STRUCTURE GEOTECHNICAL REPORT

BRIDGE REPLACEMENT
CH 25 (GRASSY ROAD) OVER I-57

Section (X1-7-1)B-2
Williamson County, Illinois
Job No. C-99-013-18/D-99-006-18
Contract No. 78619
PTB 193-033
Existing Structure No. 100-0044
Proposed Structure No. 100-0105

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1.0 Project Description and Scope

1.1 Introduction

The geotechnical investigation summarized herein was performed for the proposed bridge at CH 25 (Grassy Road) over I-57 in Williamson County, Illinois. See Appendix A for Location Map. The purpose of this report is to provide geotechnical design and construction recommendations to aid in the structure planning, final design plans and specification preparation.

1.2 Existing Structure Information

Built in 1959, the existing structure is a four span, haunched reinforced concrete deck girder bridge with reinforced concrete pile bent abutments on concrete piles and multi-column piers on reinforced concrete spread footings supported by timber piles. The existing bridge back to back abutments is 241'-9" and was constructed on a 12°52'45" left forward skew. The out-to-out bridge width is 31'-8". The four span structure spans over I-57 southbound and northbound interstate lanes.

The existing bridge has a sufficiency rating of 48.2 with a deck rating of 6, satisfactory condition with minor deterioration, superstructure rating of 4, poor condition with advanced deterioration, and a substructure rating of 6, satisfactory condition with minor deterioration.

1.3 Proposed Structure Information

The proposed structure is a two span bridge with 48" web plate girders (composite full length) supporting an 8" concrete deck on a 12°52'45" left forward skew. Anticipated span lengths are 121'-9 3/8" and 127'-5 1/2", CL brg. to CL brg. The superstructure consists of 6 plate girders spaced at 5'-10" with 2'-10" overhangs. The roadway cross section consists of 2 – 11'-0" lanes, 2 – 5'-0" shoulders and 1'-5" barriers on either side for a total out to out bridge of 34'-10". The proposed bridge is raised approximately 2 feet from existing grade at both abutments to meet the 16'-9" minimum clearance over I-57.

Grassy Road will be closed during construction of the proposed structure. Traffic is to be detoured. For further proposed structure information, see Appendix B for the Preliminary Type, Size, and Location Plan (TS&L).

2.0 Field Exploration

2.1 Subsurface Exploration and Testing

The subsurface investigation consisted of three borings (1-S through 3-S) drilled by the Illinois Department of Transportation in October of 2018. 1-S and 2-S were taken near the west and east abutment locations, respectively. 3-S was taken in the I-57 median. Soil boring exploration was performed using standard penetration tests (hollow stem auger). See Appendix C for Subsurface Data Profile Plot and Appendix D for Soil Boring Logs.

Table 2.1 - Boring Log Summary

Boring Location	Station	Offset	Ground Surface Elevation
1-S (W. Abut.)	13+24	7 ft. LT	518.40
3-S (Median)	14+76.5	43 ft. LT	498.70
2-S (E. Abut.)	15+75	7 ft. RT	521.00

2.2 Subsurface Conditions

Groundwater conditions recorded in the borings were encountered at an elevation between 473.9 and 475.5 within the embankments and at 476.7 within the I-57 median. Temperature, seasonal variations, and recent rainfall conditions may influence the levels of groundwater table. Without extended periods of observation, the measurement of groundwater conditions herein may not give a true indication of typical groundwater levels. Volume of water depends on the permeability of the soils.

Boring 1-S (W. Abut.): Stiff brown, moist silty clay was encountered from depths 0 to 25 feet (down to Elev. 493.9) having SPT (N) values ranging from 4 to 12 blows per foot, Q_u values of 0.9 to 2.7 tsf, and moisture contents ranging between 18% and 23%. At approximate depth of 25 to 45 feet (down to Elev. 473.9), a stiffer brown and mottled grey, moist silty clay layer was encountered with SPT (N) values ranging from 11 to 17 blows per foot, Q_u values of 2.3 to 3.7 tsf, and moisture contents ranging between 16% and 18%. At depths 45 to 50 feet and 55 to 85 feet, generally stiff grey, silty and clay loam layers exist with SPT (N) values ranging from 9 to 29 blows per foot, Q_u values of 0.4 to 2.0 tsf, and moisture contents ranging between 12% and 22%. The 5 ft range from 50 to 55 feet (Elev. 468.9 to Elev. 463.9) is brown, wet loam layer exhibiting 45% sand, 39% silt, and 9% clay with N = 12 and W% = 23. Below the soil at a depth of 85 feet (Elev. 433.9), the boring encounters a hard brown, dry weathered sandstone layer with SPT (N) of 100/6".

Boring 2-S (E. Abut.): Stiff brown, moist silty clay was encountered from depths 0 to 25 feet (down to Elev. 496.5) having SPT (N) values ranging from 6 to 12 blows per foot, Q_u values of 1.2 to 2.5 tsf, and moisture contents ranging between 17% and 22%. At approximate depth of 25 to 65 feet (down to Elev. 456.5), stiffer brown and mottled grey, moist clay and silty clay layers were encountered with SPT (N) values ranging from 10 to 16 blows per foot, Q_u values of 2.3 to 4.7 tsf, and moisture contents ranging between 17% and 20%. At depths 65 to 85 feet (down to Elev. 438.5), generally stiff grey, silty clay loam layers exist with SPT (N) values ranging from 8 to 21 blows per foot, Q_u values of 1.0 to 3.1 tsf, and moisture contents ranging between 11% and 20%. Below the soil at a depth of 85 feet, the boring encounters a hard brown, dry sandstone layer with SPT (N) of 100/1.5".

Boring 3-S (Median): Medium stiff brown/grey, moist clay loam from depths 0 to 10 feet (down to Elev. 488.2) having SPT (N) values ranging from 5 to 12 blows per foot, Q_u values of 0.6 to 1.0 tsf, and moisture contents ranging between 19% and 28%. At approximate depth of 10 to 40 feet (down to Elev. 459.2), stiffer brown and mottled grey, clay and silty clay layers were encountered with SPT (N) values ranging from 8 to 18 blows per foot, Q_u values of 1.5 to 5.0 tsf, and moisture contents ranging between 13% and 21%. At depths 40 to 60 feet (down to Elev. 439.2), stiff grey, clay and silty clay layers exist with SPT (N) values ranging from 4 to 8 blows per foot, Q_u values of 0.9 to 2.3 tsf, and moisture contents ranging between 18% and 22%. At depths 60 to 65 feet (down to Elev. 433.7),

a hard grey, clay loam layer exists with SPT (N) value of 24 blows per foot, Q_u of 5.2 tsf, and moisture content of 9%. Below the soil at a depth of around 65 feet, the boring encounters hard sandstone layers. The first 5 feet of sandstone exhibits Qu = 381 tsf, R% = 69, and RQD% = 8. The next 5 ft exhibits Qu = 474 tsf, R% = 100, and RQD% = 72.

3.0 Geotechnical Evaluations and Recommendations

3.1 Settlement

Based on the provided preliminary plan and profile, the anticipated difference between the existing and proposed elevations at the abutments is approximately 2 feet. The proposed abutments will be located just behind existing abutments on existing embankments. Minimal increase in new fill should not result in significant additional loading. By inspection, the new fill should result in less than 0.4 inches of additional settlement. Per IDOT Geotechnical Manual Section 6.9.2, driven pile capacity need not account for downdrag if total settlement of soil around the piling is less than 0.4 inches.

3.2 Slope Stability

Slope stability analyses of the end slopes at both abutments were performed due to proposed fill of approximately 2 feet and 1:2.4 (V:H) slope at each abutment. Engineering soil properties taken from the subsurface exploration descriptions were input and slope stability was evaluated using the software program StablPro. The Bishop's method analysis was used to search for the critical circular failure surface to calculate the factor of safety for the slope.

A critical factor of safety was calculated for four modeled conditions: short term static, long term static, short term seismic and long term seismic. Short term conditions capture full cohesive values, while long term conditions assume drained soil properties. A live load surcharge of 250 psf was considered at both abutments. For seismic analysis, a horizontal acceleration coefficient of 0.20g was calculated according to guidance in the FHWA-NHI-11-032, LFRD Seismic Analysis and Design of Transportation Geotechnical Features and Structural Foundations.

See Table 3.1 below for slope stability factors of safety at each abutment. Each abutment location achieved the minimum factor of safety of 1.5 for static conditions and 1.0 for seismic conditions. See Appendix E for soil parameters and individual output of the analyses presented in the table.

Table 3.1 - Summary of Slope Stability Calculated Factors of Safety

Location	Short Term Static	Long Term Static	Short Term Seismic	Long Term Seismic
West Abutment	4.0	1.71	2.4	1.09
East Abutment	5.0	1.67	3.0	1.07

3.3 Seismic Considerations

LRFD Seismic Soil Site Class Definition was determined based on the methodology described in IDOT AGMU 9.1 and the IDOT BBS 149 form for Seismic Site Class Determination. See Appendix F for determination.

Further seismic parameters were determined using the figures and tables provided in AASHTO LRFD Bridge Design Specifications, Article 3.10 for Earthquake Effects, EQ. These parameters are based on a 1000 Year Return Period with a Probability of Exceedance of 7% in 75 years. See table below for a summary of seismic parameters.

Table 3.2 - Summary of Seismic Parameters

Parameter	Value
Seismic Soil Site Class	C
Horizontal Peak Ground Acceleration Coefficient on Rock, PGA	0.385g
Spectral Acceleration Coefficient at period of 0.2 sec., Ss	0.730g
Spectral Acceleration Coefficient at period of 1.0 sec., S1	0.185g
Site Factor, Zero-Period, Fpga	1.02
Site Factor, Short Period, Fa	1.11
Site Factor, Long Period, Fv	1.61
Horizontal Peak Ground Acceleration Coefficient, As	0.393g
Design Spectral Acceleration at 0.2 sec. (SDS)	0.810g
Design Spectral Acceleration at 1.0 sec. (SD1)	0.297g
Seismic Performance Zone	SPZ 2

The Spectral Acceleration Coefficient at T=1.0 sec. (SD1) and Seismic Performance Zone were confirmed using Bridge Manual Planning Section 2.3.10.3.

3.4 Liquefaction

The subsurface exploration indicated a potential liquefiable soil layer in the west abutment soil boring (1-S) between elevations 468.9 to 463.9. By inspection, no liquefiable layers are present at the pier and east abutment boring locations.

A liquefaction analysis was performed using the IDOT Liquefaction Analysis spreadsheet for Boring 1-S. The factor of safety calculated indicated the layer discussed above is potentially liquefiable; thus, liquefaction effects shall be accounted for at the west abutment. See Appendix G for Liquefaction Analysis.

3.5 Scour

Scour is not applicable because this is a grade separation structure.

3.6 Mining Activity

Reviewing the Illinois State Geological Survey (ISGS) "Directory of Coal Mines in Illinois" for Williamson County, no mining activity is present at the bridge location. The nearest underground mine proximity region is located near the city of Marion, 6.5 miles north of the project location.

3.7 Lateral Load Analysis

The tables below provide soil parameters to structural engineer for lateral or displacement analysis of the foundations. The values were estimated based on the descriptions given in the soil boring logs. For short term conditions, full cohesion was used with a friction angle of 0 degrees for cohesive soils. For long term conditions, a nominal cohesion of 100 psf was used for cohesive soils. No specific analyses were performed on the soil to determine the estimated parameters.

Table 3.3 –Soil Parameters for Lateral Load Analysis at West Abutment (1-S)

Soil Description	Elev. at Bottom of Layer	γ (pcf)	Short Term		Long Term		K (pci)	ε_{50}
			c' (ksf)	θ (deg.)	c' (ksf)	θ (deg.)		
Stiff Clay	508.9	125	1.2	0	0.1	26	300	0.007
Medium Stiff to Stiff Clay	503.9	125	0.9	0	0.1	26	300	0.007
Very Stiff Silty Clay	501.4	130	2.5	0	0.1	26	500	0.005
Stiff Silty Clay	498.9	125	1.2	0	0.1	26	300	0.007
Very Stiff Silty Clay	496.4	130	2.7	0	0.1	26	500	0.005
Stiff Clay	493.9	125	1.6	0	0.1	28	300	0.007
Very Stiff Silty Clay	473.9	130	2.7	0	0.1	28	500	0.005

Stiff Silty Loam	468.9	125	1.7	0	0.1	28	300	0.007
Medium Dense Loam	463.9	120	0	30	0	30	100	0.010
Stiff Silt	458.9	125	1.4	0	0.1	28	300	0.007
Soft Silty Loam	453.9	115	0.4	0	0.1	28	20	0.025
Stiff Silty Loam	448.9	125	1.9	0	0.1	28	300	0.007
Stiff Clay Loam	443.9	125	2.0	0	0.1	28	300	0.007
Stiff Silty Loam	433.9	125	1.0	0	0.1	28	300	0.007
Sandstone	-	145	0	35	0	35	-	-

Table 3.4 –Soil Parameters for Lateral Load Analysis at East Abutment (2-S)

Soil Description	Elev. at Bottom of Layer	γ (pcf)	Short Term		Long Term		K (pci)	ε_{50}
			c' (ksf)	θ (deg.)	c' (ksf)	θ (deg.)		
Stiff Clay to Silty Clay	509.0	125	1.2	0	0.1	26	300	0.007
Stiff to V. Stiff Silty Clay	496.5	130	2.1	0	0.1	26	500	0.005
Hard Silty Clay	486.5	130	4.1	0	0.1	28	500	0.005
Very Stiff Clay	456.5	130	2.5	0	0.1	28	500	0.005
Stiff Silty Clay	446.5	125	1.0	0	0.1	28	300	0.007
Stiff Silty Clay Loam	441.5	125	1.3	0	0.1	28	300	0.007
V. Stiff Silty Clay Loam	438.5	130	3.1	0	0.1	28	500	0.005
Sandstone	-	145	0	35	0	35	-	-

Table 3.5 –Soil Parameters for Lateral Load Analysis at Pier (3-S)

Soil Description	Elev. at Bottom of Layer	γ (pcf)	Short Term		Long Term		K (pci)	ε_{50}
			c' (ksf)	θ (deg.)	c' (ksf)	θ (deg.)		
Med. Stiff Silty Clay Loam	491.7	120	0.6	0	0.1	26	100	0.010
Med. Stiff Clay Loam	488.2	120	1.0	0	0.1	26	100	0.010
Very Stiff Silty Clay Loam	486.2	130	2.1	0	0.1	26	500	0.005
Very Stiff Silty Clay	484.2	130	2.5	0	0.1	26	500	0.005
Stiff Silty Clay	481.7	125	1.6	0	0.1	26	300	0.007
Very Stiff Silty Clay	476.7	130	2.9	0	0.1	26	500	0.005
Hard Silty Clay	473.7	130	5.0	0	0.1	26	500	0.005
V. Stiff Clay to Silty Clay	466.7	130	3.1	0	0.1	28	500	0.005
Hard Clay	464.2	130	4.3	0	0.1	26	500	0.005
Stiff Silty Clay	461.7	125	1.5	0	0.1	26	300	0.007
Stiff Clay	459.2	125	3.3	0	0.1	26	300	0.007
Medium Stiff Silty Clay	449.2	120	0.9	0	0.1	26	100	0.010
Medium Stiff Clay	444.2	120	0.9	0	0.1	26	100	0.010
Very Stiff Clay	439.2	130	2.3	0	0.1	26	500	0.005
Hard Clay Loam	433.7	130	5.2	0	0.1	28	500	0.005
Sandstone	-	145	0	35	0	35	-	-

4.0 Foundation Recommendations

4.1 Abutments

Preliminary superstructure loads for the proposed structure configuration discussed above were provided by Veenstra & Kimm. Including the approach slab and abutment self-weight, each abutment will experience an estimated Total Factored Strength Load of 1,360 kips and Total Factored Extreme Event Load of 670 kips at the bottom of abutment.

Integral abutments are preferred to eliminate joints in the bridge decks, decreasing maintenance

costs and increasing service life. Foundation type for integral abutments shall be pile supported. See results of preliminary Integral Abutment Feasibility Analysis in Appendix H. The designer shall verify integral abutment feasibility analysis with final configuration. In addition, see IDOT ABD Memo 19.8 for further integral abutment design guidance.

Per the preliminary TS&L, pile bent integral abutments are anticipated with the bottom of the west abutment at Elev. 511.60 and bottom of east abutment at Elev. 514.13. The estimated pile lengths include a 2 foot embedment into the abutment. Due to the presence of sandstone at the subject site and H-piles being most effective in point bearing applications, H-piles are recommended over metal shell piles.

Tables 4.1 through 4.3 below summarize the nominal required bearing (R_N), factored resistance available (R_F), estimated pile length and estimated pile tip elevation for strength limit state and extreme event including west abutment liquefaction. R_N indicates the resistance of the pile during driving, which assists the Contractor from causing damage to the pile. R_F represents the net long term axial geotechnical resistance available to support the factored structure loads. Analyses have been performed using the IDOT Static Method of Estimating Pile Length. See Appendix I.

The factored resistance available values shown in the tables are intended to provide the designer with a range of feasible options for the anticipated vertical loading. Pile tip elevations shown range from 0 to 2 feet embedment into rock. Piles shall be evaluated for lateral resistance in final design.

