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Structure Geotechnical Report

BRIDGE CONSTRUCTION
PTB 195 ITEM 57
IL - ROUTE 157 (FAP ROUTE 592) OVER JUDY'S BRANCH
MADISON COUNTY, ILLINOIS
SECTION: 51-R
STRUCTURE NO. SN 060-0087 (EXISTING)
STRUCTURE NO. SN 060-0229 (PROPOSED)

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March 27, 2023

Prepared for:
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SCI No. 2020-0531.10

DocuSigned by:
Thomas Casey
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Exp.: 11/30/2023
LICENSED PROFESSIONAL ENGINEER
THOMAS JOSEPH CASEY
062-061853
STATE OF ILLINOIS
3/27/2023

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March 23, 2023

Eric M. Lagemann, P.E., S.E.
Fuhrmann Engineering
1022 Eastport Plaza Drive
Collinsville, Illinois 62234

RE: Structure Geotechnical Report
Bridge Construction
IL - Route 157 (FAP Route 592) over Judy's Branch
Madison County, Illinois
Section: 51-R
Structure No. SN 060-0087 (Existing)
Structure No. SN 060-0229 (Proposed)
SCI No.: 2020-0531.10

Dear Eric M. Lagemann:

Enclosed is our *Final Structure Geotechnical Report (SGR)*, dated March 2023. This report should be read in its entirety, and our recommendations considered in the design and construction of the proposed bridge. Please call if you have any questions.

Respectfully,

SCI ENGINEERING, INC.

Prakash Paudel, E.I.
Staff Engineer

Thomas J. Casey, P.E.
Chief Geotechnical Engineer

PP/TJC/snp

Enclosure
Structural Geotechnical Report

N:\Projects\2020\2020-0531 PTB 195, Item 57 Realignment of IL 162 at 157\Report\SN 060-0087 (E) 0229 (P) - IL-157 over Judy's Branch\20-0531.10 IL-157 over Judy's Branch (SN060-0229) - Final.docx

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Structure Geotechnical Report

BRIDGE CONSTRUCTION
PTB 195 ITEM 57
IL - ROUTE 157 (FAP ROUTE 592) OVER JUDY'S BRANCH
MADISON COUNTY, ILLINOIS
SECTION: 51-R
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1.0 PROJECT DESCRIPTION

The geotechnical study summarized in this report was performed for the proposed construction of the bridge that carries Illinois Route 157 over the Judy's Branch in Madison County, Illinois. Based on the TS&L provided by Fuhrmann Engineering (Fuhrmann) on August 15, 2022, the proposed structure will be a four-lane, three-span structure with a back-to-back abutment length of approximately 133 feet and an out-to-out deck width that will vary in between 213 to 247 feet. According to the provided profiles and cross sections, a maximum fill of approximately 8 to 10 feet is planned near the south approach embankment whereas minimal cuts and fills (<5 feet) is planned near the north approach embankment. The end slopes will have maximum inclination of 2 horizontal to 1 vertical (2H:1V) and the streambed of the creek will be capped with approximately 24 inches of stone riprap used for scour protection. The location of the site is shown on the *Vicinity and Topographic Map*, Figure 1.

2.0 SUBSURFACE EXPLORATION

2.1 Area Geology

The project is located approximately 7.5 miles east of the Mississippi River in the floodplain known locally as the American Bottoms. According to *Surficial Geology of Monks Mound Quadrangle, Madison and St. Clair Counties, Illinois 2007*, the near-surface soils are of the Cahokia Formation that mainly consist of silt loam with occasional thin sand and diamicton beds. The near-surface soils are soft and weakly stratified and up to 15 feet thick. These alluviums were deposited by distributary channels in fans including redeposited loess and some mud flows.

According to *Bedrock Geologic Map, Monks Mound Quadrangle, Madison and St. Clair Counties, Illinois 2001*, the bedrock at this site belongs to Carbondale and Tradewater formations. The Carbondale formation is dominated by dark gray carbonaceous and pyritic shales with siltstone intervals while the Tradewater formation is dominated by shale or claystone and commonly shows rooting.

2.2 Exploration Procedures

Two standard penetration test (SPT) borings, designated B-7 and B-19 were drilled near the proposed abutment locations, as shown on the *Aerial Photograph*, Figure-2, and *Site Plan*, Figure 3. The boring locations were selected and staked in the field by SCI personnel; however the elevations were estimated from publicly available LIDAR data. The stations and offsets were estimated from the TS&L plans provided and included in Appendix F. The field exploration was performed in general accordance with procedures outlined in the *2020 IDOT Geotechnical Manual*.

Personnel from SCI were with the drill rig to supervise drilling, log the borings, and perform field unconfined compressive strength tests of the borings. A CME 550X all-terrain-mounted drill rig equipped with both hollow stem augers and mud-rotary was used to advance the borings. SPTs were performed with a split-spoon sampler at 2½-foot intervals to 30 feet, and at 5-foot intervals thereafter to the termination depth of the borings. The unconfined compressive strength of the cohesive soils was determined with a Rimac test apparatus. A pocket penetrometer was used to measure the compressive strength if the soils were not conducive to Rimac testing. While auger refusal did not occur in any of the borings, split spoon sampler refusal did occur within the shale bedrock in both soil test borings to the depths of 87.5 to 89 feet, as detailed on the appended boring logs. Split-spoon sampler refusal is a designation applied to any material that results in SPT N-values in excess of 100 blows per foot (bpf) or 50 blows over the advancement depth of less than 6 inches.

2.3 Subsurface Conditions

Detailed information regarding the nature and thickness of the soils and rock encountered, and the results of the field sampling and laboratory testing are shown on the Boring Logs and Lab Test Results in Appendix A. The generalized soil profile is included on the *Subsurface Profile*, Figure 4.

The boring B-7 encountered 6 feet of existing fill consisting of couple feet of cinders (A-1) at the top followed by dark brown to brown silty clay loam (A-4) while no fill was encountered in boring B-19. Standard Penetration Test (SPT) N-values (the sum of the second and third blow count numbers in each sampling interval from the SPT) in the existing fill ranged from 13 to 15 blows per foot (bpf) with an average of 14 bpf and Rimac unconfined compressive strength of the loamy soil was 0.9 tons per square foot (tsf), overall classifying the fill as medium stiff to stiff in consistency and medium dense in relative density. Moisture contents in the existing fill ranged from 16 to 18 percent with an average of 17 percent.

Underlying the fill, the natural soils generally consisted of silty to sandy loam (A-4) and silty clay (A-6) to clay (A-7), with occasional layers of sand (A-3) to a nominal depth of 32 feet (El. 406) followed by clay (A-7) to silty clay loam (A-6) to the termination depth of the boring. As an exception, a gray weathered layer of clayey shale was encountered in boring B-7 at 79.5 feet (El. 358.5) that extended all the way down to 86 feet (El. 352).

In general, the natural soils were very soft to stiff in consistency and loose to medium dense in relative density, with a majority of the N-values ranging between 0 and 31 blows per foot (bpf) with an average of 10 bpf. Unconfined compressive strengths obtained from Rimac test ranged between 0.1 to 3 tons per square foot (tsf), with an average of 1.1 tsf. Moisture contents in the native soil samples ranged from 17 to 51 percent, with an average of approximately 27 percent. Table 2.1 presents a summary of the depth and elevation of the top of bedrock that was first encountered in each of the borings.

Table 2.1 – Summary of Bedrock Elevations

Boring	Ground Surface Elevation (feet)	Depth to Bedrock (feet)	Top of Bedrock Elevation (feet)
B-7	438±	86.0	352.0
B-19	438±	88.5	349.5

2.4 Groundwater Conditions

Groundwater levels observed at the time of drilling are summarized in Table 2.2. It should be noted that the groundwater level is subject to seasonal and climatic variations, the water level in the existing Judy's Branch, and other factors; and may be present at different depths in the future. In addition, without extended periods of observation, measurement of the true groundwater levels may not be possible.

Table 2.2 – Summary of Approximate Groundwater Levels

Boring	Ground Surface Elevation (feet)	Depth to Groundwater during Drilling (feet)	Groundwater Elevation during Drilling (feet)
B-7	438±	13.0	425.0
B-19	438±	16.0	422.0

3.0 GEOTECHNICAL EVALUATIONS

In order to provide design recommendations for founding the structure, we performed the following evaluations based on all available data collected and reviewed at the time of this report. This information includes subsurface explorations performed by SCI, existing plans, and communications with Fuhrmann personnel familiar with the project.

3.1 Seismic Considerations

3.1.1 Design Earthquake

Ground shaking at the foundation of structures and liquefaction of the soil under the foundation are the principle seismic hazards to be considered in design of earthquake-resistant structures. Soil liquefaction is possible within loose sand and low plastic silt deposits below the groundwater table. Liquefaction occurs when a rapid development in water pressure, caused by the ground motion, pushes sand particles apart, resulting in a loss of strength and later densification as the water pressure dissipates. This loss of strength can cause bearing capacity failure while the densification can cause excessive settlement. Potential earthquake damage can be mitigated by structural and/or geotechnical measures or procedures common to earthquake resistant design.

For the purposes of seismic design the bridge has been classified as *Regular* and *Essential*. According to the Illinois Department of Transportation Bridge Manual 2012 edition, the structure should be designed to a design earthquake with a 7 percent Probability of Exceedance (PE) over a 75-year exposure period (i.e. a 1,000-year design earthquake). The design earthquake has a Moment Magnitude (Mw) of 4.9 and a site coefficient (A_s) of 0.25g, as determined from data provided by the United States Geological Survey (USGS) National Seismic Hazard Mapping Project and procedures outlined in the All Geotechnical Manual Users (AGMU) 10.1, *Liquefaction Analysis Procedure*.

3.1.2 Site Class Determination

The seismic site soil classification for the bridge site was determined from the design earthquake data, the subsurface data, and the procedures described in AGMU Memo 09.1, *Seismic Site Class Definition*, of the IDOT Bridge Manual Design Guides. The global site Class was evaluated using methods defined as B and C, which include evaluating the SPT N-values and undrained shear strength, S_u. The following results were calculated:

- Method B using N: 8 bpf (Site Class E)
- Method C using N_{ch}: 8 bpf (Site Class E)
- Method C using S_u: 1,120 psf (Site Class D)

Based on the span and overall bridge lengths and the guidelines in the AGMU, we recommend that Site Class D be used for the project. Based on Table 3.15.2-1 the Seismic Performance Zone is 2. Seismic design parameters for the site are summarized in Table 3.1.

Table 3.1 – Seismic Design Parameters

Site Class	D
PGA	0.17
Spectral Acceleration at 0.2 sec. (S_S)	0.35g
Spectral Acceleration at 1.0 sec.(S_1)	0.10g
F_{pga}	1.46
F_a	1.52
F_v	2.40
Site Coefficient (As)	0.25
Design Spectral Acceleration at 0.2 sec. (S_{DS})	0.53g
Design Spectral Acceleration at 1.0 sec.(S_{D1})	0.23g
Seismic Design Category	B
Seismic Performance Zone	2

3.1.3 Liquefaction Potential Analysis

The liquefaction potential analysis for the site was conducted using field and laboratory data and the techniques outlined in AGMU 10.1. For the seismic hazard evaluation, it is generally not prescribed to assume that earthquakes would coincide with other extreme loading events, (i.e., reoccurring flood events) unless the structure is considered critical, for which, engineering judgement may be used to provide additional conservatism to the analysis, if necessary. The average seasonal groundwater elevation used in the analysis was estimated from the end of boring conditions and the seasonal weather conditions. Sands located above the water table are not susceptible to liquefaction.

Based on our analyses, a majority of the soils observed have sufficient strength and/or a plasticity index that make the threat of liquefaction minimal during the design earthquake. However, isolated relatively thin (<5 feet) layers of very loose silty sands encountered at approximate elevation of 425.5 in boring B-7 and 423 in boring B-19 may be susceptible to liquefaction. It is anticipated that all the piles will extend through the potentially liquefiable soils and bear on or in the underlying shale bedrock. Additionally, the unbraced length of the piles during liquefaction should not be a concern as the potentially liquefiable layers are relatively thin and do not occur uniformly across the site. The detailed input parameters and results of the Liquefaction Analyses are provided in Appendix B. While the amount of seismically induced settlement is dependent on the magnitude and distance from the seismic event, SCI estimates that the impacts from the design earthquake will be negligible.

3.2 Abutment and Pier Settlement

Based on the maximum fill of 10 feet near the south abutment, settlement of approximately 2 inches is anticipated which requires the effects of down drag be considered on the determination of axial pile capacity. Minimal cuts and fills (< 5 feet) are planned near the interior pier locations and north abutment. Therefore, settlement is not anticipated to be of concern and hence the effects of down drag on axial pile capacities can be neglected at these locations.

3.3 Bridge Approach Slabs

Based on the available information, the bridge approach slabs will likely bear on newly placed, low plastic structural fill and existing fills. In evaluating the bearing resistance of the slabs, we recommend using a modulus of subgrade reaction of 100 pounds per square inch per inch of deflection (pci).

3.4 Slope Stability

The global slope stability of both end-slopes was analyzed for end-of-construction (short-term), long-term, and seismic (pseudo-static) loading conditions. The analyses were conducted using limit equilibrium slope stability methods and the commercially available software program Slide 2018 (developed by Rocscience, Inc.). The analyses considered soil properties from the subsurface exploration data and the given slope geometries. To account for traffic loading, a surcharge load of 250 pounds per square foot (psf) was applied to the analyses. For the seismic evaluation, the peak ground acceleration (PGA) from the design earthquake along with procedures for seismic slope stability outlined in Federal Highway Administration (FHWA) publication FHWA-HI-99-012 *Geotechnical Earthquake Engineering* were utilized. Soil parameters used in the analyses and the results of the analyses are shown on the output plots in Appendix-E.

The Bishop method, as recommended by IDOT, with a circular mode of failure, was used to search for the critical factor of safety (FS). The required minimum factors of safety were obtained from Section 6.10.4 of the 2020 IDOT Geotechnical Manual for the global slope stability. The results of the global slope stability analyses are presented in Table 3.2 below. The analysis results indicate that the calculated factor of safety meets the required minimum factor of safety. Therefore, the end slopes will perform satisfactorily under short term, long term, and seismic conditions.

Table 3.2 – Summary of Estimated Global Slope Stability Factors of Safety

Analyzed End Slope	Short-Term Static Condition		Long-Term Static Condition		Seismic Condition	
	Required FOS	Estimated FOS	Required FOS	Estimated FOS	Required FOS	Estimated FOS
North Abutment	1.50	1.54	1.50	1.53	1.00	1.24
South Abutment	1.50	1.79	1.50	2.14	1.00	1.42

3.5 Scour

The pile capacity is dependent on the scour elevation and suitable protection should be provided to the foundation elements. Based on the provided TS&L, the design scour elevations for the 100-year and 200-year events for the abutment and interior bents are shown in Table 3.3 below.

Table 3.3 – Summary of Design Scour Elevations

Event/Limit State	Design Scour Elevation (ft)				Item 113
	South Abutment	Interior South Pier (Pier-1)	Interior North Pier (Pier-2)	North Abutment	
Q100	439.00	414.80	414.80	438.92	5
Q200	439.00	413.93	413.93	438.92	
Design	439.00	414.80	414.80	438.92	
Check	439.00	413.93	413.93	438.92	

3.6 Bridge Foundations

The foundation supporting the proposed bridge must provide sufficient support to resist dead and live loads, including seismic loads. As per the TS&L, integral abutments are planned for this bridge. Per the IDOT Bridge Manual, this type of abutment requires either H-Piles or metal shell piles to accommodate the deflection needs of the superstructure. The piles must be configured in a single non-battered row and oriented with their weak axis of bending placed at 90 degrees to the centerline of the bridge. The piles must also extend 2 feet into the abutment to create a fixed condition, which helps the pile withstand the lateral forces and resulting moment while at the same time carrying axial loads.

For the interior piers, several potential foundation options were considered for supporting the new bridge structure that included driven steel H-Piles, metal shell piles, drilled shafts, and shallow foundations. Shallow foundations are not recommended due to the relatively soft consistency of the shallow subsurface conditions encountered. Drilled shaft foundations were determined to be too costly, given the size of the proposed structure. SCI should be contacted for additional recommendations if drilled shafts will be considered. Driven steel H-piles and metal shell piles are feasible for both the abutments and the piers for the bridge. However, as per the latest TS&L provided on March 22, 2023, steel H-piles are planned for the bridge and hence the design information for only steel H-piles is included in Appendix C. No structure loads were provided at the time of writing this report. Therefore, a preliminary load of 1700 kips was assumed for both abutments and the interior piers.

For the driven steel foundation options, we recommend a minimum of one index pile be installed to verify the length of the piles. The index pile can be installed at either side of the creek in the general area of the abutment to help verify the pile length.

3.6.1 Driven Steel Piles

The structural capacity of driven piles depends on the allowable stress and cross-sectional areas of steel and concrete. The pile recommendations in this report assume that Steel H-piles will conform to ASHTO M270 Grade 50 (ASTM 709 Gr 50) or equivalent with a minimum yield stress of 50 kips per square inch (ksi). While metal shell piles are not anticipated, if they are used, they should conform to ASTM A252 grade 3 (or equivalent) with a minimum yield stress of 45 ksi.

Based on the most current IDOT Bridge Manual, All Geotechnical Manual User Memorandums (AGMUs), and Guide Bridge Special Provisions (GBSP), a geotechnical resistance factor (φ_G) of 0.55 was used for the design of the driven pile foundations. Geotechnical losses due to down drag was considered for the south abutment as mentioned above. Similarly, geotechnical losses associated with scour were not calculated as the scour elevations at the pier locations were not determined yet. During the seismic event the Bridge Manual allows the use of a Geotechnical Resistance Factor (φ_G) of 1.0.

All estimates of capacity were calculated using the "Modified IDOT Static Method" spreadsheet associated with the IDOT Bridge Manual, and appropriate AGMUs and GMSPs, and assume construction verification will follow the "WSDOT" formula outlined in Section 512 of the most current IDOT Standard Specifications for Road and Bridge construction. The tip elevations were calculated from the Modified IDOT Static Method spreadsheets based on the available factored resistance. It should be noted that the Static Pile Tables for Pier 1 (Interior South Pier) and Pier 2 (Interior North Pier) were the compilation of data from the nearby borings to provide the best engineering estimate for the design.

A summary of the design capacities, or factored resistance available (R_F), seismic factored resistance (R_{Fseis}), and nominal required bearing (R_N) as well as estimated pile lengths, is presented in Appendix C for additional H-pile sizes. It should be noted that H-piles driven into shale may run shorter than the IDOT spreadsheet predicts. The estimated pile lengths should be adjusted based on the index pile results. The maximum nominal required bearing and the available maximum factored resistance for typical steel H-piles for the abutments and the interior piers are shown in Table 3.4.

Table 3.4 – Maximum Nominal Required Bearing for Steel H-Piles

Abutment/ Pier	Pile Size	Maximum Nominal Required Bearing, R_{Nmax} (kips)	Maximum Factored Resistance Available (kips)	Maximum Factored Resistance Available Considering Geotechnical Losses [DD/Scour] (kips)	Estimated Length of Pile at Refusal (feet)
South Abutment	HP 12X74	589	324	298	94
	HP 12X84	664	365	339	94
	HP 14X89	705	388	357	94
	HP 14X117	929	511	479	95
Pier 1	HP 12X74	589	324	320	96
	HP 12X84	664	365	361	96
	HP 14X89	705	388	383	96
	HP 14X117	929	511	506	96
Pier 2	HP 12X74	589	324	316	98
	HP 12X84	664	365	357	98
	HP 14X89	705	388	379	98
	HP 14X117	929	511	502	100
North Abutment	HP 12X74	589	324	--	97
	HP 12X84	664	365	--	98
	HP 14X89	705	388	--	97
	HP 14X117	929	511	--	100

We recommend a minimum driven pile center to center spacing of three pile diameters, as recommended by the IDOT Bridge Manual. The maximum spacing shall be limited to 3.5 times the effective footing thickness plus 1 foot, but not to exceed 8 feet. Once the final spacing is determined, the piles should be evaluated for group effects.

3.7 Lateral Pile Response

A representation of the pile response under lateral loading exceeding 3 kips per pile is required for design of the bridge superstructure per Section 3.10.1.10 of the 2012 Bridge Manual. The lateral response can be developed by modeling the soil/shaft interaction with the computer program LPILE. Discrete elements are used in LPILE to represent the shaft and non-linear soil using springs. The non-linear soil springs are commonly referred to as P-Y curves. Tables for the pier and abutment locations summarizing approximate soil and rock parameters for the LPILE analyses are included in Appendix D (Reference: LPILE User's Manual, Ensoft, Inc., 2019).

4.0 CONSTRUCTION CONSIDERATIONS

The construction activities should be performed in accordance with the current *IDOT Standard Specifications for Road and Bridge Construction* and any pertinent Special Provisions or policies.

4.1 Temporary Sheet Pile

According to the conversations with Fuhrmann Engineering, IDOT has directed to perform staged construction of this bridge. However, due to the presence of very loose silts and loams down to an estimated depth of 15 feet from underneath the excavation line, temporary sheet piling will not be feasible for this site. Therefore, a temporary soil retention system will be needed for the proposed construction.

