STRUCTURE GEOTECHNICAL REPORT

INTERSTATE 57 OVER POND CREEK
FAI ROUTE 57, SECTION 28-5 (B-2)
REPLACEMENT STRUCTURES
028-0085 (NB) AND 028-0086 (SB).
FRANKLIN COUNTY, ILLINOIS
PTB 168-023

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TSi Project Number 20181032.00

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11-30-2019

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CONTENTS

Structure Geotechnical Report
Interstate 57 Over Pond Creek
FAI Route 57, Section 28-5 (B-2)
Replacement Structures
028-0085 (NB) and 028-0086 (SB)
Franklin County, Illinois

1.0 Project Description and Proposed Structure Information

1.1 Introduction

This report summarizes the results of a geotechnical investigation performed for the design of replacement structures for the existing bridges carrying Interstate 57 over Pond Creek south of West Frankfort, Franklin County, Illinois. The purpose of this study was to provide a geotechnical assessment of the planned replacement structures, based on subsurface conditions encountered at eight (8) borings performed by the Illinois Department of Transportation (IDOT), at the existing structures. Six (6) of the eight (8) borings were performed in October 1960 and the remaining two (2) borings were performed in April 2017. This report describes the exploration procedures used, presents the field and laboratory data, includes an assessment of the subsurface conditions in the area, and provides geotechnical recommendations for the construction.

1.2 Project Description

The project consists of the removal and replacement of the existing Interstate 57 bridges over Pond Creek in Franklin County, Illinois. The general site area is shown on the attached Vicinity Map, Figure 1 in Appendix A. A plan that shows the approximate locations of the borings performed for this study is presented as the Site and Boring Location Plan, Figure 2 in Appendix A. Pond Creek is oriented east and west beneath the existing I-57 overpass structures and flows westward. The back-to-back abutment length of the existing bridge 132 feet and 3 inches and the out-to-out deck width is 43 feet and 8 inches. Each structure consists of a three span steel 27WF superstructure supported by concrete stub abutments founded on steel H Piles and concrete piers founded on steel H Pile supported footings. It is our understanding that the existing structures will be replaced with new two-span bridges using integral abutments. Based on the information provided, it appears that staged construction will be required to maintain traffic during construction.

1.3 Proposed Structure Information

The proposed structures will consist of two two-span bridges with concrete decks. The superstructures will be supported by integral abutments and concrete piers founded on solid wall pile bents. The preliminary factored loads for the bridges are 1700 kips for the north abutments, 2400 kips for the central piers, and 1300 kips for the south abutments. The bridge side slopes are planned to be 2 horizontal to 1 vertical (2H:1V). The roadway profile across the bridges is anticipated to remain essentially unchanged, with little or no grade change for the embankments.

2.0 Subsurface Exploration and Laboratory Testing

2.1 Subsurface Exploration

In October 1960, IDOT conducted a subsurface exploration at the site, consisting of six (6) soil test borings, designated as Borings 1 through 6 for both the southbound and northbound structures. In April 2017, IDOT conducted an additional subsurface exploration consisting of two (2) borings, designated as Boring 1-S (2017) and Boring 2-S (2017). The approximate locations of both sets of borings are indicated on the Site and Boring Location Plan, Figure 2.

The 2017 borings were advanced using hollow-stem auger drilling methods to top of bedrock. Samples were generally obtained at 2.5-foot intervals. Split-spoon samples were recovered using a 2-inch outside-diameter sampler, driven by a 140-pound hammer. The drilling rig that was used for performing the April 2017 boring had a hammer with an energy efficiency rating of 75%. The split-spoon samples were placed in containers for later testing in the laboratory. A few select borings were extended into bedrock materials using rock coring procedures. The core samples recovered were measured in the field for percent recovery and Rock Quality Designation (RQD) value. The sampling sequence for each boring is summarized on the boring logs in Appendix B.

Unconfined compression tests were performed on selected split-spoon samples using a Rimac field testing machine. The resulting unconfined compressive strengths are reported on the boring logs.

Unconfined compression tests were also performed on selected rock core samples from Boring 1-S. The test results, along with a photo or the rock core, are included in Appendix B.

2.2 Laboratory Testing

A laboratory testing program consisting of natural moisture contents was conducted by IDOT to determine selected engineering properties of the obtained soil samples. The results of the individual tests are presented on the boring logs in Appendix B.

3.0 Subsurface Conditions

Details of the subsurface conditions encountered at the borings are shown on the boring logs. The general subsurface conditions encountered and their pertinent engineering characteristics are described in the following paragraphs. Conditions represented by the borings should be considered applicable only at the boring locations on the dates shown; the reported conditions may be different at other locations and at other times.

3.1 Geology

The site lies in the Illinois Basin. The surficial materials consist of glacial lakebed deposits associated with the Big Muddy River Valley. The underlying bedrock formation consists of the Modesto Formation of the Pennsylvanian System. The Modesto Formation consists primarily of shale and sandstone with some minor constituents of limestone and coal.

3.2 Generalized Subsurface Profile

The natural soils at the site are predominantly made up of silty clay, silty clay loam, silt loam, clay loam, and clay. The natural soils contain variable amounts of sand, sand seams, and gravel. Moisture contents vary from 15 to 28%. The standard penetration test (N) values range from 0, where the sampler advanced under the weight of the hammer, to 46 blows per foot (bpf). Rimac unconfined compression test values on samples typically range from 0.3 to 2.5 tons per square foot (tsf), with outlier values of 0.1 and 0.2 tsf.

A layer of medium dense to dense sand was encountered just above the sandstone bedrock in the borings. The sandstone bedrock elevations range from Elevation 353.2 to 358.7. Rock coring was performed in all of the borings except Boring 2-S. The recovery in sandstone ranged from approximately 80 to 100 percent, with one value of 25 percent.

3.3 Groundwater

At the time of drilling, groundwater was observed in the borings, at elevations ranging from Elevation 375.5 to Elevation 380.2 feet. The delayed (24 hours or more after drilling) groundwater elevations in the borings ranged from Elevation 379.1 to Elevation 392.3 feet. The presence or absence of groundwater at a particular location does not necessarily mean that groundwater will be present or absent at that location at other times. Groundwater levels may vary significantly over time due to the effect of seasonal variations in precipitation, the water level in the Pond Creek, or other factors not evident at the time of exploration.

4.0 Geotechnical Evaluations

4.1 Earthwork

Grade changes on the approach embankments will be minimal along the roadways. For lane shifts or constructability, it may require that the embankments be widened accordingly in the vicinity of the abutments. Any significant widening should be accomplished by placing fill in horizontal layers starting from the bottom, rather than attempting to place and compact material on the slope. Assuming that there are right-of-way restrictions limiting the work space at the toe of the slope, it may be necessary to cut into the existing slope to permit standard-width equipment to operate while placing additional fill up the slope. This will effectively key the new fill into the existing embankment.

4.2 Settlement

The lower portion of the soil profile could be moderately compressible. However, no significant increase in embankment loading should result from the replacement of the bridges, other than beneath the side slopes where minimal amounts of new fill will be placed to widen the embankments near the abutments. In our opinion, this should not result in a significant additional load. This minor increase should result in no more than 0.4 inches of additional settlement, thus downdrag should not be a concern at the abutments. In accordance with IDOT Geotechnical Manual, Section 6.9.2, downdrag is not a concern if the settlement is less than 0.4 inches.

4.3 Slope Stability

Initial stability analyses were performed using strength parameters based on the boring logs provided by IDOT. Adequate factors of safety were calculated for the north abutments, but the results indicated factors of safety (FS) less than 1.7 for the south abutments, and less than 1.0 for those abutments when a seismic factor equal to the peak ground acceleration modified for Site Class D (A_s) was applied, along with a reduction factor (Height-Dependent Incoherence Reduction Scaling Factor α) of approximately 0.9 to account for the height of the slope. It was noted that the critical interval in the stratigraphy at this location was a zone in which low Rimac strength values were obtained, but relatively high N values (8 bpf, converted to $N_{60} = 10$) were measured. Further analyses were performed using published correlations of N values to unconfined compressive strength (NAVFAC DM-7.1) for the critical interval. In addition, LPile analyses were performed to calculate for the additional resistance to movement provided by the existing pile foundations for the abutments and interior piers The 8-inch piles at a spacing of about 5 feet were found to offer a significant increase in the static case, raising the FS from approximately 1.7 to 2.0, but only a minor increase when the added horizontal forces from the seismic factor were applied, FS = 0.76 without piles and 0.80 with piles.

Since the FS remains less than 1.0 for the design seismic condition, a Newmark-type deflection analysis was performed using the relations put forth by Franklin and Chang (1977). This method involves comparing the seismic factor providing a FS = 1.0 to the design seismic factor, and then using the corresponding seismic velocity for the FS = 1.0 condition to calculate a maximum deflection for the design seismic factor. A seismic acceleration factor of 0.226 was found to provide a FS =1.00. With the resultant ratio of seismic factors and an estimated corresponding seismic velocity, a maximum deflection of less than 2 inches (approximately 1.7 inches) was calculated. We have assumed that this magnitude of horizontal movement is considered to be tolerable for the new structures, particularly since the calculated deflection does not account for the added resistance of the new piles. On this basis, FHWA permits the average seismic coefficient to be reduced by 50%, to verify that a required minimum FS of 1.1 is achieved. This stability analysis using the one-half reduction results in a FS = 1.18 for the south slope.

In summary, the north abutments are indicated to have an adequate FS for both static and the design seismic cases. Although the south abutments do not have a FS of 1.0 under the design seismic loading, the calculated horizontal slope deflection of approximately 1.7 inches can be considered acceptable for the new structures. The results of the stability analyses are provided on the stability summary profiles given in Appendix D; the calculated values of critical FS are summarized in the following Table 4.1:

TABLE 4.1.
CALCULATED CRITICAL FACTOR OF SAFETY

Location	Calculated Factor of Safety			
	Rimac Strength, Static	**Modified Strength, Static**	**Rimac Strength, Seismic**	**Modified Strength, Seismic**
North Abutment	2.46	--	1.21	--
South Abutment, w/out Piles	1.58	1.65	--	0.76
South Abutment, with Piles	--	2.02	--	0.80

4.4 MINING ACTIVITY

A review of undermining was made using the Illinois State Geological Survey (ISGS) website for mapped coal mines in Franklin County, Illinois. Based on this information, the project site is appears to be undermined. The apparent mine activity includes a mine operated by Old Ben Coal Co. (Index # 143, Old Ben Coal Co. No.8). The Herrin Coal layer has been mined at depths ranging from about 440 to 472 feet below existing grades. The general thickness of the coal layer was reported to be 8.5 to 10 feet; however, the thickness can range from a few inches to up to 12 feet in isolated locations.

4.5 SEISMICITY

Although several significant areas of seismic activity are present in the central United States, the site area is most directly affected by the Wabash Seismic Zone, located in south and east-central Illinois. An assessment of seismic criteria in accord with AASHTO 2009 Guide Specifications for LRFD Seismic Bridge Design has been performed for the site. The IDOT Spreadsheet "Seismic Site Class Determination" was used to determine a Soil Site Class D for the abutments and intermediate piers, if measured from the existing ground surface. The IDOT Spreadsheet

"Seismic Site Class Determination" was used to determine a Soil Site Class D for the abutments and Soil Site Class C for center pier, if measured from the approximate elevation of fixity of the piles. We understand that IDOT utilizes the approximate fixity elevation as the point of reference. The United States Geological Survey (USGS) Design Maps Summary Report website was used with the Site Class D classification to provide acceleration coefficient values Sd_s of 0.79 g and Sd_1 of 0.33 g. The results of the Site Class determination and the Design Maps Summary Report are presented in Appendix C. It is understood that IDOT District 9 has completed the liquefaction analysis and that no liquefiable soils are present at the site.

For the purposes of this report, the bridge has been assumed to be classified as "Regular and Essential." In accordance with the IDOT Bridge Manual, 2012 Edition, the structure should be designed for a design earthquake with a 7% probability of exceedance over a 75-year exposure period (1,000-year return period). A Peak Ground Acceleration (PGA) value of 0.0.311g has been determined.

Based on the guidelines in the IDOT All Geotechnical Manual Users (AGMU), including Table 3.15.2-1 in that manual, the Seismic Performance Zone is 3.

4.6 Scour

The scour should be assumed to be taken as 100 percent (%) of the scour predicted in the Hydraulic Report (0% reduction in scour depth). Abutment slope protection should be included to protect against scour potential. Countermeasure options for scour at bridge locations include webwalls to eliminate debris collection between columns, riprap, partially grouted riprap, geotextile sand containers, and sheet piling. Skin friction and lateral load design values for piers and driven piles should be ignored in the scour zone. Based on information provided by Oates Associates, Inc., the design scour elevations for the 100-year and 200-year events for the bridges are shown in Table 4.6.

