

# RED ROCK CONSULTING

## ***Report of Geotechnical Investigation***

***OF THE***

**SH 29 Bridge over Black Bear Creek  
STEPHENS COUNTY, OKLAHOMA**

**29657(04)**

***Prepared For:***

SRB  
100 Northeast 5th Street  
Oklahoma City, Oklahoma 73104  
Attention: Mr. Greg Allen, PE

***Prepared By:***

Red Rock Consulting, LLC  
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(405) 562-3328

July 19, 2018  
Project No. 18026

# RED ROCK CONSULTING

July 19, 2018

SRB  
100 Northeast 5<sup>th</sup> Street  
Oklahoma City, Oklahoma 73104

Attention: Mr. Greg Allen, PE

Re: Report of Geotechnical Investigation  
**SH 29 Bridge over Black Bear Creek**  
**Stephens County, Oklahoma**  
**29657(04)**  
Project No. 18026

Dear Mr. Allen:

I am pleased to submit herewith this report entitled "Geotechnical Investigation, SH 29 Bridge over Black Bear Creek, Stephens County, Oklahoma, 29657(04)".

In an effort to provide a more environmentally friendly service, this report has been printed double sided on 100% recycled paper.

It has been our pleasure to assist you with this project. Should you have any questions regarding the contents of this report, please contact Red Rock Consulting.

Yours very truly,  
**RED ROCK CONSULTING, LLC**  
CA No. 5707 Exp. 06/30/19



Daniel Bolin, EI  
Project Specialist



Jeremy Basler, PE  
Geotechnical Manager  
Oklahoma PE No. 20233



# REPORT OF GEOTECHNICAL INVESTIGATION

## SH 29 BRIDGE OVER BLACK BEAR CREEK STEPHENS COUNTY, OKLAHOMA

29657(04)

PROJECT NO. 18026

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# **REPORT OF GEOTECHNICAL INVESTIGATION**

## **SH 29 BRIDGE OVER BLACK BEAR CREEK STEPHENS COUNTY, OKLAHOMA**

**29657(04)**

**PROJECT NO. 18026**

### **INTRODUCTION**

#### **General**

This report presents the results of the geotechnical investigation performed for the proposed construction of an 8-span bridge along SH 29 over Black Bear Creek, located 8.6 miles west of the Garvin County line in Stephens County, Oklahoma. The new bridge is anticipated to be 8 spans along a new alignment of SH 29 located approximately 60 feet north of the existing alignment. The purpose of this investigation is to evaluate the subsurface conditions at the site and to provide information pertaining to the geotechnical aspects of the proposed project.

#### **Proposed Construction**

The project will include the replacement of the existing single-span bridge with a new 8-span bridge along a new alignment of SH 29. The new alignment is located approximately 60 feet north of the existing alignment.

#### **Scope of Work**

The scope of this investigation includes the following:

1. Review of previous geotechnical and geological information of sites near this site. This was augmented with data obtained during the field investigation phase of the project.
2. Investigation of the subsurface soils by drilling and testing a total of 10 boreholes within the planned project area
3. A laboratory testing program consisting of moisture content, Atterberg limits, and full sieve analysis on the overburden soils encountered. Also included were unconfined compressive strength tests on select rock core samples.
4. Provide an International Building Code (IBC) site classification for seismic design

## **FIELD AND LABORATORY INVESTIGATIONS**

### **Field Exploration**

Subsurface exploration was performed from May 18 to June 5, 2018. The borings were located in the field by a representative of Red Rock Consulting by measuring distances from known site reference points as depicted on the plans that were provided by SRB. The locations of the borings should be considered accurate only to the degree implied by the methods used to define them.

The subsurface exploration program consisted of drilling 10 borings under the full-time supervision of a geologist or engineer. One boring was drilled at each of the abutment and pier locations of the bridge. Two borings were drilled at pier No. 1 (B-2 and B-2A). Boring B-2A was a constructability boring that was drilled to obtain bedrock samples to test for unconfined compressive strength. The borings ranged between 88.5 and 99.5 feet. The borings are shown on the boring location diagram, which is included in Appendix A.

