ARKANSAS DEPARTMENT OF TRANSPORTATION

SUBSURFACE INVESTIGATION

STATE JOB NO. 061748

FEDERAL AID PROJECT NO. FEDERAL AID PROJECT BFPO-0026(47)

MILL CREEK STTR. & APPRS. (S)

STATE HIGHWAY 600 **SECTION** 21

IN GARLAND **COUNTY**

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

ARKANSAS DEPARTMENT OF TRANSPORTATION
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MATERIALS DIVISION
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June 24, 2024

TO: Mr. Rick Ellis, Bridge Engineer

SUBJECT: Job No. 061748
Mill Creek Str. & Apprs. (S)
Garland County
Route 600, Section 21

INTRODUCTION

Submitted herein are results of the subsurface investigation and geotechnical recommendations developed for the proposed replacement bridge planned on Hwy. 600 over Mill Creek in Garland County.

The proposed structure will be 105 feet in total length and consist of a 105-foot Continuous R.C. Slab Unit. The proposed structure will have an out-to-out width of 30 feet. The proposed alignment will be the same as the existing alignment.

Based on the geotechnical investigation request from Bridge Division, foundation loads are expected to be supported on spread footings at the intermediate bents (Bents 2 & 3) and H-Piles at the end bents (Bents 1 & 4). 2-Horizontal to 1-Vertical (2H:1V) end slopes and 2H:1V side slopes are planned at the proposed abutments. Proposed abutment slopes will be formed by cutting back the existing embankments. It is anticipated that there will be up to 15 feet of cut for the southeast and northwest abutments with slope heights of approximately 15 feet.

FIELD INVESTIGATION

A subsurface investigation was requested on December 22, 2022 by Bridge Division to develop recommendations for bridge foundations and to verify the suitability of bridge abutment configuration. Four borings were requested and two borings were drilled. Two intermediate borings included in the request were not performed due to steep slopes and accessibility issues.

The approximate locations of the borings are presented in the Plan of Borings included in Attachment A. The borings were advanced with a CME truck-mounted rotary drill rig using a combination of hollow-stem auger and rock coring drilling methods. The boring logs showing the subsurface conditions and the results of field and laboratory tests are also included in Attachment A, immediately following the Plan of Borings. A legend is included following the boring logs to describe the symbols, terms, and conventions used on logs. Standard Penetration Tests (SPT) were conducted in accordance with ASTM D1586 for field-testing and soil sampling. The correction factor for the hammer is indicated on the boring logs. Liners were not used inside the standard split-barrel samplers.

The number of blows required to drive the standard split-barrel sampler for each 6-inch increment of the total 18-inch drive were measured and recorded on the boring logs. SPT N-values are defined as the total number of blows required to advance the split barrel sampler the final 12 inches of the total 18-inch drive depth. The SPT N-values indicated on the logs are raw (uncorrected) blow counts measured in the field. Groundwater was also observed during the drilling process.

Core samples of bedrock were retrieved using NQ3-size triple-tube core barrels (rock core diameter of 1-3/4 in. and hole diameter of 3 in.). For each core run, Total Core Recovery (TCR) and Rock Quality Designation (RQD) was determined in the field and further evaluated by licensed Professional Geologists (PG). TCR, expressed as a percent, is defined as the sum of all intact core pieces divided by the total length of the core run. RQD, also expressed as a percent, is defined as the sum of all intact core pieces that are longer than 4 inches divided by the total length of the core run. TCR and RQD values of each core run are indicated on each corresponding boring log. Rock core pictures are also included in Attachment A, following the boring logs and legend.

LAB INVESTIGATION

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

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

Rock cores were first examined by a licensed PG to verify TCR and RQD measured in the field and to obtain parameters for determination of Geological Strength Index (GSI) and Rock Mass Rating (RMR). Compressive strength of rock cores was then determined by laboratory uniaxial compressive tests on intact rock cores in accordance with ASTM D7012, Method C. Results of uniaxial compressive tests and RMR are included in Attachment B.

Table 1: Summary of Laboratory Tests and Methods

Laboratory Test	ASTM	AASHTO	Denotation on Logs
Moisture Content	D2216	T 265	Solid Circle Symbol (●)
Grain Size Distribution	D6913	T 88	Whole Number in the “Percent Passing No. 200 Sieve” Column (e.g., 12)
Atterberg Limits	D4318	T 89	Plus Symbol (+) on the Right for Liquid Limit
		T 90	Plus Symbol (+) on the Left for Plastic Limit
Uniaxial Compression of Rock Cores	D7012, Method C		

The particle size through which 50% of particles by weight passing, D_{50}, is summarized in Table 2. Detailed particle size distribution curves used for D_{50} determination are included in Attachment C.

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

Bridge	Station	Sample Type	Location	D_{50}, mm
Mill Creek	104+71, 7' LT	Bulk	Creek Bank	0.38

SITE CONDITIONS

The existing bridge is 54.2 feet long, 20 feet wide and consists of timber spans (3 spans total) supported by concrete columns on concrete footings. The existing bridge is located on the same alignment of the proposed bridge. Site pictures for Hwy. 600 over Mill Creek are included in Attachment D.

SITE GEOLOGY AND GENERAL SUBSURFACE CONDITIONS

The proposed job site is located in the Ouachita Mountain Region at the east end of Lake Ouachita State Park.

This area is mapped as the Mazarn Formation. At the proposed project site, the Mazarn Formation is overlain by existing embankment material. The existing embankment material at the northwest end of the bridge consist of very loose to loose shale fragments with sandy clay. At the southeast end of the bridge, the existing embankment material consists of loose to medium dense silty gravel with sand. Gravel varies in size with some samples being cobble-size. Depth to highly weathered and weathered bedrock in Boring 1 is 14.6 feet and 21.6 below ground level (bgl), respectively. In Boring 2, depth to weathered rock is 18.8 feet bgl. No highly weathered shale was observed in Boring 2.

According to the Arkansas Office of the State Geologist stratigraphic summary of the Arkansas River Valley and Ouachita Mountains, the Mazarn Formation is predominantly shale with small amounts of siltstone, silty to conglomeratic sandstone, limestone, and glossy black chert. The shale is mostly gray-black, but thin layers of olive-gray silty shale or siltstone are interbedded with the darker shales in some sequences. When the dark and greenish shales are cleaved at an angle to bedding, they yield a ribboned surface. In many places quartzose siltstone or very fine-grained sandstone is present. Dense, bluish-gray, thin-bedded limestones may be present throughout the interval. Thin to thick beds of gray sandstone are occasionally found at random horizons, notably in the upper and lower portions of the sequence. The cherts are usually found in the upper part of the unit. Milky quartz veins are common in some areas. The unit is conformable with the underlying Crystal Mountain Sandstone. The thickness of the Mazarn Shale ranges from 1000 feet to over 2500 feet.

The rocks at this site have been deformed by the Ouachita Mountain building process causing the rocks to be steeply dipping and comprise primarily of calcareous shale with rather frequent seams and layers of limestone. In general, the shales are hard, fair to good quality rock, and the limestones are hard, good quality rock. Due to the deformation of the rock, slickensides were observed on bedding planes of the shale.

The Ouachita Mountains are known for having very thick quartz veins and thicknesses of up to 6 inches were encountered in borings**. It should be anticipated that shale, limestone and quartz veins may be encountered and can result in variable drilling conditions and difficult excavation conditions.**

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

surface elevations of slightly weathered to unweathered, competent rock, as revealed by the borings, are summarized in Table 3.

Table 3: Estimated Elevation of Competent Rock

Boring No.	Boring Location	Ground Surf. Elev.@ Boring Location, ft.	Estimated Elev. of Competent Rock, ft.
1	Sta. 103+95, 13' RT	597.5	573.5
2	Sta. 105+14, 13' RT	595.6	576.5

SEISMIC CONDITIONS

Seismic Site Class and Seismic Performance Zone – In light of the average subsurface conditions as revealed by the borings, a **Seismic Site Class C (Very Dense Soil and Soil Rock Profile)** was calculated for the proposed bridge over Mill Creek. Utilizing Seismic Site Class C and the approximate GPS coordinates of the project site, the following design peak ground acceleration coefficient (A_S), design short-period spectral acceleration coefficient (S_{DS}), as well as design long-period spectral acceleration coefficient (S_{D1}), were determined. These seismic coefficients are summarized in Table 4. For the design long-period spectral acceleration coefficient (S_{D1}) of 0.11g, a **Seismic Performance Zone 1** is considered applicable.

Table 4: Design Ground Motion Acceleration Response Coefficients

Acceleration Coefficient	Value (g)
A_S (Site PGA)	0.082
S_{DS} (0.2 sec)	0.197
S_{D1} (1 sec)	0.110

Design Response Spectrum is presented in Attachment F.

BRIDGE APPROACHES

Abutment Slope Configuration – As noted, 2H:1V end slopes and 2H:1V side slopes are planned for the abutment slopes. Proposed abutment slopes will be formed by cutting back the existing embankments. It is anticipated that there will be up to 15 feet of cut for the northwest and southeast abutments with slope heights of approximately 15 feet.

Settlement Potential – The underlying soils are mainly comprised of gravel and shale fragments with varying amounts of sand and silt. It is anticipated that most of the settlement that occurs will be elastic settlement and will take place shortly after loading is applied. Due to the granular overburden soils and shallow depth to bedrock, long-term consolidation settlement is expected to be minimal.