Table 4.2.
Summary of Design Scour Elevations

Event/Limit State	Design Scour Elevations (ft.)			Item 113 (2)
	N. Abut.	Pier	S. Abut.	
Q100	391.1	368.5	391.1	5
Q200	391.1	368.3	391.1	
Design	391.1	368.5	391.1	
Check	391.1	368.3	391.1	

5.0 Foundation Evaluations and Design Recommendations

5.1 Driven Pile Foundations

The bridge structures may be supported on driven pile foundations. Pile capacities and driving depths were initially assessed using the IDOT pile design spreadsheet "Pile Capacity and Length Estimates," version 10/18/2011. Steel H-piles and metal shell piles are both considered to be feasible for this site, however metal shell piles are not recommended because their capacities need to be limited due to the proximity of rock where a possibility of pile damage during driving may occur. Hard driving is anticipated to penetrate a sufficient distance into the lower dense sand and sandstone to achieve practical refusal, so that the maximum factored capacity based on the structural capacity of the pile can be used. Numerous available pile sections may be suitable, and final selection would be based on availability and structural requirements such as pile spacing, installation requirements, etc. Capacity reductions for liquefaction and downdrag do not apply at this site.

The maximum factored capacity and estimated pile length are provided in Table 5.1. Data for key assumptions such as pile cutoff elevation and ground surface elevation were provided to TSi by Oates Associates, Inc., along with preliminary factored loading for the bridges. The given pile lengths are based on estimated penetrations into the sandstone layer of 3, 4, and 5 feet for the north, and south abutments and the center pier, respectively. Actual penetrations may be less than or greater than these estimates.

Table 5.1.
Maximum Nominal Required Bearing

	NORTH ABUTMENT		**CENTER PIER**		**SOUTH ABUTMENT**	
PILE TYPE	Max. Reqd. Bearing of Pile **(kips)**	Length **(feet)**	Max. Reqd. Bearing of Pile **(kips)**	Length **(feet)**	Max. Reqd. Bearing of Pile **(kips)**	Length **(feet)**
Steel HP 8 X 36	286	37	286	39	286	37.5
Steel HP 10 X 42	335	37	335	39	335	37.5
Steel HP 10 X 57	454	37	454	39	454	37.5
Steel HP 12 X 53	419	37	419	39	419	37.5
Steel HP 12 X 63	497	37	497	39	497	37.5
Steel HP 12 X 74	589	37	589	39	589	37.5
Steel HP 12 X 84	664	37	664	39	664	37.5
Steel HP 14 X 73	578	37	578	39	578	37.5
Steel HP 14 X 89	705	37	705	39	705	37.5
Steel HP 14 X 102	810	37	810	39	810	37.5
Steel HP 14 X 117	929	37	929	39	929	37.5

5.2 Lateral Capacity Geotechnical Parameters

Lateral load resistance and induced lateral deflection are typically assessed using finite difference computer models based on the lateral modulus-of-subgrade reaction, such as LPILE 2012-06. Based on the conditions encountered in the borings, the parameters are estimated for use in the analysis of the lateral capacity as shown in Tables 5.1 and 5.2, using L-PILE Version 2012-06.

Table 5.1.
Parameters for Use in LPILE Analysis at South Abutments

Elevation (ft.)	LPILE Soil Type	Effective Unit Weight (pcf)	Undrained Cohesion (psf)	Strain at 50% Maximum Stress	Angle of Internal Friction (degrees)	p-y Soil Modulus K (pci)
398 - 391	Stiff Clay w/o Free Water	125	1,250	0.008	N/A	425
391 - 387	Soft Clay (Matlock)	63	350	0.025	N/A	20
387 - 381	Stiff Clay w/ Free Water	63	1,250	0.008	N/A	425
381 - 378	Soft Clay (Matlock)	63	350	0.025	N/A	20
378 - 371	Stiff Clay w/ Free Water	63	1,250	0.008	N/A	425
371 - 366	Soft Clay (Matlock)	63	350	0.025	N/A	20
366 - 361	Stiff Clay w/ Free Water	63	1,250	0.008	N/A	425
361 – 357	Sand (Reese)	63	N/A	N/A	32	51
Below 357	Sandstone	73	N/A	N/A	38	100

pcf = pounds per cubic foot
psf = pounds per square foot
pci = pounds per cubic inch

TABLE 5.2.
PARAMETERS FOR USE IN LPILE ANALYSIS AT NORTH ABUTMENTS

Elevation (ft.)	LPILE Soil Type	Effective Unit Weight (pcf)	Undrained Cohesion (psf)	Strain at 50% Maximum Stress	Angle of Internal Friction (degrees)	p-y Soil Modulus K (pci)
398.7 - 386	Stiff Clay w/o Free Water	125	1,250	0.008	N/A	425
386 - 384 -	Soft Clay (Matlock)	63	300	0.025	N/A	20
384 – 369	Stiff Clay w/ Free Water	63	1,250	0.008	N/A	425
369 – 366	Soft Clay (Matlock)	63	300	0.025	N/A	20
366 – 360.5	Stiff Clay w/ Free Water	63	1,000	0.009	N/A	350
360.5 - 357	Sand (Reese)	63	N/A	N/A	32	50
Below 357	sandstone	73	N/A	N/A	38	100

pcf = pounds per cubic foot
psf = pounds per square foot
pci = pounds per cubic inch

6.0 Construction Considerations

6.1 Temporary Sheeting and Soil Retention

The construction activities should be performed in accordance with the current IDOT Standard Specifications for Road and Bridge Construction. Trenching, excavating, and bracing should be performed in accordance with Occupational Safety and Health Administration (OSHA) regulations, and other applicable regulatory agencies. In accordance with the OSHA excavation standards, the soil at the site is considered to be Type C, which requires a side slope for excavations no steeper than 1.5H:1.0V. However, worker safety and classification of the excavation soil is the responsibility of the contractor. The excavation side slopes for structure foundations may interfere with existing utilities. This will require a temporary soil retention system such as a cantilever sheet pile wall, sheeting, or other temporary support.

Traffic along I-57 will be maintained by utilizing staged construction. It appears as though either a temporary sheet pile, which includes cantilever temporary sheet piling, or a soil retention system, will be feasible at the abutments. Soft soils observed below the anticipated retained height of approximately 7.5 feet may require additional embedment. Cantilever sheet pile systems may be designed using IDOT Design Guide 3.13.1 – Temporary Sheet Piling Design. The top of the sheets for the Type 2 cofferdam will extend 3 feet above the Estimated Water Surface Elevation (ESWE) of Elevation 384.8. Considering the relatively soft cohesive soils below the base of the intermediate piers, it is recommended that the sheets be driven to refusal on the underlying sandstone, at approximately Elevation 357.

6.2 Subgrade Water Protection

Groundwater seepage should be anticipated for excavations extending more than a few feet below the roadway level along I-57. The free water surface, stated on the boring logs, is approximately 6 feet below the ground surface at the boring locations. It is anticipated that excavations within the soil that is down to approximately Elevation 391 feet may be adequately dewatered using sump and pump methods. Excavations below that level could encounter water-bearing soil strata that may need a cofferdam or more extensive dewatering to provide a stable excavation.

6.3 Driven Pile Installation

The driven piles are to be furnished and installed according to the requirements of Section 512 of the IDOT Standard Specifications, 2012. TSi recommends that at least one test pile be driven at each substructure location, in accordance with Section 512.15. The piles should be fitted with reinforced tips to reduce the potential for damage during driving.

6.4 Subgrade, Fill, and Backfill

Earthwork activities including backfill and fill should be performed in accordance with Section 205 of the Standard Specifications.

7.0 Report Limitations

This geotechnical report has been prepared for the exclusive use of **Oates Associates, Inc.** and the **Illinois Department of Transportation** for the specific application to the subject project. The information and recommendations contained in this report have been made in accordance with generally accepted geotechnical and foundation engineering practices; no other warranties are implied or expressed.

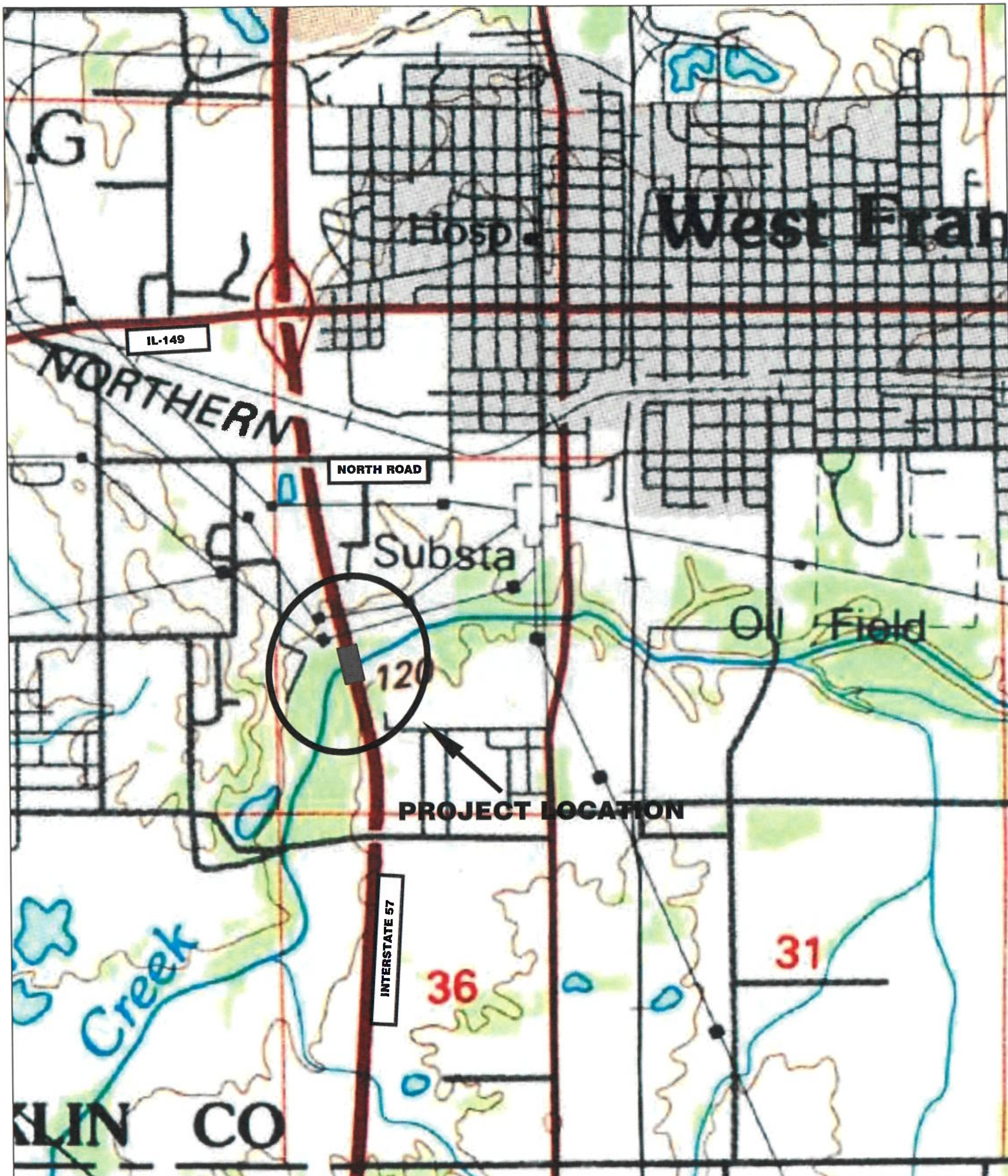
The assessments and recommendations submitted in this report are based in part upon the data obtained from the borings. The nature and extent of variations between the borings may not be evident at this time. If variations appear evident at a later date, it may be necessary to re-evaluate the recommendations of this report.

We emphasize that this report was prepared for design purposes only and may not be sufficient to prepare an accurate construction bid. Contractors reviewing this report should acknowledge that the information and recommendations contained herein are for design purposes.

If conditions at the site have changed due to natural causes or other operations, this report should be reviewed by TSi to determine the applicability of the analyses and recommendations considering the changed conditions. The report should also be reviewed by TSi if changes occur in the structure locations, sizes, and types, in the planned loads, elevations, grading and site development plans or the project concepts.

TSi requests the opportunity to review the final plans and specifications for the project prior to construction to verify that the recommendations in this report are properly interpreted and incorporated in the design and construction documents. If TSi is not accorded the opportunity to make this recommended review, we can assume no responsibility for the misinterpretation of our recommendations.