The borings were advanced using wet rotary drilling methods from an all-terrain vehicle (ATV) mounted CME 750 drill rig or a truck mounted CME 55 drill rig both equipped with an automatic hammer. The overburden in both abutment borings and select pier borings was tested and sampled as per Oklahoma Department of Transportation (ODOT) specifications as modified by Bridge Division. The overburden materials were tested with Texas Cone Penetrometer (TCP) immediately followed by standard penetration test (SPT) at 5-foot intervals. In boring B-2A, SPT was only performed at the surface of bedrock. Following SPT refusal, the hardness of bedrock in all borings, except boring B-2A, was evaluated using a TCP in 5-foot intervals for a total depth of 30 feet. After SPT refusal was attained in boring B-2A, a 3-inch diameter continuous sampler was used to obtain bedrock samples. The bedrock was cored in 5-foot sections for a total depth of 20 feet. The sampling procedures are presented on the boring logs in Appendix A and the rock core photographs are included in Appendix C.

The SPT test uses a standard, 2-inch outside diameter, split-barrel sampling spoon that is driven into the bottom of the boring with a 140-pound automatic drive hammer that falls 30 inches. The blows per foot, N, is the number of hammer blows required to advance the sampling spoon the last 12 inches, or less, of an 18-inch sampling interval. The N value is used to estimate the in-situ relative density of granular soils, the consistency of cohesive soils, and the hardness of weathered bedrock.

Drilling equipment and methods have evolved considerably over the past 65 years following the development of the first SPT empirical design correlations. As a result, the automatic drive hammers on modern geotechnical drilling rigs must be calibrated for efficiency. The efficiency of an automatic drive hammer is specific to each hammer and is expressed by an energy efficiency ratio. The energy efficiency ratio is calculated by dividing the actual measured energy delivered to the drill rod by the theoretical energy delivered by a 140-pound automatic drive hammer that falls 30 inches. The hammer efficiency can be used to convert a SPT value into an N value with a nominal 60 percent efficiency, the  $N_{60}$  value. The  $N_{60}$  value is rarely used in engineering practice but is widely considered to be more accurate and more representative of the N values used to develop the original SPT empirical design correlations. Both the N and  $N_{60}$  values are presented on the boring logs in Appendix A.

The TCP test was developed by the Texas Highway Department in accordance with the AASHTO Manual on Subsurface Investigation and was modified by the Oklahoma Department Transportation. The TCP test is a dynamic penetration test performed to determine the in-situ properties of subsurface soils and to evaluate the consistency or hardness of the bedrock material. The TCP test drives a penetrometer cone into the undisturbed cohesive overburden soil or bedrock material with a 140-pound automatic drive hammer that falls 30 inches. The cone is seated into the undisturbed cohesive soil or bedrock material by driving the cone 10 blows or 12 inches, whichever is achieved first, into the soil/bedrock. The cone is then driven an additional 12 inches or 100 blows, whichever is reached first. If the cone is driven the full 12 inches, the number of blows required to drive each 6 inches of penetration up to 12 inches is recorded. The total number of blows required for the two 6-inch increments are then recorded as the TCP blow count. If the cone is unable to be driven the full 12 inches, the penetration is recorded after every 50 blows up to 100 blows.

After performing SPT and TCP tests, as well as collecting rock cores, the holes were backfilled with grout and cuttings as required by the Oklahoma State Statutes for Geotechnical drilling.

Samples were collected and transported back to the lab for further classification and testing. The final boring logs were developed from the draft logs, observations and test results of the samples returned to the laboratory. The stratigraphic contacts indicated are only for the specific dates and locations reported, and therefore, are not necessarily representative of other locations and times. The boring logs, presenting conditions encountered at each location explored, are included in Appendix A.

## **Laboratory Testing**

Representative soil samples were tested to refine the field classifications and evaluate physical properties of the soils which may affect the geotechnical aspects of project design and construction. The laboratory testing program included the following:

- Moisture content (ASTM D2216)
- Liquid limit and plastic limit (ASTM D4318)
- Full sieve (ASTM D422)
- Uniaxial compressive strength of intact rock core (ASTM D7012 Method C)

The results of the physical laboratory tests conducted are shown on the boring logs in Appendix A and are included in Appendix B.

The above laboratory tests were performed in general accordance with applicable ASTM procedures, or generally accepted practice. It should be noted that reference to ASTM procedures does not imply that all cross-referenced procedures in ASTM standards have been used, or that all ASTM procedures used have been followed exactly. Only those ASTM procedures and/or portions of procedures, which, in the professional judgment of the geotechnical engineer of record for this report, are applicable, appropriate, and necessary for this project, have been used or followed.

## **SITE DESCRIPTION**

### **Surface Conditions**

At the time of this investigation, one reinforced concrete bridge was present along State Highway 29 over Black Bear Creek. The bridge had two lanes, one running east and one running west. The traffic on State Highway 29 was moderate to high and consisted of mostly large trucks.

