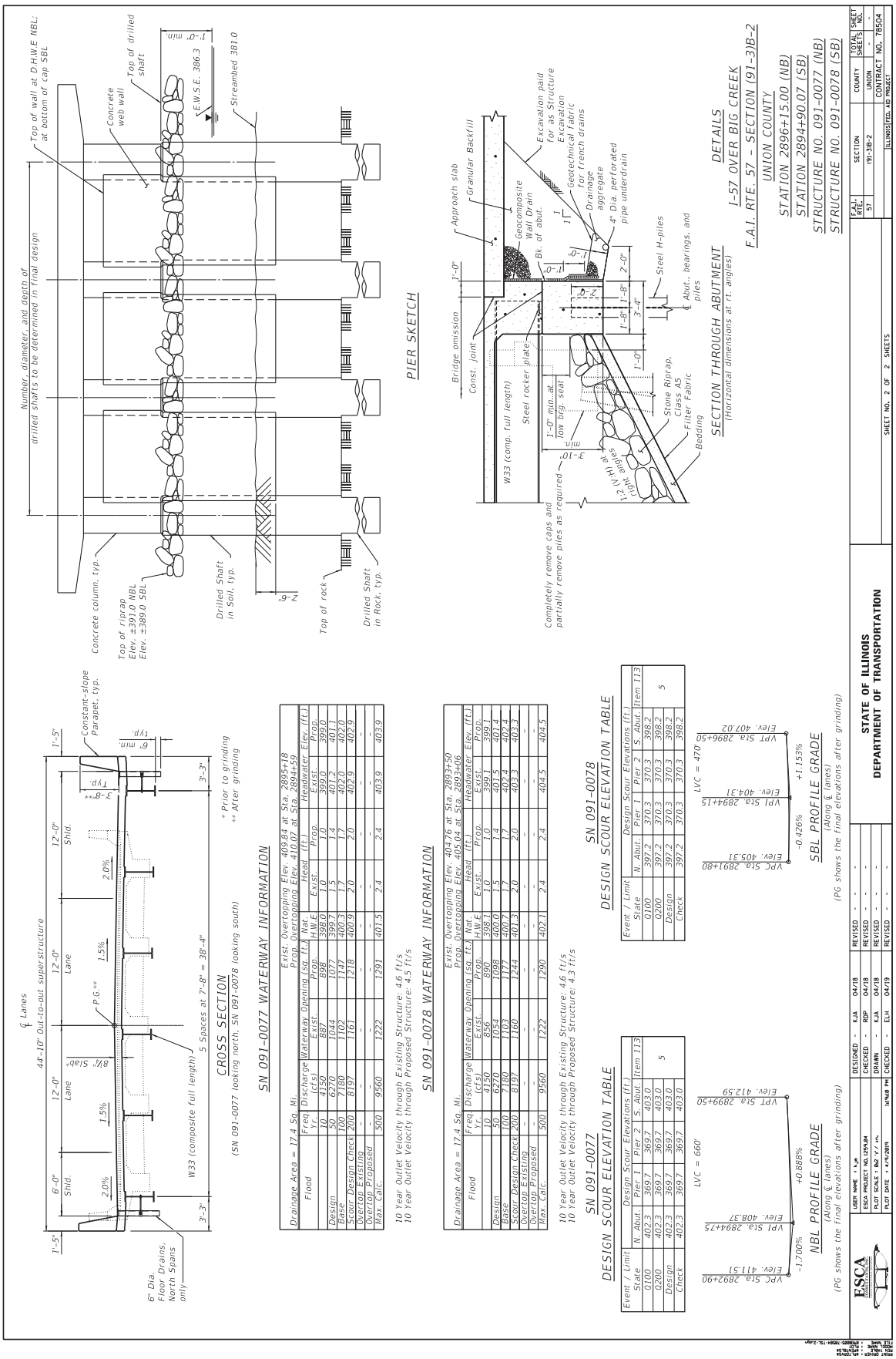
Foundation Construction: Due to consistent rock elevation data provided in the borings and in the existing pile data sheets, no test piles are recommended. Rather, the proposed pile lengths shall be extended by two feet to accommodate any variations encountered in the field. Pile shoes are recommended when driving into limestone layers. A Type 2 cofferdam would be required at each pier if the spread footing option is chosen. Temporary casing is recommended from the top of shaft to the limestone if the drilled shaft option is chosen.

Limitations

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


Pomona
Makanda
Creal Spring
Pulleys Mill
Alto Pass
Goreville
Cobden
Lick Creek
Elvira
Buncombe
Anna
Ware
Bloomfield
Balcom
Vienna
Structure Location
Dongola
Cypress
Mill Creek
Belknap
McClure
Elco
Karnak
Cypress Creek National Wildlife Refuge
Ullin
Mermet
New Grand Chain
Ohio River
Pulaski
Joppa
Olmsted
Olive Branch
Bandana
Miller City
Mounds
Mound City
Barlow
Price Landing
Future City
Cairo
N
S.N. 091-0077 &
S.N. 091-0078
I-57 Over
Big Creek
Union County


BENCHMARK: 0910005 - Aluminum disk, IDOT BM, set in top of NW Parapet wall of SN 091-0005, Sta. 2894+90, 18' RT. of ℄ NB Lanes of I-57. Elev. 412.49
EXISTING STRUCTURES: SN 091-0005 and SN 091-0006 were originally constructed in 1958 as F.A.I. 57, Section 91-3B-1. The three-span structures consist of concrete decks supported by five haunched concrete T-beams. The concrete spans are supported by concrete wall piers and open abutments. The abutments are supported by steel piles and the piers are supported on spread footings. Back to back abutments is 195'-0" NB Lanes and 167'-3" SB Lanes. The superstructure width is 34'-0" between parapets. The skew is 45° NB Lanes and 43°-53'-00" SB Lanes. Interstate traffic will be maintained utilizing crossovers.
No salvage.
Up to ½" may be ground off the bridge deck, the bridge approach slabs, and the pavement connectors.
The existing piers and abutment piles shall be removed to one foot below the proposed bottom of riprap bedding. Below this level these items shall remain in place to improve slope stability.
ELEVATION
(Showing SN 091-0077, SN 091-0078 similar)
PLAN
SECTION A-A
LOADING HL-93
Allow 50 psf for future wearing surface
DESIGN SPECIFICATIONS
2017 AASHTO LRFD
Bridge Design Specifications 8th Edition
DESIGN STRESSES
FIELD UNITS
f'c = 3,500 psi (substructure)
f'c = 4,000 psi (superstructure)
fy = 50,000 psi (AASHTO M270 Grade 50)
fy = 60,000 psi (reinforcement)
HIGHWAY CLASSIFICATION
F.A.I. 57 (I-57)
Functional Class: Interstate
SEISMIC DATA
Seismic Performance Zone (SPZ) = 3
Site Soil Class = C
LOCATION SKETCH
GENERAL PLAN & ELEVATION
I-57 OVER BIG CREEK
F.A.I. RTE. 57 - SECTION (91-3)B-2
UNION COUNTY
STATION 2896+15.00 (NB)
STATION 2894+90.07 (SB)
STRUCTURE NO. 091-0077 (NB)
STRUCTURE NO. 091-0078 (SB)
STATE OF ILLINOIS
DEPARTMENT OF TRANSPORTATION
CONTRACT NO. 78504
SHEET NO. 1 OF 2 SHEETS



Drainage Area = 17.4 Sq. Mi.

Flood	Freq. (yr.)	Discharge (cfs)	Waterway Opening (sq. ft.) Exist.	Prop.	Nat. H.W.E.	Head (ft.) Exist.	Prop.	Headwater Elev. (ft.) Exist.	Prop.
Design	10	4150	887	898	398.0	1.0	1.0	399.0	399.0
Base	50	6270	1044	1077	399.7	1.5	1.4	401.2	401.1
Scour Design Check	100	7180	1102	1147	400.3	1.7	1.7	402.0	402.0
Overtop Existing	200	8197	1161	1218	400.9	2.0	2.0	402.9	402.9
Overtop Proposed	-	-	-	-	-	-	-	-	-
Max. Calc.	500	9560	1222	1291	401.5	2.4	2.4	403.9	403.9

Exist. Overtopping Elev. 409.84 at Sta. 2895+18
Prop. Overtopping Elev. 407.07 at Sta. 2894+89

10 Year Outlet Velocity through Existing Structure: 4.6 ft/s
10 Year Outlet Velocity through Proposed Structure: 4.5 ft/s

Event / Limit State	N. Abut.	Design Scour Elevations (ft.) Pier 1	Pier 2	S. Abut.	Item 113
Q100	402.3	369.7	369.7	403.0	5
Q200	402.3	369.7	369.7	403.0	
Design	402.3	369.7	369.7	403.0	
Check	402.3	369.7	369.7	403.0	

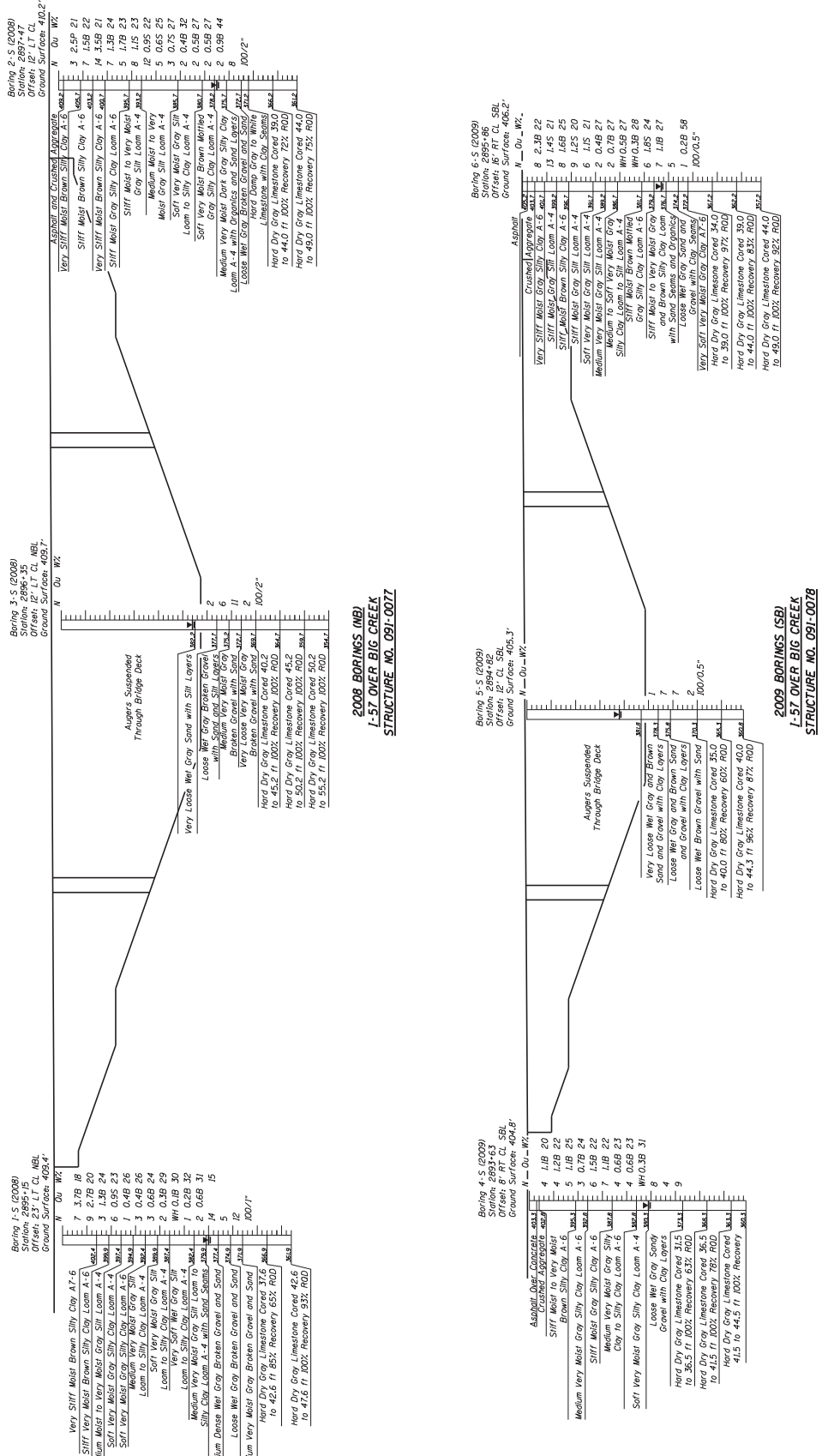
Drainage Area = 17.4 Sq. Mi.

Flood	Freq. (yr.)	Discharge (cfs)	Waterway Opening (sq. ft.) Exist.	Prop.	Nat. H.W.E.	Head (ft.) Exist.	Prop.	Headwater Elev. (ft.) Exist.	Prop.
Design	10	4150	856	890	398.1	1.0	1.0	399.1	399.1
Base	50	6270	1054	1098	400.0	1.5	1.4	401.5	401.4
Scour Design Check	100	7180	1103	1177	400.7	1.7	1.7	402.4	402.4
Overtop Existing	200	8197	1160	1244	401.3	2.0	2.0	403.3	403.3
Overtop Proposed	-	-	-	-	-	-	-	-	-
Max. Calc.	500	9560	1222	1290	402.1	2.4	2.4	404.5	404.5

Exist. Overtopping Elev. 404.76 at Sta. 2893+50
Prop. Overtopping Elev. 405.64 at Sta. 2893+06

10 Year Outlet Velocity through Existing Structure: 4.6 ft/s
10 Year Outlet Velocity through Proposed Structure: 4.3 ft/s

Event / Limit State	N. Abut.	Design Scour Elevations (ft.) Pier 1	Pier 2	S. Abut.	Item 113
Q100	397.2	370.3	370.3	398.2	5
Q200	397.2	370.3	370.3	398.2	
Design	397.2	370.3	370.3	398.2	
Check	397.2	370.3	370.3	398.2	


Boring 1-S (2008)
Station: 2895+15
Offset: 23' LT CL NBL
Ground Surface: 409.4'
Boring 2-S (2008)
Station: 2897+47
Offset: 12' LT CL
Ground Surface: 410.2'
Boring 3-S (2008)
Station: 2896+35
Offset: 12' LT CL NBL
Ground Surface: 409.7'
Augers Suspended Through Bridge Deck
2008 BORINGS (NB)
I-57 OVER BIG CREEK
STRUCTURE NO. 091-0077
Boring 4-S (2009)
Station: 2893+63
Offset: 8' RT CL SBL
Ground Surface: 404.8'
Boring 5-S (2009)
Station: 2894+82
Offset: 12' CL SBL
Ground Surface: 405.3'
Boring 6-S (2009)
Station: 2895+66
Offset: 16' RT CL SBL
Ground Surface: 406.2'
2009 BORINGS (SB)
I-57 OVER BIG CREEK
STRUCTURE NO. 091-0078

Illinois Department of Transportation

Memorandum

To:	Carrie Nelsen	Attn: Dave Piche
From:	Greg Smothers GSS	By: Rob Graeff
Subject:	*Boring Logs & Liquefaction Analysis	
Date:	May 4, 2009	

FAI 57 over Big Creek
Structures 091-0005/0006(E)
Union County

Foundation boring logs have been obtained for the above listed structure and are attached.

Liquefaction Analysis
Liquefaction calculations indicate the possibility of liquefiable soils at this structure location. The locations and depths are highlighted on the attached liquefaction analysis.

Slope Stability
At the time of this report, a preliminary TSL is not available. Therefore, we are unable to provide any slope stability calculations for the proposed endslope configuration. This office should be contacted to complete the slope stability calculations when a proposed endslope configuration is determined.

Structure Geotechnical Report
Due to a current shortage of staffing, the District Nine Geotechnical Unit is unable to complete the required Structure Geotechnical Report. Any additional foundation recommendations should be evaluated by a competent consultant.

Attachments
RG:rg

cc: Soils File

ILLINOIS DEPARTMENT OF TRANSPORTATION
District Nine Materials

Bridge Foundation Boring Log
Sheet 1 of 2

FAI 57 Over Big Creek

Route: FAI 57 **Structure Number:** 091-0005 **Date:** 11/24/2008

Section 91-3B-1 **Bored By:** R Moberly

County: Union **Location:** 2 miles North of Dongola **Checked By:** Rob Graeff

Boring No 1-S
Station 2895+15
Offset 23' Lt CL NBL
Ground Surface 409.4 **Ft**

Surf Wat Elev: 384.9
Ground Water Elevation
when Drilling 379.4
At Completion
At: **Hrs:**

DEPTH	BLOWS	Qu tsf	W%	DEPTH	BLOWS	Qu tsf	W%
Very stiff, moist, brown, Silty Clay A7-6				Very soft, wet, grey, Silt Loam to Silty Clay Loam A-4	WH	0.2B	32
					1		
				382.4			
	1			Medium, very moist, grey, Silt	WH		
	3	3.7B	18	Loam to Silty Clay Loam A-4	1	0.6B	31
	4			with Sand seams	1		
				379.9			
5.0	1			Medium Dense, wet, grey, Broken	30.0 1		
	4	2.7B	20	Gravel and Sand	8		15
	5			30% Sand; 7% Silt	6		
				2% Clay; 61% Gravel			
402.4				377.4			
Stiff, very moist, brown, Silty	1			Loose, wet, grey, Broken Gravel	5		
Clay Loam A-6	1	1.3B	24	and Sand	3		
	2			30% Sand; 7% Silt	2		
				2% Clay; 61% Gravel			
399.9				374.9			
Medium, moist to very moist, 10.0	1			Medium, very moist, grey, Broken 35.0	4		
grey, Silt Loam A-4	3	0.9S	23	Gravel and Sand	6		
	3			30% Sand; 7% Silt	6		
				2% Clay; 61% Gravel			
397.4				371.9	6		
Soft, very moist, grey, Silty Clay	WH				100/1"	Refusal	
Loam A-4	1	0.4B	26				
	WH			Cored 37.6 to 42.6 feet			
				85% Recovery; 65% RQD			
394.9							
Soft, very moist, grey, Silty Clay 15.0	WH			Hard, dry, grey, Limestone with 40.0			
Loam A-6	1	0.4B	26	a 6" void			
	2						
392.4				366.9			
Medium, very moist, grey, Silt	1						
Loam to Silty Clay Loam A-4	1	0.6B	24				
	2			Cored 42.6 to 47.6 feet			
				100% Recovery; 93% RQD			
389.9							
Soft, very moist, grey, Silt Loam 20.0	WH			Hard, dry, grey, Limestone 45.0			
to Silty Clay Loam A-4	1	0.3B	29				
	1						
387.4				361.9			
Very soft, wet, grey, Silt Loam	WH						
to Silty Clay Loam A-4	WH	0.1B	30				
	WH			Bottom of hole = 47.6 feet			
25.0	WH			50.0			

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

Sheet 2 of 2

Route: FAI 57
Section: 91-3B-1
County: Union
Date: 11/24/2008

Boring No: 1-S
Station: 2895+15
Offset: 23' Lt CL NBL
Ground Surface: 409.4 Ft

DEPTH	BLOWS	Qu tsf	W%	DEPTH	BLOWS	Qu tsf	W%
55.0				80.0			
60.0				85.0			
65.0				90.0			
70.0				95.0			
75.0				100.0			

Bottom of hole = 47.6 feet

Free water observed at 30.0 feet

Elevation referenced to BM at NW corner SN 091-0005; Elevation = 412.5 feet

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

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

ILLINOIS DEPARTMENT OF TRANSPORTATION
District Nine Materials

Bridge Foundation Boring Log
Sheet 1 of 2

FAI 57 Over Big Creek

Route: FAI 57 **Structure Number:** 091-0005 **Date:** 11/25/2008
Section 91-3B-1 **Bored By:** R Moberly
County: Union **Location:** 2 miles North of Dongola **Checked By:** Rob Graeff

Boring No 2-S
Station 2897+47
Offset 12' Lt CL
Ground Surface 410.2 **Ft**

Surf Wat Elev: 384.9
Ground Water Elevation
when Drilling 377.7
At Completion
At: **Hrs:**