APPENDIX A



NOT TO SCALE

NOTE:
DRAWING PREPARED FROM AN IMAGE
OBTAINED FROM USGS ON 03/02/2018

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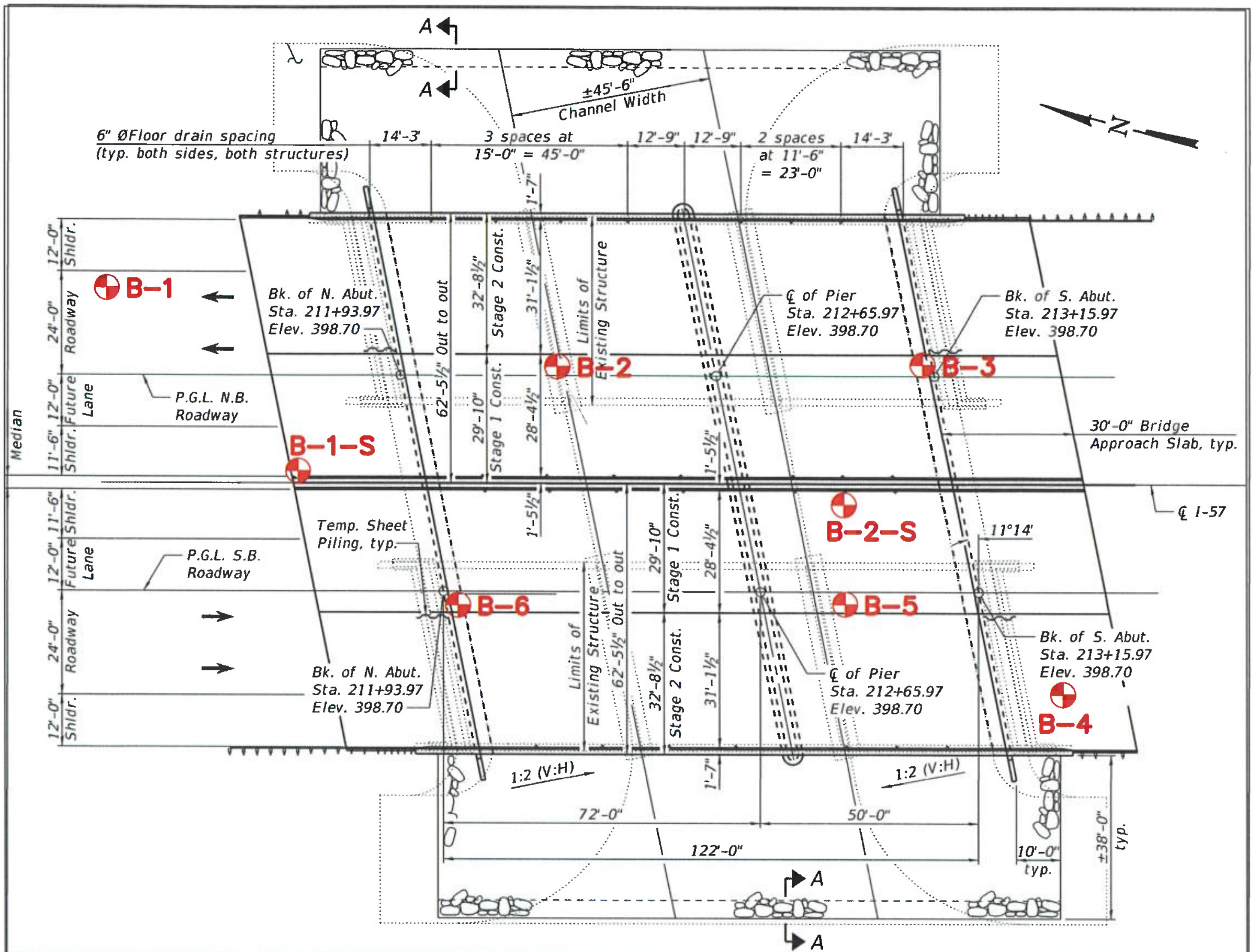
TSi geotechnical, inc.
1340 NORTH PRICE ROAD
ST. LOUIS, MISSOURI 63132

VICINITY MAP

FAI 157 OVER POND CREEK
FRANKLIN COUNTY, ILLINOIS

Drawn By: ACE	Checked By: NRL	
Project No.: 20181032.00	Date: 03/02/18	Figure 1



NOTE: THIS PLAN WAS PREPARED FROM AN IMAGE OBTAINED BY TSI FROM OATES ON 03/01/2018.

NOT TO SCALE

LEGEND

B-1 APPROXIMATE BORING LOCATION AND NUMBER

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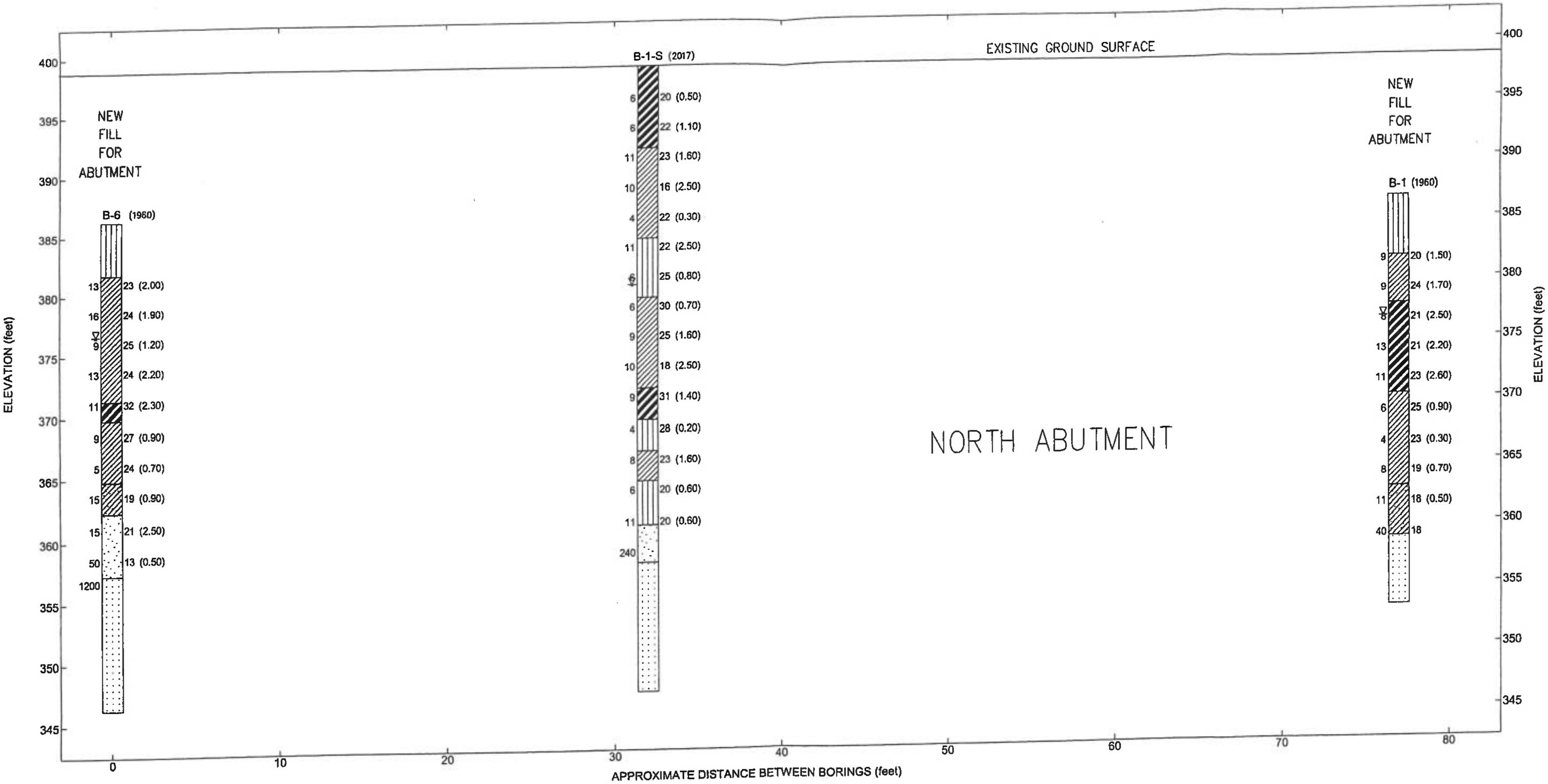
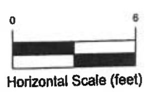
1340 N. PRICE ROAD
ST. LOUIS, MISSOURI 63132

SITE AND BORING LOCATION PLAN

FAI 57 OVER POND CREEK
FRANKLIN COUNTY, ILLINOIS

Drawn By: ACE	Checked By: NRL
Project No.: 20181032.00	Date: 03/02/18 Figure 2





NOTES:
1. Horizontal scale is approximate.
2. The existing ground surface shown is a line extended between surveyed ground surface elevations at boring locations, and does not necessarily reflect the actual ground surface between borings.
3. The generalized stratigraphy shown is an interpretation of subsurface conditions based on field and laboratory test results on samples recovered at the indicated boring locations. The conditions between the borings could vary significantly from those shown.
4. Lines showing strata breaks are intended to show estimated correlations of strata from boring to boring, not an interpretation of conditions between borings.
5. See Subsurface Profile Legend, Figure 4, for explanation of boring log data.

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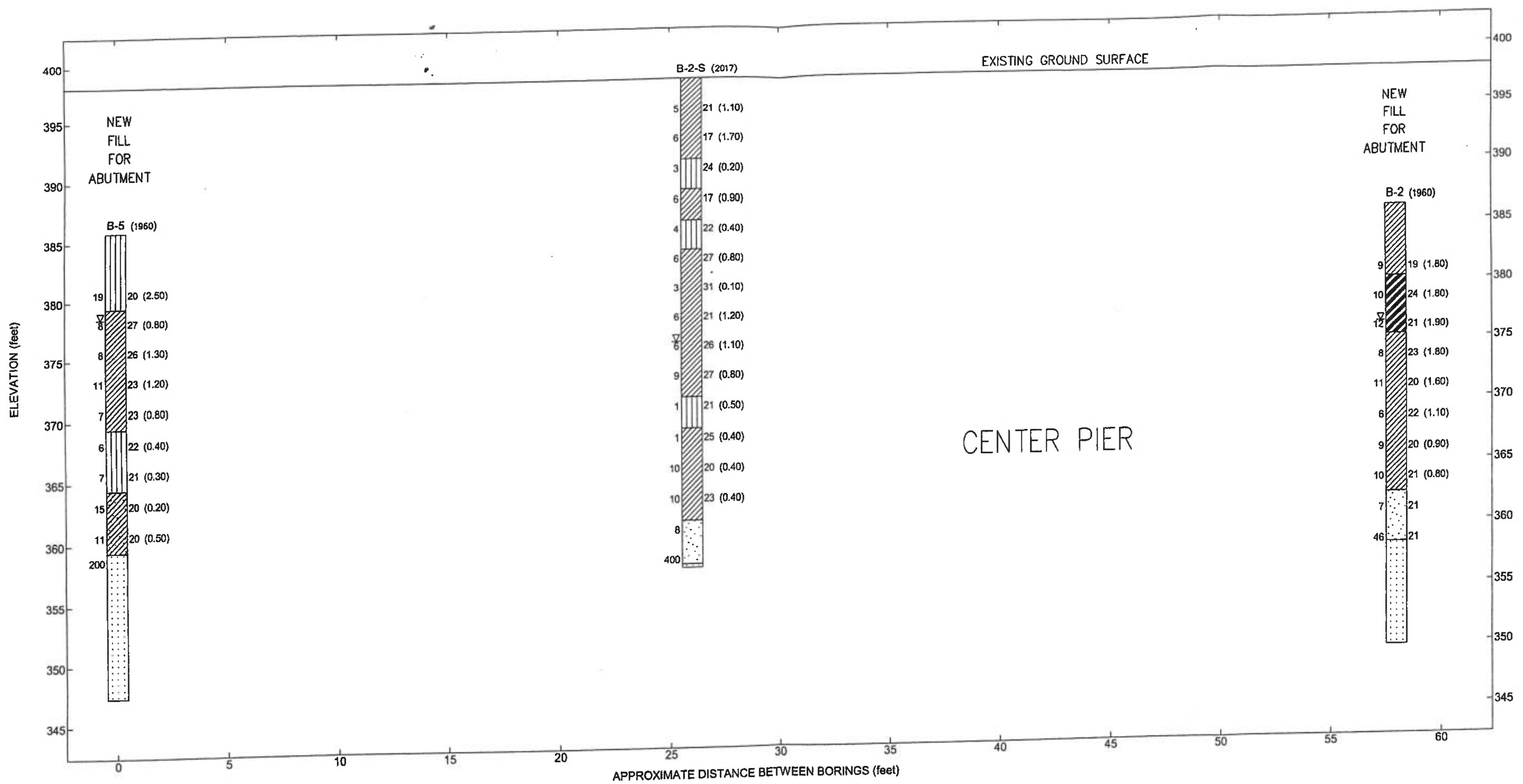
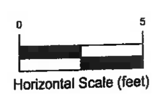
SUBSURFACE PROFILE