There is a large cattle grazing field to the north of the boring locations, which is where the proposed bridge will be located. To the southwest there is a crop field across the existing highway. To the southeast a large uncultivated area was in place. This area was very dense with large trees and undergrowth. Nearer to the project site many large trees and brush lined the existing fence. Black Bear Creek was approximately 20 feet across and had flowing water in it during drilling activities. There was two days during drilling activities when the creek was approximately 40 feet across due to the buildup of timber underneath the bridge. The timber had to be cleared by ODOT to allow the water to flow away and allow drilling to proceed. This is known to occur after every significant rain storm. All the borings were easily accessible.

All the borings were drilled on the south side of the proposed bridge in the right-of-way due to the lack of permission from the landowner to the north. The borings were drilling in a line that staggered by approximately 3 to 18 feet as approved by the client. The locations of the borings are shown on the Boring Location Diagram in Appendix A.

The surface elevations at the boring locations were determined using differential leveling procedures. Benchmark 23, which was a set cut 'X' on the northeast wingwall of the existing bridge, was used as a benchmark. The benchmark was located at station 746+82.2, 13.3 feet left of the center line of survey and had an elevation of 1087.07 feet. The location and elevation of the benchmark were shown on the plans provided by the client. Based on this benchmark, the elevations of the borings ranged from 1083.4 to 1086.1 feet. The approximate elevation at each boring location is shown on the Boring Logs and on the Boring Location Diagram in Appendix A.

## Site Geology

The geology of the project site was researched using the "Division seven Engineering Classification of Geological Materials", published by the Oklahoma Department of Transportation (ODOT) and the Geologic Map of the "Hydrologic Atlas 3 of Oklahoma, Reconnaissance of the Water Resources of the Ardmore and Sherman quadrangle, southern Oklahoma," by Donald L Hart, Jr., U.S. Geological Survey, 1974.

### ODOT PUBLICATION

The ODOT publication indicates the project site is underlain by the El Reno Unit (Per).

The El Reno unit consists of a heterogeneous mixture of sandstones, shale, siltstone, and siltstone conglomerate. In northeastern Stephens County, the lowermost 40 to 100 feet of the unit consists dominantly of sandstones which are coarse-grained, nearly white to buff, and moderately soft; but a few hard massive sandstone beds up to six feet thick occur near the base of the unit. Northward, across Grady County, the sandstones of this lower section become red, progressively finer grained, and moderately hard to hard.

The upper portion of the unit is known as "The Purple Series" in Stephens and Grady Counties. Here, some 80 feet of soft purple sandstone, 50 feet of soft pink sandstones, and 50 feet of moderately soft purple mudstone conglomerate are present in descending order. Westward, in Comanche and southern Caddo counties, the sandstones grade into red shales with minor amounts of gypsum and siltstones. Locally, in southeastern Grady County, near Cox City, a few sandstone beds in the upper portion are hard, limy, and occur in beds up to seven feet thick.

The unit thickens northward from 420 feet in Stephens County to 460 feet in Western Caddo County to 660 feet in northern Grady County.

The El Reno unit outcrops in a four to eight mile wide northwest-southeast band across southern Caddo, northeastern Comanche, and northwestern Stephens Counties. The outcrop then circles the southeastern end of the Anadarko basin in northern Stephens County and covers a broad area up to eighteen miles wide across northeastern Stephens and Grady Counties of Division 7. In Grady and eastern Caddo Counties, north of T4N, the upper 0 to 230 feet is mapped separately as the Dog Creek-Blaine subunits undifferentiated. Northward, in Division 4, and westward from Caddo County, in Division 5, the rock strata of the El Reno unit are separable and are mapped as the Flowerpot, Blaine, and Dog Creek units.

Topographically, the unit generally forms rolling hills with a pronounced escarpment at the base in Stephens and southern Grady Counties where the sandstones are thickest.

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Northwestward, the topography is rolling with gently rolling topography dominant in western Caddo County where the shales are thickest. The sandstone ridges are usually marked by oak vegetation and erosional gullies in the sandy soils. The shales generally form the valleys and gently rolling hills and support the growth of short grass. Some mesquite and prickly pear are evident in the salty or gypsiferous areas.

#### **USGS MAP**

According to the USGS geologic map, the project site is underlain by the Duncan Sandstone Member (Pd) of the El Reno Group.

