ARKANSAS DEPARTMENT OF TRANSPORTATION

SUBSURFACE INVESTIGATION

STATE JOB NO. 110861

FEDERAL AID PROJECT NO. NHPP-0019(64)

ST. FRANCIS RIVER STR. & APPRS. (COLDWATER) (S)

STATE HIGHWAY 42 **SECTION** 3

IN CROSS **COUNTY**

The information contained herein was obtained by the Department for design and estimating purposes only. It is being furnished with the express understanding that said information does not constitute a part of the Proposal or Contract and represents only the best knowledge of the Department as to the location, character and depth of the materials encountered. The information is only included and made available so that bidders may have access to subsurface information obtained by the Department and is not intended to be a substitute for personal investigation, interpretation and judgment of the bidder. The bidder should be cognizant of the possibility that conditions affecting the cost and/or quantities of work to be performed may differ from those indicated herein.

ARKANSAS DEPARTMENT OF TRANSPORTATION
ARDOT.gov | IDriveArkansas.com | Lorie H. Tudor, P.E., Director
MATERIALS DIVISION
11301 West Baseline Road | P.O. Box 2261 | Little Rock, AR 72203-2261 | Phone: 501.569.2185 | Fax: 501.569.2368

December 17, 2024

TO: Mr. Rick Ellis, Bridge Engineer

SUBJECT: Job No. 110861
St. Francis River Strs. & Apprs. (Coldwater) (S)
Cross County
Route 42, Section 3

Introduction

Submitted herein are the results of the subsurface investigation and geotechnical recommendations developed for the replacement bridge planned on Highway 42 in Cross County. It is understood the existing Highway 42 bridge over the St. Francis River was closed to traffic on November 2, 2023, due to loss of structural integrity in the bridge's timber piles. The bridge collapsed into the St. Fracis River on June 28, 2024. The existing bridge will be demolished under Job No. 110859. A Seismic Operation Classification of "Other" is assigned to the replacement bridge.

Based on the preliminary bridge layout received on November 21, 2024, the replacement bridge will be constructed in the same alignment as the existing bridge. The new bridge will consist of two identical, 270-foot-long continuous plate girder units, with each unit comprised of 3 equal spans (90'-90'-90'). It will have a total length of 542 feet and an out-to-out width of 28.5 feet.

The existing bridge abutments will be utilized with minor reshaping on the existing end slopes. The reshaping includes a combination of minor fill placement up to 2 feet and cut up to 5 feet, resulting in a 2-horizontal to 1-vertical (2H:1V) configuration for the end slopes. The existing 3H:1V configuration will be utilized for the side slopes.

Field Investigation

A subsurface investigation was requested on October 10, 2024, by Bridge Division to develop recommendations for bridge foundations and to verify suitability of bridge abutment configuration. Due to the urgency of the project, bridge layout had not been developed at the time of the subsurface investigation request. The subsurface conditions were investigated by drilling 3 borings at accessible locations.

The approximate locations of these borings are presented in the Plan of Borings included in Attachment A. The borings were advanced with a truck-mounted CME 75 rotary drill rig and a track-mounted Acker Renegade rotary drill rig using a combination of hollow-stem auger and rotary wash methods. The boring logs, showing the subsurface conditions encountered in the borings and the results of field and laboratory tests, are also included in Attachment A, following the Plan of Borings. A legend is attached after the boring logs to explain the symbols, terms, and conventions used on the logs.

Standard Penetration Tests (SPT) were conducted in accordance with ASTM D1586 for field-testing and soil sampling. The hammer correction factors for the SPT hammers are indicated on the boring logs. Liners were not used inside the standard split-barrel samplers. The number of blows required to drive the standard split-barrel sampler for each 6-inch increment of the total 18-

inch drive depth were measured and recorded on the boring logs. SPT N-values are defined as the total number of blows required to advance the split barrel sampler the final 12 inches of the total 18-inch drive depth. The SPT N-values indicated on the logs are raw (uncorrected) blow counts measured in field. Groundwater was also observed during the drilling process and noted on the logs.

Lab Investigation

All samples were brought to the Materials Division laboratory for further evaluation and testing. Soil samples were tested to evaluate index properties and to verify soil type and classification. Lab tests were performed on representative soil samples to determine moisture content, Atterberg limits, and gradation. Tested soils were classified by a licensed professional geologist (PG) in accordance with both USCS and AASHTO soil classification systems.

These test results are plotted or indicated on the logs using appropriate denotation (symbols in accordance with scale, number, text, etc.). Table 1 lists the laboratory tests; their corresponding ASTM and AASHTO test methods, and respective denotation on logs.

Table 1: Summary of Laboratory Tests and Methods

Laboratory Test	ASTM	AASHTO	Denotation on Logs
Moisture Content	D2216	T 265	Solid Circle Symbol (●)
Grain Size Distribution	D6913	T 88	Whole Number in the "Percent Passing No. 200 Sieve" Column (e.g., 12)
Atterberg Limits	D4318	T 89	Plus symbol (+) on the Right for Liquid Limit
		T 90	Plus symbol (+) on the Left for Plastic Limit

The particle size through which 50% of particles by weight passing, D_{50}, is summarized below in Table 2. The particle size distribution curve for D_{50} sample is included in Attachment B.

Table 2: Summary of D_{50} for Scour Analysis

Station	Sample Type	Location	D_{50}, mm
38+27, 32' Lt	Bulk	Creek Bank	≤0.075

To determine the corrosive potential of the foundation soils, laboratory pH and resistivity tests were performed on composite soil samples obtained from the borings. The results of pH and resistivity tests are summarized in Table 3.

Table 3: Results of Laboratory pH and Resistivity Tests

Laboratory Test	Boring	Depth, ft	Results (unit)
pH	1	10 to 20	6.7
	2	10 to 20	7.0
	3	10 to 20	7.2
Resistivity	1	10 to 20	540 (Ohms-cm)
	2	10 to 20	9550 (Ohms-cm)
	3	10 to 20	996 (Ohms-cm)

Generalized Site Conditions, Site Geology, and Subsurface Conditions

As mentioned, the existing bridge collapsed into the St. Fracis River on June 28, 2024. The existing bridge was being demolished under Job No. 110859 at the time of field investigation (late October 2024). Representative site pictures, taken in early October 2024 before demolition and in late October 2024 during demolition, are included in Attachment C. The St. Francis River flows to the south at the proposed job site. The topography surrounding the job site is relatively flat and may be subject to flooding.

The existing roadway embankment appears to be composed of clay that extends to a depth of 25 feet at the west bridge end and 15 feet at the east bridge end. The clay layer overlies alluvial deposits of the St. Francis River consisting of sandy clay, silt, and silty sand. These deposits overlie Mississippi River Valley alluvium consisting of sand, sand with silt, and gravel.

A generalized Subsurface Profile is included in Attachment D to aid in visualizing subsurface conditions and stratigraphy. Considering natural variations in stratigraphy and subsurface conditions, deviation from these illustrations on the profile must be anticipated.

Seismic Conditions

Code-Based Seismic Coefficients Considering the average subsurface conditions as revealed by the borings, a Seismic Site Class D (Stiff Soil profile) is calculated for the project site. Utilizing the Seismic Site Class D and the approximate GPS coordinates of the project site, the following code-based design peak ground acceleration coefficients (A_S), design short-period spectral acceleration coefficients (S_{DS}), as well as design long-period spectral acceleration coefficients (S_{D1}), are determined. These seismic coefficients are summarized in Table 4. Code-based Design Response Spectrum is presented in Attachment E.

Table 4: Summary of Code-Based Design Ground Motion Acceleration Response Coefficients

Acceleration Coefficient	Value (g)
A_S (Site PGA)	0.970
S_{DS} (0.2 sec)	1.744
S_{D1} (1 sec)	0.736

For the design long-period spectral acceleration coefficient (S_{D1}) of 0.736, a Seismic Performance Zone 4 is considered applicable.

A_S Adopted for Geotechnical Analysis A site-specific probabilistic ground-motion analysis has not been performed for this project. However, based on statistical analyses on the available site-specific studies (over 60 sites) performed in the soil region of Arkansas, the measured site-specific A_S values range from 27% to 83% of the code-based values, with an average A_S value equal to 56% of the code-based values. In addition, all the site-specific studies performed in the vicinity of the subject project site indicate the site-specific A_S values are less than ⅔ of the code-based values. Consequently, ⅔ of the code-based A_S value (i.e., 0.647) is utilized in geotechnical analysis for the 110861 project site which has an assigned Seismic Operational Classification of "Other" and an estimated 2025 ADT of 160 vehicles per day.

Liquefaction Analyses Liquefaction potential of the subsurface soils was evaluated based on the results of the borings and utilizing the current Microsoft Excel© spreadsheet developed by the University of Arkansas for ARDOT. An Earthquake Moment Magnitude (M_W) of 7.0 and a design peak ground acceleration coefficient (As) of 0.647 were modelled in the analyses. All the borings were analyzed to evaluate liquefaction potential. The results of liquefaction analyses are presented as a plot of calculated factor of safety against liquefaction versus depth below ground surface at the boring location. Results of liquefaction analyses are also included in Attachment E. The analyses indicate some potential of liquefaction in the top 50 feet for the project site.

Embankment Configuration

Settlement Potential The existing embankment will be utilized with minor additional fill placement that will be no thicker than 2 feet. Consequently, settlement potential is expected to be negligible.

Embankment Slope Stability Slope stability analyses have been performed to evaluate the design abutment configuration. Slope stability analyses were performed utilizing a commercial computer program Slide2 (Version 2021) developed by RocScience. Spencer analysis method was utilized to analyze abutments for both sites. Three general loading conditions were analyzed with respect to slope stability: Short Term (End of Construction) Condition, Long Term Condition, and Seismic (Pseudo-Static) Condition. A horizontal acceleration coefficient (k_h) of 0.325 ($0.5A_s$) was utilized for analysis of the Seismic Psuedo-Static Condition. A surcharge of 250 psf is included to model the live load under long term condition.

Calculated factors of safety are summarized in Table 5. Detailed graphical results of slope stability analyses are included in Attachment G.

Table 5: Results of Slope Stability analyses

Slope	Loading Condition	Calculated Min. F.S.	Recommended Min. F.S.
2H:1V End Slope – Bent 1 (West Embankment)	Short Term	3.49	1.30
	Long Term	1.68	1.40
	Seismic (k_h = 0.325)	1.27	1.05
2H:1V End Slope – Bent 7 (East Embankment)	Short Term	1.79	1.30
	Long Term	1.63	1.40
	Seismic (k_h = 0.325)	0.66	1.05

Based on the results from the slope stability analyses, the planned configuration of the west abutment is acceptable for all loading conditions. The planned configuration of the east abutment is acceptable with respect to Short Term and Long Term loading conditions; however, the slope stability analysis determined the configuration unstable under seismic loading.

Newmark Block Analysis An inadequate factor of safety under seismic condition has been calculated with respect to slope stability for the east abutment. Newmark Block Analysis has been performed on this abutment to evaluate the potential of permanent deformation. Detailed analyses are also included in Attachment G.

The calculated permanent deformation of 7.0 inches is considered acceptable to the Geotechnical Engineer. However, the Design Engineer should make the final decision whether this deformation is acceptable or not.

Foundation Recommendations

Axial Capacities It is understood that closed-end, concrete-filled steel shell piles will be utilized to support the foundation loads. Design nominal axial compression pile capacity of 170 tons is required for the 18-inch-diameter piles planned at the abutments. Design nominal axial compression pile capacity of 415 tons is required for the 30-inch-diameters piles planned at intermediate bents.

Static nominal axial capacities (compression and uplift) vs. pile tip penetration/elevation curves are provided in Attachment H for single, 18-inch-diameter and 30-inch diameter closed-end, concrete-filled steel shell piles. These pile capacity curves are developed based on the full shear strength of the subsurface soils before liquefaction occurs. Table 6 summarizes the recommended shallowest pile tip elevations to achieve the required static nominal axial compression capacities.

Table 6: Recommended Shallowest Pile Tip Elevation

Bent No.	Required Nominal Axial Resistance, Tons	Pile Diameter, Inch	Recommended Shallowest Pile Tip Elevation
1	170	18	158
2	415	30	130
3		30	108
4		30	107
5		30	119
6		30	118
7	170	18	145

Considering the minimal embankment fill placement, downdrag on piling is expected to be negligible. These capacities are determined for piles driven to the required penetration elevation. If jetting or other methods are used to assist in advancing the piles, re-evaluation of these pile capacities will be warranted.

The piles are expected to penetrate into sandy strata that are likely to be liquefied during driving with considerable resistance loss at the end of initial drive. If the required nominal bearing capacity has not been obtained when top of piles are 6 inches above plan grade, considerations may be given to restriking the piles with a warmed-up hammer after a minimum 24-hour waiting period.

Analysis indicates liquefaction potential. Seismic (post-liquefaction) nominal axial pile capacity curves for piles embedded in liquefied subsurface soils are developed utilizing residual soil shear strength. The seismic axial capacity curves are included in Attachment I.

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Geotechnical Input Parameters for Lateral Load Analysis Lateral load analysis will be performed by the structural engineer using commercial computer program Lpile. The geotechnical input parameters are included in Attachment J. These parameters include static properties of pre-liquefaction soils and seismic properties of post-liquefaction soils.

Pile Installation Piles should be installed in accordance with Section 805 (2014 Edition). Prior to piling, hammer systems furnished by the Contractor should be evaluated and approved by the Engineer.

Prebore is not anicipated to be required. Water jetting, vibrating, or other means for the purpose of assisting pile penetration are generally not expected. If warranted by specific subsurface conditions, the use of water jetting or vibrating would require review and approval by the Engineer. In addition, the final 5 feet of pile penetratin should be achieved by driving.

Piling should be observed and recorded by the Engineer. Test piles are not required, but the contractor may pursue for information purposes. Nominal bearing capacity should be determined in accordance with the method(s) shown on the plans.

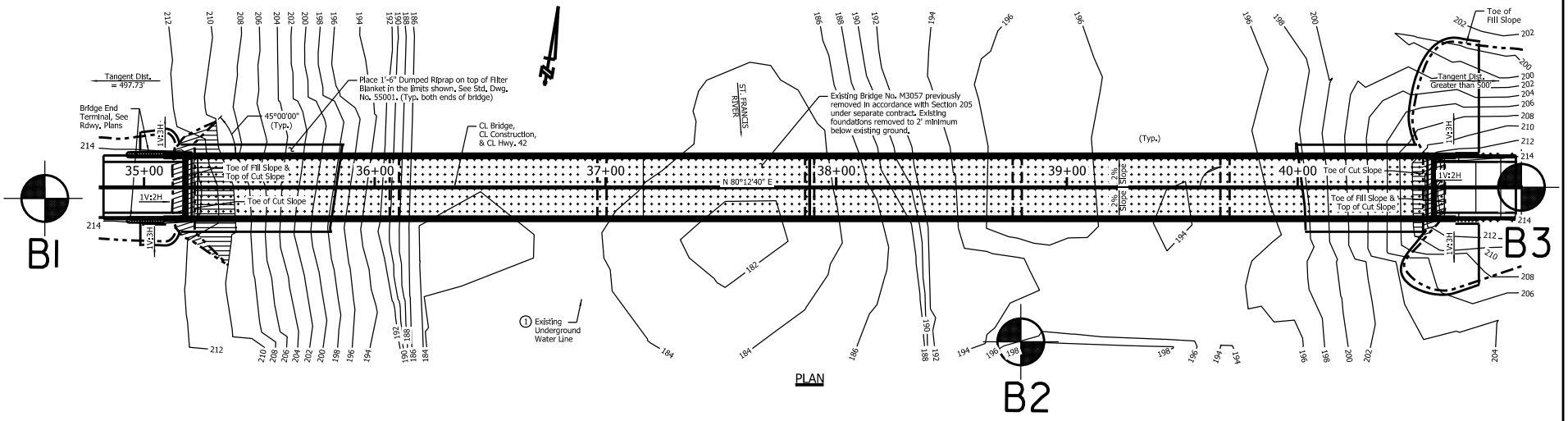
If there are any questions concerning these recommendations, please contact the Geotechnical Section.

Paul Tinsley
Materials Engineer

PT:yz:mbb:cs
cc: State Construction Engineer
District 1 Engineer
G. C. File

Attachment A

FED. ROAD DIST. NO.	STATE	FED. AID PROJ. NO.	SHEET NO.	TOTAL SHEETS
6	AR			
JOB NO.		110861		
PLAN OF BORINGS				



PLAN OF BORINGS

ST. FRANCIS RIVER STR. & APPRS. (COLDWATER) (S)
ROUTE 42, SECTION 3
CROSS COUNTY
FED. AID PROJECT

JOB NO. 110861	SHEET 1/1

ARKANSAS DEPARTMENT OF TRANSPORTATION
MATERIALS DIVISION - GEOTECHNICAL SECTION

BORING NO. 1
PAGE 1 OF 3

JOB NO. 110861 Cross County
JOB NAME: St. Francis River Str. & Apprs. (Coldwater) (S)
Route 42, Section 3
STATION: 34+57
LOCATION: 5' Right of Construction Centerline
LOGGED BY: Stanley Bates

DATE: October 29-30, 2024
TYPE OF DRILLING:
Hollow Stem Auger-Rotary Wash
EQUIPMENT: CME 75

HAMMER CORRECTION FACTOR: 1.57

COMPLETION DEPTH: 101.5

DEPTH FT.	SYMBOL	SAMPLES	DESCRIPTION OF MATERIAL	SOIL GROUP	MOISTURE CONTENT (%) PL — LL (10 20 30 40 50 60 70)	PERCENT PASSING NO. 200 SIEVE	NO. OF BLOWS PER 6-IN.	% TCR	% RQD
			SURFACE ELEVATION: 214.5						
			Asphalt	-					
			Base						
			Moist, Medium Stiff, Gray Lean Clay with Sand	CL		83	3 2-4		
				-					
5			Wet, Soft, Gray Lean Clay	CL		96	1 1-1		
				-					
			Moist, Soft, Gray Fat Clay	CH		95	1 1-1		
				-					
10				CH		99	1 1-3		
				-					
15				CH	82	95	1 1-3		
				-					
20			Moist, Medium Stiff, Brown Lean Clay	CL		89	1 2-3		
				-					
25			Wet, Loose, Gray Silty Sand	SM		39	1 2-4		
				-					
30			Wet, Loose, Gray Silt	ML		89	3 4-5		
				-					
35									

REMARKS: Water Level was 17 feet below ground level on October 30, 2024

ARKANSAS DEPARTMENT OF TRANSPORTATION
MATERIALS DIVISION - GEOTECHNICAL SECTION

BORING NO. 1
PAGE 2 OF 3

JOB NO. 110861 Cross County
JOB NAME: St. Francis River Str. & Apprs. (Coldwater) (S)
Route 42, Section 3
STATION: 34+57
LOCATION: 5' Right of Construction Centerline
LOGGED BY: Stanley Bates

DATE: October 29-30, 2024
TYPE OF DRILLING:
Hollow Stem Auger-Rotary Wash
EQUIPMENT: CME 75