FAI 57 OVER POND CREEK
FRANKLIN COUNTY, IL

Prepared By: ACE	Checked By: NRL	
Project No. 20181032.00	Date:3/2/2018	Figure 3.1





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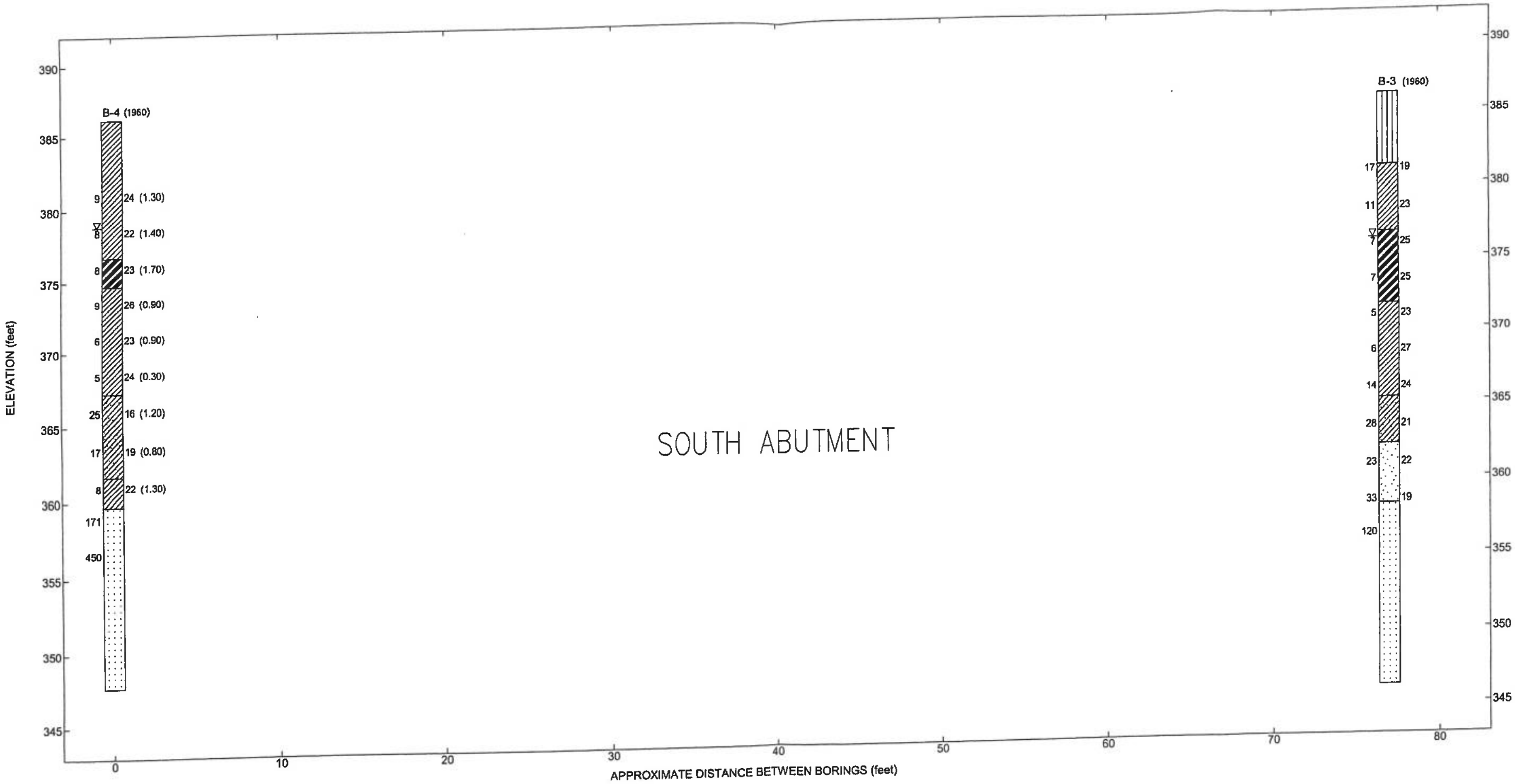
SUBSURFACE PROFILE		
FAI 57 OVER POND CREEK FRANKLIN COUNTY, IL		
Prepared By: ACE	Checked By: NRL	
Project No. 20181032.00	Date:3/2/2018	Figure 3.2



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SUBSURFACE PROFILE		
FAI 57 OVER POND CREEK FRANKLIN COUNTY, IL		
Prepared By: ACE	Checked By: NRL	
Project No. 20181032.00	Date:3/2/2018	Figure 3.3

APPENDIX B

ILLINOIS DEPARTMENT OF TRANSPORTATION
District Nine Materials

Bridge Foundation
Boring Log

FAI Route 57 Over Pond Creek

Route: FAI 57 | Structure Number: 028-0001 (N.B.) and 028-0002 (S.B.) | Date: 4/10/2017

Section (28-5B-1)D-1 | Bored By: R Moberly

County: Franklin | Location: S of SCL W. Frankfort | Checked By: R Moberly

Boring No 1-S (2017)
Station 211+60
Offset 3' Lt CL Median
Ground Surface 398.7 Ft

Surf Wat Elev: 381.3
Ground Water Elevation
when Drilling 380.2
At Completion
At: 391.1 Hrs: 168

Description	Elev.	DEPTH	BLOWS	Qu tsf	W%
Stiff, moist, brown, Clay A7-6	396.7				
Medium, very moist, brown, Clay A7-6	394.2		1 2 3	0.5B	20
Stiff, moist, brown, Clay A7-6	391.7	5.0	1 2 3	1.1B	22
Stiff, moist, brown, Silty Clay A-6	389.2		1 4 5	1.6B	23
Very stiff, moist, brown mottled tan Silty Clay Loam A-6	386.7	10.0	2 4 4	2.5B	16
Soft, very moist, brown, Silty Clay A-6	384.2		1 2 1	0.3B	22
Very stiff, moist, gray, Silty Clay Loam A-4	381.7	15.0	2 4 5	2.5B	22
Medium, very moist, gray, Silty Clay Loam A-4	379.2		1 2 3	0.8S	25
Medium, very moist, gray, Silty Clay A-6	376.7	20.0	1 2 3	0.7B	30
Stiff, moist, gray, Silty Clay A-6	374.2		1 3 4	1.6B	25
		25.0	2		

Description	Elev.	DEPTH	BLOWS	Qu tsf	W%
Very stiff, moist, gray, Silty Clay to Silty Clay Loam A-6	371.7		4 4	2.5B	18
Stiff, moist, mottled gray, Clay to Silty Clay A7-6	369.2		2 3 4	1.4B	31
Very soft, very moist, gray, Silty Clay Loam A-4	366.7	30.0	1 1 2	0.2B	28
Stiff, moist, brown, Silty Clay to Silty Clay Loam A-6	364.2		1 3 3	1.6B	23
Medium, very moist, gray, Silty Loam A-4		35.0	1 2 3	0.6B	20
	360.7		1 3 6	0.6B	20
Medium dense, moist, brown, Sand	358.2	40.0	6 17 100/5"		
Very dense, dry, brown, Sand Refusal at 41.5 feet	357.2				
Cored 41.5 to 46.5 feet 80% recovery, 32.5% RQD Very dense, dry, brown and gray, Sandstone	352.2	45.0			
Cored 46.5 to 51.5 feet 100% recovery, 73.3% RQD Very dense, dry, brown and gray, Sandstone		50.0			

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

Date: 4/10/2017

Route: FAI 57

Section: (28-5B-1)D-1

County: Franklin

Boring No: 1-S (2017)

Station: 211+60

Offset: 3' Lt CL Median

Ground Surface: 398.7 Ft

	DEPTH	BLOWS	Qu tsf	W%		DEPTH	BLOWS	Qu tsf	W%
Cored 46.5 to 51.5 feet									
Very dense, dry, brown and gray, Sandstone 346.7									
Bottom of hole = 51.5 feet									
	55.0					80.0			
Free water observed at 18.5 feet									
Washout procedures used from 38.0 to 41.5 feet									
Elevation referenced to BM at SW corner parapet wall SN 028-0002; Elevation = 400.7 feet									
To convert "N" values to "N60" multiply by 1.25	60.0					85.0			
Borehole advanced with hollow stem auger (8" O.D, 3.25" I.D.)									
	65.0					90.0			
	70.0					95.0			
	75.0					100.0			

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

ILLINOIS DEPARTMENT OF TRANSPORTATION District Nine Materials	Bridge Foundation Boring Log

FAI Route 57 Over Pond Creek — Sheet 1 of 1

Route: FAI 57 Structure Number: 028-0001 (N.B.) and 028-0002 (S.B.) Date: 4/13/2017

Section (28-5B-1)D-1 Bored By: R Moberly

County: Franklin Location: S of SCL W. Frankfort Checked By: R Moberly

Boring No 2-S (2017)
Station 212+86
Offset 3' Rt CL
Ground Surface 398.1 Ft

Surf Wat Elev: 381.3
Ground Water Elevation
when Drilling 375.6
At Completion
At: 392.3 Hrs: 168

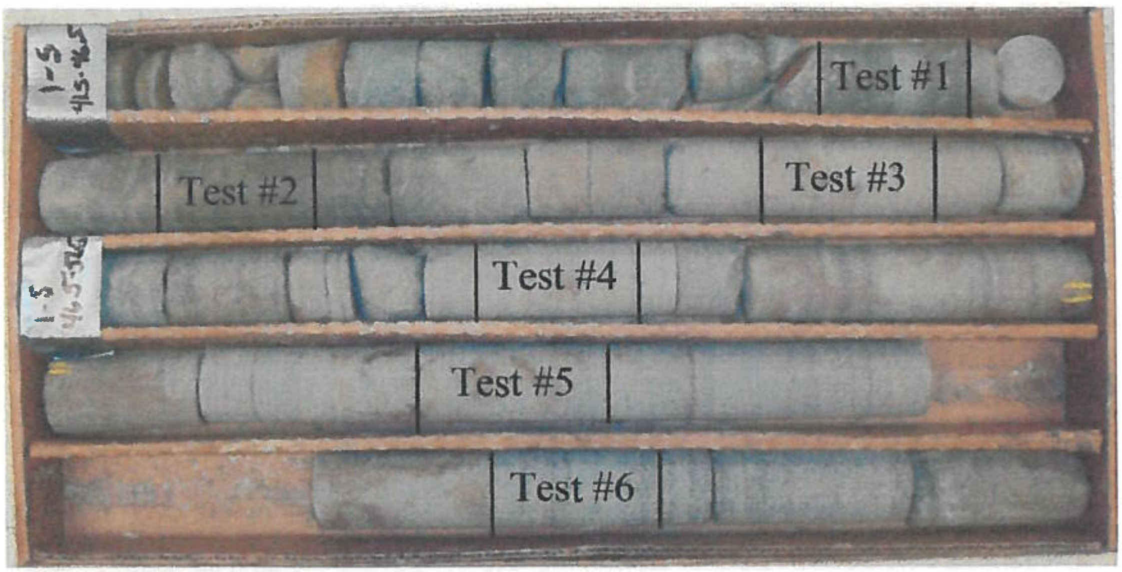
Description	Elev.	DEPTH	BLOWS	Qu tsf	W%
Stiff, very moist, brown, Clay to Clay Loam					
			2		
			2	1.1B	21
			2		
	393.6				
Stiff, moist, brown, Silty Clay		5.0	1		
			2	1.7B	17
			3		
	391.1				
Very soft, very moist, brown, Silty Clay Loam A-4			WH		
			1	0.2B	24
			1		
	388.6				
Medium, moist to very moist, brown, Silty Clay Loam to Silty Clay A-6		10.0	1		
			2	0.9B	17
			3		
	386.1				
Soft, very moist, brownish grey, Silty Clay Loam A-4			WH		
			1	0.4B	22
			2		
	383.6				
Medium, very moist, grey, Silty Clay A-6		15.0	1		
			2	0.8B	27
			3		
	381.1				
Very soft, very moist, grey, Clay to Silty Clay A-6			WH		
			WH	0.1B	31
			2		
	378.6				
Stiff, moist, light brown, Silty Clay A-6		20.0	1		
			2	1.2B	21
			3		
			1		
			2	1.1B	26
			3		
	373.6				
		25.0	1		