Approach Stability – Slope stability analyses were performed utilizing a commercial computer program Slide2 (Version 2021) developed by RocScience. The Spencer analysis method was utilized to analyze both bridge abutments. Three general loading conditions were analyzed with respect to slope stability: Short Term/End of Construction Condition, Long Term Condition, and Seismic/Pseudo-Static Condition. A horizontal acceleration coefficient (K_h) of

0.041 (0.5 A_S/g) was utilized for analysis of the Seismic/Psuedo-Static Condition. A surcharge of 250 psf was used to model the live load in the Long-Term Condition.

Slope stability analyses were performed on the 2H:1V end slopes at the northwest abutment (Bent 1) and the southeast abutment (Bent 4), to evaluate suitability of the plan configuration. Table 5 includes the results of the slope stability analyses utilizing the plan abutment layout. Graphic results of the slope stability analyses are included in Attachment G.

Table 5: Results of Slope Stability Analyses Utilizing Plan Configuration

Design Condition	Factor of Safety		Recommended Factor of Safety
	Northwest Abutment	Southeast Abutment	
End of Construction (Short Term)	5.41	1.60	1.3
Long Term	4.66	1.49	1.4
Pseudo-Static (Seismic)	4.74	1.41	1.05

Based on results from the slope stability analyses, plan configuration of the abutments are suitable.

FOUNDATION RECOMMENDATIONS

Based on plans provided by Bridge Division, spread footings are planned to support the foundation loads at the intermediate bents (Bents 2 & 3), and H-Piles are planned at the end bents (Bents 1 & 4).

Spread Footings (Bents 2 & 3) – It is understood that spread footings are planned to support foundation loads at the intermediate bents where rock is less than 15 feet below ground level. It is recommended that spread footings be embedded a minimum of 2 feet into competent bedrock. Based on the results of the borings and our field observations, spread footings founded a minimum of 2 feet into competent, slightly weathered to unweathered shale bedrock is a suitable foundation for the intermediate bents. Recommended shallowest footing bottom elevations are summarized in Table 6. Other foundation types can be evaluated upon request.

Table 6: Recommended Shallowest Footing Bottom Elevation

Bent No.	Estimated Elev. of Competent Rock, ft	Recommended Shallowest Footing Bottom Elevation
2	573.5	571.5
3	576.5	574.5

It is recommended a maximum nominal bearing capacity of **45 ksf** be utilized for spread footings embedded at least 2 feet into competent slightly weathered to unweathered bedrock. A resistance factor (φ_b) of 0.45 is considered suitable for evaluation of factored bearing resistance of spread footings on rock. Consequently, a maximum factored bearing capacity of **20 ksf** is

suitable. Post-construction settlement of spread footings founded in competent rock is expected to be negligible.

Uplift resistance can be provided by footing self-weight and structure dead loads. Footings may be sized to negate the factored uplift loads. If additional uplift resistance is needed, rock anchors can be utilized. Recommendations of rock anchors can be provided upon request.

Lateral resistance of spread footings can be evaluated utilizing a maximum nominal coefficient of friction ($\tan\delta$) of 0.70 for concrete footings on competent rock and a resistance factor for sliding (φ_τ) of 0.85. Additional lateral resistance may be provided by passive resistance of the foundation rock that is in hard contact with the spread footings. Passive resistance from any overburden soils, highly weathered rock, and the upper 2 feet of foundation rock should be neglected from passive resistance evaluation. Factored passive resistance can be provided upon request.

Any underground utilities in the plan footing excavation areas should be completely removed or relocated and properly backfilled to prevent seepage into the excavation bottom. At a minimum, sump pumps should be utilized to remove any water seepage into the excavation bottom. The excavation bottom should be dry and clear of any water prior to foundation construction. **The potential for very hard quartz layers at the proposed project site should be anticipated.** Rock excavation techniques, other than ripping, can be expected to reach plan footing bottom elevation. Any footing over-excavated should be properly backfilled with Class S concrete.

H-Piles (Bents 1 & 4) – It is understood that steel H-piling are planned to support the foundation loads at the end bents (Bents 1 and 4). Final pile size has not been determined. Steel H-piles should be driven to practical refusal and bear in the competent slightly weathered to unweathered shale bedrock. It is expected that preboring will be required at both bents in order to penetrate the overburden gravel and shale fragment layers and to penetrate through the highly weathered to weathered shale layers.

Practical refusal is defined as a maximum penetration of 1.0 inch from 20 blows by a pile hammer. For estimating pile length, a pile penetration of 6 inches into slightly weathered to unweathered bedrock is estimated. This estimated penetration is based on the results of the borings and prior experience with similar foundation rock. The results of the borings indicate moderate to severe driving conditions are to be expected. Consequently, rock points are recommended for all H-piles driven to refusal.

A minimum pile penetration of 10 feet, measured below natural ground surface, is recommended. Greater pile length/penetration may be warranted due to the lateral resistance demand. Based on the results of the borings and the assumption of approximately 6 inches of penetration into competent rock, the estimated shallowest pile tip elevations are summarized in Table 7.

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Table 7: Recommended Shallowest Prebore Elevation and Pile Tip Elevation

Bent No.	Boring Location	Estimated Elev. of Competent Rock, ft	Recommended Shallowest Prebore Elev., ft
1	103+95, 13' RT	573.5	573.0
2	105+14, 13' RT	576.5	576.0

Geotechnical Input Parameters for LPile/Group – Lateral load analysis will be performed by the Structural Engineer using commercial computer programs LPile and/or Group. The geotechnical input parameters are located in Attachment H.

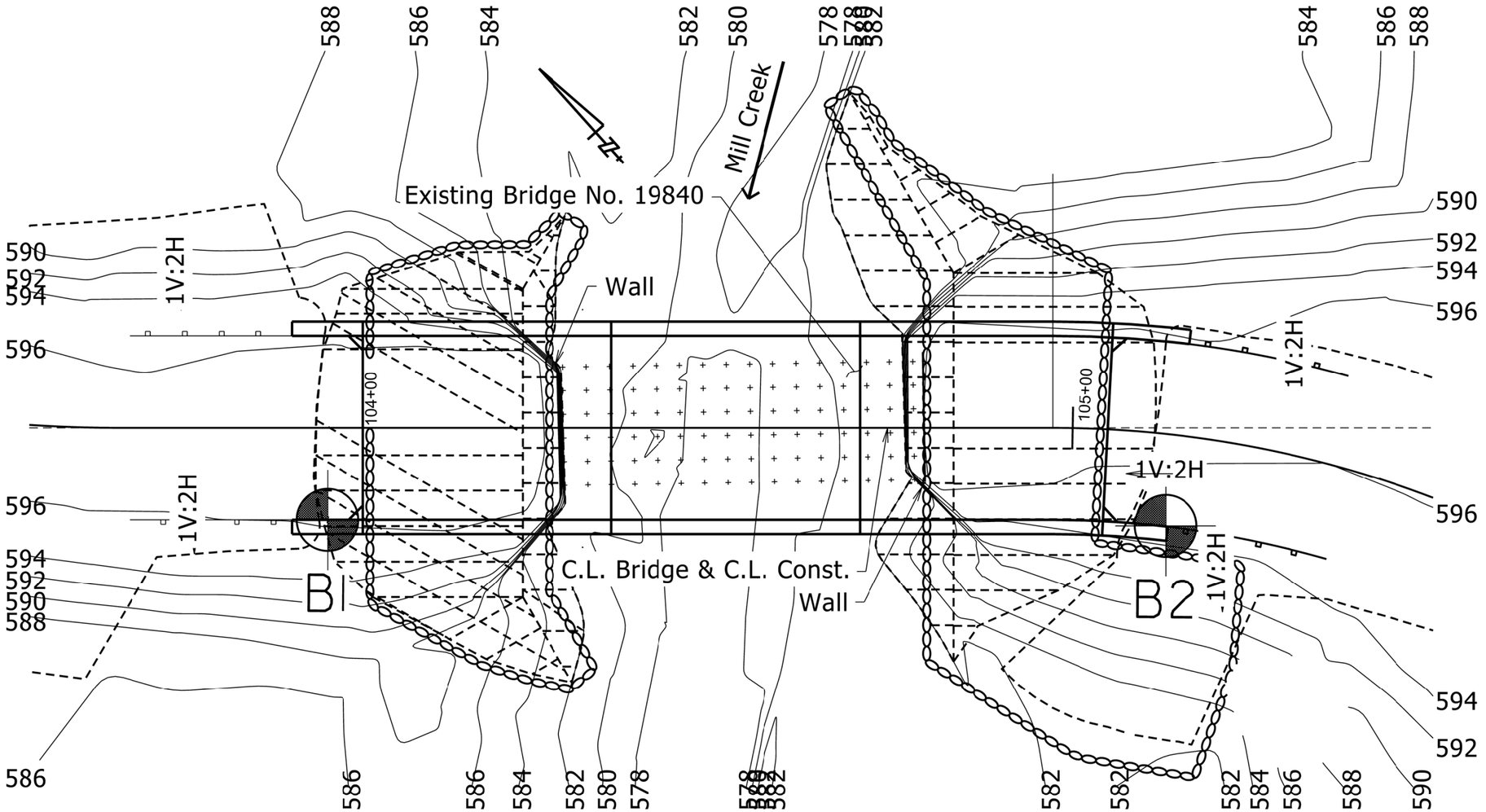
If there are any questions concerning these recommendations, please contact the Materials Division.