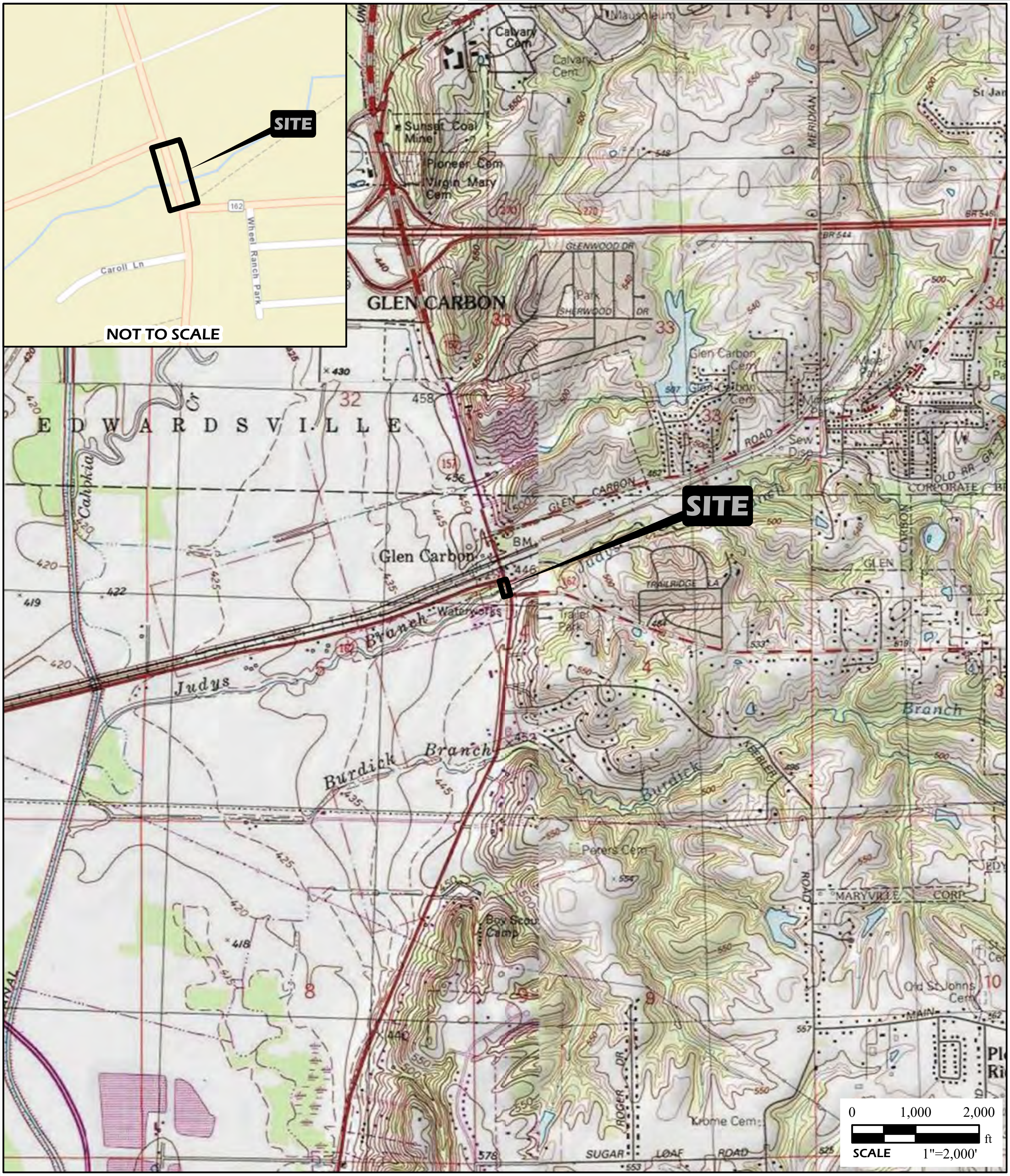
4.2 Dewatering

Based on the loamy/silty nature of the near surface soils, dewatering of the site should be anticipated. Depending on conditions at the time of construction, dewatering may consist of sumps and pumps for controlling water flow into the excavation or more aggressive dewatering using well points may be required. The fine grained loamy and silty soils may be subject to piping during dewatering and should be considered when evaluating groundwater control methods. Piping or transport of the finer materials could result in settlement of adjacent roadways or other features.

Additionally, the interior piers are planned to be above the estimated water surface elevation of 426.5 in the creek as shown on the *TS&L* in Appendix F. If construction work is planned during periods of highwater (typically March through August) and the methods discussed above do not control the flow of groundwater into the excavations, coffer dams may be required.

5.0 LIMITATIONS

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



PROJECT NAME
PTB 195 ITEM 57
IL – ROUTE 157 OVER JUDY'S BRANCH
MADISON COUNTY, ILLINOIS

VICINITY AND TOPOGRAPHIC MAP

DRAWN BY	JTM	DATE	JOB NUMBER
CHECKED BY	PP	03/2023	2020-0531.10

GENERAL NOTES/LEGEND

USGS TOPOGRAPHIC MAPS
WOOD RIVER, ILLINOIS QUADRANGLE
DATED 1994
10' CONTOURS
EDWARDSVILLE, ILLINOIS QUADRANGLE
DATED 1991
10' CONTOURS

MONKS MOUND, ILLINOIS QUADRANGLE
DATED 1954, REVISED 1993
10' CONTOURS
COLLINSVILLE, ILLINOIS QUADRANGLE
DATED 1991
10' CONTOURS

STREET MAP
HTTP://GOTO.ARCGISONLINE.COM/MAPS/WORLD_STREET_MAP

N
W E
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FIGURE
1

PROJECT NAME
PTB 195 ITEM 57
IL – ROUTE 157 OVER JUDY'S BRANCH
MADISON COUNTY, ILLINOIS

AERIAL PHOTOGRAPH

DRAWN BY	JTM	DATE	JOB NUMBER
CHECKED BY	PP	03/2023	2020-0531.10

GENERAL NOTES/LEGEND

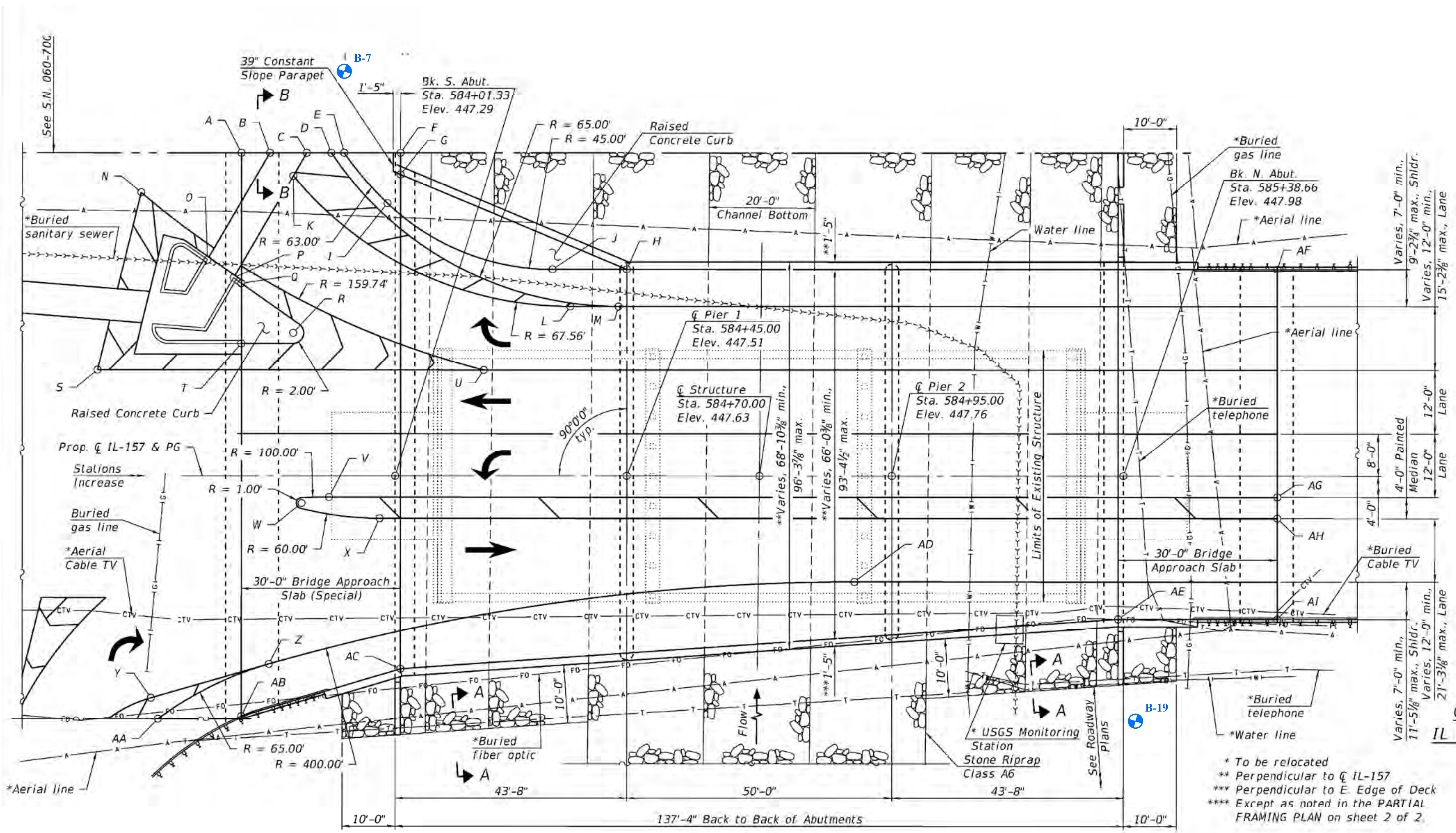
APPROXIMATE STB LOCATIONS

AERIAL PHOTOGRAPH OBTAINED FROM ARCGIS ONLINE, WORLD IMAGERY.

DIMENSIONS AND LOCATIONS ARE APPROXIMATE; ACTUAL MAY VARY. DRAWING SHALL NOT BE USED OUTSIDE THE CONTEXT OF THE REPORT FOR WHICH IT WAS GENERATED.

N W E S

FIGURE
2



APPROXIMATE STB LOCATIONS

SCALE 0 10 20 ft 1"=20'

SCI

PLAN DATED 03/20/2023 BY FUHRMANN ENGINEERING.
DIMENSIONS AND LOCATIONS ARE APPROXIMATE; ACTUAL MAY VARY. DRAWING SHALL NOT BE USED OUTSIDE THE CONTEXT OF THE REPORT FOR WHICH IT WAS GENERATED.

GENERAL NOTES/LEGEND

PROJECT NAME
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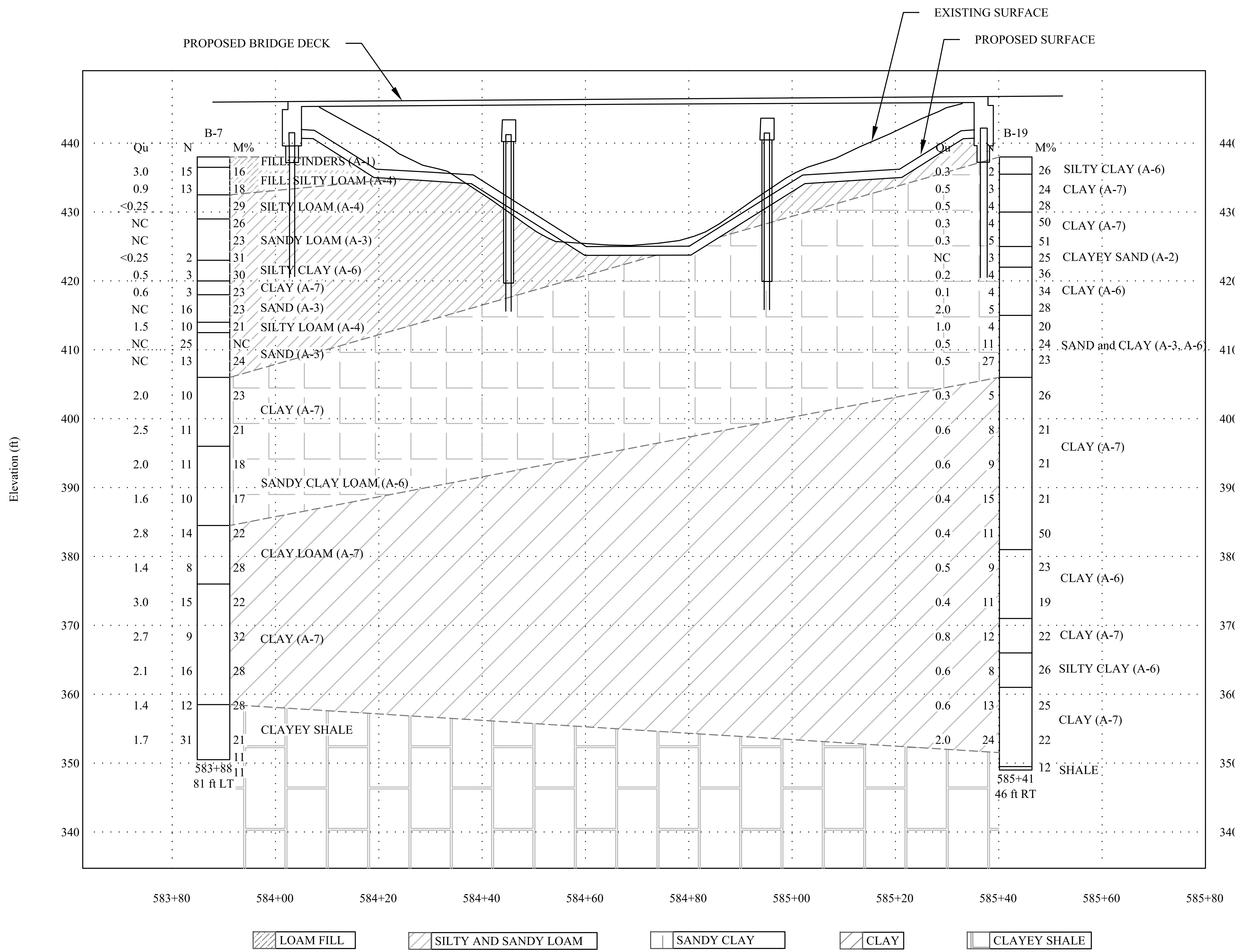
MADISON COUNTY, ILLINOIS

SITE PLAN

JOB NUMBER	2020-0531.10
DATE	03/2023
DRAWN BY	JTM
CHECKED BY	PP
FIGURE	3



General Notes/Legend

VARIATIONS IN SUBSURFACE CONDITIONS MAY AND LIKELY EXIST BETWEEN BORINGS. DASHED HORIZONS ARE INTERPRETED AND ARE SHOWN FOR ILLUSTRATION ONLY.

PROJECT NAME

PTB 195 ITEM 157
IL - ROUTE 157 OVER JUDY'S BRANCH
MADISON COUNTY, ILLINOIS

SUBSURFACE PROFILE

SCALE 1" = 15' V, 1" = 20' H

JOB NUMBER 2020-0531.10

DATE 03/2023

DRAWN BY JTM

CHECKED BY PP

FIGURE 4

Appendix A

SCI ENGINEERING, INC.
130 Point West Boulevard
St. Charles, Missouri 63301
636-949-8200
www.sciengineering.com

BORING LOG LEGEND AND NOMENCLATURE

Depth is in feet below ground surface. **Elevation** is in feet mean sea level, site datum, or as otherwise noted.

Sample Type

- **SS** Split-spoon sample, disturbed, obtained by driving a 2-inch-O.D. split-spoon sampler (ASTM D 1586).
- **NX** Diamond core bit, nominal 2-inch-diameter rock sample (ASTM D 2113).
- **ST** Thin-walled (Shelby) tube sample, relatively undisturbed, obtained by pushing a 3-inch-diameter, tube (ASTM D 1587).
- **CS** Continuous sample tube system, relatively undisturbed, obtained by split-barrel sampler in conjunction with auger advancement.
- **SV** Shear vane, field test to determine strength of cohesive soil by pushing or driving a 2-inch-diameter vane, and then shearing by torquing soil in existing and remolded states (ASTM D 2573).
- **BS** Bag sample, disturbed, obtained from cuttings.

Recovery is expressed as a ratio of the length recovered to the total length pushed, driven, cored.

Blows Numbers indicate blows per 6 inches of split-spoon sampler penetration when driven with a 140-pound hammer falling freely 30 inches. The number of total blows obtained for the second and third 6-inch increments is the N value (Standard Penetration Test or SPT) in blows per foot (ASTM D 1586). Practical refusal is considered to be 50 or more blows without achieving 6 inches of penetration, and is expressed as a ratio of 50 to actual penetration, e.g., 50/2 (50 blows for 2 inches).

For analysis, the N value is used when obtained by a cathead and rope system. When obtained by an automatic hammer, the N value may be increased by a factor of 1.3.

Vane Shear Strength is expressed as the peak strength (existing state) / the residual strength (remolded state).

Description indicates soil constituents and other classification characteristics (ASTM D 2488) and the Unified Soil Classification (ASTM D 2487). Secondary soil constituents (expressed as a percentage) are described as follows:

Trace	<5
Few	5-15
With	>15-30

Stratigraphic Breaks may be observed or interpreted, and are indicated by a dashed line. Transition between described materials may be gradual.

Laboratory Test Results

- Natural moisture content (ASTM D 2216) in percent.
- Dry density in pounds per cubic foot (pcf).
- Hand penetrometer value of apparently intact cohesive sample in kips per square foot (ksf).
- Unconfined compressive strength (ASTM D 2166) in kips per square foot (ksf).
- Liquid and Plastic Limits (ASTM D 4318) in percent.

RQD (Rock Quality Designation) is the ratio between the total length of core segments 4 inches or more in length and the total length of core drilled. RQD (expressed as a percentage) indicates insitu rock quality as follows:

Excellent	90 to 100
Good	75 to 90
Fair	50 to 75
Poor	25 to 50
Very Poor	0 to 25

Illinois Department of Transportation

Division of Highways
SCI Engineering, Inc.

SOIL BORING LOG

Date 3/1,2/2022

ROUTE Route 157/162 **DESCRIPTION** IL - Route 157 over Judy's Branch **LOGGED BY** SCI

SECTION 51-1R **LOCATION** Madison County, Illinois, **SEC.** 4, **TWP.** 3N, **RNG.** 8W
Lat 38.740837 **Long** -90.002113

COUNTY Madison **DRILLING METHOD** CME 550 w/HSA and Mud Rotary **HAMMER TYPE** Automatic

STRUCT. NO. SN 060-0229/ SN 060-7003
Station 584+70.00 and 11+32.26

BORING NO. B-7
Station 17+86
Offset 50 ft LT
Ground Surface Elev. 438.0 ft

Surface Water Elev. N/A ft
Stream Bed Elev. N/A ft

Groundwater Elev.:
First Encounter 425.0 ft ▼
Upon Completion N/A ft
After N/A **Hrs.** N/A ft

Description	DEPTH (ft)	BLOWS (/6")	UCS Qu (tsf)	MOIST (%)
FILL: CINDERS (A-1)				
436.5 — FILL: Dark brown to brown SILTY LOAM (A-4), stiff		5 6 9	3.0 P	16
	-5	4 6 7	0.9 S/10%	18
432.5 — Brown SILTY LOAM (A-4), very moist, very soft *Percentage finer than #200 test performed (21.6% passing)*		WOH WOH WOH	<0.25 P	29
Percentage finer than #200 test performed (19.9% passing) 429.0 — Brown to reddish brown SANDY LOAM (A-3) w/ silt, very moist, very loose	-10	WOH WOH 1	NC	26
Percentage finer than #200 test performed (19.2% passing)		WOH WOH 1	NC	23
▼				
Percentage finer than #200 test performed (20.3% passing) 423.0	-15	1 1 1	<0.25 P	31
Gray and Brown SILTY CLAY (A-6), moist, very soft		WOH 1 2	0.5 S/15%	30
420.0 — Gray CLAY (A-7), moist, soft *Atterberg Limits test performed (LL=34, PI=18)* 418.0	-20	1 1 2	0.6 B/20%	23

Description	DEPTH (ft)	BLOWS (/6")	UCS Qu (tsf)	MOIST (%)
Gray fine SAND (A-3), wet, medium dense		4 7 9	NC	23
414.0 — Gray SILTY LOAM (A-4), moist, stiff	-25	5 5 5	1.5 P	21
412.5 — Gray fine SAND (A-3), wet, medium dense		8 12 13	NC	NC
	-30	6 6 7	NC	24
406.0 — Gray CLAY (A-7), moist, stiff				
	-35	5 4 6	2.0 B/20%	23
	-40	4 4 7	2.5 B/20%	21

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

Illinois Department of Transportation

Division of Highways
SCI Engineering, Inc.

SOIL BORING LOG

Date 3/1,2/2022

ROUTE Route 157/162 **DESCRIPTION** IL - Route 157 over Judy's Bridge **LOGGED BY** SCI

SECTION 51-1R **LOCATION** Madison County, Illinois, **SEC.** 4, **TWP.** 3N, **RNG.** 8W
Lat 38.740837 **Long** -90.002113

COUNTY Madison **DRILLING METHOD** CME 550 w/HSA and Mud Rotary **HAMMER TYPE** Automatic

STRUCT. NO. SN 060-0229/ SN 060-7003
Station 584+70.00 and 11+32.26

BORING NO. B-7
Station 17+86
Offset 50 ft LT
Ground Surface Elev. 438.0 ft

Surface Water Elev. N/A ft
Stream Bed Elev. N/A ft

Groundwater Elev.:
First Encounter 425.0 ft ▼
Upon Completion N/A ft
After N/A **Hrs.** N/A ft

Description	DEPTH (ft)	BLOWS (/6")	UCS Qu (tsf)	MOIST (%)
Gray CLAY (A-7), moist, stiff *(continued)*				
396.0				
Gray SANDY CLAY LOAM (A-6), moist, stiff (fill)				
	-45	3 4 7	2.0 B/20%	18
	-50	3 4 6	1.6 B/20%	17
384.5				
Gray CLAY LOAM (A-7), moist, stiff	-55	5 6 8	2.8 B/20%	22
	-60	3 4 4	1.4 B/20%	28

Description	DEPTH (ft)	BLOWS (/6")	UCS Qu (tsf)	MOIST (%)
Gray CLAY LOAM (A-7), moist, stiff *(continued)*				
376.0				
Gray CLAY (A-7), moist, very stiff	-65	6 6 9	3.0 B/20%	22
Becomes brown and stiff	-70	6 4 5	2.7 B/20%	32
Becomes very stiff	-75	4 7 9	2.1 B/20%	28
Becomes gray 358.5	-80	4 5 7	1.4 B/20%	28

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

Illinois Department of Transportation

Division of Highways
SCI Engineering, Inc.

SOIL BORING LOG

Date 3/1,2/2022

ROUTE Route 157/162 **DESCRIPTION** IL - Route 157 over Judy's Branch **LOGGED BY** SCI

SECTION 51-1R **LOCATION** Madison County, Illinois, **SEC.** 4, **TWP.** 3N, **RNG.** 8W
Lat 38.740837 **Long** -90.002113

COUNTY Madison **DRILLING METHOD** CME 550 w/HSA and Mud Rotary **HAMMER TYPE** Automatic

STRUCT. NO. SN 060-0229/ SN 060-7003
Station 584+70.00 and 11+32.26

BORING NO. B-7
Station 17+86
Offset 50 ft LT
Ground Surface Elev. 438.0 ft

Surface Water Elev. N/A ft
Stream Bed Elev. N/A ft

Groundwater Elev.:
First Encounter 425.0 ft ▼
Upon Completion N/A ft
After N/A **Hrs.** N/A ft

Description	Elev.	DEPTH (ft)	BLOWS (/6")	UCS Qu (tsf)	MOIST (%)
Gray weathered CLAYEY SHALE, hard *(continued)*					
		-85	6 11 20	1.7 S/10%	21
			50/5.5" 50/2"		11
	350.5		50/5" 50/1"		11
Sampler Refusal at 87.5 feet. Borehole grouted upon completion.					
		-90			
		-95			
		-100			

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

Illinois Department of Transportation

Division of Highways
SCI Engineering, Inc.