DEPTH	BLOWS	Qu tsf	W%	DEPTH	BLOWS	Qu tsf	W%
Asphalt and Crushed Aggregate				Soft, very moist, grey, Silt Loam	1	0.4B	32
409.2				to Silty Clay Loam A-4	1		
Very stiff, moist, brown, Silty Clay A-6							
	1				WH		
	2	2.5P	21		1	0.5B	27
	1				1		
405.7				380.7			
Stiff, moist, brown, Silty Clay A-6 5.0	2			Soft, very moist, brown mottled 30.0	WH		
	3	1.5B	22	grey, Silty Clay Loam A-4	1	0.5B	27
	4				1		
403.2				378.2			
Very stiff, moist, brown, Silty Clay	2			Medium, very moist, dark grey,	WH		
A-6	6	3.5B	21	Silty Clay Loam A-4 with	1	0.9B	44
	8			organics and Sand layers	1		
400.7				375.7			
Stiff, moist, grey, Silty Clay Loam 10.0	1			Loose, wet, grey, Broken Gravel 35.0	2		
A-6	3	1.3B	24	and Sand	5		
	4			30% Sand; 7% Silt	3		
				2% Clay; 61% Gravel			
	1			372.7	5		
	2	1.7B	23	Hard, damp, grey to white,	100/2"		
	3			Limestone with Clay seams			
				371.2	Refusal		
395.7							
Stiff, moist to very moist, grey, 15.0	1			Cored 39.0 to 44.0 feet 40.0			
Silt Loam A-4	4	1.1S	23	100% Recovery; 72% RQD			
	4						
				Hard, dry, grey, Limestone			
393.2							
Medium, moist to very moist, grey,	3						
Silt Loam A-4	7	0.9S	22				
	5						
				366.2			
20.0	1			Cored 44.0 to 49.0 feet 45.0			
	2	0.6S	25	100% Recovery; 75% RQD			
	3						
				Hard, dry, grey, Limestone			
	1						
	1	0.7S	27				
	2						
				361.2			
385.7				Bottom of hole = 49.0 feet			
25.0	WH			50.0			

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

Sheet 2 of 2

Route: FAI 57
Section: 91-3B-1
County: Union
Date: 11/25/2008

Boring No: 2-S
Station: 2897+47
Offset: 12' Lt CL
Ground Surface: 410.2 Ft

DEPTH	BLOWS	Qu tsf	W%	DEPTH	BLOWS	Qu tsf	W%
55.0				80.0			
60.0				85.0			
65.0				90.0			
70.0				95.0			
75.0				100.0			

Bottom of hole = 49.0 feet

Free water observed at 32.5 feet

Elevation referenced to BM at NW corner of SN 091-0005; Elevation = 412.5 feet

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

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

ILLINOIS DEPARTMENT OF TRANSPORTATION
District Nine Materials

Bridge Foundation Boring Log

FAI 57 Over Big Creek — **Sheet 1 of 2**

Route: FAI 57/ US 51 **Structure Number:** 091-0005 **Date:** 12/4/2008

Section 91-3B-1 **Bored By:** R Moberly

County: Union **Location:** 2 miles North of Dongola **Checked By:** Rob Graeff

Boring No 3-S
Station 2896+35
Offset 12' Lt CL NBL
Ground Surface 409.7 **Ft**

Surf Wat Elev: 384.9
Ground Water Elevation
when Drilling
At Completion
At: Hrs:

DEPTH	BLOWS	Qu tsf	W%	DEPTH	BLOWS	Qu tsf	W%
Augers suspended through bridge deck to 27.5 feet							
				382.2			
				Very loose, wet, grey, Sand with Silt layers			
5.0					30.0	WH	
						1	
						1	
				377.7			
				Loose, wet, grey, broken Gravel with Sand and Silt layers		3	
						3	
				30% Sand; 7% Silt		3	
				2% Clay; 61% Gravel			
				375.2			
10.0				Medium, very moist, grey, broken	35.0	6	
				Gravel with Sand		6	
				30% Sand; 7% Silt		5	
				2% Clay; 61% Gravel			
				372.7			
				Very loose, very moist, grey,		3	
				broken Gravel with Sand		1	
				30% Sand; 7% Silt		1	
				2% Clay; 61% Gravel			
15.0				369.7	40.0	10	
				Hard, dry, grey, Limestone		100/2" Refusal	
				Cored 40.2 to 45.2 feet			
				100% Recovery; 100% RQD			
20.0				364.7	45.0		
				Cored 45.2 to 50.2 feet			
				100% Recovery; 100% RQD			
				Hard, dry, grey, Limestone			
25.0				359.7	50.0		

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

Sheet 2 of 2

Route: FAI 57/ US 51
Section: 91-3B-1
County: Union
Date: 12/4/2008

Boring No: 3-S
Station: 2896+35
Offset: 12' Lt CL NBL
Ground Surface: 409.7 Ft

DEPTH	BLOWS	Qu tsf	W%	DEPTH	BLOWS	Qu tsf	W%
Cored 50.2 to 55.2 feet 100% Recovery; 100% RQD Hard, dry, grey, Limestone							
354.7 55.0				80.0			
Bottom of hole = 55.2 feet Free water observes at 27.0 feet Elevation referenced to BM at NW corner of SN 091-0005; Elevation = 412.5 feet To convert "N" values to "N60" multiply by 1.25							
60.0				85.0			
65.0				90.0			
70.0				95.0			
75.0				100.0			

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

ILLINOIS DEPARTMENT OF TRANSPORTATION
District Nine Materials

Bridge Foundation Boring Log

Southbound FAI 57 Over Big Creek — **Sheet 1 of 1**

Route: FAI 57/ US 51 **Structure Number:** 091-0006 **Date:** 4/20/2009

Section 91-3B-1 **Bored By:** R Moberly

County: Union **Location:** 2 miles North of Dongola **Checked By:** Rob Graeff

Boring No 4-S
Station 2893+63
Offset 8' Rt CL SBL
Ground Surface 404.8 **Ft**

Surf Wat Elev: 386.3
Ground Water Elevation
when Drilling 380.3
At Completion
At: **Hrs:**

DEPTH	BLOWS	Qu tsf	W%	DEPTH	BLOWS	Qu tsf	W%
Asphalt over Concrete				Loose, wet, grey, Sandy Gravel	3		
403.3				with Clay layers	5		
Crushed aggregate 402.8							
	1				3		
Stiif, moist to very moist, brown,	2	1.1B	20	No recovery sufficient for grain-	2		
Silty Clay A-6	2			size sample in this whole layer	2		
				Assume same as 1-S.			
				30% Sand; 7% Silt			
5.0	1			2% Clay; 61% Gravel	30.0 1		
	2	1.2B	22		2		
	2				7		
				373.3			
				Hard, dry, grey, Limestone			
	1						
	2	1.1B	25	Cored 31.5 to 36.5 feet			
	3			100% Recovery; 63% RQD			
395.3							
Medium, very moist, grey, Silty 10.0	1				35.0		
Clay Loam A-6	1	0.7B	24				
	2						
				368.3			
392.8				Hard, dry, grey, Limestone			
Stiff, moist, grey, Silty Clay A-6	1						
	2	1.5B	22	Cored 36.5 to 41.5 feet			
	4			100% Recovery; 78% RQD			
15.0	1			Stopped 2' short because of sand	40.0		
	3	1.1B	22	and gravel coming in on core			
	4			barrel and imminent rain.			
				363.3			
387.8				Hard, dry, grey, Limestone			
Medium, very moist, grey, Silty	1						
Clay to Silty Clay Loam A-6	1	0.6B	23	Cored 41.5 to 44.5 feet			
	3			100% Recovery;			
				360.3			
20.0	1			Bottom of hole = 44.5 feet	45.0		
	2	0.6B	23				
	2			Free water observed at 24.5 feet			
382.8				Elevation referenced to BM @			
Soft, very moist, grey, Silty Clay	WH			091-0005; Elevation = 412.5 ft			
Loam A-4	WH	0.3B	31				
	WH			To convert "N" values to "N60"			
				multiply by 1.25			
380.3							
25.0	1				50.0		

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

ILLINOIS DEPARTMENT OF TRANSPORTATION
District Nine Materials

Bridge Foundation Boring Log
Sheet 1 of 2

Southbound FAI 57 Over Big Creek

Route: FAI 57/ US 51 **Structure Number:** 091-0006 **Date:** 4/22/2009
Section 91-3B-1 **Bored By:** R Moberly
County: Union **Location:** 2 miles North of Dongola **Checked By:** Rob Graeff

Boring No 5-S
Station 2894+82
Offset 12' Rt CL SBL
Ground Surface 405.3 **Ft**

Surf Wat Elev: 386.3
Ground Water Elevation
when Drilling 386.3
At Completion
At: Hrs:

DEPTH	BLOWS	Qu tsf	W%	DEPTH	BLOWS	Qu tsf	W%
Concrete Bridge Deck					1		
404.3					WH		
Augers suspended through bridge deck				378.3			
				Loose, wet, grey and brown, Sand and Gravel with Clay layers	1		
					3		
					4		
				375.8			
5.0				Loose, wet, brown, Gravel with Sand	30.0 3		
					3		
					4		
				Insufficient recovery in every sample to obtain a grain size sample. Assume same as 1-S.			
				30% Sand; 7% Silt	2		
				2% Clay; 61% Gravel	2		
10.0				370.3	35.0 21		
				Hard, dry, grey, Limestone	100/0.5"		
				Cored 35.0 to 40.0 feet 80% Recovery: 60% RQD	-		
				Note: Observed cavity from @ 37.0 to 38.0 feet during coring	-		
15.0				365.3	40.0		
				Hard, dry, grey, Limestone			
				Cored 40.0 to 44.3 feet 96% Recovery; 87% RQD			
				360.8			
20.0					45.0		
				Bottom of hole = 44.3 feet			
				Free water observed at 19.0 feet			
				Elevation referenced to BM @ SN 091-0005; Elev.= 412.5 feet			
381.8							
Very loose, wet, grey and brown, Sand and Gravel with Clay layers				To convert "N" values to "N60" multiply by 1.25			
25.0	WH				50.0		

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

Sheet 2 of 2

Route: FAI 57/ US 51
Section: 91-3B-1
County: Union
Date: 4/22/2009

Boring No: 5-S
Station: 2894+82
Offset: 12' Rt CL SBL
Ground Surface: 405.3 Ft

DEPTH	BLOWS	Qu tsf	W%	DEPTH	BLOWS	Qu tsf	W%
55.0				80.0			
60.0				85.0			
65.0				90.0			
70.0				95.0			
75.0				100.0			

Note: Second core sample could not be advanced past 44.3 feet due to loose gravel in bottom of hole which filled the top of the barrel. Could not get third core sample for same reason. Course gravel continued to come in at bottom of augers. These rocks became lodged in the barrel and prevented advancement of the coring. Several attempts were made with no success. Coring ceased as possibility of overtime approached.
RM

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

ILLINOIS DEPARTMENT OF TRANSPORTATION
District Nine Materials

Bridge Foundation Boring Log

Southbound FAI 57 Over Big Creek — **Sheet 1 of 2**

Route: FAI 57/ US 51 **Structure Number:** 091-0006 **Date:** 4/21/2009

Section 91-3B-1 **Bored By:** R Moberly

County: Union **Location:** 2 miles North of Dongola **Checked By:** Rob Graeff

Boring No 6-S
Station 2895+86
Offset 16' Rt CL SBL
Ground Surface 406.2 **Ft**

Surf Wat Elev: 386.3
Ground Water Elevation
when Drilling 377.7
At Completion
At: Hrs:

DEPTH	BLOWS	Qu tsf	W%	DEPTH	BLOWS	Qu tsf	W%
Asphalt 405.2				Stiff, moist, brown mottled grey, Silty Clay Loam A-6	3	1.8S	24
					3		
Crushed Aggregate				379.2			
403.7	4			Stiff, moist to very moist, grey and brown, Silty Clay Loam with Sand seams and organics	WH		
Very stiff, moist, grey, Silty Clay A-6	5	2.3B	22		1	1.1B	27
	3				6		
401.7				376.7			
Stiff, moist, grey, Silt Loam A-4 5.0	2			Loose, wet, grey, Sand and Gravel with Clay seams 30% Sand; 7% Silt 2% Clay; 61% Gravel 30.0	1		
	6	1.4S	21		4		
	7				1		
399.2				374.2			
Stiff, moist, brown, Silty Clay A-6	1			Very soft, very moist, grey, Clay A7-6	1		
	4	1.6B	25		1	0.2B	58
	4				WH		
396.7				372.2			
Stiff, moist, grey, Silt Loam A-4 10.0	2			Hard, dry, grey, Limestone 35.0	100/0.5"		
	4	1.2S	20	Cored 34.0 to 39.0 feet 100% Recovery; 97% RQD			
	5						
	1						
	3	1.1S	21				
	3						
391.7				367.2			
Soft, very moist, grey, Silt Loam A-4 15.0	1			Hard, dry, grey, Limestone 40.0			
	1	0.4B	27	Cored 39.0 to 44.0 feet 100% Recovery; 83% RQD			
	1						
389.2				362.2			
Medium, very moist, grey, Silt Loam A-4	WH			Hard, dry, grey, Limestone 45.0			
	1	0.7B	27	Cored 44.0 to 49.0 feet 100% Recovery; 92% RQD			
	1						
386.7				357.2			
Medium to soft, very moist, grey, Silty Clay Loam to Silt Loam A-4 20.0	WH			Bottom of hole = 49.0 feet 50.0			
	WH	0.5B	27				
	WH						
	WH						
	WH	0.3B	28				
	WH						
381.7							
25.0	1						

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

Sheet 2 of 2

Route: FAI 57/ US 51
Section: 91-3B-1
County: Union
Date: 4/21/2009

Boring No: 6-S
Station: 2895+86
Offset: 16' Rt CL SBL
Ground Surface: 406.2 Ft

DEPTH	BLOWS	Qu tsf	W%	DEPTH	BLOWS	Qu tsf	W%
55.0				80.0			
60.0				85.0			
65.0				90.0			
70.0				95.0			
75.0				100.0			

Bottom of hole = 49.0 feet

Free water observed at 28.5 feet

Elevation referenced to BM @ SN 091-0005; Elev. = 412.5 ft

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

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

ILLINOIS DEPARTMENT OF TRANSPORTATION
District Nine Materials

Bridge Foundation Boring Log
Sheet 1 of 1

FAI 57 Over Big Creek
Route: FAI 57 Structure Number: 091-0005/0006 Date: 9/17/2018
Section 91-3B-1 Bored By: L Estel
County: Union Location: 2 miles North of Dongola Checked By: A Hayes

Boring No 1-S (2018)
Station 2894+90
Offset 65' Lt CL NBL
Ground Surface 400.5 Ft

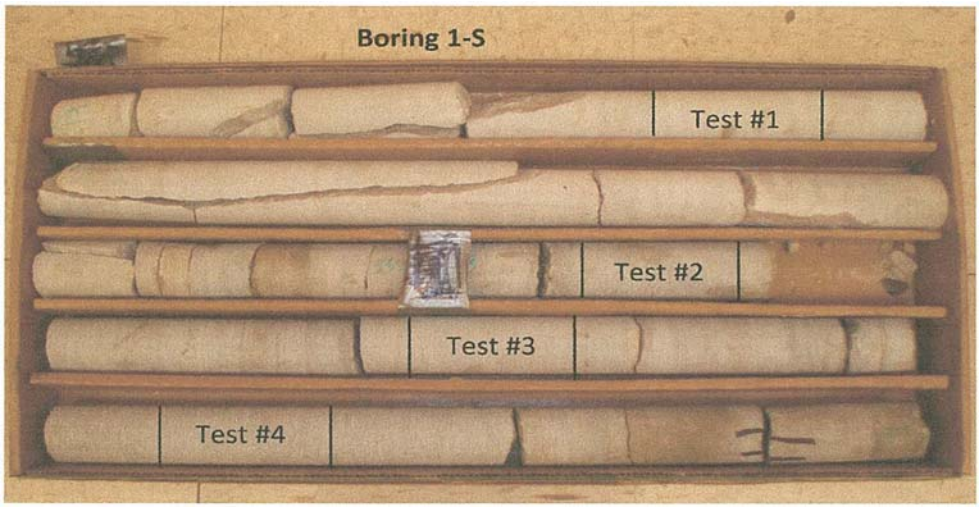
Surf Wat Elev:
Ground Water Elevation
when Drilling 369.50
At Completion
At: Hrs:

DEPTH	BLOWS	Qu tsf	W%	DEPTH	BLOWS	Qu tsf	W%
Augered to bedrock							
See 1996 and 2008 borings for soil data				Bedrock encountered at a depth of 28.0 feet 372.5			
Offset referenced from direction of travel				Cored 28.0 to 33.0 feet			
				Hard, dry, grey, Limestone with			
5.0				vertical shear plane 30.0			
				100% Recovery, 78% RQD*			
				Unc. Comp. at 29.4' = 11,236 psi			
				367.5			
				Cored 33.0 to 37.5 feet			
				Hard, dry, grey, Limestone			
10.0				35.0			
				100% Recovery, 87% RQD			
				Unc. Comp. at 33.4' = 5,886 psi			
				Unc. Comp. at 34.7' = 10,559 psi			
				Unc. Comp. at 36.3' = 6,202 psi			
				363.0			
				Bottom of hole = 37.5 feet			
				Free water observed at 31.0 feet			
15.0				40.0			
				Elevation referenced to BM at NW parapet wall of SN 091-0005			
				Elevation = 412.49 feet			
				To convert "N" values to "N60" multiply by 1.50			
				Borehole advanced with hollow stem auger 6" OD, 3.25" ID			
20.0				RQD* = Pieces with a vertical shear counted as sound 45.0			
25.0				50.0			

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

Illinois Department of Transportation
District Nine Materials
Unconfined Compressive Strength

FAI 57 (I57)
Structure 091-0005/0006 - Boring 1-S
(2018) Union County



Boring #	Specimen#	Depth	Unconfined Compression
1-S	1	29'5"	11,236 psi
1-S	2	33'5"	5,886 psi
1-S	3	34'8"	10,559 psi
1-S	4	36'3"	6,202 psi

Foundation Core Instructions
Use 1.78" for the diameter
3.8" is the length

$$\frac{\pi d^2}{4} = 2.487$$

Pounds divided by 2.487 = psi

ILLINOIS DEPARTMENT OF TRANSPORTATION
District Nine Materials

Bridge Foundation Boring Log
Sheet 1 of 1

FAI 57 Over Big Creek
Route: FAI 57 Structure Number: 091-0005/0006 Date: 9/18/2018
Section 91-3B-1 Bored By: L Estel
County: Union Location: 2 miles North of Dongola Checked By: A Hayes

Boring No 2-S (2018)
Station 2896+20
Offset 45' Lt CL SBL
Ground Surface 401.3 Ft

Surf Wat Elev:
Ground Water Elevation
when Drilling 370.30
At Completion
At: Hrs:

DEPTH	BLOWS	Qu tsf	W%

Augered to bedrock

See 1996 and 2008 borings for soil data

Offset referenced from direction of travel

5.0

10.0

15.0

20.0

25.0

Bedrock encountered at a depth of 28.8 feet 372.3

Cored 28.8 to 32.4 feet
Hard, dry, grey, Limestone
100% Recovery; 88% RQD
Unc. Comp. at 29.4' = 7,123 psi
Unc. Comp. at 30.3' = 5,699 psi
Unc. Comp. at 30.7' = 5,869 psi
368.8

Cored 32.4 to 37.4 feet
Hard, dry, grey, Limestone

100% Recovery; 97% RQD
Unc. Comp. at 33.4' = 10,967 psi
Unc. Comp. at 35.1' = 7,945 psi
Unc. Comp. at 36.4' = 5,659 psi
363.8

Bottom of hole = 37.4 feet

Free water observed at 31.0 feet

Elevation referenced to BM at NW parapet wall of SN 091-0005
Elevation = 412.49 feet

To convert "N" values to "N60" multiply by 1.50

Borehole advanced with hollow stem auger 6" OD, 3.25" ID

Offset referenced from direction of travel

30.0

35.0

40.0

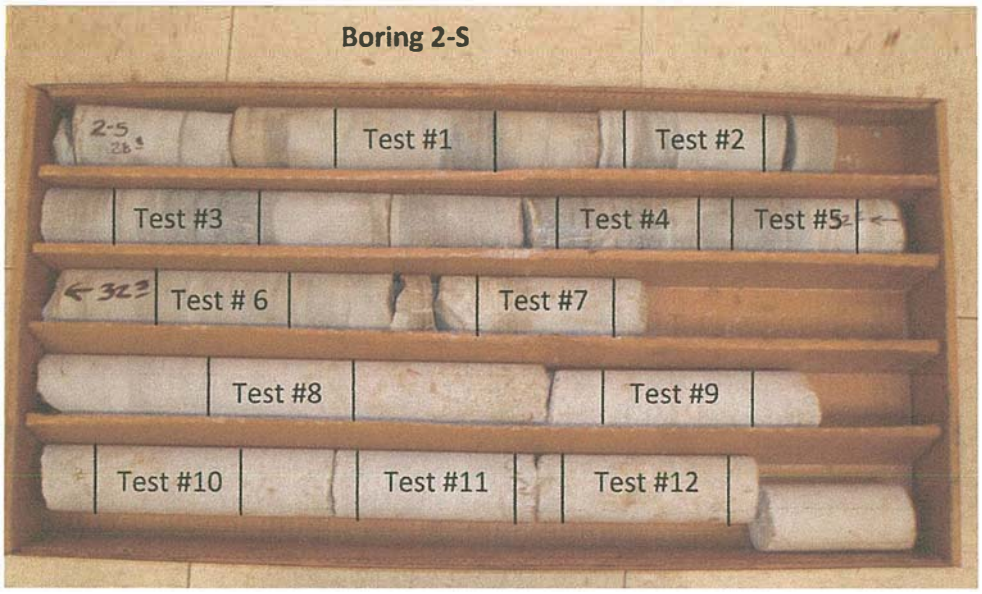
45.0

50.0

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

Illinois Department of Transportation
District Nine Materials
Unconfined Compressive Strength