HAMMER CORRECTION FACTOR: 1.57

COMPLETION DEPTH: 101.5

DEPTH FT.	SYMBOL	SAMPLES	DESCRIPTION OF MATERIAL SURFACE ELEVATION: 214.5	SOIL GROUP	MOISTURE CONTENT (%) PL — LL (10 20 30 40 50 60 70)	PERCENT PASSING NO. 200 SIEVE	NO. OF BLOWS PER 6-IN.	%TCR	%RQD
40			Wet, Loose, Gray Silt with Sand	ML		71	1 4-6		
45			Wet, Medium Dense, Gray Silty Sand	-			5 6-9		
50			Wet, Medium Dense, Gray Poorly Graded Sand with Silt	SP-SM		5	7 13-13		
55			Wet, Medium Dense, Gray Sand with Trace Organic Matter	-			8 12-13		
60			Wet, Medium Dense, Gray Poorly Graded Sand	SP		4	6 10-16		
65			Wet, Dense, Gray Sand	-			10 20-21		
70			Wet, Medium Dense, Gray Poorly	SP-SM		5	9 14-12		

REMARKS: Water Level was 17 feet below ground level on October 30, 2024

ARKANSAS DEPARTMENT OF TRANSPORTATION
MATERIALS DIVISION - GEOTECHNICAL SECTION

BORING NO. 1
PAGE 3 OF 3

JOB NO. 110861 Cross County
JOB NAME: St. Francis River Str. & Apprs. (Coldwater) (S)
Route 42, Section 3
STATION: 34+57
LOCATION: 5' Right of Construction Centerline
LOGGED BY: Stanley Bates

DATE: October 29-30, 2024
TYPE OF DRILLING:
Hollow Stem Auger-Rotary Wash
EQUIPMENT: CME 75

HAMMER CORRECTION FACTOR: 1.57

COMPLETION DEPTH: 101.5

DEPTH FT.	SYMBOL	SAMPLES	DESCRIPTION OF MATERIAL	SOIL GROUP	MOISTURE CONTENT (%) PL — LL (10 20 30 40 50 60 70)	PERCENT PASSING NO. 200 SIEVE	NO. OF BLOWS PER 6-IN.	%TCR	%RQD
75			Graded Sand with Silt	-			8 15-13		
80			Wet, Dense, Gray Poorly Graded Sand with Silt and Gravel	SP-SM		5	12 17-16		
85			Wet, Dense, Gray Sand with Trace Gravel	-			9 19-24		
90			Wet, Very Dense, Gray Poorly Graded Sand with Silt and Trace Gravel	SP-SM -		5	18 27-26		
95			Wet, Dense, Gray Poorly Graded Sand with Silt and Trace Gravel	SP-SM -		5	8 17-14		
100			Wet, Dense, Gray Poorly Graded Sand with Trace Gravel	SP -		4	15 22-19		
				SP		3	7 15-16		
105			Boring Terminated						

REMARKS: Water Level was 17 feet below ground level on October 30, 2024

ARKANSAS DEPARTMENT OF TRANSPORTATION
MATERIALS DIVISION - GEOTECHNICAL SECTION

BORING NO. 2
PAGE 1 OF 4

JOB NO. 110861 Cross County
JOB NAME: St. Francis River Str. & Apprs. (Coldwater) (S)
Route 42, Section 3
STATION: 38+80
LOCATION: 67' Right of Construction Centerline
LOGGED BY: Stanley Bates

DATE: October 22-23, 2024
TYPE OF DRILLING:
Hollow Stem Auger-Rotary Wash
EQUIPMENT: Acker 2

HAMMER CORRECTION FACTOR: 1.55

COMPLETION DEPTH: 121.5

DEPTH FT.	SYMBOL	SAMPLES	DESCRIPTION OF MATERIAL	SOIL GROUP	MOISTURE CONTENT (%) PL — LL (10 20 30 40 50 60 70)	PERCENT PASSING NO. 200 SIEVE	NO. OF BLOWS PER 6-IN.	%TCR	%RQD
			SURFACE ELEVATION: 195.9						
			Moist, Soft, Brown to Dark Brown Sandy Lean Clay	-			0 2-2		
5				CL		66	1 2-2		
				-					
			Moist, Loose, Brown Silty Sand	SM		44	1 3-2		
			Moist, Loose, Brown Silty Sand	SM		21			
10				-		15	2 3-3		
			Wet, Loose, Brown Silty Sand*	SM					
				-					
15				SP		1	1 4-5		
			Wet, Loose, Gray Poorly Graded Sand	-					
20				SP-SM		9	3 6-7		
			Wet, Medium Dense, Gray Poorly Graded Sand with Silt	-			4 9-9		
25									
30				SP-SM		9	5 7-9		
35									

REMARKS: *Water level on October 28, 2024 was 11.5 feet below ground level.

ARKANSAS DEPARTMENT OF TRANSPORTATION
MATERIALS DIVISION - GEOTECHNICAL SECTION

BORING NO. 2
PAGE 2 OF 4

JOB NO. 110861 Cross County
JOB NAME: St. Francis River Str. & Apprs. (Coldwater) (S)
Route 42, Section 3
STATION: 38+80
LOCATION: 67' Right of Construction Centerline
LOGGED BY: Stanley Bates

DATE: October 22-23, 2024
TYPE OF DRILLING:
Hollow Stem Auger-Rotary Wash
EQUIPMENT: Acker 2

HAMMER CORRECTION FACTOR: 1.55

COMPLETION DEPTH: 121.5

DEPTH FT.	SYMBOL	SAMPLES	DESCRIPTION OF MATERIAL SURFACE ELEVATION: 195.9	SOIL GROUP	MOISTURE CONTENT (%) PL — LL (10 20 30 40 50 60 70)	PERCENT PASSING NO. 200 SIEVE	NO. OF BLOWS PER 6-IN.	%TCR	%RQD
40			Wet, Medium Dense, Gray Poorly Graded Sand with Silt	-			6 11-13		
				SP-SM		7	6 10-11		
45				-			5 9-11		
50									
				SP-SM		7	6 8-10		
55			Wet, Medium Dense, Gray Sand with Silt and Trace Gravel and Trace Organic Matter	-			6 12-16		
60									
				SP		4	8 9-8		
65			Wet, Medium Dense, Gray Poorly Graded Sand						
				-			4 8-12		
70			Wet, Medium Dense, Gray Sand with Trace Gravel and Trace Organic Matter						

REMARKS: *Water level on October 28, 2024 was 11.5 feet below ground level.

ARKANSAS DEPARTMENT OF TRANSPORTATION
MATERIALS DIVISION - GEOTECHNICAL SECTION

BORING NO. 2
PAGE 3 OF 4

JOB NO. 110861 Cross County
JOB NAME: St. Francis River Str. & Apprs. (Coldwater) (S)
Route 42, Section 3
STATION: 38+80
LOCATION: 67' Right of Construction Centerline
LOGGED BY: Stanley Bates

DATE: October 22-23, 2024
TYPE OF DRILLING:
Hollow Stem Auger-Rotary Wash
EQUIPMENT: Acker 2

HAMMER CORRECTION FACTOR: 1.55

COMPLETION DEPTH: 121.5

DEPTH FT.	SYMBOL	SAMPLES	DESCRIPTION OF MATERIAL SURFACE ELEVATION: 195.9	SOIL GROUP	MOISTURE CONTENT (%) PL — LL (10 20 30 40 50 60 70)	PERCENT PASSING NO. 200 SIEVE	NO. OF BLOWS PER 6-IN.	%TCR	%RQD
75			Wet, Medium Dense, Gray Well Graded Sand with Gravel and Trace Organic Matter	SW		3	5 6-7		
80			Wet, Medium Dense, Gray Sand with Some Gravel	-			8 11-14		
85			Wet, Medium Dense, Gray Poorly Graded Sand with Some Gravel and Trace Organic Matter	SP		3	5 8-9		
90			Wet, Medium Dense, Gray Sand with Trace Gravel	-			4 11-10		
95			Wet, Dense, Gray Poorly Graded Sand with Trace Gravel	SP -		3	10 16-15		
100			Wet, Medium Dense, Gray Well Graded Sand with Gravel	SW		3	9 13-16		
105			Wet, Very Dense, Gray Gravel with Sand (No sample recovered)	-			40 (2")		

REMARKS: *Water level on October 28, 2024 was 11.5 feet below ground level.

ARKANSAS DEPARTMENT OF TRANSPORTATION
MATERIALS DIVISION - GEOTECHNICAL SECTION

BORING NO. 2
PAGE 4 OF 4

JOB NO. 110861 Cross County
JOB NAME: St. Francis River Str. & Apprs. (Coldwater) (S)
Route 42, Section 3
STATION: 38+80
LOCATION: 67' Right of Construction Centerline
LOGGED BY: Stanley Bates

DATE: October 22-23, 2024
TYPE OF DRILLING:
Hollow Stem Auger-Rotary Wash
EQUIPMENT: Acker 2

HAMMER CORRECTION FACTOR: 1.55

COMPLETION DEPTH: 121.5

DEPTH FT.	SYMBOL	SAMPLES	DESCRIPTION OF MATERIAL SURFACE ELEVATION: 195.9	SOIL GROUP	MOISTURE CONTENT (%) PL — LL (10 20 30 40 50 60 70)	PERCENT PASSING NO. 200 SIEVE	NO. OF BLOWS PER 6-IN.	% TCR	% RQD
110			Wet, Medium Dense, Gray Silty Gravel with Sand	GM -		34	3 7-12		
115			Wet, Medium Dense, Gray Poorly Graded Sand with Gravel	SP -		3	3 4-15		
120			Wet, Medium Dense, Gray Sand with Silt and Trace Gravel	SP-SM -		10	5 10-9		
			Wet, Medium Dense, Gray Poorly Graded Sand with Silt and Gravel	SP-SM		5	9 14-12		
125			Boring Terminated						
130									
135									
140									

REMARKS: *Water level on October 28, 2024 was 11.5 feet below ground level.

ARKANSAS DEPARTMENT OF TRANSPORTATION
MATERIALS DIVISION - GEOTECHNICAL SECTION

BORING NO. 3
PAGE 1 OF 4

JOB NO. 110861 Cross County
JOB NAME: St. Francis River Str. & Apprs. (Coldwater) (S)
Route 42, Section 3
STATION: 40+97
LOCATION: Construction Centerline
LOGGED BY: Stanley Bates

DATE: October 14-16, 2024
TYPE OF DRILLING:
Hollow Stem Auger-Rotary Wash
EQUIPMENT: CME 75

HAMMER CORRECTION FACTOR: 1.57

COMPLETION DEPTH: 121.5

DEPTH FT.	SYMBOL	SAMPLES	DESCRIPTION OF MATERIAL	SOIL GROUP	MOISTURE CONTENT (%) PL — LL (10 20 30 40 50 60 70)	PERCENT PASSING NO. 200 SIEVE	NO. OF BLOWS PER 6-IN.	% TCR	% RQD
			SURFACE ELEVATION: 214.9						
			Asphalt	-					
			Base						
			Moist, Medium Stiff, Dark Gray Fat Clay	CH		99	2 2-4		
				-					
5			Moist, Medium Stiff, Dark Gray Lean Clay	CL		99	2 3-5		
				-					
			Moist, Medium Stiff, Dark Gray Fat Clay	CH		99	1 3-4		
				-					
10			Moist, Stiff, Dark Gray Lean Clay	CL		97	4 5-8		
				-					
15			Moist, Dark Brown Sandy Lean Clay	CL		51			
			Wet, Soft, Dark Gray Sandy Lean Clay	CL		58	0 1-1		
				-					
20			Wet, Dark Brown Sandy Lean Clay	CL		52			
			Wet, Very Soft, Dark Brown Sandy Lean Clay	CL		69	0 0-0		
				-					
25				CL		71	0 0-0		
				-					
30			Wet, Loose, Brown Poorly Graded Sand with Silt	SP-SM		5	2 4-6		
				-					
35									

REMARKS:

ARKANSAS DEPARTMENT OF TRANSPORTATION
MATERIALS DIVISION - GEOTECHNICAL SECTION

BORING NO. 3
PAGE 2 OF 4

JOB NO. 110861 Cross County
JOB NAME: St. Francis River Str. & Apprs. (Coldwater) (S)
Route 42, Section 3
STATION: 40+97
LOCATION: Construction Centerline
LOGGED BY: Stanley Bates

DATE: October 14-16, 2024
TYPE OF DRILLING:
Hollow Stem Auger-Rotary Wash
EQUIPMENT: CME 75

HAMMER CORRECTION FACTOR: 1.57

COMPLETION DEPTH: 121.5

DEPTH FT.	SYMBOL	SAMPLES	DESCRIPTION OF MATERIAL	SOIL GROUP	MOISTURE CONTENT (%) PL — LL (10 20 30 40 50 60 70)	PERCENT PASSING NO. 200 SIEVE	NO. OF BLOWS PER 6-IN.	%TCR	%RQD
			SURFACE ELEVATION: 214.9						
40			Wet, Very Loose, Brown Poorly Graded Sand with Silt	SP-SM		9	2 1-1		
			Wet, Soft, Dark Brown Sandy Clay	-					
45			Wet, Medium Dense, Gray Poorly Graded Sand with Silt	SP-SM		12	3 5-8		
				-					
50			Wet, Medium Dense, Gray Poorly Graded Sand with Silt	SP-SM		5	4 10-16		
				-					
55				SP-SM		6	7 9-12		
				-					
60			Wet, Medium Dense, Gray Poorly Graded Sand	SP		4	6 8-11		
				-					
65			Wet, Medium Dense, Gray Poorly Graded Sand with Silt	SP-SM		7	4 7-10		
				-					
70			Wet, Medium Dense, Gray Poorly Graded Sand with Silt, Trace Gravel, and Trace Organic Matter	SP-SM		6	6 13-10		
				-					

REMARKS:

ARKANSAS DEPARTMENT OF TRANSPORTATION
MATERIALS DIVISION - GEOTECHNICAL SECTION

BORING NO. 3
PAGE 3 OF 4

JOB NO. 110861 Cross County
JOB NAME: St. Francis River Str. & Apprs. (Coldwater) (S)
Route 42, Section 3
STATION: 40+97
LOCATION: Construction Centerline
LOGGED BY: Stanley Bates

DATE: October 14-16, 2024
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Hollow Stem Auger-Rotary Wash
EQUIPMENT: CME 75

HAMMER CORRECTION FACTOR: 1.57

COMPLETION DEPTH: 121.5

DEPTH FT.	SYMBOL	SAMPLES	DESCRIPTION OF MATERIAL	SOIL GROUP	MOISTURE CONTENT (%) PL — LL (10 20 30 40 50 60 70)	PERCENT PASSING NO. 200 SIEVE	NO. OF BLOWS PER 6-IN.	%TCR	%RQD
			SURFACE ELEVATION: 214.9						
75			Wet, Medium Dense, Gray Poorly Graded Sand with Gravel	SP -		4	10 16-11		
80			Wet, Dense, Gray Poorly Graded Sand with Silt, Some Gravel, and Trace Organic Matter	SP-SM -		5	10 15-16		
85			Wet, Dense, Gray Well Graded Sand with Silt and Some Gravel	SW-SM -		7	12 16-20		
90			Wet, Medium Dense, Gray Poorly Graded Sand with Some Gravel and Trace Organic Matter	SP -		2	4 6-11		
95			Wet, Medium Dense, Gray Poorly Graded Sand with Silt and Some Gravel	SP-SM -		11	8 12-15		
100			Wet, Dense, Gray Poorly Graded Sand with Some Gravel	SP -		4	16 18-18		
105			Wet, Medium Dense, Gray Poorly Graded Sand	SP -		3	4 11-14		

REMARKS:

ARKANSAS DEPARTMENT OF TRANSPORTATION
MATERIALS DIVISION - GEOTECHNICAL SECTION

BORING NO. 3
PAGE 4 OF 4

JOB NO. 110861 Cross County
JOB NAME: St. Francis River Str. & Apprs. (Coldwater) (S)
Route 42, Section 3
STATION: 40+97
LOCATION: Construction Centerline
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HAMMER CORRECTION FACTOR: 1.57

COMPLETION DEPTH: 121.5

DEPTH FT.	SYMBOL	SAMPLES	DESCRIPTION OF MATERIAL	SOIL GROUP	MOISTURE CONTENT (%) PL 10 20 30 40 50 60 70 LL	PERCENT PASSING NO. 200 SIEVE	NO. OF BLOWS PER 6-IN.	% TCR	% RQD
			SURFACE ELEVATION: 214.9						
				SP		3	5 12-11		
				-					
110			Wet, Medium Dense, Gray Poorly Graded Sand with Gravel	SP		3	6 11-8		
				-					
115				SP-SM		5	17 20-25		
			Wet, Dense, Gray Poorly Graded Sand with Silt	-					
120									
			Wet, Very Dense, Gray Poorly Graded Sand with Silt	SP-SM		7	20 27-36		
			Boring Terminated						
125									
130									
135									
140									

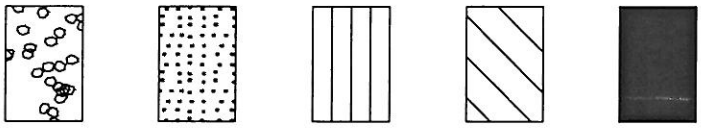
REMARKS:

LEGEND

SOIL TYPES

(SHOWN IN SYMBOL COLUMN)

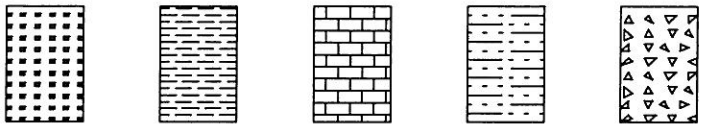
(PREDOMINANT TYPE SHOWN HEAVY)



GRAVEL | SAND | SILT | CLAY | ORGANIC MATTER

ROCK TYPES

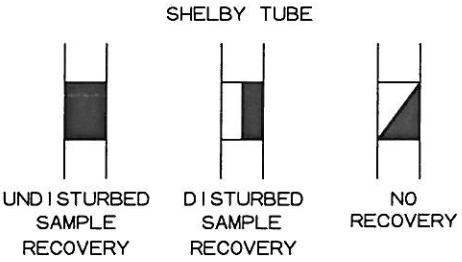
(SHOWN IN SYMBOL COLUMN)



SANDSTONE | SHALE or SILTSTONE | LIMESTONE or DOLOMITE | ALTERNATING LAYERS of SHALE and SANDSTONE | OTHER

SAMPLER TYPES

(SHOWN IN SAMPLE COLUMN)