Table 4.1 - H-Pile Capacity at the West Abutment – Strength Limit State

Pile Size	Nominal Required Bearing, R_N (kips)	Factored Resistance Available, R_F (kips)	Estimated Pile Length (ft.)	Estimated Pile Tip Elevation (ft.)
HP12x74	398	219	80	433.6
	521	286	81	432.6
HP12x84	404	222	80	433.6
	528	290	81	432.6
	638	351	82	431.6
HP14x73	464	255	80	433.6
HP14x89	474	261	80	433.6
	620	341	81	432.6
HP14x102	481	265	80	433.6
	628	345	81	432.6
	774	426	82	431.6

HP14x117	491	270	80	433.6
	639	351	81	432.6
	787	433	82	431.6

Table 4.2 - H-Pile Capacity at the West Abutment – Extreme Limit State (Liquefaction)

Pile Size	Nominal Required Bearing, R_N (kips)	Factored Resistance Available, R_F (kips)	Estimated Pile Length (ft.)	Estimated Pile Tip Elevation (ft.)
HP12x74	398	101	80	433.6
	521	224	81	432.6
HP12x84	404	103	80	433.6
	528	227	81	432.6
	638	337	82	431.6
HP14x73	464	119	80	433.6
HP14x89	474	126	80	433.6
	620	272	81	432.6
HP14x102	481	129	80	433.6
	628	276	81	432.6
	774	422	82	431.6
HP14x117	491	135	80	433.6
	639	283	81	432.6
	787	431	82	431.6

Table 4.3 - H-Pile Capacity at the East Abutment – Strength Limit State

Pile Size	Nominal Required Bearing, R_N (kips)	Factored Resistance Available, R_F (kips)	Estimated Pile Length (ft.)	Estimated Pile Tip Elevation (ft.)
HP12x74	461	253	78	438.1
	583	321	79	437.1
HP12x84	467	257	78	438.1
	590	325	79	437.1
HP14x73	538	296	78	438.1
HP14x89	549	302	78	438.1
	695	382	79	437.1
HP14x102	556	306	78	438.1
	703	386	79	437.1
HP14x117	566	312	78	438.1
	714	393	79	437.1

4.2 Pier

Preliminary superstructure loads for the proposed structure configuration discussed above were provided by Veenstra & Kimm. Including the self-weight of a multi-column pier, the pier will experience an estimated Total Factored Load of 2,600 kips.

Spread footing on soil, drilled shaft foundation and pile-supported footing are several options considered at the pier. The existing piers are creosoted timber pile supported spread footings.

Spread Footing on Soil: Soil layers within 10 feet of the ground line at the pier have Qu values of 1.0 tsf or less. Stiffer silty clay layers below offer slightly better Qu values, but construction depths are not cost efficient. Thus, spread footings on soil are not recommended.

Drilled Shafts: Drilled shafts are typically preferred when subsurface information indicates a highly sloping, irregular, or very poorly defined rock surface. At the project location, the rock surface is fairly consistent across the borings. In addition, the rock surface is located approximately 65 feet below the ground line.

Pile-Supported Footing: Due to the rock depth, driven piles are more efficient than drilled shafts. In addition, driven piles are recommended at the abutments so pile driving equipment will already be mobilized. As noted above, pile-supported footing matches the existing substructure foundations.

In Seismic Performance Zone 2, battered piles are not recommended to avoid additional stiffness effects and difficulty predicting behavior during a seismic event. The designer shall verify final proposed pile configuration misses the existing piles at pier.

Per the preliminary TS&L, a multi-column pier with three rows of piles in the footing are anticipated with the bottom of the footing matching the existing pier footing at Elev. 495.41. The estimated pile lengths include a 2 foot embedment into the pier footing. Similar to the abutments, H-piles are recommended over metal shell piles due the presence of sandstone at the subject site.

Table 4.4 below summarizes the nominal required bearing (R_N), factored resistance available (R_F), estimated pile length and estimated pile tip elevation. R_N indicates the resistance of the pile during driving, which assists the Contractor from causing damage to the pile. R_F represents the net long term axial geotechnical resistance available to support the factored structure loads. Analysis has been performed using the IDOT Static Method of Estimating Pile Length. See Appendix I.

The factored resistance available values shown in the tables are intended to provide the designer with a range of feasible options for the anticipated vertical loading. Pile tip elevations shown range from 0 to 2 feet embedment into rock. Piles will need to be evaluated for lateral resistance in final design.

Table 4.4 - H-Pile Capacity at the Pier – Strength Limit State

Pile Size	Nominal Required Bearing, R_N (kips)	Factored Resistance Available, R_F (kips)	Estimated Pile Length (ft.)	Estimated Pile Tip Elevation (ft.)
HP12x53	264	145	64	433.4
	385	212	65	432.4
HP12x63	272	150	64	433.4
	394	217	65	432.4
HP12x74	278	153	64	433.4
	400	220	65	432.4
	523	288	66	431.4
HP12x84	283	156	64	433.4
	406	224	65	432.4
	530	291	66	431.4
HP14x73	322	177	64	433.4
	467	257	65	432.4

HP14x89	331	182	64	433.4
	477	262	65	432.4
	623	343	66	431.4
HP14x102	337	186	64	433.4
	484	266	65	432.4
	631	347	66	431.4
HP14x117	346	190	64	433.4
	494	272	65	432.4
	642	353	66	431.4

5.0 Construction Considerations

5.1 Construction Activities

All construction activities shall be performed in accordance with the current IDOT Standard Specifications for Road and Bridge Construction and any pertinent Special Provisions or Policies.

5.2 Temporary Soil Retention System / Sheet Piling

Temporary sheet piling will not be required to construct the abutments because the structure will be closed to all traffic during construction. Constructing the footing at the pier appears feasible within the median without requiring a temporary soil retention system or sheet piling. From the preliminary TS&L, the distance from ground surface to the bottom of proposed pier spread footing is approximately 5 feet. The designer shall verify the need for retention with the final configuration.

5.3 Foundation Construction

Abutment soil borings, 1-S and 2-S, are located at the proposed abutment locations. In lieu of a test pile at proposed abutments, the proposed pile length may be extended by two feet to accommodate length variations in the field. At the pier, a test pile is recommended due to the proximity of the median boring location from the proposed pier and the number of proposed piles required. Pile shoes are recommended when driving into hard sandstone.

Conventional pile driving equipment and methodologies shall be assumed.

5.4 Excavation

Excavation shall be performed in accordance with IDOT Standard Specifications Section 202. Substructure construction shall occur after removal of the existing structure is complete.

The existing contract plans indicate a 36" culvert pipe near each proposed abutment location. The designer shall coordinate potential conflicts in final design.

A Joint Utility Locating Information for Excavators (J.U.L.I.E.) locate shall be performed prior to commencing construction activities to determine underground utilities within the project limits. In addition, IDOT shall be contacted to locate private utilities.

At foundation and structural fill locations, the exposed subgrade shall be proofrolled to aid in locating any unstable and unsuitable materials. Unstable and unsuitable materials shall be removed and replaced with compacted structural fill.

6.0 Limitations

The analysis and discussion provided herein are for the exclusive use of IDOT and Veenstra & Kimm. They are based upon the subsurface data obtained at boring locations within the bridge area and are specific to the project described, our understanding of the project as described herein, and geotechnical engineering practice consistent with the standard of care.

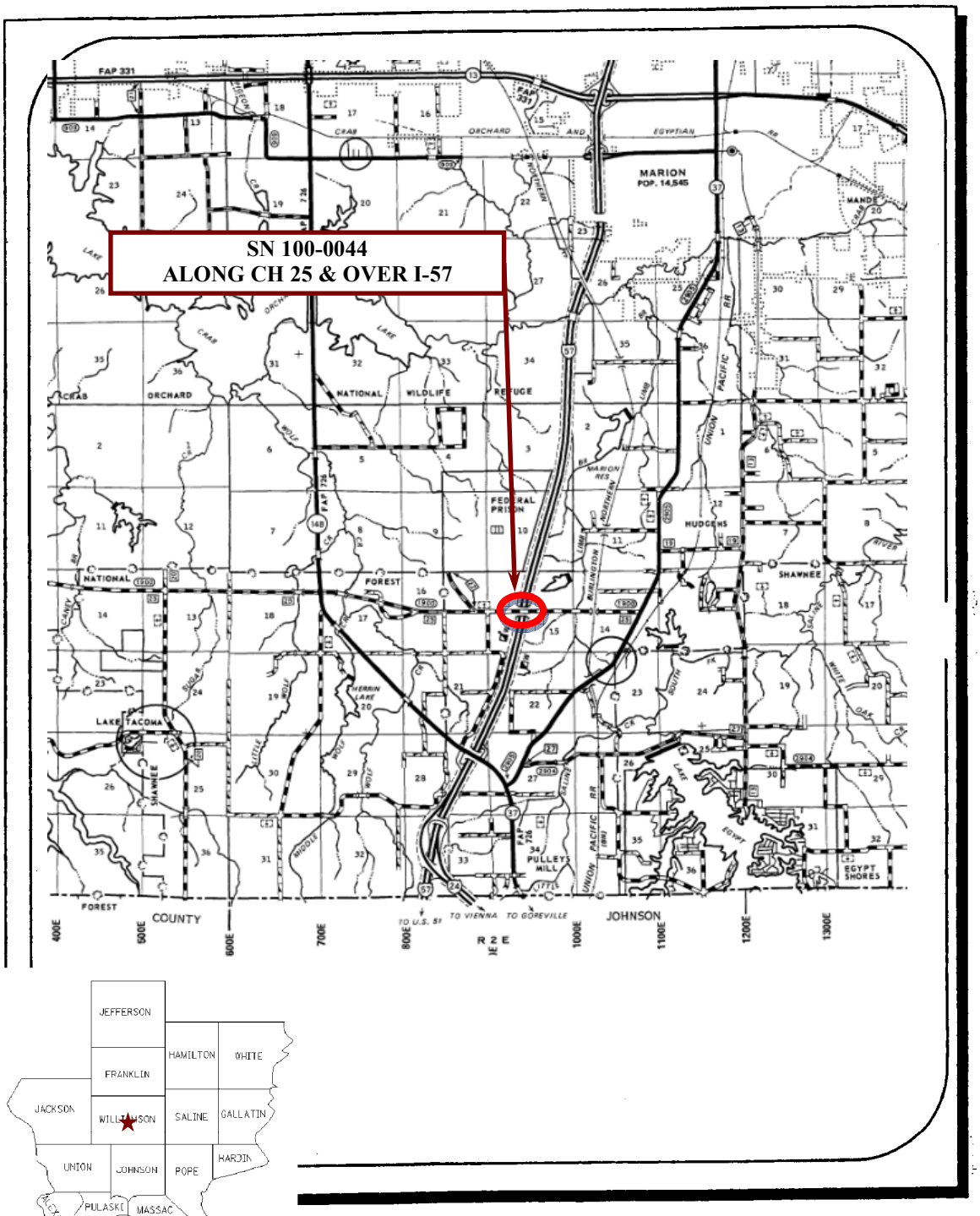
Appendix A

Location Map

LOCATION MAP

F.A.I. 57 (I 57)

WILLIAMSON County



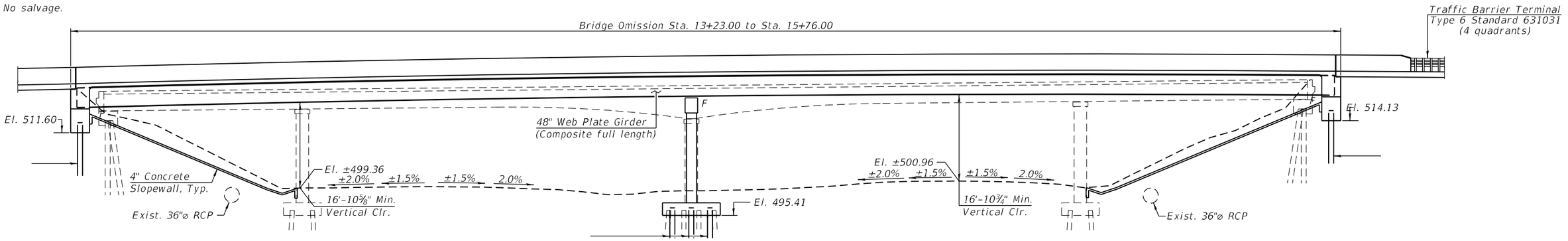
Appendix B

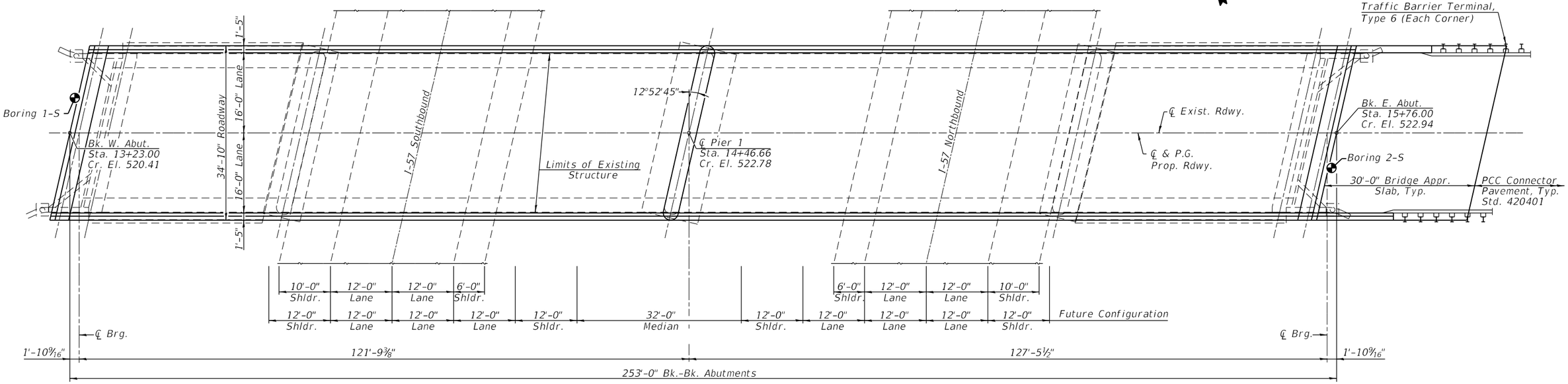
Preliminary Type, Size, and Location Plan (TS&L)

Bench Mark: BM 4-A – Chiseled "□" on South End of Concrete Guardwall, south of East Pier, East of northbound I-57, of Structure 100-0044. Station 15+14.50, 42.25' Rt. Elev. – 503.256

Existing Structure: SN 100-0044 was constructed in 1959 under Section X1-7HB at Sta. 14+46.66. The existing structure is a 4-span, haunched reinforced concrete deck girder bridge having a back-to-back abutment length of 241'-9" and a 26'-0" face-to-face of curb and 31'-8" out-to-out of deck at a 12°52'45" left forward skew. The superstructure consists of a reinforced concrete slab supported by five haunched concrete T-beams. The substructure consists of reinforced concrete pile bent abutments supported by concrete piles and multi-column piers on reinforced concrete spread footings supported by timber piles. The structure will be replaced under road closure.

No salvage.





GENERAL PLAN & ELEVATION
GRASSY LAKE ROAD
OVER INTERSTATE 57
SECTION (X1-7-1)B-2
WILLIAMSON COUNTY
STATION 14+46.66
STRUCTURE NO.

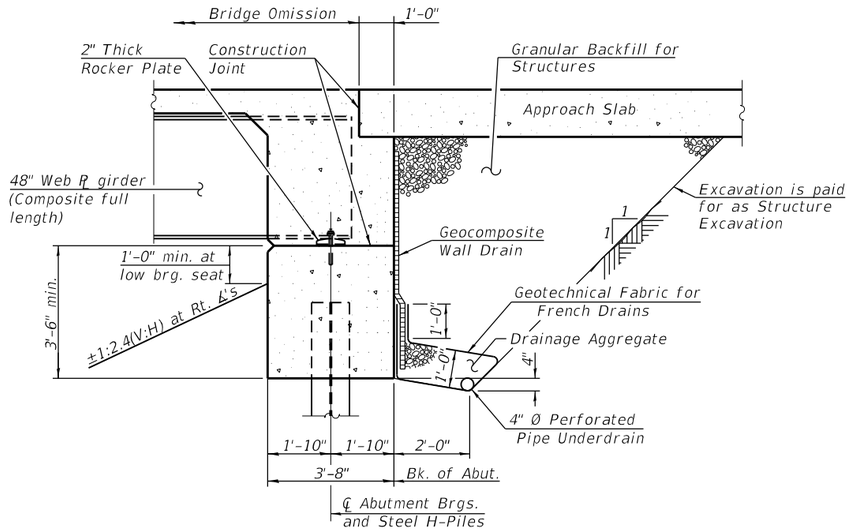
Veenstra & Kimm, Inc.
Springfield, IL. Phone: (217)544-8033

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

STATE OF ILLINOIS
DEPARTMENT OF TRANSPORTATION

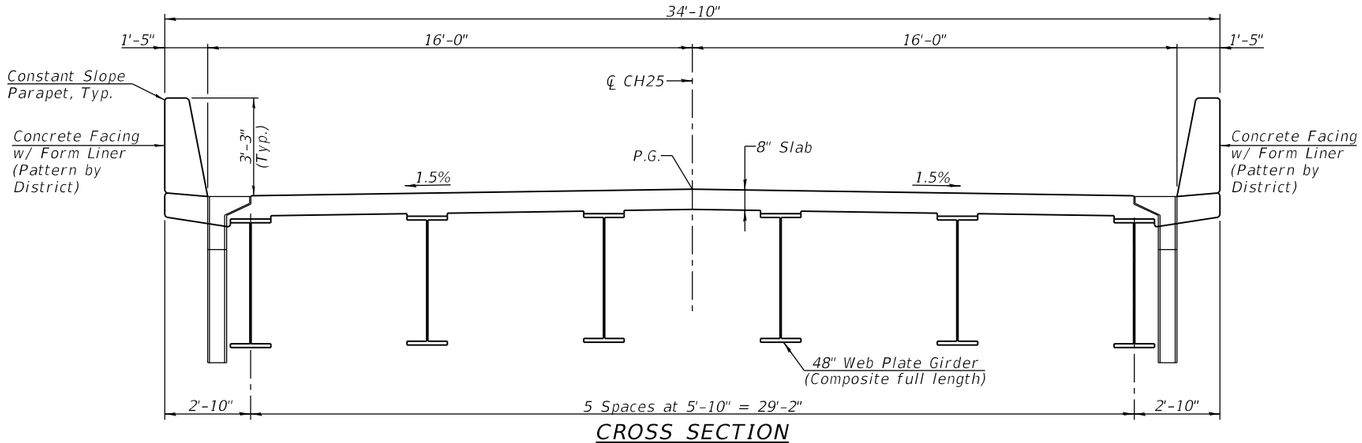
GENERAL PLAN & ELEVATION
S.N. 100-0104
SHEET NO. 1 OF 2 SHEETS