FAI 57 (I57)
Structure 091-0005/0006 - Boring 2-S
(2018) Union County



Boring #	Specimen#	Depth	Unconfined Compression
2-S	1	29'5"	7,123 psi
2-S	2	30'3"	5,699 psi
2-S	3	30'8"	5,869 psi
2-S	4	31'8"	8,361 psi
2-S	5	32'3"	9,950 psi
2-S	6	33'0"	16,136 psi
2-S	7	33'5"	10,967 psi
2-S	8	34'3"	6,554 psi
2-S	9	35'1"	7,945 psi

2-S	10	35'5"	7,045 psi
2-S	11	36'0"	7,258 psi
2-S	12	36'5"	5,659 psi

Foundation Core Instructions
Use 1.78" for the diameter
3.8" is the length

$$\frac{\pi d^2}{4} = 2.487$$

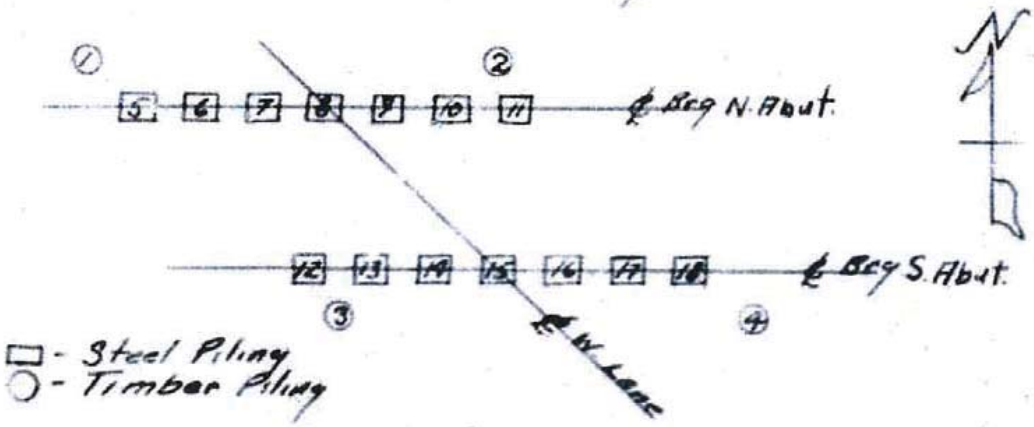
Pounds divided by 2.487 = psi

PILE DATA

Dongola
FAI 57(4)
Proj {I-57-1(61)27
I-04-1(24)

Sta 2834+88.10 W.
Sec 91-38-1
Union County

40 ton bearing Specified on Plans for Steel Piling (128P53)
15 ton bearing Specified on Plans for Creosote Timber Piling
All dimensions and Spacing as shown on Plans



Pile No	Plan Length	Furn. Length	Driven Length	Bearing (tons)
1	34	34	28	Refusal
2	34	34	28.5	"
3	34	34	31.0	"
4	34	34	30.3	"
5		Test		"
6	25	26	25.7	"
7	25	26	25.5	"
8	25	26	25.5	"
9	25	26	25.2	"
10	25	26	25.6	"
11	25	26	25.5	"
12	30	30	28.5	"
13	30	30	29.0	"
14	30	30	28.7	"
15	30	30	28.9	"
16	30	30	28.9	"
17	30	30	29.3	"
18		Test		"

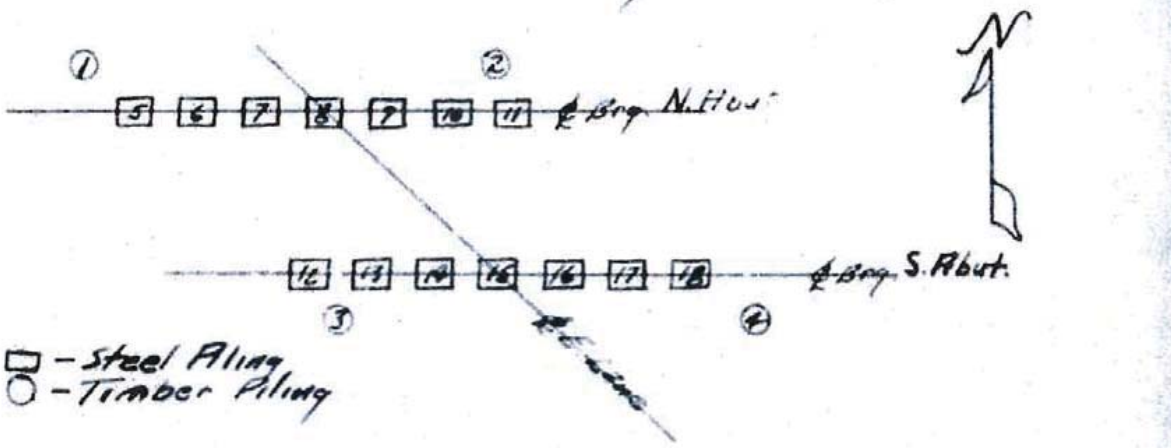
	Creosote Pile	Steel Pile	
Total Plan Length	136	330	Lin ft.
Total Furn. Length	136	336	"
Total Driven Length	117.8	326.3	"

PILE DATA

Dongola
FAE 57(4)
Proj. {E-57-1(11)27
{E-09-1(24)

Std. 2896 r15 E
Sec. 91-38-1
Union County

40 ton bearing Specified on Plans for Steel Piling (12 BP 53)
15 ton bearing Specified on Plans for Creosoted Timber Piling
All dimensions and Spacing as shown on plans



Pile No.	Plan Length	Furn Length	Driven Length	Bearing (tons)
1	37	37	33.8	Refusal
2	37	37	36.5	"
3	37	37	35.0	"
4	37	37	36.0	"
5		test		"
6	32	32	31.3	"
7	32	32	31.0	"
8	32	32	31.5	"
9	32	32	31.0	"
10	32	32	31.4	"
11	32	32	31.5	"
12	33	33	31.6	"
13	33	33	32.3	"
14	33	33	31.7	"
15	33	33	32.4	"
16	33	33	31.9	"
17	33	33	32.8	"
18		test		"

	Creosote Pile	Steel Pile	
Total Plan length	148	390	Lin ft
Total Furn length	148	390	"
Total Driven length	141.3	380.4	"

Illinois Department of Transportation

LIQUEFACTION ANALYSIS

REFERENCE BORING NUMBER ==========: 1-S
ELEVATION OF BORING GROUND SURFACE ==========: 409.40 FT.
DEPTH TO GROUNDWATER - DURING DRILLING ==========: 30.00 FT. (Below Boring Ground Surface)
DEPTH TO GROUNDWATER - DURING EARTHQUAKE ==========: 23.06 FT. (Below Finished Grade Cut or Fill Surface)
PEAK HORIZ. GROUND SURFACE ACCELERATION COEFFICIENT (As) =====: 0.764
EARTHQUAKE MOMENT MAGNITUDE ==========: 7.7
FINISHED GRADE FILL OR CUT FROM BORING SURFACE ==========: -6.94 FT. (Cut Depth)
HAMMER EFFICIENCY==========: 73 %
BOREHOLE DIAMETER==========: 8 IN.
SAMPLING METHOD==========: Sampler w/out Liners

EQ MAGNITUDE SCALING FACTOR
(MSF) = **0.957**

AVG. SHEAR WAVE VELOCITY (top 40')
$V^{*}_{s,40'}$ = **343** FT./SEC.

PGA CALCULATOR
Earthquake Moment Magnitude = 7.67
Source-To-Site Distance, R (km) = 24.22
Ground Motion Prediction Equations = NMSZ
PGA = **0.764**

	BORING DATA							CONDITIONS DURING DRILLING					CONDITIONS DURING EARTHQUAKE								
ELEV. OF SAMPLE (FT.)	BORING SAMPLE DEPTH (FT.)	SPT N VALUE (BLOWS)	UNCONF. COMPR. STR., Q_u (TSF.)	% FINES < #200 (%)	PLAST. INDEX PI	LIQUID LIMIT LL	MOIST. CONTENT w_c (%)	EFFECTIVE UNIT WT. (KCF.)	EFFECTIVE VERT. STRESS (KSF.)	CORR. SPT N VALUE $(N_1)_{60}$	EQUIV. CLN. SAND SPT N VALUE $(N_1)_{60cs}$	CRR RESIST. MAG 7.5 $CRR_{7.5}$	EFFECTIVE UNIT WT. (KCF.)	EFFECTIVE VERT. STRESS (KSF.)	TOTAL VERT. STRESS (KSF.)	OVER-BURDEN CORR. FACT. (Ks)	CORR. RESIST. $CRR_{7.5}$ CRR	SOIL MASS PART. FACTOR (r_d)	EQ INDUCED CSR	FACTOR OF SAFETY * CRR/CSR
404.9	4.5	7	3.7					0.138	0.621	11.941	11.941	0.131								
402.4	7	9	2.7					0.134	0.956	14.095	14.095	0.151	0.134	0.008	0.008	1.500	**0.217**	0.999	**0.496**	**N.L. (1)**
399.9	9.5	3	1.3					0.125	1.269	4.543	4.543	0.069	0.125	0.321	0.321	1.459	**0.096**	0.948	**0.471**	**N.L. (1)**
397.4	12	6	0.9					0.120	1.569	8.923	8.923	0.104	0.120	0.621	0.621	1.318	**0.131**	0.893	**0.443**	**N.L. (1)**
394.9	14.5	1	0.4					0.111	1.846	1.451	1.451	0.051	0.111	0.898	0.898	1.187	**0.057**	0.834	**0.414**	**N.L. (1)**
392.4	17	3	0.4					0.111	2.124	4.212	4.212	0.066	0.111	1.176	1.176	1.125	**0.071**	0.774	**0.384**	**N.L. (1)**
389.9	19.5	3	0.6					0.116	2.414	4.047	4.047	0.065	0.116	1.466	1.466	1.077	**0.067**	0.714	**0.354**	**N.L. (1)**
387.4	22	2	0.3					0.108	2.684	2.595	2.595	0.056	0.108	1.736	1.736	1.041	**0.056**	0.656	**0.326**	**N.L. (1)**
384.9	24.5	1	0.1					0.098	2.929	1.252	1.252	0.050	0.098	1.981	1.981	1.014	**0.048**	0.602	**0.299**	**N.L. (1)**
382.4	27	1	0.2					0.104	3.189	1.204	1.204	0.050	0.104	2.241	2.241	0.989	**0.047**	0.554	**0.275**	**N.L. (1)**
379.9	29.5	2	0.6					0.116	3.479	2.304	2.304	0.054	0.116	2.531	2.531	0.965	**0.050**	0.511	**0.254**	**N.L. (1)**
377.4	32	14						0.064	3.639	15.861	15.861	0.169	0.064	2.691	2.815	0.938	**0.151**	0.474	**0.247**	**0.611 (D)**
374.9	34.5	5						0.055	3.776	5.533	5.533	0.076	0.055	2.828	3.109	0.943	**0.069**	0.444	**0.242**	**0.285 (C)**
371.9	37.5	12						0.063	3.965	12.945	12.945	0.140	0.063	3.017	3.485	0.916	**0.123**	0.414	**0.237**	**0.519 (D)**
366.9	42.5	100						0.083	4.380	######	120.562	0.877	0.083	3.432	4.212	0.825	**0.691**	0.378	**0.230**	**N.L. (3)**
361.9	47.5	100						0.083	4.795	######	114.342	0.830	0.083	3.847	4.939	0.788	**0.625**	0.355	**0.226**	**N.L. (3)**
356.9	52.5	100						0.083	5.210	######	108.672	0.787	0.083	4.262	5.666	0.756	**0.569**	0.341	**0.225**	**N.L. (3)**
349.4	60	100						0.083	5.833	######	100.944	0.728	0.083	4.885	6.757	0.716	**0.499**	0.329	**0.226**	**N.L. (3)**

* FACTOR OF SAFETY DESCRIPTIONS

N.L. (1) = NOT LIQUEFIABLE, ABOVE EQ GROUND WATER ELEVATION
N.L. (2) = NOT LIQUEFIABLE, PI $\geq$ 12 OR w_c/LL $\leq$ 0.85
N.L. (3) = NOT LIQUEFIABLE, $(N_1)_{60} > 25$
(C) = CONTRACTIVE SOIL TYPES
(D) = DILATIVE SOIL TYPES

Printed 12/10/2018

Page 1 of 1

BBS 146 (11/01/16)

Illinois Department of Transportation

LIQUEFACTION ANALYSIS

REFERENCE BORING NUMBER ==========: 2-S
ELEVATION OF BORING GROUND SURFACE ==========: 409.20 FT.
DEPTH TO GROUNDWATER - DURING DRILLING ==========: 31.50 FT. (Below Boring Ground Surface)
DEPTH TO GROUNDWATER - DURING EARTHQUAKE ==========: 25.55 FT. (Below Finished Grade Cut or Fill Surface)
PEAK HORIZ. GROUND SURFACE ACCELERATION COEFFICIENT (As) =====: 0.764
EARTHQUAKE MOMENT MAGNITUDE ==========: 7.7
FINISHED GRADE FILL OR CUT FROM BORING SURFACE ==========: -5.95 FT. (Cut Depth)
HAMMER EFFICIENCY==========: 73 %
BOREHOLE DIAMETER==========: 8 IN.
SAMPLING METHOD==========: Sampler w/out Liners

EQ MAGNITUDE SCALING FACTOR
(MSF) = **0.957**

AVG. SHEAR WAVE VELOCITY (top 40')
$V^{*}_{s,40'}$ = **433** FT./SEC.

PGA CALCULATOR
Earthquake Moment Magnitude = 7.67
Source-To-Site Distance, R (km) = 24.22
Ground Motion Prediction Equations = NMSZ
PGA = **0.764**

	BORING DATA							CONDITIONS DURING DRILLING					CONDITIONS DURING EARTHQUAKE							
ELEV. OF SAMPLE (FT.)	BORING SAMPLE DEPTH (FT.)	SPT N VALUE (BLOWS)	UNCONF. COMPR. STR., Q_u (TSF.)	% FINES < #200 (%)	PLAST. INDEX PI	LIQUID LIMIT LL	MOIST. CONTENT w_c (%)	EFFECTIVE UNIT WT. (KCF.)	EFFECTIVE VERT. STRESS (KSF.)	CORR. SPT N VALUE $(N_1)_{60}$	EQUIV. CLN. SAND SPT N VALUE $(N_1)_{60cs}$	CRR RESIST. MAG 7.5 $CRR_{7.5}$	EFFECTIVE UNIT WT. (KCF.)	EFFECTIVE VERT. STRESS (KSF.)	TOTAL VERT. STRESS (KSF.)	OVER-BURDEN CORR. FACT. (Ks)	CORR. RESIST. $CRR_{7.5}$ CRR	SOIL MASS PART. FACTOR (r_d)	EQ INDUCED CSR	FACTOR OF SAFETY * CRR/CSR
405.7	3.5	3	2.5					0.133	0.466	5.367	5.367	0.075								
403.2	6	7	1.5					0.126	0.781	11.336	11.336	0.125	0.126	0.006	0.006	1.500	**0.179**	1.000	**0.496**	**N.L. (1)**
400.7	8.5	14	3.5					0.137	1.123	22.922	22.922	0.256	0.137	0.349	0.349	1.500	**0.367**	0.973	**0.483**	**N.L. (1)**
398.2	11	7	1.3					0.125	1.436	10.538	10.538	0.118	0.125	0.661	0.661	1.315	**0.148**	0.942	**0.468**	**N.L. (1)**
395.7	13.5	5	1.7					0.128	1.756	7.300	7.300	0.090	0.128	0.981	0.981	1.180	**0.102**	0.906	**0.450**	**N.L. (1)**
393.2	16	8	1.1					0.123	2.063	11.265	11.265	0.124	0.123	1.289	1.289	1.127	**0.134**	0.865	**0.430**	**N.L. (1)**
390.7	18.5	12	0.9					0.120	2.363	16.443	16.443	0.175	0.120	1.589	1.589	1.082	**0.181**	0.821	**0.408**	**N.L. (1)**
388.2	21	5	0.6					0.116	2.653	6.492	6.492	0.084	0.116	1.879	1.879	1.026	**0.082**	0.775	**0.385**	**N.L. (1)**
385.7	23.5	3	0.7					0.117	2.946	3.731	3.731	0.063	0.117	2.171	2.171	0.995	**0.060**	0.728	**0.361**	**N.L. (1)**
383.2	26	2	0.4					0.111	3.223	2.387	2.387	0.055	0.111	2.449	2.449	0.972	**0.051**	0.681	**0.338**	**N.L. (1)**
380.7	28.5	2	0.5					0.114	3.508	2.288	2.288	0.054	0.114	2.734	2.734	0.950	**0.049**	0.637	**0.316**	**N.L. (1)**
378.2	31	2	0.5					0.114	3.793	2.196	2.196	0.054	0.114	3.019	3.019	0.932	**0.048**	0.595	**0.296**	**N.L. (1)**
375.7	33.5	2	0.9		10	40	44	0.058	3.938	2.155	2.155	0.054	0.058	3.164	3.289	0.923	**0.047**	0.558	**0.288**	**0.163 (C)**
372.7	36.5	8						0.059	4.115	8.425	8.425	0.100	0.059	3.341	3.653	0.904	**0.086**	0.520	**0.282**	**0.305 (C)**
371.2	38	100						0.083	4.240	######	122.408	0.890	0.083	3.465	3.871	0.822	**0.700**	0.503	**0.279**	**N.L. (3)**
366.2	43	100						0.083	4.655	######	116.030	0.842	0.083	3.880	4.598	0.785	**0.633**	0.459	**0.270**	**N.L. (3)**
361.2	48	100						0.083	5.070	######	110.272	0.799	0.083	4.295	5.325	0.754	**0.576**	0.429	**0.264**	**N.L. (3)**
356.2	53	100						0.083	5.485	######	104.992	0.759	0.083	4.710	6.052	0.727	**0.527**	0.410	**0.262**	**N.L. (3)**
349.2	60	100						0.083	6.066	98.213	98.213	0.707	0.083	5.291	7.070	0.694	**0.469**	0.395	**0.262**	**N.L. (3)**

* FACTOR OF SAFETY DESCRIPTIONS

N.L. (1) = NOT LIQUEFIABLE, ABOVE EQ GROUND WATER ELEVATION
N.L. (2) = NOT LIQUEFIABLE, PI $\geq$ 12 OR w_c/LL $\leq$ 0.85
N.L. (3) = NOT LIQUEFIABLE, $(N_1)_{60} > 25$
(C) = CONTRACTIVE SOIL TYPES
(D) = DILATIVE SOIL TYPES

Illinois Department of Transportation

LIQUEFACTION ANALYSIS

REFERENCE BORING NUMBER ==========: 3-S
ELEVATION OF BORING GROUND SURFACE ==========: 382.20 FT.
DEPTH TO GROUNDWATER - DURING DRILLING ==========: 0.00 FT. (Below Boring Ground Surface)
DEPTH TO GROUNDWATER - DURING EARTHQUAKE ==========: 0.00 FT. (Below Finished Grade Cut or Fill Surface)
PEAK HORIZ. GROUND SURFACE ACCELERATION COEFFICIENT (As) =====: 0.764
EARTHQUAKE MOMENT MAGNITUDE ==========: 7.7
FINISHED GRADE FILL OR CUT FROM BORING SURFACE ==========: -1.20 FT. (Cut Depth)
HAMMER EFFICIENCY==========: 73 %
BOREHOLE DIAMETER==========: 8 IN.
SAMPLING METHOD==========: Sampler w/out Liners

EQ MAGNITUDE SCALING FACTOR
(MSF) = **0.957**

AVG. SHEAR WAVE VELOCITY (top 40')
$V^{*}_{s,40'}$ = **769** FT./SEC.