Description	Elev.	DEPTH	BLOWS	Qu tsf	W%
Medium, very moist, grey and brown, Silty Clay Loam to Silty Clay A-6			3	0.8B	27
			4		
	371.1				
Soft to medium, very moist, grey, Silty Clay Loam A-4			WH		
			WH	0.5B	21
			1		
	368.6				
Soft, very moist, brown, Sandy Clay A-6		30.0	WH		
			WH	0.4B	25
			1		
	366.1				
Soft, very moist, brown, Silty Clay to Silty Clay Loam A-6			3		
			4	0.4B	20
			4		
	363.6				
Soft, very moist, brown, Sandy Loam to Sandy Clay Loam A-6		35.0	1		
			3	0.4B	23
			5		
5' blow-in	361.1				
Loose, wet, brown and grey, Sand			1		
			2		
	359.6		4		
Medium to very dense, moist, brown and grey, Sand					
		40.0	11		
	357.6		33		
Very dense Sandstone	357.1		100/3"		
Bottom of hole = 40.8 Feet					
Free water observed at 22.5 Feet					
Wash-out procedures used from 37.0 to 39.5 feet					
		45.0			
Elevation referenced to BM at SW parapet wall on SN 028-0002; Elevation = 400.7 feet					
Borehole advanced with hollow stem auger (8" O.D, 3.25" I.D.)					
To convert "N" values to "N60" multiply by 1.25					
	348.1	50.0			

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

Illinois Department of Transportation
District Nine Materials
Unconfined Compressive Strength

FAI 57
Structure 028-0001/028-0002 (Boring 1-S)
Franklin County



Boring #	Specimen#	Depth	Unconfined Compression
1-S	1	43'0"	3,048 psi
1-S	2	44'10"	3,430 psi
1-S	3	46'0"	3,713 psi
1-S	4	47'0"	2,963 psi
1-S	5	50'0"	3,850 psi
1-S	6	51'0"	2,244 psi

BRIDGE FOUNDATION BORING LOG

PROJECT	—	BRIDGE	carrying Interstate	Date	October 1960
ROUTE	F.A.I. 57		over Pond Creek	Bor. Eng.	W. E. Stallman
SEC.	28-5B-1	STA.	212+50	Drilling Tech.	J.H.M.
COUNTY	Franklin				

Boring No. 1
Station 211+25
Offset 48' Lt. "m"

Surface Water El. —
Groundwater El. at Completion 376.5
After 72 Hours 380.5

	Elevation		N	Qu t/s.f.	Type Failure	w (%)
Ground Surface	386.7	0				
Medium and dry grey silty loam to silty clay loam A-4(8)						
	381.7	-5				
Medium stiff and moist grey silty clay A-6(10-11)			9	1.5	P	20
	379.7					
Medium stiff and moist brown with grey streaks silty clay A-6(12)			9	1.7	S	24
	377.7					
Stiff and moist grey mottled brown clay A-7-6(13-15)		-10				
			8	2.5	B	21
			13	2.2	B	21
		-15				
			11	2.6	B	23
	370.2					
Medium to soft and moist to very moist grey mottled brown silty clay A-6(11-12)			6	0.9	B	25
		-20				
			4	0.3	B	23
	364.7					
(see next column)						

	Elevation		N	Qu t/s.f.	Type Failure	w (%)
Medium and moist grey clay loam A-6(8)			8	0.7	B	19
	362.7					
Medium and wet brown sandy loam		-25				
			11	0.5	P	18
	358.7		40	—	—	18
				—	—	9
Soft and dry brown to grey medium graded sandstone with small clay seams (80% Recovery)		-30				
	352.2					
Soft and dry grey medium graded sandstone (100% Recovery)						
	353.2					
Bottom of Hole = 33.5 feet		-35				
		-40				
		-45				

Notes
Sandstone was cored from 28.5 feet

Hole was washed to obtain samples between 26.0 and 27.5 feet

During drilling operation, it appeared that free water was encountered at 17.0 feet.

N - Standard Penetration Test - Blows per foot to drive 2" O.D. Split Spoon Sampler with 140# hammer.

Qu - Unconfined Compressive Strength - t/sf

w - Water Content - percentage

Type failure:
B - Bugle Failure
S - Shear Failure
E - Estimated Value

BRIDGE FOUNDATION BORING LOG

PROJECT —
BRIDGE carrying Interstate over Pond Creek
Date October 1960
ROUTE F.A.I. 57
Bor. Eng. W. E. Stallman
SEC. 28-5B-1
STA. 212+50
Drilling Tech. J.H.M.
COUNTY Franklin

Boring No. 2
Station 212+21
Offset 29' Lt. "M"

Surface Water El. —
Groundwater El. at Completion 376.2
After 24 Hours 379.2

Description	Elevation	N	Qu t/s.f.	Type Failure	w (%)
Ground Surface 386.2	0				
Medium and dry brown to grey silty clay loam A-6(8-9)					
381.7	-5				
Stiff and dry grey mottled brown clay to silty clay A-6(12)					
380.2		9	1.8	S	19
Stiff and moist grey clay A-7-6(13-14)					
		10	1.8	S	24
	-10				
375.2		12	1.9	S	21
Medium stiff and moist grey silty clay A-6(11-12)					
		8	1.8	S	23
	-15				
		11	1.6	B	20
		6	1.1	B	22
366.7	-20				
Medium and moist grey silty clay to clay loam A-6(8)					
		9	0.9	B	20

Description	Elevation	N	Qu t/s.f	Type Failure	w (%)
(See previous column)		10	0.8	B	21
362.2					
Loose and wet brown fine sand	-25				
		7	-	-	21
358.2		46	-	-	21
			-	-	23
Soft and dry medium grained grey sandstone with narrow clay seams (25% Recovery)	-30				
354.2					
Soft and dry medium grained grey sandstone (100% Recovery)	-35				
349.7					
Bottom of Hole - 36.5 feet	-40				
	-45				

Notes:
Sandstone was cored from 29.5 feet.
Hole was washed to obtain sample between 26.0' and 27.5 feet.
During drilling operation it appeared that free water was encountered at 15.0 feet

- Standard Penetration Test - lows per foot to drive 2" ı.D. Split Spoon Sampler with ı0# hammer.

Qu - Unconfined Compressive Strength - t/sf

w - Water Content - percentage

Type failure:
B - Bugle Failure
S - Shear Failure
E - Estimated Value

BRIDGE FOUNDATION BORING LOG

PROJECT —
BRIDGE carrying Interstate over Pond Creek
Date October 1960

ROUTE F.A.I. 57
Bor. Eng. W. E. Stallman

SEC. 28-5B-1
STA. 212+50
Drilling Tech. J.H.M.

COUNTY Franklin

Boring No. 3
Station 213+11
Offset 29' Lt. "M"

Surface Water El. —
Groundwater El. at Completion 376.2
After 24 Hours 379.2

Description	Elevation	N	Qu t/s.f.	Type Failure	w (%)
Ground Surface	386.20				
Medium stiff and damp grey mottled brown silty clay loam A-4(8)					
	381.2 / -5				
Medium stiff and moist grey mottled brown silty clay A-6(11-12)		17	2.7	S	19
		11	1.1	B	23
	376.7				
Stiff and moist grey mottled brown silty clay to clay A-7-6(13)	-10				
		7	1.4	B	25
		7	0.9	B	25
	371.7				
Medium and very moist grey mottled brown clay loam A-6(6)	-15				
		5	0.9	-	23
		6	0.3	B	27
	367.2				
Medium and moist grey mottled brown silty clay to clay A-6(11-12)	-20				
	365.2	14	0.8	-	24
(see next column)					

Description	Elevation	N	Qu t/s.f	Type Failure	w (%)
Soft and wet brown sandy loam		28	0.5	P	21
	362.2				
Medium packed and wet brown to grey fine sand	-25				
		23	-	-	22
	358.2	33	-	-	19
Soft rotten and moist grey brown streaked sandstone			-	-	11
	-30	100 Blows in 10 inches			
	354.7				
Medium soft and dry medium grained sandstone (100% Recovery)					
	-35				
	346.2 / -40				
Bottom of Hole = 40.0 feet					
	-45				

Notes:
Sandstone was cored from 31.5 feet
Hole was washed to obtain samples between 21.0 feet and 31.5 feet
During drilling operation it appeared that free water was encountered at 15.0 feet

N - Standard Penetration Test - Blows per foot to drive 2" O.D. Split Spoon Sampler with 140# hammer.

Qu - Unconfined Compressive Strength - t/sf

w - Water Content - percentage

Type failure:
B - Bugle Failure
S - Shear Failure
E - Estimated Value

BRIDGE FOUNDATION BORING LOG

PROJECT —
ROUTE F.A.I. 57
SEC. 28-5B-1
COUNTY Franklin

BRIDGE carrying Interstate over Pond Creek
STA. 212+50

Date October 1960
Bor. Eng. W. E. Stallman
Drilling Tech. J.H.M.

Boring No. 4
Station 213+26
Offset 48' Rt "M"

Surface Water El. -
Groundwater El. at Completion 378.7
After 24 Hours 380.2

Description	Elevation	N	Qu t/s.f.	Type Failure	w (%)
Ground Surface 386.2	0				
Medium and moist grey silty clay loam A-6(8-9)					
381.2	-5				
Stiff and moist grey mottled brown silty clay A-6(11-12)		9	1.3	P	24
		8	1.4	S	22
376.7					
Stiff and moist grey mottled brown silty clay A-7-6(14)	-10	8	1.7	B	23
374.7					
Medium and moist grey mottled brown silty clay A-6(11)		9	0.9	B	26
372.2					
Medium and moist grey mottled brown silty clay loam A-6(10)	-15	6	0.9	B	23
		5	0.3	B	24
367.2					
Medium stiff and very moist to wet brown sandy clay loam to sandy loam	-20	25	1.2	S	16
(see previous column)		17	0.8	P	19
361.7	-25				
Stiff and moist brown clay loam A-6(7-8)		8	1.3	P	22
359.7					
Soft and moist grey and brown sandstone		100 Blows in 7 inches			
356.7	-30				
Medium soft and dry medium grained sandstone (100% Recovery)		75 Blows in 2 inches			
	-35				
347.7					
Bottom of Hole = 38.5 feet					
	-40				
	-45				

Notes:
Sandstone was cored from 29.5 feet
Hole was washed to obtain samples between 21.0 feet to 29.5 feet
During drilling operation, it appeared that free water was encountered at 15.0 feet

N - Standard Penetration Test - Blows per foot to drive 2" O.D. Spilt Spoon Sampler with 140# hammer.

Qu - Unconfined Compressive Strength - t/sf

w - Water Content - percentage

Type failure:
B - Bugle Failure
S - Shear Failure
E - Estimated Value

BRIDGE FOUNDATION BORING LOG

PROJECT —

ROUTE F.A.I. 57

SEC. 28-5B-1

COUNTY Franklin

BRIDGE carrying Interstate Over Pond Creek

STA. 212+50

Date October 1960

Bor. Eng. W. E. Stallman

Drilling Tech. J.H.M.

Boring No. 5

Station 212+80

Offset 29' Rt "M"

Surface Water El. —

Groundwater El. at Completion 378.4

After 24 Hours 379.1

Description	Elevation	N	Qu t/s.f.	Type Failure	w (%)
Ground Surface 385.9	0				
Medium and slightly moist brown silty clay loam A-4(8)					
381.4					
Very stiff and slightly moist grey silt loam A-4(8)	-5				
		19	2.5	S	20
379.4					
Medium stiff and moist grey mottled brown silty clay A-6(12)					
		8	0.8	B	27
	-10				
		8	1.3	B	26
373.4					
Medium stiff and moist bluish grey to grey mottled brown silty clay loam A-6(9-10)					
		11	1.2	S	23
	-15				
		7	0.8	S	23
			0.7	B	25
369.4					
Soft and wet grey mottled brown clay loam A-4(7-8)					
		6	0.4	S	22
	-20				
		7	0.3	B	21
364.4					
(see next column)					

Description	Elevation	N	Qu t/s.f.	Type Failure	w (%)
Medium and wet grey and brown sandy loam					
		15	0.2	P	20
	-25				
		11	0.5	P	20
359.4					
Soft and moist medium grained grey sandstone		100 blows in 6 inches			
356.4					
Soft and dry medium grained sandstone (85% Recovery)	-30				
	-35				
347.4					
Bottom of Hole ≠ 38.5 feet					
	-40				
	-45				

Notes:
Sandstone was cored from 29.5 feet
Hole was washed to obtain samples between 23.5 feet and 29.5 feet
During drilling operation, it appeared that free water was encountered at 15.0 feet

N - Standard Penetration Test - Blows per foot to drive 2" O.D. Split Spoon Sampler with 140# hammer.