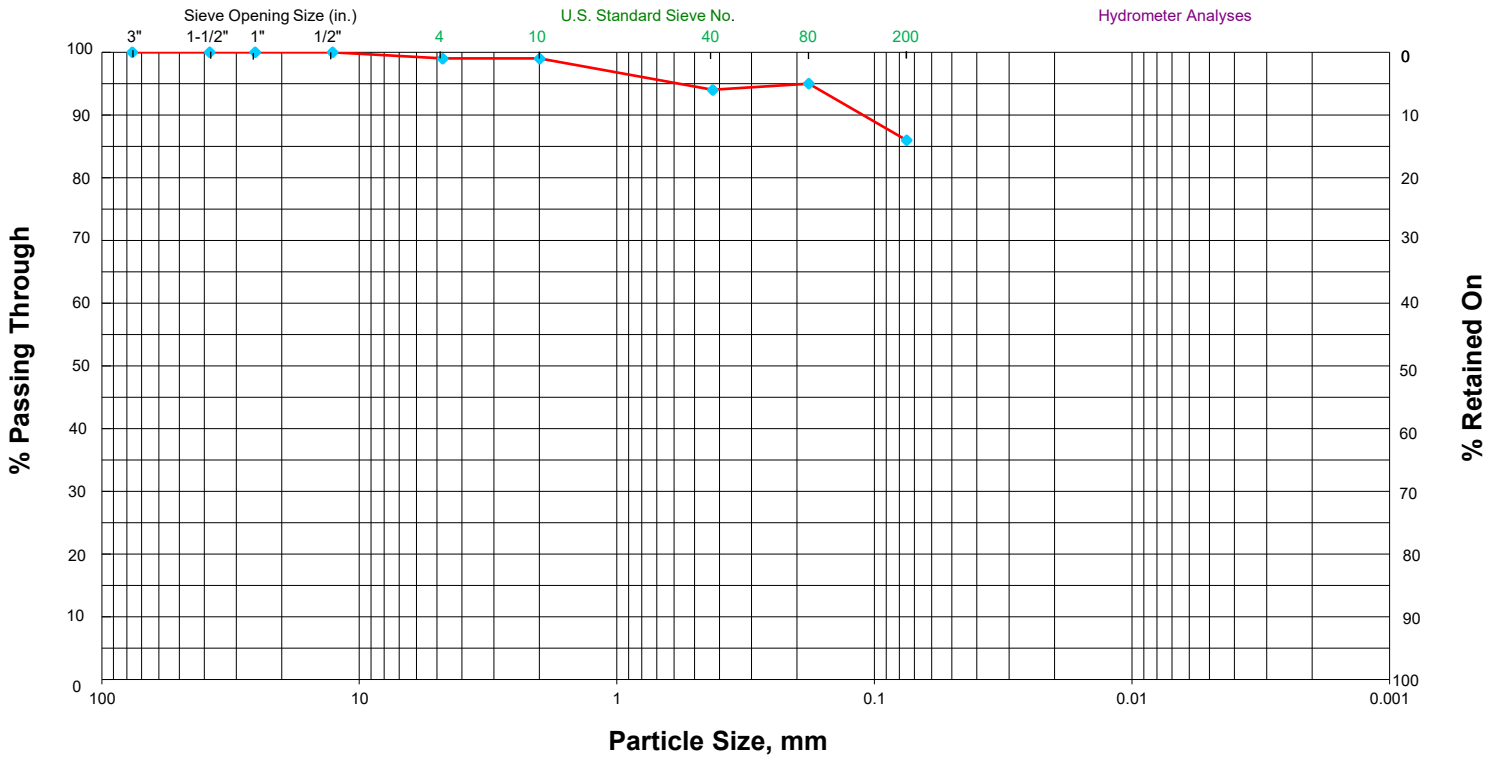
TERMS DESCRIBING CONSISTENCY OR CONDITION

GRANULAR SOIL		CLAY		CLAY-SHALE		SHALE	
'N' Value	Density	'N' Value	Consistency	'N' Value	Consistency	'N' Value	Consistency
0-4	Very Loose	0-1	Very Soft	0-1	Very Soft		
5-10	Loose	2-4	Soft	2-4	Soft	31-60	Soft
11-30	Medium Dense	5-8	Medium Stiff	5-8	Medium Stiff	Over 60	
31-50	Dense	9-15	Stiff	9-15	Stiff	More than 2'	
Over 50	Very Dense	16-30	Very Stiff	16-30	Very Stiff	Penetration	
		31-60	Hard	31-60	Hard	in 60 Blows:	Medium Hard
		Over 60	Very Hard	Over 60	Very Hard	Less than 2'	
						Penetration	
						in 60 Blows:	Hard

1. Ground water elevations indicated on boring logs represent ground water elevations at date or time shown on boring log. Absence of water surface implies that no ground water data is available but does not necessarily mean that ground water will not be encountered at locations or within the vertical reaches of these borings.
2. Borings represent subsurface conditions at their respective locations for their respective depths. Variations in conditions between or adjacent to boring locations may be encountered.
3. Terms used for describing soils according to their texture or grain size distribution are in accordance with the Unified Soil Classification System.

Standard Penetration Test – Driving a 2.0" O.D., 1-3/8" I.D. sampler a distance of 1.0 foot into undisturbed soil with a 140 pound hammer free falling a distance of 30 inches. It is customary to drive the spoon 6.0 inches to seat into undisturbed soil, then perform the test. The number of hammer blows for seating the spoon and performing the test are recorded for each 6 inches of penetration on the drill log. The field "N" Value (N_f) can be obtained by adding the bottom two numbers for example: $\frac{6}{8-9} \Rightarrow 8+9=17 blows/ft$. The "N" Value corrected to 60% efficiency (N_{60}) can be obtained by multiplying N_f by the hammer correction factor published on the boring log.

Attachment B



Particle Size Distribution Curve for D_{50} Sample

Station 38+27, 32' Lt of CL

Attachment C

SITE PICTURES

Job No.: 110861
Job Name: St. Francis River Str. & Apprs. (Coldwater) (S)

South side of east bridge end looking northeast (Early October 2024 Before Demolition)

SITE PICTURES

Job No.: 110861
Job Name: St. Francis River Str. & Apprs. (Coldwater) (S)

Looking northwest from the east bridge end (Early October 2024 Before Demolition)

SITE PICTURES

Job No.: 110861
Job Name: St. Francis River Str. & Apprs. (Coldwater) (S)

South side of east bridge end looking north (Late October 2024 During Demolition)

SITE PICTURES

Job No.: 110861
Job Name: St. Francis River Str. & Apprs. (Coldwater) (S)

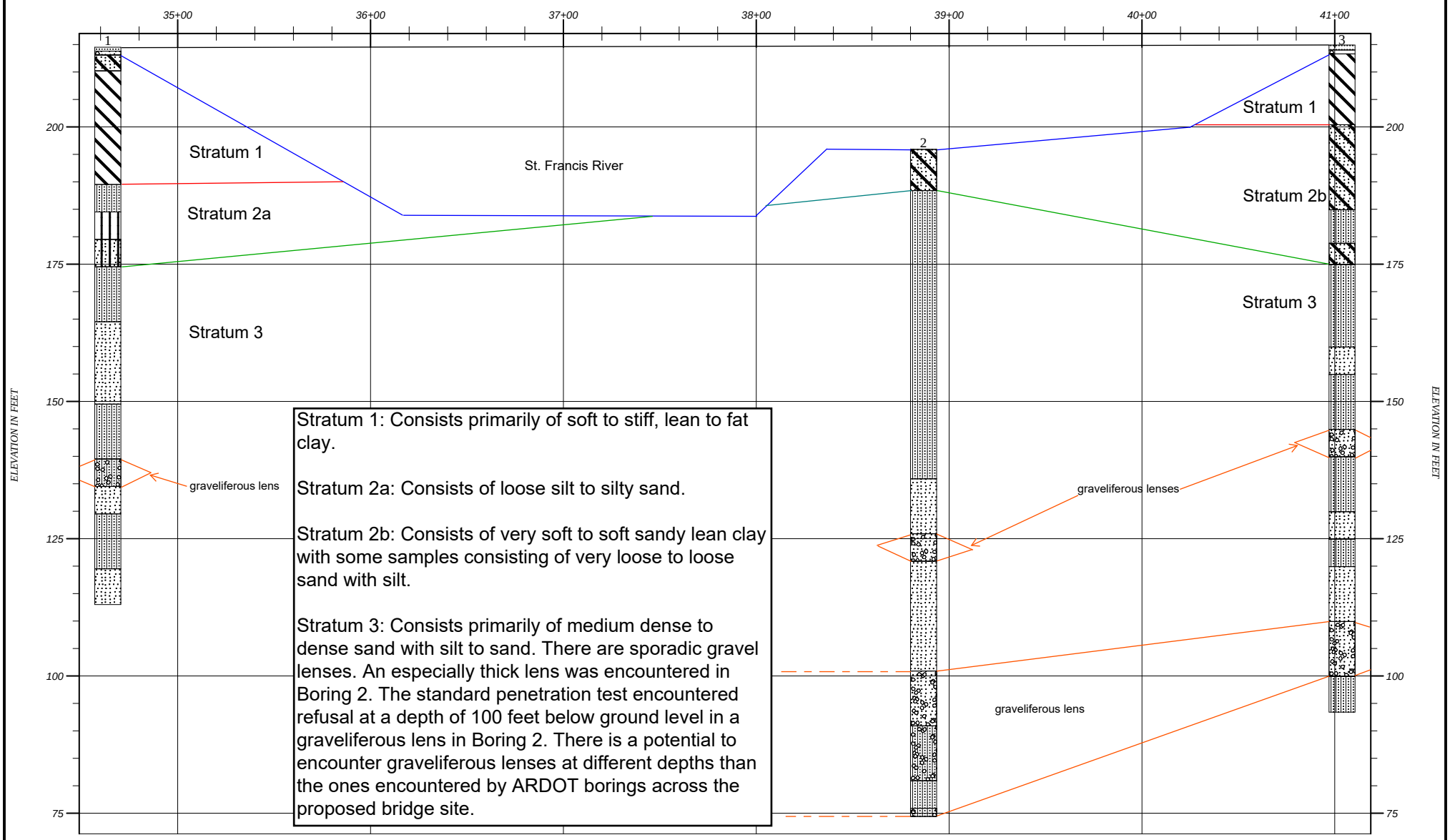
South side of east bridge end looking west (Late October 2024 During Demolition)

SITE PICTURES

Job No.: 110861
Job Name: St. Francis River Str. & Apprs. (Coldwater) (S)

South side of collapsed bridge looking northwest towards west bridge end (Late October 2024 During Demolition)

Attachment D



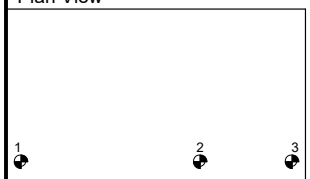
Stratum 1: Consists primarily of soft to stiff, lean to fat clay.

Stratum 2a: Consists of loose silt to silty sand.

Stratum 2b: Consists of very soft to soft sandy lean clay with some samples consisting of very loose to loose sand with silt.

Stratum 3: Consists primarily of medium dense to dense sand with silt to sand. There are sporadic gravel lenses. An especially thick lens was encountered in Boring 2. The standard penetration test encountered refusal at a depth of 100 feet below ground level in a graveliferous lens in Boring 2. There is a potential to encounter graveliferous lenses at different depths than the ones encountered by ARDOT borings across the proposed bridge site.

Plan View



Strata symbols

- Asphalt
- sand and gravel
- sandy clay
- clay
- silty sand
- silt/cemented silt
- sandy silt
- sand
- silty sand with gravel
- gravel

Arkansas Department of Transportation

Generalized Subsurface Profile

HORIZONTAL SCALE: Not to scale	DRAWN BY/APPROVED BY	DATE DRAWN
VERTICAL SCALE: Not to scale	James Carson Sloan/Masan Brown	11/19/2024

St. Francis River Str. & Apprs. (Coldwater) (S)

Route 42, Section 3

PROJECT NO. 110861

Cross County

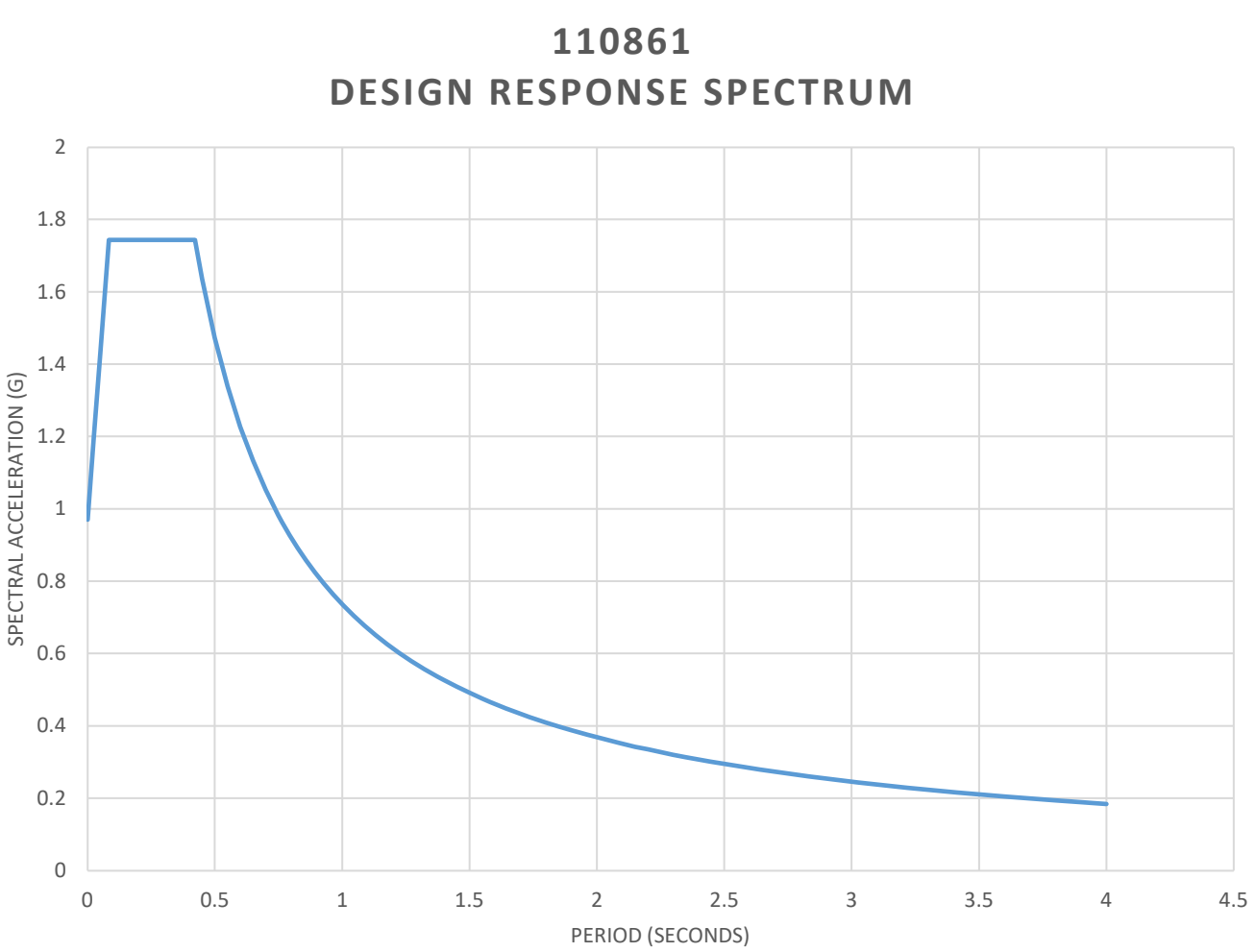
FIGURE NUMBER

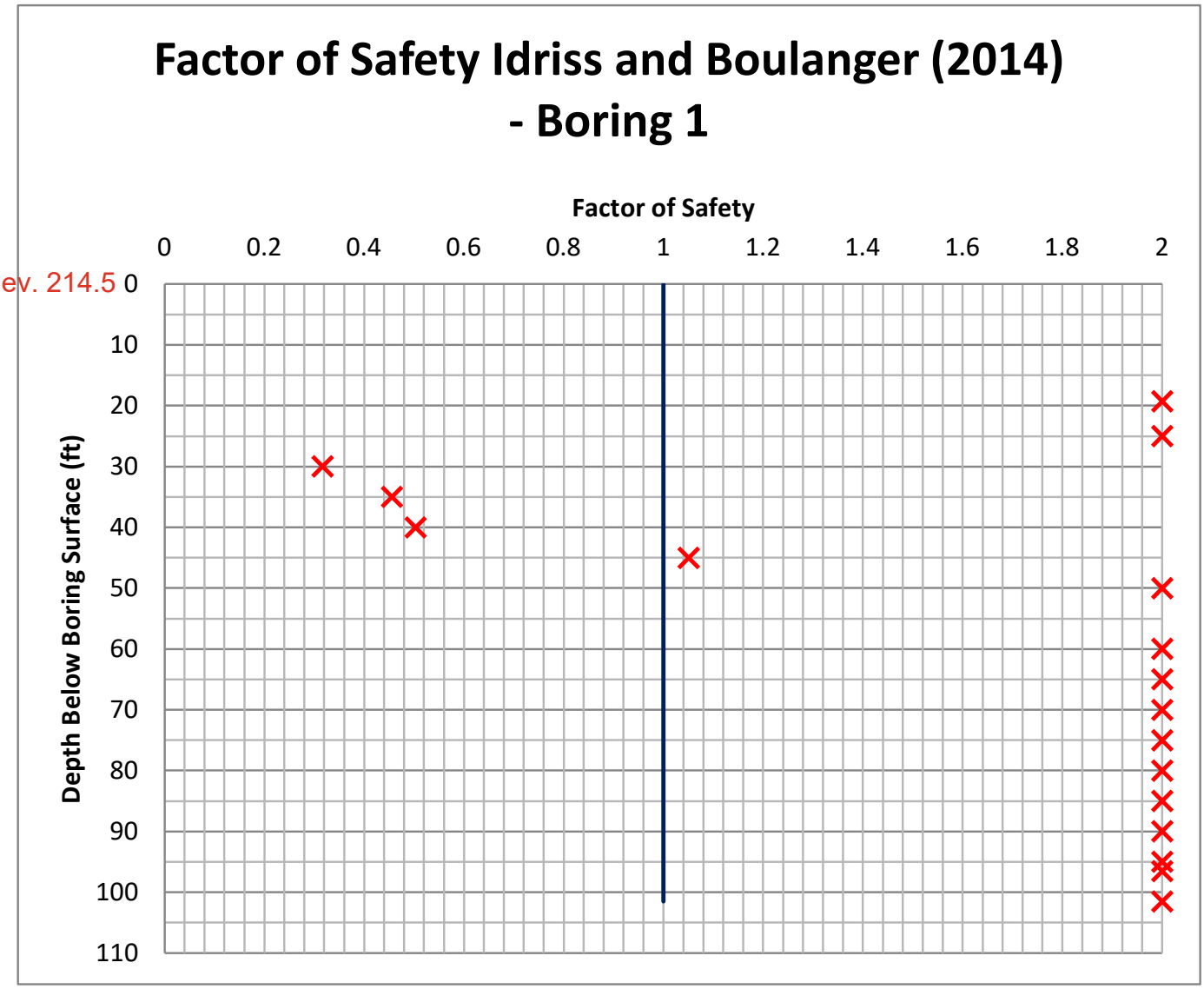
Attachment E

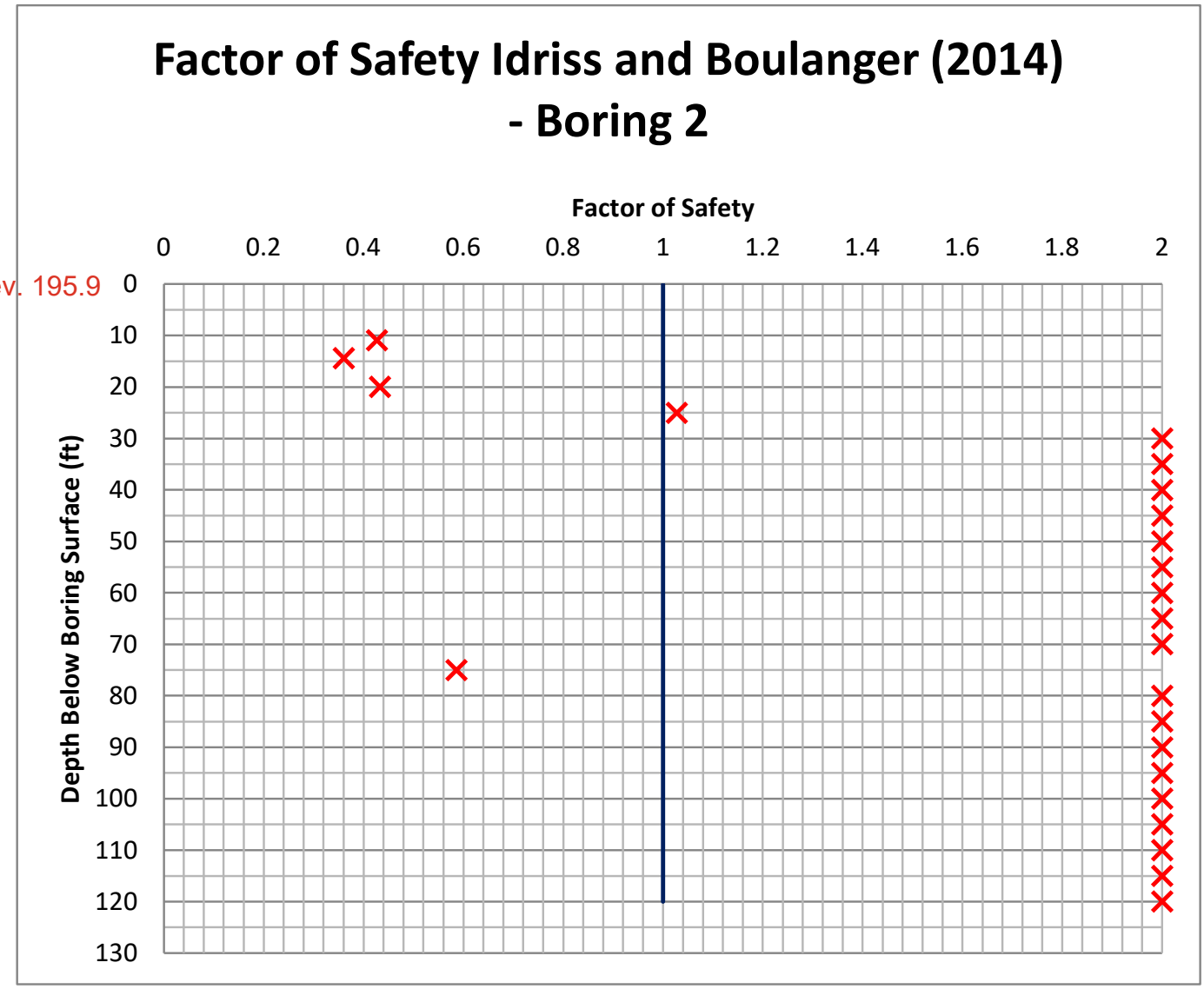
Title:	110861
Latitude:	35.364496
Longitude:	-90.576977
Site Class	D