F.A.S. RTE.	SECTION	COUNTY	TOTAL SHEETS	SHEET NO.
	(X1-7-1)B-2	WILLIAMSON	____	____
		CONTRACT NO. 78619		
	ILLINOIS FED. AID PROJECT			



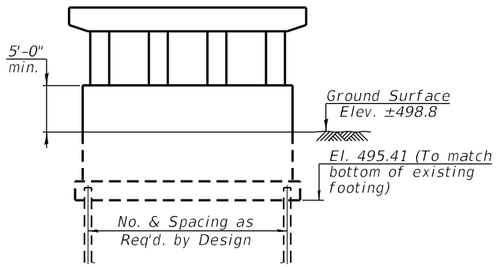
SECTION THRU INTEGRAL ABUTMENT

(Horiz. dim. @ Rt. ℄'s)

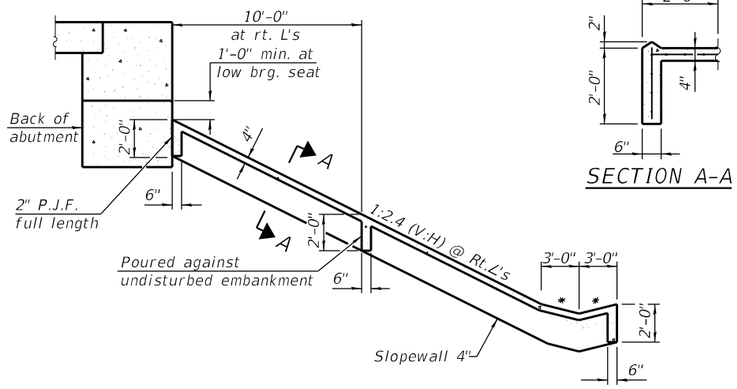


CROSS SECTION

(Looking East)



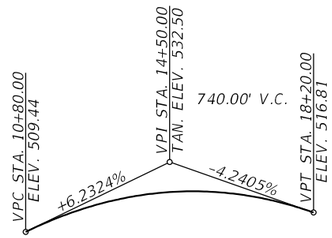
PIER SKETCH



SECTION THRU CONCRETE SLOPEWALL

*1:6 (V:H)

SECTION A-A



PROFILE GRADE

(Along NB & SB I-57)

PROFILE GRADE

(Along ℄ CH-25)

HIGHWAY CLASSIFICATION

FAS 1900 – Grassy Road
Functional Class: Major Collector
ADT: 1100 (2017); 1410 (2042)
ADTT: 40 (2017); 55 (2042)
DHV: 100 (2017); 125 (2042)
Design Speed: 45 m.p.h.
Posted Speed: 55 m.p.h.
Two-way Traffic Directional Dist. 50:50

F.A.I. Rte. 57 – I-57
Functional Class: Interstate
ADT: 30900 (2017); 44830 (2042)
ADTT: 11,550 (2017); 16,760 (2042)
DHV: 2,780 (2017); 4,035 (2042)
Design Speed: 70 m.p.h.
Posted Speed: 70 m.p.h.
Two-way Traffic Directional Dist. 50:50

LOADING HL-93

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

DESIGN SPECIFICATIONS

2017 AASHTO LRFD Bridge Design Specifications, 8th Edition.

DESIGN STRESSES

FIELD UNITS

f'_c = 3,500 psi
f'_c = 4,000 psi (Superstructure Concrete)
f_y = 60,000 psi (Reinforcement)
f_y = 50,000 psi (M270 Grade 50)

DETAILS
C.H. 25 (GRASSY LAKE ROAD)
OVER INTERSTATE 57
SECTION (X1-7-1)B-2
WILLIAMSON COUNTY
STATION 14+46.66
STRUCTURE NO.

Veenstra & Kimm, Inc.
Springfield, IL. Phone: (217)544-8033

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

STATE OF ILLINOIS
DEPARTMENT OF TRANSPORTATION

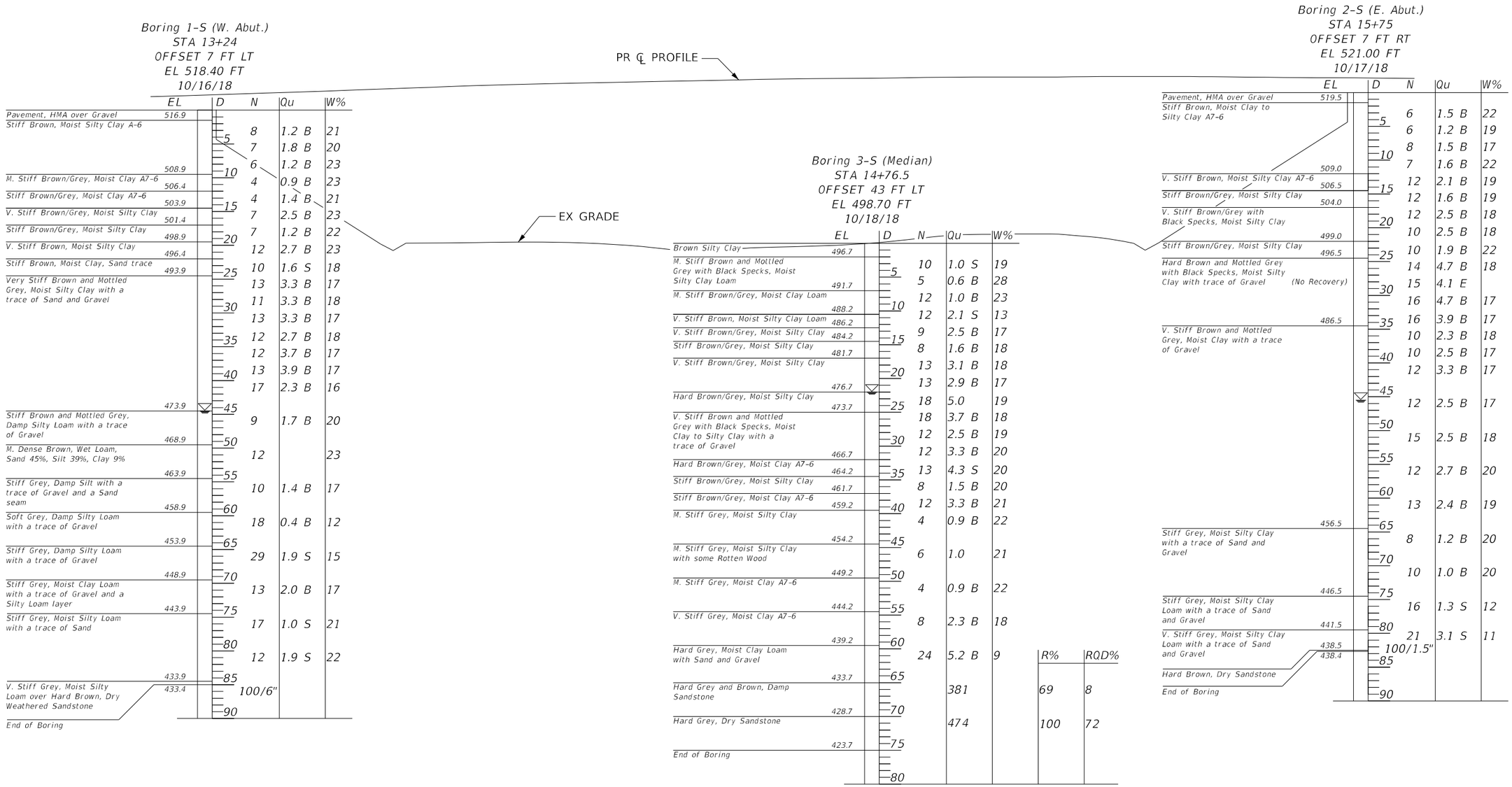
DETAILS
S.N. 100-0104
SHEET NO. 2 OF 2 SHEETS

F.A.S. RTE.	SECTION	COUNTY	TOTAL SHEETS	SHEET NO.
	(X1-7-1)B-2	WILLIAMSON	____	____
		CONTRACT NO. 78619		
	ILLINOIS	FED. AID PROJECT		

Appendix C

Subsurface Data Profile Plot

Note: Boring Stationing and Offsets shown in reference to Grassy Road profile.



LEGEND

EL = Elevation (FT)
D = Depth Below Existing Ground Surface (FT)
N = SPT N-VALUE (AASHTO T206)
Qu = Unconfined Compressive Strength in tons per sq. ft. (tsf)
Failure Mode (B=bulge, S=shear, P=penetrometer)
W% = Moisture Content Percentage

▽ = Groundwater Level First Encountered

Soil profile is for illustrative purposes only. Actual conditions will vary.

SUBSURFACE DATA PROFILE
GRASSY ROAD OVER INTERSTATE 57
SECTION (X1-7-1)B-2
WILLIAMSON COUNTY
STATION 14+46.66
SN 100-0044 (EXIST.)

FILE NAME = P:\Effingham\4268 - IDOT 193-33 D9 VV_VK\Work Order #3\SGR\Subsurface Data Profile\Subsurface Data Profile.dgn	USER NAME = tziegler	DESIGNED - WMK	REVISED -	STATE OF ILLINOIS DEPARTMENT OF TRANSPORTATION		F.A.I. RTE.	SECTION	COUNTY	TOTAL SHEETS	SHEET NO.
	PLOT SCALE = 2.0000 ' / In.	DRAWN - WMK	REVISED -			57	(X1-7-1)B-2	WILLIAMSON	1	1
Default	PLOT DATE = 8/25/2020	CHECKED - TJZ	REVISED -							
		DATE - 7/23/20	REVISED -		SHEET 1 OF 1 SHEETS			ILLINOIS	FED. AID PROJECT	

Appendix D

Soil Boring Logs

Illinois Department of Transportation

Memorandum

To:	Carrie Nelsen	Attn: Dave Piche
From:	Keith Roberts	By: Aaron Hayes (RG) AWH
Subject:	Boring Logs	
Date:	December 20, 2018	

Grassy Road (CH 25) over FAI-57
Structure No. 100-0044 (Existing)
Section (X1-7-1)B-2
Williamson County

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

Boring 1-S, near the west abutment, shows a layer of potentially liquefiable soil from a depth of 49.5 to 54.5 feet. A liquefaction analysis should be completed once the proposed structure's dimensions are determined.

The old borings completed for the existing structure built in 1959 are also attached.

Attachments
AWH:ah

cc: Soils File\Williamson County\Structure Borings

ILLINOIS DEPARTMENT OF TRANSPORTATION
District Nine Materials

Bridge Foundation Boring Log

FAP 1900 (CH 25) Grassy Rd Over FAI-57 — Sheet 1 of 2

Route: Grassy Rd — Structure Number: 100-0044 — Date: 10/16/2018

Section (X1-7-1)B-2 — Bored By: L Estel

County: Williamson — Location: 1.4 miles West of IL 37 (W. Abut.) — Checked By: A Hayes

Boring No 1-S
Station 13+24 (Grassy Rd)
Offset 7' LT of CL
Ground Surface 518.4 Ft

Surf Wat Elev:
Ground Water Elevation
when Drilling 473.9
At Completion
At: Hrs:

DEPTH	BLOWS	Qu tsf	W%	Material
				Cored Pavement, HMA over GRAVEL
516.9				
	2			
	4	1.2B	21	Stiff Brown, Moist SILTY CLAY A-6
	4			
5.0	1			
	3	1.8B	20	
	4			
	WH			
	2	1.2B	23	
	4			
508.9				
10.0	1			
	2	0.9B	23	M. Stiff Brown and Grey, Moist CLAY A7-6
	2			
506.4				
	1			
	1	1.4B	21	Stiff Brown and Grey, Moist CLAY A7-6
	3			
503.9				
15.0	1			
	3	2.5B	23	V. Stiff Brown and Grey, Moist SILTY CLAY
	4			
501.4				
	1			
	3	1.2B	22	Stiff Brown and Grey, Moist SILTY CLAY
	4			
498.9				
20.0	3			
	5	2.7B	23	V. Stiff Brown, Moist SILTY CLAY
	7			
496.4				
	1			
	3	1.6S	18	Stiff Brown, Moist CLAY with a trace of SAND
	7			
493.9				
25.0	1			

DEPTH	BLOWS	Qu tsf	W%	Material
	6	3.3B	17	V. Stiff Brown and Mottled Grey, Moist SILTY CLAY with a trace of SAND and GRAVEL
	7			
	1			
	5	3.3B	18	
	6			
30.0	1			
	6	3.3B	17	
	7			
	1			
	5	2.7B	18	
	7			
35.0	1			
	5	3.7B	17	
	7			
	1			
	6	3.9B	17	
	7			
40.0	1			
	7	2.3B	16	
	10			
473.9				
45.0	1			
	4	1.7B	20	Stiff Brown and Mottled Grey, Damp SILTY LOAM with a trace of GRAVEL
	5			
468.9				
50.0	1			

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

Route: Grassy Rd
Date: 10/16/2018
Section: (X1-7-1)B-2
County: Williamson

Boring No: 1-S
Station: 13+24 (Grassy Rd)
Offset: 7' LT of CL
Ground Surface: 518.4 Ft

	DEPTH	BLOWS	Qu tsf	W%
M. Dense Brown, Wet LOAM		6		23
Sand 45%		6		
Silt 39%				
Clay 9%				
(Washed) 463.9				
	55.0	1		
Stiff Grey, Damp SILT with a		5	1.4B	17
trace of GRAVEL and a SAND		5		
seam				
458.9				
	60.0	4		
Soft Grey, Damp SILTY LOAM		9	0.4B	12
with a trace of GRAVEL		9		
453.9				
	65.0	4		
Stiff Grey, Damp SILTY LOAM		13	1.9S	15
with a trace of GRAVEL		16		
448.9				
	70.0	6		
Stiff Grey, Moist CLAY LOAM		6	2.0B	17
with a trace of GRAVEL and a		7		
SILTY LOAM layer				
443.9				
	75.0	3		

	DEPTH	BLOWS	Qu tsf	W%
Stiff Grey, Moist SILTY LOAM		8	1.0S	21
with a trace of SAND		9		
	80.0	1		
		5	1.9S	22
		7		
433.9				
V. Stiff Grey, Moist SILTY LOAM	85.0	100/6"		
over Hard Brown, Dry				
Weathered SANDSTONE				
	90.0			
Bottom of hole @ 85 feet				
Free water observed @ 44.5 Feet				
Elevation referenced to BM #4,				
cut square on median pier of				
SN 100-0044; Elev. 501.70	95.0			
Borehole advanced with hollow				
stem auger (8" O.D., 3.25" I.D.)				
To convert "N" values to "N60"				
multiply by 1.5				
	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

FAP 1900 (CH 25) Grassy Rd Over FAI-57 — Sheet 1 of 2

Route: CH 25 (Grassy R — Structure Number: 100-0044 — Date: 10/17/2018

Section (X1-7-1)B-2 — Bored By: L Estel

County: Williamson — Location: 1.4 miles West of IL 37 (E. Abut.) — Checked By: A Hayes

Boring No 2-S
Station 15+75 (Grassy Rd)
Offset 7' RT of CL
Ground Surface 521.0 Ft

Surf Wat Elev:
Ground Water Elevation
when Drilling 475.5
At Completion
At: Hrs:

DEPTH	BLOWS	Qu tsf	W%	DEPTH	BLOWS	Qu tsf	W%
Cored Pavement, HMA over GRAVEL				Hard Brown and Mottled Grey with Specks of Black, Moist SILTY CLAY with a trace of GRAVEL	7	4.7B	18
519.5					7		
	1				2		
Stiff Brown, Moist CLAY to SILTY CLAY A7-6	3	1.5B	22	(No Recovery)	7	4.1E	
	3				8		
5.0	1			30.0	2		
	3	1.2B	19		7	4.7B	17
	3				9		
	1				2		
	4	1.5B	17		7	3.9B	17
	4				9		
				486.5			
10.0	1			35.0	2		
	3	1.6B	22	V. Stiff Brown and Mottled Grey, Moist CLAY with a trace of GRAVEL	4	2.3B	18
	4				6		
509.0							
	2				1		
V. Stiff Brown, Moist CLAY to SILTY CLAY A7-6	6	2.1B	19		5	2.5B	17
	6				5		
506.5							
15.0	2			40.0	2		
Stiff Brown and Mottled Grey, Moist SILTY CLAY	6	1.6B	19		5	3.3B	17
	6				7		
504.0							
	1						
V. Stiff Brown and Mottled Grey with Specks of Black, Moist SILTY CLAY	6	2.5B	18				
	6						
20.0	1			45.0	1		
	5	2.5B	18		5	2.5B	17
	5				7		
499.0							
	1						
Stiff Brown and Mottled Grey with Specks of Black, Moist SILTY CLAY	5	1.9B	22				
	5						
496.5							
25.0	2			50.0	1		

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

Route: CH 25 (Grassy RD)
Section: (X1-7-1)B-2
County: Williamson
Date: 10/17/2018

Boring No: 2-S
Station: 15+75 (Grassy Rd)
Offset: 7' RT of CL
Ground Surface: 521.0 Ft

	DEPTH	BLOWS	Qu tsf	W%
		7	2.5B	18
		8		
	55.0	1		
V. Stiff Brown and Mottled Grey, Moist CLAY with a trace of GRAVEL		5	2.7B	20
		7		
456.5	60.0	1		
		5	2.4B	19
		8		
	65.0	2		
Stiff Grey, Moist SILTY CLAY with a trace of SAND and GRAVEL		4	1.2B	20
		4		
	70.0	1		
		5	1.0B	20
446.5		5		
	75.0	3		