Paul Tinsley
Materials Engineer

PT:yz:pjt:cjs
cc: State Construction Engineer
District 6 Engineer
G. C. File

Attachment A

FED. ROAD DIST. NO.	STATE	FED. AID PROJ. NO.	SHEET NO.	TOTAL SHEETS
6	AR			
JOB NO.		061748		
PLAN OF BORINGS				



PLAN

PLAN OF BORINGS	
MILL CREEK STR. & APPRS. (S) ROUTE 600, SECTION 21 GARLAND COUNTY FED. AID PROJ. STPB-0026(47)	
JOB NO. 061748	SHEET 1/1
NTS	

ARKANSAS DEPARTMENT OF TRANSPORTATION
MATERIALS DIVISION - GEOTECHNICAL SECTION

BORING NO. 1
PAGE 1 OF 2

JOB NO. 061748 Garland County
JOB NAME: Mill Creek Str. & Apprs. (S)
Route 600, Section 21
STATION: 103+95
LOCATION: 13' Right of Construction Centerline
LOGGED BY: Stanley Bates

DATE: April 2 and 17, 2024
TYPE OF DRILLING:
Hollow Stem Auger-Diamond Core
EQUIPMENT: CME 75

HAMMER CORRECTION FACTOR: 1.57

COMPLETION DEPTH: 38.7

DEPTH FT.	SYMBOL	SAMPLES	DESCRIPTION OF MATERIAL SURFACE ELEVATION: 597.5	SOIL GROUP	MOISTURE CONTENT (%) PL — LL (10 20 30 40 50 60 70)	PERCENT PASSING NO. 200 SIEVE	NO. OF BLOWS PER 6-IN.	% TCR	% RQD
			Moist, Medium Dense, Brown Gravel with Silt	-					
				GP-GM	•	9	1 4-7		
5				-					
			Moist, Loose, Brown Silty Gravel with Sand	GM	•	16	5 5-2		
				-					
			Moist, Loose, Brown Silty Gravel with Sand	GM	•	22	6 6-4		
				-					
10				GP-GM	•		3 7-7		
			Moist, Medium Dense, Brown Gravel with Silt and Sand						
15									
			SHALE - Highly Weathered, Soft, Brown and Gray		•		19 25-12		
20									
			SHALE - Highly Weathered, Very Soft, Dark Gray				16 16-13		
			SHALE - Weathered, Medium Hard, Dark Gray				21 60 (2")	0	0
			SHALE - Weathered, Medium Hard, Dark Gray (No Recovery)						
25			SHALE WITH FREQUENT LIMESTONE LAYERS - Slightly Weathered, Medium Hard (Limestone-Hard), Frequent Quartz Veins, Steeply Dipping, Dark Gray	-				50	0
			SHALE WITH OCCASIONAL LIMESTONE LAYERS - Unweathered, Hard, Occasional Quartz Veins, Steeply Dipping, Dark Gray						
30								92	0
			LIMESTONE INTERBEDDED WITH SHALE - Unweathered, Hard, Occasional Quartz Veins, Steeply						
35									

REMARKS:

ARKANSAS DEPARTMENT OF TRANSPORTATION
MATERIALS DIVISION - GEOTECHNICAL SECTION

BORING NO. 1
PAGE 2 OF 2

JOB NO. 061748 Garland County
JOB NAME: Mill Creek Str. & Apprs. (S)
Route 600, Section 21
STATION: 103+95
LOCATION: 13' Right of Construction Centerline
LOGGED BY: Stanley Bates

DATE: April 2 and 17, 2024
TYPE OF DRILLING:
Hollow Stem Auger-Diamond Core
EQUIPMENT: CME 75

HAMMER CORRECTION FACTOR: 1.57

COMPLETION DEPTH: 38.7

DEPTH FT.	SYMBOL	SAMPLES	DESCRIPTION OF MATERIAL	SOIL GROUP	MOISTURE CONTENT (%) PL — LL (10 20 30 40 50 60 70)	PERCENT PASSING NO. 200 SIEVE	NO. OF BLOWS PER 6-IN.	% TCR	% RQD
			SURFACE ELEVATION: 597.5						
			Dipping, Dark Gray LIMESTONE - Unweathered, Hard, Occasional Quartz Veins, Steeply Dipping, Gray					98	74
40			CALCAREOUS SHALE - Unweathered, Hard, Occasional Quartz Veins, Steeply Dipping, Dark Gray						
			LIMESTONE - Unweathered, Hard, Occasional Quartz Veins, Steeply Dipping, Gray						
45			Boring Terminated						
50									
55									
60									
65									
70									

REMARKS:

ARKANSAS DEPARTMENT OF TRANSPORTATION
MATERIALS DIVISION - GEOTECHNICAL SECTION

BORING NO. 2
PAGE 1 OF 2

JOB NO. 061748 Garland County
JOB NAME: Mill Creek Str. & Apprs. (S)
Route 600, Section 21
STATION: 105+14
LOCATION: 13' Right of Construction Centerline
LOGGED BY: Jesse Burdine

DATE: April 22, 2024
TYPE OF DRILLING:
Hollow Stem Auger-Diamond Core
EQUIPMENT: CME 75

HAMMER CORRECTION FACTOR: 1.57

COMPLETION DEPTH: 47.7

DEPTH FT.	SYMBOL	SAMPLES	DESCRIPTION OF MATERIAL SURFACE ELEVATION: 595.6	SOIL GROUP	MOISTURE CONTENT (%) PL 10 20 30 40 50 60 70 LL	PERCENT PASSING NO. 200 SIEVE	NO. OF BLOWS PER 6-IN.	% TCR	% RQD
			Wet, Very Loose, Reddish Brown and Gray Silty Sand with Gravel	- SM		35	2 1-1		
5							2 1-1		
			Moist, Very Loose, Brown and Gray Shale Fragments with Sandy Silt				1 1-1		
10							2 1-2		
15			Moist, Loose, Brown and Gray Shale Fragments with Sandy Silt				4 4-5		
20			SHALE - Weathered, Medium Hard, Black				60 (5")		
			CALCAREOUS SHALE - Slightly Weathered, Hard, Occasional Calcite Partings and Seams, Steeply Dipping, Dark Gray					48	0
25			CALCAREOUS SHALE - Slightly Weathered, Hard, Frequent Calcite Seams, Occasional Quartz Veins, Steeply Dipping, Dark Gray	-				40	0
30			CALCAREOUS SHALE - Unweathered, Hard, Frequent Calcite Seams, Occasional Quartz Veins, Steeply Dipping, Dark Gray					69	15
			QUARTZ VEIN						
35			CALCAREOUS SHALE - Unweathered, Hard, Frequent Calcite Seams, Occasional Quartz Veins, Steeply Dipping, Dark Gray						

REMARKS:

ARKANSAS DEPARTMENT OF TRANSPORTATION
MATERIALS DIVISION - GEOTECHNICAL SECTION

BORING NO. 2
PAGE 2 OF 2

JOB NO. 061748 Garland County
JOB NAME: Mill Creek Str. & Apprs. (S)
Route 600, Section 21
STATION: 105+14
LOCATION: 13' Right of Construction Centerline
LOGGED BY: Jesse Burdine

DATE: April 22, 2024
TYPE OF DRILLING:
Hollow Stem Auger-Diamond Core
EQUIPMENT: CME 75

HAMMER CORRECTION FACTOR: 1.57

COMPLETION DEPTH: 47.7

DEPTH FT.	SYMBOL	SAMPLES	DESCRIPTION OF MATERIAL SURFACE ELEVATION: 595.6	SOIL GROUP	MOISTURE CONTENT (%) PL 10 20 30 40 50 60 70 LL	PERCENT PASSING NO. 200 SIEVE	NO. OF BLOWS PER 6-IN.	% TCR	% RQD
			CALCAREOUS SHALE - Unweathered, Hard, Frequent Calcite Seams, Steeply Dipping, Dark Gray					12	0
40			CALCAREOUS SHALE - Unweathered, Hard, Occasional Calcite Seams, Steeply Dipping, Dark Gray					83	35
45			CALCAREOUS SHALE WITH FREQUENT LIMESTONE LAYERS - Unweathered, Hard, Frequent Calcite Seams, Steeply Dipping, Dark Gray					80	15
50			CALCAREOUS SHALE - Unweathered, Hard, Frequent Calcite Seams, Frequent Quartz Veins (up to 0.4ft thick), Steeply Dipping, Dark Gray Boring Terminated						
55									
60									
65									
70									

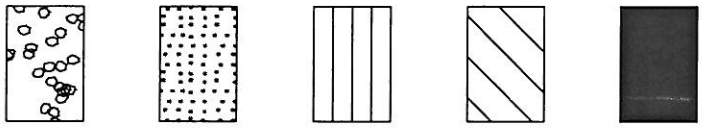
REMARKS:

LEGEND

SOIL TYPES

(SHOWN IN SYMBOL COLUMN)

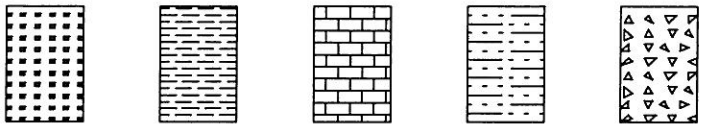
(PREDOMINANT TYPE SHOWN HEAVY)



GRAVEL | SAND | SILT | CLAY | ORGANIC MATTER

ROCK TYPES

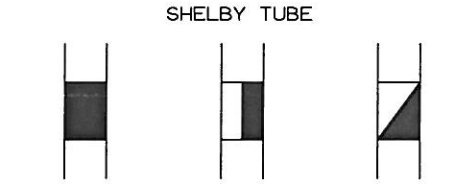
(SHOWN IN SYMBOL COLUMN)