SOIL BORING LOG

Date 3/14,15/2022

ROUTE Route 157/162 **DESCRIPTION** IL - Route 157 over Judy's Branch **LOGGED BY** SCI

SECTION 51-1R **LOCATION** Madison County, Illinois, **SEC.** 4, **TWP.** 3N, **RNG.** 8W
Lat 38.741338 **Long** -90.001838

COUNTY Madison **DRILLING METHOD** CME 550 w/HSA and Mud Rotary **HAMMER TYPE** Automatic

STRUCT. NO. SN 060-0229
Station 584+70.00

BORING NO. B-19
Station 585+41
Offset 46 ft RT
Ground Surface Elev. 438.0 ft

Surface Water Elev. N/A ft
Stream Bed Elev. N/A ft

Groundwater Elev.:
First Encounter 422.0 ft ▼
Upon Completion N/A ft
After N/A **Hrs.** N/A ft

Description	DEPTH (ft)	BLOWS (/6")	UCS Qu (tsf)	MOIST (%)
Brown SILTY CLAY (A-6), very soft				
		WOH 1 1	0.3 S/20%	26
435.5 — Gray CLAY (A-7), some fine to medium sand, clay is loose to medium stiff				
	-5	1 1 2	0.5 P	24
		2 2 2	0.5 P	28
430.0 — Tan and gray CLAY (A-7), soft				
	-10	2 2 2	0.3 S/20%	50
		WOH 2 3	0.3 S/5%	51
425.0 — CLAYEY SAND (A-2), sand is fine to coarse, very loose				
	-15	1 1 2	NC	25
422.0 ▼ — Gray CLAY (A-6), soft				
		2 2 2	0.2 S/5%	36
	-20	WOH 2 2	0.1 S/5%	34

Description	DEPTH (ft)	BLOWS (/6")	UCS Qu (tsf)	MOIST (%)
Gray CLAY (A-6), soft *(continued)*				
Becomes silty		1 2 3	2.0 P	28
415.0 — Gray SAND and CLAY (A-3, A-6), sand is loose to medium dense, clay is medium stiff				
	-25	2 2 2	1.0 P	20
		2 3 8	0.5 P	24
	-30	4 14 13	0.5 P	23
406.0 — Light brown CLAY (A-7), medium stiff				
	-35	3 2 3	0.3 P	26
	-40	3 4 4	0.6 B/20%	21

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

Illinois Department of Transportation

Division of Highways
SCI Engineering, Inc.

SOIL BORING LOG

Date 3/14,15/2022

ROUTE Route 157/162 **DESCRIPTION** IL - Route 157 over Judy's Bridge **LOGGED BY** SCI

SECTION 51-1R **LOCATION** Madison County, Illinois, **SEC.** 4, **TWP.** 3N, **RNG.** 8W
Lat 38.741338 **Long** -90.001838

COUNTY Madison **DRILLING METHOD** CME 550 w/HSA and Mud Rotary **HAMMER TYPE** Automatic

STRUCT. NO. SN 060-0229
Station 584+70.00

BORING NO. B-19
Station 585+41
Offset 46 ft RT
Ground Surface Elev. 438.0 ft

Surface Water Elev. N/A ft
Stream Bed Elev. N/A ft

Groundwater Elev.:
First Encounter 422.0 ft ▼
Upon Completion N/A ft
After N/A **Hrs.** N/A ft

Description	DEPTH (ft)	BLOWS (/6")	UCS Qu (tsf)	MOIST (%)
Light brown CLAY (A-7), medium stiff *(continued)*				
Becomes gray	-45	4 3 6	0.6 B/20%	21
	-50	5 6 9	0.4 S/6%	21
Becomes light brown	-55	4 4 7	0.4 S/15%	50
381.0 — Light brown and gray CLAY (A-6), medium stiff				
	-60	4 4 5	0.5 S/10%	23

Description	DEPTH (ft)	BLOWS (/6")	UCS Qu (tsf)	MOIST (%)
Light brown and gray CLAY (A-6), medium stiff *(continued)*				
Becomes silty	-65	4 5 6	0.4 S/10%	19
371.0 — Gray CLAY (A-7), medium stiff				
	-70	4 4 8	0.8 B/20%	22
366.0 — Gray SILTY CLAY (A-6), medium stiff				
	-75	4 3 5	0.6 B/20%	26
361.0 — Gray CLAY (A-7), medium stiff				
	-80	5 5 8	0.6 B/20%	25

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

Illinois Department of Transportation

Division of Highways
SCI Engineering, Inc.

SOIL BORING LOG

Date 3/14,15/2022

ROUTE Route 157/162 **DESCRIPTION** IL - Route 157 over Judy's Branch **LOGGED BY** SCI

SECTION 51-1R **LOCATION** Madison County, Illinois, **SEC.** 4, **TWP.** 3N, **RNG.** 8W
Lat 38.741338 **Long** -90.001838

COUNTY Madison **DRILLING METHOD** CME 550 w/HSA and Mud Rotary **HAMMER TYPE** Automatic

STRUCT. NO. SN 060-0229
Station 584+70.00

BORING NO. B-19
Station 585+41
Offset 46 ft RT
Ground Surface Elev. 438.0 ft

Surface Water Elev. N/A ft
Stream Bed Elev. N/A ft

Groundwater Elev.:
First Encounter 422.0 ft ▼
Upon Completion N/A ft
After N/A **Hrs.** N/A ft

Description	Elev.	DEPTH (ft)	BLOWS (/6")	UCS Qu (tsf)	MOIST (%)
Gray CLAY (A-7), medium stiff *(continued)*					
some weathered limestone		-85	6 8 16	2.0 P	22
	349.5				
Gray SHALE, hard	349.0		50/5"		12
Sampler Refusal at 89 feet. Borehole grouted upon completion.		-90			
		-95			
		-100			

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

Appendix B

Illinois Department of Transportation

LIQUEFACTION ANALYSIS

REFERENCE BORING NUMBER ==================================== B-7 S Abut
ELEVATION OF BORING GROUND SURFACE ========================= 438.00 FT.
DEPTH TO GROUNDWATER - DURING DRILLING ====================== 13.00 FT. (Below Boring Ground Surface)
DEPTH TO GROUNDWATER - DURING EARTHQUAKE ================== 13.00 FT. (Below Finished Grade Cut or Fill Surface)
PEAK HORIZ. GROUND SURFACE ACCELERATION COEFFICIENT (As) ===== 0.433
EARTHQUAKE MOMENT MAGNITUDE ================================ 5.1
FINISHED GRADE FILL OR CUT FROM BORING SURFACE =============== 2.44 FT. (Fill Height)
HAMMER EFFICIENCY== 73 %
BOREHOLE DIAMETER== 6 IN.
SAMPLING METHOD== Sampler w/out Liners

EQ MAGNITUDE SCALING FACTOR
(MSF) = **2.362**

AVG. SHEAR WAVE VELOCITY (top 40')
$V^*_{s,40'}$ = **359** FT./SEC.

PGA CALCULATOR
Earthquake Moment Magnitude = 5.1
Source-To-Site Distance, R (km) = 10
Ground Motion Prediction Equations = CEUS
PGA = **0.297**

	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
435.5	2.5	15	2					0.130	0.325	29.061	29.061	0.413	0.130	0.618	0.618	1.500	**1.464**	0.889	**0.250**	**N.L. (1)**
433	5	13	0.9					0.120	0.625	21.839	21.839	0.240	0.120	0.918	0.918	1.291	**0.731**	0.826	**0.233**	**N.L. (1)**
430.5	7.5	1		21.6				0.095	0.863	1.452	5.452	0.075	0.095	1.155	1.155	1.131	**0.202**	0.759	**0.214**	**N.L. (1)**
428	10	1		19.9		26	26	0.095	1.100	1.466	5.179	0.073	0.095	1.393	1.393	1.088	**0.189**	0.692	**0.195**	**N.L. (1)**
425.5	12.5	1		19.2		23	23	0.095	1.338	1.452	5.031	0.072	0.033	1.475	1.596	1.075	**0.184**	0.626	**0.191**	**0.963 (C)**
423	15	2		20.3				0.048	1.458	2.926	6.829	0.086	0.048	1.595	1.872	1.062	**0.216**	0.564	**0.186**	**1.161 (C)**
420.5	17.5	3	0.5	50	12	30	30	0.051	1.585	4.368	10.241	0.115	0.051	1.723	2.156	1.050	**0.286**	0.507	**0.178**	**N.L. (2)**
418	20	3	0.6		18	34	23	0.053	1.718	4.312	4.312	0.067	0.053	1.855	2.444	1.027	**0.163**	0.455	**0.169**	**N.L. (2)**
415.5	22.5	16						0.065	1.880	23.850	23.850	0.271	0.065	2.018	2.763	1.016	**0.650**	0.411	**0.158**	**4.114 (D)**
413	25	10	1		5	21	21	0.059	2.028	13.731	13.731	0.148	0.059	2.165	3.066	0.995	**0.347**	0.373	**0.149**	**2.329 (D)**
410.5	27.5	25						0.069	2.200	37.650	37.650	0.000	0.069	2.338	3.395	0.962	**0.000**	0.342	**0.140**	**N.L. (3)**
408	30	13						0.063	2.358	17.181	17.181	0.183	0.063	2.495	3.708	0.956	**0.413**	0.316	**0.132**	**3.129 (D)**
403	35	10	2		12	23	23	0.067	2.693	12.204	12.204	0.133	0.067	2.830	4.355	0.932	**0.293**	0.278	**0.120**	**N.L. (2)**
398	40	11	2.5		12	21	21	0.070	3.043	12.662	12.662	0.137	0.070	3.180	5.017	0.904	**0.293**	0.254	**0.113**	**N.L. (2)**
393	45	11	2		12	18	18	0.067	3.378	12.013	12.013	0.131	0.067	3.515	5.664	0.884	**0.274**	0.239	**0.109**	**N.L. (2)**
388	50	10	1.6		12	17	17	0.065	3.703	10.402	10.402	0.117	0.065	3.840	6.301	0.870	**0.240**	0.230	**0.106**	**N.L. (2)**
383	55	14	2.8		12	22	22	0.072	4.063	13.817	13.817	0.148	0.072	4.200	6.973	0.840	**0.294**	0.225	**0.105**	**N.L. (2)**
378	60	8	1.4		12	28	28	0.063	4.378	7.550	7.550	0.092	0.063	4.515	7.600	0.849	**0.185**	0.221	**0.105**	**N.L. (2)**
373	65	15	3		12	22	22	0.072	4.738	13.466	13.466	0.145	0.072	4.875	8.272	0.810	**0.277**	0.213	**0.102**	**N.L. (2)**
368	70	9	2.7		12	32	32	0.071	5.093	7.705	7.705	0.093	0.071	5.230	8.939	0.822	**0.181**	0.206	**0.099**	**N.L. (2)**
363	75	16	2.1		12	28	28	0.068	5.433	13.121	13.121	0.142	0.068	5.570	9.591	0.785	**0.263**	0.199	**0.097**	**N.L. (2)**
358	80	12	1.4		12	28	28	0.063	5.748	9.484	9.484	0.109	0.063	5.885	10.218	0.792	**0.203**	0.192	**0.094**	**N.L. (2)**
353	85	31	1.7					0.065	6.073	25.033	25.033	0.293	0.065	6.210	10.855	0.705	**0.487**	0.185	**0.091**	**N.L. (3)**

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

Illinois Department of Transportation

LIQUEFACTION ANALYSIS

REFERENCE BORING NUMBER ==================================== B-19 N Abut
ELEVATION OF BORING GROUND SURFACE ========================= 438.00 FT.
DEPTH TO GROUNDWATER - DURING DRILLING ===================== 16.00 FT. (Below Boring Ground Surface)
DEPTH TO GROUNDWATER - DURING EARTHQUAKE ================== 16.00 FT. (Below Finished Grade Cut or Fill Surface)
PEAK HORIZ. GROUND SURFACE ACCELERATION COEFFICIENT (As) ===== 0.433
EARTHQUAKE MOMENT MAGNITUDE =============================== 5.1
FINISHED GRADE FILL OR CUT FROM BORING SURFACE ============== 3.13 FT. (Fill Height)
HAMMER EFFICIENCY=== 73 %
BOREHOLE DIAMETER=== 6 IN.
SAMPLING METHOD=== Sampler w/out Liners

EQ MAGNITUDE SCALING FACTOR
(MSF) = **2.362**

AVG. SHEAR WAVE VELOCITY (top 40')
$V^{*}_{s,40'}$ = **381** FT./SEC.

PGA CALCULATOR
Earthquake Moment Magnitude = 5.1
Source-To-Site Distance, R (km) = 10
Ground Motion Prediction Equations = CEUS
PGA = **0.297**

ELEV. OF SAMPLE (FT.)	BORING DATA: 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 (%)	CONDITIONS DURING DRILLING: 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 $CRR_{7.5}$	CONDITIONS DURING EARTHQUAKE: 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
435.5	2.5	2	0.3					0.108	0.270	3.494	3.494	0.061	0.108	0.646	0.646	1.268	**0.184**	0.889	**0.250**	**N.L. (1)**
433	5	3	0.5					0.114	0.555	4.759	4.759	0.070	0.114	0.931	0.931	1.179	**0.196**	0.831	**0.234**	**N.L. (1)**
430.5	7.5	4	0.5					0.114	0.840	5.848	5.848	0.079	0.114	1.216	1.216	1.121	**0.208**	0.769	**0.217**	**N.L. (1)**
428	10	4	0.3					0.108	1.110	5.847	5.847	0.079	0.108	1.486	1.486	1.076	**0.199**	0.706	**0.199**	**N.L. (1)**
425.5	12.5	5	0.3					0.108	1.380	7.182	7.182	0.089	0.108	1.756	1.756	1.041	**0.219**	0.643	**0.181**	**N.L. (1)**
423	15	3						0.105	1.643	4.195	4.195	0.066	0.043	1.863	1.996	1.026	**0.161**	0.583	**0.176**	**0.915 (C)**
420.5	17.5	4	0.2		12	36	36	0.042	1.748	5.603	5.603	0.077	0.042	1.968	2.257	1.015	**0.184**	0.527	**0.170**	**N.L. (2)**
418	20	4	0.1		12	34	34	0.035	1.835	5.595	5.595	0.077	0.035	2.056	2.501	1.006	**0.182**	0.477	**0.163**	**N.L. (2)**
415.5	22.5	5	1.5		12	28	28	0.064	1.995	6.837	6.837	0.086	0.064	2.216	2.817	0.991	**0.202**	0.433	**0.155**	**N.L. (2)**
413	25	4	1	50	12	20	20	0.059	2.143	5.348	11.417	0.126	0.059	2.363	3.120	0.974	**0.290**	0.395	**0.147**	**N.L. (2)**
410.5	27.5	11	0.5	50	12	24	24	0.051	2.270	14.501	22.401	0.248	0.051	2.491	3.404	0.951	**0.557**	0.363	**0.140**	**N.L. (2)**
408	30	27	0.5	50				0.051	2.398	39.525	52.430	0.329	0.051	2.618	3.687	0.919	**0.715**	0.337	**0.133**	**N.L. (3)**
403	35	5	0.3		12	26	26	0.046	2.628	6.179	6.179	0.081	0.046	2.848	4.229	0.941	**0.180**	0.298	**0.125**	**N.L. (2)**
398	40	8	0.2		12	21	21	0.042	2.838	9.560	9.560	0.109	0.042	3.058	4.751	0.920	**0.237**	0.273	**0.119**	**N.L. (2)**
393	45	9	0.6		12	21	21	0.053	3.103	10.308	10.308	0.116	0.053	3.323	5.328	0.900	**0.246**	0.258	**0.116**	**N.L. (2)**
388	50	15	0.4		12	21	21	0.049	3.348	16.825	16.825	0.179	0.049	3.568	5.885	0.867	**0.366**	0.248	**0.115**	**N.L. (2)**
383	55	11	0.4		12	50	50	0.049	3.593	11.688	11.688	0.128	0.049	3.813	6.442	0.868	**0.263**	0.243	**0.115**	**N.L. (2)**
378	60	9	0.3		12	23	23	0.046	3.823	9.235	9.235	0.106	0.046	4.043	6.984	0.864	**0.217**	0.239	**0.116**	**N.L. (2)**
373	65	11	0.3		12	19	19	0.046	4.053	10.901	10.901	0.121	0.046	4.273	7.526	0.847	**0.242**	0.230	**0.114**	**N.L. (2)**
368	70	12	0.8		12	22	22	0.057	4.338	11.400	11.400	0.126	0.057	4.558	8.123	0.832	**0.247**	0.223	**0.112**	**N.L. (2)**
363	75	8	0.6		12	26	26	0.053	4.603	7.323	7.323	0.090	0.053	4.823	8.700	0.838	**0.179**	0.216	**0.110**	**N.L. (2)**
358	80	13	0.6		12	25	25	0.053	4.868	11.494	11.494	0.127	0.053	5.088	9.277	0.810	**0.242**	0.209	**0.107**	**N.L. (2)**
353	85	24	1.5		12	22	22	0.064	5.188	21.173	21.173	0.231	0.064	5.408	9.909	0.754	**0.411**	0.202	**0.104**	**N.L. (2)**

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

Appendix C

Illinois Department of Transportation

IDOT STATIC METHOD OF ESTIMATING PILE LENGTH

SUBSTRUCTURE==================================== N Abutment (SN060-0229)
REFERENCE BORING ================================ B-19
LRFD or ASD or SEISMIC ============================== LRFD
PILE CUTOFF ELEV. ================================= 439.92 ft
GROUND SURFACE ELEV. AGAINST PILE DURING DRIVING = 438.92 ft
GEOTECHNICAL LOSS TYPE (None, Scour, Liquef., DD) ===== None
BOTTOM ELEV. OF SCOUR, LIQUEF., or DD ================= ft
TOP ELEV. OF LIQUEF. (so layers above apply DD) =============== ft

TOTAL FACTORED SUBSTRUCTURE LOAD ============== 1700 kips
TOTAL LENGTH OF SUBSTRUCTURE (along skew)========= 96.53 ft
NUMBER OF ROWS OF PILES PER SUBSTRUCTURE ====== 1
Approx. Factored Loading Applied per pile at 8 ft. Cts ============ 140.89 KIPS
Approx. Factored Loading Applied per pile at 3 ft. Cts ============ 52.83 KIPS

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

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
929 KIPS	**929** KIPS	**511** KIPS	**100** 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 SIDE RESIST. (KIPS)	NOMINAL END BRG. RESIST. (KIPS)	NOMINAL 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.)
435.50	3.42	0.30	2		4.0		9.6	5.9		**6.8**	7	0	0	4	4
433.00	2.50		3	Fine Sand	0.6	5.6	15.2	0.9	0.9	**8.5**	9	0	0	5	7
430.50	2.50		4	Fine Sand	0.8	10.6	11.6	1.2	1.7	**9.0**	9	0	0	5	9
428.00	2.50	0.30	4		2.9	6.2	14.6	4.3	1.0	**13.3**	13	0	0	7	12
425.50	2.50	0.30	5		2.9	6.2	**15.5**	4.3	1.0	17.3	15	0	0	9	14
423.00	2.50	0.20	3		2.0	4.1	**15.4**	2.9	0.7	19.9	15	0	0	8	17
420.50	2.50	0.10	4		1.0	2.1	**18.5**	1.5	0.3	21.7	18	0	0	10	19
418.00	2.50	0.20	4		2.0	4.1	30.1	2.9	0.7	**26.2**	26	0	0	14	22
415.50	2.50		5	Very Fine Silty Sand	0.9	13.7	31.9	1.4	2.2	**27.7**	28	0	0	15	24
413.00	2.50		4	Clean Coarse Sand	1.0	14.6	58.5	1.4	2.4	**33.3**	33	0	0	18	27
410.50	2.50		11	Clean Coarse Sand	2.7	40.3	119.7	3.9	6.5	**46.7**	47	0	0	26	29
408.00	2.50		27	Medium Sand	6.0	98.8	45.2	8.8	16.1	**42.5**	43	0	0	23	32
403.00	5.00		5	Medium Sand	2.2	18.3	**33.3**	3.2	3.0	43.4	33	0	0	18	37
398.00	5.00	0.20	8		4.0	4.1	**45.5**	5.8	0.7	50.6	45	0	0	25	42
393.00	5.00	0.60	9		11.1	12.4	**52.5**	16.4	2.0	66.3	53	0	0	29	47
388.00	5.00	0.40	15		7.7	8.2	**60.2**	11.3	1.3	77.6	60	0	0	33	52
383.00	5.00	0.40	11		7.7	8.2	**65.8**	11.3	1.3	88.6	66	0	0	36	57
378.00	5.00	0.30	9		5.9	6.2	**71.7**	8.6	1.0	97.2	72	0	0	39	62
373.00	5.00	0.30	11		5.9	6.2	**87.9**	8.6	1.0	107.5	88	0	0	48	67
368.00	5.00	0.80	12		14.3	16.5	**106.3**	21.0	2.7	129.1	106	0	0	58	72
363.00	5.00	1.00	8		17.2	20.6	**123.6**	25.3	3.3	154.4	124	0	0	68	77
358.00	5.00	1.00	13		17.2	20.6	**161.4**	25.3	3.3	183.1	161	0	0	89	82
349.50	8.50	2.00	24		48.0	41.2	351.2	70.4	6.7	**276.5**	277	0	0	152	90
348.50	1.00			Shale	60.4	183.0	411.6	88.7	29.8	**365.2**	365	0	0	201	91.4
347.50	1.00			Shale	60.4	183.0	472.0	88.7	29.8	**453.8**	454	0	0	250	92.4
346.50	1.00			Shale	60.4	183.0	**532.5**	88.7	29.8	542.5	532	0	0	293	93.4
345.50	1.00			Shale	60.4	183.0	**592.9**	88.7	29.8	631.1	593	0	0	326	94.4
344.50	1.00			Shale	60.4	183.0	**653.3**	88.7	29.8	719.8	653	0	0	359	95.4
343.50	1.00			Shale	60.4	183.0	**713.7**	88.7	29.8	808.5	714	0	0	393	96.4
342.50	1.00			Shale	60.4	183.0	**774.1**	88.7	29.8	897.1	774	0	0	426	97.4
341.50	1.00			Shale	60.4	183.0	**834.5**	88.7	29.8	985.8	835	0	0	459	98.4
340.50	1.00			Shale	60.4	183.0	**895.0**	88.7	29.8	1074.4	895	0	0	492	99.4
339.50	1.00			Shale	60.4	183.0	**955.4**	88.7	29.8	1163.1	~~955~~	~~0~~	~~0~~	~~525~~	~~100.4~~
338.50	1.00			Shale	60.4	183.0	**1015.8**	88.7	29.8	1251.7	~~1016~~	~~0~~	~~0~~	~~559~~	~~101.4~~
337.50	1.00			Shale	60.4	183.0	**1076.2**	88.7	29.8	1340.4	~~1076~~	~~0~~	~~0~~	~~592~~	~~102.4~~
336.50	1.00			Shale	60.4	183.0	**1136.6**	88.7	29.8	1429.0	~~1137~~	~~0~~	~~0~~	~~625~~	~~103.4~~
335.50	1.00			Shale	60.4	183.0	**1197.0**	88.7	29.8	1517.7	~~1197~~	~~0~~	~~0~~	~~658~~	~~104.4~~
334.50	1.00			Shale		183.0			29.8						

Pile Design Table for N Abutment (SN060-0229) utilizing Boring #B-19

	Nominal Required Bearing (Kips)	Factored Resistance Available (Kips)	Estimated Pile Length (Ft.)
Steel HP 10 X 42			
	80	44	77
	101	55	82
	179	99	90
	335	184	94
	335	184	96
Steel HP 10 X 57			
	81	45	77
	103	57	82
	184	101	90
	454	250	96
Steel HP 12 X 53			
	84	46	72
	98	54	77
	126	69	82
	215	118	90
	418	230	94
	418	230	96
Steel HP 12 X 63			
	85	47	72
	99	54	77
	127	70	82
	220	121	90
	497	273	95
	497	273	96
Steel HP 12 X 74			
	86	47	72
	100	55	77
	129	71	82
	224	123	90
	589	324	97
Steel HP 12 X 84			
	87	48	72
	102	56	77
	131	72	82
	227	125	90
	664	365	98
Steel HP 14 X 73			
	85	47	67
	102	56	72
	119	66	77
	155	85	82
	260	143	90
	578	318	95
	578	318	96
Steel HP 14 X 89			
	86	47	67
	104	57	72
	121	66	77
	157	86	82
	266	147	90
	705	388	97
Steel HP 14 X 102			
	87	48	67
	105	58	72
	122	67	77
	159	88	82
	271	149	90
	810	445	98
Steel HP 14 X 117			
	88	48	67
	106	58	72
	124	68	77
	161	89	82
	277	152	90
	929	511	100

Illinois Department of Transportation

IDOT STATIC METHOD OF ESTIMATING PILE LENGTH

SUBSTRUCTURE==================================== Int N Pier est. (SN060-0229)
REFERENCE BORING ================================ B-19
LRFD or ASD or SEISMIC ============================ LRFD
PILE CUTOFF ELEV. ================================ 439.92 ft
GROUND SURFACE ELEV. AGAINST PILE DURING DRIVING = 432.58 ft
GEOTECHNICAL LOSS TYPE (None, Scour, Liquef., DD) ===== None
BOTTOM ELEV. OF SCOUR, LIQUEF., or DD ================= ft
TOP ELEV. OF LIQUEF. (so layers above apply DD) =============== ft

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

Maximum Nominal Req'd Bearing of Pile	Maximum Nominal Req.d Bearing of Boring	Maximum Factored Resistance Available in Boring	Maximum Pile Driveable Length in Boring
929 KIPS	**929** KIPS	**511** KIPS	**100** FT.