	DEPTH	BLOWS	Qu tsf	W%
Stiff Grey, Moist SILTY CLAY LOAM with a trace of SAND and GRAVEL		7	1.3S	12
441.5		9		
	80.0	3		
V. Stiff Grey, Moist SILTY CLAY LOAM with a trace of SAND and GRAVEL		9	3.1S	11
438.5		12		
Hard Brown, Dry SANDSTONE		100/1.5"		
	85.0			
	90.0			
Bottom of hole @ 82.5 feet				
Free water observed @ 45.5 feet				
Elevation referenced to BM #4, cut square on median pier of SN 100-0044; Elev. 501.70	95.0			
Borehole advanced with hollow stem auger (8" O.D, 3.25" I.D.)				
To convert "N" values to "N60" multiply by 1.5				
	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

FAP 1900 (CH 25) Grassy Rd Over FAI-57 — Sheet 1 of 2

Route: Grassy Rd — Structure Number: 100-0044 — Date: 10/18/2018

Section (X1-7-1)B-2 — Bored By: L Estel

County: Williamson — Location: 1.4 miles West of IL 37 (Median) — Checked By: A Hayes

Boring No 3-S
Station 236+30 (I-57)
Offset 33' LT of NBCL
Ground Surface 498.7 Ft

Surf Wat Elev:
Ground Water Elevation
when Drilling 476.7
At Completion
At: Hrs:

	DEPTH	BLOWS	Qu tsf	W%
Brown SILTY CLAY (observed from auger cuttings)				
496.7				
		1		
M. Stiff Brown and Mottled Grey with Specks of Black, Moist SILTY CLAY LOAM		5	1.0S	19
		5		
	5.0	1		
		3	0.6B	28
		2		
491.7				
		1		
M. Stiff Brown and Mottled Grey with Specks of Black, Moist CLAY LOAM		6	1.0B	23
		6		
	10.0	2		
488.2		6	2.1S	13
V. Stiff Brown, Moist SILTY CLAY LOAM		6		
486.2		2		
V. Stiff Brown and Mottled Grey with Specks of Black, Moist CLAY to SILTY CLAY with a trace of GRAVEL		4	2.5B	17
484.2		5		
	15.0	1		
Stiff Brown and Mottled Grey with Specks of Black, Moist CLAY to SILTY CLAY with a trace of GRAVEL		3	1.6B	18
481.7		5		
		1		
V. Stiff Brown and Mottled Grey with Specks of Black, Moist CLAY to SILTY CLAY with a trace of GRAVEL		6	3.1B	18
		7		
	20.0	2		
		6	2.9B	17
		7		
476.7				
		2		
Hard Brown and Mottled Grey with Specks of Black, Moist CLAY to SILTY CLAY with a trace of GRAVEL		8	5.0	19
		10		
473.7	25.0	3		

	DEPTH	BLOWS	Qu tsf	W%
V. Stiff Brown and Mottled Grey with Specks of Black, Moist CLAY to SILTY CLAY with a trace of GRAVEL		8	3.7B	18
		10		
		2		
		5	2.5B	19
		7		
	30.0	1		
		5	3.3B	20
		7		
466.7				
		2		
Hard Brown and Mottled Grey with Specks of Black, Moist CLAY A7-6 with a trace of GRAVEL		5	4.3S	20
464.2		8		
	35.0	1		
Stiff Brown and Mottled Grey, Moist SILTY CLAY with a trace of GRAVEL		4	1.5B	20
		4		
461.7				
		1		
Stiff Brown and Mottled Grey, Moist CLAY A7-6 with a trace of SAND and GRAVEL		5	3.3B	21
		7		
459.2				
	40.0	1		
M. Stiff Grey, Moist SILTY CLAY		2	0.9B	22
		2		
454.2				
	45.0	1		
M. Stiff Grey, Moist SILTY CLAY with some Rotton Wood		3	1.0	21
		3		
449.2				
	50.0	WH		

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

Route: Grassy Rd
Section: (X1-7-1)B-2
County: Williamson
Date: 10/18/2018

Boring No: 3-S
Station: 236+30 (I-57)
Offset: 33' LT of NBCL
Ground Surface: 498.7 Ft

	DEPTH	BLOWS	Qu tsf	W%
M. Stiff Grey, Moist CLAY A7-6		2 2	0.9B	22
	444.2			
	55.0	1		
V. Stiff Grey, Moist CLAY A7-6		3 5	2.3B	18
	439.2			
	60.0	3		
Hard Grey, Moist CLAY LOAM with SAND and GRAVEL		11 13	5.2B	9
	433.7	65.0		
Hard Grey and Brown, Damp SANDSTONE Auger refusal @ Elev. 433.7 (Borehoe continued with rock coring) Elev. 433.7 to 428.7; Recovery 69%, RQD 8% Average Unconfined Compressive Strength 5,295 psi		100/0"		
	428.7	70.0		
Hard Grey, Dry SANDSTONE Elev. 428.7 to 423.7; Recovery 100%, RQD 72% Average Unconfined Compressive Strength 6,585 psi				
	423.7	75.0		

DEPTH	BLOWS	Qu tsf	W%
80.0			
85.0			
90.0			
95.0			
100.0			

Bottom of hole @ 75.0 feet

Free water observed @ 22 feet

Elevation referenced to BM #4, cut square on median pier of SN 100-0044; Elev. 501.70

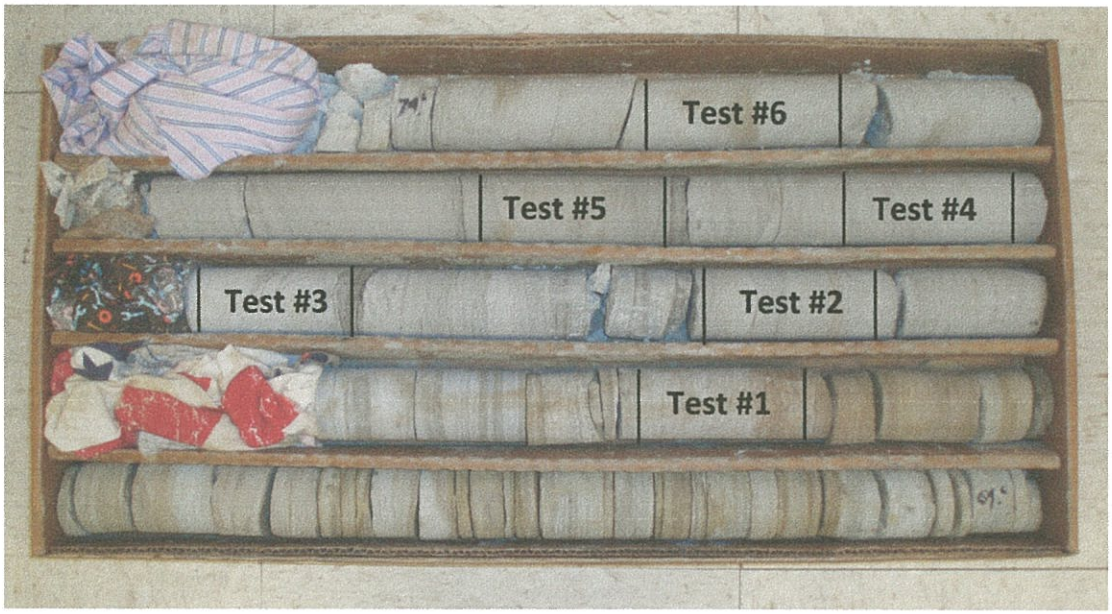
Borehole advanced with hollow stem auger (8" O.D., 3.25" I.D.)

To convert "N" values to "N60" multiply by 1.5

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

CH25 (Grassy Rd.) over I-57
Structure 100-0044 (Boring 3-S)
Williamson County



Boring #	Specimen#	Depth	Unconfined Compression
3-S	1	67'	5,133 psi
3-S	2	69'	6,590 psi
3-S	3	70'	4,172 psi
3-S	4	70' 9"	5,834 psi
3-S	5	71' 6"	5,746 psi
3-S	6	73'	8,183 psi

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

Pounds divided by 2.487 = psi

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

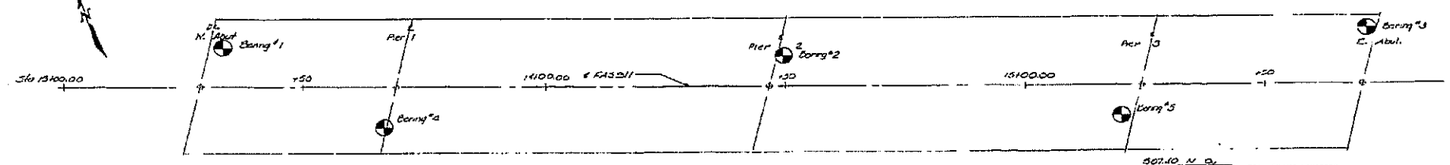
FAI-57

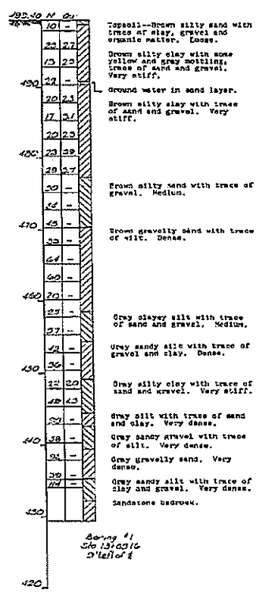
SHEET NO 9
9 SHEETS

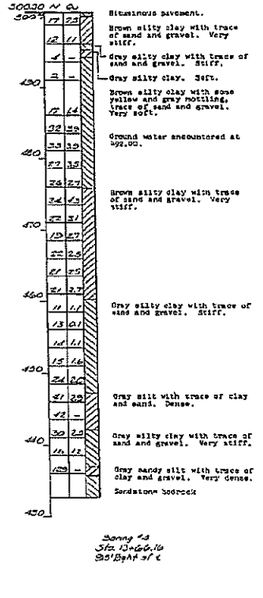
COUNTY NO.	SECTION	COUNTY	TOTAL SHEETS	SHEET NO.
4	X1-7HB	WILLIAMSON	26	14

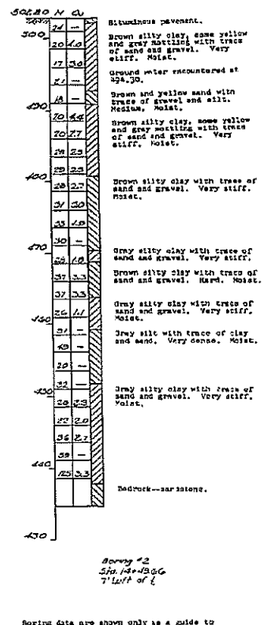
F.A.S. ROUTE NO. | SECTION | PROJECT

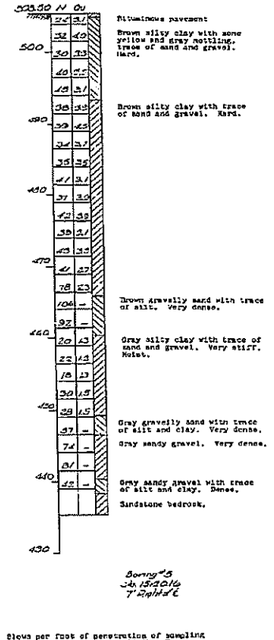
LOCATION OF BORINGS

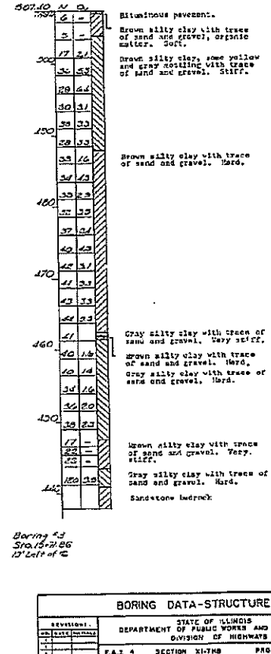












Boring data are shown only as a guide to bidders in estimating soil conditions which may be encountered in the work.

N Blows per foot of penetration of sampling spoon. Hammer weight = 140 lbs. Drop = 30 inches.

Qu Unconfined compressive strength in tons per square foot.