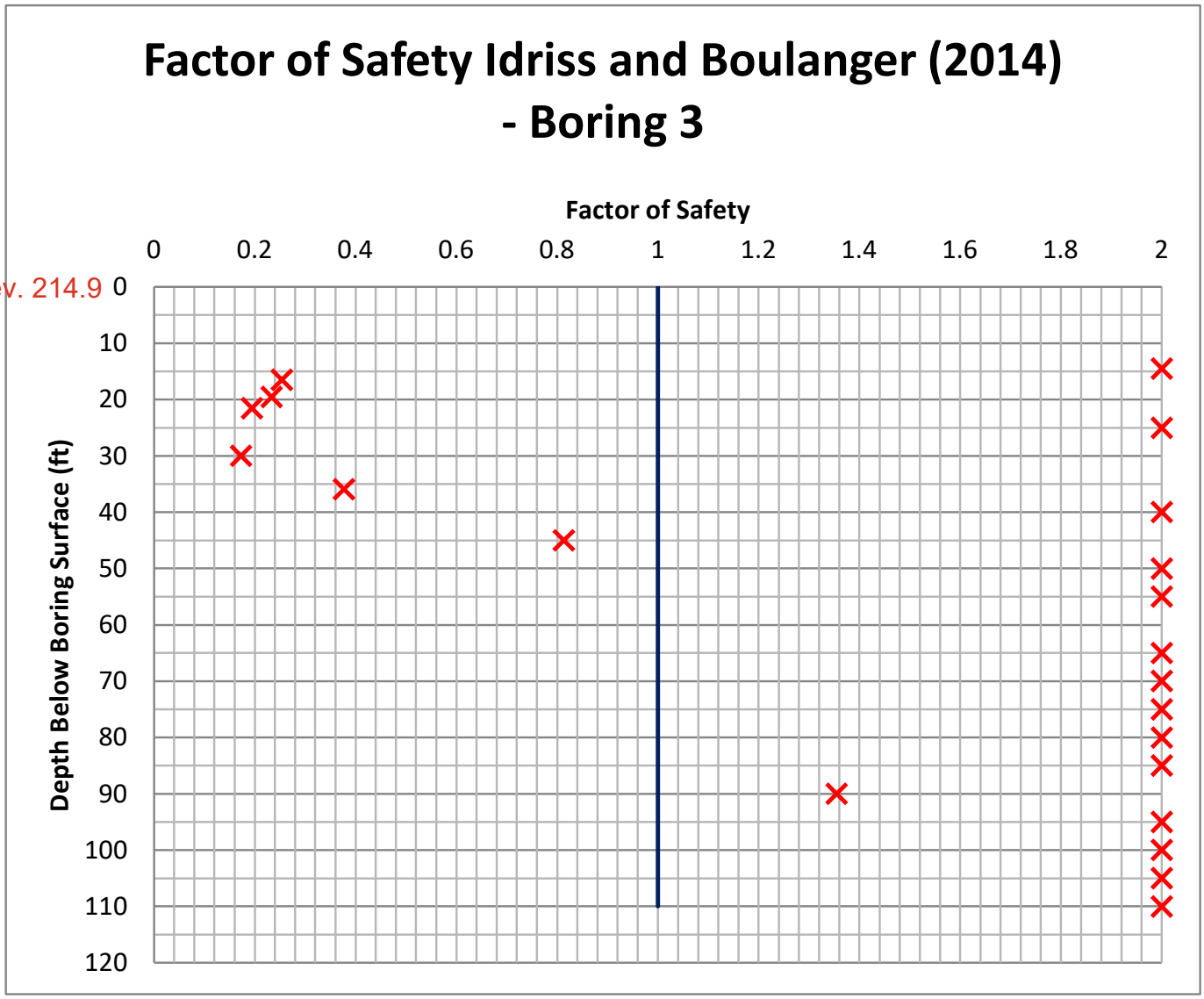
Get USGS Data

PGA:	0.97
F_{PGA}:	1
A_S:	0.97
S_S:	1.744
F_A:	1
S_{DS}:	1.744
S_1:	0.486
F_V:	1.514
S_{D1}:	0.736
S_{Dc}:	D
T_S:	0.422
T_0:	0.084



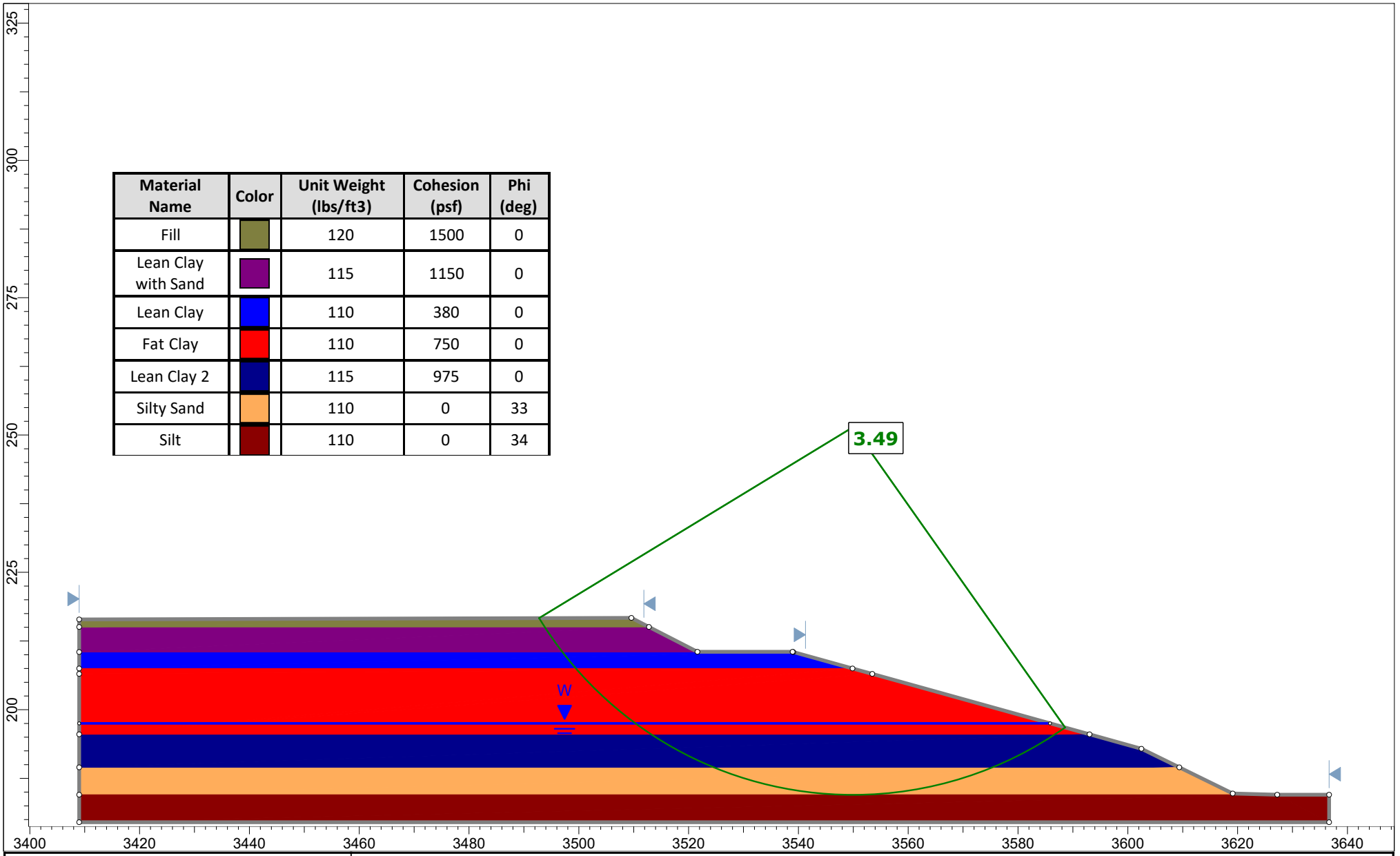

Factor of Safety Idriss and Boulanger (2014) - Boring 1
Factor of Safety
0
0.2
0.4
0.6
0.8
1
1.2
1.4
1.6
1.8
2
Elev. 214.5
Depth Below Boring Surface (ft)
0
10
20
30
40
50
60
70
80
90
100
110


Factor of Safety Idriss and Boulanger (2014) - Boring 2
Factor of Safety
0
0.2
0.4
0.6
0.8
1
1.2
1.4
1.6
1.8
2
Elev. 195.9
Depth Below Boring Surface (ft)
0
10
20
30
40
50
60
70
80
90
100
110
120
130


Factor of Safety Idriss and Boulanger (2014) - Boring 3
Factor of Safety
0
0.2
0.4
0.6
0.8
1
1.2
1.4
1.6
1.8
2
Elev. 214.9
Depth Below Boring Surface (ft)
0
10
20
30
40
50
60
70
80
90
100
110
120

Attachment G

Material Name	Color	Unit Weight (lbs/ft3)	Cohesion (psf)	Phi (deg)
Fill		120	1500	0
Lean Clay with Sand		115	1150	0
Lean Clay		110	380	0
Fat Clay		110	750	0
Lean Clay 2		115	975	0
Silty Sand		110	0	33
Silt		110	0	34

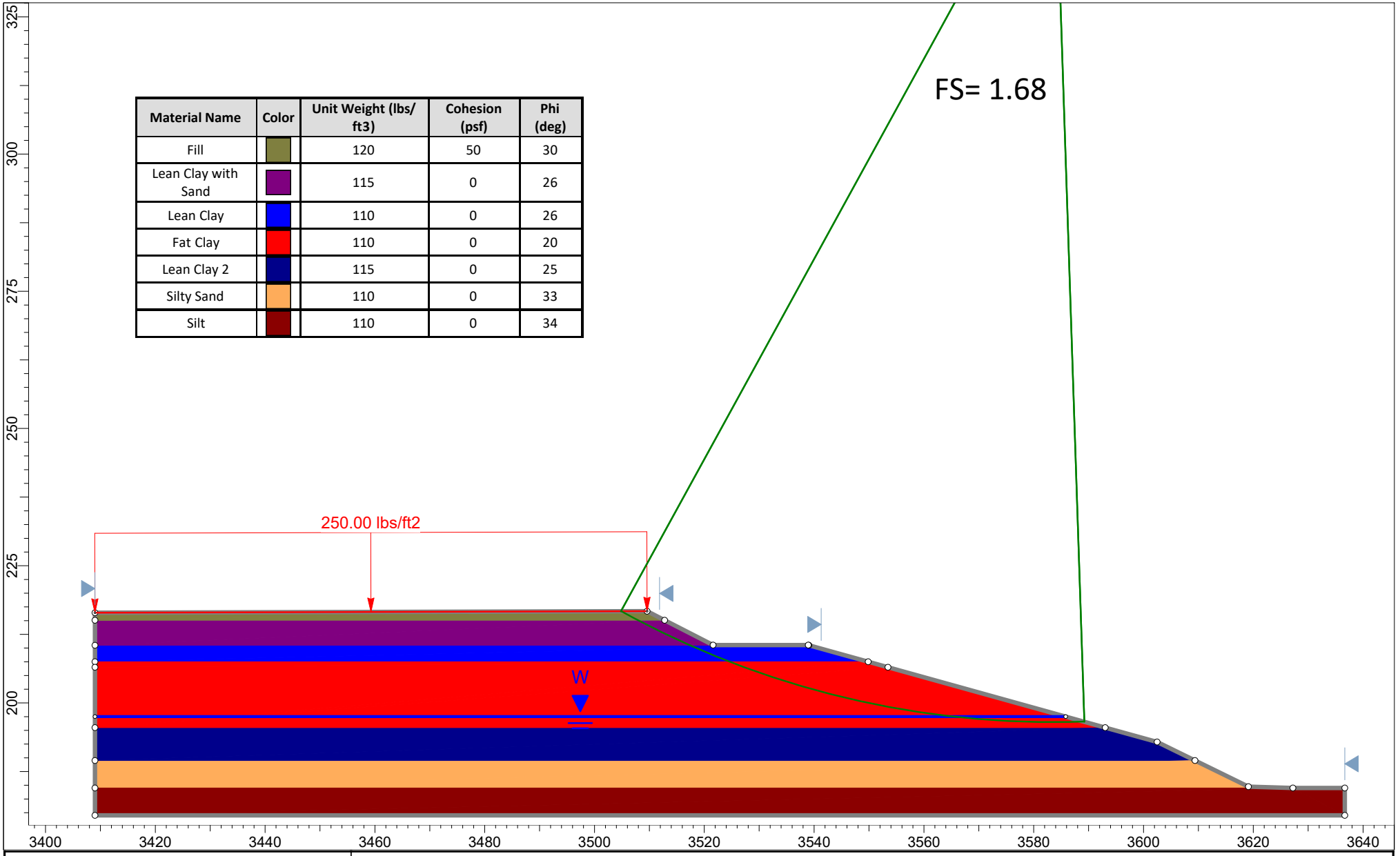


rocscience

SLIDEINTERPRET 9.019

Project	110861- Hwy. 42 over ST. FRANCIS RIVER		
Site	Site 1/1	Analysis Type	Short Term
Analyzed By	MBB	Configuration	West Abutment
Date	12/3/2024		

Material Name	Color	Unit Weight (lbs/ ft3)	Cohesion (psf)	Phi (deg)
Fill		120	50	30
Lean Clay with Sand		115	0	26
Lean Clay		110	0	26
Fat Clay		110	0	20
Lean Clay 2		115	0	25
Silty Sand		110	0	33
Silt		110	0	34

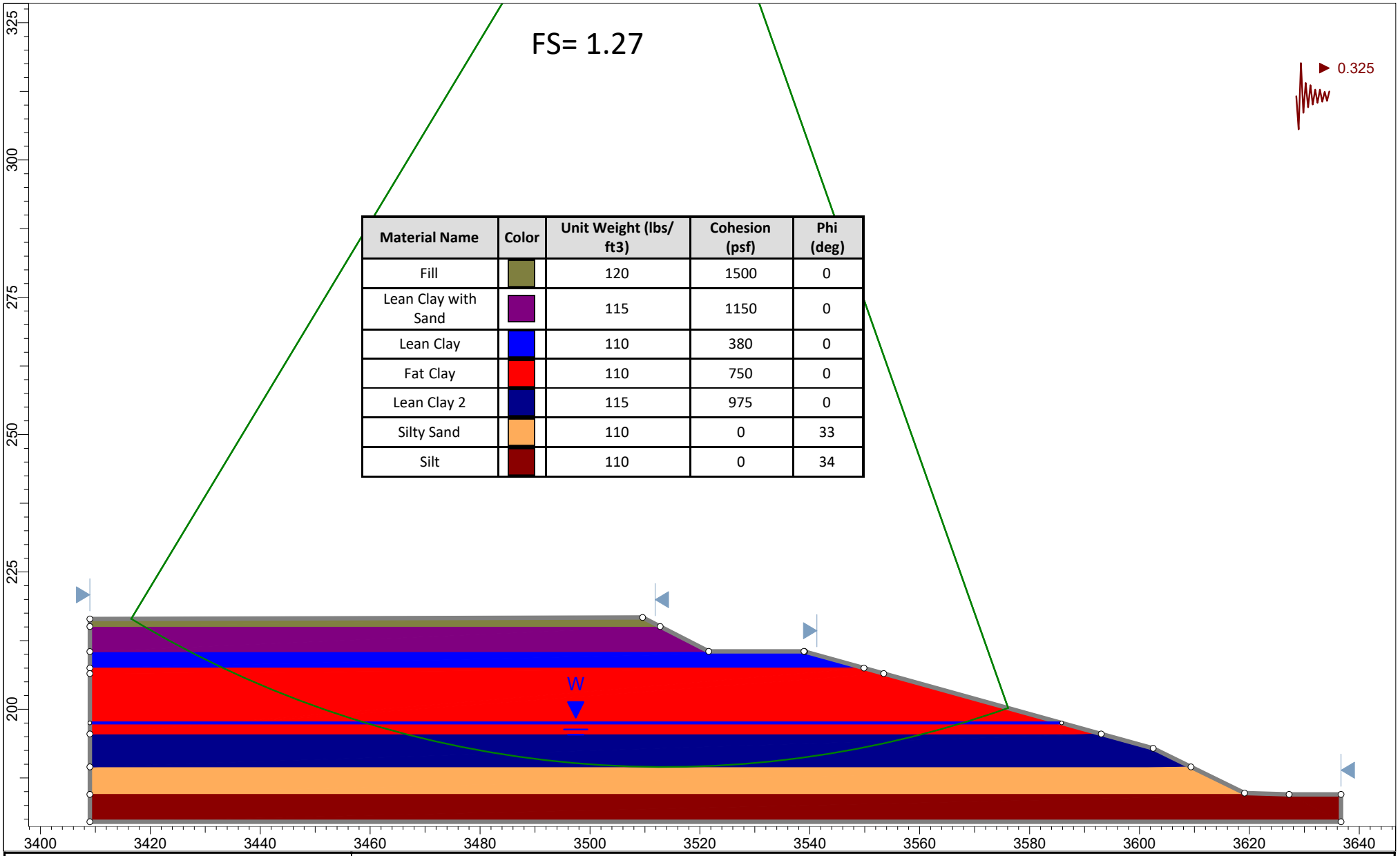


rocscience

SLIDEINTERPRET 9.019

Project	110861- Hwy. 42 over ST. FRANCIS RIVER		
Site	Site 1/1	Analysis Type	Long Term
Analyzed By	MBB	Configuration	West Abutment
Date	12/3/2024		