PGA CALCULATOR
Earthquake Moment Magnitude = 7.67
Source-To-Site Distance, R (km) = 24.22
Ground Motion Prediction Equations = NMSZ
PGA = **0.764**

	BORING DATA							CONDITIONS DURING DRILLING					CONDITIONS DURING EARTHQUAKE								
ELEV. OF SAMPLE (FT.)	BORING SAMPLE DEPTH (FT.)	SPT N VALUE (BLOWS)	UNCONF. COMPR. STR., Q_u (TSF.)	% FINES < #200 (%)	PLAST. INDEX PI	LIQUID LIMIT LL	MOIST. CONTENT w_c (%)	EFFECTIVE UNIT WT. (KCF.)	EFFECTIVE VERT. STRESS (KSF.)	CORR. SPT N VALUE $(N_1)_{60}$	EQUIV. CLN. SAND SPT N VALUE $(N_1)_{60cs}$	CRR RESIST. MAG 7.5 $CRR_{7.5}$	EFFECTIVE UNIT WT. (KCF.)	EFFECTIVE VERT. STRESS (KSF.)	TOTAL VERT. STRESS (KSF.)	OVER-BURDEN CORR. FACT. (Ks)	CORR. RESIST. $CRR_{7.5}$ CRR	SOIL MASS PART. FACTOR (r_d)	EQ INDUCED CSR	FACTOR OF SAFETY * CRR/CSR
377.7	4.5	2						0.048	0.216	3.901	3.901	0.064	0.048	0.158	0.364	1.500	**0.092**	0.999	**1.141**	0.081 (C)
375.2	7	6						0.057	0.359	11.129	11.129	0.123	0.057	0.301	0.663	1.500	**0.177**	0.997	**1.091**	0.162 (D)
372.7	9.5	11						0.062	0.514	22.051	22.051	0.243	0.062	0.456	0.974	1.500	**0.348**	0.995	**1.056**	0.330 (D)
369.7	12.5	2						0.048	0.658	3.856	3.856	0.064	0.048	0.600	1.305	1.287	**0.079**	0.992	**1.072**	0.074 (C)
364.7	17.5	100						0.083	1.073	######	215.159	1.583	0.083	1.015	2.032	1.343	**2.033**	0.985	**0.979**	**N.L. (3)**
359.7	22.5	100						0.083	1.488	######	199.281	1.465	0.083	1.430	2.759	1.171	**1.641**	0.973	**0.932**	**N.L. (3)**
354.7	27.5	100						0.083	1.903	######	183.638	1.349	0.083	1.845	3.486	1.057	**1.364**	0.955	**0.896**	**N.L. (3)**
344.7	37.5	100						0.083	2.733	######	157.271	1.152	0.083	2.675	4.940	0.911	**1.004**	0.895	**0.821**	**N.L. (3)**
334.7	47.5	100						0.083	3.563	######	137.420	1.003	0.083	3.505	6.394	0.818	**0.785**	0.813	**0.736**	**N.L. (3)**
322.2	60	100						0.083	4.600	######	118.360	0.860	0.083	4.542	8.212	0.737	**0.606**	0.730	**0.655**	**N.L. (3)**

* FACTOR OF SAFETY DESCRIPTIONS
N.L. (1) = NOT LIQUEFIABLE, ABOVE EQ GROUND WATER ELEVATION
N.L. (2) = NOT LIQUEFIABLE, PI $\geq$ 12 OR $w_c/LL \leq 0.85$
N.L. (3) = NOT LIQUEFIABLE, $(N_1)_{60} > 25$
(C) = CONTRACTIVE SOIL TYPES
(D) = DILATIVE SOIL TYPES

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Illinois Department of Transportation

LIQUEFACTION ANALYSIS

REFERENCE BORING NUMBER ==========: 4-S
ELEVATION OF BORING GROUND SURFACE ==========: 402.80 FT.
DEPTH TO GROUNDWATER - DURING DRILLING ==========: 22.50 FT. (Below Boring Ground Surface)
DEPTH TO GROUNDWATER - DURING EARTHQUAKE ==========: 17.30 FT. (Below Finished Grade Cut or Fill Surface)
PEAK HORIZ. GROUND SURFACE ACCELERATION COEFFICIENT (As) =====: 0.764
EARTHQUAKE MOMENT MAGNITUDE ==========: 7.7
FINISHED GRADE FILL OR CUT FROM BORING SURFACE ==========: -5.20 FT. (Cut Depth)
HAMMER EFFICIENCY==========: 73 %
BOREHOLE DIAMETER==========: 8 IN.
SAMPLING METHOD==========: Sampler w/out Liners

EQ MAGNITUDE SCALING FACTOR
(MSF) = **0.957**

AVG. SHEAR WAVE VELOCITY (top 40')
$V^{*}_{s,40'}$ = **502** FT./SEC.

PGA CALCULATOR
Earthquake Moment Magnitude = 7.67
Source-To-Site Distance, R (km) = 24.22
Ground Motion Prediction Equations = NMSZ
PGA = **0.764**

	BORING DATA							CONDITIONS DURING DRILLING					CONDITIONS DURING EARTHQUAKE								
ELEV. OF SAMPLE (FT.)	BORING SAMPLE DEPTH (FT.)	SPT N VALUE (BLOWS)	UNCONF. COMPR. STR., Q_u (TSF.)	% FINES < #200 (%)	PLAST. INDEX PI	LIQUID LIMIT LL	MOIST. CONTENT w_c (%)	EFFECTIVE UNIT WT. (KCF.)	EFFECTIVE VERT. STRESS (KSF.)	CORR. SPT N VALUE $(N_1)_{60}$	EQUIV. CLN. SAND SPT N VALUE $(N_1)_{60cs}$	CRR RESIST. MAG 7.5 $CRR_{7.5}$	EFFECTIVE UNIT WT. (KCF.)	EFFECTIVE VERT. STRESS (KSF.)	TOTAL VERT. STRESS (KSF.)	OVER-BURDEN CORR. FACT. (Ks)	CORR. RESIST. $CRR_{7.5}$ CRR	SOIL MASS PART. FACTOR (r_d)	EQ INDUCED CSR	FACTOR OF SAFETY * CRR/CSR
400.3	2.5	4	1.1					0.123	0.308	7.552	7.552	0.092								
397.8	5	4	1.2					0.124	0.618	6.812	6.812	0.086								
395.3	7.5	5	1.1					0.123	0.925	7.810	7.810	0.094	0.123	0.283	0.283	1.500	**0.135**	0.986	**0.490**	**N.L. (1)**
392.8	10	3	0.7					0.117	1.218	4.666	4.666	0.070	0.117	0.575	0.575	1.298	**0.086**	0.968	**0.481**	**N.L. (1)**
390.3	12.5	6	1.5					0.126	1.533	9.086	9.086	0.105	0.126	0.890	0.890	1.216	**0.122**	0.947	**0.470**	**N.L. (1)**
387.8	15	7	1.1					0.123	1.840	10.236	10.236	0.115	0.123	1.198	1.198	1.142	**0.126**	0.921	**0.458**	**N.L. (1)**
385.3	17.5	4	0.6					0.116	2.130	5.635	5.635	0.077	0.116	1.488	1.488	1.075	**0.079**	0.892	**0.443**	**N.L. (1)**
382.8	20	4	0.6					0.116	2.420	5.406	5.406	0.075	0.116	1.778	1.778	1.036	**0.074**	0.858	**0.426**	**N.L. (1)**
380.3	22.5	1	0.3					0.108	2.690	1.299	1.299	0.050	0.108	2.048	2.048	1.007	**0.048**	0.822	**0.408**	**N.L. (1)**
377.8	25	8						0.059	2.838	10.201	10.201	0.115	0.059	2.195	2.351	0.992	**0.109**	0.783	**0.416**	**0.262 (C)**
375.3	27.5	4						0.053	2.970	5.012	5.012	0.072	0.053	2.328	2.640	0.981	**0.068**	0.743	**0.418**	**0.163 (C)**
373.3	29.5	9						0.060	3.090	11.084	11.084	0.123	0.060	2.448	2.885	0.966	**0.114**	0.710	**0.416**	**0.274 (C)**
368.3	34.5	100						0.083	3.505	######	136.650	0.998	0.083	2.863	3.612	0.887	**0.846**	0.635	**0.398**	**N.L. (3)**
363.3	39.5	100						0.083	3.920	######	128.693	0.938	0.083	3.278	4.339	0.840	**0.753**	0.571	**0.376**	**N.L. (3)**
360.3	42.5	100						0.083	4.169	######	124.352	0.905	0.083	3.527	4.775	0.816	**0.706**	0.541	**0.364**	**N.L. (3)**
350.3	52.5	100						0.083	4.999	######	111.712	0.810	0.083	4.357	6.229	0.750	**0.581**	0.477	**0.339**	**N.L. (3)**
342.8	60	100						0.083	5.622	######	103.553	0.748	0.083	4.979	7.319	0.711	**0.508**	0.455	**0.332**	**N.L. (3)**

* FACTOR OF SAFETY DESCRIPTIONS

N.L. (1) = NOT LIQUEFIABLE, ABOVE EQ GROUND WATER ELEVATION
N.L. (2) = NOT LIQUEFIABLE, PI $\geq$ 12 OR w_c/LL $\leq$ 0.85
N.L. (3) = NOT LIQUEFIABLE, $(N_1)_{60} > 25$
(C) = CONTRACTIVE SOIL TYPES
(D) = DILATIVE SOIL TYPES

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LIQUEFACTION ANALYSIS

REFERENCE BORING NUMBER ==========: 5-S
ELEVATION OF BORING GROUND SURFACE ==========: 381.80 FT.
DEPTH TO GROUNDWATER - DURING DRILLING ==========: 0.00 FT. (Below Boring Ground Surface)
DEPTH TO GROUNDWATER - DURING EARTHQUAKE ==========: 0.00 FT. (Below Finished Grade Cut or Fill Surface)
PEAK HORIZ. GROUND SURFACE ACCELERATION COEFFICIENT (As) =====: 0.764
EARTHQUAKE MOMENT MAGNITUDE ==========: 7.7
FINISHED GRADE FILL OR CUT FROM BORING SURFACE ==========: -0.80 FT. (Cut Depth)
HAMMER EFFICIENCY==========: 73 %
BOREHOLE DIAMETER==========: 8 IN.
SAMPLING METHOD==========: Sampler w/out Liners

EQ MAGNITUDE SCALING FACTOR
(MSF) = **0.957**

AVG. SHEAR WAVE VELOCITY (top 40')
$V^{*}_{s,40'}$ = **852** FT./SEC.

PGA CALCULATOR
Earthquake Moment Magnitude = 7.67
Source-To-Site Distance, R (km) = 24.22
Ground Motion Prediction Equations = NMSZ
PGA = **0.764**

	BORING DATA							CONDITIONS DURING DRILLING					CONDITIONS DURING EARTHQUAKE								
ELEV. OF SAMPLE (FT.)	BORING SAMPLE DEPTH (FT.)	SPT N VALUE (BLOWS)	UNCONF. COMPR. STR., Q_u (TSF.)	% FINES < #200 (%)	PLAST. INDEX PI	LIQUID LIMIT LL	MOIST. CONTENT w_c (%)	EFFECTIVE UNIT WT. (KCF.)	EFFECTIVE VERT. STRESS (KSF.)	CORR. SPT N VALUE $(N_1)_{60}$	EQUIV. CLN. SAND SPT N VALUE $(N_1)_{60cs}$	CRR RESIST. MAG 7.5 $CRR_{7.5}$	EFFECTIVE UNIT WT. (KCF.)	EFFECTIVE VERT. STRESS (KSF.)	TOTAL VERT. STRESS (KSF.)	OVER-BURDEN CORR. FACT. (Ks)	CORR. RESIST. $CRR_{7.5}$ CRR	SOIL MASS PART. FACTOR (r_d)	EQ INDUCED CSR	FACTOR OF SAFETY * CRR/CSR
378.3	3.5	1						0.043	0.151	1.962	1.962	0.053	0.043	0.116	0.285	1.500	**0.076**	1.000	**1.217**	0.062 (C)
375.8	6	7						0.058	0.296	13.453	13.453	0.145	0.058	0.261	0.586	1.500	**0.208**	0.999	**1.113**	0.187 (D)
372.8	9	7						0.058	0.470	13.322	13.322	0.144	0.058	0.435	0.947	1.491	**0.205**	0.998	**1.079**	0.190 (D)
370.3	11.5	23						0.068	0.640	51.701	51.701	0.322	0.068	0.605	1.273	1.500	**0.461**	0.997	**1.042**	N.L. (3)
365.3	16.5	100						0.083	1.055	######	214.179	1.576	0.083	1.020	2.000	1.340	**2.020**	0.994	**0.968**	N.L. (3)
360.8	21	100						0.083	1.428	######	200.781	1.476	0.083	1.394	2.654	1.183	**1.670**	0.990	**0.937**	N.L. (3)
350.8	31	100						0.083	2.258	######	171.227	1.256	0.083	2.224	4.108	0.981	**1.179**	0.973	**0.892**	N.L. (3)
340.8	41	100						0.083	3.088	######	147.966	1.082	0.083	3.054	5.562	0.864	**0.895**	0.934	**0.845**	N.L. (3)
330.8	51	100						0.083	3.918	######	130.256	0.949	0.083	3.884	7.016	0.785	**0.713**	0.875	**0.785**	N.L. (3)
321.8	60	100						0.083	4.665	######	117.292	0.852	0.083	4.631	8.325	0.732	**0.596**	0.822	**0.734**	N.L. (3)

* FACTOR OF SAFETY DESCRIPTIONS
N.L. (1) = NOT LIQUEFIABLE, ABOVE EQ GROUND WATER ELEVATION
N.L. (2) = NOT LIQUEFIABLE, PI $\geq$ 12 OR $w_c/LL \leq 0.85$
N.L. (3) = NOT LIQUEFIABLE, $(N_1)_{60} > 25$
(C) = CONTRACTIVE SOIL TYPES
(D) = DILATIVE SOIL TYPES

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LIQUEFACTION ANALYSIS

REFERENCE BORING NUMBER ==========: 6-S
ELEVATION OF BORING GROUND SURFACE ==========: 403.70 FT.
DEPTH TO GROUNDWATER - DURING DRILLING ==========: 26.00 FT. (Below Boring Ground Surface)
DEPTH TO GROUNDWATER - DURING EARTHQUAKE ==========: 20.86 FT. (Below Finished Grade Cut or Fill Surface)
PEAK HORIZ. GROUND SURFACE ACCELERATION COEFFICIENT (As) =====: 0.764
EARTHQUAKE MOMENT MAGNITUDE ==========: 7.7
FINISHED GRADE FILL OR CUT FROM BORING SURFACE ==========: -5.14 FT. (Cut Depth)
HAMMER EFFICIENCY==========: 73 %
BOREHOLE DIAMETER==========: 8 IN.
SAMPLING METHOD==========: Sampler w/out Liners

EQ MAGNITUDE SCALING FACTOR
(MSF) = **0.957**

AVG. SHEAR WAVE VELOCITY (top 40')
$V^{*}_{s,40'}$ = **393** FT./SEC.

PGA CALCULATOR
Earthquake Moment Magnitude = 7.67
Source-To-Site Distance, R (km) = 24.22
Ground Motion Prediction Equations = NMSZ
PGA = **0.764**

	BORING DATA							CONDITIONS DURING DRILLING					CONDITIONS DURING EARTHQUAKE							
ELEV. OF SAMPLE (FT.)	BORING SAMPLE DEPTH (FT.)	SPT N VALUE (BLOWS)	UNCONF. COMPR. STR., Q_u (TSF.)	% FINES < #200 (%)	PLAST. INDEX PI	LIQUID LIMIT LL	MOIST. CONTENT w_c (%)	EFFECTIVE UNIT WT. (KCF.)	EFFECTIVE VERT. STRESS (KSF.)	CORR. SPT N VALUE $(N_1)_{60}$	EQUIV. CLN. SAND SPT N VALUE $(N_1)_{60cs}$	CRR RESIST. MAG 7.5 $CRR_{7.5}$	EFFECTIVE UNIT WT. (KCF.)	EFFECTIVE VERT. STRESS (KSF.)	TOTAL VERT. STRESS (KSF.)	OVER-BURDEN CORR. FACT. (Ks)	CORR. RESIST. $CRR_{7.5}$ CRR	SOIL MASS PART. FACTOR (r_d)	EQ INDUCED CSR	FACTOR OF SAFETY * CRR/CSR
401.7	2	8	2.3					0.132	0.264	15.797	15.797	0.168								
399.2	4.5	13	1.4					0.125	0.577	24.351	24.351	0.280								
396.7	7	8	1.6					0.127	0.894	12.625	12.625	0.137	0.127	0.236	0.236	1.500	**0.197**	0.974	**0.484**	**N.L. (1)**
394.2	9.5	9	1.2					0.124	1.204	14.015	14.015	0.150	0.124	0.546	0.546	1.416	**0.204**	0.934	**0.464**	**N.L. (1)**
391.7	12	6	1.1					0.123	1.512	9.048	9.048	0.105	0.123	0.854	0.854	1.228	**0.123**	0.890	**0.442**	**N.L. (1)**
389.2	14.5	2	0.4					0.111	1.789	2.940	2.940	0.058	0.111	1.131	1.131	1.134	**0.063**	0.841	**0.418**	**N.L. (1)**
386.7	17	2	0.7					0.117	2.082	2.834	2.834	0.057	0.117	1.424	1.424	1.083	**0.059**	0.790	**0.392**	**N.L. (1)**
384.2	19.5	1	0.5					0.114	2.367	1.362	1.362	0.050	0.114	1.709	1.709	1.044	**0.050**	0.738	**0.366**	**N.L. (1)**
381.7	22	1	0.3					0.108	2.637	1.309	1.309	0.050	0.108	1.979	1.979	1.014	**0.049**	0.686	**0.341**	**N.L. (1)**
379.2	24.5	6	1.8					0.128	2.957	7.473	7.473	0.092	0.128	2.299	2.299	0.983	**0.086**	0.637	**0.316**	**N.L. (1)**
376.7	27	7	1.1		12	40	27	0.060	3.107	8.549	8.549	0.101	0.060	2.449	2.511	0.968	**0.093**	0.591	**0.301**	**N.L. (2)**
374.2	29.5	5						0.055	3.244	5.994	5.994	0.080	0.055	2.586	2.805	0.960	**0.073**	0.550	**0.296**	**0.247 (C)**
372.2	31.5	1	0.2		12	41	58	0.042	3.328	1.186	1.186	0.050	0.042	2.670	3.013	0.955	**0.045**	0.520	**0.292**	**N.L. (2)**
367.2	36.5	100						0.083	3.743	######	131.826	0.961	0.083	3.085	3.740	0.861	**0.791**	0.461	**0.278**	**N.L. (3)**
362.2	41.5	100						0.083	4.158	######	124.414	0.906	0.083	3.500	4.467	0.818	**0.709**	0.421	**0.267**	**N.L. (3)**
357.2	46.5	100						0.083	4.573	######	117.794	0.856	0.083	3.915	5.194	0.782	**0.640**	0.395	**0.260**	**N.L. (3)**
352.2	51.5	100						0.083	4.988	######	111.795	0.810	0.083	4.330	5.921	0.752	**0.582**	0.378	**0.257**	**N.L. (3)**
343.7	60	100						0.083	5.694	######	102.648	0.741	0.083	5.036	7.157	0.707	**0.501**	0.363	**0.256**	**N.L. (3)**

* FACTOR OF SAFETY DESCRIPTIONS

N.L. (1) = NOT LIQUEFIABLE, ABOVE EQ GROUND WATER ELEVATION
N.L. (2) = NOT LIQUEFIABLE, PI $\geq$ 12 OR $w_c/LL \leq 0.85$
N.L. (3) = NOT LIQUEFIABLE, $(N_1)_{60} > 25$
(C) = CONTRACTIVE SOIL TYPES
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Illinois Department of Transportation

IDOT STATIC METHOD OF ESTIMATING PILE LENGTH

SUBSTRUCTURE========== NB North Abutment
REFERENCE BORING ========== 1-S
LRFD or ASD or SEISMIC ========== LRFD
PILE CUTOFF ELEV. ========== 404.31 ft
GROUND SURFACE ELEV. AGAINST PILE DURING DRIVING = 402.31 ft
GEOTECHNICAL LOSS TYPE (None, Scour, Liquef., DD) ====== None
BOTTOM ELEV. OF SCOUR, LIQUEF., or DD ========== ft
TOP ELEV. OF LIQUEF. (so layers above apply DD) ========== ft

TOTAL FACTORED SUBSTRUCTURE LOAD ========== 820 kips
TOTAL LENGTH OF SUBSTRUCTURE (along skew)========== 64.00 ft
NUMBER OF ROWS OF PILES PER SUBSTRUCTURE ====== 1
Approx. Factored Loading Applied per pile at 8 ft. Cts ========== 102.50 KIPS
Approx. Factored Loading Applied per pile at 3 ft. Cts ========== 38.44 KIPS

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

Maximum Nominal Req'd Bearing of Pile	Maximum Nominal Req.d Bearing of Boring	Maximum Factored Resistance Available in Boring	Maximum Pile Driveable Length in Boring
418 KIPS	**418** KIPS	**230** KIPS	**35** FT.