Structures by: CLARK and DAILY, Consulting Engineers, Urbana, Illinois

BORING DATA-STRUCTURE X1-7HB

STATE OF ILLINOIS
DEPARTMENT OF PUBLIC WORKS AND BUILDINGS
DIVISION OF HIGHWAYS

F.A.I 4 SECTION X1-7HB PROJECT I-04-1(14)
STA. 292 + 82.52 WILLIAMSON COUNTY

HOMER L. CHASTAIN & ASSOCIATES
CONSULTING ENGINEERS
CHICAGO, ILLINOIS

DRAWN 12-27-57
TRACED 1-2-58
CHK'D 1-3-58

PROJECT NO. 1140

SHEET NO. 9 OF 9

G&D NO. 317-B

F.A.I ROUTE 4 SECTION X1-7HB WILLIAMSON CO. BORING DATA

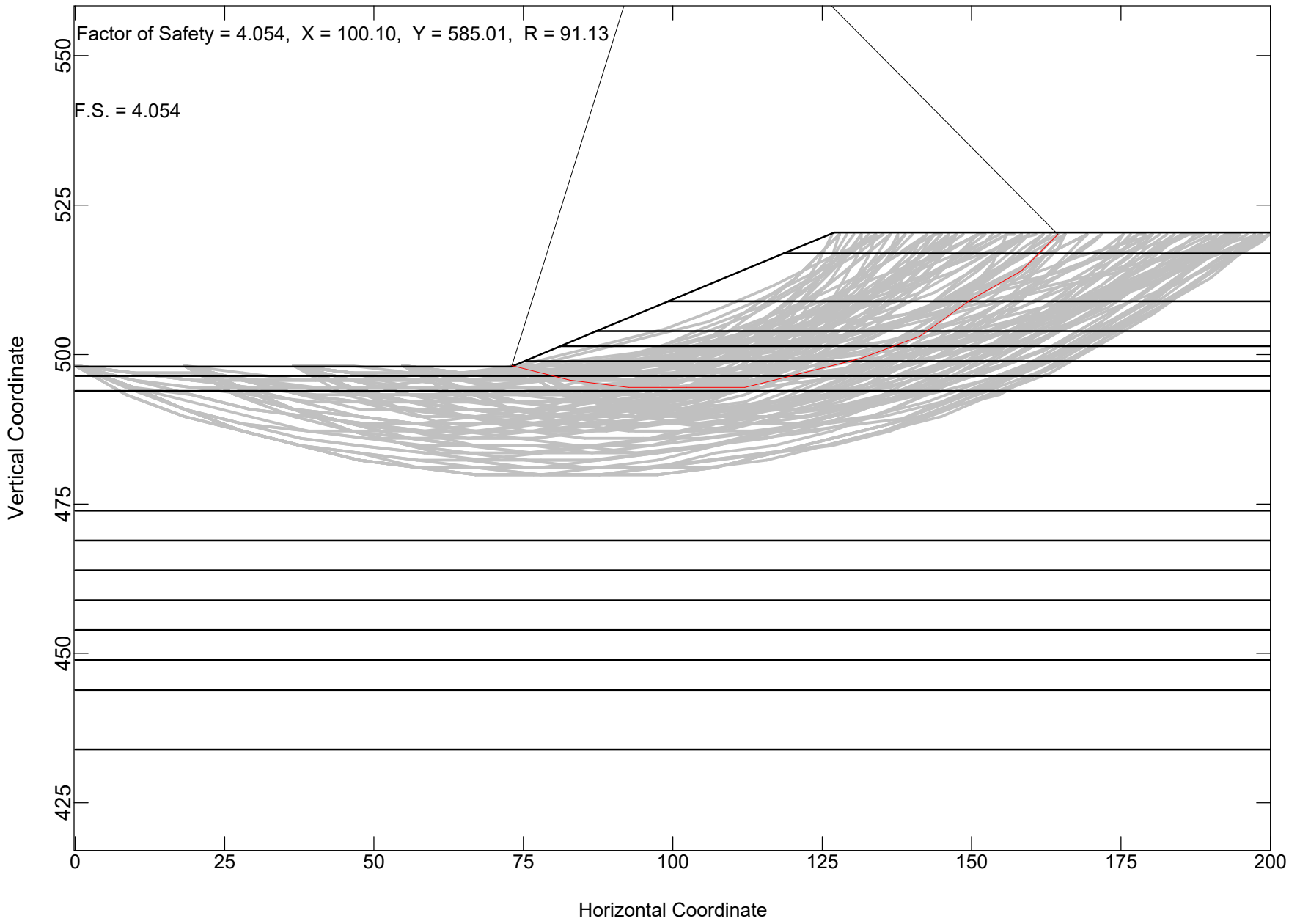
Appendix E

Global Stability Analysis

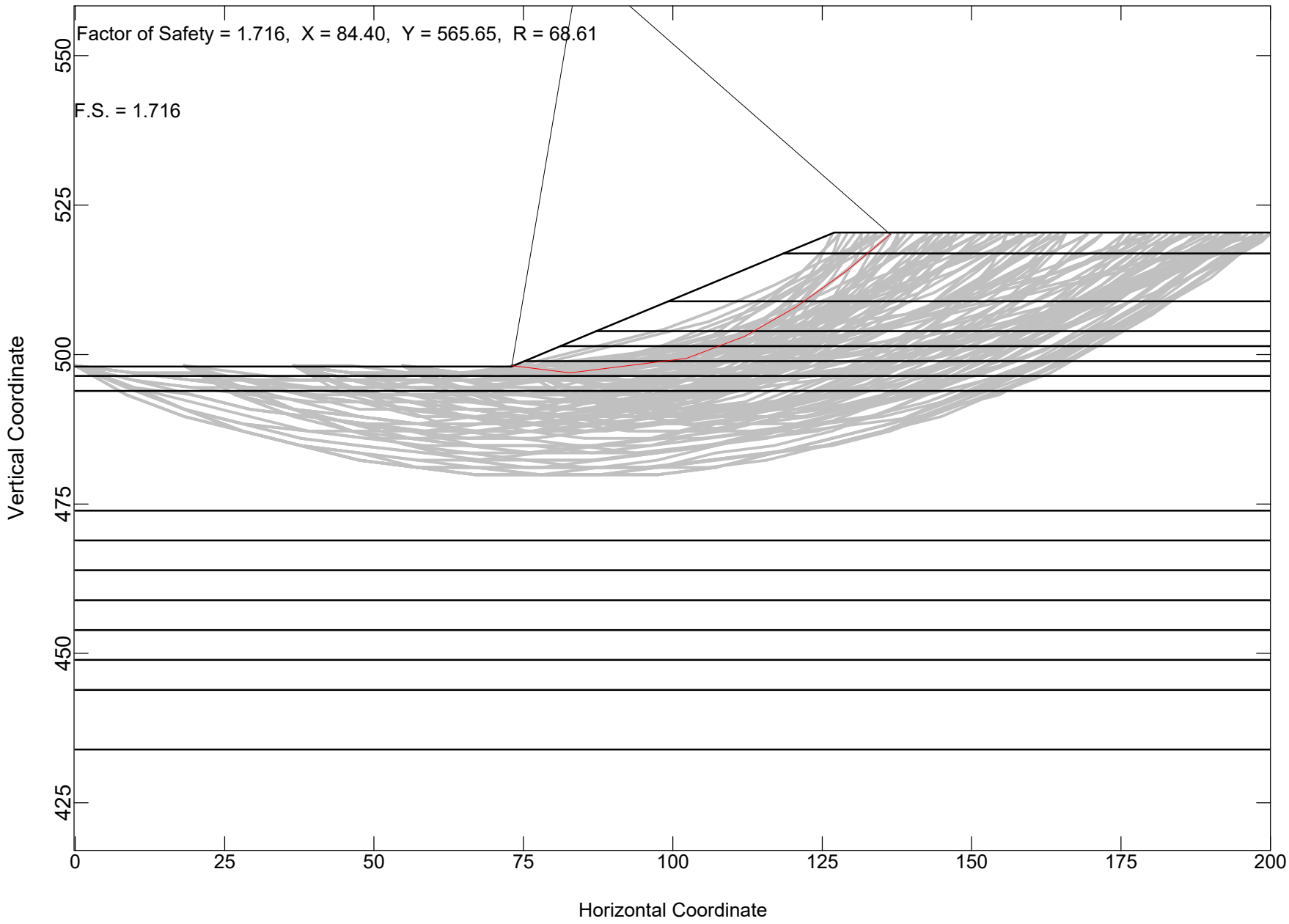
Soil Parameters for Slope Stability Analysis at West Abutment (1-S)

Layer #	Soil Description	Elev. at Bottom of Layer	γ (pcf)	Short Term		Long Term	
				c' (ksf)	θ (deg.)	c' (ksf)	θ (deg.)
1	Embankment	516.9	120	0	30	0	30
2	Stiff Clay	508.9	125	1.2	0	0.1	26
3	Medium Stiff to Stiff Clay	503.9	125	0.9	0	0.1	26
4	Very Stiff Silty Clay	501.4	130	2.5	0	0.1	26
5	Stiff Silty Clay	498.9	125	1.2	0	0.1	26
6	Very Stiff Silty Clay	496.4	130	2.7	0	0.1	26
7	Stiff Clay	493.9	125	1.6	0	0.1	28
8	Very Stiff Silty Clay	473.9	130	2.7	0	0.1	28
9	Stiff Silty Loam	468.9	125	1.7	0	0.1	28
10	Medium Dense Loam	463.9	120	0	30	0	30
11	Stiff Silt	458.9	125	1.4	0	0.1	28
12	Soft Silty Loam	453.9	115	0.4	0	0.1	28
13	Stiff Silty Loam	448.9	125	1.9	0	0.1	28
14	Stiff Clay Loam	443.9	125	2.0	0	0.1	28
15	Stiff Silty Loam	433.9	125	1.0	0	0.1	28
16	Sandstone	-	145	0	35	0	35

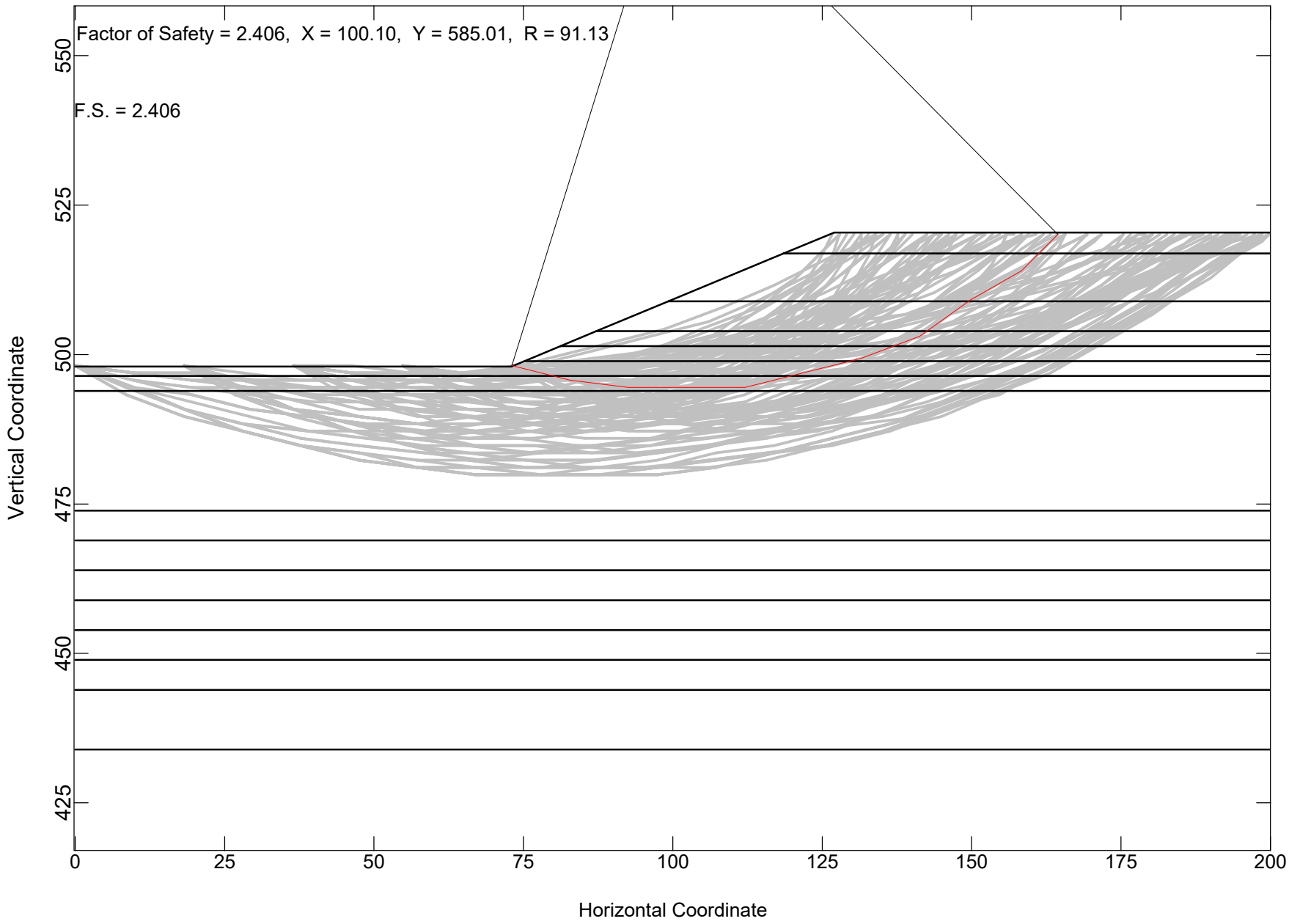
West Abutment - Short Term Static



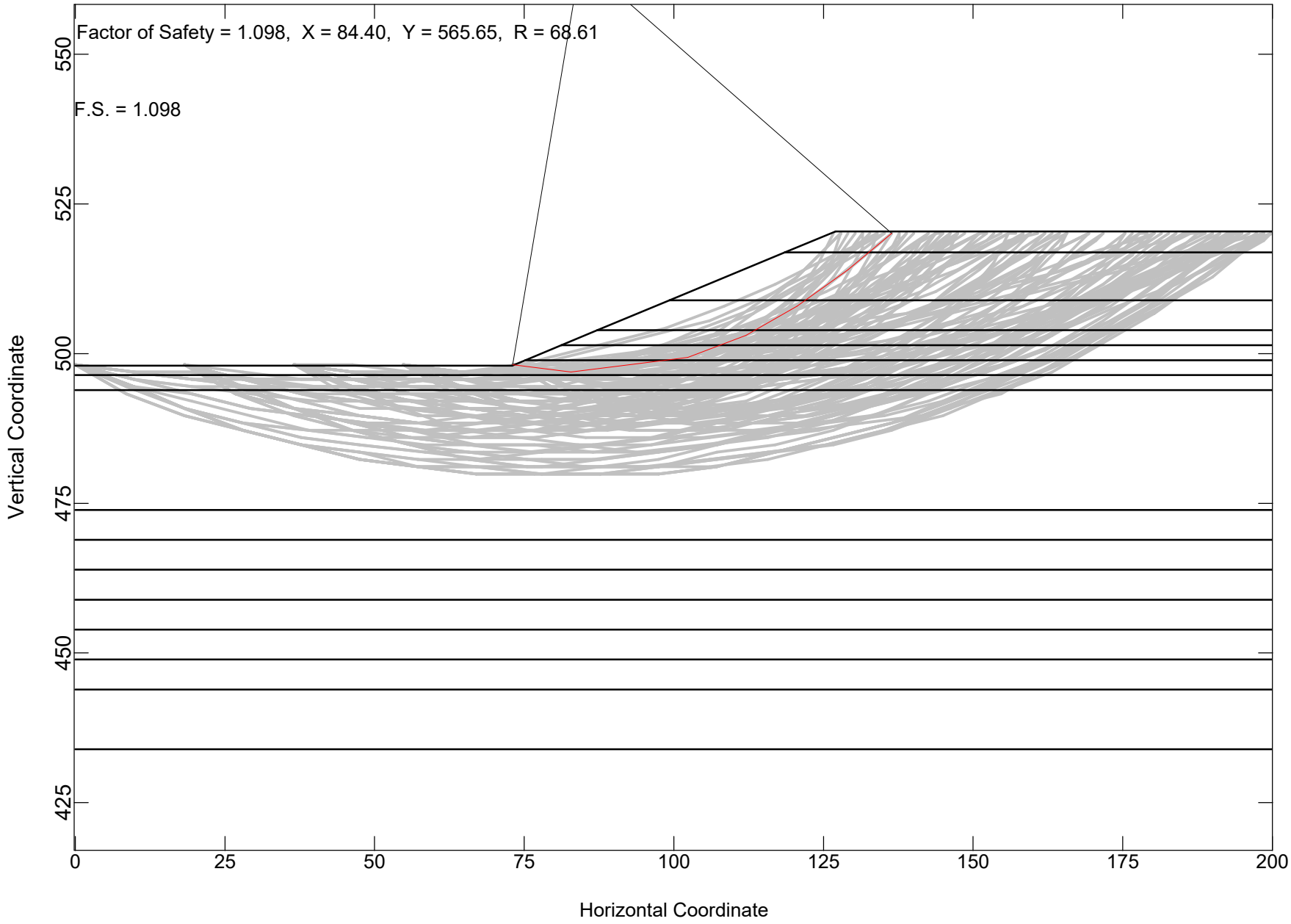
West Abutment - Long Term Static



West Abutment - Short Term Seismic



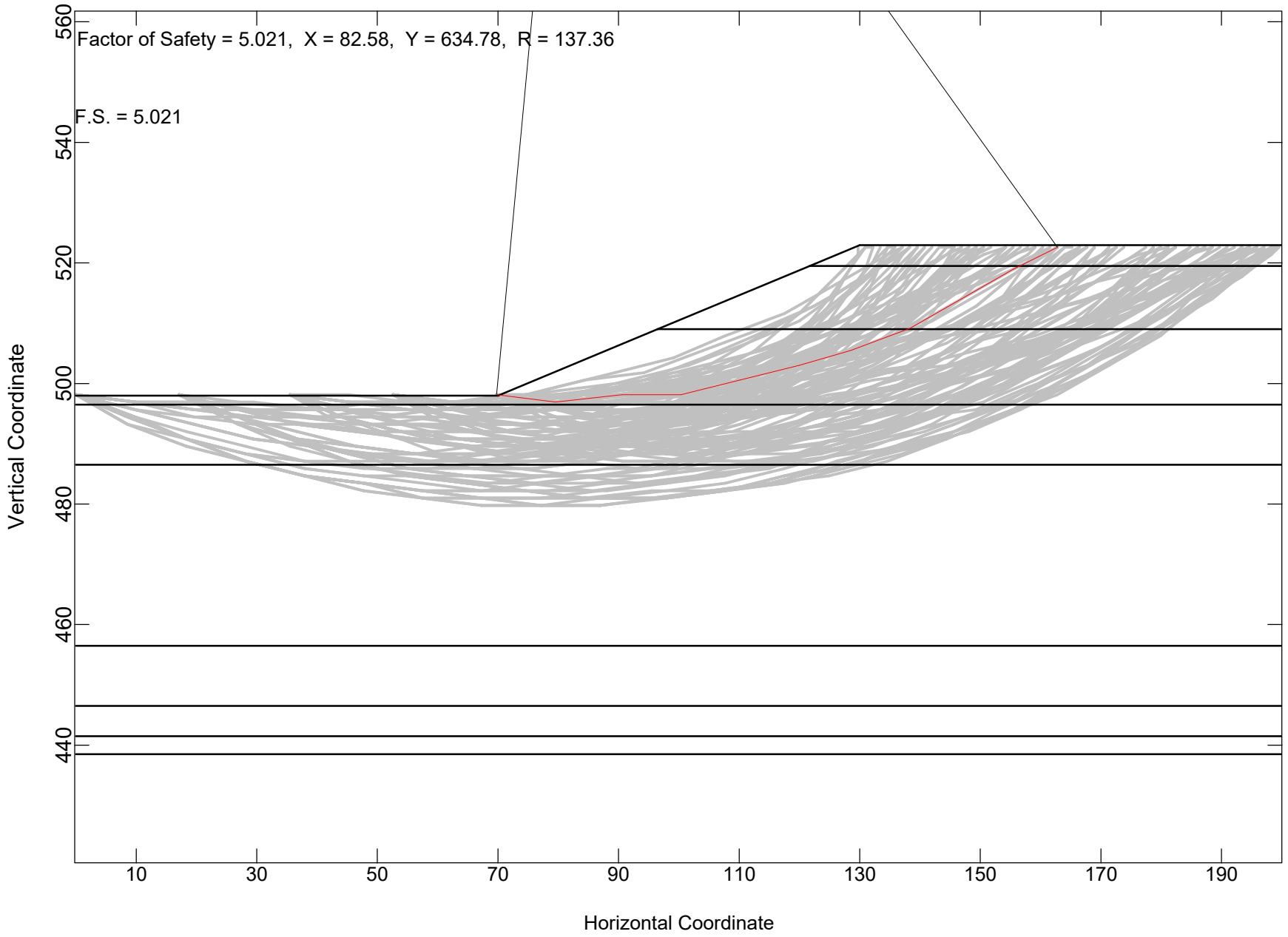
West Abutment - Long Term Seismic



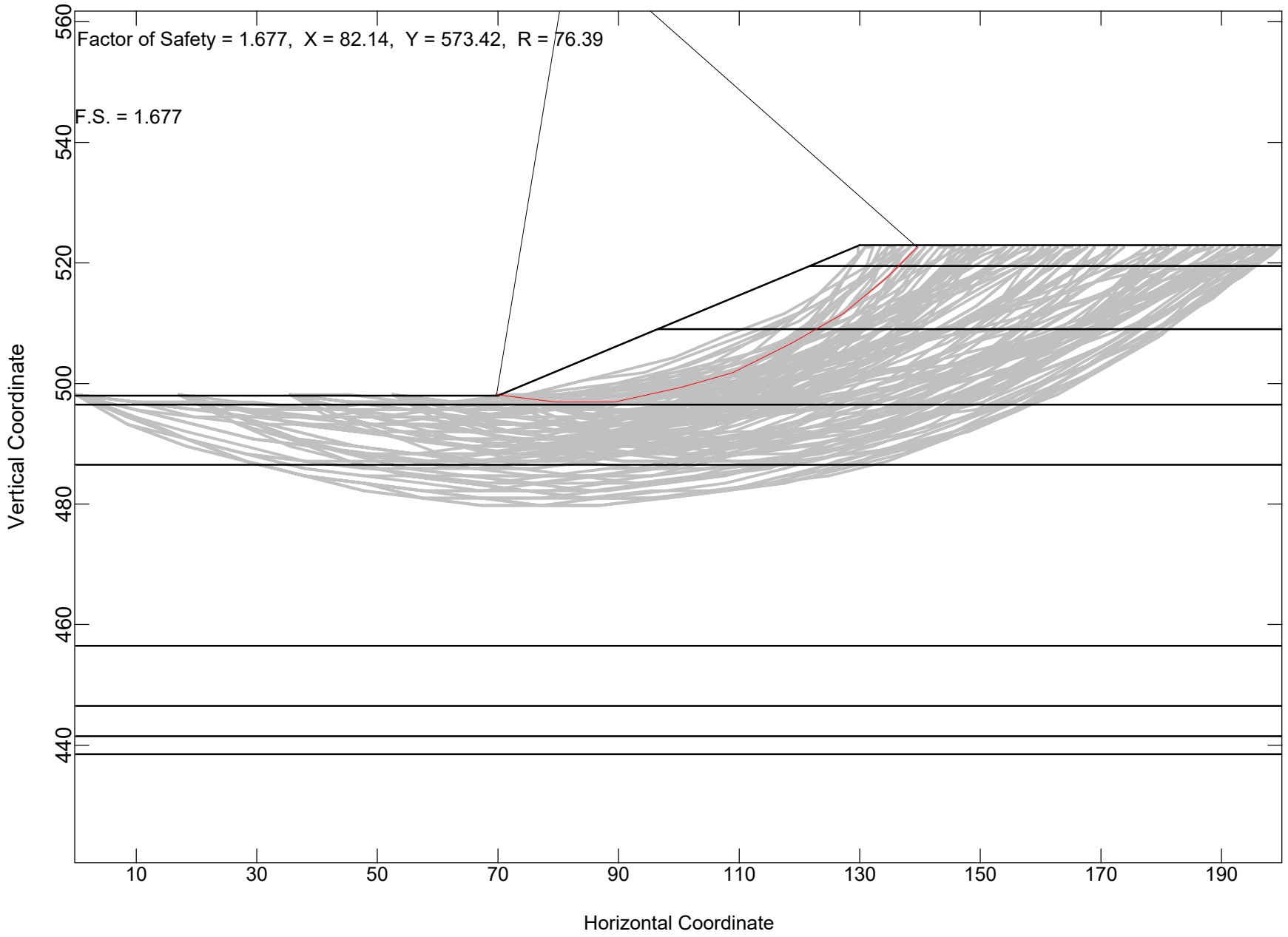
Soil Parameters for Slope Stability Analysis at East Abutment (2-S)