TOTAL FACTORED SUBSTRUCTURE LOAD ============== 1700 kips
TOTAL LENGTH OF SUBSTRUCTURE (along skew)========= 96.53 ft
NUMBER OF ROWS OF PILES PER SUBSTRUCTURE ====== 1
Approx. Factored Loading Applied per pile at 8 ft. Cts ============ 140.89 KIPS
Approx. Factored Loading Applied per pile at 3 ft. Cts ============ 52.83 KIPS

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

BOT. OF LAYER ELEV. (FT.)	LAYER THICK. (FT.)	UNCONF. COMPR. STRENGTH (TSF.)	S.P.T. N VALUE (BLOWS)	GRANULAR OR ROCK LAYER DESCRIPTION	NOMINAL SIDE RESIST. (KIPS)	NOMINAL END BRG. RESIST. (KIPS)	NOMINAL 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.)
430.00	2.58	0.50	4		4.9		11.1	7.2		***8.2***	8	0	0	4	10
427.50	2.50	0.30	4		2.9	6.2	14.0	4.3	1.0	***12.5***	12	0	0	7	12
425.00	2.50	0.30	5		2.9	6.2	***14.9***	4.3	1.0	16.4	15	0	0	8	15
422.50	2.50	0.20	3		2.0	4.1	***14.8***	2.9	0.7	19.0	15	0	0	8	17
420.00	2.50	0.10	4		1.0	2.1	***17.9***	1.5	0.3	20.9	18	0	0	10	20
417.50	2.50	0.20	4		2.0	4.1	29.5	2.9	0.7	***25.3***	25	0	0	14	22
415.00	2.50		5	Very Fine Silty Sand	0.9	13.7	31.3	1.4	2.2	***26.9***	27	0	0	15	25
412.50	2.50		4	Clean Coarse Sand	1.0	14.6	57.9	1.4	2.4	***32.5***	32	0	0	18	27
410.00	2.50		11	Clean Coarse Sand	2.7	40.3	119.2	3.9	6.5	***45.9***	46	0	0	25	30
407.50	2.50		27	Medium Sand	6.0	98.8	44.6	8.8	16.1	***41.6***	42	0	0	23	32
402.50	5.00		5	Medium Sand	2.2	18.3	***32.7***	3.2	3.0	42.6	33	0	0	18	37
397.50	5.00	0.20	8		4.0	4.1	***44.9***	5.8	0.7	49.7	45	0	0	25	42
392.50	5.00	0.60	9		11.1	12.4	***51.9***	16.4	2.0	65.4	52	0	0	29	47
387.50	5.00	0.40	15		7.7	8.2	***59.6***	11.3	1.3	76.7	60	0	0	33	52
382.50	5.00	0.40	11		7.7	8.2	***65.2***	11.3	1.3	87.7	65	0	0	36	57
377.50	5.00	0.30	9		5.9	6.2	***71.1***	8.6	1.0	96.3	71	0	0	39	62
372.50	5.00	0.30	11		5.9	6.2	***87.3***	8.6	1.0	106.6	87	0	0	48	67
367.50	5.00	0.80	12		14.3	16.5	***105.7***	21.0	2.7	128.3	106	0	0	58	72
362.50	5.00	1.00	8		17.2	20.6	***123.0***	25.3	3.3	153.6	123	0	0	68	77
357.50	5.00	1.00	13		17.2	20.6	***160.8***	25.3	3.3	182.2	161	0	0	88	82
349.50	8.00	2.00	24		45.2	41.2	347.8	66.3	6.7	***271.5***	272	0	0	149	90
348.50	1.00			Shale	60.4	183.0	408.2	88.7	29.8	***360.2***	360	0	0	198	91.4
347.50	1.00			Shale	60.4	183.0	468.6	88.7	29.8	***448.8***	449	0	0	247	92.4
346.50	1.00			Shale	60.4	183.0	***529.0***	88.7	29.8	537.5	529	0	0	291	93.4
345.50	1.00			Shale	60.4	183.0	***589.5***	88.7	29.8	626.1	589	0	0	324	94.4
344.50	1.00			Shale	60.4	183.0	***649.9***	88.7	29.8	714.8	650	0	0	357	95.4
343.50	1.00			Shale	60.4	183.0	***710.3***	88.7	29.8	803.4	710	0	0	391	96.4
342.50	1.00			Shale	60.4	183.0	***770.7***	88.7	29.8	892.1	771	0	0	424	97.4
341.50	1.00			Shale	60.4	183.0	***831.1***	88.7	29.8	980.7	831	0	0	457	98.4
340.50	1.00			Shale	60.4	183.0	***891.5***	88.7	29.8	1069.4	892	0	0	490	99.4
339.50	1.00			Shale	60.4	183.0	***952.0***	88.7	29.8	1158.1	~~952~~	~~0~~	~~0~~	~~524~~	~~100.4~~
338.50	1.00			Shale	60.4	183.0	***1012.4***	88.7	29.8	1246.7	~~1012~~	~~0~~	~~0~~	~~557~~	~~101.4~~
337.50	1.00			Shale	60.4	183.0	***1072.8***	88.7	29.8	1335.4	~~1073~~	~~0~~	~~0~~	~~590~~	~~102.4~~
336.50	1.00			Shale	60.4	183.0	***1133.2***	88.7	29.8	1424.0	~~1133~~	~~0~~	~~0~~	~~623~~	~~103.4~~
335.50	1.00			Shale	60.4	183.0	***1193.6***	88.7	29.8	1512.7	~~1194~~	~~0~~	~~0~~	~~656~~	~~104.4~~
334.50	1.00			Shale		183.0			29.8						

Pile Design Table for Int N Pier est. (SN060-0229) utilizing Boring #B-19

	Nominal Required Bearing (Kips)	Factored Resistance Available (Kips)	Estimated Pile Length (Ft.)
Steel HP 8 X 36			
	79	44	82
	141	78	90
	286	157	95
	286	157	98
Steel HP 10 X 42			
	79	44	77
	100	55	82
	176	97	90
	335	184	94
	335	184	98
Steel HP 10 X 57			
	81	45	77
	103	57	82
	180	99	90
	454	250	96
	454	250	98
Steel HP 12 X 53			
	83	46	72
	98	54	77
	125	69	82
	210	116	90
	418	230	94
	418	230	98
Steel HP 12 X 63			
	84	46	72
	98	54	77
	127	70	82
	216	119	90
	497	273	95
	497	273	98
Steel HP 12 X 74			
	85	47	72
	100	55	77
	129	71	82
	220	121	90
	589	324	97
	589	324	98
Steel HP 12 X 84			
	87	48	72
	101	56	77
	131	72	82
	223	123	90
	664	365	98
Steel HP 14 X 73			
	84	46	67
	102	56	72
	119	65	77
	155	85	82
	255	141	90
	578	318	95
	578	318	98
Steel HP 14 X 89			
	85	47	67
	103	57	72
	120	66	77
	157	86	82
	262	144	90
	705	388	97
	705	388	98
Steel HP 14 X 102			
	86	47	67
	104	57	72
	121	67	77
	159	87	82
	266	146	90
	810	445	98
Steel HP 14 X 117			
	87	48	67
	106	58	72
	123	68	77
	161	88	82
	272	149	90
	929	511	100

Illinois Department of Transportation

IDOT STATIC METHOD OF ESTIMATING PILE LENGTH

SUBSTRUCTURE==================================== Int N Pier est. (SN060-0229)
REFERENCE BORING ================================ B-19
LRFD or ASD or SEISMIC =============================== LRFD
PILE CUTOFF ELEV. ================================= 439.92 ft
GROUND SURFACE ELEV. AGAINST PILE DURING DRIVING = 432.58 ft
GEOTECHNICAL LOSS TYPE (None, Scour, Liquef., DD) ===== Scour
BOTTOM ELEV. OF SCOUR, LIQUEF., or DD ============== 414.80 ft
TOP ELEV. OF LIQUEF. (so layers above apply DD) =============== ft

TOTAL FACTORED SUBSTRUCTURE LOAD ============== 1700 kips
TOTAL LENGTH OF SUBSTRUCTURE (along skew)========= 96.53 ft
NUMBER OF ROWS OF PILES PER SUBSTRUCTURE ====== 1

Approx. Factored Loading Applied per pile at 8 ft. Cts ============ 140.89 KIPS
Approx. Factored Loading Applied per pile at 3 ft. Cts ============ 52.83 KIPS

PILE TYPE AND SIZE ============= Steel HP 14 X 117

Pile Perimeter============================== 4.850 FT. Unplugged Pile Perimeter============== 7.117 FT.
Pile End Bearing Area========================== 1.469 SQFT. Unplugged Pile End Bearing Area======== 0.239 SQFT.

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
929 KIPS	**929** KIPS	**502** KIPS	**100** 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 SIDE RESIST. (KIPS)	NOMINAL END BRG. RESIST. (KIPS)	NOMINAL 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.)
430.00	2.58	0.50	4		4.9		11.1	7.2		***8.2***	8	3	0	2	10
427.50	2.50	0.30	4		2.9	6.2	14.0	4.3	1.0	***12.5***	12	4	0	3	12
425.00	2.50	0.30	5		2.9	6.2	***14.9***	4.3	1.0	16.4	15	6	0	2	15
422.50	2.50	0.20	3		2.0	4.1	***14.8***	2.9	0.7	19.0	15	7	0	1	17
420.00	2.50	0.10	4		1.0	2.1	***17.9***	1.5	0.3	20.9	18	8	0	2	20
417.50	2.50	0.20	4		2.0	4.1	29.5	2.9	0.7	***25.3***	25	9	0	5	22
415.00	2.50		5	Very Fine Silty Sand	0.9	13.7	31.3	1.4	2.2	***26.9***	27	9	0	6	25
412.50	2.50		4	Clean Coarse Sand	1.0	14.6	57.9	1.4	2.4	***32.5***	32	9	0	9	27
410.00	2.50		11	Clean Coarse Sand	2.7	40.3	119.2	3.9	6.5	***45.9***	46	9	0	16	30
407.50	2.50		27	Medium Sand	6.0	98.8	44.6	8.8	16.1	***41.6***	42	9	0	14	32
402.50	5.00		5	Medium Sand	2.2	18.3	***32.7***	3.2	3.0	42.6	33	9	0	9	37
397.50	5.00	0.20	8		4.0	4.1	***44.9***	5.8	0.7	49.7	45	9	0	16	42
392.50	5.00	0.60	9		11.1	12.4	***51.9***	16.4	2.0	65.4	52	9	0	19	47
387.50	5.00	0.40	15		7.7	8.2	***59.6***	11.3	1.3	76.7	60	9	0	24	52
382.50	5.00	0.40	11		7.7	8.2	***65.2***	11.3	1.3	87.7	65	9	0	27	57
377.50	5.00	0.30	9		5.9	6.2	***71.1***	8.6	1.0	96.3	71	9	0	30	62
372.50	5.00	0.30	11		5.9	6.2	***87.3***	8.6	1.0	106.6	87	9	0	39	67
367.50	5.00	0.80	12		14.3	16.5	***105.7***	21.0	2.7	128.3	106	9	0	49	72
362.50	5.00	1.00	8		17.2	20.6	***123.0***	25.3	3.3	153.6	123	9	0	58	77
357.50	5.00	1.00	13		17.2	20.6	***160.8***	25.3	3.3	182.2	161	9	0	79	82
349.50	8.00	2.00	24		45.2	41.2	347.8	66.3	6.7	***271.5***	272	9	0	140	90
348.50	1.00			Shale	60.4	183.0	408.2	88.7	29.8	***360.2***	360	9	0	189	91.4
347.50	1.00			Shale	60.4	183.0	468.6	88.7	29.8	***448.8***	449	9	0	238	92.4
346.50	1.00			Shale	60.4	183.0	***529.0***	88.7	29.8	537.5	529	9	0	282	93.4
345.50	1.00			Shale	60.4	183.0	***589.5***	88.7	29.8	626.1	589	9	0	315	94.4
344.50	1.00			Shale	60.4	183.0	***649.9***	88.7	29.8	714.8	650	9	0	348	95.4
343.50	1.00			Shale	60.4	183.0	***710.3***	88.7	29.8	803.4	710	9	0	381	96.4
342.50	1.00			Shale	60.4	183.0	***770.7***	88.7	29.8	892.1	771	9	0	415	97.4
341.50	1.00			Shale	60.4	183.0	***831.1***	88.7	29.8	980.7	831	9	0	448	98.4
340.50	1.00			Shale	60.4	183.0	***891.5***	88.7	29.8	1069.4	892	9	0	481	99.4
339.50	1.00			Shale	60.4	183.0	***952.0***	88.7	29.8	1158.1	~~952~~	~~9~~	~~0~~	~~514~~	~~100.4~~
338.50	1.00			Shale	60.4	183.0	***1012.4***	88.7	29.8	1246.7	~~1012~~	~~9~~	~~0~~	~~548~~	~~101.4~~
337.50	1.00			Shale	60.4	183.0	***1072.8***	88.7	29.8	1335.4	~~1073~~	~~9~~	~~0~~	~~581~~	~~102.4~~
336.50	1.00			Shale	60.4	183.0	***1133.2***	88.7	29.8	1424.0	~~1133~~	~~9~~	~~0~~	~~614~~	~~103.4~~
335.50	1.00			Shale	60.4	183.0	***1193.6***	88.7	29.8	1512.7	~~1194~~	~~9~~	~~0~~	~~647~~	~~104.4~~
334.50	1.00			Shale		183.0			29.8						

Pile Design Table for Int N Pier est. (SN060-0229) utilizing Boring #B-19

	Nominal Required Bearing (Kips)	Factored Resistance Available (Kips)	Estimated Pile Length (Ft.)
Steel HP 8 X 36			
	79	38	82
	141	73	90
	286	152	95
	286	152	98

	Nominal Required Bearing (Kips)	Factored Resistance Available (Kips)	Estimated Pile Length (Ft.)
Steel HP 10 X 42			
	100	49	82
	176	90	90
	335	178	94
	335	178	98
Steel HP 10 X 57			
	103	50	82
	180	93	90
	454	243	96
	454	243	98
Steel HP 12 X 53			
	98	46	77
	125	61	82
	210	108	90
	418	223	94
	418	223	98
Steel HP 12 X 63			
	98	47	77
	127	62	82
	216	111	90
	497	266	95
	497	266	98
Steel HP 12 X 74			
	100	47	77
	129	63	82
	220	113	90
	589	316	97
	589	316	98

	Nominal Required Bearing (Kips)	Factored Resistance Available (Kips)	Estimated Pile Length (Ft.)
Steel HP 12 X 84			
	101	48	77
	131	64	82
	223	115	90
	664	357	98
Steel HP 14 X 73			
	102	47	72
	119	56	77
	155	76	82
	255	132	90
	578	309	95
	578	309	98
Steel HP 14 X 89			
	103	48	72
	120	57	77
	157	77	82
	262	135	90
	705	379	97
	705	379	98
Steel HP 14 X 102			
	104	48	72
	121	58	77
	159	78	82
	266	137	90
	810	436	98
Steel HP 14 X 117			
	106	49	72
	123	58	77
	161	79	82
	272	140	90
	929	502	100
I			

Illinois Department of Transportation

IDOT STATIC METHOD OF ESTIMATING PILE LENGTH

SUBSTRUCTURE==================================== Int S Pier est. (SN060-0229)
REFERENCE BORING ================================ B-7
LRFD or ASD or SEISMIC =============================== LRFD
PILE CUTOFF ELEV. ================================= 440.00 ft
GROUND SURFACE ELEV. AGAINST PILE DURING DRIVING = 432.58 ft
GEOTECHNICAL LOSS TYPE (None, Scour, Liquef., DD) ===== None
BOTTOM ELEV. OF SCOUR, LIQUEF., or DD ================= ft
TOP ELEV. OF LIQUEF. (so layers above apply DD) =============== ft

TOTAL FACTORED SUBSTRUCTURE LOAD ============== 1700 kips
TOTAL LENGTH OF SUBSTRUCTURE (along skew)========= 96.53 ft
NUMBER OF ROWS OF PILES PER SUBSTRUCTURE ====== 1
Approx. Factored Loading Applied per pile at 8 ft. Cts ============ 140.89 KIPS
Approx. Factored Loading Applied per pile at 3 ft. Cts ============ 52.83 KIPS

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

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
929 KIPS	929 KIPS	511 KIPS	95 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 SIDE RESIST. (KIPS)	NOMINAL END BRG. RESIST. (KIPS)	NOMINAL 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.)
430.00	2.58		0	Very Fine Silty Sand	0.0		1.6	0.0		0.3	0	0	0	0	10
427.50	2.50		1	Very Fine Silty Sand	0.2	1.6	2.6	0.3	0.3	0.7	1	0	0	0	13
425.00	2.50		1	Very Fine Silty Sand	0.2	2.4	5.9	0.3	0.4	1.4	1	0	0	1	15
422.50	2.50		2	Very Fine Silty Sand	0.4	5.5	10.6	0.6	0.9	2.7	3	0	0	1	18
420.00	2.50	0.48	3		4.6	9.9	13.5	6.7	1.6	9.1	9	0	0	5	20
417.50	2.50		3	Very Fine Silty Sand	0.6	8.2	64.4	0.8	1.3	18.1	18	0	0	10	23
415.00	2.50		16	Fine Sand	3.3	58.6	36.7	4.9	9.5	18.0	18	0	0	10	25
412.50	2.50		10	Very Fine Silty Sand	1.9	27.5	102.6	2.8	4.5	31.1	31	0	0	17	28
410.00	2.50		25	Medium Sand	5.5	91.5	64.2	8.1	14.9	32.1	32	0	0	18	30
407.50	2.50		13	Medium Sand	2.9	47.6	60.5	4.2	7.7	35.2	35	0	0	19	33
402.50	5.00	1.99	10		28.2	41.0	98.7	41.3	6.7	78.2	78	0	0	43	38
397.50	5.00	2.48	11		32.5	51.1	121.1	47.7	8.3	124.2	121	0	0	67	43
392.50	5.00	1.99	11		28.2	41.0	141.2	41.3	6.7	164.2	141	0	0	78	48
387.50	5.00	1.60	10		24.4	32.9	190.3	35.8	5.4	204.0	190	0	0	105	53
382.50	5.00	2.80	14		35.3	57.7	196.2	51.8	9.4	251.1	196	0	0	108	58
377.50	5.00	1.37	8		21.9	28.2	252.3	32.1	4.6	288.8	252	0	0	139	63
372.50	5.00	3.03	15		37.4	62.4	283.7	54.8	10.1	342.6	284	0	0	156	68
367.50	5.00	2.74	9		34.8	56.4	305.1	51.1	9.2	391.5	305	0	0	168	73
362.50	5.00	2.09	16		29.0	43.0	320.5	42.6	7.0	431.9	321	0	0	176	78
357.50	5.00	1.43	12		22.6	29.4	347.6	33.1	4.8	465.7	348	0	0	191	83
352.00	5.50	1.65	31		27.4	34.0	524.0	40.2	5.5	530.2	524	0	0	288	88
351.00	1.00			Shale	60.4	183.0	584.5	88.7	29.8	618.8	584	0	0	321	89
350.00	1.00			Shale	60.4	183.0	644.9	88.7	29.8	707.5	645	0	0	355	90
349.00	1.00			Shale	60.4	183.0	705.3	88.7	29.8	796.1	705	0	0	388	91
348.00	1.00			Shale	60.4	183.0	765.7	88.7	29.8	884.8	766	0	0	421	92
347.00	1.00			Shale	60.4	183.0	826.1	88.7	29.8	973.4	826	0	0	454	93
346.00	1.00			Shale	60.4	183.0	886.6	88.7	29.8	1062.1	887	0	0	488	94
345.00	1.00			Shale	60.4	183.0	947.0	88.7	29.8	1150.7	~~947~~	~~0~~	~~0~~	~~521~~	~~95~~
344.00	1.00			Shale	60.4	183.0	1007.4	88.7	29.8	1239.4	~~1007~~	~~0~~	~~0~~	~~554~~	~~96~~
343.00	1.00			Shale	60.4	183.0	1067.8	88.7	29.8	1328.0	~~1068~~	~~0~~	~~0~~	~~587~~	~~97~~
342.00	1.00			Shale	60.4	183.0	1128.2	88.7	29.8	1416.7	~~1128~~	~~0~~	~~0~~	~~621~~	~~98~~
341.00	1.00			Shale	60.4	183.0	1188.6	88.7	29.8	1505.3	~~1189~~	~~0~~	~~0~~	~~654~~	~~99~~
340.00	1.00			Shale	60.4	183.0	1249.1	88.7	29.8	1594.0	~~1249~~	~~0~~	~~0~~	~~687~~	~~100~~
339.00	1.00			Shale	60.4	183.0	1309.5	88.7	29.8	1682.6	~~1309~~	~~0~~	~~0~~	~~720~~	~~101~~
338.00	1.00			Shale	60.4	183.0	1369.9	88.7	29.8	1771.3	~~1370~~	~~0~~	~~0~~	~~753~~	~~102~~
337.00	1.00			Shale	60.4	183.0	1430.3	88.7	29.8	1860.0	~~1430~~	~~0~~	~~0~~	~~787~~	~~103~~
336.00	1.00			Shale		183.0			29.8						