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.)
402.25	0.06	2.70			0.3		18.3	0.5		***2.5***	2	0	0	1	2
399.75	2.50	1.30			8.6	17.9	21.4	12.6	2.0	***14.5***	14	0	0	8	5
397.25	2.50	0.90			6.5	12.4	***20.9***	9.5	1.4	23.2	21	0	0	12	7
394.75	2.50	0.40			3.1	5.5	***24.1***	4.6	0.6	27.8	24	0	0	13	10
392.25	2.50	0.40			3.1	5.5	***30.0***	4.6	0.6	32.7	30	0	0	16	12
389.75	2.50	0.60			4.6	8.3	***30.4***	6.7	0.9	38.9	30	0	0	17	15
387.25	2.50	0.30			2.4	4.1	***30.1***	3.5	0.5	42.1	30	0	0	17	17
384.75	2.50	0.10			0.8	1.4	***32.3***	1.2	0.2	43.4	32	0	0	18	20
382.25	2.50	0.20			1.6	2.8	***39.4***	2.4	0.3	46.4	39	0	0	22	22
379.75	2.50	0.60			4.6	8.3	70.0	6.7	0.9	***55.9***	56	0	0	31	25
377.25	2.50		14	Sandy Gravel	3.2	34.3	***51.2***	4.7	3.8	58.3	51	0	0	28	27
374.75	2.50		5	Sandy Gravel	1.2	12.2	69.5	1.7	1.3	***61.8***	62	0	0	34	30
371.75	3.00		12	Sandy Gravel	3.3	29.4	288.4	4.9	3.2	***90.3***	90	0	0	50	33
371.25	0.50			Limestone	49.4	245.0	337.8	72.3	26.8	***162.6***	163	0	0	89	33.1
370.75	0.50			Limestone	49.4	245.0	387.2	72.3	26.8	***234.8***	235	0	0	129	33.6
370.25	0.50			Limestone	49.4	245.0	436.7	72.3	26.8	***307.1***	307	0	0	169	34.1
369.75	0.50			Limestone	49.4	245.0	486.1	72.3	26.8	***379.3***	379	0	0	209	34.6
369.25	0.50			Limestone	49.4	245.0	535.5	72.3	26.8	***451.6***	~~452~~	~~0~~	~~0~~	~~248~~	~~35.1~~
368.75	0.50			Limestone	49.4	245.0	584.9	72.3	26.8	***523.8***	~~524~~	~~0~~	~~0~~	~~288~~	~~35.6~~
368.25	0.50			Limestone	49.4	245.0	634.3	72.3	26.8	***596.1***	~~596~~	~~0~~	~~0~~	~~328~~	~~36.1~~
367.25	1.00			Limestone	98.8	245.0	***733.1***	144.5	26.8	740.6	~~733~~	~~0~~	~~0~~	~~403~~	~~37.1~~
366.25	1.00			Limestone	98.8	245.0	***832.0***	144.5	26.8	885.1	~~832~~	~~0~~	~~0~~	~~458~~	~~38.1~~
365.25	1.00			Limestone		245.0			26.8						

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Illinois Department of Transportation

IDOT STATIC METHOD OF ESTIMATING PILE LENGTH

SUBSTRUCTURE========== NB North Abutment
REFERENCE BORING ========== 1-S
LRFD or ASD or SEISMIC ========== SEISMIC
PILE CUTOFF ELEV. ========== 404.31 ft
GROUND SURFACE ELEV. AGAINST PILE DURING DRIVING = 402.31 ft
GEOTECHNICAL LOSS TYPE (None, Scour, Liquef., DD) ====== Liquef.
BOTTOM ELEV. OF SCOUR, LIQUEF., or DD ========== 371.90 ft
TOP ELEV. OF LIQUEF. (so layers above apply DD) ========== 379.90 ft

TOTAL SEISMIC SUBSTRUCTURE LOAD ========== 615 kips
TOTAL LENGTH OF SUBSTRUCTURE (along skew)========== 64.00 ft
NUMBER OF ROWS OF PILES PER SUBSTRUCTURE ====== 1
Approx. Seismic Loading Applied per pile spaced at 8 ft. Cts ======= 76.88 KIPS
Approx. Seismic Loading Applied per pile spaced at 3 ft. Cts ======= 28.83 KIPS

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

Maximum Nominal Req'd Bearing of Pile	Maximum Nominal Req.d Bearing of Boring	Maximum Seismic Resistance Available in Boring	Maximum Pile Driveable Length in Boring
929 KIPS	**137** KIPS	**46** KIPS	**33** FT.

PILE TYPE AND SIZE ========== Steel HP 14 X 117
Pile Perimeter========== 4.850 FT. Unplugged Pile Perimeter========== 7.117 FT.
Pile End Bearing Area========== 1.469 SQFT. Unplugged Pile End Bearing Area========= 0.239 SQFT.

BOT. OF LAYER ELEV. (FT.)	LAYER THICK. (FT.)	UNCONF. COMPR. STRENGTH (TSF.)	S.P.T. N VALUE (BLOWS)	GRANULAR OR ROCK LAYER DESCRIPTION	ULTIMATE SIDE RESIST. (KIPS)	ULTIMATE END BRG. RESIST. (KIPS)	ULTIMATE TOTAL RESIST. (KIPS)	ULTIMATE UNPLUGGED SIDE RESIST. (KIPS)	ULTIMATE UNPLUGGED END BRG. RESIST. (KIPS)	ULTIMATE UNPLUGGED TOTAL RESIST. (KIPS)	NOMINAL REQ'D BEARING (KIPS)	NOMINAL GEOTECH. LOSS FROM LIQUEF. & DD (KIPS)	FACTORED GEOTECH. LOSS LOAD FROM DD (KIPS)	SEISMIC RESISTANCE AVAILABLE (KIPS)	ESTIMATED PILE LENGTH (FT.)
402.25	0.06	2.70			0.4		27.2	0.6		***5.0***	5	0	0	4	2
399.75	2.50	1.30			10.5	26.8	29.5	15.5	4.4	***19.1***	19	11	12	-4	5
397.25	2.50	0.90			7.9	18.5	***27.1***	11.6	3.0	29.0	27	19	21	-13	7
394.75	2.50	0.40			3.8	8.2	***30.9***	5.6	1.3	34.7	31	23	25	-17	10
392.25	2.50	0.40			3.8	8.2	***38.9***	5.6	1.3	41.0	39	27	29	-17	12
389.75	2.50	0.60			5.6	12.4	***38.3***	8.2	2.0	48.2	38	32	35	-29	15
387.25	2.50	0.30			2.9	6.2	***37.1***	4.3	1.0	51.8	37	35	39	-37	17
384.75	2.50	0.10			1.0	2.1	***40.2***	1.5	0.3	53.6	40	36	40	-36	20
382.25	2.50	0.20			2.0	4.1	***50.4***	2.9	0.7	57.9	50	38	42	-30	22
379.75	2.50	0.60			5.6	12.4	94.9	8.2	2.0	***72.4***	72	44	42	-13	25
377.25	2.50		14	Sandy Gravel	4.0	51.2	***65.9***	5.8	8.3	72.8	66	48	42	-24	27
374.75	2.50		5	Sandy Gravel	1.4	18.3	93.0	2.1	3.0	***79.1***	79	49	42	-12	30
371.75	3.00		12	Sandy Gravel	4.1	43.9	419.2	6.0	7.1	***137.4***	137	49	42	46	33
371.25	0.50			Limestone	60.4	366.1	479.6	88.7	59.5	***226.1***	226	49	42	135	33.1
370.75	0.50			Limestone	60.4	366.1	540.0	88.7	59.5	***314.7***	315	49	42	224	33.6
370.25	0.50			Limestone	60.4	366.1	600.4	88.7	59.5	***403.4***	403	49	42	312	34.1
369.75	0.50			Limestone	60.4	366.1	660.8	88.7	59.5	***492.1***	492	49	42	401	34.6
369.25	0.50			Limestone	60.4	366.1	721.3	88.7	59.5	***580.7***	581	49	42	490	35.1
368.75	0.50			Limestone	60.4	366.1	781.7	88.7	59.5	***669.4***	669	49	42	578	35.6
368.25	0.50			Limestone	60.4	366.1	842.1	88.7	59.5	***758.0***	758	49	42	667	36.1
367.29	0.96			Limestone	116.2	366.1	958.3	170.6	59.5	***928.6***	929	49	42	838	37
366.29	1.00			Limestone	120.8	366.1	***1079.2***	177.3	59.5	1105.9	~~1079~~	~~49~~	~~42~~	~~988~~	~~38~~
365.29	1.00			Limestone		366.1			59.5						

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Illinois Department of Transportation

IDOT STATIC METHOD OF ESTIMATING PILE LENGTH

SUBSTRUCTURE========== NB South Abutment
REFERENCE BORING ========== 2-S
LRFD or ASD or SEISMIC ========== LRFD
PILE CUTOFF ELEV. ========== 405.04 ft
GROUND SURFACE ELEV. AGAINST PILE DURING DRIVING = 403.04 ft
GEOTECHNICAL LOSS TYPE (None, Scour, Liquef., DD) ====== None
BOTTOM ELEV. OF SCOUR, LIQUEF., or DD ========== ft
TOP ELEV. OF LIQUEF. (so layers above apply DD) ========== ft

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

Maximum Nominal Req'd Bearing of Pile	Maximum Nominal Req.d Bearing of Boring	Maximum Factored Resistance Available in Boring	Maximum Pile Driveable Length in Boring
335 KIPS	**335** KIPS	**184** KIPS	**35** FT.

TOTAL FACTORED SUBSTRUCTURE LOAD ========== 820 kips
TOTAL LENGTH OF SUBSTRUCTURE (along skew)========== 64.00 ft
NUMBER OF ROWS OF PILES PER SUBSTRUCTURE ====== 1
Approx. Factored Loading Applied per pile at 8 ft. Cts ========== 102.50 KIPS
Approx. Factored Loading Applied per pile at 3 ft. Cts ========== 38.44 KIPS

PILE TYPE AND SIZE ========== Steel HP 10 X 42
Plugged Pile Perimeter========== 3.300 FT. Unplugged Pile Perimeter========== 4.858 FT.
Plugged Pile End Bearing Area========== 0.680 SQFT. Unplugged Pile End Bearing Area========= 0.086 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.)
402.99	0.05	1.50			0.2		33.5	0.2		***4.5***	4	0	0	2	2
400.49	2.50	3.50	14		14.1	33.4	26.7	20.8	4.2	***22.6***	23	0	0	12	5
397.99	2.50	1.30			7.2	12.4	37.7	10.6	1.6	***33.7***	34	0	0	19	7
395.49	2.50	1.70			8.6	16.2	***40.6***	12.7	2.1	45.6	41	0	0	22	10
392.99	2.50	1.10			6.3	10.5	***45.0***	9.3	1.3	54.7	45	0	0	25	12
390.49	2.50	0.90			5.4	8.6	***47.5***	7.9	1.1	62.3	48	0	0	26	15
387.99	2.50	0.60			3.8	5.7	***52.3***	5.6	0.7	68.0	52	0	0	29	17
385.49	2.50	0.70			4.3	6.7	***53.8***	6.4	0.8	74.0	54	0	0	30	20
382.99	2.50	0.40			2.6	3.8	***57.3***	3.9	0.5	78.0	57	0	0	32	22
380.49	2.50	0.50			3.2	4.8	***60.5***	4.7	0.6	82.7	61	0	0	33	25
377.99	2.50	0.50			3.2	4.8	***67.6***	4.7	0.6	87.9	68	0	0	37	27
375.49	2.50	0.90			5.4	8.6	***77.9***	7.9	1.1	96.5	78	0	0	43	30
372.49	3.00		8	Sandy Gravel	1.8	13.6	235.7	2.7	1.7	***118.9***	119	0	0	65	33
371.99	0.50			Limestone	41.1	169.5	276.8	60.5	21.5	***179.5***	179	0	0	99	33.1
371.49	0.50			Limestone	41.1	169.5	317.9	60.5	21.5	***240.0***	240	0	0	132	33.6
370.99	0.50			Limestone	41.1	169.5	359.0	60.5	21.5	***300.5***	301	0	0	165	34.1
370.49	0.50			Limestone	41.1	169.5	400.2	60.5	21.5	***361.0***	~~361~~	~~0~~	~~0~~	~~199~~	~~34.6~~
369.99	0.50			Limestone	41.1	169.5	441.3	60.5	21.5	***421.5***	~~422~~	~~0~~	~~0~~	~~232~~	~~35.1~~
368.99	1.00			Limestone	82.2	169.5	***523.5***	121.0	21.5	542.6	~~523~~	~~0~~	~~0~~	~~288~~	~~36.1~~
367.99	1.00			Limestone	82.2	169.5	***605.7***	121.0	21.5	663.6	~~606~~	~~0~~	~~0~~	~~333~~	~~37.1~~
366.99	1.00			Limestone	82.2	169.5	***687.9***	121.0	21.5	784.7	~~688~~	~~0~~	~~0~~	~~378~~	~~38.1~~
365.99	1.00			Limestone		169.5			21.5						

Illinois Department of Transportation

IDOT STATIC METHOD OF ESTIMATING PILE LENGTH

SUBSTRUCTURE========== NB South Abutment
REFERENCE BORING ========== 2-S
LRFD or ASD or SEISMIC ========== SEISMIC
PILE CUTOFF ELEV. ========== 405.04 ft
GROUND SURFACE ELEV. AGAINST PILE DURING DRIVING = 403.04 ft
GEOTECHNICAL LOSS TYPE (None, Scour, Liquef., DD) ====== Liquef.
BOTTOM ELEV. OF SCOUR, LIQUEF., or DD ========== 372.70 ft
TOP ELEV. OF LIQUEF. (so layers above apply DD) ========== 378.20 ft

TOTAL SEISMIC SUBSTRUCTURE LOAD ========== 615 kips
TOTAL LENGTH OF SUBSTRUCTURE (along skew)========== 64.00 ft
NUMBER OF ROWS OF PILES PER SUBSTRUCTURE ====== 1
Approx. Seismic Loading Applied per pile spaced at 8 ft. Cts ======= 76.88 KIPS
Approx. Seismic Loading Applied per pile spaced at 3 ft. Cts ======= 28.83 KIPS

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

Maximum Nominal Req'd Bearing of Pile	Maximum Nominal Req.d Bearing of Boring	Maximum Seismic Resistance Available in Boring	Maximum Pile Driveable Length in Boring
810 KIPS	**721** KIPS	**538** KIPS	**36** FT.

PILE TYPE AND SIZE ========== Steel HP 14 X 102
Plugged Pile Perimeter========== 4.800 FT. Unplugged Pile Perimeter========== 7.058 FT.
Plugged Pile End Bearing Area========== 1.439 SQFT. Unplugged Pile End Bearing Area========== 0.208 SQFT.

BOT. OF LAYER ELEV. (FT.)	LAYER THICK. (FT.)	UNCONF. COMPR. STRENGTH (TSF.)	S.P.T. N VALUE (BLOWS)	GRANULAR OR ROCK LAYER DESCRIPTION	ULTIMATE PLUGGED SIDE RESIST. (KIPS)	ULTIMATE PLUGGED END BRG. RESIST. (KIPS)	ULTIMATE PLUGGED TOTAL RESIST. (KIPS)	ULTIMATE UNPLUGGED SIDE RESIST. (KIPS)	ULTIMATE UNPLUGGED END BRG. RESIST. (KIPS)	ULTIMATE UNPLUGGED TOTAL RESIST. (KIPS)	NOMINAL REQ'D BEARING (KIPS)	NOMINAL GEOTECH. LOSS FROM LIQUEF. & DD (KIPS)	FACTORED GEOTECH. LOSS LOAD FROM DD (KIPS)	SEISMIC RESISTANCE AVAILABLE (KIPS)	ESTIMATED PILE LENGTH (FT.)
402.99	0.05	1.50			0.2		70.8	0.3		***10.6***	11	0	0	10	2
400.49	2.50	3.50	14		20.6	70.6	47.0	30.2	10.2	***34.4***	34	21	23	-9	5
397.99	2.50	1.30			10.4	26.2	65.5	15.3	3.8	***50.9***	51	31	34	-15	7
395.49	2.50	1.70			12.6	34.3	***66.0***	18.5	5.0	67.6	66	44	48	-26	10
392.99	2.50	1.10			9.2	22.2	***71.1***	13.5	3.2	80.5	71	53	58	-40	12
390.49	2.50	0.90			7.8	18.1	***72.9***	11.5	2.6	91.2	73	61	67	-55	15
387.99	2.50	0.60			5.5	12.1	***80.4***	8.1	1.8	99.6	80	66	73	-59	17
385.49	2.50	0.70			6.3	14.1	***80.7***	9.3	2.0	108.0	81	73	80	-72	20
382.99	2.50	0.40			3.8	8.1	***86.5***	5.6	1.2	113.9	87	76	84	-74	22
380.49	2.50	0.50			4.7	10.1	***91.2***	6.9	1.5	120.8	91	81	89	-79	25
377.99	2.50	0.50			4.7	10.1	***104.0***	6.9	1.5	128.8	104	86	89	-71	27
375.49	2.50	0.90			7.8	18.1	***122.3***	11.5	2.6	141.8	122	94	89	-61	30
372.49	3.00		8	Sandy Gravel	2.7	28.7	454.8	4.0	4.2	***193.5***	194	94	89	10	33
371.99	0.50			Limestone	59.8	358.5	514.6	87.9	51.9	***281.5***	281	94	89	98	33.1
371.49	0.50			Limestone	59.8	358.5	574.4	87.9	51.9	***369.4***	369	94	89	186	33.6
370.99	0.50			Limestone	59.8	358.5	634.2	87.9	51.9	***457.3***	457	94	89	274	34.1
370.49	0.50			Limestone	59.8	358.5	694.0	87.9	51.9	***545.2***	545	94	89	362	34.6
369.99	0.50			Limestone	59.8	358.5	753.8	87.9	51.9	***633.2***	633	94	89	450	35.1
369.49	0.50			Limestone	59.8	358.5	813.6	87.9	51.9	***721.1***	721	94	89	538	35.6
368.49	1.00			Limestone	119.6	358.5	933.2	175.9	51.9	***896.9***	~~897~~	~~94~~	~~89~~	~~714~~	~~36.6~~
367.49	1.00			Limestone	119.6	358.5	***1052.7***	175.9	51.9	1072.8	~~1053~~	~~94~~	~~89~~	~~870~~	~~37.6~~
366.49	1.00			Limestone		358.5			51.9						

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Illinois Department of Transportation

IDOT STATIC METHOD OF ESTIMATING PILE LENGTH

SUBSTRUCTURE========== SB North Abutment
REFERENCE BORING ========== 4-S
LRFD or ASD or SEISMIC ========== LRFD
PILE CUTOFF ELEV. ========== 399.27 ft
GROUND SURFACE ELEV. AGAINST PILE DURING DRIVING = 397.27 ft
GEOTECHNICAL LOSS TYPE (None, Scour, Liquef., DD) ====== None
BOTTOM ELEV. OF SCOUR, LIQUEF., or DD ========== ft
TOP ELEV. OF LIQUEF. (so layers above apply DD) ========== ft

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

Maximum Nominal Req'd Bearing of Pile	Maximum Nominal Req.d Bearing of Boring	Maximum Factored Resistance Available in Boring	Maximum Pile Driveable Length in Boring
418 KIPS	**418** KIPS	**230** KIPS	**29** FT.

TOTAL FACTORED SUBSTRUCTURE LOAD ========== 770 kips
TOTAL LENGTH OF SUBSTRUCTURE (along skew)========== 64.00 ft
NUMBER OF ROWS OF PILES PER SUBSTRUCTURE ====== 1
Approx. Factored Loading Applied per pile at 8 ft. Cts ========== 96.25 KIPS
Approx. Factored Loading Applied per pile at 3 ft. Cts ========== 36.09 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.)
394.97	2.30	1.10			7.0		16.6	10.2		***11.3***	11	0	0	6	4
392.47	2.50	0.70			5.2	9.6	32.9	7.6	1.1	***20.1***	20	0	0	11	7
389.97	2.50	1.50			9.5	20.7	36.9	13.9	2.3	***33.5***	33	0	0	18	9
387.47	2.50	1.10			7.6	15.2	***37.6***	11.1	1.7	43.8	38	0	0	21	12
384.97	2.50	0.60			4.6	8.3	***42.2***	6.7	0.9	50.5	42	0	0	23	14
382.47	2.50	0.60			4.6	8.3	***42.6***	6.7	0.9	56.7	43	0	0	23	17
379.97	2.50	0.30			2.4	4.1	***60.5***	3.5	0.5	61.9	60	0	0	33	19
377.47	2.50		8	Sandy Gravel	1.9	19.6	***52.5***	2.7	2.1	63.5	53	0	0	29	22
374.97	2.50		4	Sandy Gravel	0.9	9.8	***65.7***	1.4	1.1	66.2	66	0	0	36	24
372.97	2.00		9	Sandy Gravel	1.7	22.0	290.3	2.4	2.4	***93.1***	93	0	0	51	26
372.47	0.50			Limestone	49.4	245.0	339.7	72.3	26.8	***165.3***	165	0	0	91	26.8
371.97	0.50			Limestone	49.4	245.0	389.1	72.3	26.8	***237.6***	238	0	0	131	27.3
371.47	0.50			Limestone	49.4	245.0	438.5	72.3	26.8	***309.8***	310	0	0	170	27.8
370.97	0.50			Limestone	49.4	245.0	488.0	72.3	26.8	***382.1***	382	0	0	210	28.3
370.47	0.50			Limestone	49.4	245.0	537.4	72.3	26.8	***454.3***	~~454~~	~~0~~	~~0~~	~~250~~	~~28.8~~
369.97	0.50			Limestone	49.4	245.0	586.8	72.3	26.8	***526.6***	~~527~~	~~0~~	~~0~~	~~290~~	~~29.3~~
369.47	0.50			Limestone	49.4	245.0	636.2	72.3	26.8	***598.8***	~~599~~	~~0~~	~~0~~	~~329~~	~~29.8~~
368.47	1.00			Limestone	98.8	245.0	***735.0***	144.5	26.8	743.3	~~735~~	~~0~~	~~0~~	~~404~~	~~30.8~~
367.47	1.00			Limestone	98.8	245.0	***833.8***	144.5	26.8	887.8	~~834~~	~~0~~	~~0~~	~~459~~	~~31.8~~
366.47	1.00			Limestone		245.0			26.8						

Illinois Department of Transportation

IDOT STATIC METHOD OF ESTIMATING PILE LENGTH

SUBSTRUCTURE========== SB North Abutment
REFERENCE BORING ========== 4-S
LRFD or ASD or SEISMIC ========== SEISMIC
PILE CUTOFF ELEV. ========== 399.27 ft
GROUND SURFACE ELEV. AGAINST PILE DURING DRIVING = 397.27 ft
GEOTECHNICAL LOSS TYPE (None, Scour, Liquef., DD) ====== Liquef.
BOTTOM ELEV. OF SCOUR, LIQUEF., or DD ========== 373.30 ft
TOP ELEV. OF LIQUEF. (so layers above apply DD) ========== 380.30 ft

TOTAL SEISMIC SUBSTRUCTURE LOAD ========== 578 kips
TOTAL LENGTH OF SUBSTRUCTURE (along skew)========== 64.00 ft
NUMBER OF ROWS OF PILES PER SUBSTRUCTURE ====== 1
Approx. Seismic Loading Applied per pile spaced at 8 ft. Cts ======= 72.25 KIPS
Approx. Seismic Loading Applied per pile spaced at 3 ft. Cts ======= 27.09 KIPS

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

Maximum Nominal Req'd Bearing of Pile	Maximum Nominal Req.d Bearing of Boring	Maximum Seismic Resistance Available in Boring	Maximum Pile Driveable Length in Boring
929 KIPS	**141** KIPS	**36** KIPS	**26** FT.