Layer #	Soil Description	Elev. at Bottom of Layer	γ (pcf)	Short Term		Long Term	
				c' (ksf)	θ (deg.)	c' (ksf)	θ (deg.)
1	Embankment	519.5	120	0	30	0	30
2	Stiff Clay to Silty Clay	509.0	125	1.2	0	0.1	26
3	Stiff to V. Stiff Silty Clay	496.5	130	2.1	0	0.1	26
4	Hard Silty Clay	486.5	130	4.1	0	0.1	28
5	Very Stiff Clay	456.5	130	2.5	0	0.1	28
6	Stiff Silty Clay	446.5	125	1.0	0	0.1	28
7	Stiff Silty Clay Loam	441.5	125	1.3	0	0.1	28
8	V. Stiff Silty Clay Loam	438.5	130	3.1	0	0.1	28
9	Sandstone	-	145	0	35	0	35

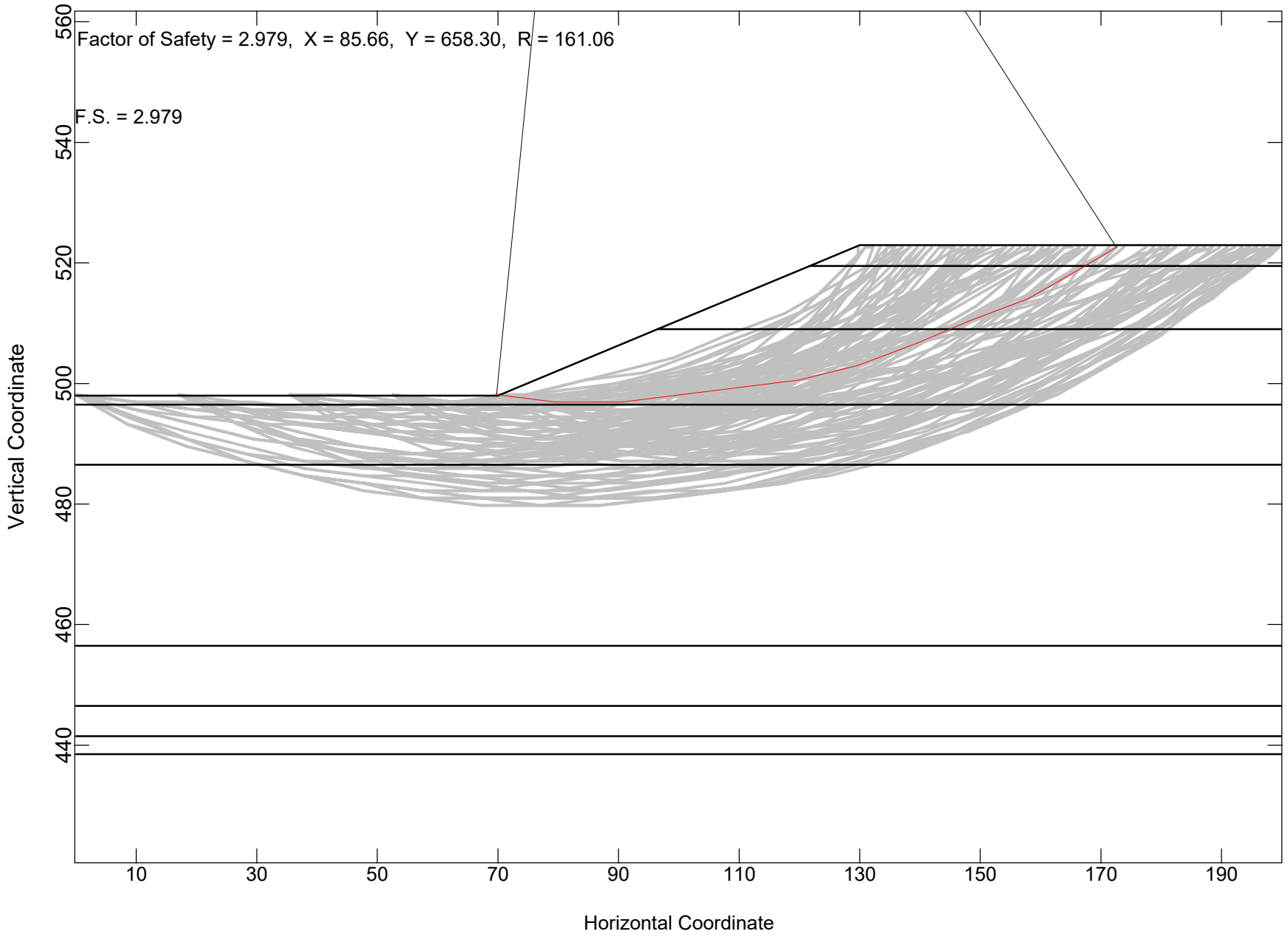
East Abutment - Short Term Static



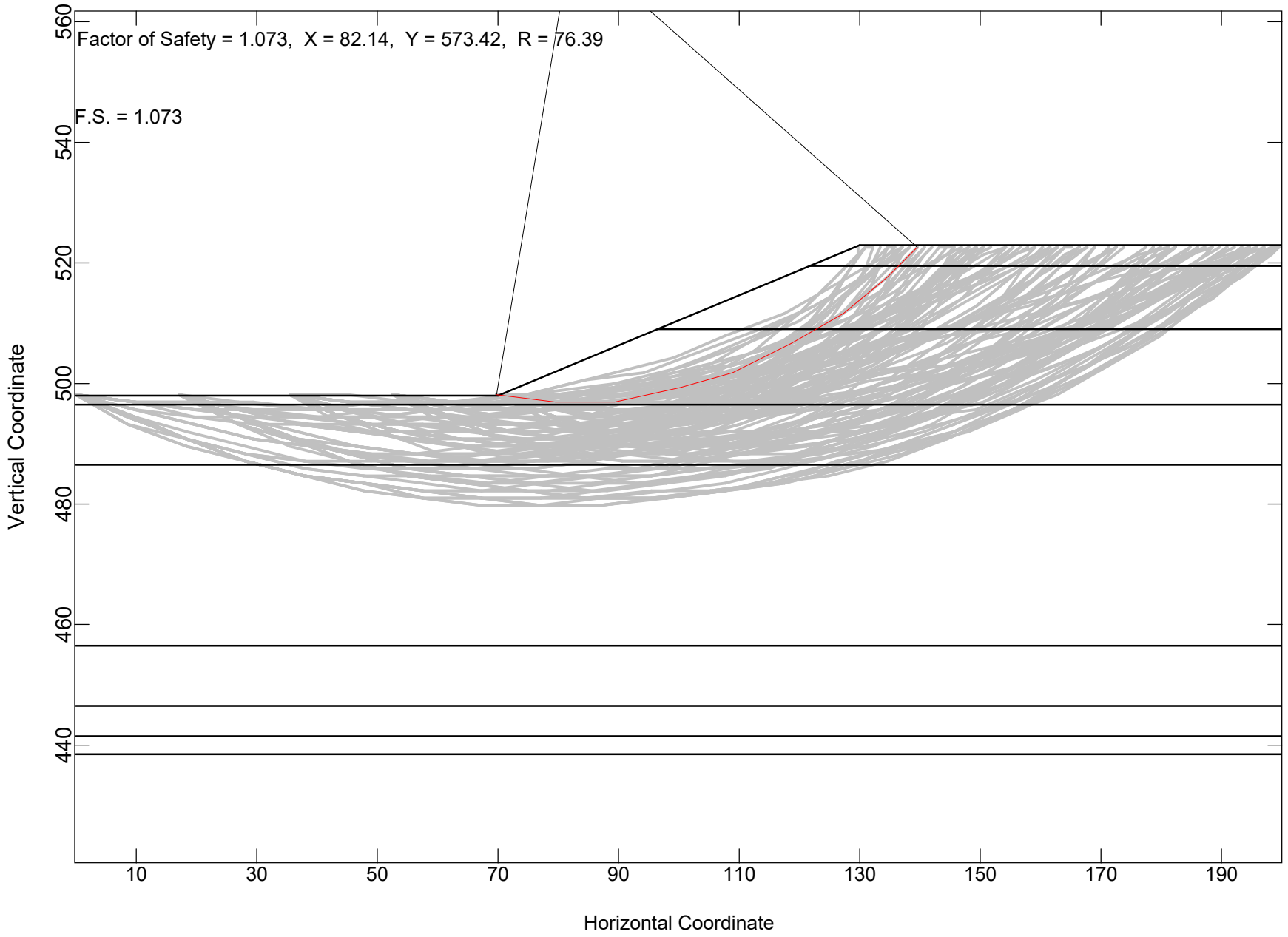
East Abutment - Long Term Static



East Abutment - Short Term Seismic



East Abutment - Long Term Seismic



Appendix F

Seismic Site Class Determination

Illinois Department of Transportation

SEISMIC SITE CLASS DETERMINATION

PROJECT TITLE=====Grassy Rd over I-57

Substructure 1

Base of Substruct. Elev. (or ground surf for bents	511.6	ft.
Pile or Shaft Dia.	12	inches
Boring Number	1-S	
Top of Boring Elev.	518.4	ft.
Approximate Fixity Elev.	505.6	ft.

Individual Site Class Definition:

N (bar): 14 (Blows/ft.) Soil Site Class E
N_{ch} (bar): NA (Blows/ft.) NA
s_u (bar): 1.74 (ksf) Soil Site Class D <----Controls

Seismic Soil Column Depth (ft)	Bot. Of Sample Elevation	Sample Thick. (ft.)	N	Qu (tsf)	Layer Description Boundary
	514.9	3.50	8	1.20	
	511.9	3.00	7	1.80	
	508.9	3.00	6	1.20	B
	506.4	2.50	4	0.90	B
1.7	503.9	2.50	4	1.40	B
4.2	501.4	2.50	7	2.50	B
6.7	498.9	2.50	7	1.20	B
9.2	496.4	2.50	12	2.70	B
11.7	493.9	2.50	10	1.60	B
14.2	491.4	2.50	13	3.30	
16.7	488.9	2.50	11	3.30	
19.2	486.4	2.50	13	3.30	
21.7	483.9	2.50	12	2.70	
24.2	481.4	2.50	12	3.70	
26.7	478.9	2.50	13	3.90	
31.7	473.9	5.00	17	2.30	B
36.7	468.9	5.00	9	1.70	B
41.7	463.9	5.00	12		B
46.7	458.9	5.00	10	1.40	B
51.7	453.9	5.00	18	0.40	B
56.7	448.9	5.00	29	1.90	B
61.7	443.9	5.00	13	2.00	B
66.7	438.9	5.00	17	1.00	
71.7	433.9	5.00	12	1.90	B
87.2	418.4	15.50	100	99.00	R

Substructure 2

Base of Substruct. Elev. (or ground surf for bents	495.41	ft.
Pile or Shaft Dia.	12	inches
Boring Number	3-S	
Top of Boring Elev.	498.7	ft.
Approximate Fixity Elev.	489.41	ft.

Individual Site Class Definition:

N (bar): 10 (Blows/ft.) Soil Site Class E
N_{ch} (bar): NA (Blows/ft.) NA
s_u (bar): 2.06 (ksf) Soil Site Class C <----Controls

Seismic Soil Column Depth (ft)	Bot. Of Sample Elevation	Sample Thick. (ft.)	N	Qu (tsf)	Layer Description Boundary
	495.2	3.50	10	1.00	
	491.7	3.50	5	0.60	B
1.2	488.2	3.50	12	1.00	B
3.2	486.2	2.00	12	2.10	B
5.2	484.2	2.00	9	2.50	B
7.7	481.7	2.50	8	1.60	B
10.2	479.2	2.50	13	3.10	
12.7	476.7	2.50	13	2.90	B
15.7	473.7	3.00	18	5.00	B
17.7	471.7	2.00	18	3.70	
20.2	469.2	2.50	12	2.50	
22.7	466.7	2.50	12	3.30	B
25.2	464.2	2.50	13	4.30	B
27.7	461.7	2.50	8	1.50	B
30.2	459.2	2.50	12	3.30	B
35.2	454.2	5.00	4	0.90	B
40.2	449.2	5.00	6	1.00	B
45.2	444.2	5.00	4	0.90	B
50.2	439.2	5.00	8	2.30	B
55.2	434.2	5.00	24	5.20	B
70.7	418.7	15.50	100	99.00	R

Substructure 3

Base of Substruct. Elev. (or ground surf for bents	514.13	ft.
Pile or Shaft Dia.	12	inches
Boring Number	2-S	
Top of Boring Elev.	521	ft.
Approximate Fixity Elev.	508.13	ft.

Individual Site Class Definition:

N (bar): 15 (Blows/ft.) Soil Site Class D
N_{ch} (bar): NA (Blows/ft.) NA
s_u (bar): 2.36 (ksf) Soil Site Class C <----Controls

Seismic Soil Column Depth (ft)	Bot. Of Sample Elevation	Sample Thick. (ft.)	N	Qu (tsf)	Layer Description Boundary
	518.0	3.00	6	1.50	
	515.0	3.00	6	1.20	
	512.0	3.00	8	1.50	
	509.0	3.00	7	1.60	B
1.6	506.5	2.50	12	2.10	B
4.1	504.0	2.50	12	1.60	B
6.6	501.5	2.50	12	2.50	
9.1	499.0	2.50	10	2.50	B
11.6	496.5	2.50	10	1.90	B
14.1	494.0	2.50	14	4.70	
16.6	491.5	2.50	15	4.10	
19.1	489.0	2.50	16	4.70	
21.6	486.5	2.50	16	3.90	B
24.1	484.0	2.50	10	2.30	
26.6	481.5	2.50	10	2.50	
31.6	476.5	5.00	12	3.30	
36.6	471.5	5.00	12	2.50	
41.6	466.5	5.00	15	2.50	
46.6	461.5	5.00	12	2.70	
51.6	456.5	5.00	13	2.40	B
56.6	451.5	5.00	8	1.20	
61.6	446.5	5.00	10	1.00	B
66.6	441.5	5.00	16	1.30	B
69.6	438.5	3.00	21	3.10	B
87.1	421.0	17.50	100	99.00	R

Substructure 4

Base of Substruct. Elev. (or ground surf for bents)		ft.
Pile or Shaft Dia.		inches
Boring Number		
Top of Boring Elev.		ft.
Approximate Fixity Elev.		ft.