Qu - Unconfined Compressive Strength - t/sf

w - Water Content - percentage

Type failure:
B - Bugle Failure
S - Shear Failure
E - Estimated Value

BRIDGE FOUNDATION BORING LOG

PROJECT —
ROUTE F.A.I. 57
SEC. 28-5B-1
COUNTY Franklin

BRIDGE carrying Interstate over Pond Creek
STA. 212+50

Date October 1960
Bor. Eng. W. E. Stallman
Drilling Tech. J.H.M.

Boring No. 6
Station 211+89
Offset 29' Rt. "M"

Surface Water El. ____
Groundwater El. at Completion 376.5
After 120 Hours 380.5

Description	Elevation	Depth	N	Qu t/s.f.	Type Failure	w (%)
Ground Surface	386.3	0				
Medium and damp brown silty clay loam A-4(8)						
	381.8	-5				
Stiff and slightly moist grey silty clay loam A-6(9)			13	2.0	P	23
	379.3					
Medium stiff to very stiff and slightly moist grey mottled brown silty clay A-6(10-11)			16	1.9	B	24
		-10	9	1.2	B	25
			13	2.2	B	24
	371.3	-15				
Very stiff and moist grey mottled brown clay A-7-6(14)			11	2.3	B	32
	369.8					
Medium and moist grey mottled brown silty clay A-6(10)			9	0.9	B	27
	367.3					
Medium and wet grey mottled brown silty clay loam to clay loam A-6(8)		-20	5	0.7	B	24
	364.8					
(see next column)						

Description	Elevation	Depth	N	Qu t/s.f	Type Failure	w (%)
Medium and wet grey mottled brown sandy loam			15	0.9	B	19
	362.3					
Well graded and wet grey mottled brown fine sand		-25	15	2.5	P	21
			50	0.5	S	13
	357.3					
Soft and moist medium grained grey to brown sandstone	356.3	-30	100 Blows in 1 inch			
Hard and dry medium grained grey sandstone (95% Recovery)						
	351.8					
Medium soft and dry grey sandstone with clay seams intermixed in layers (90% Recovery)		-35				
	346.3	40				
Bottom of Hole = 40.0 feet						
		-45				

Notes:
Sandstone was cored from 30.0 feet to 40.0 feet
Hole was washed to obtain samples between 26.0 feet and 29.5 feet
During drilling operation, it appeared that free water was encountered at 17.0 feet

- Standard Penetration Test - lows per foot to drive 2" .D. Spilt Spoon Sampler with 0# hammer.

Qu - Unconfined Compressive Strength - t/sf

w - Water Content - percentage

Type failure:
B - Bugle Failure
S - Shear Failure
E - Estimated Value

APPENDIX C

SEISMIC SITE CLASS DETERMINATION

I.D.O.T. BBS FOUNDATIONS AND GEOTECHNICAL UNIT

Modified on 12/10/10

PROJECT TITLE===== FAI 57 over Pond Creek

Substructure 1

Base of Substruct. Elev. (or ground surf for bents)	391.62	ft.
Pile or Shaft Dia.	12	inches
Boring Number	1-S	
Top of Boring Elev.	398.7	ft.

Approximate Fixity Elev. 385.62 ft.

Individual Site Class Definition:

N (bar): 18 (Blows/ft.) Soil Site Class D
N_{ch} (bar): NA (Blows/ft.) NA
s_u (bar): 1.87 (ksf) Soil Site Class D <----Controls

Seismic Soil Column Depth (ft)	Bot. Of Sample Elevation	Sample Thick. (ft.)	N	Qu (tsf)	Layer Description Boundary
	395.7	3.00	5	0.50	B
	393.2	2.50	5	1.10	B
	390.7	2.50	9	1.60	B
	388.2	2.50	8	2.50	B
	385.7	2.50	3	0.30	B
2.4	383.2	2.50	9	2.50	B
4.9	380.7	2.50	5	0.80	B
7.4	378.2	2.50	5	0.70	B
9.9	375.7	2.50	7	1.60	B
12.4	373.2	2.50	8	2.50	B
14.9	370.7	2.50	7	1.40	B
17.4	368.2	2.50	3	0.20	B
19.9	365.7	2.50	6	1.60	B
22.4	363.2	2.50	5	0.60	B
24.9	360.7	2.50	9	0.60	B
27.4	358.2	2.50	100	5.00	B
87.9	297.7	60.50	100	5.00	R

Substructure 2

Base of Substruct. Elev. (or ground surf for bents)	375.5	ft.
Pile or Shaft Dia.	12	inches
Boring Number	2-S	
Top of Boring Elev.	398.1	ft.

Approximate Fixity Elev. 369.5 ft.

Individual Site Class Definition:

N (bar): 14 (Blows/ft.) Soil Site Class E
N_{ch} (bar): NA (Blows/ft.) NA
s_u (bar): 2.15 (ksf) Soil Site Class C <----Controls

Seismic Soil Column Depth (ft)	Bot. Of Sample Elevation	Sample Thick. (ft.)	N	Qu (tsf)	Layer Description Boundary
	393.6	4.50	4	1.10	B
	391.1	2.50	5	1.70	B
	388.6	2.50	2	0.20	B
	386.1	2.50	5	0.90	B
	383.6	2.50	3	0.40	B
	381.1	2.50	5	0.80	B
	378.6	2.50	2	0.10	B
	376.1	2.50	5	1.20	B
	373.6	2.50	5	1.10	B
	371.1	2.50	7	0.80	B
0.9	368.6	2.50	1	0.50	B
3.4	366.1	2.50	1	0.40	B
5.9	363.6	2.50	8	0.40	B
8.4	361.1	2.50	8	0.40	B
10.9	358.6	2.50	6	5.00	B
71.4	298.1	60.50	100	5.00	R

Substructure 3

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

Approximate Fixity Elev. ft.

Individual Site Class Definition:

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

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

Substructure 4

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

Approximate Fixity Elev. ft.

Individual Site Class Definition:

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

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

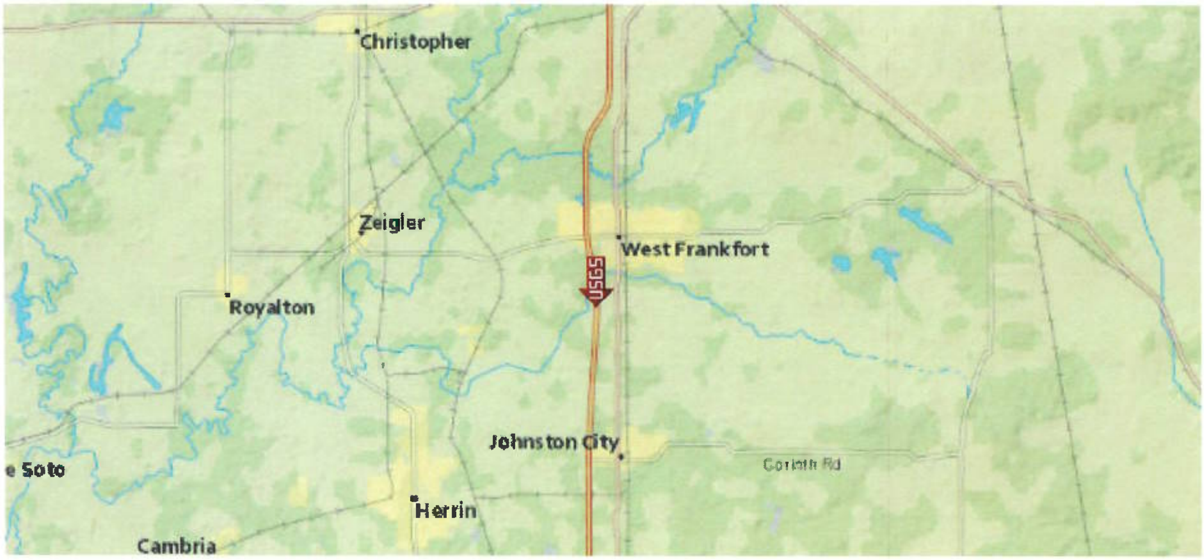
Global Site Class Definition: Substructures 1 through 2

N (bar): 16 (Blows/ft.) Soil Site Class D
N_{ch} (bar): (Blows/ft.) NA
s_u (bar): 2 (ksf) Soil Site Class D <----Controls

USGS Design Maps Summary Report

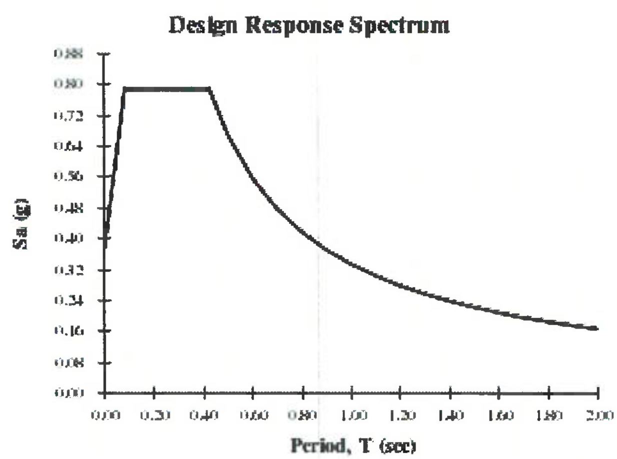
User–Specified Input

Building Code Reference Document	2009 AASHTO Guide Specifications for LRFD Seismic Bridge Design (which utilizes USGS hazard data available in 2002)
Site Coordinates	37.88237°N, 88.94272°W
Site Soil Classification	Site Class D – "Stiff Soil"