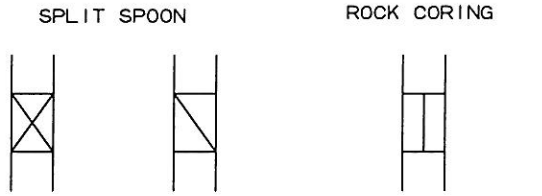
SANDSTONE | SHALE or SILTSTONE | LIMESTONE or DOLOMITE | ALTERNATING LAYERS of SHALE and SANDSTONE | OTHER

SAMPLER TYPES

(SHOWN IN SAMPLE COLUMN)



UNDISTURBED SAMPLE RECOVERY | DISTURBED SAMPLE RECOVERY | NO RECOVERY



SAMPLE RECOVERY | NO RECOVERY | % RECOVERY INDICATED ON LOGS

TERMS DESCRIBING CONSISTENCY OR CONDITION

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

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

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

ROCK CORE PHOTO

Job No.: 061748
Job Name: Mill Creek Str. & Apprs. (S)

Station and Offset, ft: Sta. 103+95, 13 feet Right of Construction Centerline (Boring 1)
Depth, ft: 22.3 – 28.7
(No return for the core run from 22.3 to 23.7)

ROCK CORE PHOTO

Job No.: 061748
Job Name: Mill Creek Str. & Apprs. (S)

Station and Offset, ft: Sta. 103+95, 13 feet Right of Construction Centerline (Boring 1)
Depth, ft: 28.7 – 38.7

ROCK CORE PHOTO

Job No.: 061748
Job Name: Mill Creek Str. & Apprs. (S)

Station and Offset, ft: Sta. 105+14, 13 feet Right of Construction Centerline (Boring 2)
Depth, ft: 19.2 – 32.7

ROCK CORE PHOTO

Job No.: 061748
Job Name: Mill Creek Str. & Apprs. (S)

Station and Offset, ft: Sta. 105+14, 13 feet Right of Construction Centerline (Boring 2)
Depth, ft: 32.7 – 47.7

Attachment B

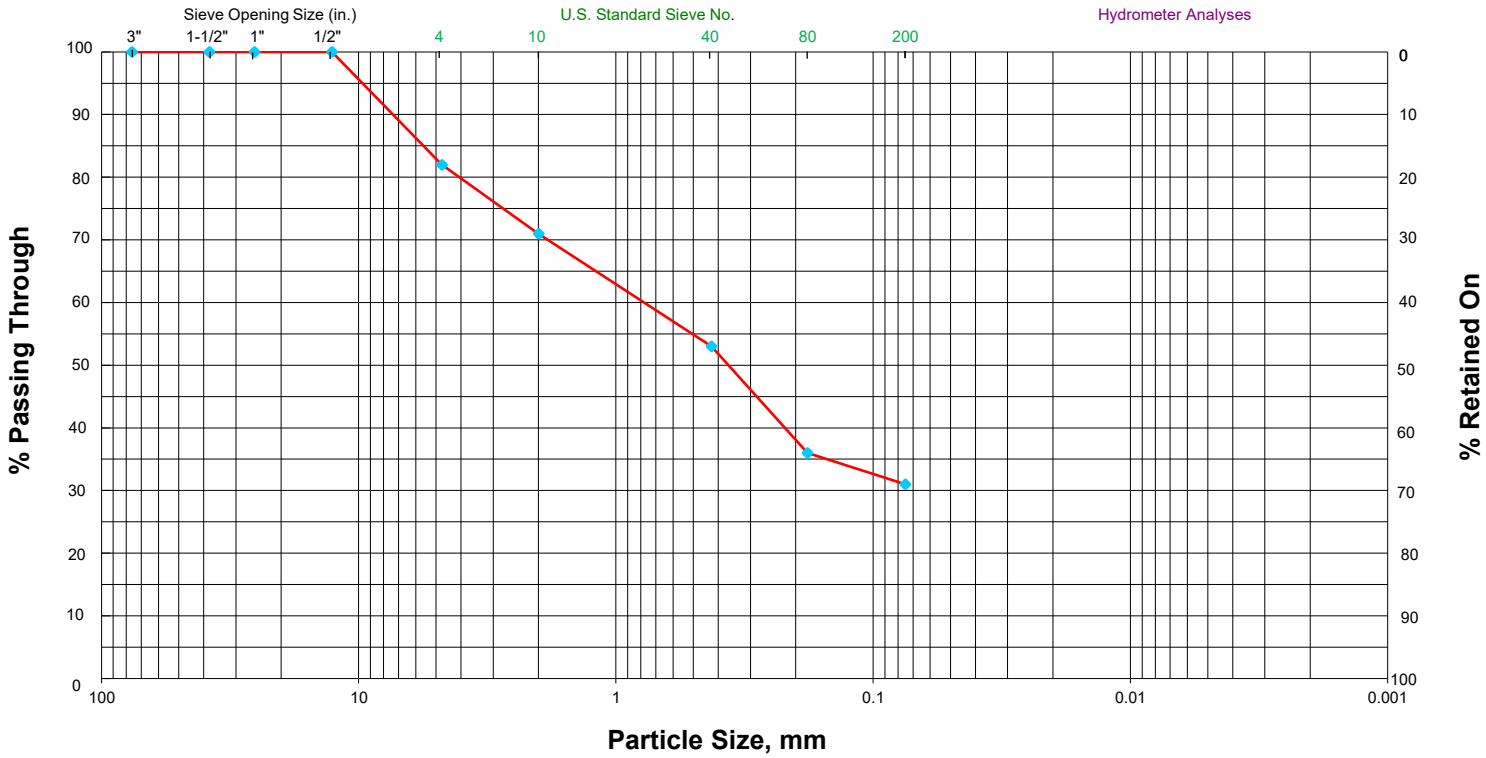
Summary of Rock Core Uniaxial Compression Test Results, Geological Strength Index (GSI) and Rock Mass Rating (RMR)

Project Number: 061748
Project Name: Mill Creek Str. & Apprs. (S)
Date Tested: 4/23/2024

GSI: 65

Sample Location			Uniaxial Compressive Strength									RMR							Notes
Station	Location	Depth (ft.)	Diameter (in.)	Height (in.)	Weight (g)	Unit Weight (pcf)	Total Load (lbs.)	Correction Factor	Stress (psi)	Rock Type	Uniaxial Compressive Strength Rating	RQD Rating	Spacing of Joints	Condition of Joints	Groundwater Condition	Sum	Class Number	Description	
103+95	13' RT	34.2	1.76	3.55	383.35	169	22,300	1.00	9,166	Limestone	7	17	20	12	7	63	II	GOOD ROCK	
103+95	13' RT	36.2	1.75	3.59	376.15	166	8,390	1.00	3,488	Calcareous Shale	2	17	20	12	7	58	III	FAIR ROCK	
103+95	13' RT	37.8	1.76	3.43	370.93	169	40,410	1.00	16,610	Limestone	12	17	20	12	7	68	II	GOOD ROCK	
103+95	13' RT	38.4	1.76	3.50	374.62	168	34,670	1.00	14,251	Limestone	7	17	20	12	7	63	II	GOOD ROCK	
105+14	13' RT	31.3	1.76	2.98	306.32	161	16,490	0.98	6,612	Calcareous Shale	4	3	10	6	7	30	IV	POOR ROCK	
105+14	13' RT	40.4	1.76	3.05	318.40	163	26,840	0.98	10,795	Calcareous Shale	7	8	10	6	7	38	IV	POOR ROCK	

Attachment C



Particle Size Distribution Curve for D_{50} Sample

Sta. 104+71, 7' LT of CL

Attachment D

SITE PICTURES

Job No.: 061748
Job Name: Mill Creek Str. & Apprs. (S)

East side of bridge looking west (downstream) (October 2022)

SITE PICTURES

Job No.: 061748
Job Name: Mill Creek Str. & Apprs. (S)

South pier footing (looking south) (October 2022)

SITE PICTURES

Job No.: 061748
Job Name: Mill Creek Str. & Apprs. (S)