FS= 1.27

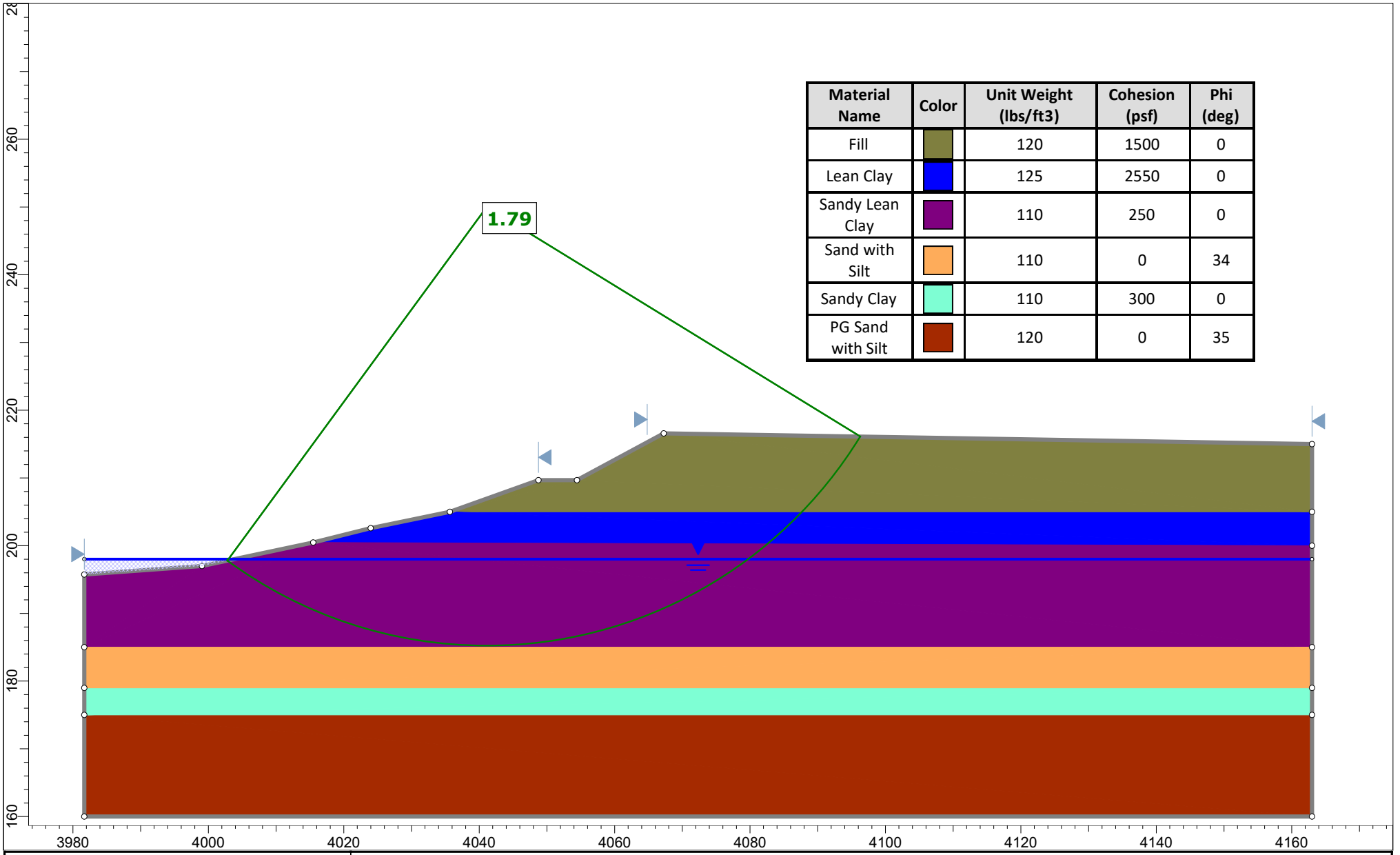


Material Name	Color	Unit Weight (lbs/ ft3)	Cohesion (psf)	Phi (deg)
Fill		120	1500	0
Lean Clay with Sand		115	1150	0
Lean Clay		110	380	0
Fat Clay		110	750	0
Lean Clay 2		115	975	0
Silty Sand		110	0	33
Silt		110	0	34

rocscience

SLIDEINTERPRET 9.019

Project	110861- Hwy. 42 over ST. FRANCIS RIVER		
Site	Site 1/1	Analysis Type	Seismic
Analyzed By	MBB	Configuration	West Abutment
Date	12/3/2024		

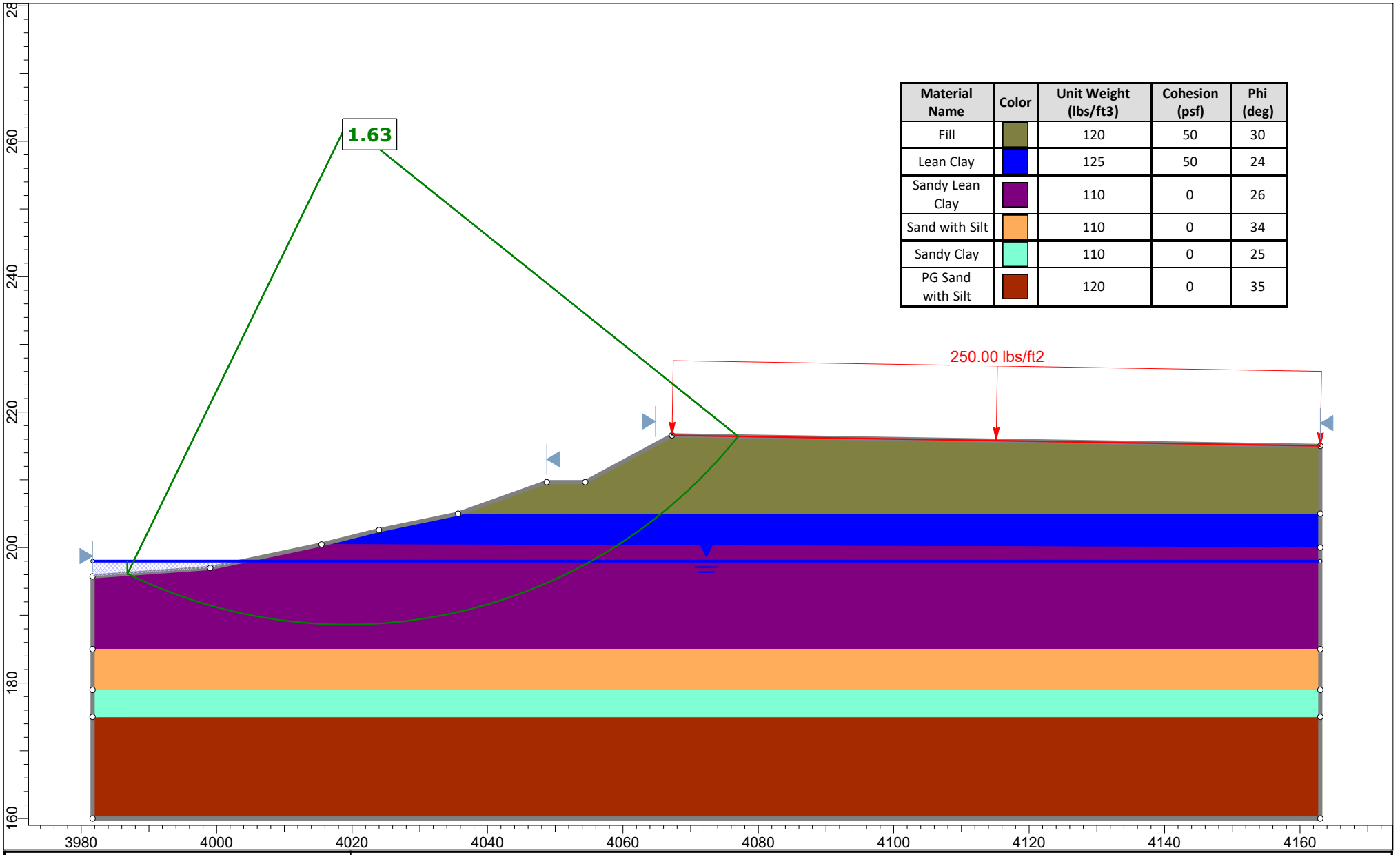


Material Name	Color	Unit Weight (lbs/ft3)	Cohesion (psf)	Phi (deg)
Fill		120	1500	0
Lean Clay		125	2550	0
Sandy Lean Clay		110	250	0
Sand with Silt		110	0	34
Sandy Clay		110	300	0
PG Sand with Silt		120	0	35

rocscience

SLIDEINTERPRET 9.019

Project	110861- Hwy. 42 over ST. FRANCIS RIVER		
Site	Site 1/1	Analysis Type	Short Term
Analyzed By	MBB	Configuration	East Abutment
Date	12/3/2024		



Material Name	Color	Unit Weight (lbs/ft3)	Cohesion (psf)	Phi (deg)
Fill		120	50	30
Lean Clay		125	50	24
Sandy Lean Clay		110	0	26
Sand with Silt		110	0	34
Sandy Clay		110	0	25
PG Sand with Silt		120	0	35

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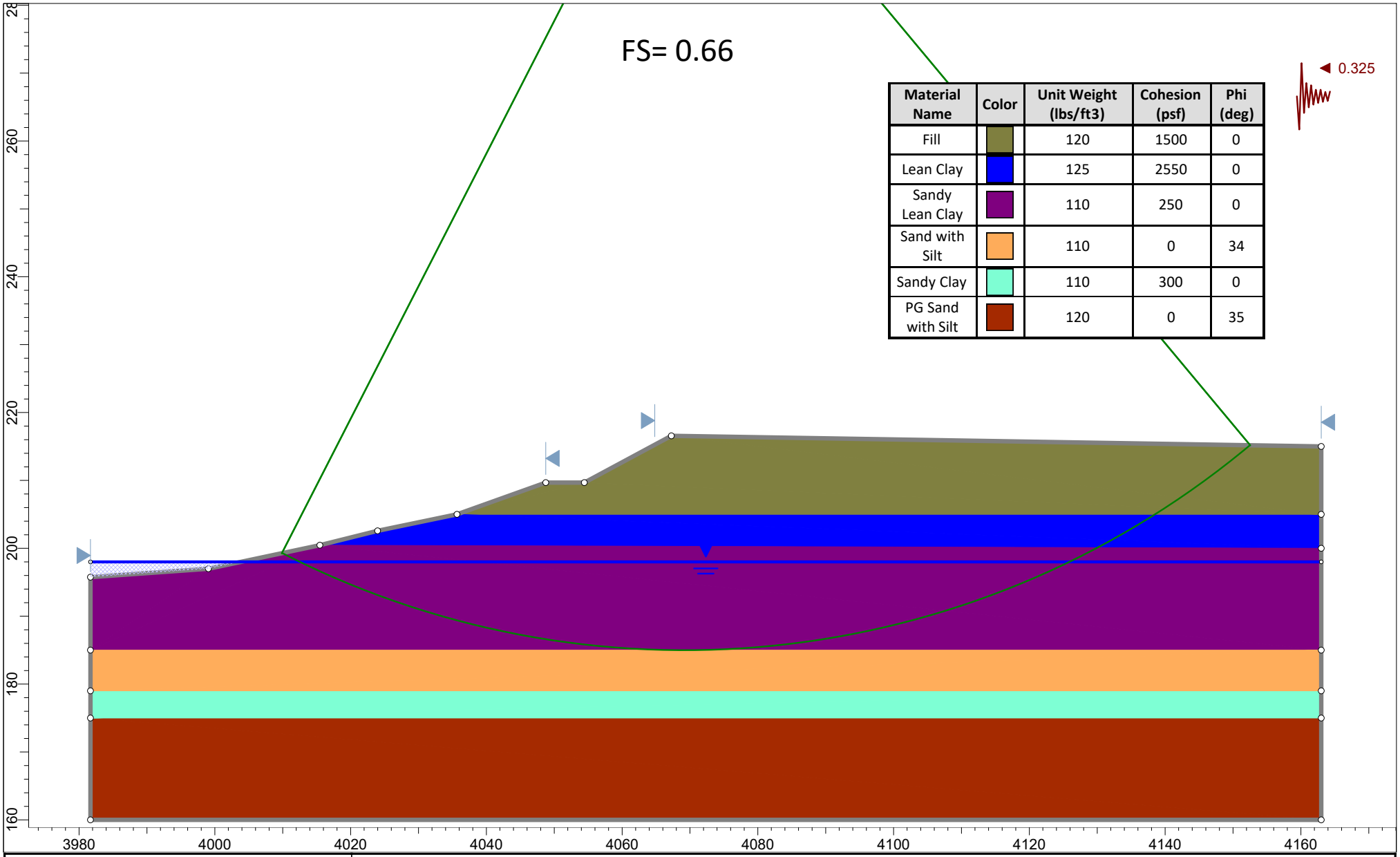
SLIDEINTERPRET 9.019

Project	110861- Hwy. 42 over ST. FRANCIS RIVER		
Site	Site 1/1	Analysis Type	Long Term
Analyzed By	MBB	Configuration	East Abutment
Date	12/3/2024		



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SLIDEINTERPRET 9.019

Project	110861- Hwy. 42 over ST. FRANCIS RIVER		
Site	Site 1/1	Analysis Type	Seismic
Analyzed By	MBB	Configuration	East Abutment
Date	12/3/2024		

Materials Division

Input By: MB 11/12/2024
Checked by: YZ 12/03/2024

NEWMARK'S DISPLACEMENT ANALYSIS METHOD (NDAM) - CALTRANS MEMO-TO-DESINERS (MTD) 20-15
Job No.: 110861

1. Seismic Parameters

1.1 Design Peak Ground Acceleration

1.1.1 General Procedure

$PGA := 0.97$ $F_{PGA} := 1.00$ $A_S := F_{PGA} \cdot PGA = 0.97$

1.1.2 Site-Specific Procedure

$HPGA := 0.647$

Horizontal peak ground acceleration coefficient - Page 4 of 24
Also k_{h_max}, amax, kmax, etc. - Page 2 of 24

$k_{h\_max} := HPGA$

Horizontal peak ground acceleration coefficient - Page 4 of 24

1.1.3 Adopted Value

$k_{h\_max} := \max\left(\frac{2}{3} A_S, k_{h\_max}\right) = 0.647$

Horizontal peak ground acceleration coefficient used for analysis

1.2 Other Seismic Parameters

$k_{h\_y} := 0.165$

Yield acceleration of the failure mass, i.e., the horizontal acceleration that results in a factor of safety of 1.0 in a pseudo-static limit equilibrium slope stability analysis, bckcalculated by using stability analysis software - Page 2 of 24

$M_w := 7.0$

Moment magnitude - Page 4 of 24

2. Newmark's Displacement (Lateral Spreading)

$a := -0.22 - 2.83 \ln\left(k_{h\_y}\right) - 0.333 \cdot \left(\ln\left(k_{h\_y}\right)\right)^2 = 3.798$

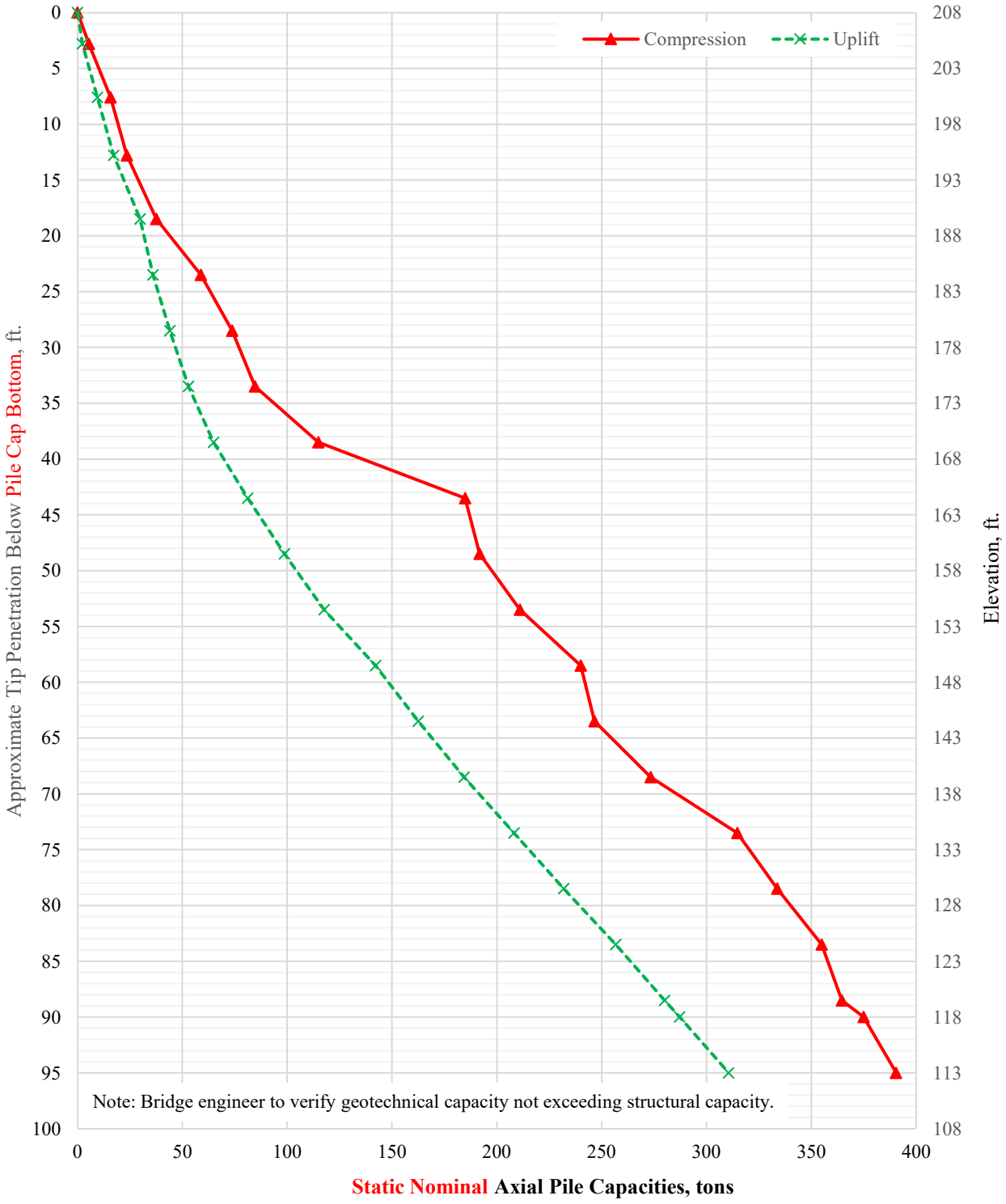
$b := 0.566 \ln\left(k_{h\_y}\right) \cdot \ln\left(HPGA\right) + 3.04 \cdot \ln\left(HPGA\right) = -0.88$