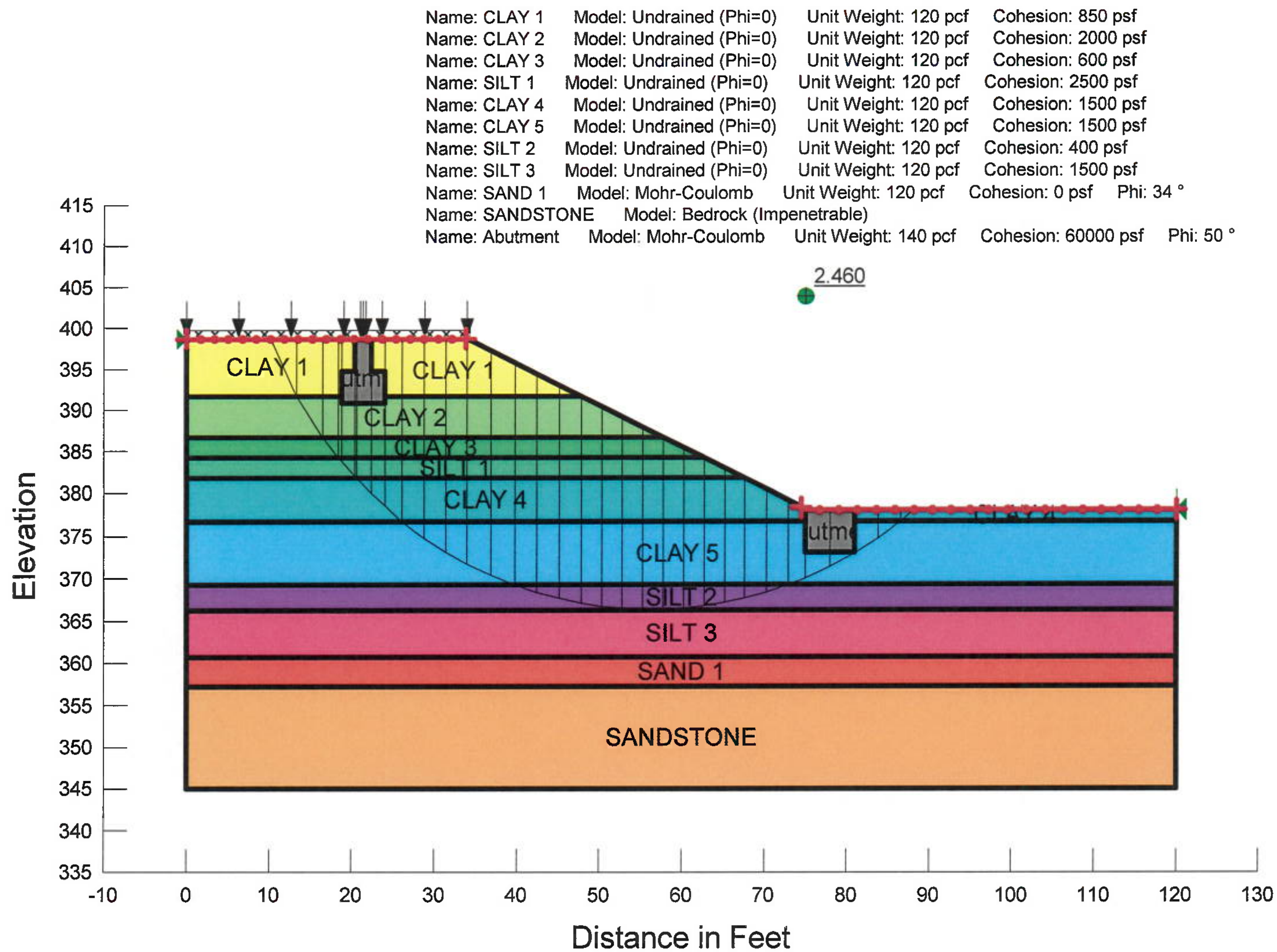


USGS–Provided Output

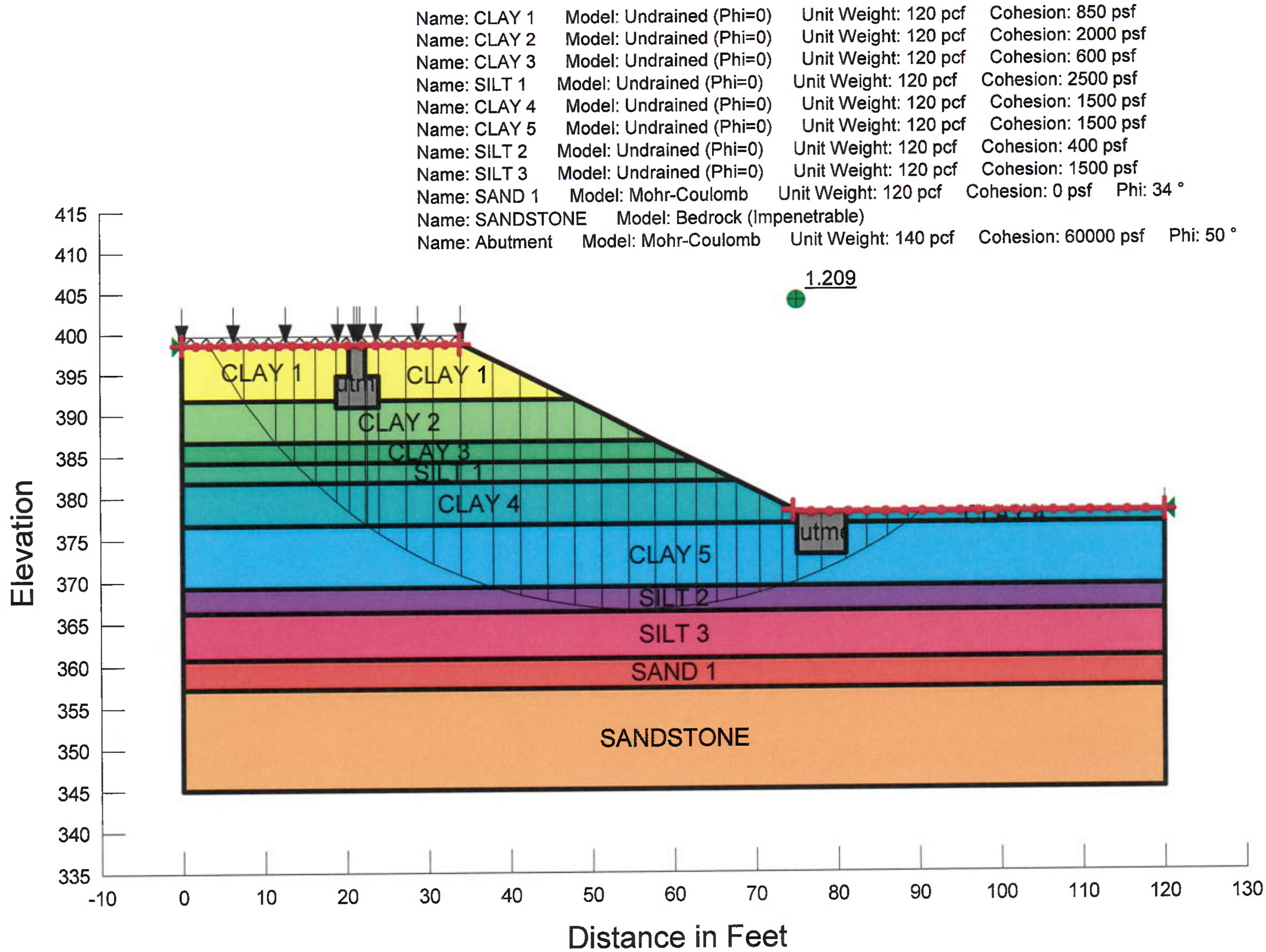
PGA =	0.311 g	**A_s =**	0.370 g
S_S =	0.596 g	**S_{DS} =**	0.789 g
S_1 =	0.153 g	**S_{D1} =**	0.334 g



APPENDIX D

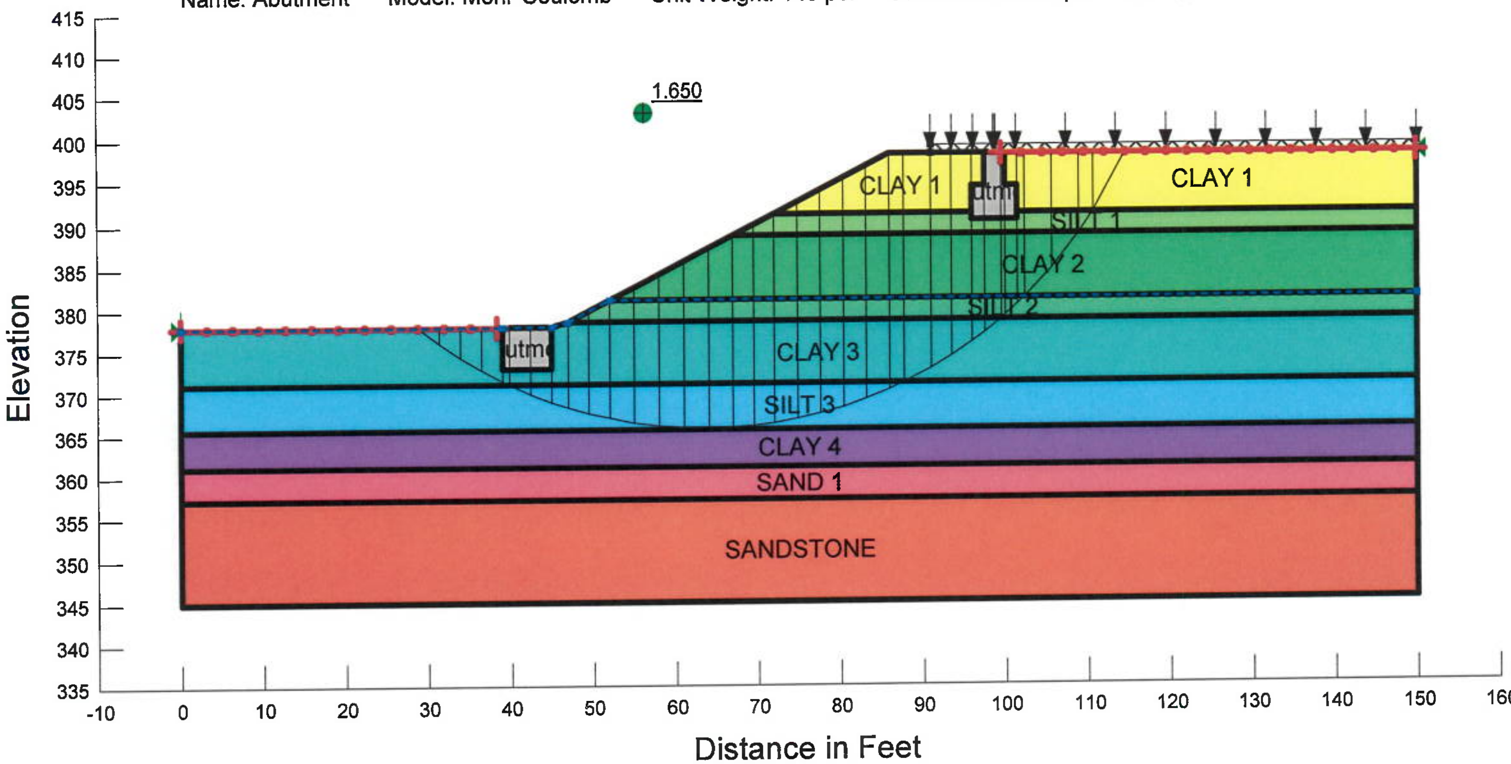


Project Name: Interstate 57 Over Pond Creek
Project Number: 20181032.00
Station 211+60, Boring 1-S NBL
Analysis: Undrained Condition



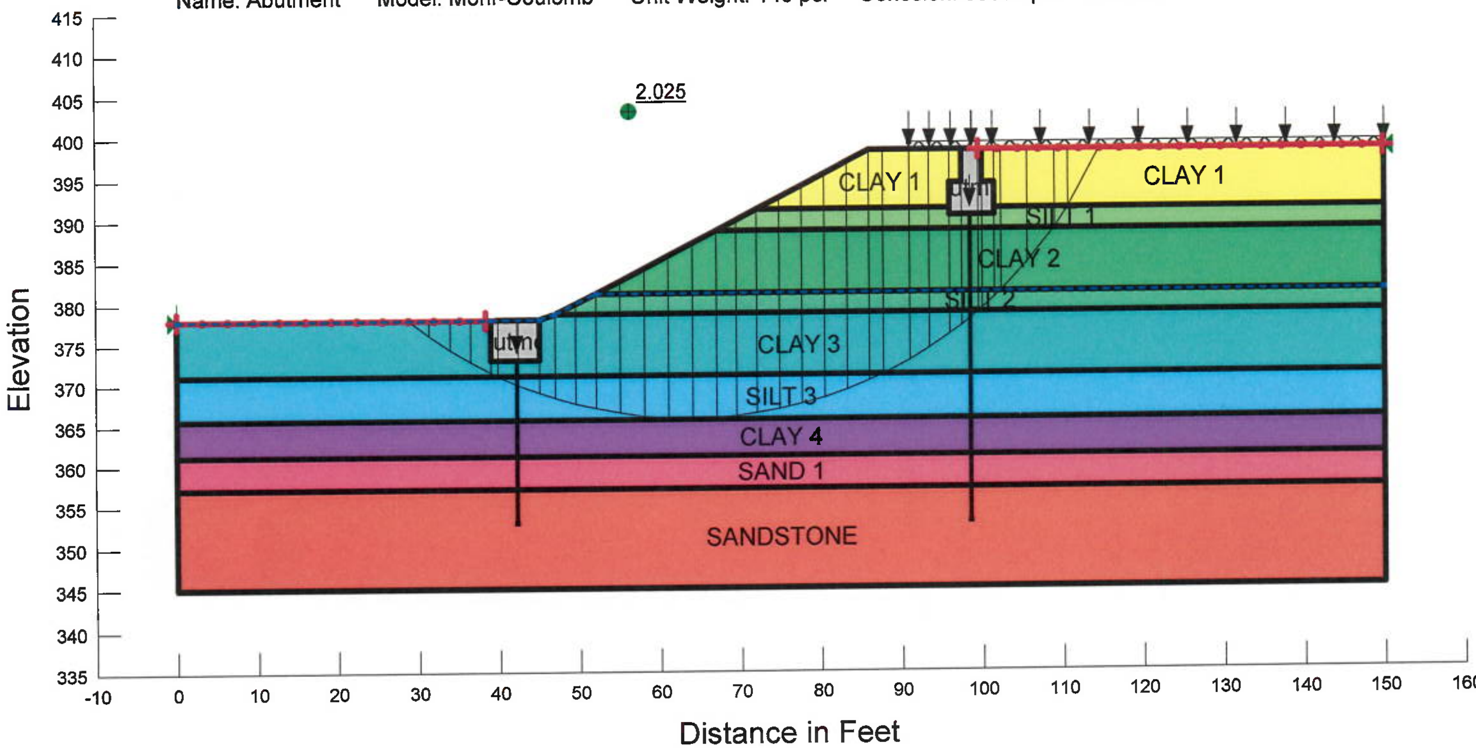
Project Name: Interstate 57 Over Pond Creek
Project Number: 20181032.00
Station 211+60, Boring 1-S NBL
Analysis: Undrained Condition (PGA = 0.37)