Sandstone, white to buff, fine- to coarse-grained, moderately indurated, with interbedded mudstone conglomerates and siltstones; thickness, 100 to 400 feet, decreasing southeastward. Yields small to moderate amounts of water of fair quality.

## Subsurface Conditions

Information collected during the field investigation indicates that the overburden material consisted of primarily of lean clay with varying amounts of sand and various combinations of sand and silt. These materials extended from the surface to the top of bedrock. The overburden encountered in the borings appeared to be native to the site.

The depth to bedrock ranged between 57 and 61 feet in the borings. The bedrock in the borings consisted of poorly cemented to very well cemented sandstone.

The unconfined compressive strength of the bedrock cores recovered from boring B-2 ranged between 744 and 1,161 psi. The rock coring had a relatively low recovery rate in all of the runs. These results are shown on the boring logs in Appendix A and in the lab results in Appendix B.

The approximate depths to bedrock and conditions are summarized in Table 1.

**Table 1 – Depth to Bedrock and Conditions**

Boring	Depth to Bedrock (feet)	Elevation (feet)	Type of Bedrock	Hardness	UC Compressive Strength
B-1	57.5	1027	sandstone	poorly cemented to very well cemented	
B-2	57	1027.2	sandstone	cemented to very well cemented	744 – 1,161 psi
B-3	60.5	1023.7	sandstone	poorly cemented to very well cemented	
B-4	61	1024.7	sandstone	poorly cemented to very well cemented	
B-5	61	1024.2	sandstone	poorly cemented to very well cemented	
B-6	61	1025.1	sandstone	poorly cemented to very well cemented	
B-7	59.5	1025.8	sandstone	well cemented to very well cemented	
B-8	59	1024.4	sandstone	poorly well cemented to very well cemented	
B-9	59	1025	sandstone	well cemented to very well cemented	

Subsurface conditions are described in greater detail on the boring logs in Appendix A. Photographs of the rock cores collected are presented in Appendix C.

## Groundwater Conditions

Groundwater conditions were monitored in all borings immediately following completion of drilling operations in borings B-1, B-2, B-8 and B-9 and after a period of delay in borings B-1, B-2, B-3, B-6, B-7 and B-8. All borings remained open following drilling activities except borings B-4 and B-5 that collapsed at 2 feet and 3 feet, respectively. The approximate groundwater levels are summarized in Table 2. It should be noted that the groundwater levels measured immediately following drilling may not be precise due to the nature of wet rotary drilling. The groundwater levels measured after a period of delay may not be precise due to the location of the borings being near a creek that gathers large amounts of water and the rainfall events experienced during drilling activities.

**Table 2 – Groundwater Levels**

Boring	Approximate Groundwater Levels				
	Immediately Following Drilling		Hours After Drilling		
	Depth (feet)	Elevation (feet)	Hours	Depth (feet)	Elevation (feet)
B-1	2.5	1082	168	3	1081.5
B-2	3	1081.2	192	12	1072.2
B2-A	3	1081.2	192	12	1072.2
B-3	NA	--	192	2.5	1081.7
B-4	Collapsed at 2 feet				
B-5	Collapsed at 3 feet				
B-6	NA	--	456	6	1080.1
B-7	NA	--	168	2.5	1082.8
B-8	4.5	1078.9	24	8	1075.4
B-9	2.5	1081.5	--	--	--

To obtain more accurate groundwater level information, long-term observations in a well or piezometer that is sealed from the influence of surface water would be needed. Fluctuations in groundwater levels can occur due to seasonal variations in the amount of rainfall, runoff, altered drainage paths, and other factors not evident at the time borings were advanced. Consequently, the contractor should be aware of this possibility while constructing this project.

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### **International Building Code Site Class**

From the geotechnical investigation and subsequent laboratory tests, the onsite soils yield an **International Building Code (IBC) Site Class “D”**. This site class is based on the average standard penetration resistance (SPT) procedure, and a maximum boring depth of 99.5 feet. **This site class does not account for induced earth movement, such as the recent earthquakes due to injection wells.** To obtain a more accurate site class, more extensive testing must be used to evaluate the subsurface conditions.