$c := -0.244 \cdot \left(\ln\left(HPGA\right)\right)^2 + 0.278 \cdot \left(M_w - 7\right) = -0.046$

$\Delta := 0.3937 \cdot \exp\left(a + b + c\right) \cdot in = 7.0\ in$

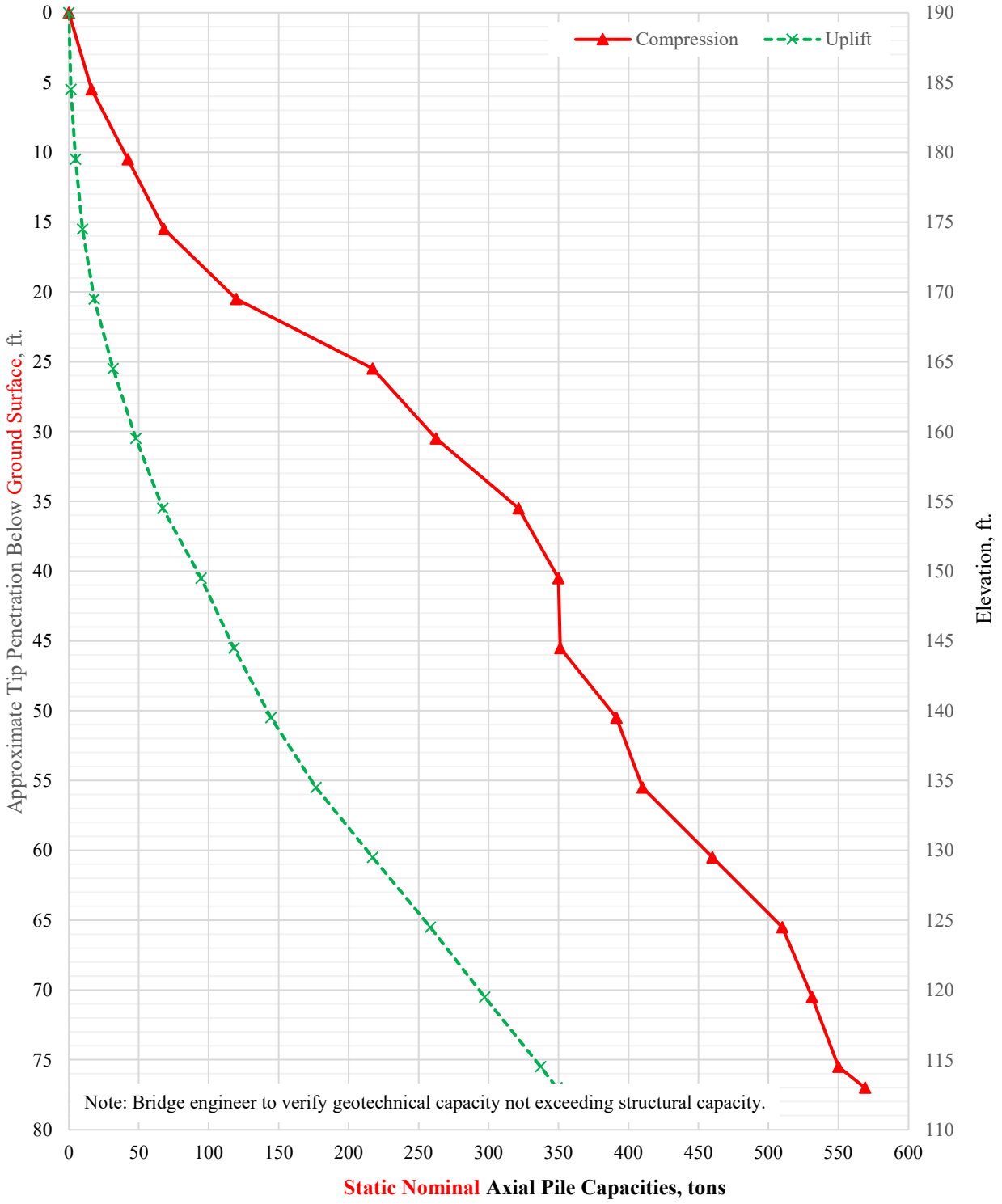
Estimated permanent displacement / lateral spreading (Eq. 1 - Page 3 of 24)

Attachment H



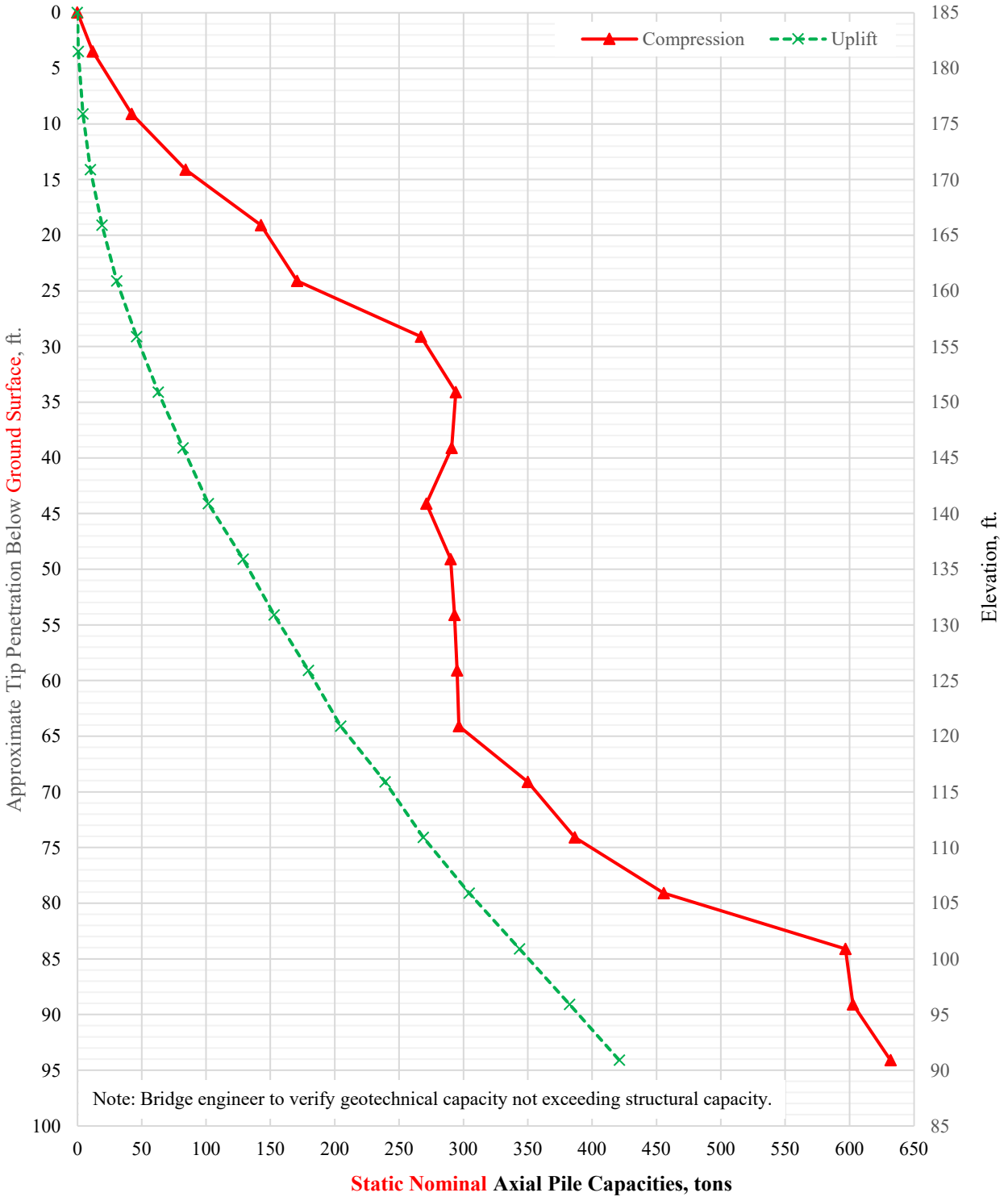
SINGLE 18"-DIAMETER CLOSED-END STEEL SHELL PILE

Bent 1
Project No.: 110861
Location: Cross County



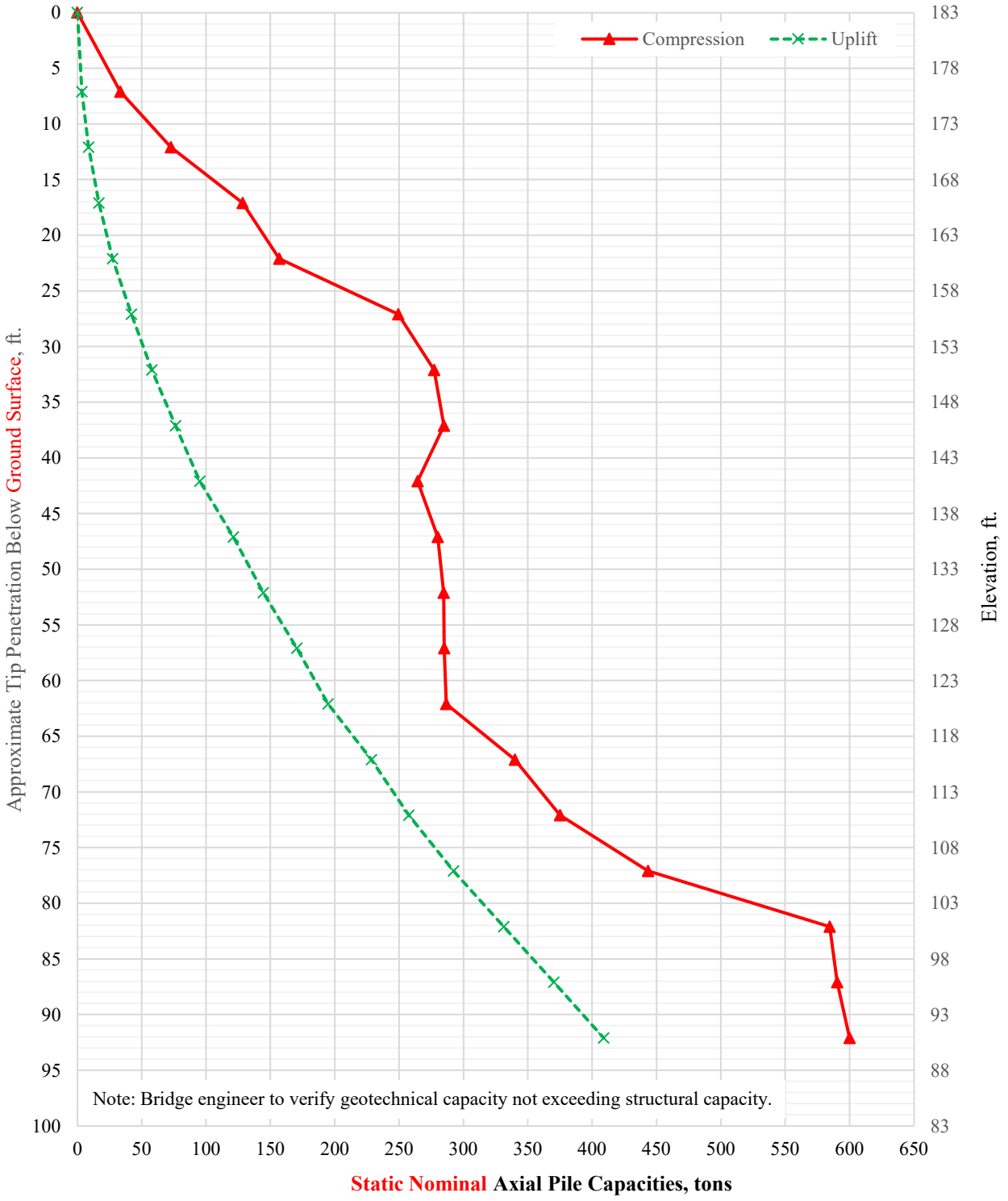
SINGLE 30"-DIAMETER CONCRETE FILLED STEEL SHELL PILE

Bent 2
Project No.: 110861
Location: Cross County



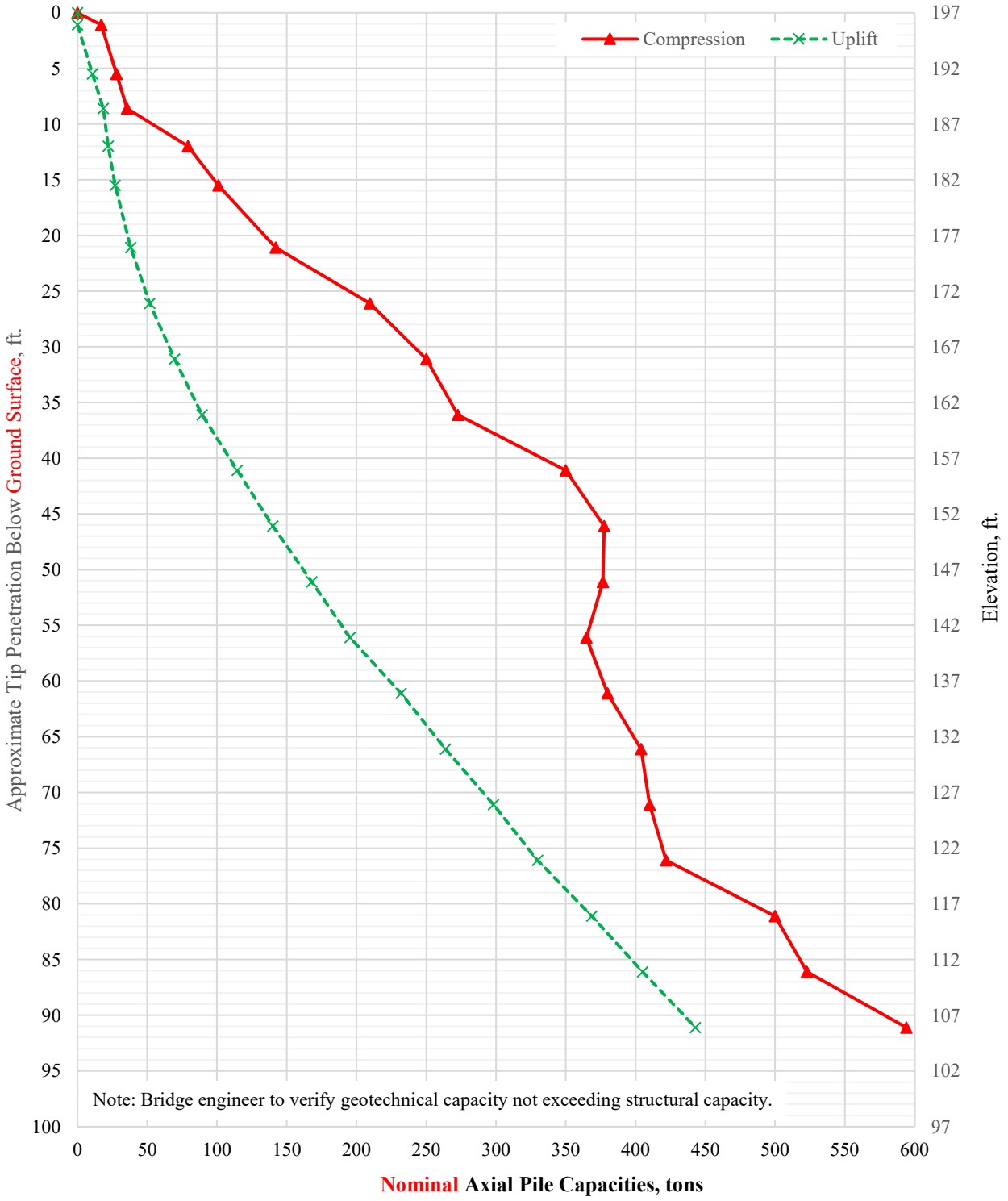
SINGLE 30"-DIAMETER CONCRETE FILLED STEEL SHELL PILE

Bent 3
Project No.: 110861
Location: Cross County



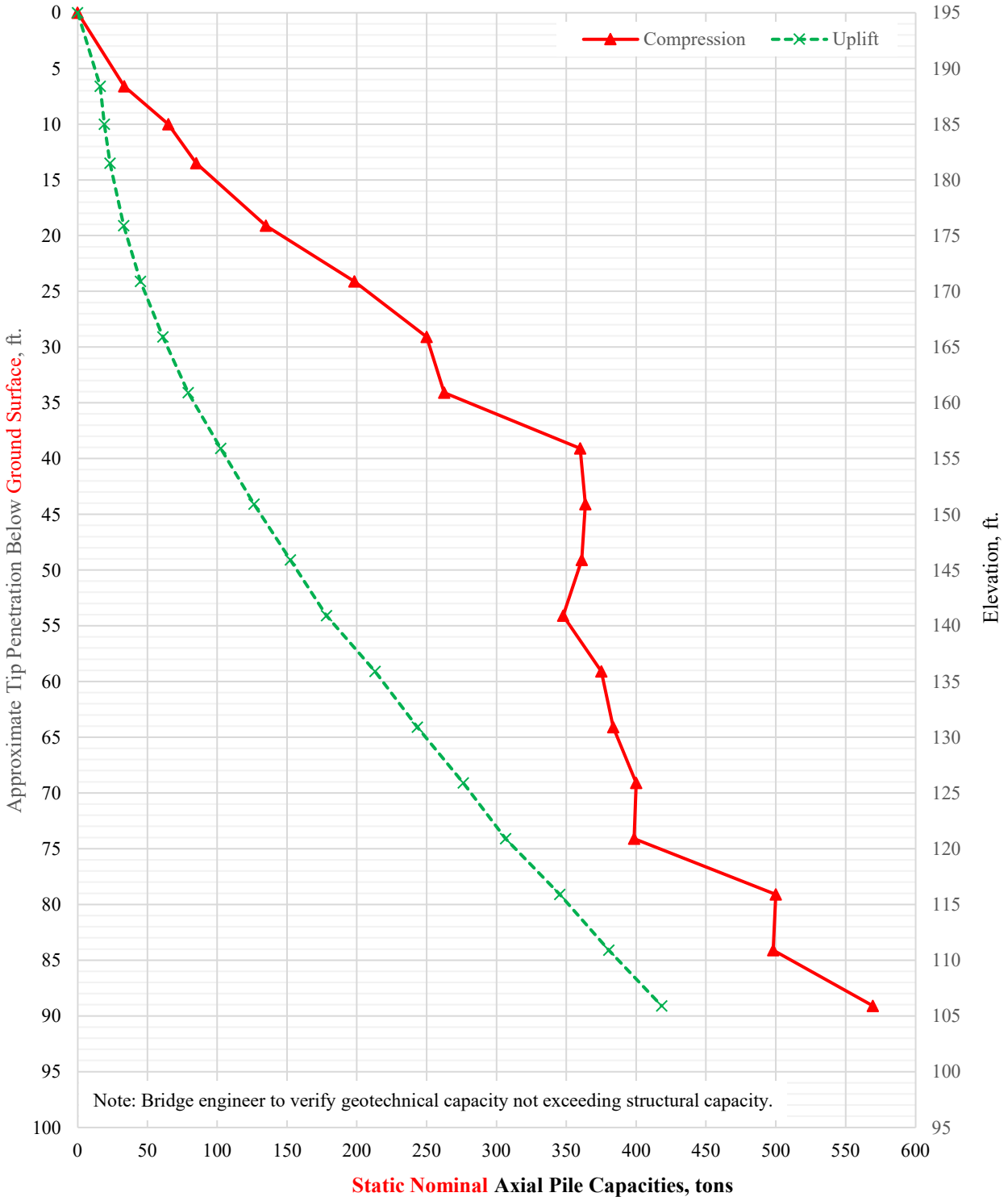
SINGLE 30"-DIAMETER CONCRETE FILLED STEEL SHELL PILE