Individual Site Class Definition:

N (bar): (Blows/ft.) NA
N_{ch} (bar): (Blows/ft.) NA
s_u (bar): (ksf) NA

Seismic Soil Column Depth (ft)	Bot. Of Sample Elevation	Sample Thick. (ft.)	N	Qu (tsf)	Layer Description Boundary

Global Site Class Definition: Substructures 1 through 3

N (bar): 13 (Blows/ft.) Soil Site Class E
N_{ch} (bar): (Blows/ft.) NA, H < 0.1*H (Total)
s_u (bar): 2.06 (ksf) Soil Site Class C <----Controls

Appendix G

Liquefaction Analysis

USGS Deaggregation Report

*** Deaggregation of Seismic Hazard at One Period of Spectral Acceleration ***
*** Data from Dynamic: Conterminous U.S. 2014 (v4.1.4) ****
PSHA Deaggregation. %contributions.
site: Grassy Rd/I-57
longitude: 88.976°W
latitude: 37.648°E
imt: Peak Ground Acceleration
vs30 = 760 m/s (B/C boundary)
return period: 975 yrs.
#This deaggregation corresponds to: Total
Summary statistics for PSHA PGA deaggregation, r=distance, ε=epsilon:
Deaggregation targets:
Return period: 975 yrs
Exceedance rate: 0.001025641 yr^{-1}
PGA ground motion: 0.29612444 g
Mode (largest m-r bin):
m: 7.52
r: 47.98 km
ε_0: -0.29 σ
Contribution: 13.57 %
Mode (largest m-r-ε_0 bin):
m: 7.51
r: 49.09 km
ε_0: -0.2 σ
Contribution: 5.51 %

Closest Distance, rRup (km)	Magnitude (Mw)	ALL_ε	ε=[2.5,∞)	ε=[2,2.5)	ε=[1.5,2)	ε=[1,1.5)	ε=[0.5,1)	ε=(-∞,0.5)	ε=[-0.5,∞)	ε=[-1,-0.5)
50	7.5	13.566	1.681	3.365	5.509	2.568	0.068	0.34	0.035	0
130	7.7	8.465	2.066	3.585	2.175	0.602	0.037	0	0	0
70	7.5	7.546	0.672	4.244	2.057	0.568	0.003	0.002	0	0
50	7.3	5.813	0.022	0.096	4.991	0.621	0.003	0.08	0	0
10	4.9	5.002	0.987	0.561	1.573	1.197	0.522	0.129	0.033	0
10	5.1	4.073	0.428	0.513	0.524	1.453	0.884	0.164	0.108	0
130	7.5	3.4	1.895	1.006	0.465	0.018	0.016	0	0	0
10	5.3	3.188	0.644	0.229	0.795	0.998	0.355	0.081	0.086	0
50	7.7	3.07	0.002	0.973	1.882	0.139	0	0.053	0.02	0
50	6.9	3.044	0.502	1.892	0.507	0.077	0.002	0.06	0.005	0
10	4.7	2.843	0.448	0.375	0.774	0.601	0.566	0.07	0.009	0
10	5.5	2.411	0.427	0.254	0.876	0.491	0.256	0.108	0	0
130	7.9	2.317	0.291	0.612	1.102	0.295	0	0.013	0.005	0
10	5.7	1.768	0.062	0.215	0.144	0.181	0.786	0.238	0.047	0.096
50	7.1	1.36	0.195	0.551	0.419	0.158	0.004	0.015	0.017	0.001
70	6.9	1.308	0.002	0.591	0.59	0.087	0.038	0	0	0
10	5.9	1.258	0.177	0.041	0.077	0.433	0.249	0.2	0.056	0.025
10	6.1	1.161	0.125	0.042	0.151	0.178	0.28	0.208	0.154	0.023
30	5.5	1.091	0.083	0.372	0.422	0.179	0.031	0.004	0	0
30	5.7	1.063	0.248	0.418	0.296	0.084	0.014	0.003	0	0
30	5.3	1.057	0.238	0.505	0.239	0.068	0.007	0	0	0
30	6.1	1.036	0.087	0.221	0.295	0.307	0.096	0.02	0.009	0.001
50	6.7	0.987	0.42	0.449	0.098	0.005	0.014	0.002	0	0

- Inputting the various rRup and Mw values into the IDOT liquefaction analysis spreadsheet, the largest m-r bin controls max PGA (rRup = 50 km, Mw = 7.5).

LIQUEFACTION ANALYSIS

Illinois Department of Transportation

REFERENCE BORING NUMBER ========== W. Abut.
ELEVATION OF BORING GROUND SURFACE ========== 518.40 FT.
DEPTH TO GROUNDWATER - DURING DRILLING ========== 41.50 FT. (Below Boring Ground Surface)
DEPTH TO GROUNDWATER - DURING EARTHQUAKE ========== 43.50 FT. (Below Finished Grade Cut or Fill Surface)
PEAK HORIZ. GROUND SURFACE ACCELERATION COEFFICIENT (As) ===== 0.362 = 1.2 x 0.292
EARTHQUAKE MOMENT MAGNITUDE ========== 7.5
FINISHED GRADE FILL OR CUT FROM BORING SURFACE ========== 2.00 FT. (Fill Height)
HAMMER EFFICIENCY========== 73 %
BOREHOLE DIAMETER========== 8 IN.
SAMPLING METHOD========== Sampler w/ Liners Unknown (w/ Liners worst case)

EQ MAGNITUDE SCALING FACTOR
(MSF) = **1.000**

AVG. SHEAR WAVE VELOCITY (top 40')
$\bar{V}_{s,40'}$ = **503** FT./SEC.

PGA CALCULATOR
Earthquake Moment Magnitude = 7.5
Source-To-Site Distance, R (km) = 50
Ground Motion Prediction Equations = NMSZ
PGA = **0.292**

	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
513.9	4.5	8	1.2					0.124	0.558	12.622	12.622	0.137	0.124	0.798	0.798	1.274	**0.175**	0.959	**0.226**	**N.L. (1)**
511.4	7	7	1.8					0.128	0.878	10.012	10.012	0.113	0.128	1.118	1.118	1.160	**0.131**	0.938	**0.221**	**N.L. (1)**
508.9	9.5	6	1.2					0.124	1.188	8.438	8.438	0.100	0.124	1.428	1.428	1.092	**0.109**	0.913	**0.215**	**N.L. (1)**
506.4	12	4	0.9					0.120	1.488	5.516	5.516	0.076	0.120	1.728	1.728	1.042	**0.079**	0.884	**0.208**	**N.L. (1)**
503.9	14.5	4	1.4					0.125	1.801	5.331	5.331	0.075	0.125	2.041	2.041	1.008	**0.075**	0.852	**0.201**	**N.L. (1)**
501.4	17	7	2.5					0.133	2.133	8.917	8.917	0.104	0.133	2.373	2.373	0.975	**0.101**	0.818	**0.193**	**N.L. (1)**
498.9	19.5	7	1.2					0.124	2.443	8.533	8.533	0.100	0.124	2.683	2.683	0.949	**0.095**	0.783	**0.184**	**N.L. (1)**
496.4	22	12	2.7					0.134	2.778	13.903	13.903	0.149	0.134	3.018	3.018	0.914	**0.136**	0.747	**0.176**	**N.L. (1)**
493.9	24.5	10	1.6					0.127	3.096	11.044	11.044	0.122	0.127	3.336	3.336	0.898	**0.110**	0.712	**0.168**	**N.L. (1)**
491.4	27	13	3.3					0.136	3.436	13.639	13.639	0.147	0.136	3.676	3.676	0.869	**0.128**	0.679	**0.160**	**N.L. (1)**
488.9	29.5	11	3.3					0.136	3.776	10.980	10.980	0.122	0.136	4.016	4.016	0.859	**0.105**	0.649	**0.153**	**N.L. (1)**
486.4	32	13	3.3					0.136	4.116	12.367	12.367	0.135	0.136	4.356	4.356	0.837	**0.113**	0.622	**0.146**	**N.L. (1)**
483.9	34.5	12	2.7					0.134	4.451	10.909	10.909	0.121	0.134	4.691	4.691	0.828	**0.100**	0.599	**0.141**	**N.L. (1)**
481.4	37	12	3.7					0.138	4.796	10.430	10.430	0.117	0.138	5.036	5.036	0.817	**0.095**	0.579	**0.136**	**N.L. (1)**
478.9	39.5	13	3.9					0.138	5.141	10.825	10.825	0.120	0.138	5.381	5.381	0.802	**0.097**	0.563	**0.132**	**N.L. (1)**
473.9	44.5	17	2.3		7	27	16	0.069	5.486	13.625	13.625	0.147	0.069	5.726	5.913	0.777	**0.114**	0.539	**0.131**	**N.L. (2)**
468.9	49.5	9	1.7		7	27	20	0.065	5.811	6.966	6.966	0.087	0.065	6.051	6.550	0.800	**0.070**	0.523	**0.133**	**N.L. (2)**
463.9	54.5	12						0.063	6.126	8.983	8.983	0.104	0.063	6.366	7.177	0.781	**0.081**	0.513	**0.136**	**0.596 (C)**
458.9	59.5	10	1.4		7	27	17	0.063	6.441	7.239	7.239	0.090	0.063	6.681	7.804	0.782	**0.070**	0.507	**0.139**	**N.L. (2)**
453.9	64.5	18	0.4		7	27	12	0.049	6.686	12.693	12.693	0.138	0.049	6.926	8.361	0.745	**0.103**	0.496	**0.141**	**N.L. (2)**
448.9	69.5	29	1.9		7	27	15	0.067	7.021	19.736	19.736	0.212	0.067	7.261	9.008	0.698	**0.148**	0.489	**0.143**	**N.L. (2)**
443.9	74.5	13	2		7	27	17	0.067	7.356	8.552	8.552	0.101	0.067	7.596	9.655	0.753	**0.076**	0.482	**0.144**	**N.L. (2)**
438.9	79.5	17	1		7	27	21	0.059	7.651	10.878	10.878	0.121	0.059	7.891	10.262	0.732	**0.089**	0.475	**0.145**	**N.L. (2)**
433.9	84.5	12	1.9		7	27	22	0.067	7.986	7.437	7.437	0.091	0.067	8.226	10.909	0.747	**0.068**	0.468	**0.146**	**N.L. (2)**
432.9	85.5	100						0.083	8.069	61.491	61.491	0.414	0.083	8.309	11.054	0.579	**0.240**	0.467	**0.146**	**N.L. (3)**
431.9	86.5	100						0.083	8.152	61.014	61.014	0.410	0.083	8.392	11.200	0.577	**0.237**	0.465	**0.146**	**N.L. (3)**
430.9	87.5	100						0.083	8.235	60.544	60.544	0.406	0.083	8.475	11.345	0.574	**0.233**	0.464	**0.146**	**N.L. (3)**

Note: Plasticity Index, PI and Liquid Limit, LL for cohesive layers below the groundwater depth are estimated. Cohesive layers below the groundwater and within the upper 60 ft of the geotechnical profile are stiff and not considered potentially liquefiable.

* 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

Appendix H

Integral Abutment Feasibility Analysis

Illinois Department of Transportation

INTEGRAL ABUTMENT FEASIBILITY ANALYSIS

Modified 10/30/17

GENERAL DATA

STRUCTURE NUMBER	100-0105		TOTAL STRUCTURE LENGTH	249.24	FT
STRUCTURE TYPE	MULTI-SPAN		NUMBER OF SPANS	2	
STRUCTURE SKEW	12.88	DEGREES	END SPAN LENGTH	121.78	FT
SUPER. DATA IN REFERENCE TO SUB. DATA	ABUT 1		ADJACENT INTERIOR SPAN LENGTH	0.01	FT

SUPERSTRUCTURE POSITIVE MOMENT REGION DATA (END OR MAIN SPAN)

BEAM TYPE	PLATE GIRDER	
TOP FLANGE WIDTH	14.00	IN
TOP FLANGE THICKNESS	1.00	IN
WEB DEPTH	48.00	IN
WEB THICKNESS	0.50	IN
BOTTOM FLANGE WIDTH	14.00	IN
BOTTOM FLANGE THICKNESS	1.00	IN
BEAM SPACING PERP. TO CL	5.83	FT
SLAB THICKNESS	8.00	IN
SLAB F'C	4.00	KSI

SUPERSTRUCTURE POSITIVE MOMENT REGION DATA (ADJACENT SPAN)

TOP FLANGE WIDTH	14.00	IN
TOP FLANGE THICKNESS	1.00	IN
WEB DEPTH	48.00	IN
WEB THICKNESS	0.50	IN
BOTTOM FLANGE WIDTH	14.00	IN
BOTTOM FLANGE THICKNESS	1.00	IN
BEAM SPACING PERP. TO CL	5.83	FT
SLAB THICKNESS	8.00	IN
SLAB F'C	4.00	KSI

ABUTMENT #1 DATA

ABUTMENT NAME	West	
ABUTMENT REFERENCE BORING	1-S	
BOTTOM OF ABUTMENT ELEVATION	511.6	FT
ESTIMATED NUMBER OF PILES AT ABUT.	6	
PILE SPACING PERP. TO CL	5.833	FT

ABUTMENT #2 DATA

ABUTMENT NAME	East	
ABUTMENT REFERENCE BORING	2-S	
BOTTOM OF ABUTMENT ELEVATION	514.13	FT
ESTIMATED NUMBER OF PILES AT ABUT.	6	
PILE SPACING PERP. TO CL	5.833	FT

SOIL DATA FOR 10 FT BENEATH BOTTOM OF ABUTMENT #1

BOT. OF LAYER ELEV. (FT)	*LAYER THICKNESS (FT)*	*UNCONFINED COMPRESSIVE STRENGTH (TSF)*	*N S.P.T. VALUE (BLOWS/12 IN.)*	*Qu EQUIV. FOR N VALUE (TSF)*
508.90	2.70	1.2		
506.40	2.50	0.9		
503.90	2.50	1.4		
501.60	2.30	2.5		

10.00 FT = TOTAL DEPTH ENTERED

SOIL DATA FOR 10 FT BENEATH BOTTOM OF ABUTMENT #2

BOT. OF LAYER ELEV. (FT)	*LAYER THICKNESS (FT)*	*UNCONFINED COMPRESSIVE STRENGTH (TSF)*	*N S.P.T. VALUE (BLOWS/12 IN.)*	*Qu EQUIV. FOR N VALUE (TSF)*
511.50	2.63	1.5		
509.00	2.50	1.6		
506.50	2.50	2.1		
504.13	2.37	1.60		

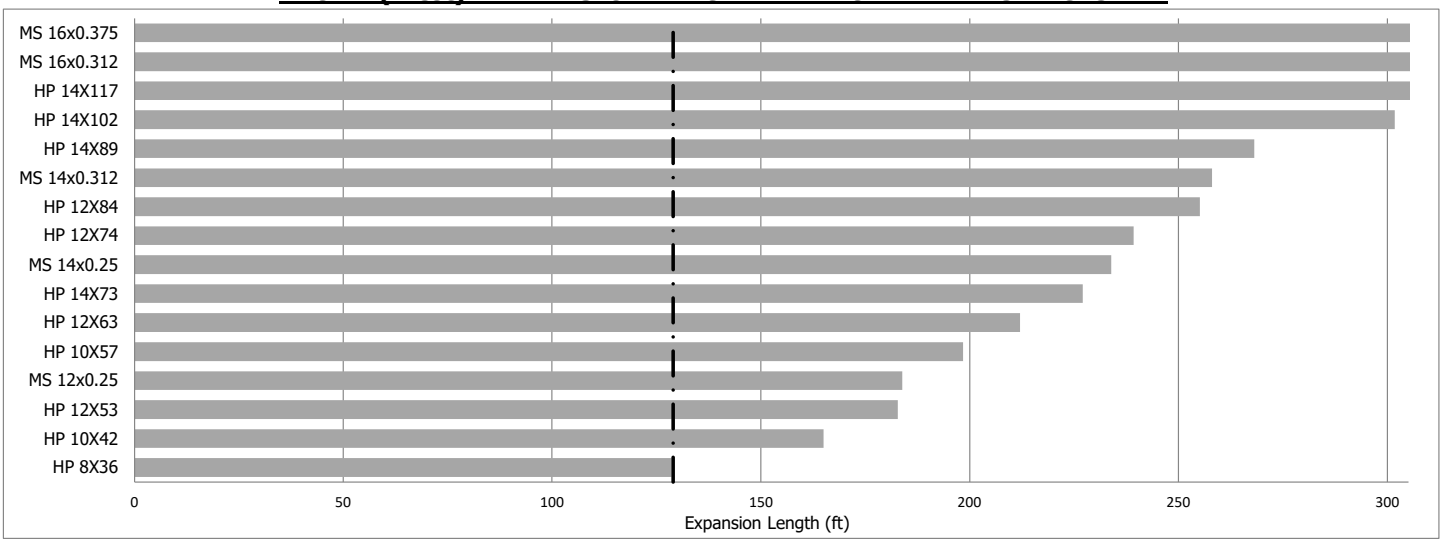
10.00 FT = TOTAL DEPTH ENTERED

WEIGHTED AVERAGE Qu FOR ABUTMENT #1	1.47	TSF	WEIGHTED AVERAGE Qu FOR ABUTMENT #2	1.70	TSF
PILE STIFFNESS MODIFIER FOR ABUTMENT #1 = 1/(1.45-[0.3*1.47])	0.99		PILE STIFFNESS MODIFIER FOR ABUTMENT #2 = 1/(1.45-[0.3*1.7])	1.06	

DISTANCE TO CENTROID OF STIFFNESS FROM ABUTMENT #1 = [0.99*6*0+1.06*6*249.24]/[0.99*6+1.06*6] = 128.93 FT

DISTANCE TO CENTROID OF STIFFNESS FROM ABUTMENT #2 = [1.06*6*0+0.99*6*249.24]/[1.06*6+0.99*6] = 120.31 FT

ABUT 1 (West) - EXPANSION LENGTH LIMIT CHART - 12.9 DEG. SKEW



= Estimated expansion length for the indicated abutment. Piles with an expansion length greater than this are suitable for consideration.
(Note: The same size pile should be used at both abutments.)

Appendix I

Driven Pile Analysis

IDOT STATIC METHOD OF ESTIMATING PILE LENGTH

SUBSTRUCTURE========== W. Abut.
REFERENCE BORING ========== 1-S
LRFD or ASD or SEISMIC ========== LRFD
PILE CUTOFF ELEV. ========== 513.60 ft
GROUND SURFACE ELEV. AGAINST PILE DURING DRIVING = 511.60 ft
GEOTECHNICAL LOSS TYPE (None, Scour, Liquef., DD) ====== None
BOTTOM ELEV. OF SCOUR, LIQUEF., or DD ========== 511.60 ft
TOP ELEV. OF LIQUEF. (so layers above apply DD) ========== 511.60 ft

TOTAL FACTORED SUBSTRUCTURE LOAD ========== 1360 kips
TOTAL LENGTH OF SUBSTRUCTURE (along skew)========== 35.73 ft
NUMBER OF ROWS OF PILES PER SUBSTRUCTURE ======= 1
Approx. Factored Loading Applied per pile at 8 ft. Cts ========== 304.51 KIPS
Approx. Factored Loading Applied per pile at 3 ft. Cts ========== 114.19 KIPS

PILE TYPE AND SIZE ========== Steel HP 12 X 74
Plugged Pile Perimeter========== 4.050 FT. Unplugged Pile Perimeter========== 5.908 FT.
Plugged Pile End Bearing Area========== 1.025 SQFT. Unplugged Pile End Bearing Area========= 0.151 SQFT.