PILE TYPE AND SIZE ========== Steel HP 14 X 117
Pile Perimeter========== 4.850 FT. Unplugged Pile Perimeter========== 7.117 FT.
Pile End Bearing Area========== 1.469 SQFT. Unplugged Pile End Bearing Area========= 0.239 SQFT.

BOT. OF LAYER ELEV. (FT.)	LAYER THICK. (FT.)	UNCONF. COMPR. STRENGTH (TSF.)	S.P.T. N VALUE (BLOWS)	GRANULAR OR ROCK LAYER DESCRIPTION	ULTIMATE SIDE RESIST. (KIPS)	ULTIMATE END BRG. RESIST. (KIPS)	ULTIMATE TOTAL RESIST. (KIPS)	ULTIMATE UNPLUGGED SIDE RESIST. (KIPS)	ULTIMATE UNPLUGGED END BRG. RESIST. (KIPS)	ULTIMATE UNPLUGGED TOTAL RESIST. (KIPS)	NOMINAL REQ'D BEARING (KIPS)	NOMINAL GEOTECH. LOSS FROM LIQUEF. & DD (KIPS)	FACTORED GEOTECH. LOSS LOAD FROM DD (KIPS)	SEISMIC RESISTANCE AVAILABLE (KIPS)	ESTIMATED PILE LENGTH (FT.)
394.97	2.30	1.10			8.5		23.0	12.5		***14.9***	15	9	9	-3	4
392.47	2.50	0.70			6.4	14.4	45.8	9.4	2.3	***26.9***	27	15	16	-4	7
389.97	2.50	1.50			11.7	30.9	49.2	17.1	5.0	***42.7***	43	27	29	-13	9
387.47	2.50	1.10			9.3	22.7	***48.2***	13.6	3.7	54.7	48	36	40	-27	12
384.97	2.50	0.60			5.6	12.4	***53.8***	8.2	2.0	62.8	54	41	46	-33	14
382.47	2.50	0.60			5.6	12.4	***53.2***	8.2	2.0	70.0	53	47	52	-46	17
379.97	2.50	0.30			2.9	6.2	79.3	4.3	1.0	***78.1***	78	50	52	-24	19
377.47	2.50		8	Sandy Gravel	2.3	29.3	***66.9***	3.3	4.8	79.0	67	52	52	-37	22
374.97	2.50		4	Sandy Gravel	1.1	14.6	86.3	1.7	2.4	***83.7***	84	53	52	-22	24
372.97	2.00		9	Sandy Gravel	2.0	32.9	421.5	3.0	5.4	***140.8***	141	53	52	36	26
372.47	0.50			Limestone	60.4	366.1	481.9	88.7	59.5	***229.5***	229	53	52	124	26.8
371.97	0.50			Limestone	60.4	366.1	542.3	88.7	59.5	***318.1***	318	53	52	213	27.3
371.47	0.50			Limestone	60.4	366.1	602.7	88.7	59.5	***406.8***	407	53	52	302	27.8
370.97	0.50			Limestone	60.4	366.1	663.1	88.7	59.5	***495.4***	495	53	52	390	28.3
370.47	0.50			Limestone	60.4	366.1	723.6	88.7	59.5	***584.1***	584	53	52	479	28.8
369.97	0.50			Limestone	60.4	366.1	784.0	88.7	59.5	***672.7***	673	53	52	568	29.3
369.47	0.50			Limestone	60.4	366.1	844.4	88.7	59.5	***761.4***	761	53	52	656	29.8
368.53	0.94			Limestone	114.1	366.1	958.5	167.4	59.5	***928.8***	929	53	52	824	30.7
367.53	1.00			Limestone	120.8	366.1	***1079.3***	177.3	59.5	1106.1	~~1079~~	~~53~~	~~52~~	~~974~~	~~31.7~~
366.53	1.00			Limestone		366.1			59.5						

Illinois Department of Transportation

IDOT STATIC METHOD OF ESTIMATING PILE LENGTH

SUBSTRUCTURE========== SB South Abutment
REFERENCE BORING ========== 6-S
LRFD or ASD or SEISMIC ========== LRFD
PILE CUTOFF ELEV. ========== 400.23 ft
GROUND SURFACE ELEV. AGAINST PILE DURING DRIVING = 398.23 ft
GEOTECHNICAL LOSS TYPE (None, Scour, Liquef., DD) ====== None
BOTTOM ELEV. OF SCOUR, LIQUEF., or DD ========== ft
TOP ELEV. OF LIQUEF. (so layers above apply DD) ========== ft

TOTAL FACTORED SUBSTRUCTURE LOAD ========== 770 kips
TOTAL LENGTH OF SUBSTRUCTURE (along skew)========== 64.00 ft
NUMBER OF ROWS OF PILES PER SUBSTRUCTURE ====== 1
Approx. Factored Loading Applied per pile at 8 ft. Cts ========== 96.25 KIPS
Approx. Factored Loading Applied per pile at 3 ft. Cts ========== 36.09 KIPS

PILE TYPE AND SIZE ========== Steel HP 12 X 53
Plugged Pile Perimeter========== 3.967 FT. Unplugged Pile Perimeter========== 5.800 FT.
Plugged Pile End Bearing Area========== 0.983 SQFT. Unplugged Pile End Bearing Area========= 0.108 SQFT.

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

Maximum Nominal Req'd Bearing of Pile	Maximum Nominal Req.d Bearing of Boring	Maximum Factored Resistance Available in Boring	Maximum Pile Driveable Length in Boring
418 KIPS	**418** KIPS	**230** KIPS	**31** FT.

BOT. OF LAYER ELEV. (FT.)	LAYER THICK. (FT.)	UNCONF. COMPR. STRENGTH (TSF.)	S.P.T. N VALUE (BLOWS)	GRANULAR OR ROCK LAYER DESCRIPTION	NOMINAL PLUGGED SIDE RESIST. (KIPS)	NOMINAL PLUGGED END BRG. RESIST. (KIPS)	NOMINAL PLUGGED TOTAL RESIST. (KIPS)	NOMINAL UNPLUG'D SIDE RESIST. (KIPS)	NOMINAL UNPLUG'D END BRG. RESIST. (KIPS)	NOMINAL UNPLUG'D TOTAL RESIST. (KIPS)	NOMINAL REQ'D BEARING (KIPS)	FACTORED GEOTECH. LOSS FROM SCOUR or DD (KIPS)	FACTORED GEOTECH. LOSS LOAD FROM DD (KIPS)	FACTORED RESISTANCE AVAILABLE (KIPS)	ESTIMATED PILE LENGTH (FT.)
396.37	1.86	1.60			7.4		24.0	10.8		***12.7***	13	0	0	7	4
393.87	2.50	1.20			8.1	16.5	30.7	11.9	1.8	***24.4***	24	0	0	13	6
391.37	2.50	1.10			7.6	15.2	***28.7***	11.1	1.7	34.4	29	0	0	16	9
388.87	2.50	0.40			3.1	5.5	***35.9***	4.6	0.6	39.5	36	0	0	20	11
386.37	2.50	0.70			5.2	9.6	***38.4***	7.6	1.1	46.8	38	0	0	21	14
383.87	2.50	0.50			3.9	6.9	***39.5***	5.7	0.8	52.2	40	0	0	22	16
381.37	2.50	0.30			2.4	4.1	62.6	3.5	0.5	***58.0***	58	0	0	32	19
378.87	2.50	1.80			10.8	24.8	***63.7***	15.8	2.7	72.7	64	0	0	35	21
376.37	2.50	1.10			7.6	15.2	***68.4***	11.1	1.7	83.5	68	0	0	38	24
373.87	2.50		5	Sandy Gravel	1.2	12.2	***60.1***	1.7	1.3	84.1	60	0	0	33	26
371.87	2.00	0.20			1.3	2.8	303.6	1.9	0.3	***112.5***	113	0	0	62	28
371.37	0.50			Limestone	49.4	245.0	353.0	72.3	26.8	***184.8***	185	0	0	102	28.9
370.87	0.50			Limestone	49.4	245.0	402.4	72.3	26.8	***257.0***	257	0	0	141	29.4
370.37	0.50			Limestone	49.4	245.0	451.9	72.3	26.8	***329.3***	329	0	0	181	29.9
369.87	0.50			Limestone	49.4	245.0	501.3	72.3	26.8	***401.5***	402	0	0	221	30.4
369.37	0.50			Limestone	49.4	245.0	550.7	72.3	26.8	***473.8***	~~474~~	~~0~~	~~0~~	~~261~~	~~30.9~~
368.87	0.50			Limestone	49.4	245.0	600.1	72.3	26.8	***546.0***	~~546~~	~~0~~	~~0~~	~~300~~	~~31.4~~
367.87	1.00			Limestone	98.8	245.0	698.9	144.5	26.8	***690.5***	~~691~~	~~0~~	~~0~~	~~380~~	~~32.4~~
366.87	1.00			Limestone	98.8	245.0	***797.7***	144.5	26.8	835.0	~~798~~	~~0~~	~~0~~	~~439~~	~~33.4~~
365.87	1.00			Limestone	98.8	245.0	***896.6***	144.5	26.8	979.5	~~897~~	~~0~~	~~0~~	~~493~~	~~34.4~~
364.87	1.00			Limestone		245.0			26.8						

Illinois Department of Transportation

IDOT STATIC METHOD OF ESTIMATING PILE LENGTH

SUBSTRUCTURE========== SB South Abutment
REFERENCE BORING ========== 6-S
LRFD or ASD or SEISMIC ========== SEISMIC
PILE CUTOFF ELEV. ========== 400.23 ft
GROUND SURFACE ELEV. AGAINST PILE DURING DRIVING = 398.23 ft
GEOTECHNICAL LOSS TYPE (None, Scour, Liquef., DD) ====== Liquef.
BOTTOM ELEV. OF SCOUR, LIQUEF., or DD ========== 374.20 ft
TOP ELEV. OF LIQUEF. (so layers above apply DD) ========== 376.70 ft

TOTAL SEISMIC SUBSTRUCTURE LOAD ========== 578 kips
TOTAL LENGTH OF SUBSTRUCTURE (along skew)========== 64.00 ft
NUMBER OF ROWS OF PILES PER SUBSTRUCTURE ====== 1
Approx. Seismic Loading Applied per pile spaced at 8 ft. Cts ======= 72.25 KIPS
Approx. Seismic Loading Applied per pile spaced at 3 ft. Cts ======= 27.09 KIPS

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

Maximum Nominal Req'd Bearing of Pile	Maximum Nominal Req.d Bearing of Boring	Maximum Seismic Resistance Available in Boring	Maximum Pile Driveable Length in Boring
929 KIPS	**165** KIPS	**31** KIPS	**28** FT.

PILE TYPE AND SIZE ========== Steel HP 14 X 117
Pile Perimeter========== 4.850 FT. Unplugged Pile Perimeter========== 7.117 FT.
Pile End Bearing Area========== 1.469 SQFT. Unplugged Pile End Bearing Area========= 0.239 SQFT.

BOT. OF LAYER ELEV. (FT.)	LAYER THICK. (FT.)	UNCONF. COMPR. STRENGTH (TSF.)	S.P.T. N VALUE (BLOWS)	GRANULAR OR ROCK LAYER DESCRIPTION	ULTIMATE SIDE RESIST. (KIPS)	ULTIMATE END BRG. RESIST. (KIPS)	ULTIMATE TOTAL RESIST. (KIPS)	ULTIMATE UNPLUGGED SIDE RESIST. (KIPS)	ULTIMATE UNPLUGGED END BRG. RESIST. (KIPS)	ULTIMATE UNPLUGGED TOTAL RESIST. (KIPS)	NOMINAL REQ'D BEARING (KIPS)	NOMINAL GEOTECH. LOSS FROM LIQUEF. & DD (KIPS)	FACTORED GEOTECH. LOSS LOAD FROM DD (KIPS)	SEISMIC RESISTANCE AVAILABLE (KIPS)	ESTIMATED PILE LENGTH (FT.)
396.37	1.86	1.60			9.1		33.8	13.3		***17.3***	17	9	10	-2	4
393.87	2.50	1.20			9.9	24.7	41.7	14.6	4.0	***31.6***	32	19	21	-8	6
391.37	2.50	1.10			9.3	22.7	***36.5***	13.6	3.7	42.9	37	28	31	-23	9
388.87	2.50	0.40			3.8	8.2	***46.6***	5.6	1.3	49.5	47	32	35	-21	11
386.37	2.50	0.70			6.4	14.4	***48.8***	9.4	2.3	58.2	49	39	42	-32	14
383.87	2.50	0.50			4.7	10.3	***49.4***	6.9	1.7	64.5	49	43	48	-42	16
381.37	2.50	0.30			2.9	6.2	83.3	4.3	1.0	***73.8***	74	46	51	-23	19
378.87	2.50	1.80			13.2	37.1	***82.0***	19.3	6.0	90.8	82	59	65	-43	21
376.37	2.50	1.10			9.3	22.7	***87.0***	13.6	3.7	103.7	87	69	65	-47	24
373.87	2.50		5	Sandy Gravel	1.4	18.3	***74.2***	2.1	3.0	103.5	74	69	65	-60	26
371.87	2.00	0.20			1.6	4.1	437.7	2.3	0.7	***164.7***	165	69	65	31	28
371.37	0.50			Limestone	60.4	366.1	498.2	88.7	59.5	***253.3***	253	69	65	119	28.9
370.87	0.50			Limestone	60.4	366.1	558.6	88.7	59.5	***342.0***	342	69	65	208	29.4
370.37	0.50			Limestone	60.4	366.1	619.0	88.7	59.5	***430.7***	431	69	65	297	29.9
369.87	0.50			Limestone	60.4	366.1	679.4	88.7	59.5	***519.3***	519	69	65	385	30.4
369.37	0.50			Limestone	60.4	366.1	739.8	88.7	59.5	***608.0***	608	69	65	474	30.9
368.87	0.50			Limestone	60.4	366.1	800.2	88.7	59.5	***696.6***	697	69	65	562	31.4
367.87	1.00			Limestone	120.8	366.1	921.1	177.3	59.5	***873.9***	874	69	65	740	32.4
367.56	0.31			Limestone	37.3	366.1	958.4	54.8	59.5	***928.7***	929	69	65	795	32.7
366.56	1.00			Limestone	120.8	366.1	***1079.3***	177.3	59.5	1106.0	~~1079~~	~~69~~	~~65~~	~~945~~	~~33.7~~
365.56	1.00			Limestone		366.1			59.5						

Slope Stability Soil Parameters SN 091-0077

Northbound, North Abutment (LRFD)				
Bottom Elev.	Layer Number	Unit Weight (lbs/ft^3)	Cohesion (lbs/ft^2)	Friction Angle (deg.)
402.4	1	136.1	3343	-
399.9	2	124.6	1300	-
397.4	3	120.3	900	-
394.9	4	111.4	400	-
392.4	5	111.4	400	-
389.9	6	115.7	600	-
387.4	7	108.4	300	-
382.4	8	101.0	150	-
379.9	9	115.7	600	-
377.4	10	126.3	-	32.6
374.9	11	117.5	-	28.8
371.9	12	124.9	-	32.0
	13	144.9	-	44.0

Northbound, North Abutment (Seismic)				
Bottom Elev.	Layer Number	Unit Weight (lbs/ft^3)	Cohesion (lbs/ft^2)	Friction Angle (deg.)
402.4	1	136.1	3343	-
399.9	2	124.6	1300	-
397.4	3	120.3	900	-
394.9	4	111.4	400	-
392.4	5	111.4	400	-
389.9	6	115.7	600	-
387.4	7	108.4	300	-
382.4	8	101.0	150	-
379.9	9	115.7	600	-
377.4	10	126.3	-	**13.0**
374.9	11	117.5	-	**11.5**
371.9	12	124.9	-	**12.8**
	13	144.9	-	44.0

Northbound, South Abutment (LRFD)				
Bottom Elev.	Layer Number	Unit Weight (lbs/ft^3)	Cohesion (lbs/ft^2)	Friction Angle (deg.)
405.7	1	132.6	2500	-
403.2	2	126.3	1500	-
400.7	3	136.9	3500	-
395.7	4	126.2	1500	-
393.2	5	122.6	1100	-
385.7	6	117.8	733	-
380.7	7	112.6	450	-
378.2	8	113.8	500	-
375.7	9	120.3	900	-
372.7	10	121.5	-	30.4
	11	144.9	-	44.0

Northbound, South Abutment (Seismic)				
Bottom Elev.	Layer Number	Unit Weight (lbs/ft^3)	Cohesion (lbs/ft^2)	Friction Angle (deg.)
405.7	1	132.6	2500	-
403.2	2	126.3	1500	-
400.7	3	136.9	3500	-
395.7	4	126.2	1500	-
393.2	5	122.6	1100	-
385.7	6	117.8	733	-
380.7	7	112.6	450	-
378.2	8	113.8	500	-
375.7	9	120.3	**360**	-
372.7	10	121.5	-	**12.2**
	11	144.9	-	44.0

Northbound, North Abutment (1-S)

			X	Y
PGL @ Back/Abut:	409.97			
Approach Slab Thickness:	1.25	Bottom of Slope Coordinates:	60.00	381.00
Bottom of Approach Slab:	408.72			
		Top of Slope Coordinates:	117.45	408.72
Ditch at Bottom of Slope:	381.00			
		Bottom Initiation Pt Range (X):	5	60
Slope Height:	27.72			
Horizontal Slope Length:	55.44	Top Termination Pt Range (X):	117.45	173
Berm Length:	2.01			

Northbound, South Abutment (2-S)

			X	Y
PGL @ Back/Abut:	410.8			
Approach Slab Thickness:	1.25	Bottom of Slope Coordinates:	60.00	381.00
Bottom of Approach Slab:	409.55			
		Top of Slope Coordinates:	117.45	409.55
Ditch at Bottom of Slope:	381.00			
		Bottom Initiation Pt Range (X):	3	60
Slope Height:	28.55			
Horizontal Slope Length:	57.1	Top Termination Pt Range (X):	117.45	175
Berm Length:	0.35			

Slope Stability Soil Parameters SN 091-0078

Southbound, North Abutment (LRFD)				
Bottom Elev.	Layer Number	Unit Weight (lbs/ft^3)	Cohesion (lbs/ft^2)	Friction Angle (deg.)
395.3	1	122.9	1133	-
392.8	2	117.5	700	-
387.8	3	124.5	1300	-
382.8	4	115.7	600	-
380.3	5	108.4	300	-
373.3	6	119.7	-	29.7
	7	144.9	-	44.0

Southbound, North Abutment (Seismic)				
Bottom Elev.	Layer Number	Unit Weight (lbs/ft^3)	Cohesion (lbs/ft^2)	Friction Angle (deg.)
395.3	1	122.9	1133	-
392.8	2	117.5	700	-
387.8	3	124.5	1300	-
382.8	4	115.7	600	-
380.3	5	108.4	300	-
373.3	6	119.7	-	**11.9**
	7	144.9	-	44.0

Southbound, North Abutment (4-S)