Pile Design Table for Int S Pier est. (SN060-0229) utilizing Boring #B-7

	Nominal Required Bearing (Kips)	Factored Resistance Available (Kips)	Estimated Pile Length (Ft.)
Steel HP 8 X 36			
	92	50	53
	102	56	58
	125	69	63
	144	79	68
	159	87	73
	171	94	78
	185	102	83
	246	135	88
	286	157	90

	Nominal Required Bearing (Kips)	Factored Resistance Available (Kips)	Estimated Pile Length (Ft.)
Steel HP 10 X 42			
	89	49	48
	117	64	53
	127	70	58
	158	87	63
	181	99	68
	198	109	73
	212	116	78
	229	126	83
	317	174	88
	335	184	89
Steel HP 10 X 57			
	91	50	48
	120	66	53
	130	72	58
	162	89	63
	185	102	68
	203	111	73
	216	119	78
	234	129	83
	325	179	88
	454	250	92
	454	250	96
Steel HP 12 X 53			
	93	51	43
	111	61	48
	147	81	53
	156	86	58
	197	108	63
	224	123	68
	243	134	73
	258	142	78
	279	154	83
	401	221	88
	418	230	89
Steel HP 12 X 63			
	94	52	43
	112	61	48
	149	82	53
	158	87	58
	199	109	63
	226	124	68
	245	135	73
	260	143	78
	282	155	83
	406	223	88
	497	273	90
Steel HP 12 X 74			
	95	53	43
	113	62	48
	151	83	53
	160	88	58
	202	111	63
	229	126	68
	249	137	73
	264	145	78
	286	157	83
	412	227	88
	589	324	92
	589	324	96

	Nominal Required Bearing (Kips)	Factored Resistance Available (Kips)	Estimated Pile Length (Ft.)
Steel HP 12 X 84			
	64	35	38
	97	53	43
	115	63	48
	153	84	53
	162	89	58
	205	113	63
	232	128	68
	252	139	73
	267	147	78
	289	159	83
	419	231	88
	664	365	93
	664	365	96
Steel HP 14 X 73			
	74	41	38
	116	64	43
	136	75	48
	183	100	53
	189	104	58
	243	133	63
	273	150	68
	294	162	73
	310	170	78
	336	185	83
	502	276	88
	578	318	90
Steel HP 14 X 89			
	75	41	38
	118	65	43
	138	76	48
	185	102	53
	192	105	58
	246	135	63
	277	152	68
	298	164	73
	313	172	78
	340	187	83
	509	280	88
	705	388	92
	705	388	96
Steel HP 14 X 102			
	77	42	38
	119	66	43
	139	77	48
	188	103	53
	194	107	58
	249	137	63
	280	154	68
	301	166	73
	317	174	78
	344	189	83
	517	284	88
	810	445	93
	810	445	96
Steel HP 14 X 117			
	78	43	38
	121	67	43
	141	78	48
	190	105	53
	196	108	58
	252	139	63
	284	156	68
	305	168	73
	321	176	78
	348	191	83
	524	288	88
	929	511	95
	929	511	96

Illinois Department of Transportation

IDOT STATIC METHOD OF ESTIMATING PILE LENGTH

SUBSTRUCTURE=================================== Int S Pier est. (SN060-0229)
REFERENCE BORING ================================ B-7
LRFD or ASD or SEISMIC ============================ LRFD
PILE CUTOFF ELEV. ================================ 440.00 ft
GROUND SURFACE ELEV. AGAINST PILE DURING DRIVING = 432.58 ft
GEOTECHNICAL LOSS TYPE (None, Scour, Liquef., DD) ===== Scour
BOTTOM ELEV. OF SCOUR, LIQUEF., or DD ============== 414.80 ft
TOP ELEV. OF LIQUEF. (so layers above apply DD) =============== ft

TOTAL FACTORED SUBSTRUCTURE LOAD ============= 1700 kips
TOTAL LENGTH OF SUBSTRUCTURE (along skew)========= 96.53 ft
NUMBER OF ROWS OF PILES PER SUBSTRUCTURE ====== 1
Approx. Factored Loading Applied per pile at 8 ft. Cts ============ 140.89 KIPS
Approx. Factored Loading Applied per pile at 3 ft. Cts ============ 52.83 KIPS

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

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
929 KIPS	**929** KIPS	**506** KIPS	**95** 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 SIDE RESIST. (KIPS)	NOMINAL END BRG. RESIST. (KIPS)	NOMINAL 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.)
430.00	2.58		0	Very Fine Silty Sand	0.0		1.6	0.0		0.3	0	0	0	0	10
427.50	2.50		1	Very Fine Silty Sand	0.2	1.6	2.6	0.3	0.3	0.7	1	0	0	0	13
425.00	2.50		1	Very Fine Silty Sand	0.2	2.4	5.9	0.3	0.4	1.4	1	0	0	1	15
422.50	2.50		2	Very Fine Silty Sand	0.4	5.5	10.6	0.6	0.9	2.7	3	0	0	1	18
420.00	2.50	0.48	3		4.6	9.9	13.5	6.7	1.6	9.1	9	3	0	2	20
417.50	2.50		3	Very Fine Silty Sand	0.6	8.2	64.4	0.8	1.3	18.1	18	3	0	7	23
415.00	2.50		16	Fine Sand	3.3	58.6	36.7	4.9	9.5	18.0	18	5	0	5	25
412.50	2.50		10	Very Fine Silty Sand	1.9	27.5	102.6	2.8	4.5	31.1	31	5	0	12	28
410.00	2.50		25	Medium Sand	5.5	91.5	64.2	8.1	14.9	32.1	32	5	0	13	30
407.50	2.50		13	Medium Sand	2.9	47.6	60.5	4.2	7.7	35.2	35	5	0	14	33
402.50	5.00	1.99	10		28.2	41.0	98.7	41.3	6.7	78.2	78	5	0	38	38
397.50	5.00	2.48	11		32.5	51.1	121.1	47.7	8.3	124.2	121	5	0	62	43
392.50	5.00	1.99	11		28.2	41.0	141.2	41.3	6.7	164.2	141	5	0	73	48
387.50	5.00	1.60	10		24.4	32.9	190.3	35.8	5.4	204.0	190	5	0	100	53
382.50	5.00	2.80	14		35.3	57.7	196.2	51.8	9.4	251.1	196	5	0	103	58
377.50	5.00	1.37	8		21.9	28.2	252.3	32.1	4.6	288.8	252	5	0	134	63
372.50	5.00	3.03	15		37.4	62.4	283.7	54.8	10.1	342.6	284	5	0	151	68
367.50	5.00	2.74	9		34.8	56.4	305.1	51.1	9.2	391.5	305	5	0	163	73
362.50	5.00	2.09	16		29.0	43.0	320.5	42.6	7.0	431.9	321	5	0	171	78
357.50	5.00	1.43	12		22.6	29.4	347.6	33.1	4.8	465.7	348	5	0	186	83
352.00	5.50	1.65	31		27.4	34.0	524.0	40.2	5.5	530.2	524	5	0	283	88
351.00	1.00			Shale	60.4	183.0	584.5	88.7	29.8	618.8	584	5	0	316	89
350.00	1.00			Shale	60.4	183.0	644.9	88.7	29.8	707.5	645	5	0	350	90
349.00	1.00			Shale	60.4	183.0	705.3	88.7	29.8	796.1	705	5	0	383	91
348.00	1.00			Shale	60.4	183.0	765.7	88.7	29.8	884.8	766	5	0	416	92
347.00	1.00			Shale	60.4	183.0	826.1	88.7	29.8	973.4	826	5	0	449	93
346.00	1.00			Shale	60.4	183.0	886.6	88.7	29.8	1062.1	887	5	0	483	94
345.00	1.00			Shale	60.4	183.0	947.0	88.7	29.8	1150.7	~~947~~	~~5~~	~~0~~	~~516~~	~~95~~
344.00	1.00			Shale	60.4	183.0	1007.4	88.7	29.8	1239.4	~~1007~~	~~5~~	~~0~~	~~549~~	~~96~~
343.00	1.00			Shale	60.4	183.0	1067.8	88.7	29.8	1328.0	~~1068~~	~~5~~	~~0~~	~~582~~	~~97~~
342.00	1.00			Shale	60.4	183.0	1128.2	88.7	29.8	1416.7	~~1128~~	~~5~~	~~0~~	~~615~~	~~98~~
341.00	1.00			Shale	60.4	183.0	1188.6	88.7	29.8	1505.3	~~1189~~	~~5~~	~~0~~	~~649~~	~~99~~
340.00	1.00			Shale	60.4	183.0	1249.1	88.7	29.8	1594.0	~~1249~~	~~5~~	~~0~~	~~682~~	~~100~~
339.00	1.00			Shale	60.4	183.0	1309.5	88.7	29.8	1682.6	~~1309~~	~~5~~	~~0~~	~~715~~	~~101~~
338.00	1.00			Shale	60.4	183.0	1369.9	88.7	29.8	1771.3	~~1370~~	~~5~~	~~0~~	~~748~~	~~102~~
337.00	1.00			Shale	60.4	183.0	1430.3	88.7	29.8	1860.0	~~1430~~	~~5~~	~~0~~	~~782~~	~~103~~
336.00	1.00			Shale		183.0			29.8						

Pile Design Table for Int S Pier est. (SN060-0229) utilizing Boring #B-7

	Nominal Required Bearing (Kips)	Factored Resistance Available (Kips)	Estimated Pile Length (Ft.)
Steel HP 8 X 36			
	92	48	53
	102	53	58
	125	66	63
	144	76	68
	159	85	73
	171	91	78
	185	99	83
	246	133	88
	286	155	90
Steel HP 10 X 42			
	89	45	48
	117	61	53
	127	67	58
	158	84	63
	181	96	68
	198	106	73
	212	113	78
	229	123	83
	317	171	88
	335	181	89
Steel HP 10 X 57			
	91	47	48
	120	62	53
	130	68	58
	162	85	63
	185	98	68
	203	108	73
	216	115	78
	234	125	83
	325	175	88
	454	246	92
	454	246	96
Steel HP 12 X 53			
	93	47	43
	111	57	48
	147	77	53
	156	82	58
	197	104	63
	224	119	68
	243	130	73
	258	138	78
	279	149	83
	401	217	88
	418	226	89
Steel HP 12 X 63			
	94	48	43
	112	57	48
	149	78	53
	158	83	58
	199	105	63
	226	120	68
	245	131	73
	260	139	78
	282	151	83
	406	219	88
	497	269	90
Steel HP 12 X 74			
	95	48	43
	113	58	48
	151	79	53
	160	84	58
	202	107	63
	229	122	68
	249	133	73
	264	141	78
	286	153	83
	412	223	88
	589	320	92
	589	320	96
Steel HP 12 X 84			
	97	49	43
	115	59	48
	153	80	53
	162	85	58
	205	109	63
	232	124	68
	252	134	73
	267	143	78
	289	155	83
	419	226	88
	664	361	93
	664	361	96
Steel HP 14 X 73			
	74	36	38
	116	59	43
	136	70	48
	183	96	53
	189	99	58
	243	129	63
	273	145	68
	294	157	73
	310	165	78
	336	180	83
	502	271	88
	578	313	90
Steel HP 14 X 89			
	75	37	38
	118	60	43
	138	71	48
	185	97	53
	192	100	58
	246	130	63
	277	147	68
	298	159	73
	313	167	78
	340	182	83
	509	275	88
	705	383	92
	705	383	96
Steel HP 14 X 102			
	77	37	38
	119	61	43
	139	72	48
	188	98	53
	194	102	58
	249	132	63
	280	149	68
	301	161	73
	317	169	78
	344	184	83
	517	279	88
	810	440	93
	810	440	96
Steel HP 14 X 117			
	78	38	38
	121	62	43
	141	73	48
	190	100	53
	196	103	58
	252	134	63
	284	151	68
	305	163	73
	321	171	78
	348	186	83
	524	283	88
	929	506	95
	929	506	96

Illinois Department of Transportation

IDOT STATIC METHOD OF ESTIMATING PILE LENGTH

SUBSTRUCTURE==================================== S Abutment (SN060-0229)
REFERENCE BORING ================================ B-7
LRFD or ASD or SEISMIC ============================== LRFD
PILE CUTOFF ELEV. ================================= 440.00 ft
GROUND SURFACE ELEV. AGAINST PILE DURING DRIVING = 439.00 ft
GEOTECHNICAL LOSS TYPE (None, Scour, Liquef., DD) ===== None
BOTTOM ELEV. OF SCOUR, LIQUEF., or DD ================= ft
TOP ELEV. OF LIQUEF. (so layers above apply DD) ============== ft

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

Maximum Nominal Req'd Bearing of Pile	Maximum Nominal Req.d Bearing of Boring	Maximum Factored Resistance Available in Boring	Maximum Pile Driveable Length in Boring
929 KIPS	**929** KIPS	**511** KIPS	**95** FT.

TOTAL FACTORED SUBSTRUCTURE LOAD ============== 1700 kips
TOTAL LENGTH OF SUBSTRUCTURE (along skew)========== 96.53 ft
NUMBER OF ROWS OF PILES PER SUBSTRUCTURE ====== 1
Approx. Factored Loading Applied per pile at 8 ft. Cts ============ 140.89 KIPS
Approx. Factored Loading Applied per pile at 3 ft. Cts ============ 52.83 KIPS

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

BOT. OF LAYER ELEV. (FT.)	LAYER THICK. (FT.)	UNCONF. COMPR. STRENGTH (TSF.)	S.P.T. N VALUE (BLOWS)	GRANULAR OR ROCK LAYER DESCRIPTION	NOMINAL SIDE RESIST. (KIPS)	NOMINAL END BRG. RESIST. (KIPS)	NOMINAL 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.)
435.50	3.50		15	Clean Coarse Sand	5.1		24.0	7.4		***10.5***	11	0	0	6	5
433.00	2.50	0.92	13		8.0	18.9	***13.1***	11.8	3.1	19.3	13	0	0	7	7
430.50	2.50		0	Very Fine Silty Sand	0.0	0.0	***15.9***	0.0	0.0	19.7	16	0	0	9	10
428.00	2.50		1	Very Fine Silty Sand	0.2	2.7	***16.1***	0.3	0.4	20.0	16	0	0	9	12
425.50	2.50		1	Very Fine Silty Sand	0.2	2.7	***19.0***	0.3	0.4	20.7	19	0	0	10	15
423.00	2.50		2	Very Fine Silty Sand	0.4	5.5	23.8	0.6	0.9	***22.0***	22	0	0	12	17
420.50	2.50	0.48	3		4.6	9.9	***26.7***	6.7	1.6	28.4	27	0	0	15	20
418.00	2.50		3	Very Fine Silty Sand	0.6	8.2	77.6	0.8	1.3	***37.4***	37	0	0	21	22
415.50	2.50		16	Fine Sand	3.3	58.6	49.8	4.9	9.5	***37.2***	37	0	0	20	25
413.00	2.50		10	Very Fine Silty Sand	1.9	27.5	115.7	2.8	4.5	***50.4***	50	0	0	28	27
410.50	2.50		25	Medium Sand	5.5	91.5	77.3	8.1	14.9	***51.4***	51	0	0	28	30
408.00	2.50		13	Medium Sand	2.9	47.6	73.6	4.2	7.7	***54.5***	55	0	0	30	32
403.00	5.00	1.99	10		28.2	41.0	111.8	41.3	6.7	***97.5***	97	0	0	54	37
398.00	5.00	2.48	11		32.5	51.1	***134.2***	47.7	8.3	143.5	134	0	0	74	42
393.00	5.00	1.99	11		28.2	41.0	***154.3***	41.3	6.7	183.5	154	0	0	85	47
388.00	5.00	1.60	10		24.4	32.9	***203.4***	35.8	5.4	223.3	203	0	0	112	52
383.00	5.00	2.80	14		35.3	57.7	***209.3***	51.8	9.4	270.3	209	0	0	115	57
378.00	5.00	1.37	8		21.9	28.2	***265.4***	32.1	4.6	308.0	265	0	0	146	62
373.00	5.00	3.03	15		37.4	62.4	***296.8***	54.8	10.1	361.9	297	0	0	163	67
368.00	5.00	2.74	9		34.8	56.4	***318.2***	51.1	9.2	410.8	318	0	0	175	72
363.00	5.00	2.09	16		29.0	43.0	***333.6***	42.6	7.0	451.1	334	0	0	183	77
358.00	5.00	1.43	12		22.6	29.4	***360.7***	33.1	4.8	485.0	361	0	0	198	82
352.00	6.00	1.65	31		29.9	34.0	***539.7***	43.8	5.5	553.1	540	0	0	297	88
351.00	1.00			Shale	60.4	183.0	***600.1***	88.7	29.8	641.7	600	0	0	330	89
350.00	1.00			Shale	60.4	183.0	***660.5***	88.7	29.8	730.4	660	0	0	363	90
349.00	1.00			Shale	60.4	183.0	***720.9***	88.7	29.8	819.0	721	0	0	397	91
348.00	1.00			Shale	60.4	183.0	***781.3***	88.7	29.8	907.7	781	0	0	430	92
347.00	1.00			Shale	60.4	183.0	***841.7***	88.7	29.8	996.3	842	0	0	463	93
346.00	1.00			Shale	60.4	183.0	***902.2***	88.7	29.8	1085.0	902	0	0	496	94
345.00	1.00			Shale	60.4	183.0	***962.6***	88.7	29.8	1173.6	~~963~~	~~0~~	~~0~~	~~529~~	~~95~~
344.00	1.00			Shale	60.4	183.0	***1023.0***	88.7	29.8	1262.3	~~1023~~	~~0~~	~~0~~	~~563~~	~~96~~
343.00	1.00			Shale	60.4	183.0	***1083.4***	88.7	29.8	1350.9	~~1083~~	~~0~~	~~0~~	~~596~~	~~97~~
342.00	1.00			Shale	60.4	183.0	***1143.8***	88.7	29.8	1439.6	~~1144~~	~~0~~	~~0~~	~~629~~	~~98~~
341.00	1.00			Shale		183.0			29.8						

Pile Design Table for S Abutment (SN060-0229) utilizing Boring #B-7

	Nominal Required Bearing (Kips)	Factored Resistance Available (Kips)	Estimated Pile Length (Ft.)
Steel HP 8 X 36			
	78	43	47
	99	54	52
	109	60	57
	132	73	62
	151	83	67
	166	91	72
	178	98	77
	192	106	82
	255	140	88
	286	157	89
	286	157	94

	Nominal Required Bearing (Kips)	Factored Resistance Available (Kips)	Estimated Pile Length (Ft.)
Steel HP 10 X 42			
	82	45	42
	98	54	47
	126	69	52
	136	75	57
	167	92	62
	190	104	67
	207	114	72
	221	121	77
	238	131	82
	327	180	88
	335	184	89
	335	184	94
Steel HP 10 X 57			
	84	46	42
	100	55	47
	129	71	52
	139	77	57
	171	94	62
	194	107	67
	212	116	72
	225	124	77
	243	134	82
	336	185	88
	454	250	91
	454	250	94
Steel HP 12 X 53			
	76	42	37
	104	57	42
	121	67	47
	158	87	52
	167	92	57
	208	114	62
	234	129	67
	254	140	72
	268	148	77
	290	159	82
	414	228	88
	418	230	89
	418	230	94
Steel HP 12 X 63			
	78	43	37
	105	58	42
	123	67	47
	159	88	52
	169	93	57
	210	115	62
	237	130	67
	256	141	72
	271	149	77
	293	161	82
	419	230	88
	497	273	90
	497	273	94
Steel HP 12 X 74			
	79	44	37
	106	59	42
	124	68	47
	162	89	52
	171	94	57
	213	117	62
	240	132	67
	260	143	72
	275	151	77
	297	163	82
	426	234	88
	589	324	92
	589	324	94

	Nominal Required Bearing (Kips)	Factored Resistance Available (Kips)	Estimated Pile Length (Ft.)
Steel HP 12 X 84			
	80	44	37
	108	59	42
	126	69	47
	164	90	52
	173	95	57
	216	119	62
	244	134	67
	263	145	72
	278	153	77
	301	165	82
	432	238	88
	664	365	93
	664	365	94
Steel HP 14 X 73			
	93	51	37
	129	71	42
	149	82	47
	195	107	52
	202	111	57
	255	140	62
	286	157	67
	307	169	72
	322	177	77
	349	192	82
	517	285	88
	578	318	90
	578	318	94
Steel HP 14 X 89			
	94	52	37
	131	72	42
	150	83	47
	198	109	52
	204	112	57
	259	142	62
	290	159	67
	311	171	72
	326	179	77
	353	194	82
	525	289	88
	705	388	92
	705	388	94
Steel HP 14 X 102			
	96	53	37
	132	73	42
	152	84	47
	201	110	52
	207	114	57
	262	144	62
	293	161	67
	314	173	72
	330	181	77
	357	196	82
	532	293	88
	810	445	93
	810	445	94
Steel HP 14 X 117			
	55	30	32
	97	54	37
	134	74	42
	154	85	47
	203	112	52
	209	115	57
	265	146	62
	297	163	67
	318	175	72
	334	183	77
	361	198	82
	540	297	88
	929	511	95

Illinois Department of Transportation

IDOT STATIC METHOD OF ESTIMATING PILE LENGTH

SUBSTRUCTURE==================================== S Abutment (SN060-0229)
REFERENCE BORING ================================ B-7
LRFD or ASD or SEISMIC ============================== LRFD
PILE CUTOFF ELEV. ================================= 440.00 ft
GROUND SURFACE ELEV. AGAINST PILE DURING DRIVING = 439.00 ft
GEOTECHNICAL LOSS TYPE (None, Scour, Liquef., DD) ===== DD
BOTTOM ELEV. OF SCOUR, LIQUEF., or DD ============== 418.00 ft
TOP ELEV. OF LIQUEF. (so layers above apply DD) =============== ft