Bent 4
Project No.: 110861
Location: Cross County



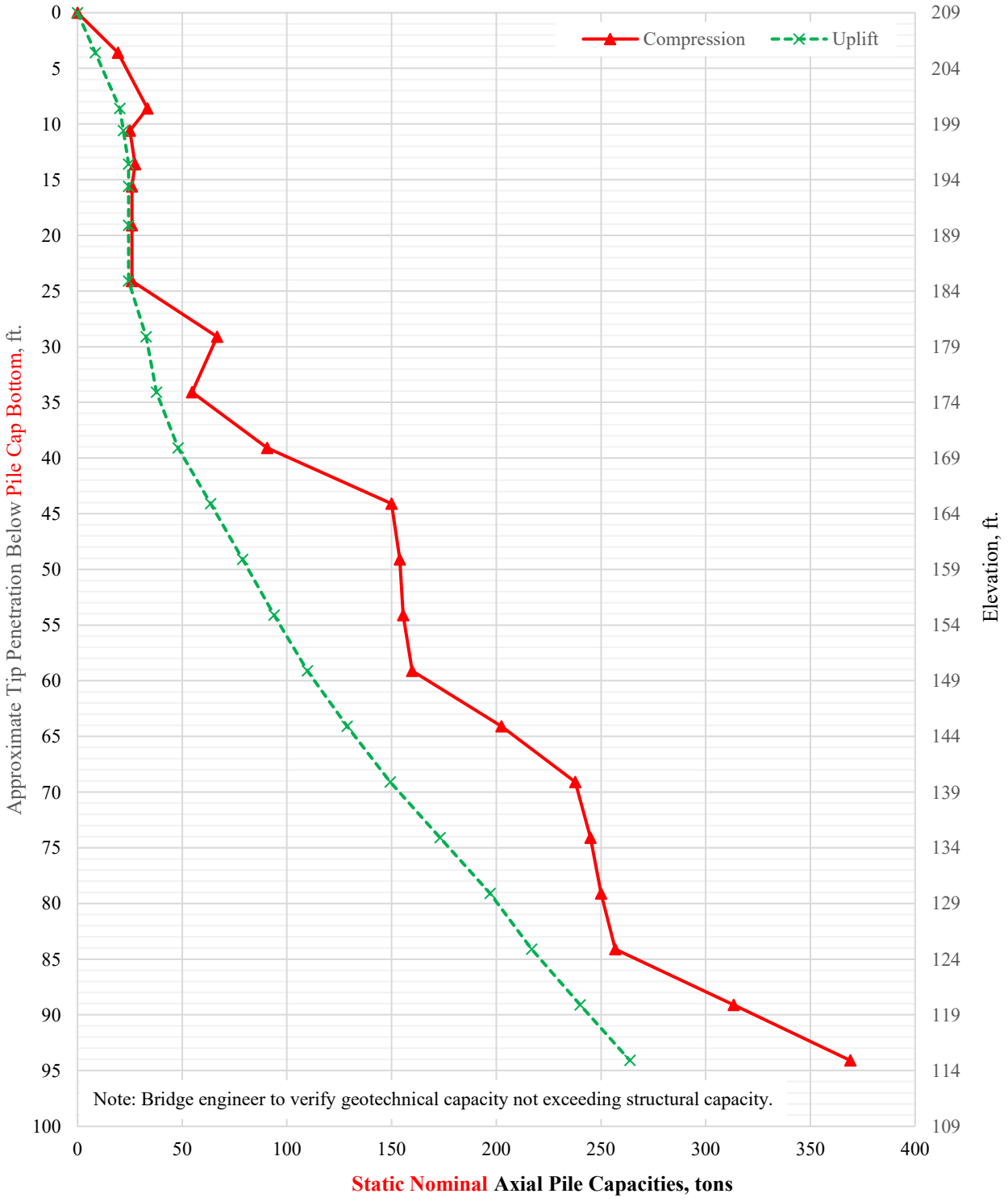
SINGLE 30"-DIAMETER CONCRETE FILLED STEEL SHELL PILE

Bent 5
Project No.: 110861
Location: Cross County



SINGLE 30"-DIAMETER CONCRETE FILLED STEEL SHELL PILE

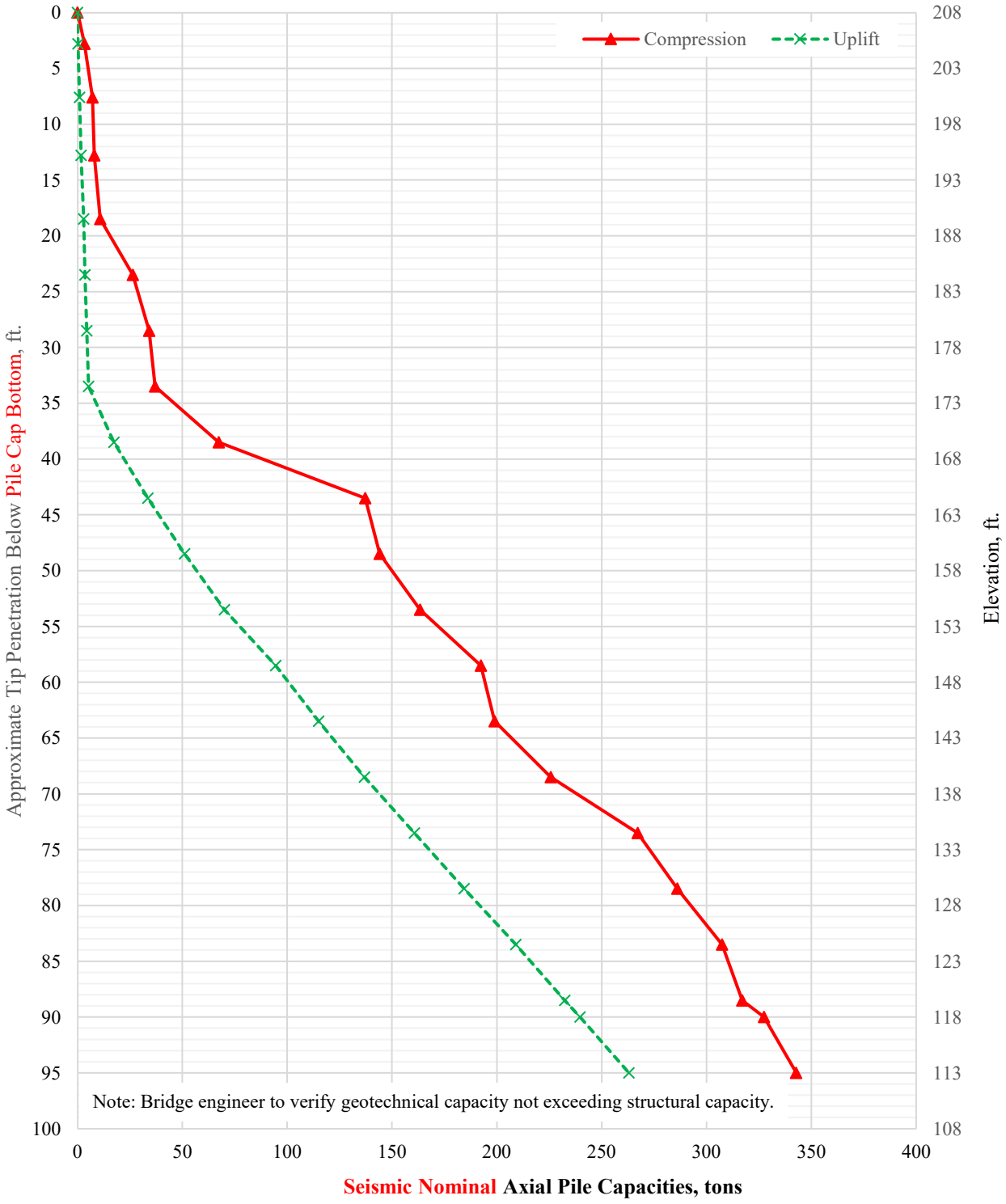
Bent 6
Project No.: 110861
Location: Cross County



SINGLE 18"-DIAMETER CLOSED-END STEEL SHELL PILE

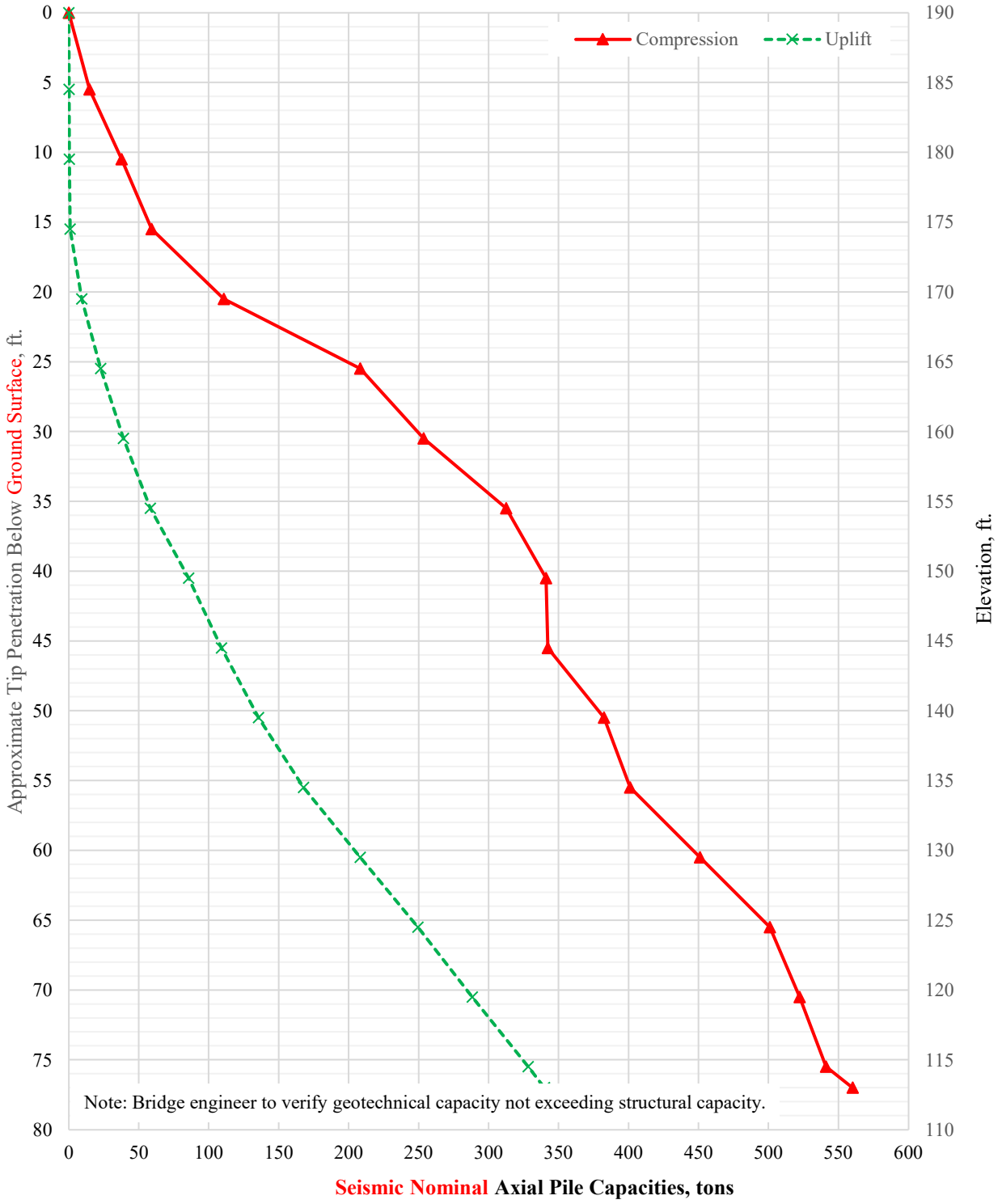
Bent 7
Project No.: 110861
Location: Cross County

Attachment I



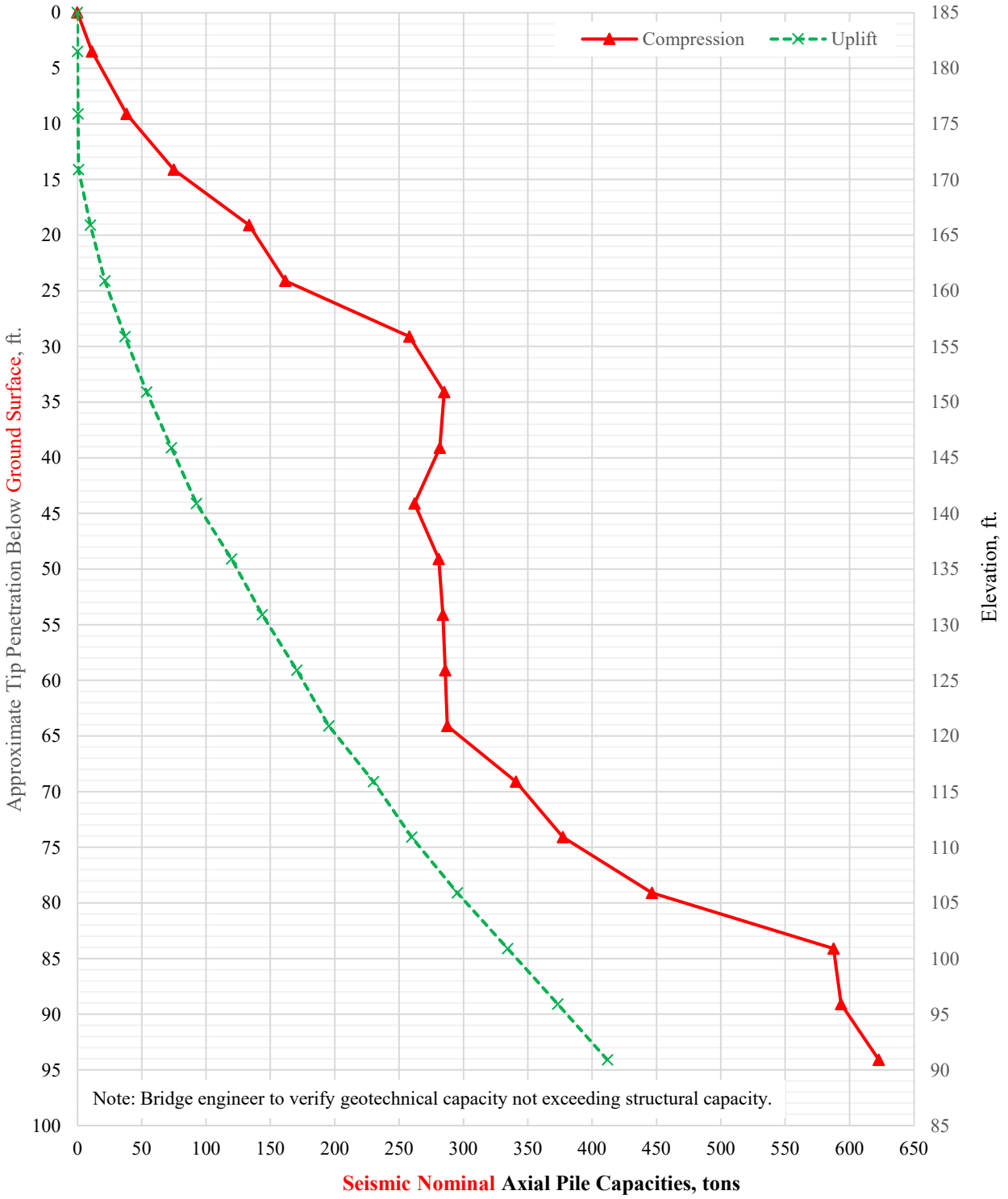
SINGLE 18"-DIAMETER CLOSED-END STEEL SHELL PILE