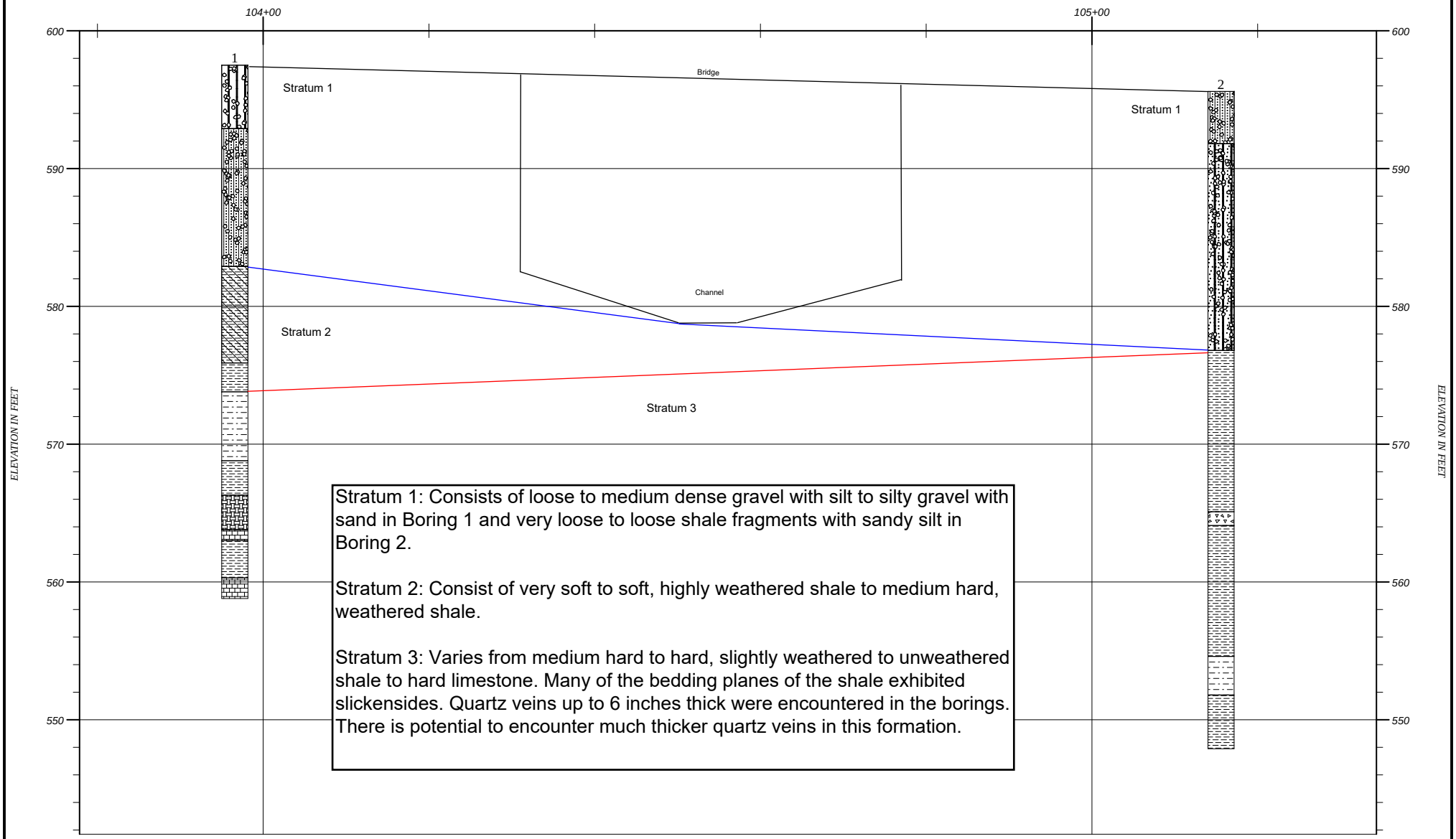
Underside of deck of the southern span (October 2022)

SITE PICTURES

Job No.: 061748
Job Name: Mill Creek Str. & Apprs. (S)

Sediment under south span (October 2022)

Attachment E

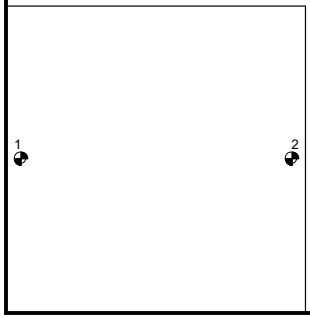


Stratum 1: Consists of loose to medium dense gravel with silt to silty gravel with sand in Boring 1 and very loose to loose shale fragments with sandy silt in Boring 2.

Stratum 2: Consist of very soft to soft, highly weathered shale to medium hard, weathered shale.

Stratum 3: Varies from medium hard to hard, slightly weathered to unweathered shale to hard limestone. Many of the bedding planes of the shale exhibited slickensides. Quartz veins up to 6 inches thick were encountered in the borings. There is potential to encounter much thicker quartz veins in this formation.

Plan View



Strata symbols

- gravel with silt
- silty sand with gravel
- shale with clay seams/highly weathered shale
- shale
- shale with limestone seams
- limestone interbedded with shale
- limestone
- sandy silt and gravel
- quartz

Arkansas Department of Transportation

Generalized Subsurface Profile

HORIZONTAL SCALE: Not to scale VERTICAL SCALE: Not to scale	DRAWN BY/APPROVED BY James Carson Sloan/Paul Tierney	DATE DRAWN 5/8/2024

Mill Creek Str. & Apprs. (S)

Route 600, Section 21

PROJECT NO. 061748

Garland County

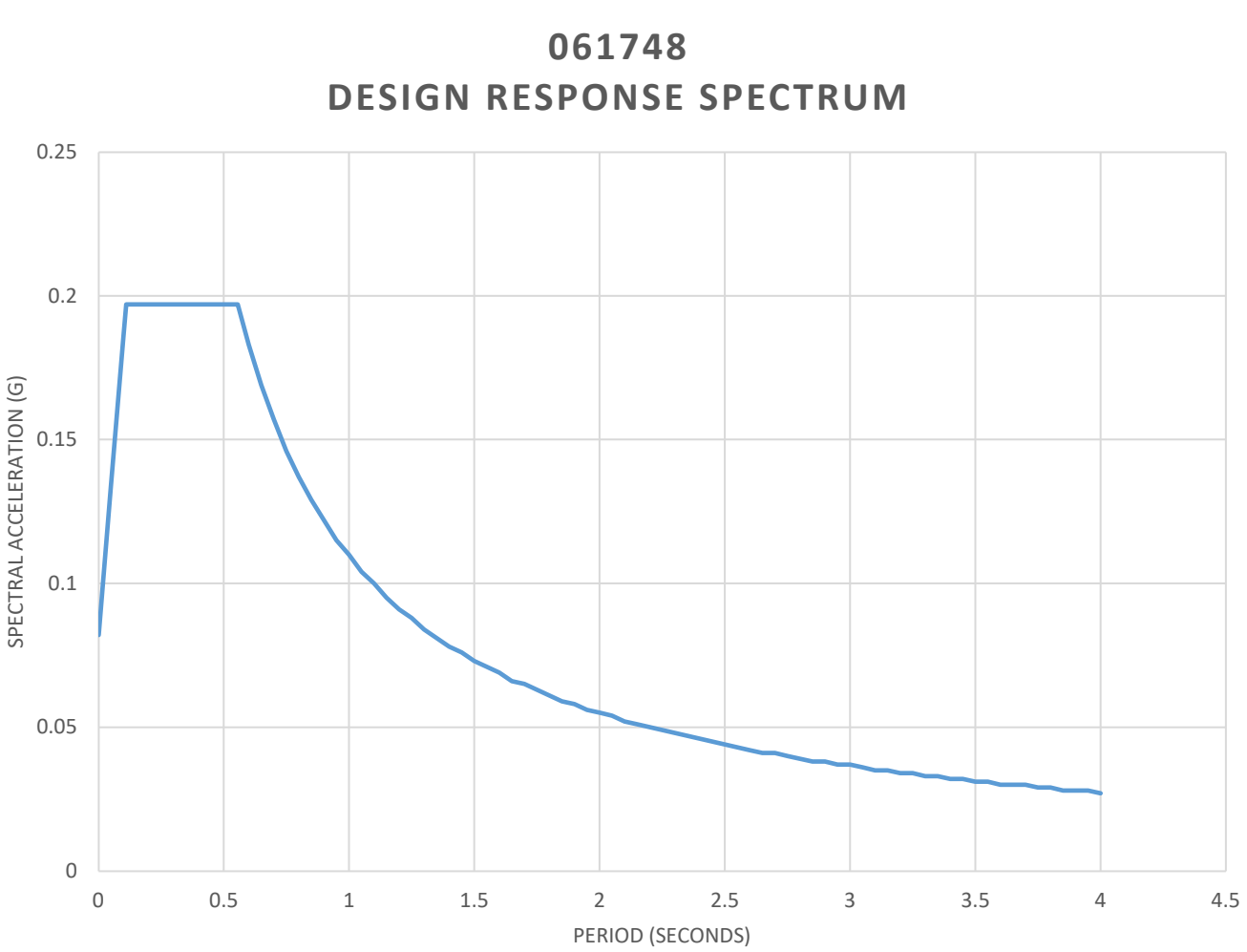
FIGURE NUMBER

Attachment F

Title:	061748 - Mill Creek Str. & Apprs. (S)
Latitude:	36.62663
Longitude:	-93.166139
Site Class	C