TOTAL FACTORED SUBSTRUCTURE LOAD ============== 1700 kips
TOTAL LENGTH OF SUBSTRUCTURE (along skew)========= 96.53 ft
NUMBER OF ROWS OF PILES PER SUBSTRUCTURE ====== 1
Approx. Factored Loading Applied per pile at 8 ft. Cts ============ 140.89 KIPS
Approx. Factored Loading Applied per pile at 3 ft. Cts ============ 52.83 KIPS

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

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
929 KIPS	**929** KIPS	**479** KIPS	**95** 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 SIDE RESIST. (KIPS)	NOMINAL END BRG. RESIST. (KIPS)	NOMINAL 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.)
435.50	3.50		15	Clean Coarse Sand	5.1		24.0	7.4		***10.5***	11	3	6	-3	5
433.00	2.50	0.92	13		8.0	18.9	***13.1***	11.8	3.1	19.3	13	7	14	-14	7
430.50	2.50		0	Very Fine Silty Sand	0.0	0.0	***15.9***	0.0	0.0	19.7	16	7	14	-13	10
428.00	2.50		1	Very Fine Silty Sand	0.2	2.7	***16.1***	0.3	0.4	20.0	16	7	15	-13	12
425.50	2.50		1	Very Fine Silty Sand	0.2	2.7	***19.0***	0.3	0.4	20.7	19	7	15	-12	15
423.00	2.50		2	Very Fine Silty Sand	0.4	5.5	23.8	0.6	0.9	***22.0***	22	8	15	-11	17
420.50	2.50	0.48	3		4.6	9.9	***26.7***	6.7	1.6	28.4	27	10	20	-16	20
418.00	2.50		3	Very Fine Silty Sand	0.6	8.2	77.6	0.8	1.3	***37.4***	37	10	21	-11	22
415.50	2.50		16	Fine Sand	3.3	58.6	49.8	4.9	9.5	***37.2***	37	10	21	-11	25
413.00	2.50		10	Very Fine Silty Sand	1.9	27.5	115.7	2.8	4.5	***50.4***	50	10	21	-4	27
410.50	2.50		25	Medium Sand	5.5	91.5	77.3	8.1	14.9	***51.4***	51	10	21	-3	30
408.00	2.50		13	Medium Sand	2.9	47.6	73.6	4.2	7.7	***54.5***	55	10	21	-1	32
403.00	5.00	1.99	10		28.2	41.0	111.8	41.3	6.7	***97.5***	97	10	21	22	37
398.00	5.00	2.48	11		32.5	51.1	***134.2***	47.7	8.3	143.5	134	10	21	42	42
393.00	5.00	1.99	11		28.2	41.0	***154.3***	41.3	6.7	183.5	154	10	21	53	47
388.00	5.00	1.60	10		24.4	32.9	***203.4***	35.8	5.4	223.3	203	10	21	80	52
383.00	5.00	2.80	14		35.3	57.7	***209.3***	51.8	9.4	270.3	209	10	21	84	57
378.00	5.00	1.37	8		21.9	28.2	***265.4***	32.1	4.6	308.0	265	10	21	115	62
373.00	5.00	3.03	15		37.4	62.4	***296.8***	54.8	10.1	361.9	297	10	21	132	67
368.00	5.00	2.74	9		34.8	56.4	***318.2***	51.1	9.2	410.8	318	10	21	144	72
363.00	5.00	2.09	16		29.0	43.0	***333.6***	42.6	7.0	451.1	334	10	21	152	77
358.00	5.00	1.43	12		22.6	29.4	***360.7***	33.1	4.8	485.0	361	10	21	167	82
352.00	6.00	1.65	31		29.9	34.0	***539.7***	43.8	5.5	553.1	540	10	21	265	88
351.00	1.00			Shale	60.4	183.0	***600.1***	88.7	29.8	641.7	600	10	21	299	89
350.00	1.00			Shale	60.4	183.0	***660.5***	88.7	29.8	730.4	660	10	21	332	90
349.00	1.00			Shale	60.4	183.0	***720.9***	88.7	29.8	819.0	721	10	21	365	91
348.00	1.00			Shale	60.4	183.0	***781.3***	88.7	29.8	907.7	781	10	21	398	92
347.00	1.00			Shale	60.4	183.0	***841.7***	88.7	29.8	996.3	842	10	21	432	93
346.00	1.00			Shale	60.4	183.0	***902.2***	88.7	29.8	1085.0	902	10	21	465	94
345.00	1.00			Shale	60.4	183.0	***962.6***	88.7	29.8	1173.6	~~963~~	~~10~~	~~21~~	~~498~~	~~95~~
344.00	1.00			Shale	60.4	183.0	***1023.0***	88.7	29.8	1262.3	~~1023~~	~~10~~	~~21~~	~~531~~	~~96~~
343.00	1.00			Shale	60.4	183.0	***1083.4***	88.7	29.8	1350.9	~~1083~~	~~10~~	~~21~~	~~564~~	~~97~~
342.00	1.00			Shale	60.4	183.0	***1143.8***	88.7	29.8	1439.6	~~1144~~	~~10~~	~~21~~	~~598~~	~~98~~
341.00	1.00			Shale		183.0			29.8						

Pile Design Table for S Abutment (SN060-0229) utilizing Boring #B-7

	Nominal Required Bearing (Kips)	Factored Resistance Available (Kips)	Estimated Pile Length (Ft.)
Steel HP 8 X 36			
	109	43	57
	132	55	62
	151	66	67
	166	74	72
	178	81	77
	192	88	82
	255	123	88
	286	140	89
	286	140	94
Steel HP 10 X 42			
	126	48	52
	136	54	57
	167	70	62
	190	83	67
	207	93	72
	221	100	77
	238	110	82
	327	159	88
	335	163	89
	335	163	94
Steel HP 10 X 57			
	129	49	52
	139	55	57
	171	72	62
	194	85	67
	212	95	72
	225	102	77
	243	112	82
	336	163	88
	454	228	91
	454	228	94
Steel HP 12 X 53			
	121	41	47
	158	61	52
	167	66	57
	208	89	62
	234	103	67
	254	114	72
	268	122	77
	290	134	82
	414	202	88
	418	204	89
	418	204	94
Steel HP 12 X 63			
	123	42	47
	159	62	52
	169	67	57
	210	90	62
	237	104	67
	256	115	72
	271	123	77
	293	135	82
	419	204	88
	497	247	90
	497	247	94
Steel HP 12 X 74			
	124	42	47
	162	63	52
	171	68	57
	213	91	62
	240	106	67
	260	117	72
	275	125	77
	297	137	82
	426	208	88
	589	298	92
	589	298	94
Steel HP 12 X 84			
	126	43	47
	164	64	52
	173	69	57
	216	92	62
	244	107	67
	263	118	72
	278	126	77
	301	139	82
	432	211	88
	664	339	93
	664	339	94
Steel HP 14 X 73			
	149	51	47
	195	77	52
	202	81	57
	255	110	62
	286	127	67
	307	138	72
	322	147	77
	349	161	82
	517	254	88
	578	287	90
	578	287	94
Steel HP 14 X 89			
	150	52	47
	198	78	52
	204	82	57
	259	112	62
	290	128	67
	311	140	72
	326	149	77
	353	163	82
	525	258	88
	705	357	92
	705	357	94
Steel HP 14 X 102			
	152	53	47
	201	79	52
	207	83	57
	262	113	62
	293	130	67
	314	142	72
	330	150	77
	357	165	82
	532	262	88
	810	414	93
	810	414	94
Steel HP 14 X 117			
	134	42	42
	154	53	47
	203	80	52
	209	84	57
	265	115	62
	297	132	67
	318	144	72
	334	152	77
	361	167	82
	540	265	88
	929	479	95

Appendix D

Appendix D - L-Pile Parameters (SN060-0229)

	Depth (ft)	Elevation (ft)	Abbreviated Soil Description	Effective Unit Weight (pcf)	Cohesion (psf)	Phi (degrees)	Soil Modulus Parameter (pci)	E_{50}
North Abutment B-19	0 to 17.6	439.6 to 422	Soft Sandy Clay (without free water)	120	250	--	30	0.02
	17.6 to 29	422 to 410.6	Soft Sandy Clay (with free water)	55	250	--	30	0.02
	29 to 74	410.6 to 365.6	Medium Stiff Clay (with free water)	55	500	--	80	0.01
	74 to 90.1	365.6 to 349.5	Stiff Clay (with free water)	55	1500	--	500	0.007
	90.1+	< 349.5	Shale	130	5000	44	2000	0.004

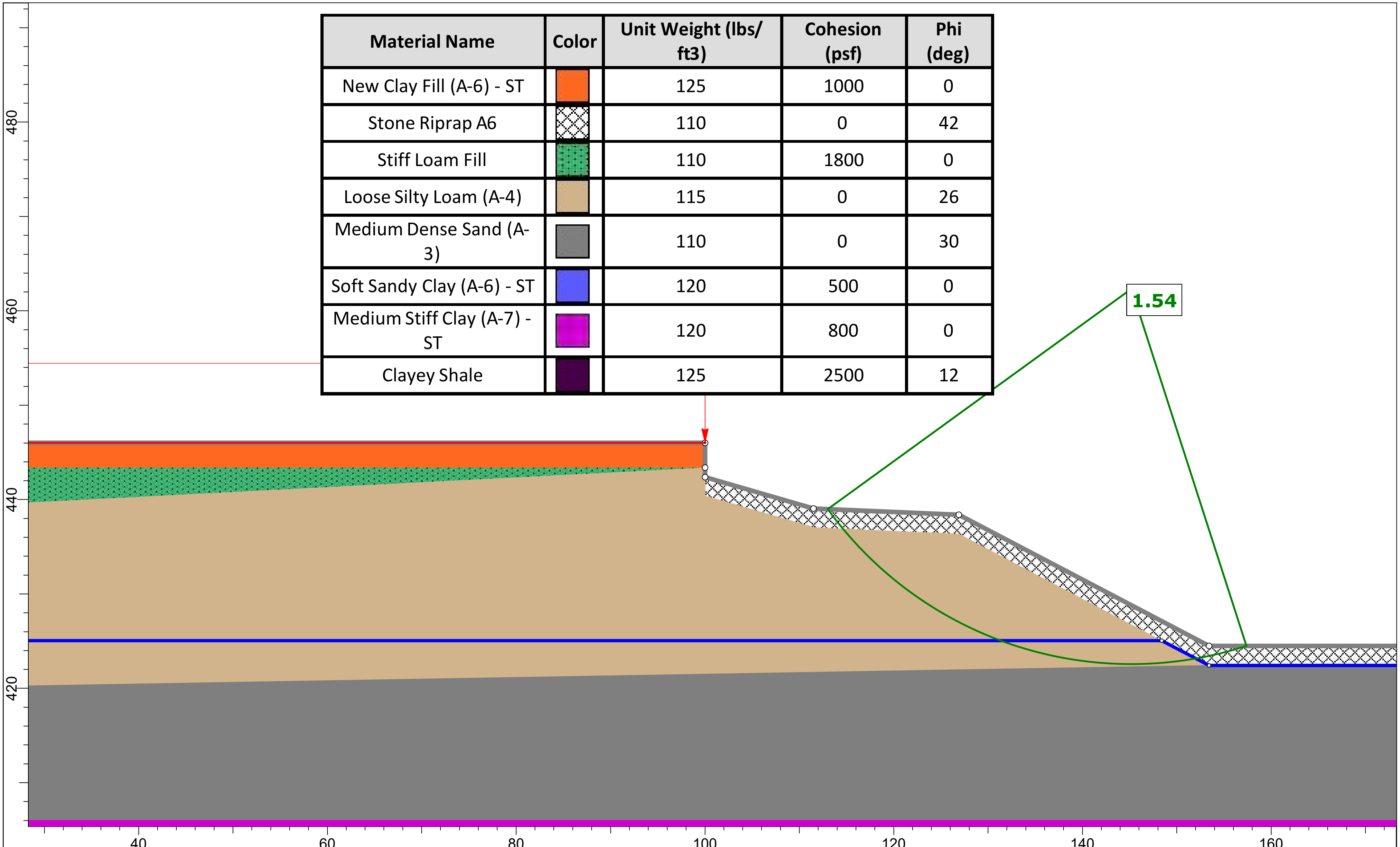
	Depth (ft)	Elevation (ft)	Abbreviated Soil Description	Effective Unit Weight (pcf)	Cohesion (psf)	Phi (degrees)	Soil Modulus Parameter (pci)	E_{50}
Int. North Pier B-19	0 to 10.6	432.6 to 422	Soft Sandy Clay (without free water)	120	250	--	30	0.02
	10.6 to 22	422 to 410.6	Soft Sandy Clay (with free water)	55	250	--	30	0.02
	22 to 67	410.6 to 365.6	Medium Stiff Clay (with free water)	55	500	--	80	0.01
	67 to 83.1	365.6 to 349.5	Stiff Clay (with free water)	55	1500	--	500	0.007
	83.1+	< 349.5	Shale	130	5000	44	2000	0.004

	Depth (ft)	Elevation (ft)	Abbreviated Soil Description	Effective Unit Weight (pcf)	Cohesion (psf)	Phi (degrees)	Soil Modulus Parameter (pci)	E_{50}
Int. South Pier B-7	0 to 14.6	432.6 to 418	Submerged Loose Loam	50	--	26	20	--
	14.6 to 26.6	418 to 406	Submerged Medium Dense Sand	45	--	30	60	--
	26.6 to 80.6	406 to 352	Medium Stiff Clay (with free water)	55	2000	--	700	0.007
	80.6+	< 352	Shale	130	5000	44	2000	0.004

	Depth (ft)	Elevation (ft)	Abbreviated Soil Description	Effective Unit Weight (pcf)	Cohesion (psf)	Phi (degrees)	Soil Modulus Parameter (pci)	E_{50}
South Abutment B-7	0 to 7.6	439.6 to 432	Medium Stiff Silty Loam (without free water)	115	1000	--	100	0.01
	7.6 to 21.6	432 to 418	Submerged Loose Loam	50	--	26	20	--
	21.6 to 33.6	418 to 406	Submerged Medium Dense Sand	45	--	30	60	--
	33.6 to 87.6	406 to 352	Medium Stiff Clay (with free water)	55	2000	--	700	0.007
	87.6+	< 352	Shale	130	5000	44	2000	0.004

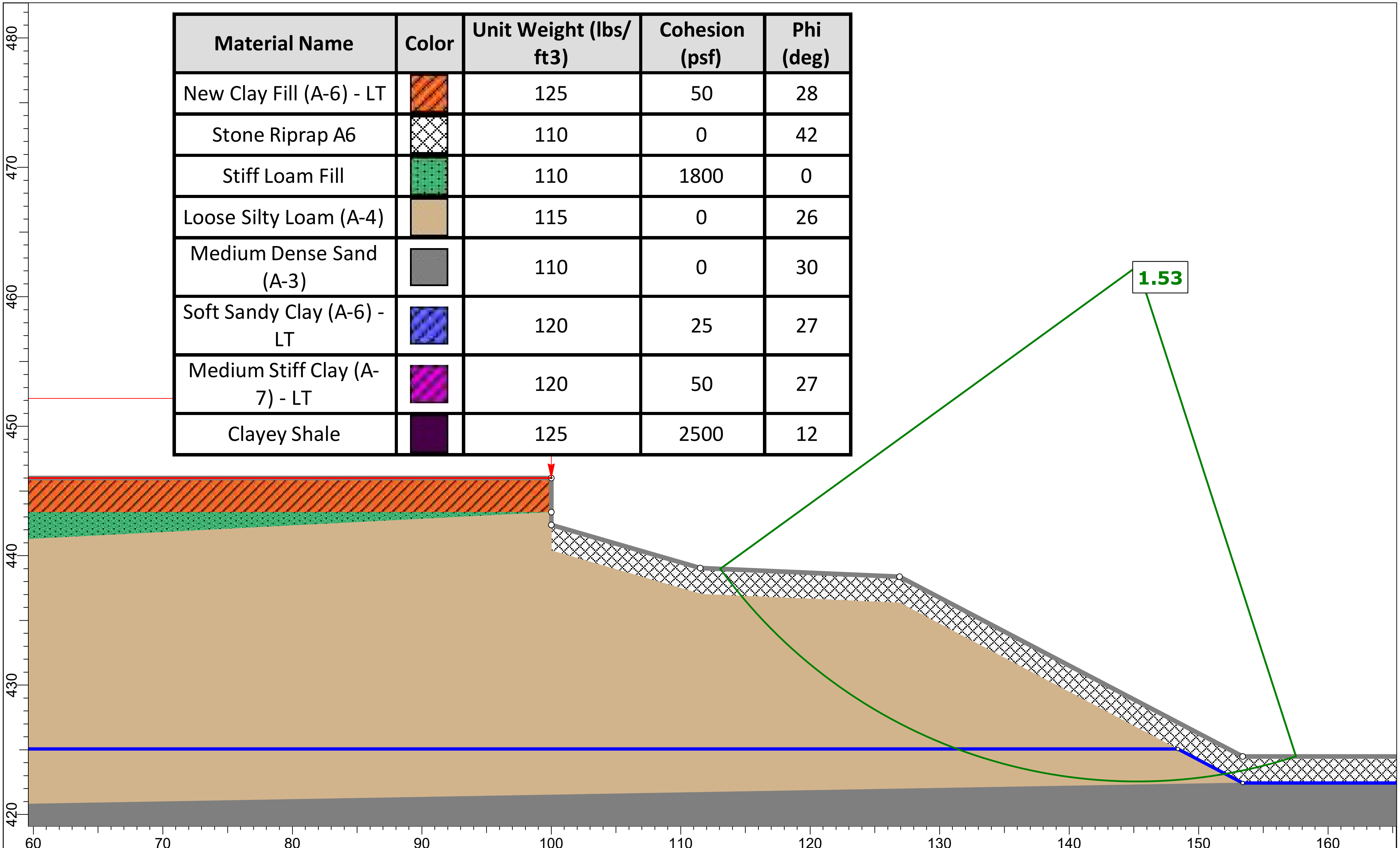
Appendix E

Material Name	Color	Unit Weight (lbs/ft3)	Cohesion (psf)	Phi (deg)
New Clay Fill (A-6) - ST		125	1000	0
Stone Riprap A6		110	0	42
Stiff Loam Fill		110	1800	0
Loose Silty Loam (A-4)		115	0	26
Medium Dense Sand (A-3)		110	0	30
Soft Sandy Clay (A-6) - ST		120	500	0
Medium Stiff Clay (A-7) - ST		120	800	0
Clayey Shale		125	2500	12



SLIDEINTERPRET 9.020

Project	PTB 195 Item 57 IL-157 over Judy's Branch (SN 060-0229)				
Analysis Description	End Slope North Abut (Short Term)			*Location*	Madison County, Illinois
Drawn By PP	*Reviewed By:* TJC	*Scale* 1:169		*Company*	SCI Engineering, Inc.
Date 5/23/2022	*Project #* 2020-0531.10			*File Name*	Slope Stability Analysis.slmd

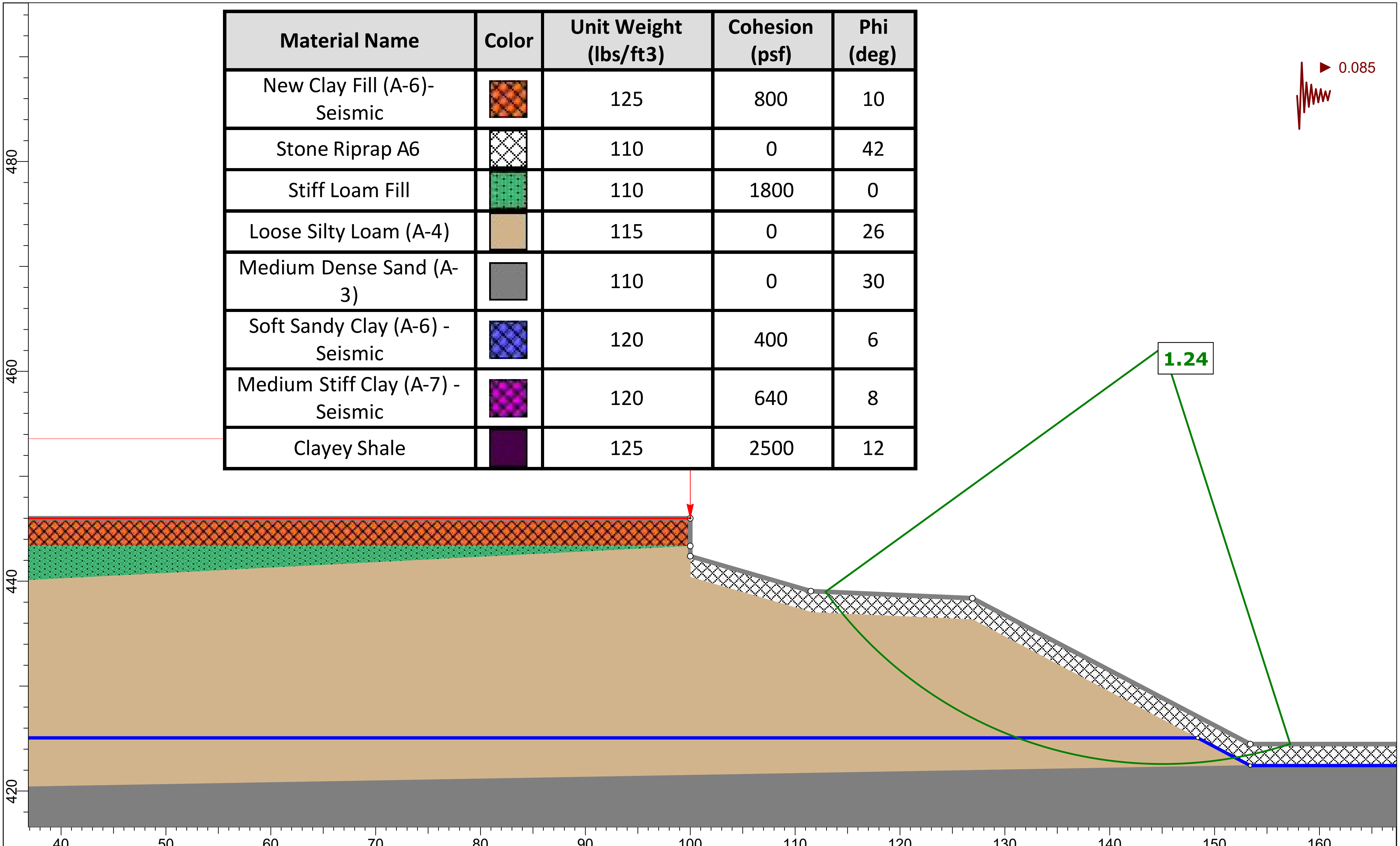


Material Name	Color	Unit Weight (lbs/ft3)	Cohesion (psf)	Phi (deg)
New Clay Fill (A-6) - LT		125	50	28
Stone Riprap A6		110	0	42
Stiff Loam Fill		110	1800	0
Loose Silty Loam (A-4)		115	0	26
Medium Dense Sand (A-3)		110	0	30
Soft Sandy Clay (A-6) - LT		120	25	27
Medium Stiff Clay (A-7) - LT		120	50	27
Clayey Shale		125	2500	12