Name: CLAY 1	Model: Undrained (Phi=0)	Unit Weight: 120 pcf	Cohesion: 1400 psf	
Name: SILT 1	Model: Undrained (Phi=0)	Unit Weight: 120 pcf	Cohesion: 200 psf	
Name: CLAY 2	Model: Undrained (Phi=0)	Unit Weight: 120 pcf	Cohesion: 900 psf	
Name: SILT 2	Model: Undrained (Phi=0)	Unit Weight: 120 pcf	Cohesion: 100 psf	
Name: CLAY 3	Model: Undrained (Phi=0)	Unit Weight: 120 pcf	Cohesion: 1040 psf	
Name: SILT 3	Model: Undrained (Phi=0)	Unit Weight: 120 pcf	Cohesion: 450 psf	
Name: CLAY 4	Model: Undrained (Phi=0)	Unit Weight: 120 pcf	Cohesion: 1000 psf	
Name: SAND 1	Model: Mohr-Coulomb	Unit Weight: 120 pcf	Cohesion: 0 psf	Phi: 30 °
Name: SANDSTONE	Model: Bedrock (Impenetrable)			
Name: Abutment	Model: Mohr-Coulomb	Unit Weight: 140 pcf	Cohesion: 60000 psf	Phi: 50 °



Project Name: Interstate 57 Over Pond Creek
Project Number: 20181032.00
Station 212+86, Boring 2-S SBL
Analysis: Undrained Condition Without Piles, Clay 4 modified for N-values

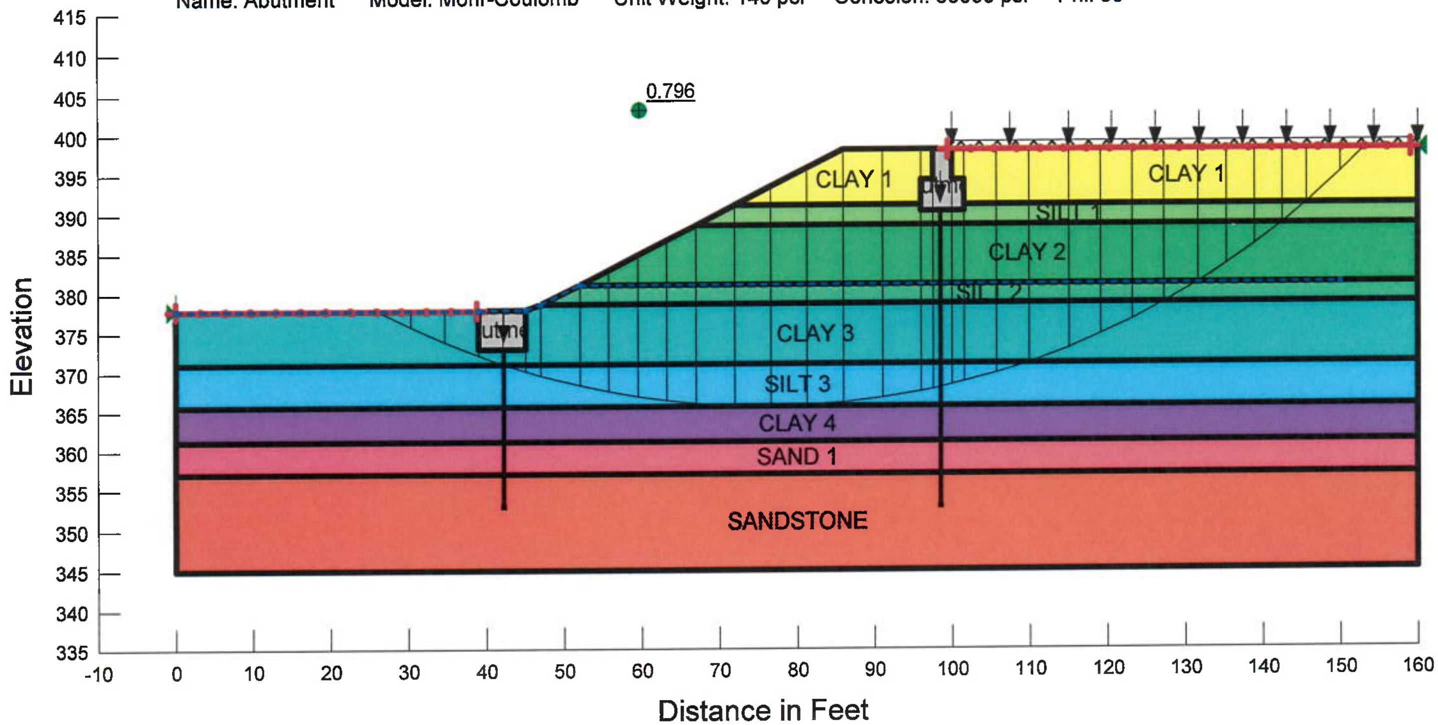
Name: CLAY 1 Model: Undrained (Phi=0) Unit Weight: 120 pcf Cohesion: 1400 psf
Name: SILT 1 Model: Undrained (Phi=0) Unit Weight: 120 pcf Cohesion: 200 psf
Name: CLAY 2 Model: Undrained (Phi=0) Unit Weight: 120 pcf Cohesion: 900 psf
Name: SILT 2 Model: Undrained (Phi=0) Unit Weight: 120 pcf Cohesion: 100 psf
Name: CLAY 3 Model: Undrained (Phi=0) Unit Weight: 120 pcf Cohesion: 1040 psf
Name: SILT 3 Model: Undrained (Phi=0) Unit Weight: 120 pcf Cohesion: 450 psf
Name: CLAY 4 Model: Undrained (Phi=0) Unit Weight: 120 pcf Cohesion: 1000 psf
Name: SAND 1 Model: Mohr-Coulomb Unit Weight: 120 pcf Cohesion: 0 psf Phi: 30 °
Name: SANDSTONE Model: Bedrock (Impenetrable)
Name: Abutment Model: Mohr-Coulomb Unit Weight: 140 pcf Cohesion: 60000 psf Phi: 50 °



Project Name: Interstate 57 Over Pond Creek
Project Number: 20181032.00
Station 212+86, Boring 2-S SBL
Analysis: Undrained Condition With Piles, Clay 4 modified for N-values

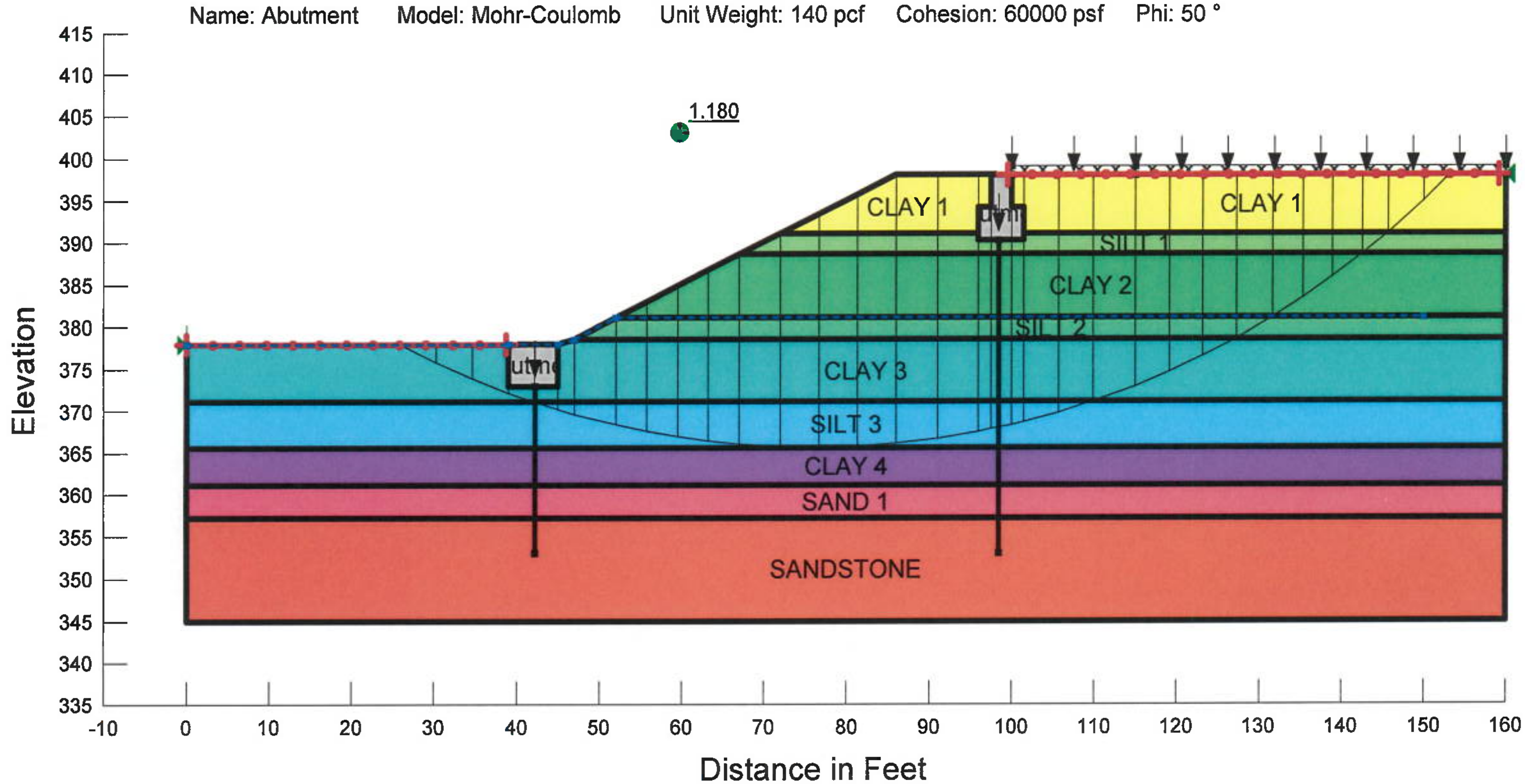
SOIL PROPERTIES

Name: CLAY 1	Model: Undrained (Phi=0)	Unit Weight: 120 pcf	Cohesion: 1400 psf	
Name: SILT 1	Model: Undrained (Phi=0)	Unit Weight: 120 pcf	Cohesion: 200 psf	
Name: CLAY 2	Model: Undrained (Phi=0)	Unit Weight: 120 pcf	Cohesion: 900 psf	
Name: SILT 2	Model: Undrained (Phi=0)	Unit Weight: 120 pcf	Cohesion: 100 psf	
Name: CLAY 3	Model: Undrained (Phi=0)	Unit Weight: 120 pcf	Cohesion: 1040 psf	
Name: SILT 3	Model: Undrained (Phi=0)	Unit Weight: 120 pcf	Cohesion: 450 psf	
Name: CLAY 4	Model: Undrained (Phi=0)	Unit Weight: 120 pcf	Cohesion: 1000 psf	
Name: SAND 1	Model: Mohr-Coulomb	Unit Weight: 120 pcf	Cohesion: 0 psf	Phi: 30 °
Name: SANDSTONE	Model: Bedrock (Impenetrable)			
Name: Abutment	Model: Mohr-Coulomb	Unit Weight: 140 pcf	Cohesion: 60000 psf	Phi: 50 °



Project Name: Interstate 57 Over Pond Creek
Project Number: 20181032.00
Station 212+86, Boring 2-S SBL
Analysis: Undrained Condition With Piles (Ks = 0.333), Clay 4 modified for N-values

Name: CLAY 1 Model: Undrained (Phi=0) Unit Weight: 120 pcf Cohesion: 1400 psf
Name: SILT 1 Model: Undrained (Phi=0) Unit Weight: 120 pcf Cohesion: 200 psf
Name: CLAY 2 Model: Undrained (Phi=0) Unit Weight: 120 pcf Cohesion: 900 psf
Name: SILT 2 Model: Undrained (Phi=0) Unit Weight: 120 pcf Cohesion: 100 psf
Name: CLAY 3 Model: Undrained (Phi=0) Unit Weight: 120 pcf Cohesion: 1040 psf
Name: SILT 3 Model: Undrained (Phi=0) Unit Weight: 120 pcf Cohesion: 450 psf
Name: CLAY 4 Model: Undrained (Phi=0) Unit Weight: 120 pcf Cohesion: 1000 psf
Name: SAND 1 Model: Mohr-Coulomb Unit Weight: 120 pcf Cohesion: 0 psf Phi: 30 °
Name: SANDSTONE Model: Bedrock (Impenetrable)
Name: Abutment Model: Mohr-Coulomb Unit Weight: 140 pcf Cohesion: 60000 psf Phi: 50 °



Project Name: Interstate 57 Over Pond Creek
Project Number: 20181032.00
Station 212+86, Boring 2-S SBL
Analysis: Undrained Condition With Piles (Ks = 0.167), Clay 4 modified for N-values