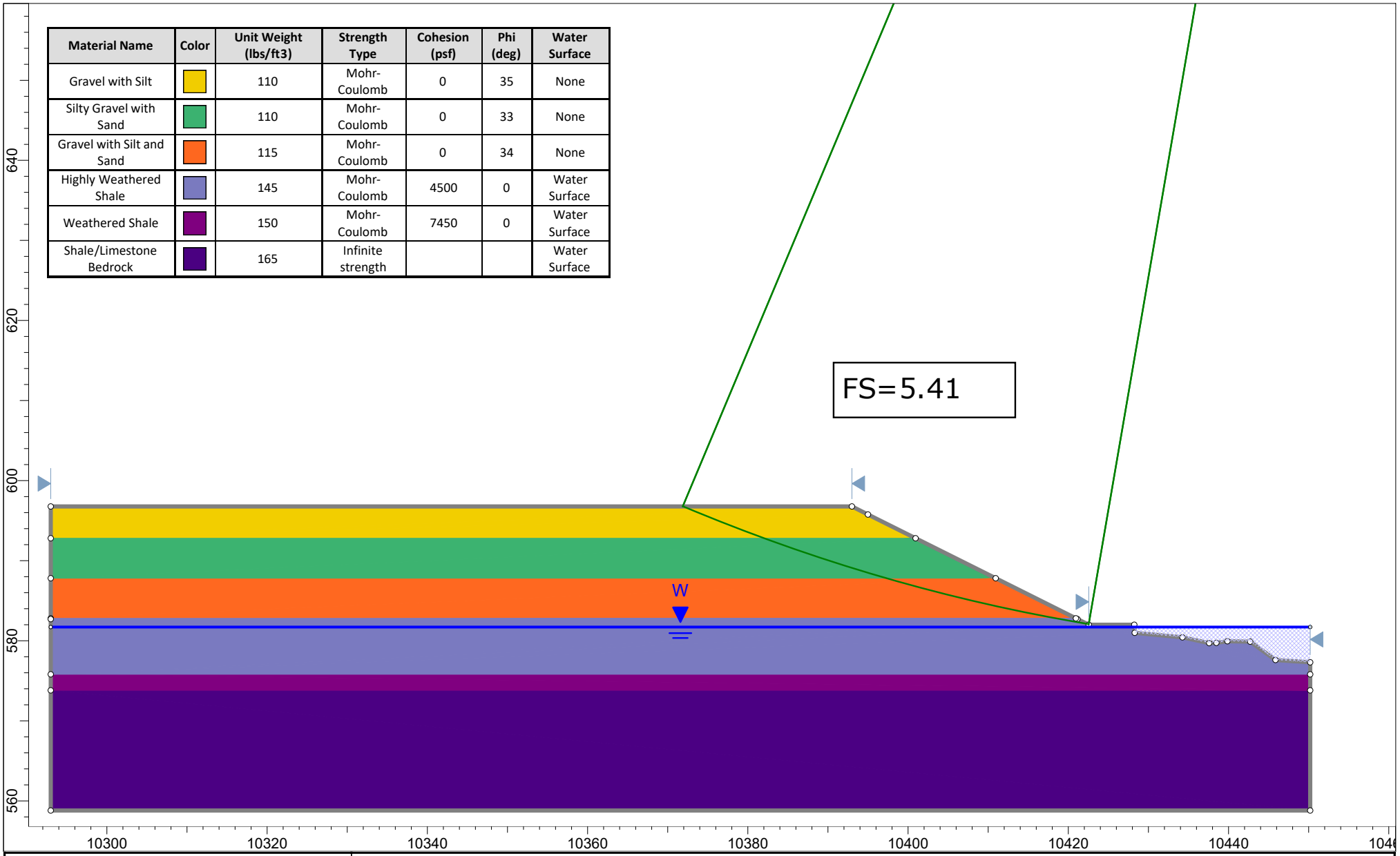
Get USGS Data

PGA:	0.069
F_{PGA}:	1.2
A_S:	0.082
S_S:	0.164
F_A:	1.2
S_{DS}:	0.197
S_1:	0.065
F_V:	1.7
S_{D1}:	0.11
S_{Dc}:	A
T_S:	0.556
T_0:	0.111



Attachment G

Material Name	Color	Unit Weight (lbs/ft3)	Strength Type	Cohesion (psf)	Phi (deg)	Water Surface
Gravel with Silt		110	Mohr-Coulomb	0	35	None
Silty Gravel with Sand		110	Mohr-Coulomb	0	33	None
Gravel with Silt and Sand		115	Mohr-Coulomb	0	34	None
Highly Weathered Shale		145	Mohr-Coulomb	4500	0	Water Surface
Weathered Shale		150	Mohr-Coulomb	7450	0	Water Surface
Shale/Limestone Bedrock		165	Infinite strength			Water Surface



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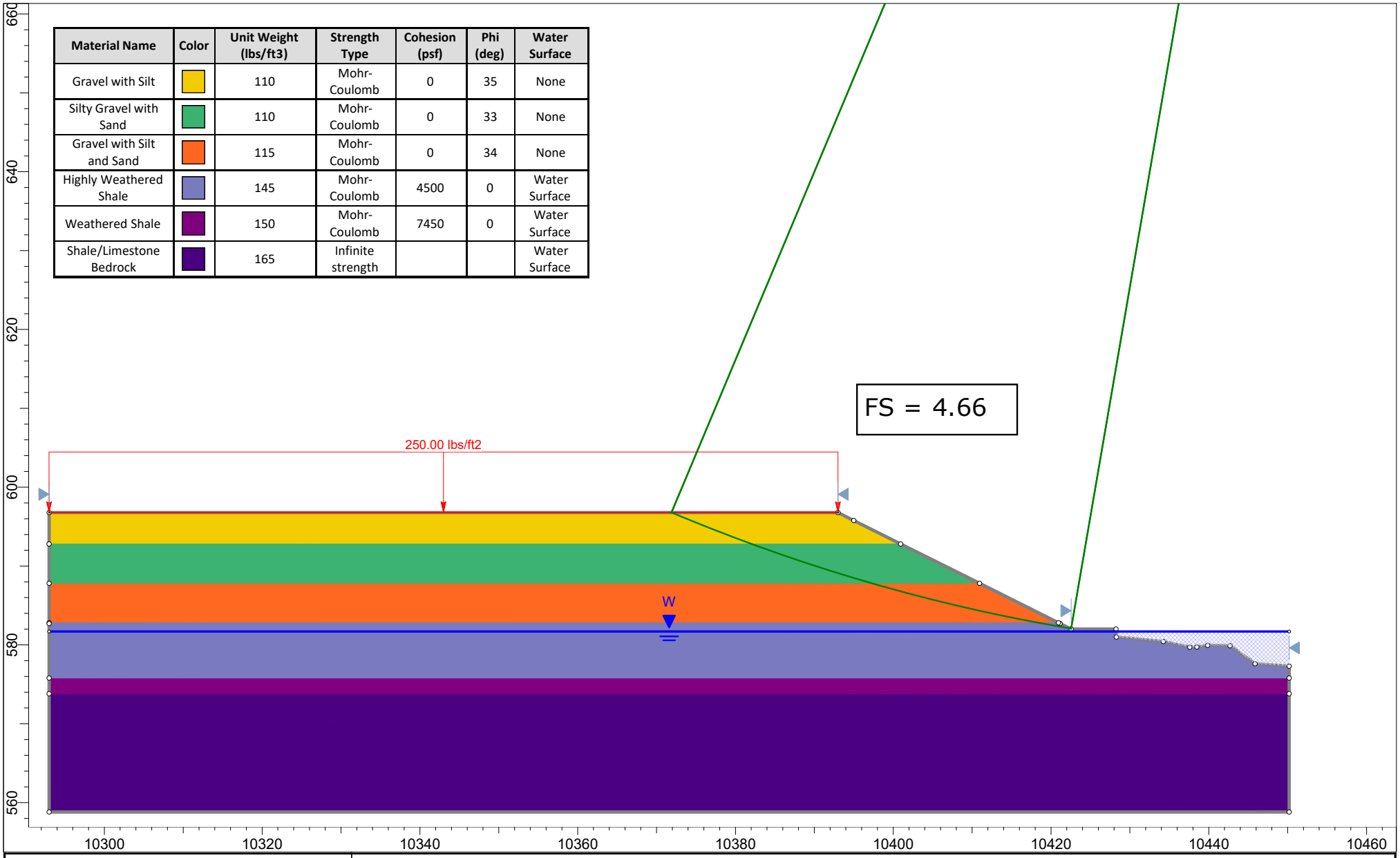
SLIDEINTERPRET 9.019

Project	061748 - Mill Creek Str. & Apprs. (S)		
Site	Hwy. 600 over Mill Creek	*Analysis Type*	Short Term/End of Construction
Analyzed By	PT	*Configuration*	Northwest Abutment
Date	6/18/2024		

Material Name	Color	Unit Weight (lbs/ft3)	Strength Type	Cohesion (psf)	Phi (deg)	Water Surface
Gravel with Silt		110	Mohr-Coulomb	0	35	None
Silty Gravel with Sand		110	Mohr-Coulomb	0	33	None
Gravel with Silt and Sand		115	Mohr-Coulomb	0	34	None
Highly Weathered Shale		145	Mohr-Coulomb	4500	0	Water Surface
Weathered Shale		150	Mohr-Coulomb	7450	0	Water Surface
Shale/Limestone Bedrock		165	Infinite strength			Water Surface



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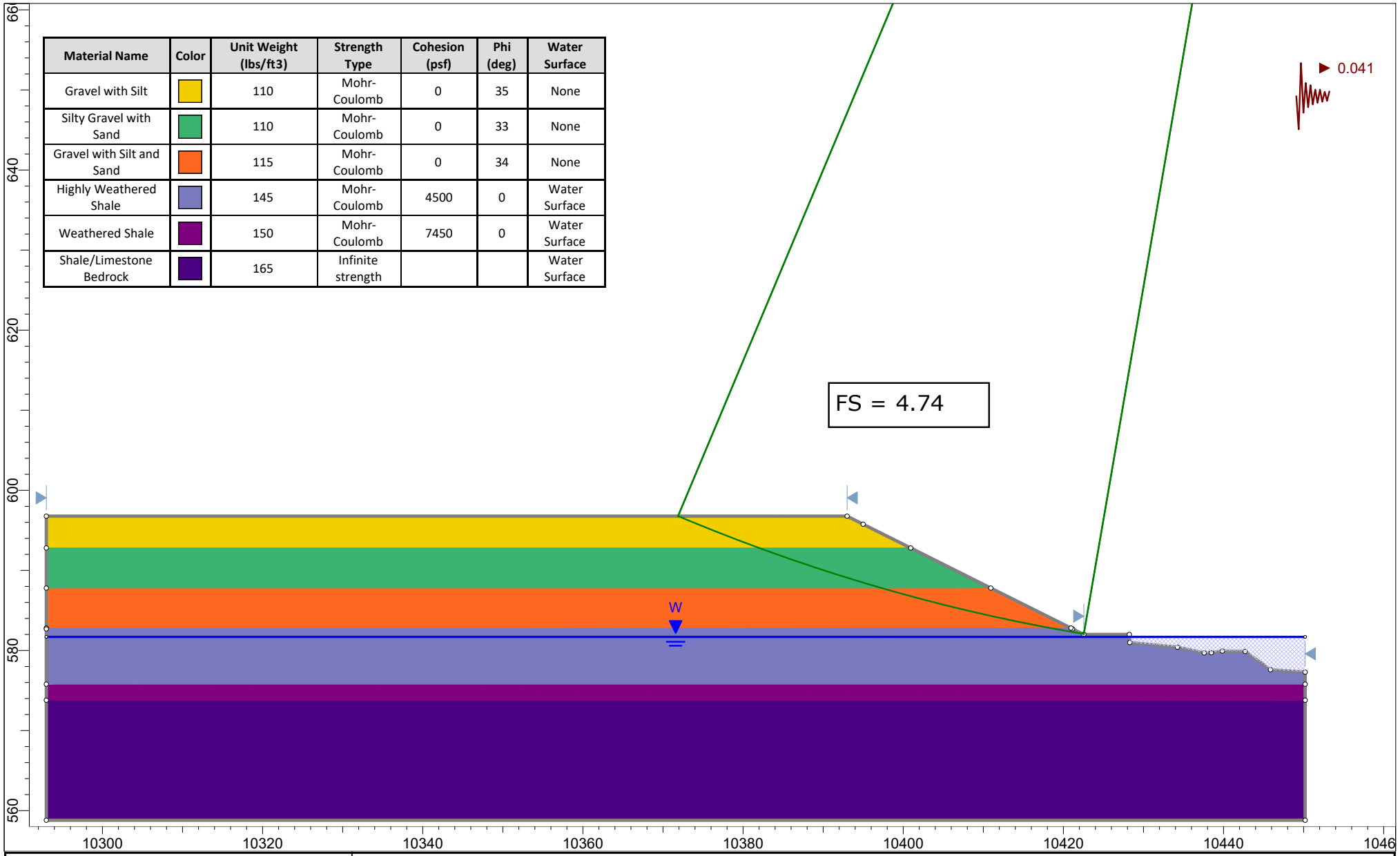
SLIDEINTERPRET 9.019