SLIDEINTERPRET 9.020

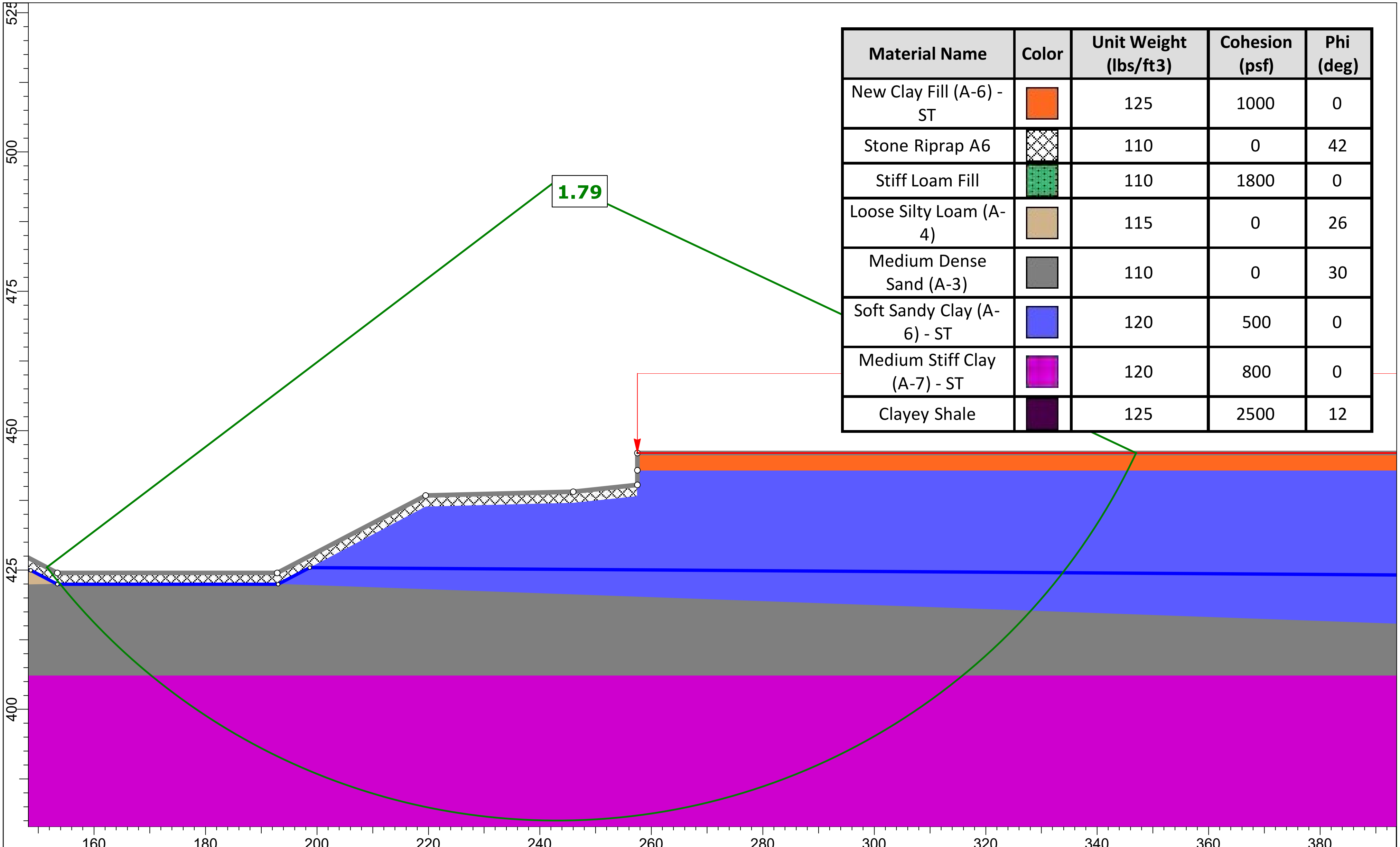
Project	PTB 195 Item 57 IL-157 over Judy's Branch (SN 060-0229)		
Analysis Description	End Slope North Abut (Long Term)	Location	Madison County, Illinois
Drawn By PP	*Reviewed By:* TJC	*Scale* 1:123	*Company* SCI Engineering, Inc.
Date 5/23/2022	*Project #* 2020-0531.10		*File Name* Slope Stability Analysis.slmd

Material Name	Color	Unit Weight (lbs/ft3)	Cohesion (psf)	Phi (deg)
New Clay Fill (A-6)-Seismic		125	800	10
Stone Riprap A6		110	0	42
Stiff Loam Fill		110	1800	0
Loose Silty Loam (A-4)		115	0	26
Medium Dense Sand (A-3)		110	0	30
Soft Sandy Clay (A-6) - Seismic		120	400	6
Medium Stiff Clay (A-7) - Seismic		120	640	8
Clayey Shale		125	2500	12



Project	PTB 195 Item 57 IL-157 over Judy's Branch (SN 060-0229)		
Analysis Description	End Slope North Abut (Seismic)	Location	Madison County, Illinois
Drawn By PP	*Reviewed By:* TJC	*Scale* 1:152	*Company* SCI Engineering, Inc.
Date 5/23/2022	Project # 2020-0531.10		*File Name* Slope Stability Analysis.slmd

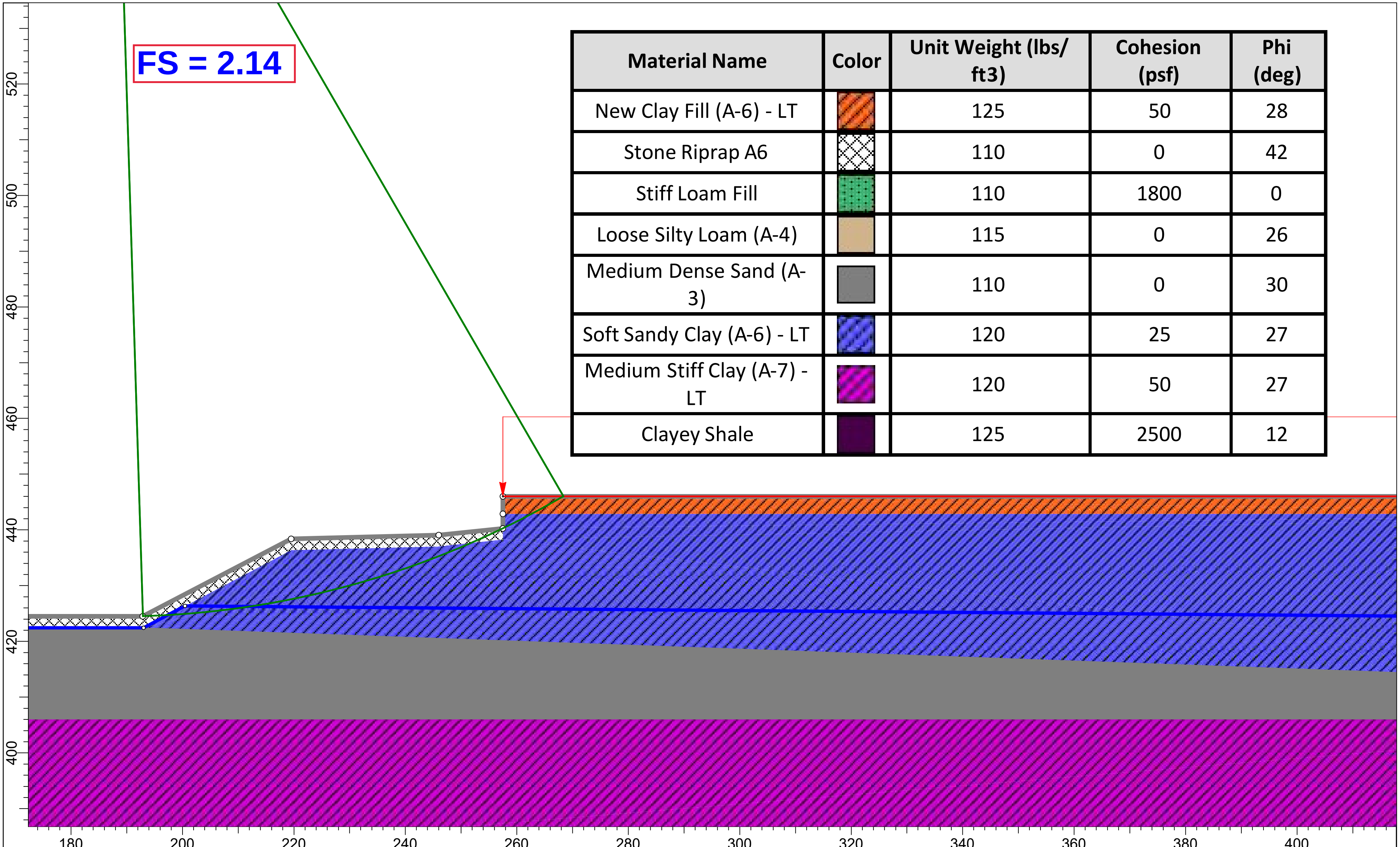
SLIDEINTERPRET 9.020



Material Name	Color	Unit Weight (lbs/ft3)	Cohesion (psf)	Phi (deg)
New Clay Fill (A-6) - ST		125	1000	0
Stone Riprap A6		110	0	42
Stiff Loam Fill		110	1800	0
Loose Silty Loam (A-4)		115	0	26
Medium Dense Sand (A-3)		110	0	30
Soft Sandy Clay (A-6) - ST		120	500	0
Medium Stiff Clay (A-7) - ST		120	800	0
Clayey Shale		125	2500	12

SLIDEINTERPRET 9.020

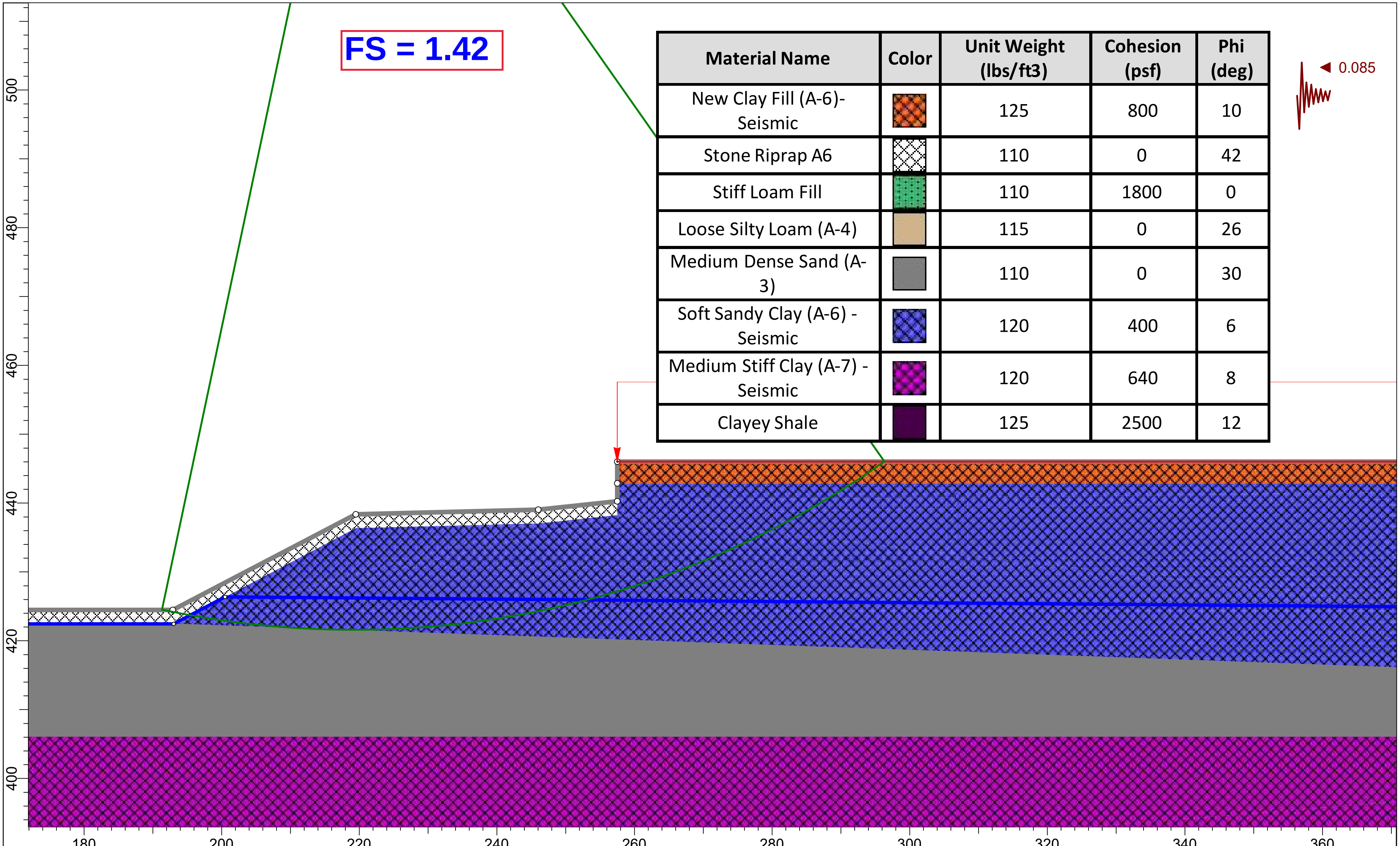
Project	PTB 195 Item 57 IL-157 over Judy's Branch (SN 060-0229)		
Analysis Description	End Slope South Abut (Short Term)	*Location*	Madison County, Illinois
Drawn By PP	*Reviewed By:* TJC	*Scale* 1:286	*Company* SCI Engineering, Inc.
Date 5/23/2022	*Project #* 2020-0531.10	*File Name*	Slope Stability Analysis.slmd



Material Name	Color	Unit Weight (lbs/ft3)	Cohesion (psf)	Phi (deg)
New Clay Fill (A-6) - LT		125	50	28
Stone Riprap A6		110	0	42
Stiff Loam Fill		110	1800	0
Loose Silty Loam (A-4)		115	0	26
Medium Dense Sand (A-3)		110	0	30
Soft Sandy Clay (A-6) - LT		120	25	27
Medium Stiff Clay (A-7) - LT		120	50	27
Clayey Shale		125	2500	12

SLIDEINTERPRET 9.020

Project	PTB 195 Item 57 IL-157 over Judy's Branch (SN 060-0229)				
Analysis Description	End Slope South Abut (Long Term)			*Location*	Madison County, Illinois
Drawn By	PP	*Reviewed By:* TJC	*Scale* 1:286	*Company*	SCI Engineering, Inc.
Date	5/23/2022	*Project #*	2020-0531.10	*File Name*	Slope Stability Analysis.slmd



Material Name	Color	Unit Weight (lbs/ft3)	Cohesion (psf)	Phi (deg)
New Clay Fill (A-6)-Seismic		125	800	10
Stone Riprap A6		110	0	42
Stiff Loam Fill		110	1800	0
Loose Silty Loam (A-4)		115	0	26
Medium Dense Sand (A-3)		110	0	30
Soft Sandy Clay (A-6) - Seismic		120	400	6
Medium Stiff Clay (A-7) - Seismic		120	640	8
Clayey Shale		125	2500	12

SLIDEINTERPRET 9.020

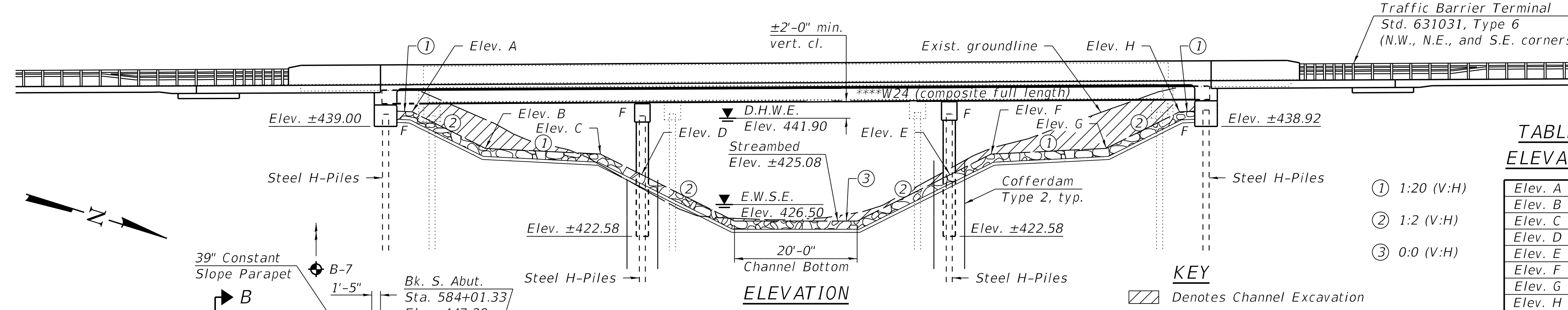
Project	PTB 195 Item 57 IL-157 over Judy's Branch (SN 060-0229)		
Analysis Description	End Slope South Abut (Seismic)	Location	Madison County, Illinois
Drawn By: PP / Reviewed By: TJC / Scale: 1:232		Company	SCI Engineering, Inc.
Date: 5/23/2022	Project #: 2020-0531.10	File Name	Slope Stability Analysis.slmd

Appendix F

Benchmark: Cut "□", with +, on top of parapet wall at Northwest corner of IL-157 Bridge over Judys Branch (S.N. 060-0087). Elev. 449.226.

Existing Structure: S.N. 060-0087 was originally built in 1933 under Section 117-B to carry F.A.P. Rte. 592 over Judys Branch. A deck replacement was completed in 1982 under Section 117BR-2 to replace the original deck, in addition to also replacing the expansion joints and deck drains. The existing superstructure consists of a 7½" thick composite reinforced concrete deck supported by steel W-shape beams. The substructure consists of reinforced concrete abutments supported by concrete piles and reinforced concrete pier bents, supported by concrete piles. Fixed bearings are located at the abutments and expansion bearings are located at the piers. The existing slopewalls consist of bare earth. The existing structure has a total length of 121'-2⅜" bk. to bk. of abutments and a total width of 47'-6" out to out of deck. The bridge will be closed during construction.

No Salvage



1. 1:20 (V:H)
2. 1:2 (V:H)
3. 0:0 (V:H)

KEY

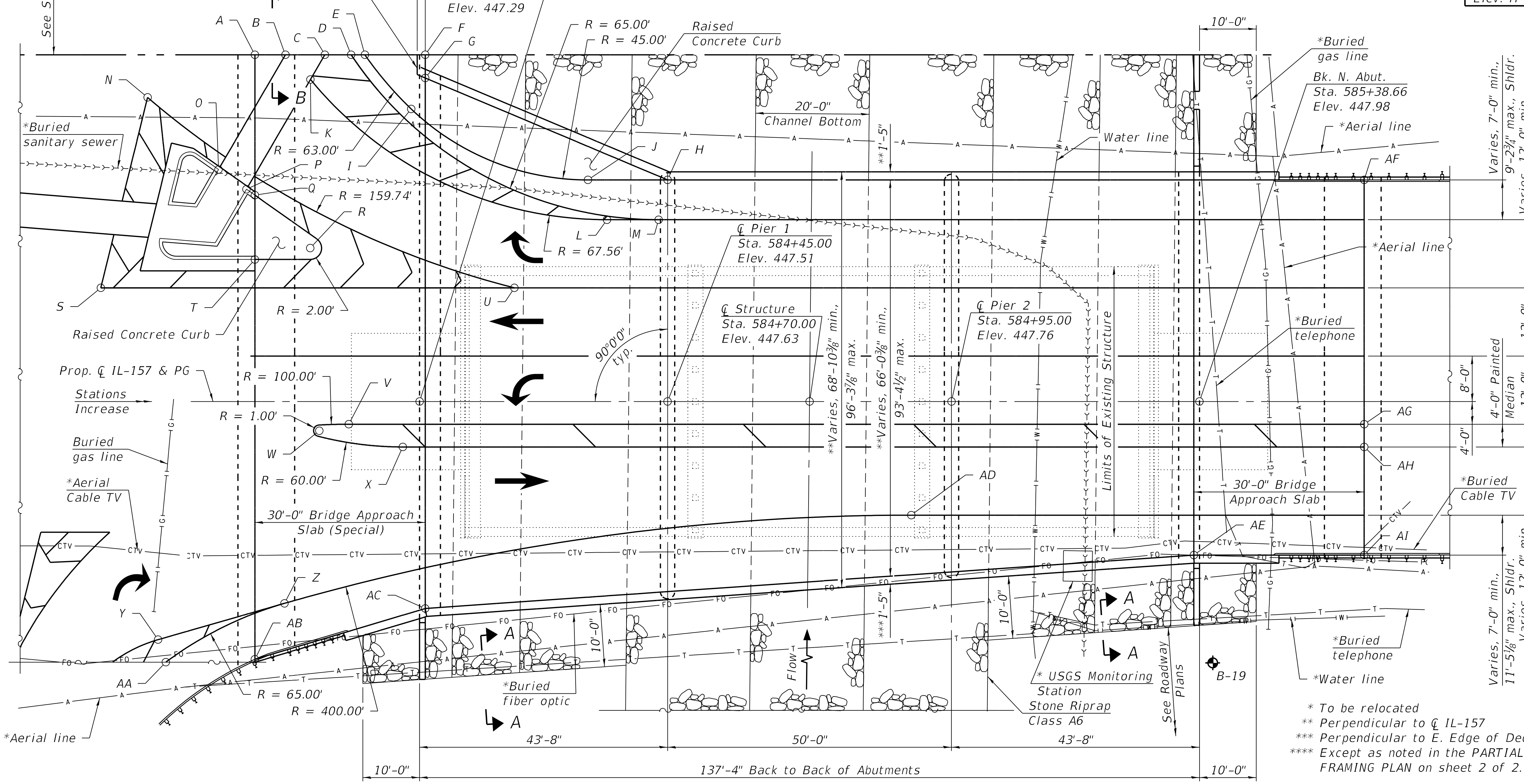
▨ Denotes Channel Excavation

TABLE OF ELEVATIONS

Elev. A	±441.89
Elev. B	±436.93
Elev. C	±436.00
Elev. D	±432.58
Elev. E	±432.58
Elev. F	±436.00
Elev. G	±436.93
Elev. H	±441.89

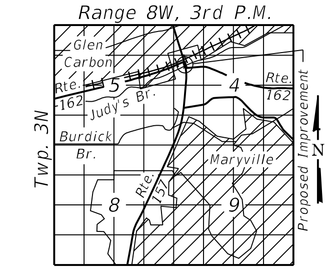
TABLE OF ROADWAY STATIONS AND OFFSETS

Point	Station	Offset
A	583+72.33	61.03' Lt.
B	583+77.70	61.03' Lt.
C	583+84.65	61.03' Lt.
D	583+89.28	61.03' Lt.
E	583+91.70	61.03' Lt.
F	584+02.33	61.03' Lt.
G	584+02.33	56.94' Lt.
H	584+45.00	39.00' Lt.
I	583+99.85	51.50' Lt.
J	584+30.97	39.00' Lt.
K	583+82.12	56.69' Lt.
L	584+34.33	32.00' Lt.
M	584+43.42	32.00' Lt.
N	583+53.44	53.52' Lt.
O	583+65.92	40.83' Lt.
P	583+70.85	37.36' Lt.
Q	583+72.33	36.32' Lt.
R	583+82.07	27.00' Lt.
S	583+45.20	20.00' Lt.
T	583+72.33	25.00' Lt.
U	584+18.02	20.00' Lt.
V	583+88.86	4.00' Rt.
W	583+83.66	5.14' Rt.
X	583+98.38	8.00' Rt.
Y	583+55.28	41.92' Rt.
Z	583+77.55	35.52' Rt.
AA	583+56.66	45.87' Rt.
AB	583+72.33	45.37' Rt.
AC	584+02.33	36.43' Rt.
AD	584+87.90	20.00' Rt.
AE	585+37.67	27.03' Rt.
AF	585+67.67	39.00' Rt.
AG	585+67.67	4.00' Rt.
AH	585+67.67	8.00' Rt.
AI	585+67.67	27.03' Rt.