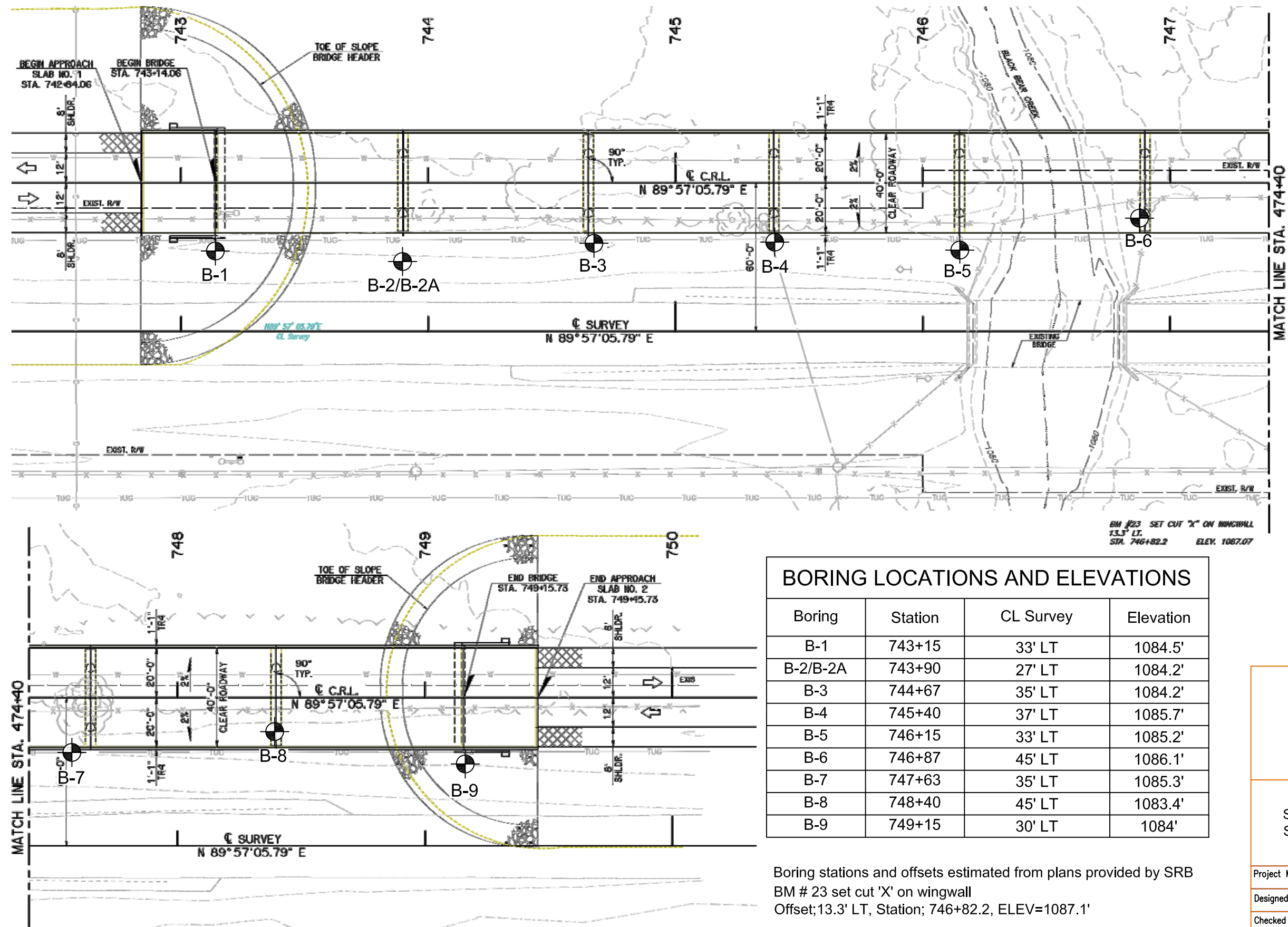
**SH 29 Bridge over Black Bear Creek  
Stephens County, Oklahoma  
29657(04)  
RRC Project No. 18026  
July 19, 2018**

## **CLOSURE**

The data presented in this report are based on the negotiated scope for this project and site conditions as they existed at the time of the field exploration. The conditions encountered in the exploratory borings are assumed to be representative subsurface conditions within the study area.

This report was prepared for the exclusive use of SRB, ODOT and their agents and consultants. It should be made available to prospective contractors for information and factual data only and not as a warranty of subsurface conditions similar to those interpreted from the boring logs or discussions presented herein.