Project	061748 - Mill Creek Str. & Apprs. (S)		
Site	Hwy. 600 over Mill Creek	*Analysis Type*	Long Term
Analyzed By	PT	*Configuration*	Northwest Abutment
Date	6/18/2024		

Material Name	Color	Unit Weight (lbs/ft3)	Strength Type	Cohesion (psf)	Phi (deg)	Water Surface
Gravel with Silt		110	Mohr-Coulomb	0	35	None
Silty Gravel with Sand		110	Mohr-Coulomb	0	33	None
Gravel with Silt and Sand		115	Mohr-Coulomb	0	34	None
Highly Weathered Shale		145	Mohr-Coulomb	4500	0	Water Surface
Weathered Shale		150	Mohr-Coulomb	7450	0	Water Surface
Shale/Limestone Bedrock		165	Infinite strength			Water Surface



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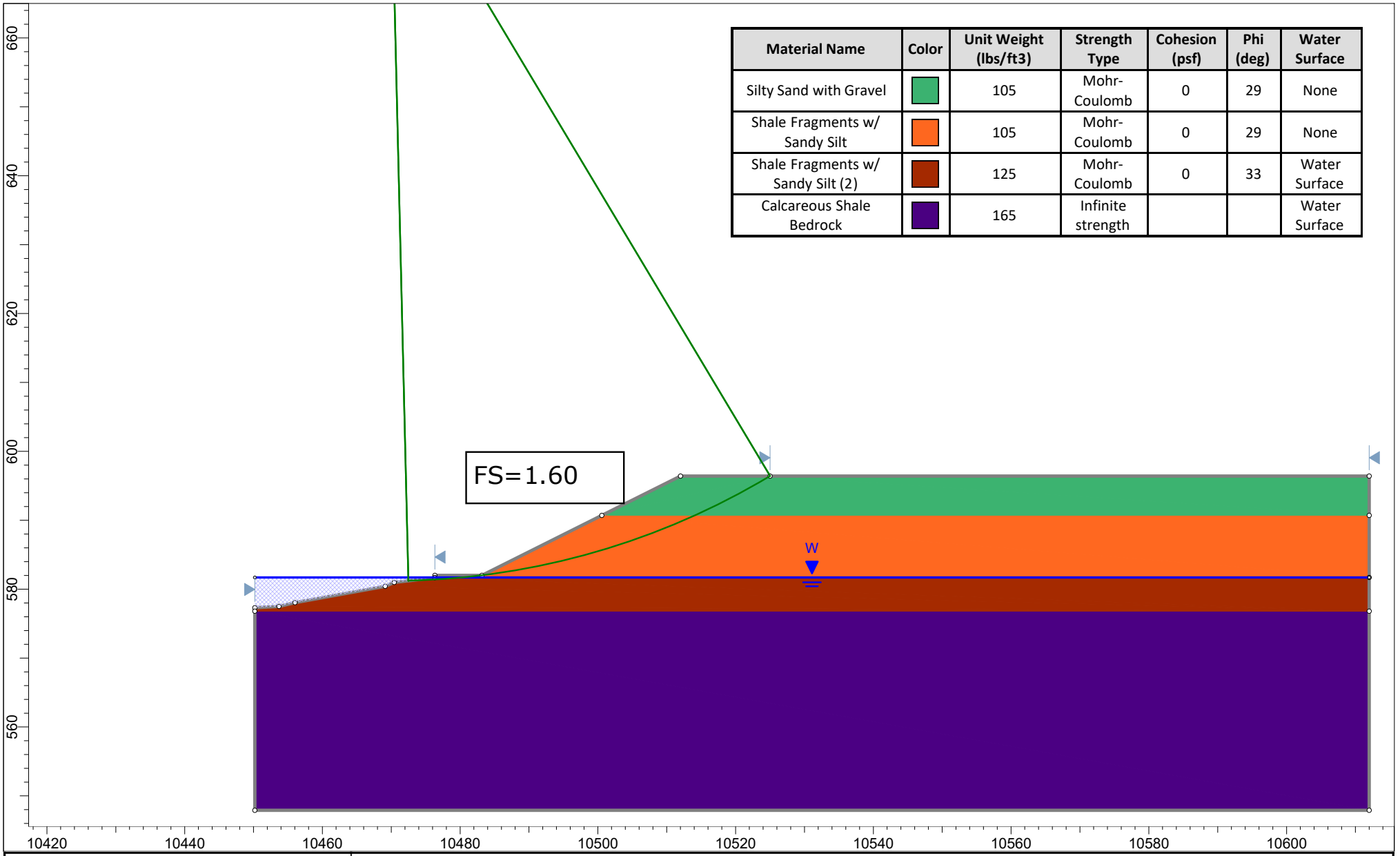
SLIDEINTERPRET 9.019

Project	061748 - Mill Creek Str. & Apprs. (S)		
Site	Hwy. 600 over Mill Creek	*Analysis Type*	Seismic
Analyzed By	PT	*Configuration*	Northwest Abutment
Date	6/18/2024		

Material Name	Color	Unit Weight (lbs/ft3)	Strength Type	Cohesion (psf)	Phi (deg)	Water Surface
Silty Sand with Gravel		105	Mohr-Coulomb	0	29	None
Shale Fragments w/ Sandy Silt		105	Mohr-Coulomb	0	29	None
Shale Fragments w/ Sandy Silt (2)		125	Mohr-Coulomb	0	33	Water Surface
Calcareous Shale Bedrock		165	Infinite strength			Water Surface



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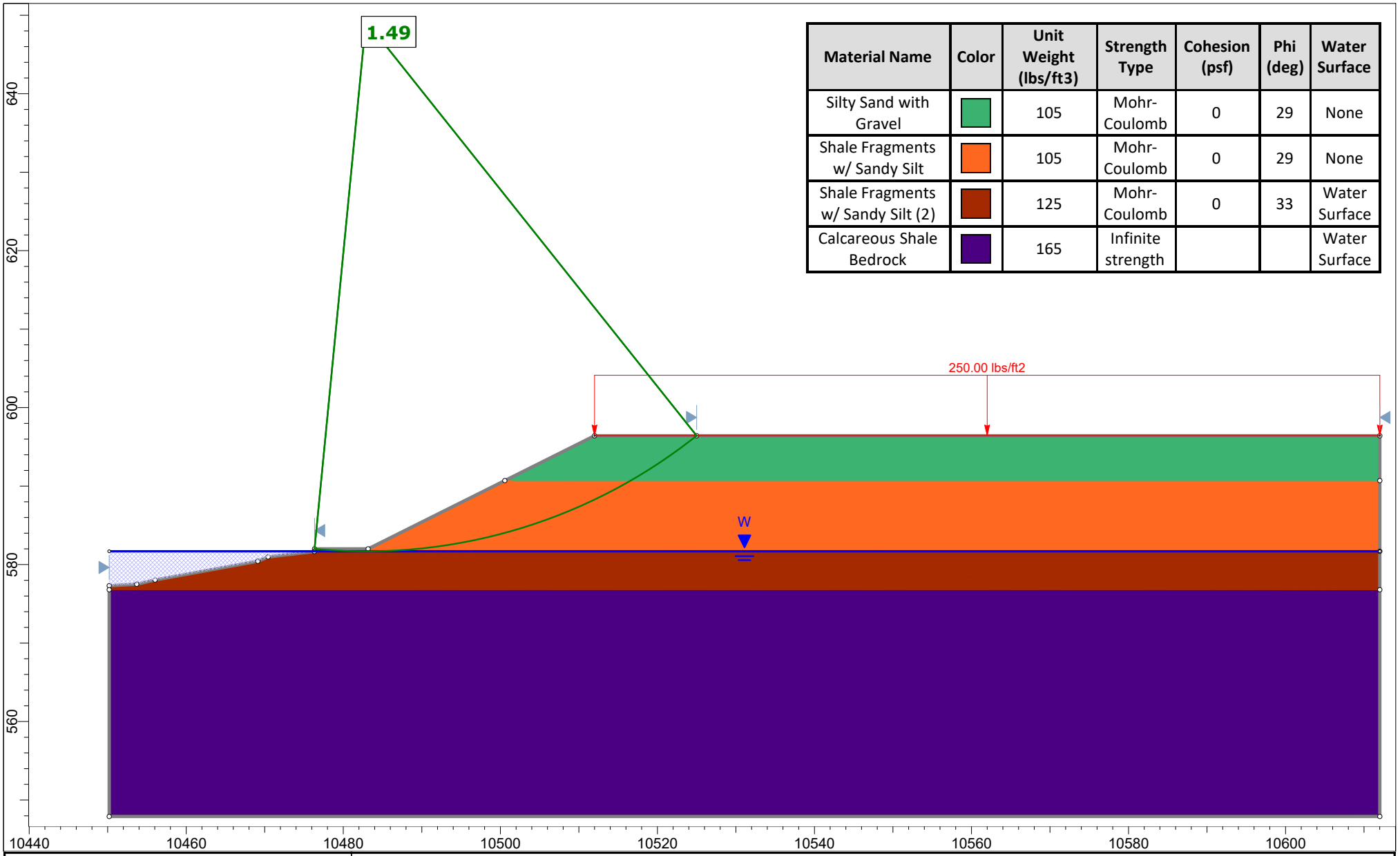
SLIDEINTERPRET 9.019