* To be relocated
** Perpendicular to ℄ IL-157
*** Perpendicular to E. Edge of Deck
**** Except as noted in the PARTIAL FRAMING PLAN on sheet 2 of 2.

Note:
For Sections A-A and B-B, see sheet 2 of 2.



LOCATION SKETCH

GENERAL PLAN & ELEVATION
IL RTE. 157 OVER JUDYS BRANCH
F.A.P. ROUTE 586
SECTION 51-1R
MADISON COUNTY
STATION 584+70.00
STRUCTURE NO. 060-0229

FUHRMANN ENGINEERING
WWW. FUHRMANN-ENG .COM

USER NAME =	DESIGNED - T.S. Friederich	REVISED -
	CHECKED - E.M. Lagemann	REVISED -
PLOT SCALE =	DRAWN - T.S. Friederich	REVISED -
PLOT DATE =	CHECKED - E.M. Lagemann	REVISED -

STATE OF ILLINOIS
DEPARTMENT OF TRANSPORTATION

SHEET 1 OF 2 SHEETS

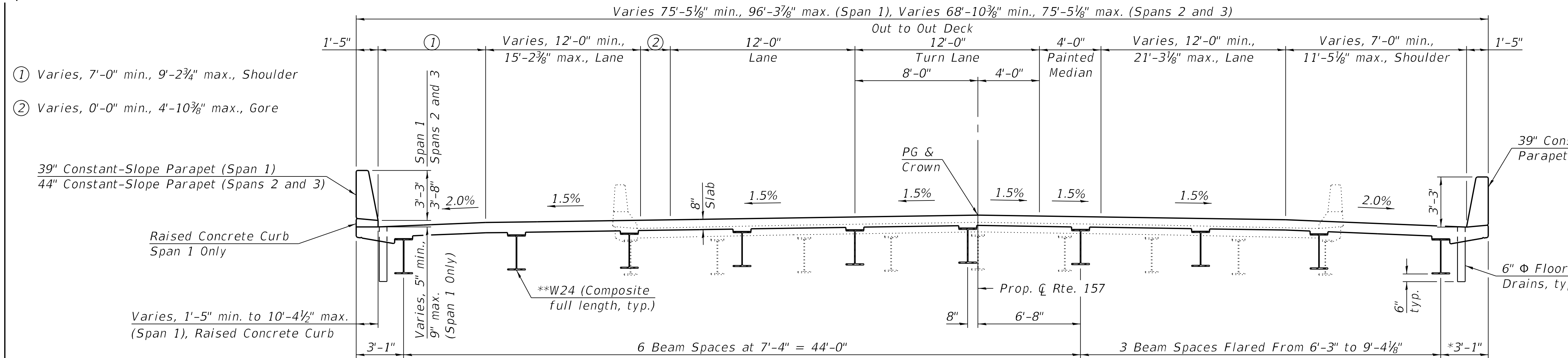
F.A.P RTE.	SECTION	COUNTY	TOTAL SHEETS	SHEET NO.
586	51-1R	MADISON		

CONTRACT NO. 76A46

ILLINOIS FED. AID PROJECT

MODEL: Default
FILE NAME: G:\FEIjobs_2020\20-1581 PTB 195-57 REALIGNMENT IL 162 AT IL 157 PH II D-98-009-04 - FEI PRIME\CADD\CADD Sheets\0600229-76A46-001-TSL.dgn

3/20/2023 7:58:06 AM



Note:
All dimensions perp. to ℄ Rte. 157

CROSS-SECTION

(Looking North)

* Parallel to Edge of Deck
** Except as noted in the PARTIAL FRAMING PLAN

HIGHWAY CLASSIFICATION

F.A.P. Rte. 592 - IL Rte. 157
Functional Class: Other Principal Arterial
ADT: 10,100 (2021); 14,225 (2044)
ADTT: 606 (2021); 854 (2044)
DHV: 1,690 (2044)
Design Speed: 45 m.p.h.
Posted Speed: 45 m.p.h.
Two-Way Traffic
Directional Distribution: 50:50

LOADING HL-93

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

DESIGN SPECIFICATIONS

2020 AASHTO LRFD Bridge
Design Specifications, 9th Edition

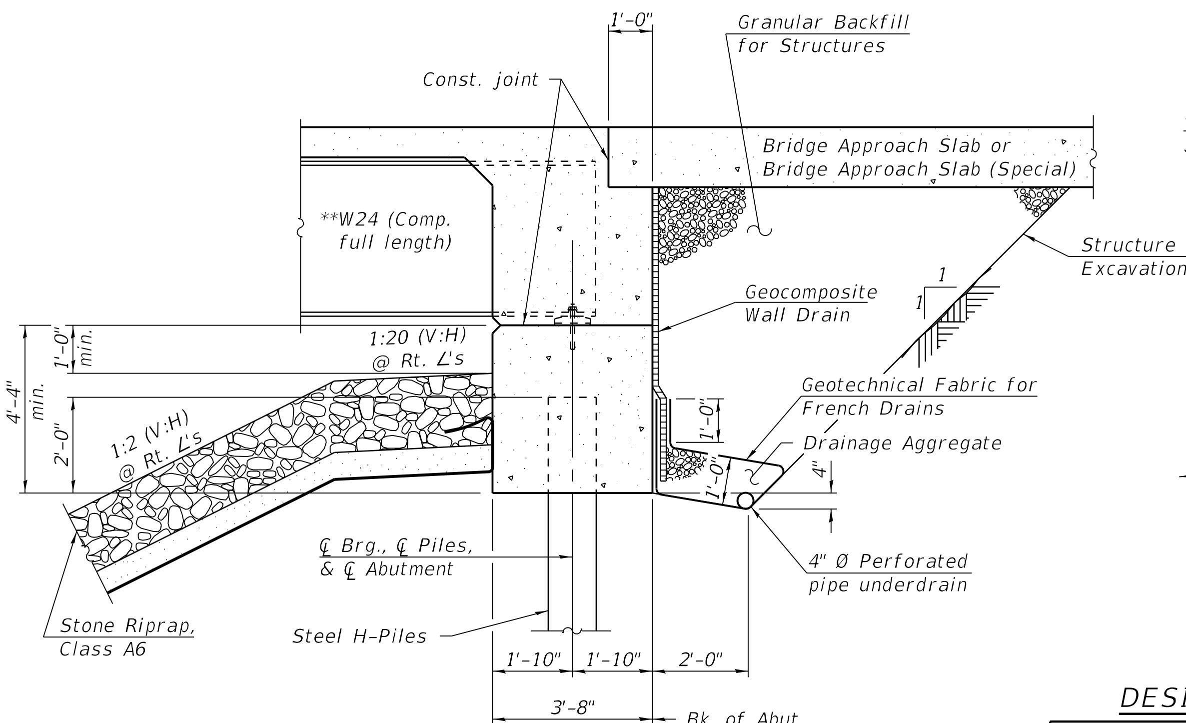
DESIGN STRESSES

FIELD UNITS

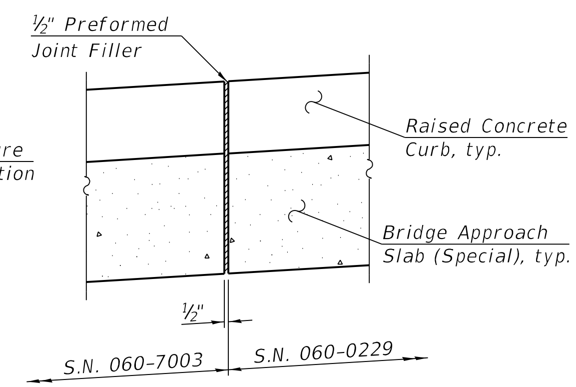
f'c = 3,500 psi
f'c = 4,000 psi (Superstructure)
fy = 60,000 psi (Reinforcement)
fy = 50,000 psi (M270 Grade 50)

SEISMIC DATA

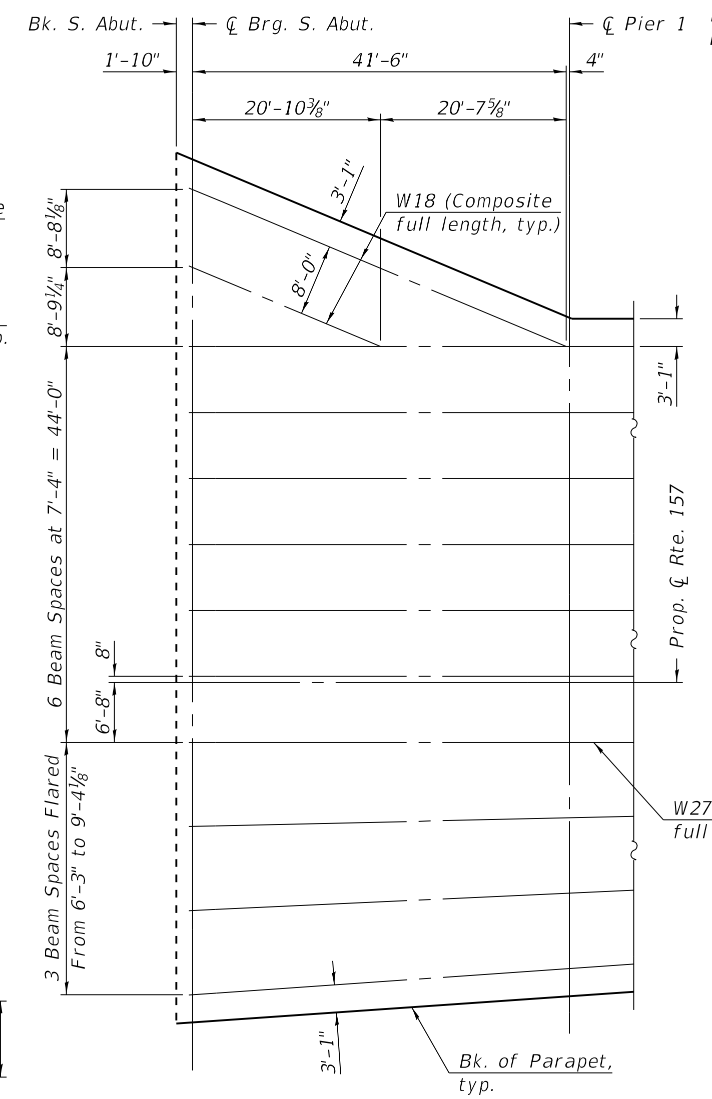
Seismic Performance Zone (SPZ) = 2
Design Spectral Acceleration at 1.0 sec. (SD1) = 0.23g
Design Spectral Acceleration at 0.2 sec. (SDS) = 0.53g
Soil Site Class = D



SECTION THRU INTEGRAL ABUTMENT

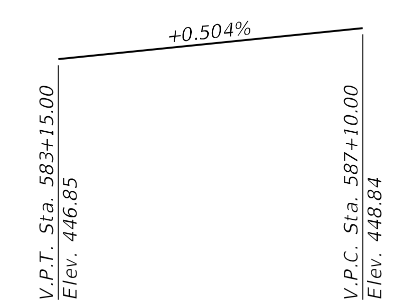


SECTION B-B



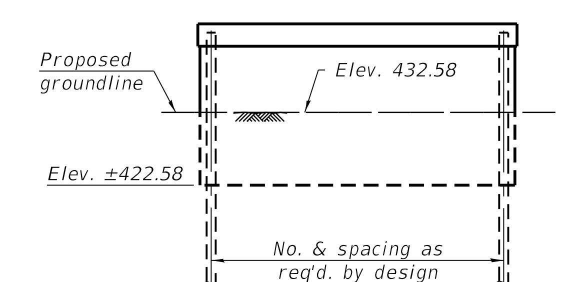
PARTIAL FRAMING PLAN

(Span 1)



PROFILE GRADE

(℄ Rte. 157)



PIER SKETCH

DESIGN SCOUR ELEVATION TABLE

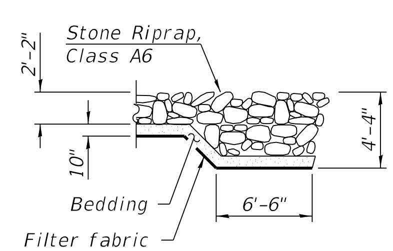
Event / Limit State	Design Scour Elevations (ft.)				
	S. Abut.	Pier 1	Pier 2	N. Abut.	Item 113
Q100	439.00	414.80	414.80	438.92	5
Q200	439.00	413.93	413.93	438.92	
Design	439.00	414.80	414.80	438.92	
Check	439.00	413.93	413.93	438.92	

WATERWAY INFORMATION

Drainage Area = 8.6 sq. mi.
Existing Overtopping Elev. = 445.83 at Sta. 582+50.00
Proposed Overtopping Elev. = 446.42 at Sta. 581+42.36

Flood Event	Freq. Yr.	Discharge, Q C.F.S.	Waterway Opening - Ft²		Natural H.W.E. - Ft.	Head - Ft.		Headwater Elevation - Ft.	
			Existing	Proposed		Existing	Proposed	Existing	Proposed
Design	50	5750	883	1146	441.9	0.5	0.3	442.4	442.2
Base	100	6590	941	1214	442.4	1.5	0.4	443.9	442.8
Scour Design Check	200	7600	987	1287	443.0	1.3	0.6	444.3	443.7
Overtop Existing	N/A	---	---	---	---	---	---	---	---
Overtop Proposed	N/A	---	---	---	---	---	---	---	---
Max. Calc.	500	8920	998	1367	443.7	1.3	1.6	445.0	445.3

10 Year Velocity Through Existing Bridge = 5.43 ft/s
10 Year Velocity Through Proposed Bridge = 4.46 ft/s



SECTION A-A

Note:
For Location of Sections A-A and B-B, see sheet 1 of 2.

DETAILS
IL RTE. 157 OVER JUDYS BRANCH
F.A.P. ROUTE 586
SECTION 51-1R
MADISON COUNTY
STATION 584+70.00
STRUCTURE NO. 060-0229

Important Information about Your
Geotechnical Engineering Report

Subsurface problems are a principal cause of construction delays, cost overruns, claims, and disputes.

While you cannot eliminate all such risks, you can manage them. The following information is provided to help.

Geotechnical Services Are Performed for Specific Purposes, Persons, and Projects

Geotechnical engineers structure their services to meet the specific needs of their clients. A geotechnical engineering study conducted for a civil engineer may not fulfill the needs of a construction contractor or even another civil engineer. Because each geotechnical engineering study is unique, each geotechnical engineering report is unique, prepared *solely* for the client. No one except you should rely on your geotechnical engineering report without first conferring with the geotechnical engineer who prepared it. *And no one — not even you* — should apply the report for any purpose or project except the one originally contemplated.

Read the Full Report

Serious problems have occurred because those relying on a geotechnical engineering report did not read it all. Do not rely on an executive summary. Do not read selected elements only.

A Geotechnical Engineering Report Is Based on A Unique Set of Project-Specific Factors

Geotechnical engineers consider a number of unique, project-specific factors when establishing the scope of a study. Typical factors include: the client's goals, objectives, and risk management preferences; the general nature of the structure involved, its size, and configuration; the location of the structure on the site; and other planned or existing site improvements, such as access roads, parking lots, and underground utilities. Unless the geotechnical engineer who conducted the study specifically indicates otherwise, do not rely on a geotechnical engineering report that was:

- not prepared for you,
- not prepared for your project,
- not prepared for the specific site explored, or
- completed before important project changes were made.

Typical changes that can erode the reliability of an existing geotechnical engineering report include those that affect:

- the function of the proposed structure, as when it's changed from a parking garage to an office building, or from a light industrial plant to a refrigerated warehouse,
- elevation, configuration, location, orientation, or weight of the proposed structure,
- composition of the design team, or
- project ownership.

As a general rule, *always* inform your geotechnical engineer of project changes—even minor ones—and request an assessment of their impact. *Geotechnical engineers cannot accept responsibility or liability for problems that occur because their reports do not consider developments of which they were not informed.*

Subsurface Conditions Can Change

A geotechnical engineering report is based on conditions that existed at the time the study was performed. *Do not rely on a geotechnical engineering report* whose adequacy may have been affected by: the passage of time; by man-made events, such as construction on or adjacent to the site; or by natural events, such as floods, earthquakes, or groundwater fluctuations. *Always* contact the geotechnical engineer before applying the report to determine if it is still reliable. A minor amount of additional testing or analysis could prevent major problems.

Most Geotechnical Findings Are Professional Opinions

Site exploration identifies subsurface conditions only at those points where subsurface tests are conducted or samples are taken. Geotechnical engineers review field and laboratory data and then apply their professional judgment to render an opinion about subsurface conditions throughout the site. Actual subsurface conditions may differ—sometimes significantly—from those indicated in your report. Retaining the geotechnical engineer who developed your report to provide construction observation is the most effective method of managing the risks associated with unanticipated conditions.

A Report's Recommendations Are *Not* Final

Do not overrely on the construction recommendations included in your report. *Those recommendations are not final,* because geotechnical engineers develop them principally from judgment and opinion. Geotechnical engineers can finalize their recommendations only by observing actual subsurface conditions revealed during construction. *The geotechnical engineer who developed your report cannot assume responsibility or liability for the report's recommendations if that engineer does not perform construction observation.*

A Geotechnical Engineering Report Is Subject to Misinterpretation

Other design team members' misinterpretation of geotechnical engineering reports has resulted in costly problems. Lower that risk by having your geotechnical engineer confer with appropriate members of the design team after submitting the report. Also retain your geotechnical engineer to review pertinent elements of the design team's plans and specifications. Contractors can also misinterpret a geotechnical engineering report. Reduce that risk by having your geotechnical engineer participate in prebid and preconstruction conferences, and by providing construction observation.

Do Not Redraw the Engineer's Logs

Geotechnical engineers prepare final boring and testing logs based upon their interpretation of field logs and laboratory data. To prevent errors or omissions, the logs included in a geotechnical engineering report should *never* be redrawn for inclusion in architectural or other design drawings. Only photographic or electronic reproduction is acceptable, *but recognize that separating logs from the report can elevate risk.*

Give Contractors a Complete Report and Guidance

Some owners and design professionals mistakenly believe they can make contractors liable for unanticipated subsurface conditions by limiting what they provide for bid preparation. To help prevent costly problems, give contractors the complete geotechnical engineering report, *but* preface it with a clearly written letter of transmittal. In that letter, advise contractors that the report was not prepared for purposes of bid development and that the report's accuracy is limited; encourage them to confer with the geotechnical engineer who prepared the report (a modest fee may be required) and/or to conduct additional study to obtain the specific types of information they need or prefer. A prebid conference can also be valuable. *Be sure contractors have sufficient time* to perform additional study. Only then might you be in a position to give contractors the best information available to you, while requiring them to at least share some of the financial responsibilities stemming from unanticipated conditions.

Read Responsibility Provisions Closely

Some clients, design professionals, and contractors do not recognize that geotechnical engineering is far less exact than other engineering disciplines. This lack of understanding has created unrealistic expectations that have led to disappointments, claims, and disputes. To help reduce the risk of such outcomes, geotechnical engineers commonly include a variety of explanatory provisions in their reports. Sometimes labeled "limitations" many of these provisions indicate where geotechnical engineers' responsibilities begin and end, to help others recognize their own responsibilities and risks. *Read these provisions closely.* Ask questions. Your geotechnical engineer should respond fully and frankly.

Geoenvironmental Concerns Are Not Covered

The equipment, techniques, and personnel used to perform a *geoenvironmental* study differ significantly from those used to perform a *geotechnical* study. For that reason, a geotechnical engineering report does not usually relate any geoenvironmental findings, conclusions, or recommendations; e.g., about the likelihood of encountering underground storage tanks or regulated contaminants. *Unanticipated environmental problems have led to numerous project failures.* If you have not yet obtained your own geoenvironmental information, ask your geotechnical consultant for risk management guidance. *Do not rely on an environmental report prepared for someone else.*

Obtain Professional Assistance To Deal with Mold

Diverse strategies can be applied during building design, construction, operation, and maintenance to prevent significant amounts of mold from growing on indoor surfaces. To be effective, all such strategies should be devised for the *express purpose* of mold prevention, integrated into a comprehensive plan, and executed with diligent oversight by a professional mold prevention consultant. Because just a small amount of water or moisture can lead to the development of severe mold infestations, a number of mold prevention strategies focus on keeping building surfaces dry. While groundwater, water infiltration, and similar issues may have been addressed as part of the geotechnical engineering study whose findings are conveyed in this report, the geotechnical engineer in charge of this project is not a mold prevention consultant; ***none of the services performed in connection with the geotechnical engineer's study were designed or conducted for the purpose of mold prevention. Proper implementation of the recommendations conveyed in this report will not of itself be sufficient to prevent mold from growing in or on the structure involved.***

Rely, on Your ASFE-Member Geotechncial Engineer for Additional Assistance

Membership in ASFE/The Best People on Earth exposes geotechnical engineers to a wide array of risk management techniques that can be of genuine benefit for everyone involved with a construction project. Confer with your ASFE-member geotechnical engineer for more information.

ASFE
THE BEST PEOPLE ON EARTH

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