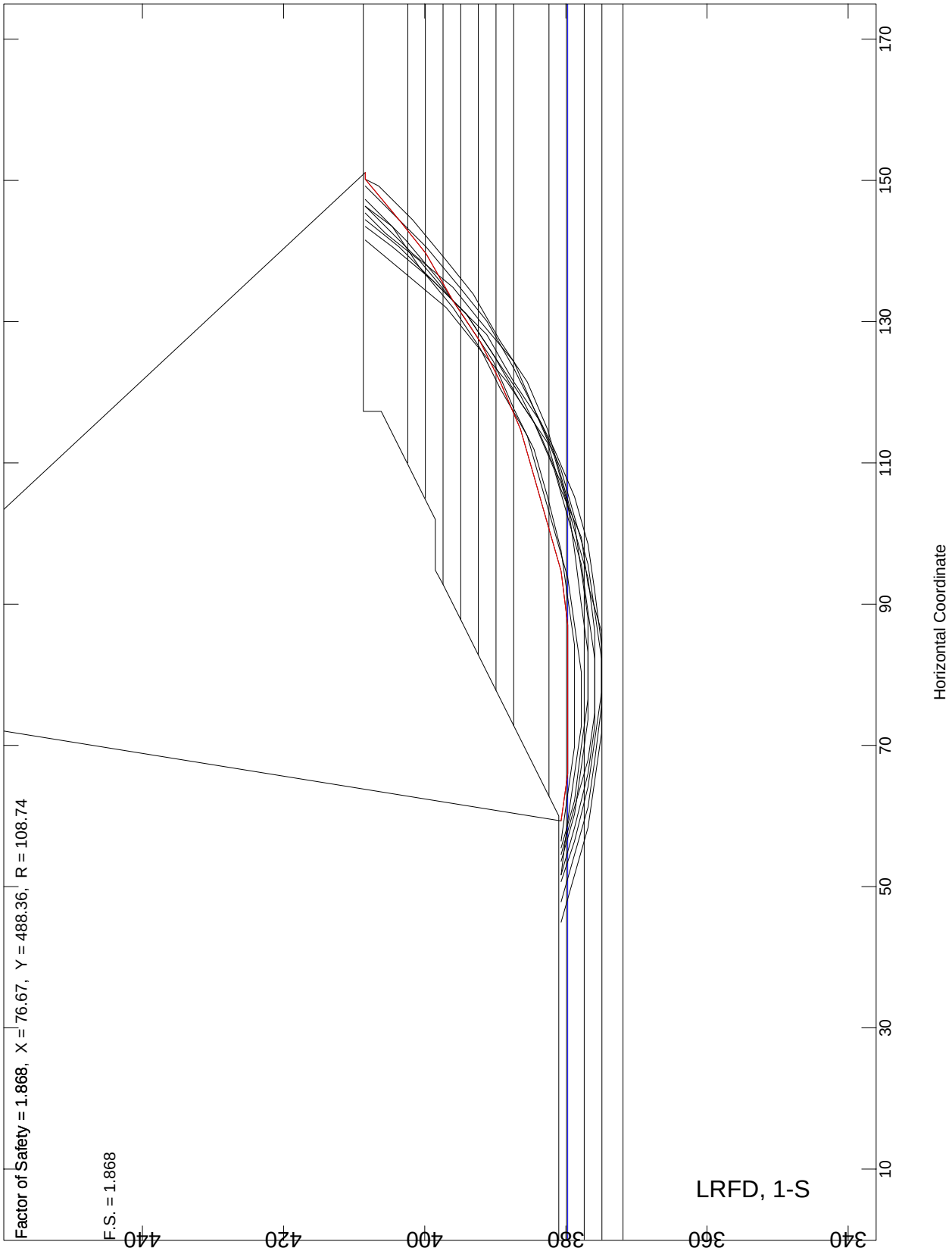
			X	Y
PGL @ Back/Abut:	405.19			
Approach Slab Thickness:	1.25	Bottom of Slope Coordinates:	50.00	381.00
Bottom of Approach Slab:	403.94			
		Top of Slope Coordinates:	97.57	403.94
Ditch at Bottom of Slope:	381.00			
		Bottom Initiation Pt Range (X):	4	50
Slope Height:	22.94			
Horizontal Slope Length:	45.88	Top Termination Pt Range (X):	97.57	143
Berm Length:	1.69			

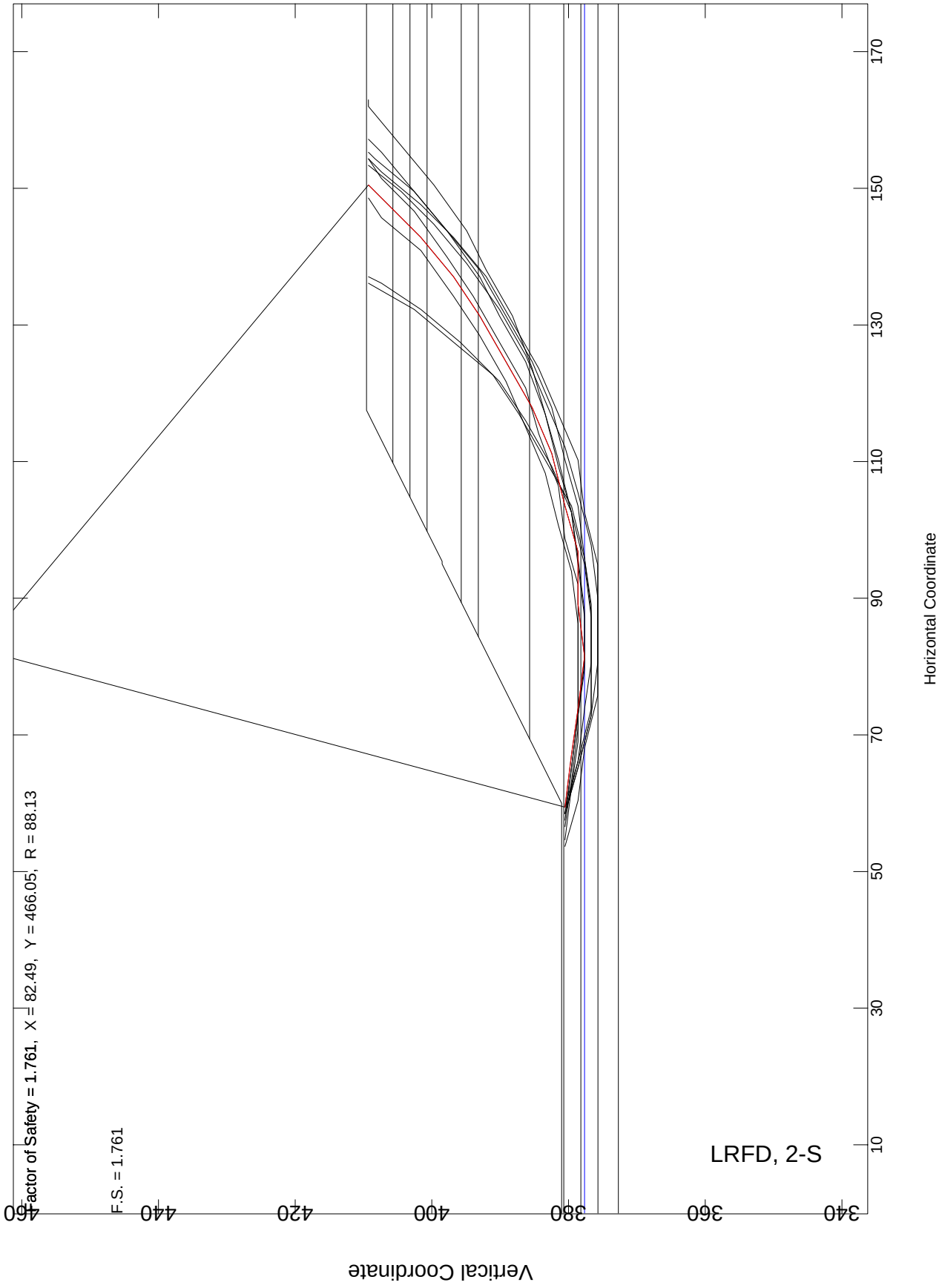
Southbound, South Abutment (LRFD)				
Bottom Elev.	Layer Number	Unit Weight (lbs/ft^3)	Cohesion (lbs/ft^2)	Friction Angle (deg.)
401.7	1	131.5	2300	-
399.2	2	125.4	1400	-
396.7	3	127.0	1600	-
391.7	4	123.1	1150	-
389.2	5	111.4	400	-
386.7	6	117.5	700	-
381.7	7	111.1	400	-
379.2	8	128.5	1800	-
376.7	9	122.6	1100	-
374.2	10	117.5	-	28.8
372.2	11	104.3	200	-
	12	144.9	-	44.0

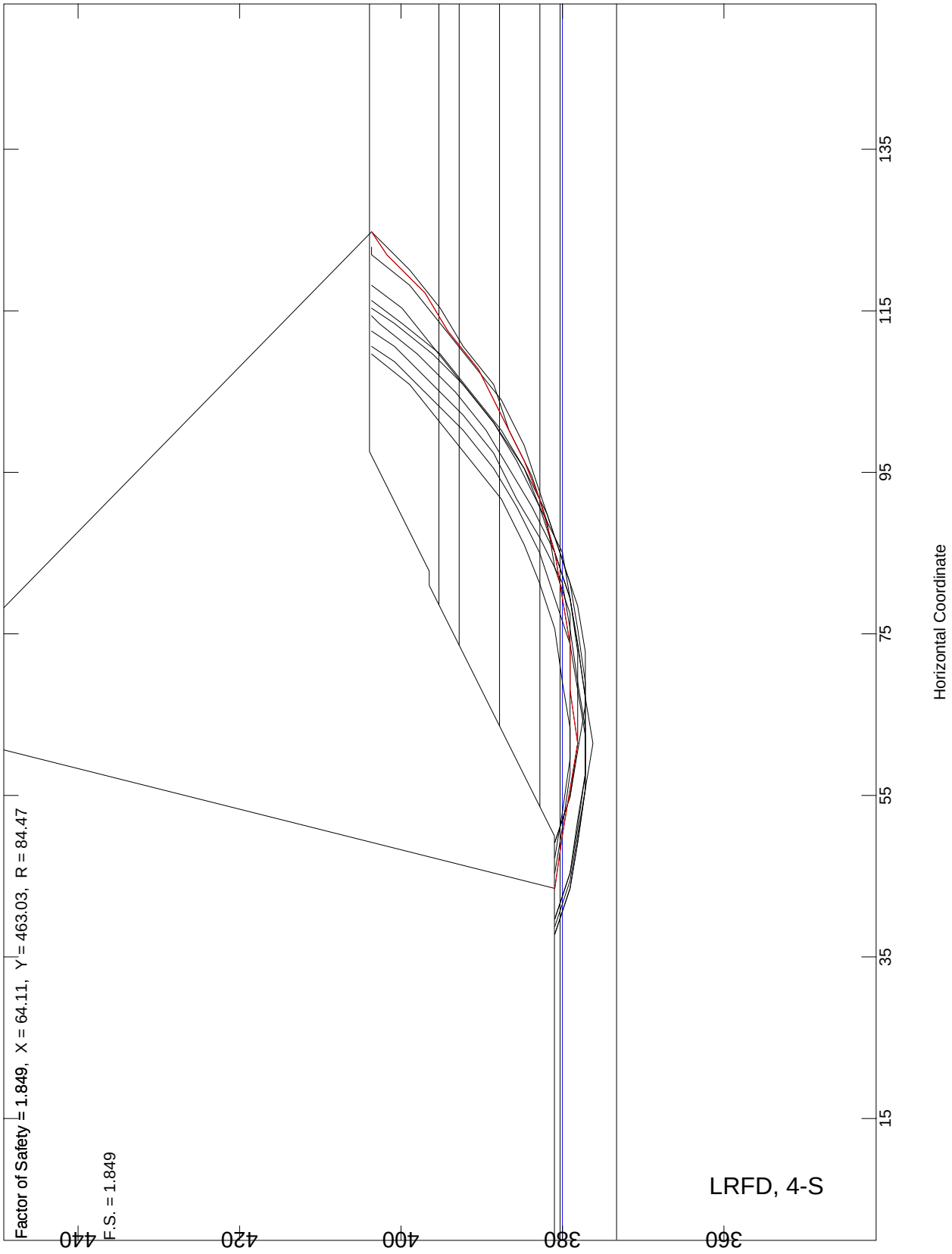
Southbound, South Abutment (Seismic)				
Bottom Elev.	Layer Number	Unit Weight (lbs/ft^3)	Cohesion (lbs/ft^2)	Friction Angle (deg.)
401.7	1	131.5	2300	-
399.2	2	125.4	1400	-
396.7	3	127.0	1600	-
391.7	4	123.1	1150	-
389.2	5	111.4	400	-
386.7	6	117.5	700	-
381.7	7	111.1	400	-
379.2	8	128.5	1800	-
376.7	9	122.6	1100	-
374.2	10	117.5	-	**11.5**
372.2	11	104.3	200	-
	12	144.9	-	44.0

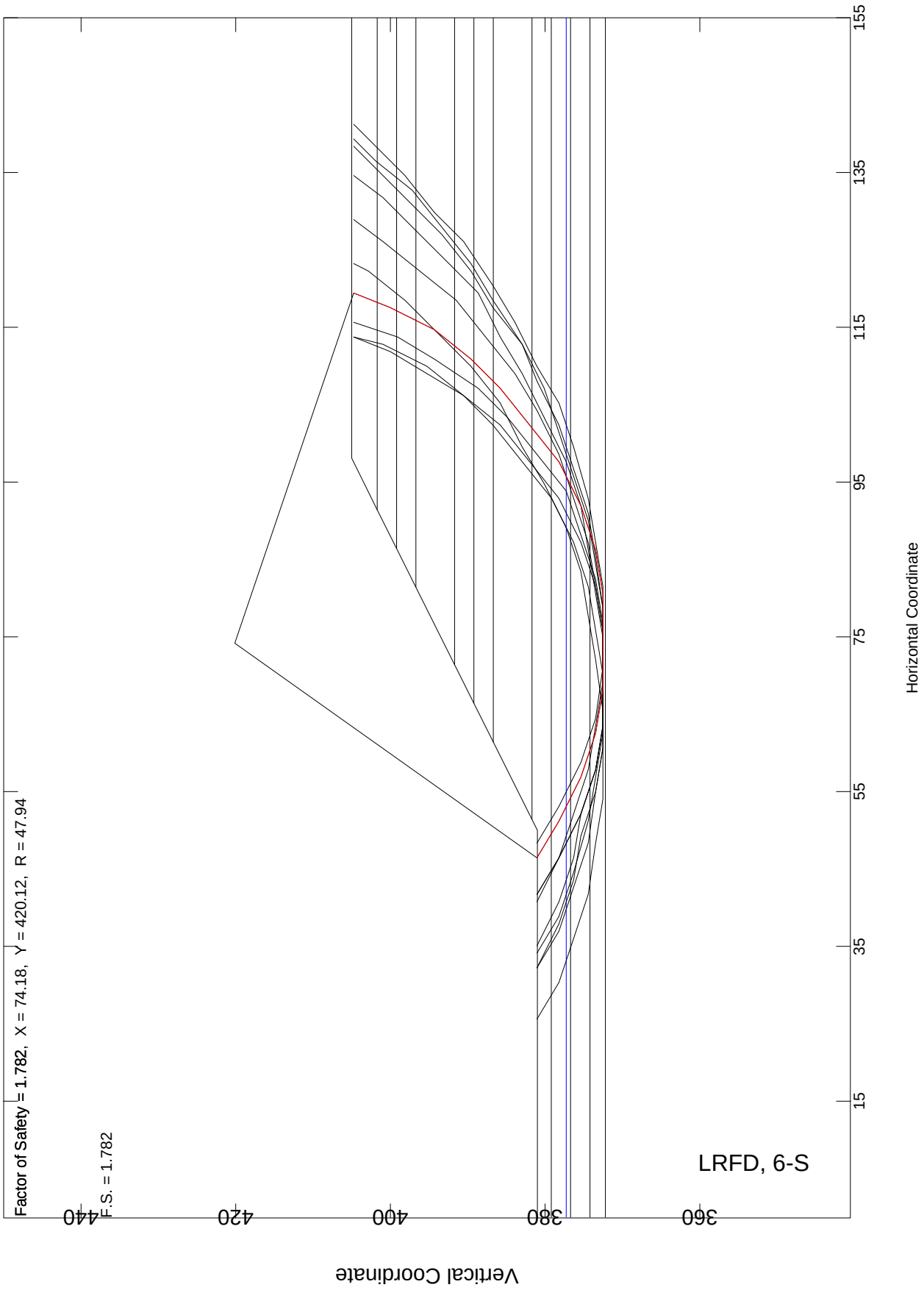
Southbound, South Abutment (6-S)

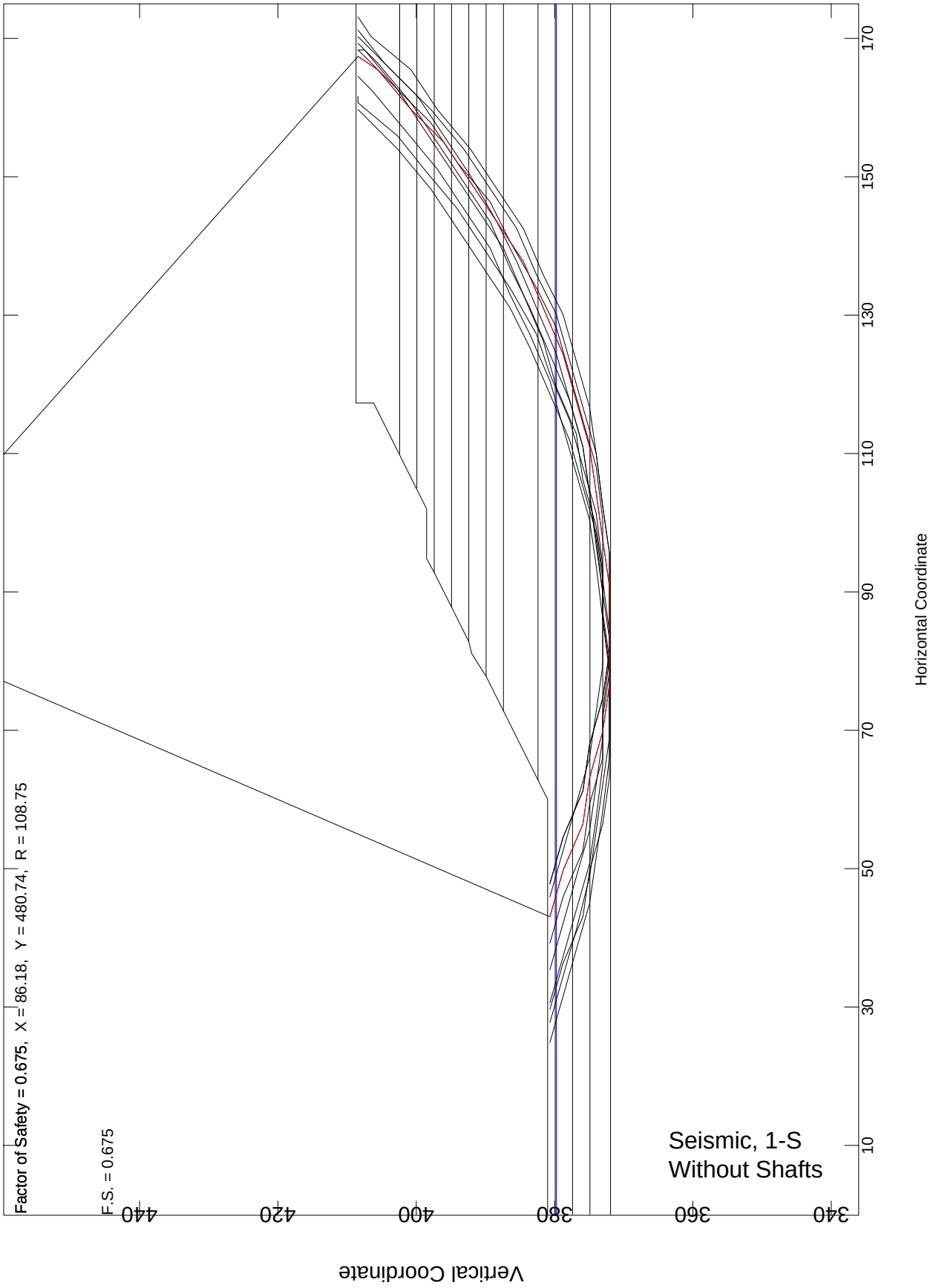
			X	Y
PGL @ Back/Abut:	406.29			
Approach Slab Thickness:	1.25	Bottom of Slope Coordinates:	50.00	381.00
Bottom of Approach Slab:	405.04			
		Top of Slope Coordinates:	98.08	405.04
Ditch at Bottom of Slope:	381.00			
		Bottom Initiation Pt Range (X):	2	50
Slope Height:	24.04			
Horizontal Slope Length:	48.08	Top Termination Pt Range (X):	98.08	146
Berm Length:	0.00			