Bent 1
Project No.: 110861
Location: Cross County



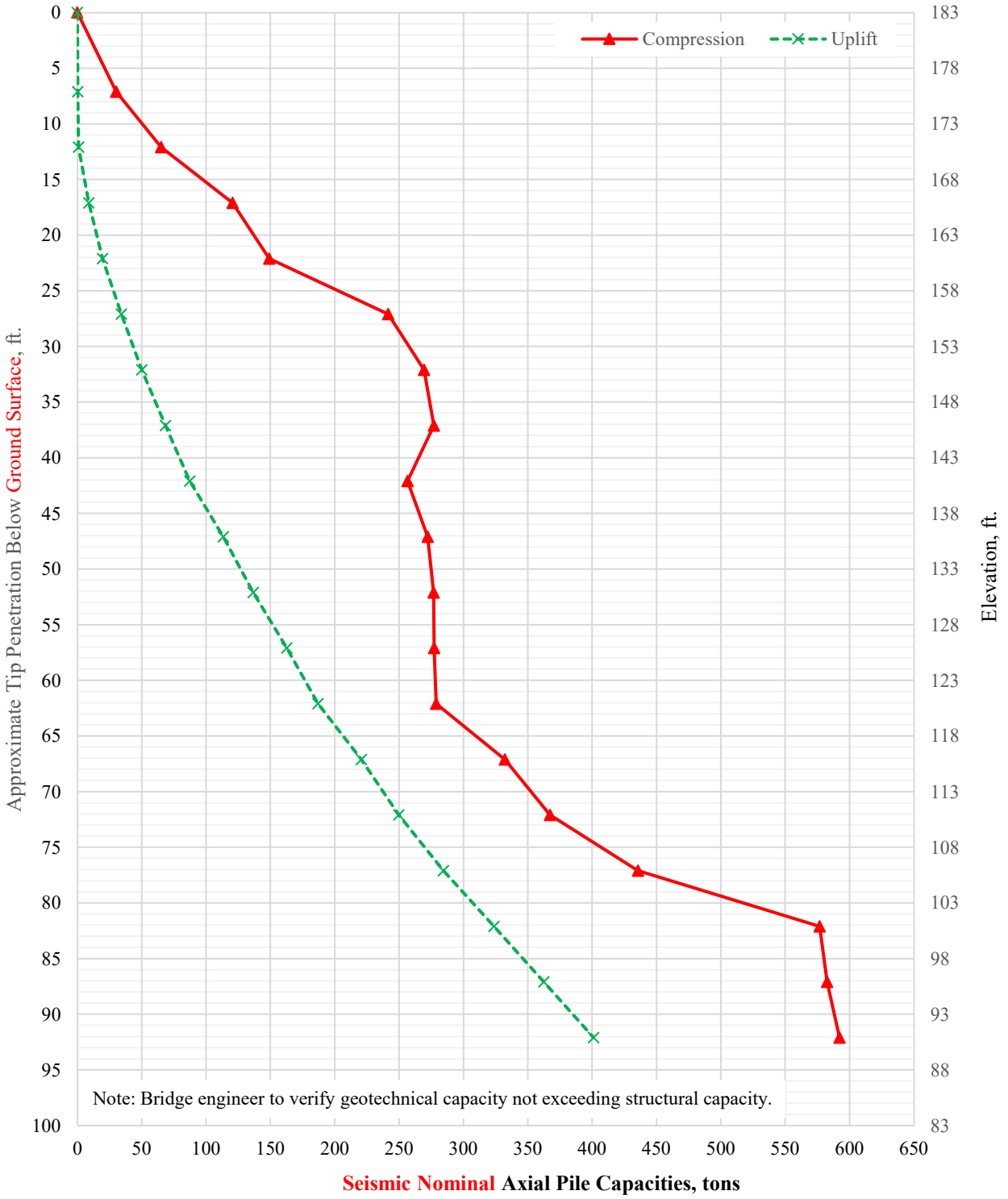
SINGLE 30"-DIAMETER CONCRETE FILLED STEEL SHELL PILE

Bent 2
Project No.: 110861
Location: Cross County



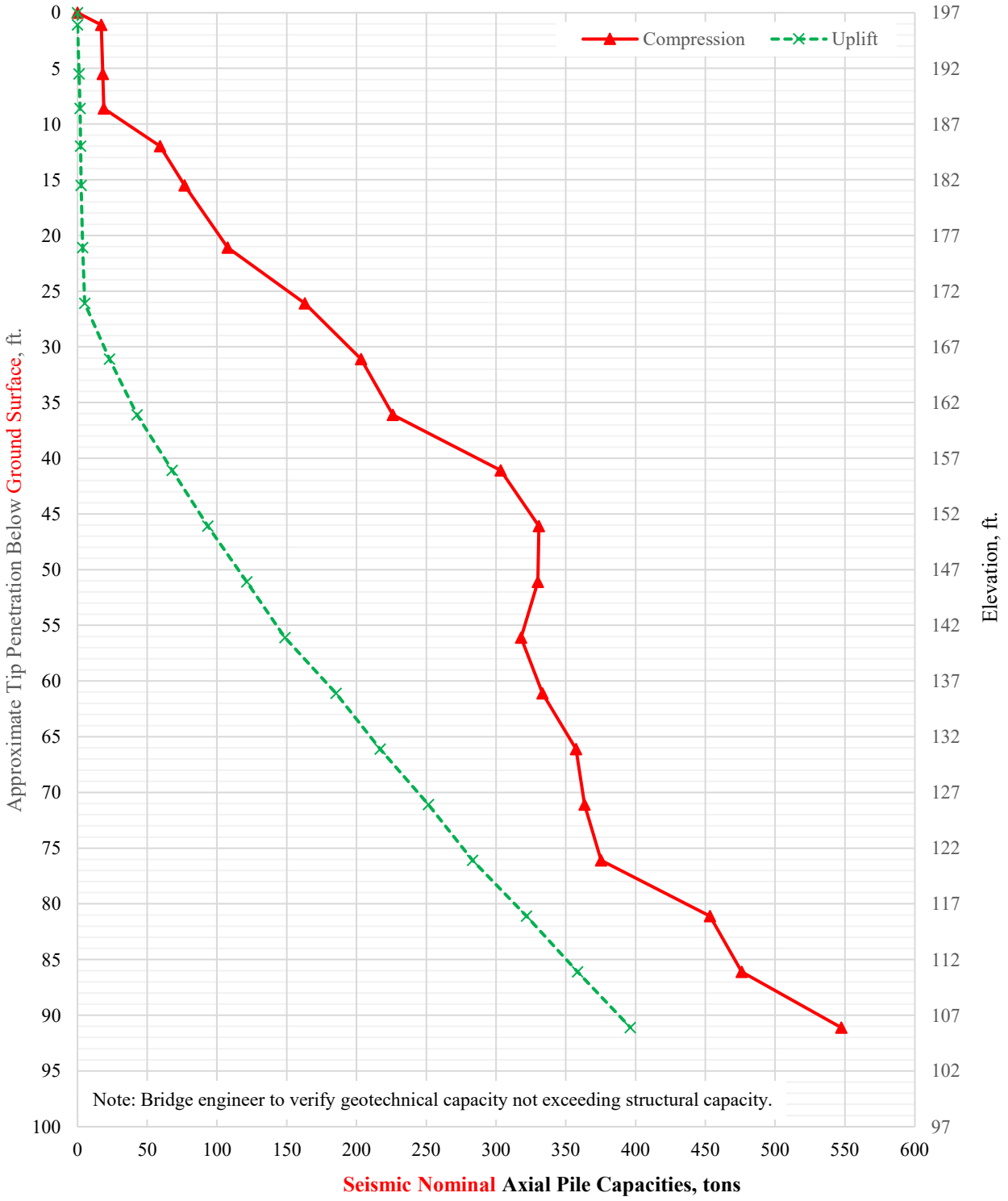
SINGLE 30"-DIAMETER CONCRETE FILLED STEEL SHELL PILE

Bent 3
Project No.: 110861
Location: Cross County



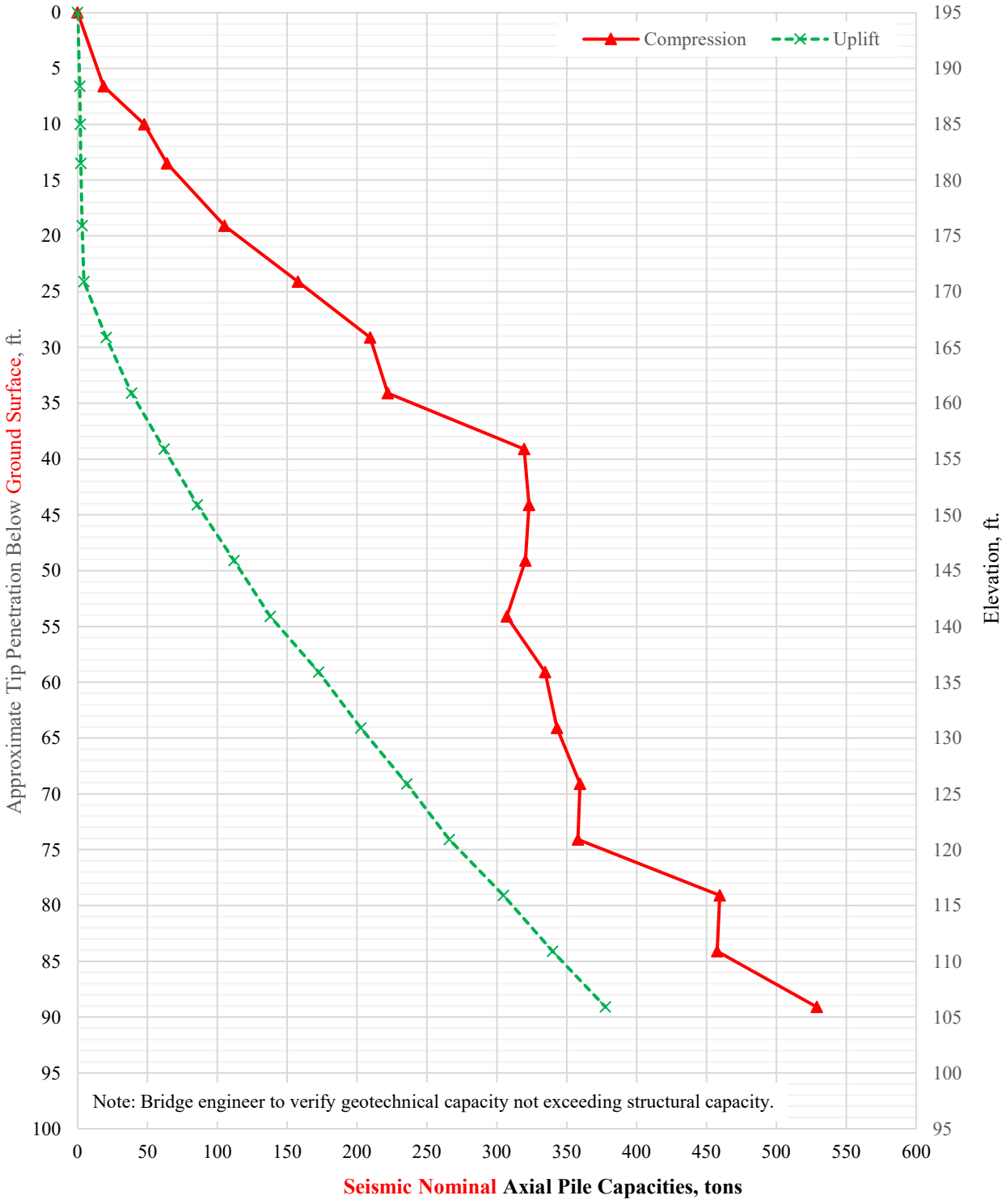
SINGLE 30"-DIAMETER CONCRETE FILLED STEEL SHELL PILE

Bent 4
Project No.: 110861
Location: Cross County



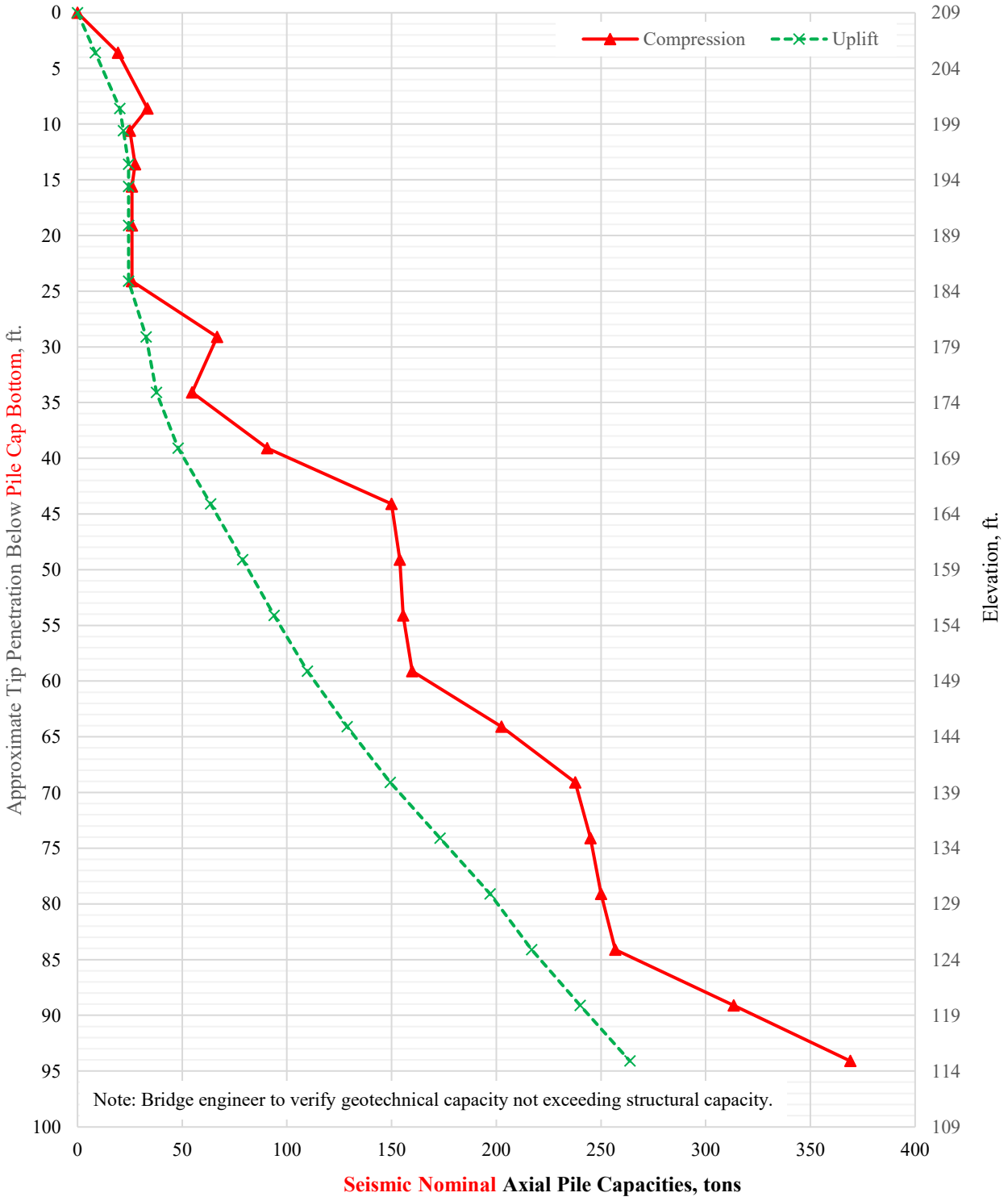
SINGLE 30"-DIAMETER CONCRETE FILLED STEEL SHELL PILE

Bent 5
Project No.: 110861
Location: Cross County



SINGLE 30"-DIAMETER CONCRETE FILLED STEEL SHELL PILE

Bent 6
Project No.: 110861
Location: Cross County



SINGLE 18"-DIAMETER CLOSED-END STEEL SHELL PILE

Bent 7
Project No.: 110861
Location: Cross County

Attachment J

Static Lateral Parameters

Job No.:	110861
Site No.:	1

Input by:	MBB	11/27/2024
Checked by:	MLG	12/5/2024
Back-checked by:	YZ	12/10/2024

Bents 1 & 2 - Boring 1

Elevation, ft		Material	Model	Effective Unit Weight, γ',pcf	Undrained Shear Strength of Soil (C_u) (psf)	Strain Factor (ε_{50} for Soil) / k_m for Rock)	Friction Angle, ϕ, °	Soil Modulus, k, pci
Top	Bottom							
Above Ground Surface		Fill	Soft Clay (Matlock)	120	750	0.010	NA	NA
Ground	210	Lean Clay with Sand	Soft Clay (Matlock)	115	1150	0.007	NA	NA
210	198	Lean to Fat Clay	Soft Clay (Matlock)	110	550	0.010	NA	NA
198	190	Lean to Fat Clay	Soft Clay (Matlock)	50	950	0.010	NA	NA
190	170	Silty Sand / Silt / Silt with Sand	Sand (Reese)	60	NA	NA	32	40
170	140	Sand / Sand with Silt and Trace Oragnics	Sand (Reese)	75	NA	NA	37	104
below 140		Sand with Silt and Gravel	Sand (Reese)	80	NA	NA	39	127

Bents 3-6 - Boring 2

Elevation, ft		Material	Model	Effective Unit Weight, γ',pcf	Undrained Shear Strength of Soil (C_u) (psf)	Strain Factor (ε_{50} for Soil) / k_m for Rock)	Friction Angle, ϕ, °	Soil Modulus, k, pci
Top	Bottom							
Ground	189	Sandy Lean Clay	Soft Clay (Matlock)	110	750	0.010	NA	NA
189	184	Silty Sand	Sand (Reese)	105	NA	NA	34	102
184	136	Sand / Sand with Silt	Sand (Reese)	65	NA	NA	36	92
136	101	Sand with Gravel and Trace Organic Matter	Sand (Reese)	70	NA	NA	36	92
below 101		Sand	Sand (Reese)	75	NA	NA	37	104

Bent 7- Boring 3

Elevation, ft		Material	Model	Effective Unit Weight, γ',pcf	Undrained Shear Strength of Soil (C_u) (psf)	Strain Factor (ε_{50} for Soil) / k_m for Rock)	Friction Angle, ϕ, °	Soil Modulus, k, pci
Top	Bottom							
Above Ground Surface		Fill	Soft Clay (Matlock)	120	750	0.01	NA	NA
Ground	200	Fat to Lean Clay	Stiff Clay w/o Free Water (Reese)	115	1650	0.007	NA	NA
200	185	Sandy Lean Clay	Soft Clay (Matlock)	45	150	0.050	NA	NA
185	179	Sand with Silt	Sand (Reese)	60	NA	NA	34	66
179	175	Sandy Clay	Soft Clay (Matlock)	45	350	0.020	NA	NA
175	145	Sand with silt, Gravel, and Trace Orgainics	Sand (Reese)	70	NA	NA	36	92
145	130	Sand with Gravel / Sand with Silt	Sand (Reese)	75	NA	NA	37	104
130	100	Sand / Sand with Gravel / Sand with Silt	Sand (Reese)	70	NA	NA	36	92
below 100		Sand with Silt	Sand (Reese)	90	NA	NA	39	127

Post-Liquefaction Lateral Parameters

Job No.:	110861	Input by:	YZ	12/10/2024
Site No.:	1	Checked by:	MLG	12/11/2024
		Back-checked by:	YZ	12/11/2024

Bents 1 & 2 - Boring 1

Elevation, ft		Material	Liquefiable?	Model	Effective Unit Weight, γ',pcf	Undrained Shear Strength of Soil (C_u) (psf)	Strain Factor (ε_{50} for Soil) / k_m for Rock)	Friction Angle, ϕ, °	Soil Modulus, k, pci
Top	Bottom								
Above Ground Surface		Fill	N	Soft Clay (Matlock)	120	750	0.010	NA	NA
Ground	210	Lean Clay with Sand	N	Soft Clay (Matlock)	115	1150	0.007	NA	NA
210	198	Lean to Fat Clay	N	Soft Clay (Matlock)	110	550	0.010	NA	NA
198	190	Lean to Fat Clay	N	Soft Clay (Matlock)	50	950	0.010	NA	NA
190	174.5	Silty Sand / Silt / Silt with Sand	Y	Sand (Reese)	60	NA	NA	20	20
174.5	170	Silty Sand / Silt / Silt with Sand	N	Sand (Reese)	60	NA	NA	32	40
170	140	Sand / Sand with Silt and Trace Oragnics	N	Sand (Reese)	75	NA	NA	37	104
below 140		Sand with Silt and Gravel	N	Sand (Reese)	80	NA	NA	39	127

Bents 3-6 - Boring 2

Elevation, ft		Material	Liquefiable?	Model	Effective Unit Weight, γ',pcf	Undrained Shear Strength of Soil (C_u) (psf)	Strain Factor (ε_{50} for Soil) / k_m for Rock)	Friction Angle, ϕ, °	Soil Modulus, k, pci
Top	Bottom								
Ground	189	Sandy Lean Clay	N	Soft Clay (Matlock)	110	750	0.010	NA	NA
189	184	Silty Sand	Y	Sand (Reese)	45	NA	NA	12	20
184	176	Sand / Sand with Silt	Y	Sand (Reese)	65	NA	NA	20	20
176	136	Sand / Sand with Silt	N	Sand (Reese)	65	NA	NA	36	92
136	101	Sand with Gravel and Trace Organic Matter	N	Sand (Reese)	70	NA	NA	36	92
below 101		Sand	N	Sand (Reese)	75	NA	NA	37	104

Bent 7- Boring 3

Elevation, ft		Material	Liquefiable?	Model	Effective Unit Weight, γ',pcf	Undrained Shear Strength of Soil (C_u) (psf)	Strain Factor (ε_{50} for Soil) / k_m for Rock)	Friction Angle, ϕ, °	Soil Modulus, k, pci
Top	Bottom								
Above Ground Surface		Fill	N	Soft Clay (Matlock)	120	750	0.01	NA	NA
Ground	200	Fat to Lean Clay	N	Stiff Clay w/o Free Water (Reese)	115	1650	0.007	NA	NA
200	185	Sandy Lean Clay	Y	Soft Clay (Matlock)	45	120	0.050	NA	NA
185	179	Sand with Silt	Y	Sand (Reese)	60	NA	NA	20	20
179	175	Sandy Clay	Y	Soft Clay (Matlock)	45	280	0.020	NA	NA
175	170	Sand with silt, Gravel, and Trace Orgainics	Y	Sand (Reese)	70	NA	NA	20	20
170	145	Sand with silt, Gravel, and Trace Orgainics	N	Sand (Reese)	70	NA	NA	36	92
145	130	Sand with Gravel / Sand with Silt	N	Sand (Reese)	75	NA	NA	37	104
130	100	Sand / Sand with Gravel / Sand with Silt	N	Sand (Reese)	70	NA	NA	36	92
below 100		Sand with Silt	N	Sand (Reese)	90	NA	NA	39	127