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

Maximum Nominal Req'd Bearing of Pile	Maximum Nominal Req.d Bearing of Boring	Maximum Factored Resistance Available in Boring	Maximum Pile Driveable Length in Boring
589 KIPS	**589** KIPS	**324** KIPS	**82** 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.)
508.90	2.70	1.20			9.0		21.9	13.1		***15.0***	15	0	0	8	5
506.40	2.50	0.90			6.6	12.9	35.7	9.6	1.9	***25.7***	26	0	0	14	7
503.90	2.50	1.40			9.3	20.1	60.8	13.5	3.0	***41.6***	42	0	0	23	10
501.40	2.50	2.50			13.6	35.9	***55.7***	19.9	5.3	58.7	56	0	0	31	12
498.90	2.50	1.20			8.3	17.2	85.6	12.1	2.5	***74.0***	74	0	0	41	15
496.40	2.50	2.70			14.4	38.8	***84.1***	21.0	5.7	92.6	84	0	0	46	17
493.90	2.50	1.60			10.2	23.0	***96.2***	14.8	3.4	107.7	96	0	0	53	20
491.40	2.50		13	Hard Till	1.4	24.9	***93.8***	2.1	3.7	109.3	94	0	0	52	22
488.90	2.50		11	Hard Till	1.2	21.1	***98.9***	1.8	3.1	111.6	99	0	0	54	25
486.40	2.50		13	Hard Till	1.4	24.9	***114.2***	2.1	3.7	115.8	114	0	0	63	27
483.90	2.50	2.70			14.4	38.8	***112.8***	21.0	5.7	134.4	113	0	0	62	30
481.40	2.50		12	Hard Till	1.3	23.0	***116.0***	1.9	3.4	136.6	116	0	0	64	32
478.90	2.50		13	Hard Till	1.4	24.9	***125.6***	2.1	3.7	139.9	126	0	0	69	35
473.90	5.00	2.30			25.8	33.0	***142.8***	37.6	4.9	176.3	143	0	0	79	40
468.90	5.00	1.70			21.2	24.4	***162.5***	30.9	3.6	207.0	163	0	0	89	45
463.90	5.00		12	Very Fine Silty Sand	3.8	23.0	***163.5***	5.5	3.4	212.1	163	0	0	90	50
458.90	5.00	1.40			18.6	20.1	***167.7***	27.1	3.0	237.1	168	0	0	92	55
453.90	5.00	0.40			6.4	5.7	***195.6***	9.4	0.8	249.6	196	0	0	108	60
448.90	5.00	1.90			22.8	27.3	***219.9***	33.3	4.0	283.1	220	0	0	121	65
443.90	5.00	2.00			23.6	28.7	***229.1***	34.4	4.2	315.4	229	0	0	126	70
438.90	5.00	1.00			14.4	14.4	***256.4***	21.0	2.1	338.3	256	0	0	141	75
433.90	5.00	1.90	12		22.8	27.3	459.4	33.3	4.0	***398.2***	398	0	0	219	80
432.90	1.00			Sandstone	84.1	207.5	543.5	122.7	30.6	***520.8***	521	0	0	286	80.7
431.90	1.00			Sandstone	84.1	207.5	***627.6***	122.7	30.6	643.5	~~628~~	~~0~~	~~0~~	~~345~~	~~81.7~~
430.90	1.00			Sandstone	84.1	207.5	***711.7***	122.7	30.6	766.2	~~712~~	~~0~~	~~0~~	~~391~~	~~82.7~~
429.90	1.00			Sandstone		207.5			30.6						

IDOT STATIC METHOD OF ESTIMATING PILE LENGTH

SUBSTRUCTURE========== W. Abut.
REFERENCE BORING ========== 1-S
LRFD or ASD or SEISMIC ========== SEISMIC
PILE CUTOFF ELEV. ========== 513.60 ft
GROUND SURFACE ELEV. AGAINST PILE DURING DRIVING = 511.60 ft
GEOTECHNICAL LOSS TYPE (None, Scour, Liquef., DD) ====== Liquef.
BOTTOM ELEV. OF SCOUR, LIQUEF., or DD ========== 463.90 ft
TOP ELEV. OF LIQUEF. (so layers above apply DD) ========== 468.90 ft

TOTAL SEISMIC SUBSTRUCTURE LOAD ========== 670 kips
TOTAL LENGTH OF SUBSTRUCTURE (along skew)========== 35.73 ft
NUMBER OF ROWS OF PILES PER SUBSTRUCTURE ======= 1
Approx. Seismic Loading Applied per pile spaced at 8 ft. Cts ======= 150.01 KIPS
Approx. Seismic Loading Applied per pile spaced at 3 ft. Cts ======= 56.26 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
589 KIPS	**589** KIPS	**291** KIPS	**82** FT.

PILE TYPE AND SIZE ========== Steel HP 12 X 74
Plugged Pile Perimeter========== 4.050 FT. Unplugged Pile Perimeter========== 5.908 FT.
Plugged Pile End Bearing Area========== 1.025 SQFT. Unplugged Pile End Bearing Area========= 0.151 SQFT.

BOT. OF LAYER ELEV. (FT.)	LAYER THICK. (FT.)	UNCONF. COMPR. STRENGTH (TSF.)	S.P.T. N VALUE (BLOWS)	GRANULAR OR ROCK LAYER DESCRIPTION	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.)
508.90	2.70	1.20			9.0		21.9	13.1		***15.0***	15	9	10	-4	5
506.40	2.50	0.90			6.6	12.9	35.7	9.6	1.9	***25.7***	26	16	17	-7	7
503.90	2.50	1.40			9.3	20.1	60.8	13.5	3.0	***41.6***	42	25	27	-11	10
501.40	2.50	2.50			13.6	35.9	***55.7***	19.9	5.3	58.7	56	38	42	-25	12
498.90	2.50	1.20			8.3	17.2	85.6	12.1	2.5	***74.0***	74	47	52	-24	15
496.40	2.50	2.70			14.4	38.8	***84.1***	21.0	5.7	92.6	84	61	67	-44	17
493.90	2.50	1.60			10.2	23.0	***96.2***	14.8	3.4	107.7	96	71	79	-54	20
491.40	2.50		13	Hard Till	1.4	24.9	***93.8***	2.1	3.7	109.3	94	73	80	-59	22
488.90	2.50		11	Hard Till	1.2	21.1	***98.9***	1.8	3.1	111.6	99	74	82	-57	25
486.40	2.50		13	Hard Till	1.4	24.9	***114.2***	2.1	3.7	115.8	114	75	83	-44	27
483.90	2.50	2.70			14.4	38.8	***112.8***	21.0	5.7	134.4	113	90	99	-76	30
481.40	2.50		12	Hard Till	1.3	23.0	***116.0***	1.9	3.4	136.6	116	91	100	-76	32
478.90	2.50		13	Hard Till	1.4	24.9	***125.6***	2.1	3.7	139.9	126	93	102	-69	35
473.90	5.00	2.30			25.8	33.0	***142.8***	37.6	4.9	176.3	143	118	130	-106	40
468.90	5.00	1.70			21.2	24.4	***162.5***	30.9	3.6	207.0	163	140	154	-131	45
463.90	5.00		12	Very Fine Silty Sand	3.8	23.0	***163.5***	5.5	3.4	212.1	163	143	154	-134	50
458.90	5.00	1.40			18.6	20.1	***167.7***	27.1	3.0	237.1	168	143	154	-130	55
453.90	5.00	0.40			6.4	5.7	***195.6***	9.4	0.8	249.6	196	143	154	-102	60
448.90	5.00	1.90			22.8	27.3	***219.9***	33.3	4.0	283.1	220	143	154	-77	65
443.90	5.00	2.00			23.6	28.7	***229.1***	34.4	4.2	315.4	229	143	154	-68	70
438.90	5.00	1.00			14.4	14.4	***256.4***	21.0	2.1	338.3	256	143	154	-41	75
433.90	5.00	1.90	12		22.8	27.3	459.4	33.3	4.0	***398.2***	398	143	154	101	80
432.90	1.00			Sandstone	84.1	207.5	543.5	122.7	30.6	***520.8***	521	143	154	224	80.7
431.90	1.00			Sandstone	84.1	207.5	***627.6***	122.7	30.6	643.5	~~628~~	~~143~~	~~154~~	~~330~~	~~81.7~~
430.90	1.00			Sandstone	84.1	207.5	***711.7***	122.7	30.6	766.2	~~712~~	~~143~~	~~154~~	~~414~~	~~82.7~~
429.90	1.00			Sandstone		207.5			30.6						

IDOT STATIC METHOD OF ESTIMATING PILE LENGTH

SUBSTRUCTURE========== E. Abut.
REFERENCE BORING ========== 2-S
LRFD or ASD or SEISMIC ========== LRFD
PILE CUTOFF ELEV. ========== 516.13 ft
GROUND SURFACE ELEV. AGAINST PILE DURING DRIVING = 514.13 ft
GEOTECHNICAL LOSS TYPE (None, Scour, Liquef., DD) ====== None
BOTTOM ELEV. OF SCOUR, LIQUEF., or DD ========== 514.13 ft
TOP ELEV. OF LIQUEF. (so layers above apply DD) ========== 514.13 ft

TOTAL FACTORED SUBSTRUCTURE LOAD ========== 1360 kips
TOTAL LENGTH OF SUBSTRUCTURE (along skew)========== 35.73 ft
NUMBER OF ROWS OF PILES PER SUBSTRUCTURE ======= 1
Approx. Factored Loading Applied per pile at 8 ft. Cts ========== 304.51 KIPS
Approx. Factored Loading Applied per pile at 3 ft. Cts ========== 114.19 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
589 KIPS	**589** KIPS	**324** KIPS	**80** FT.

PILE TYPE AND SIZE ========== Steel HP 12 X 74
Plugged Pile Perimeter========== 4.050 FT. Unplugged Pile Perimeter========== 5.908 FT.
Plugged Pile End Bearing Area========== 1.025 SQFT. Unplugged Pile End Bearing Area========= 0.151 SQFT.

BOT. OF LAYER ELEV. (FT.)	LAYER THICK. (FT.)	UNCONF. COMPR. STRENGTH (TSF.)	S.P.T. N VALUE (BLOWS)	GRANULAR OR ROCK LAYER DESCRIPTION	NOMINAL PLUGGED SIDE RESIST. (KIPS)	NOMINAL PLUGGED END BRG. RESIST. (KIPS)	NOMINAL PLUGGED TOTAL RESIST. (KIPS)	NOMINAL UNPLUG'D SIDE RESIST. (KIPS)	NOMINAL UNPLUG'D END BRG. RESIST. (KIPS)	NOMINAL UNPLUG'D TOTAL RESIST. (KIPS)	NOMINAL REQ'D BEARING (KIPS)	FACTORED GEOTECH. LOSS FROM SCOUR or DD (KIPS)	FACTORED GEOTECH. LOSS LOAD FROM DD (KIPS)	FACTORED RESISTANCE AVAILABLE (KIPS)	ESTIMATED PILE LENGTH (FT.)
511.50	2.63	1.50			10.2		33.2	14.9		***18.3***	18	0	0	10	5
509.00	2.50	1.60			10.2	23.0	50.6	14.8	3.4	***34.3***	34	0	0	19	7
506.50	2.50	2.10			12.2	30.2	55.6	17.7	4.5	***50.9***	51	0	0	28	10
504.00	2.50	1.60			10.2	23.0	78.7	14.8	3.4	***67.7***	68	0	0	37	12
501.50	2.50	2.50			13.6	35.9	92.3	19.9	5.3	***87.6***	88	0	0	48	15
499.00	2.50	2.50			13.6	35.9	***97.3***	19.9	5.3	106.2	97	0	0	54	17
496.50	2.50	1.90			11.4	27.3	***108.3***	16.6	4.0	122.8	108	0	0	60	20
494.00	2.50		14	Hard Till	1.5	26.8	***111.7***	2.3	4.0	125.3	112	0	0	61	22
491.50	2.50		15	Hard Till	1.7	28.7	***115.3***	2.4	4.2	128.0	115	0	0	63	25
489.00	2.50		16	Hard Till	1.8	30.6	***117.1***	2.6	4.5	130.6	117	0	0	64	27
486.50	2.50		16	Hard Till	1.8	30.6	***121.2***	2.6	4.5	133.5	121	0	0	67	30
484.00	2.50	2.30			12.9	33.0	***137.0***	18.8	4.9	152.7	137	0	0	75	32
481.50	2.50	2.50			13.6	35.9	***137.7***	19.9	5.3	170.7	138	0	0	76	35
476.50	5.00		12	Hard Till	2.6	23.0	***153.3***	3.9	3.4	176.5	153	0	0	84	40
471.50	5.00	2.50			27.3	35.9	***180.5***	39.8	5.3	216.3	181	0	0	99	45
466.50	5.00	2.50			27.3	35.9	***210.7***	39.8	5.3	256.5	211	0	0	116	50
461.50	5.00	2.70			28.8	38.8	***235.1***	42.0	5.7	297.8	235	0	0	129	55
456.50	5.00	2.40			26.5	34.5	***244.4***	38.7	5.1	334.0	244	0	0	134	60
451.50	5.00	1.20			16.6	17.2	***258.2***	24.2	2.5	357.8	258	0	0	142	65
446.50	5.00	1.00			14.4	14.4	***276.9***	21.0	2.1	379.4	277	0	0	152	70
441.50	5.00	1.30			17.6	18.7	***320.3***	25.7	2.8	408.9	320	0	0	176	75
438.50	3.00	3.10	21		19.0	44.5	502.3	27.8	6.6	***460.7***	461	0	0	253	78
437.50	1.00			Sandstone	84.1	207.5	586.4	122.7	30.6	***583.4***	583	0	0	321	78.6
436.50	1.00			Sandstone	84.1	207.5	***670.5***	122.7	30.6	706.1	~~671~~	~~0~~	~~0~~	~~369~~	~~79.6~~
435.50	1.00			Sandstone	84.1	207.5	***754.6***	122.7	30.6	828.8	~~755~~	~~0~~	~~0~~	~~415~~	~~80.6~~
434.50	1.00			Sandstone		207.5			30.6						

IDOT STATIC METHOD OF ESTIMATING PILE LENGTH

SUBSTRUCTURE========== Pier
REFERENCE BORING ========== 3-S
LRFD or ASD or SEISMIC ========== LRFD
PILE CUTOFF ELEV. ========== 497.41 ft
GROUND SURFACE ELEV. AGAINST PILE DURING DRIVING = 495.41 ft
GEOTECHNICAL LOSS TYPE (None, Scour, Liquef., DD) ====== None
BOTTOM ELEV. OF SCOUR, LIQUEF., or DD ========== 495.41 ft
TOP ELEV. OF LIQUEF. (so layers above apply DD) ========== 495.41 ft

TOTAL FACTORED SUBSTRUCTURE LOAD ========== 2600 kips
TOTAL LENGTH OF SUBSTRUCTURE (along skew)========== 36.00 ft
NUMBER OF ROWS OF PILES PER SUBSTRUCTURE ======= 3
Approx. Factored Loading Applied per pile at 8 ft. Cts ========== 192.59 KIPS
Approx. Factored Loading Applied per pile at 3 ft. Cts ========== 72.22 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	**66** 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.)
494.20	1.21	1.00	10		3.4		11.7	5.0		***5.9***	6	0	0	3	3
491.70	2.50	0.60	5		4.6	8.3	21.7	6.7	0.9	***13.2***	13	0	0	7	6
488.20	3.50	1.00	12		9.9	13.8	46.8	14.4	1.5	***29.2***	29	0	0	16	9
486.20	2.00	2.10	12		9.5	28.9	61.8	13.9	3.2	***43.8***	44	0	0	24	11
484.20	2.00	2.50	9		10.7	34.5	60.1	15.6	3.8	***58.0***	58	0	0	32	13
481.70	2.50	1.60	8		10.0	22.0	***71.9***	14.6	2.4	72.8	72	0	0	40	16
479.20	2.50		13	Hard Till	1.4	23.9	89.4	2.1	2.6	***76.6***	77	0	0	42	18
476.70	2.50	2.90			14.8	40.0	***97.3***	21.7	4.4	97.5	97	0	0	54	21
473.70	3.00		18	Hard Till	2.3	33.1	***99.6***	3.4	3.6	100.9	100	0	0	55	24
471.70	2.00		18	Hard Till	1.6	33.1	***102.6***	2.3	3.6	103.4	103	0	0	56	26
469.20	2.50	2.50			13.4	34.5	***103.5***	19.5	3.8	121.5	104	0	0	57	28
466.70	2.50		12	Hard Till	1.3	22.0	***106.7***	1.9	2.4	123.6	107	0	0	59	31
464.20	2.50		13	Hard Till	1.4	23.9	***104.8***	2.1	2.6	125.3	105	0	0	58	33
461.70	2.50	1.50			9.5	20.7	***115.8***	13.9	2.3	139.4	116	0	0	64	36
459.20	2.50		12	Hard Till	1.3	22.0	***107.4***	1.9	2.4	140.3	107	0	0	59	38
454.20	5.00	0.90			12.9	12.4	***121.7***	18.9	1.4	159.3	122	0	0	67	43
449.20	5.00	1.00			14.1	13.8	***134.4***	20.6	1.5	179.8	134	0	0	74	48
444.20	5.00	0.90			12.9	12.4	***166.7***	18.9	1.4	200.8	167	0	0	92	53
439.20	5.00	2.30			25.3	31.7	***204.3***	36.9	3.5	239.1	204	0	0	112	58
433.70	5.50		24	Hard Till	5.7	44.1	365.0	8.3	4.8	***264.4***	264	0	0	145	64
432.70	1.00			Sandstone	82.4	199.1	447.3	120.4	21.8	***384.8***	385	0	0	212	64.7
431.70	1.00			Sandstone	82.4	199.1	529.7	120.4	21.8	***505.2***	~~505~~	~~0~~	~~0~~	~~278~~	~~65.7~~
430.70	1.00			Sandstone	82.4	199.1	***612.1***	120.4	21.8	625.7	~~612~~	~~0~~	~~0~~	~~337~~	~~66.7~~
429.70	1.00			Sandstone		199.1			21.8						