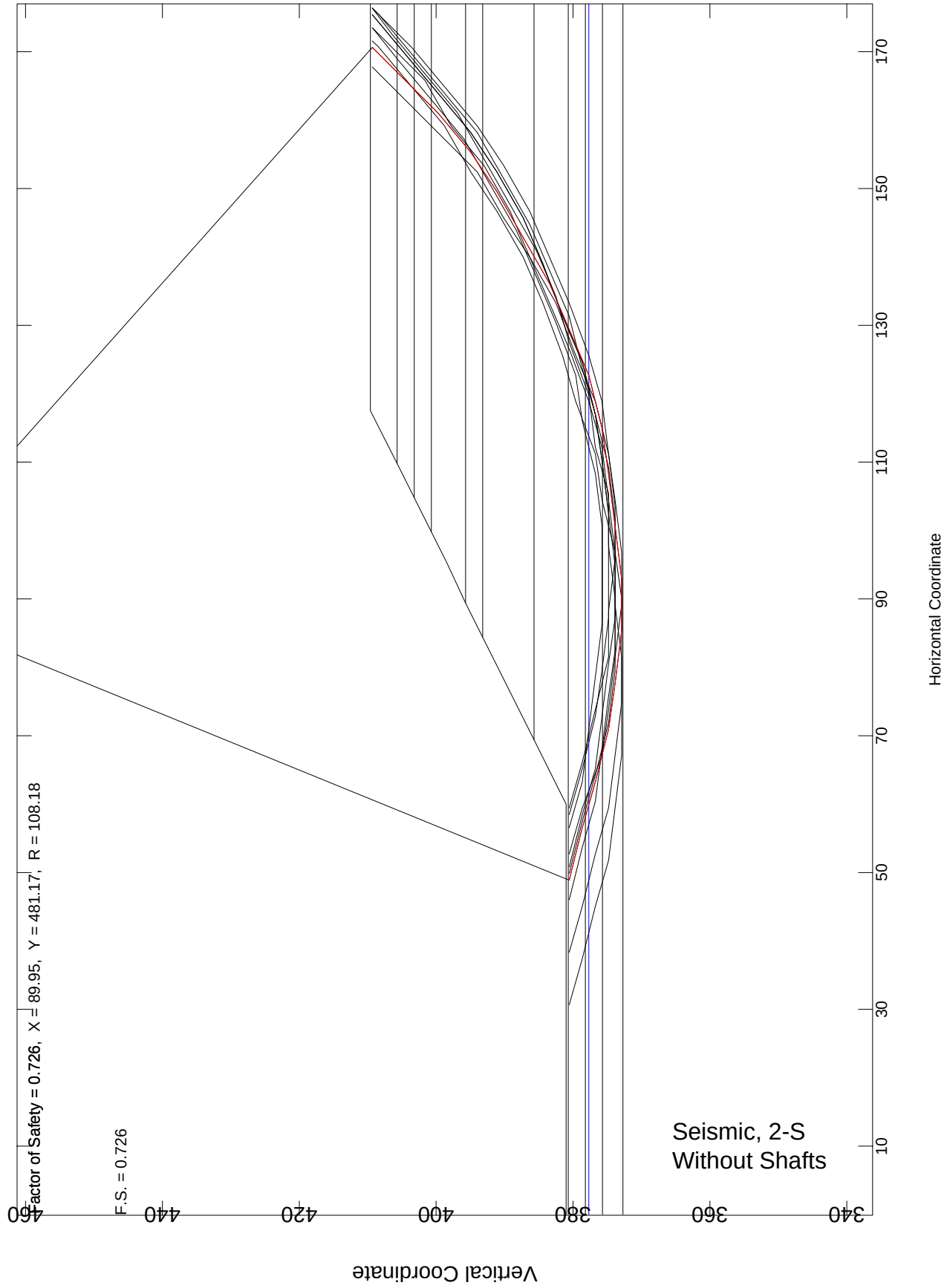

Factor of Safety = 1.868, X = 76.67, Y = 488.36, R = 108.74
F.S. = 1.868
LRFD, 1-S
Horizontal Coordinate
Vertical Coordinate
10
30
50
70
90
110
130
150
170
340
360
380
400
420
440

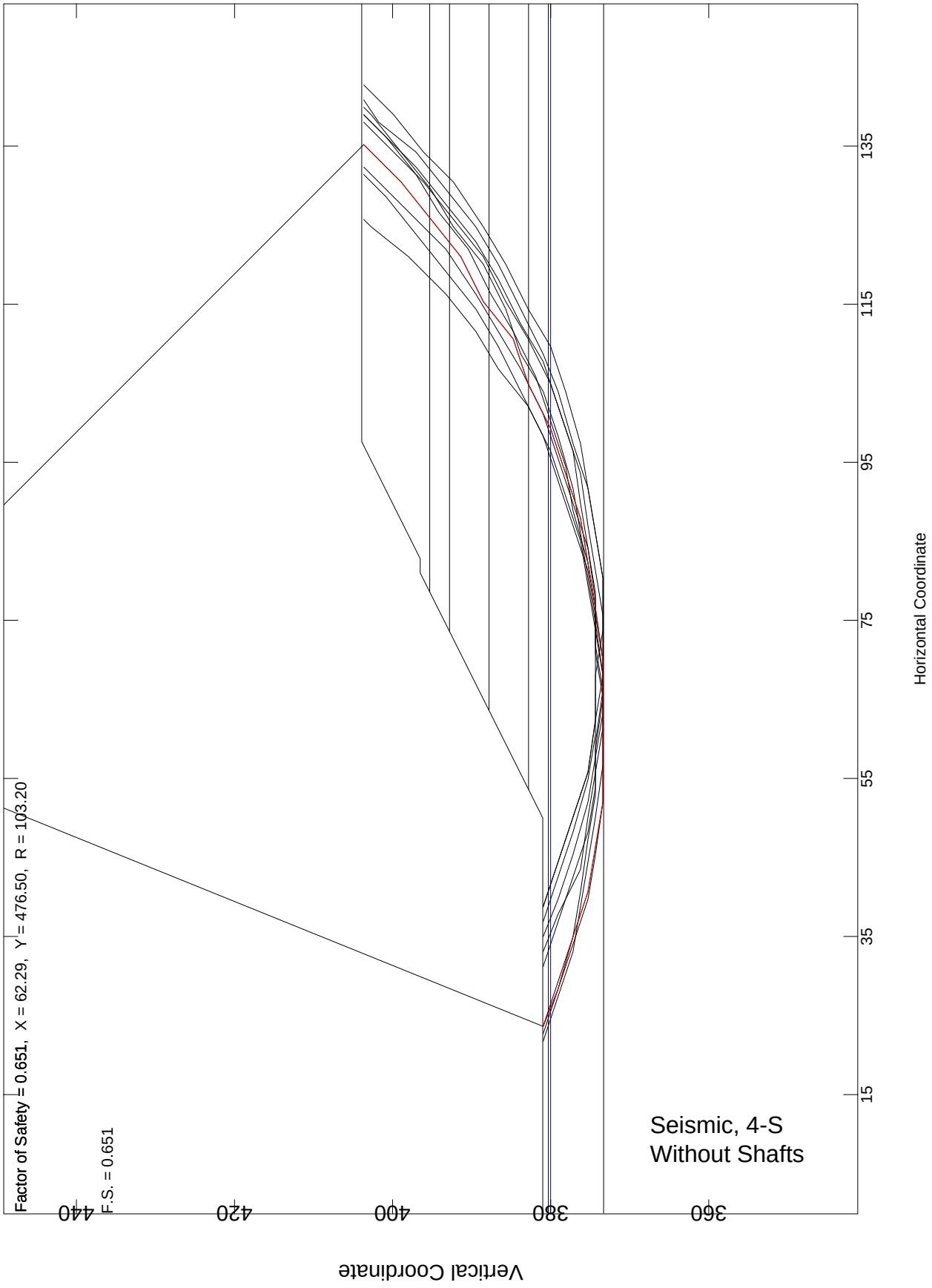

Factor of Safety = 1.761, X = 82.49, Y = 466.05, R = 88.13
F.S. = 1.761
LRFD, 2-S
Vertical Coordinate
Horizontal Coordinate
340
360
380
400
420
440
460
10
30
50
70
90
110
130
150
170

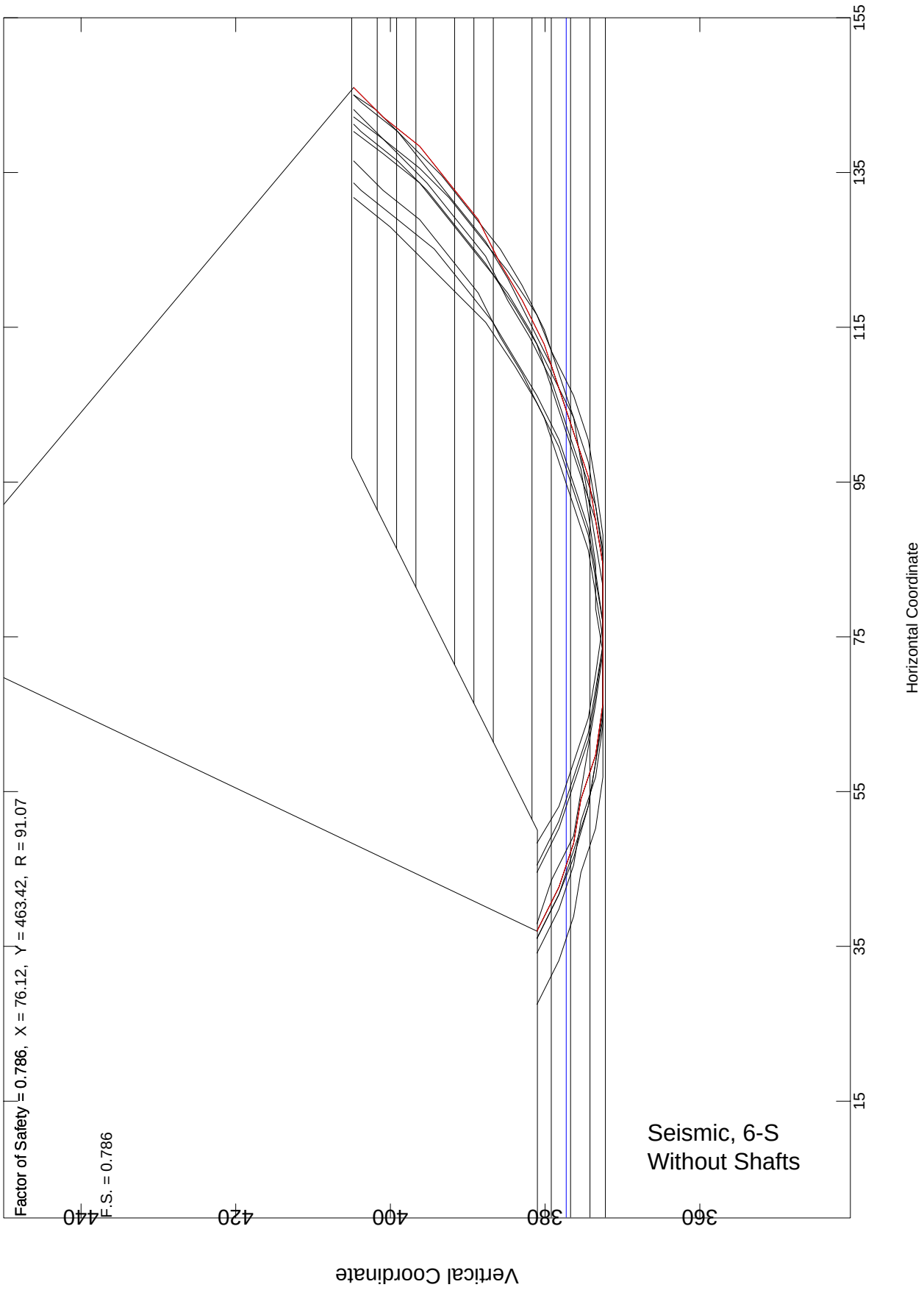

Factor of Safety = 1.849, X = 64.11, Y = 463.03, R = 84.47
F.S. = 1.849
LRFD, 4-S
Horizontal Coordinate
Vertical Coordinate
15
35
55
75
95
115
135
360
380
400
420
440

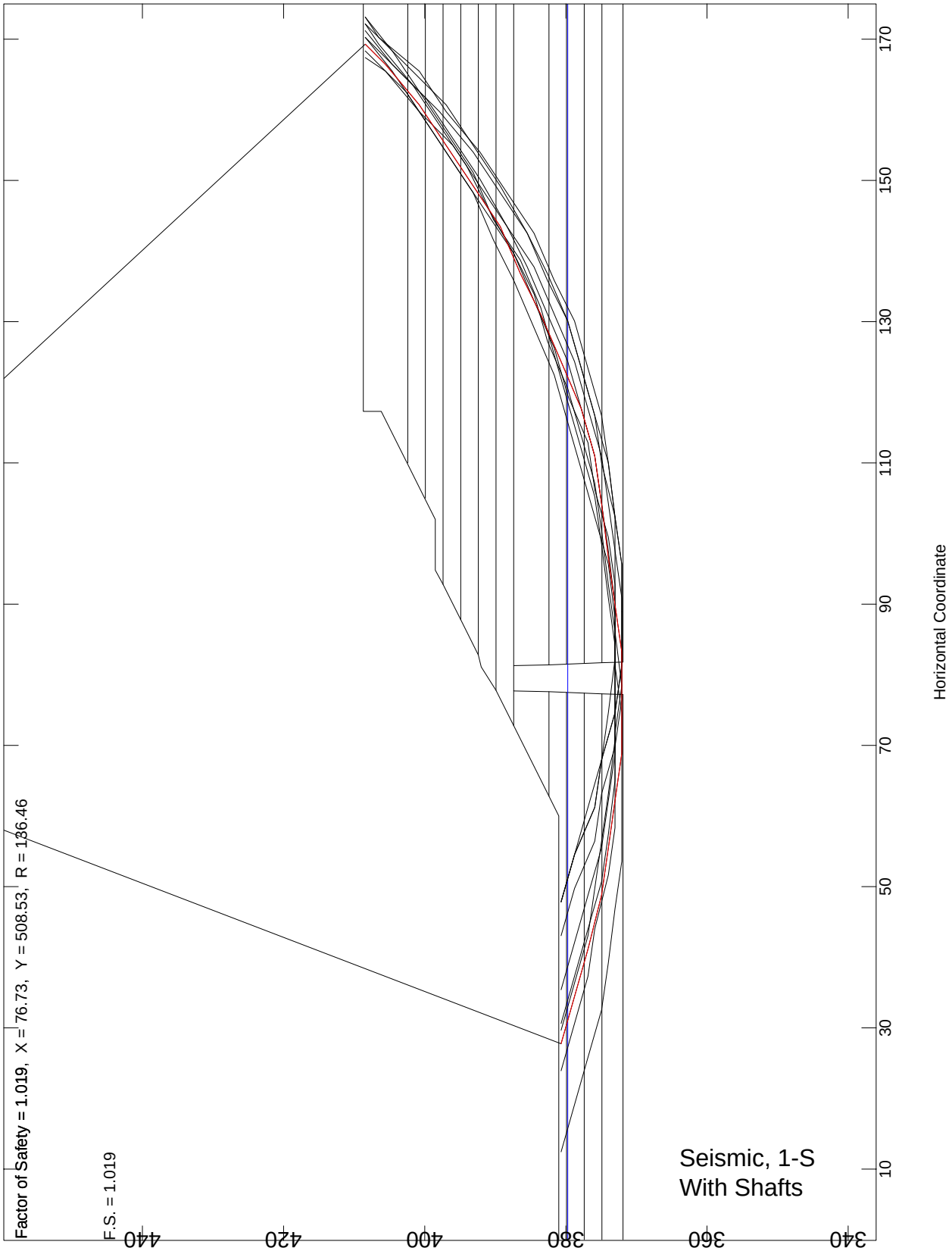

Factor of Safety = 1.782, X = 74.18, Y = 420.12, R = 47.94
F.S. = 1.782
LRFD, 6-S
Horizontal Coordinate
Vertical Coordinate
155
135
115
95
75
55
35
15
360
380
400
420
440

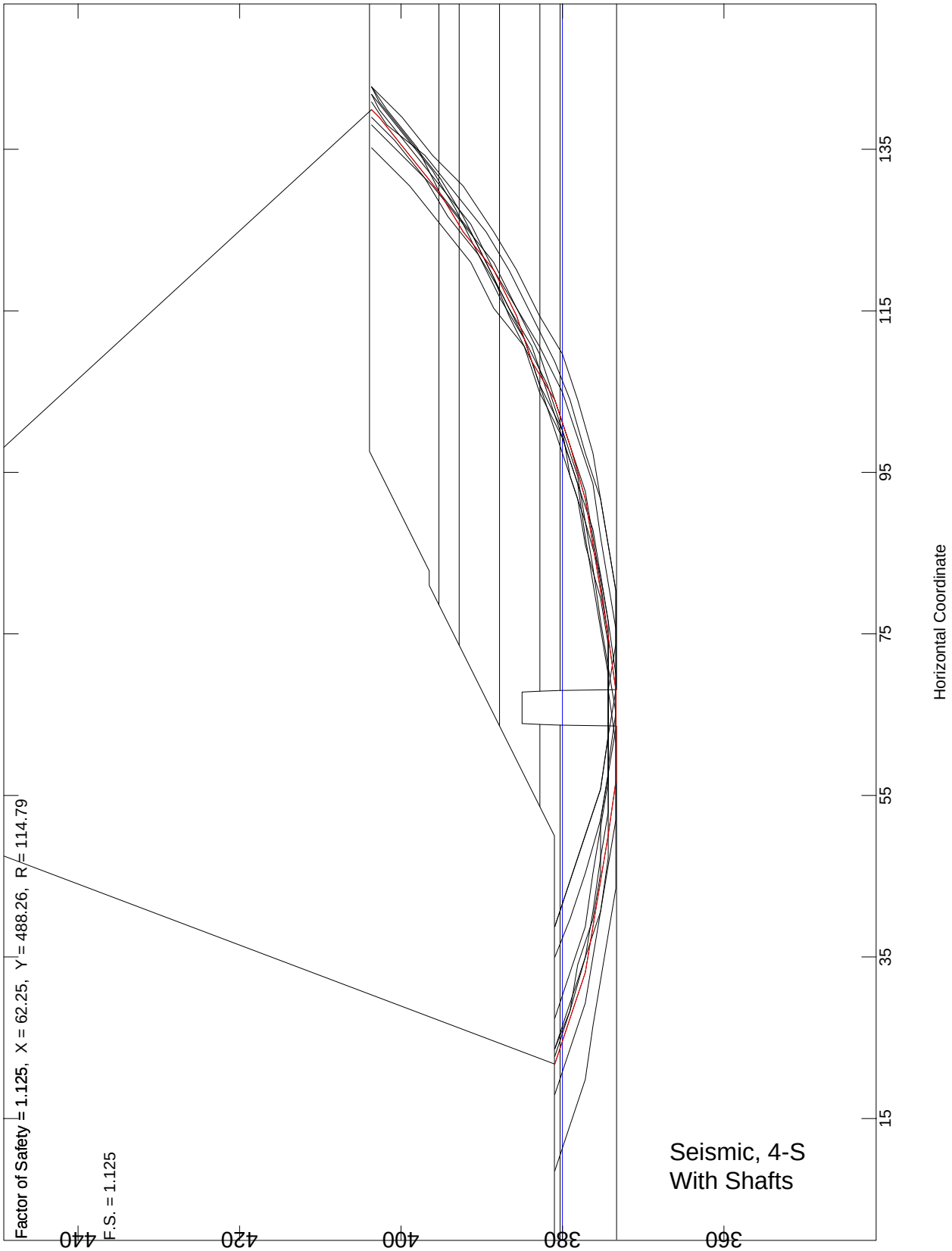

Factor of Safety = 0.675, X = 86.18, Y = 480.74, R = 108.75
F.S. = 0.675
Seismic, 1-S
Without Shafts
Horizontal Coordinate
Vertical Coordinate
10
30
50
70
90
110
130
150
170
340
360
380
400
420
440


Factor of Safety = 0.726, X = 89.95, Y = 481.17, R = 108.18
F.S. = 0.726
Seismic, 2-S
Without Shafts
Horizontal Coordinate
Vertical Coordinate
10
30
50
70
90
110
130
150
170
340
360
380
400
420
440
460


Factor of Safety = 0.651, X = 62.29, Y = 476.50, R = 103.20
F.S. = 0.651
Seismic, 4-S
Without Shafts
Horizontal Coordinate
Vertical Coordinate
15
35
55
75
95
115
135
360
380
400
420
440


Factor of Safety = 0.786, X = 76.12, Y = 463.42, R = 91.07
F.S. = 0.786
Seismic, 6-S
Without Shafts
Horizontal Coordinate
Vertical Coordinate
155
135
115
95
75
55
35
15
360
380
400
420
440


Factor of Safety = 1.019, X = 76.73, Y = 508.53, R = 136.46
F.S. = 1.019
Seismic, 1-S
With Shafts
Horizontal Coordinate
Vertical Coordinate
10
30
50
70
90
110
130
150
170
340
360
380
400
420
440


Factor of Safety = 1.125, X = 62.25, Y = 488.26, R = 114.79
F.S. = 1.125
Seismic, 4-S
With Shafts
Horizontal Coordinate
Vertical Coordinate
15
35
55
75
95
115
135
360
380
400
420
440