Project	061748 - Mill Creek Str. & Apprs. (S)		
Site	Hwy. 600 over Mill Creek	*Analysis Type*	Short Term/End of Construction
Analyzed By	PT	*Configuration*	Southeast Abutment
Date	6/18/2024		



Material Name	Color	Unit Weight (lbs/ft3)	Strength Type	Cohesion (psf)	Phi (deg)	Water Surface
Silty Sand with Gravel		105	Mohr-Coulomb	0	29	None
Shale Fragments w/ Sandy Silt		105	Mohr-Coulomb	0	29	None
Shale Fragments w/ Sandy Silt (2)		125	Mohr-Coulomb	0	33	Water Surface
Calcareous Shale Bedrock		165	Infinite strength			Water Surface

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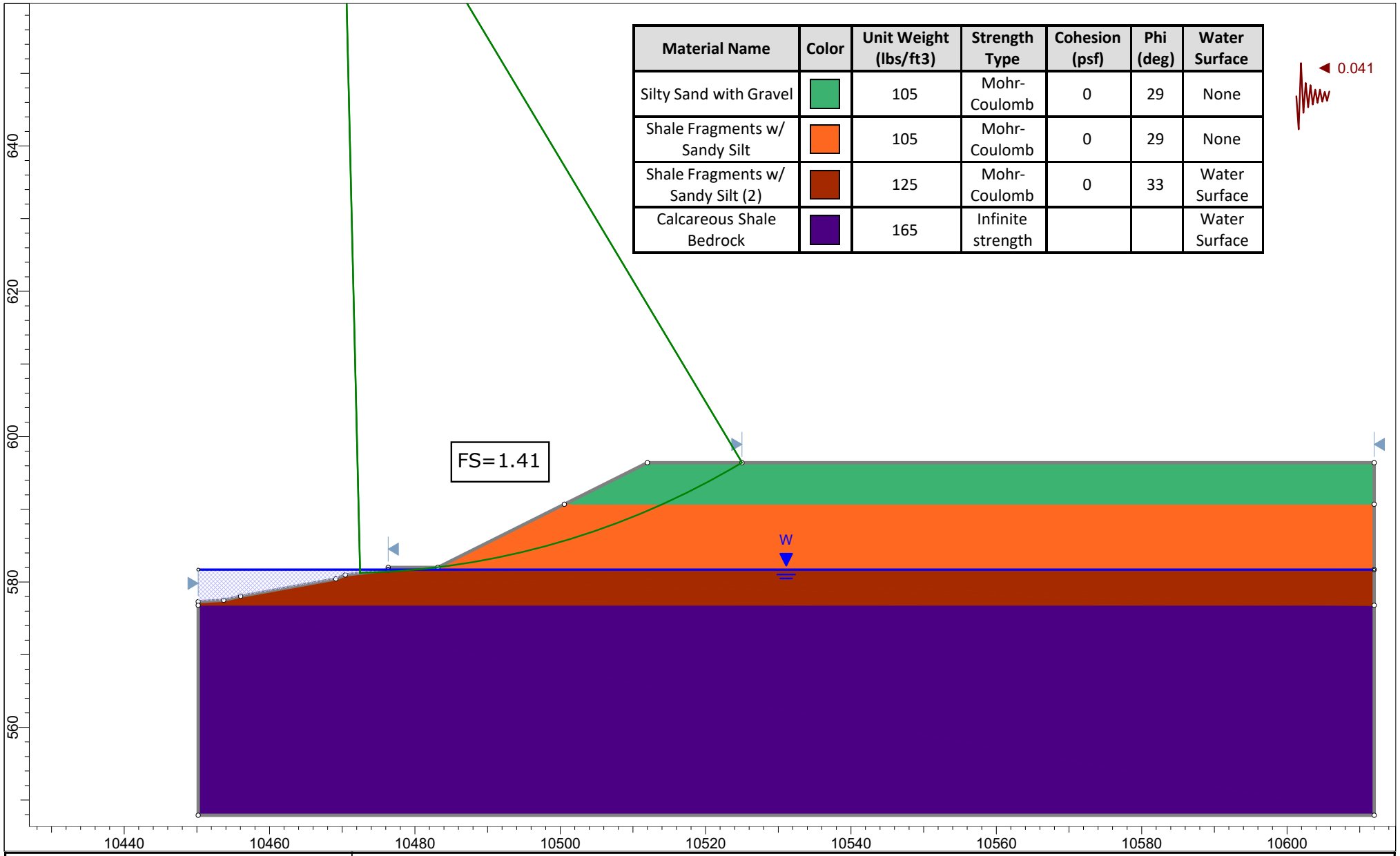
SLIDEINTERPRET 9.019

Project	061748 - Mill Creek Str. & Apprs. (S)		
Site	Hwy. 600 over Mill Creek	*Analysis Type*	Long Term
Analyzed By	PT	*Configuration*	Southeast Abutment
Date	6/18/2024		

Material Name	Color	Unit Weight (lbs/ft3)	Strength Type	Cohesion (psf)	Phi (deg)	Water Surface
Silty Sand with Gravel		105	Mohr-Coulomb	0	29	None
Shale Fragments w/ Sandy Silt		105	Mohr-Coulomb	0	29	None
Shale Fragments w/ Sandy Silt (2)		125	Mohr-Coulomb	0	33	Water Surface
Calcareous Shale Bedrock		165	Infinite strength			Water Surface



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SLIDEINTERPRET 9.019

Project	061748 - Mill Creek Str. & Apprs. (S)		
Site	Hwy. 600 over Mill Creek	*Analysis Type*	Seismic
Analyzed By	PT	*Configuration*	Southeast Abutment
Date	6/18/2024		

Attachment H

Job No.:	061748
Site No.:	1

Input by:	PT	5/20/2024
Checked by:	MB	6/10/2024
Back-checked by:	YZ	6/17/2024

Boring 1

Elevation, ft		Material	Model	Effective Unit Weight, γ',pcf	Undrained Shear Strength of Soil (C_u) (psf)	Strain Factor (ε_{50} for Soil) / k_m for Rock)	Friction Angle, ϕ, °	Soil Modulus, k, pci	Uniaxial Compressive Strength, q_u, psi	Rock Mass Modulus, E_{rm}, 10^6 psi	RQD, %
Top	Bottom										
Ground (597.5)	593	Gravel with Silt	Sand (Reese)	110	NA	NA	35	124	NA	NA	NA
593	588	Gravel with Sand	Sand (Reese)	110	NA	NA	33	78	NA	NA	NA
588	583	Gravel with Silt and Sand	Sand (Reese)	115	NA	NA	34	102	NA	NA	NA
583	576	Highly Weathered Shale	Stiff Clay W/ Free Water (Matlock)	85	4500	0.004	NA	2000	NA	NA	NA
576	574	Weathered Shale	Stiff Clay W/ Free Water (Matlock)	85	7450	0.004	NA	2000	NA	NA	NA
Below 574		Shale/Limestone Bedrock	Weak Rock	100	NA	0.0005	NA	NA	7700	2.2	25

Boring 2

Elevation, ft		Material	Model	Effective Unit Weight, γ',pcf	Undrained Shear Strength of Soil (C_u) (psf)	Strain Factor (ε_{50} for Soil) / k_m for Rock)	Friction Angle, ϕ, °	Soil Modulus, k, pci	Uniaxial Compressive Strength, q_u, psi	Rock Mass Modulus, E_{rm}, 10^6 psi	RQD, %
Top	Bottom										
Ground (595.6)	592	Silty Sand with Gravel	Sand (Reese)	105	NA	NA	29	20	NA	NA	NA
592	582	Shale Fragments with Sandy Silt	Sand (Reese)	105	NA	NA	29	20	NA	NA	NA
582	577	Shale Fragments with Sandy Silt	Sand (Reese)	60	NA	NA	33	52	NA	NA	NA
below 577		Calcareous Shale Bedrock	Weak Rock	100	NA	0.0005	NA	NA	7700	2.1	11