## **APPENDIX A**



### BORING LOCATIONS AND ELEVATIONS

Boring	Station	CL Survey	Elevation
B-1	743+15	33' LT	1084.5'
B-2/B-2A	743+90	27' LT	1084.2'
B-3	744+67	35' LT	1084.2'
B-4	745+40	37' LT	1085.7'
B-5	746+15	33' LT	1085.2'
B-6	746+87	45' LT	1086.1'
B-7	747+63	35' LT	1085.3'
B-8	748+40	45' LT	1083.4'
B-9	749+15	30' LT	1084'

Boring stations and offsets estimated from plans provided by SRB  
 BM # 23 set cut 'X' on wingwall  
 Offset; 13.3' LT, Station; 746+82.2, ELEV=1087.1'

**RED ROCK**  
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PO Box 30591  
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**BORING LOCATION DIAGRAM**  
 SH 29 OVER BLACK BEAR CREEK  
 STEPHENS COUNTY, OKLAHOMA  
 29657(04)

Project Mngr:	SAH	Project No.	18026
Designed By:	SAH	Scale:	NOT TO SCALE
Checked By:	JWB	Date:	7/5/2018
Approved By:	JWB	Page No:	1/1

**CLIENT** SRB **PROJECT NAME** SH 29 Bridge over Black Bear Creek  
**PROJECT NUMBER** 18026 **PROJECT LOCATION** Stephens County, Oklahoma  
**DATE STARTED** 5/30/18 **COMPLETED** 5/30/18 **GROUND ELEVATION** 1084.5 ft **STATION** 743+15 **OFFSET** 33' LT  
**DRILLING CONTRACTOR** DSO - Drilling Services of Oklahoma **GROUND WATER LEVELS:**  
**DRILLING METHOD** wet rotary - CME 750 ATV **DURING DRILLING** NA  
**LOGGED BY** SAH **CHECKED BY** JWB **168 hrs AFTER DRILLING** 3.0 ft / Elev 1081.5 ft  
**NOTES** 29657(04) **Cave In Depth** open

ELEVATION (ft)	DEPTH (ft)	GRAPHIC LOG	MATERIAL DESCRIPTION	SAMPLE TYPE	BLOW COUNTS N	BLOW COUNTS N60	MOISTURE CONTENT (%)	ATTERBERG LIMITS			PASSING #200 SIEVE (%)
0								LIQUID LIMIT	PLASTIC LIMIT	PLASTICITY INDEX	
			<b>SANDY LEAN CLAY</b> , brown, medium stiff 1084.5'	⊗ SPT	5	7	22	27	17	10	60.1
1080			<b>SILTY, CLAYEY SAND</b> , brown, very loose 1079.5'	⊗ SPT	0	0	22	21	16	5	39.2
10			<b>LEAN CLAY with SAND</b> , reddish brown, soft 1074.5'	⊗ SPT	1	1	25	30	15	15	79.3
1070				▼ TC	8						
			<b>SILTY CLAY with SAND</b> , reddish brown, medium stiff 1067.5'	⊗ SPT	8	11	26	24	17	7	72.8
20			<b>SILTY SAND</b> , reddish brown to brown, very soft to stiff 1064.5'	⊗ SPT	5	7	24	0	0	NP	34.7
1060			<b>LEAN CLAY with SAND</b> , reddish brown to brown, very soft 1059.5'	⊗ SPT	10	13	21	40	14	26	73.9
30				▼ TC	12						
1050				⊗ SPT	1	1	27	35	13	22	78.1
			<b>LEAN CLAY</b> , brown, medium stiff to very stiff 1049.5'	⊗ SPT	7	9	23	34	14	20	85.9
40				▼ TC	15						
1040			<b>SILTY SAND</b> , brown, medium dense 1042.5'	⊗ SPT	14	19	21	0	0	NP	30.0
			<b>SANDY LEAN CLAY</b> , brown, very soft to stiff 1039.5'	⊗ SPT	0	0	21	24	12	12	61.3
50				▼ TC	14						
1030			<b>LEAN CLAY with SAND</b> , dark gray, stiff to very stiff 1032.5'	⊗ SPT	9	12	27	39	12	27	80.9
				▼ TC	13						
60			<b>SANDSTONE</b> , gray, poorly cemented to very well cemented 1027'	⊗ SPT	23	31	30	45	18	27	90.2
				▼ SPT	50/5.5"		19	31	16	15	86.5
				▼ TC	50/2.3"						
				▼ TC	50/0.5"						
1020				▼ TC	50/0.5"						
				▼ TC	50/0.4"						
70				▼ TC	50/0.8"						
				▼ TC	50/0.4"						

1 DURING AFTER CAVE IN WITH N60 18026 LOGS.GPJ DATA TEMPLATE.GDT 7/19/18

(Continued Next Page)

CLIENT SRB

PROJECT NAME SH 29 Bridge over Black Bear Creek

PROJECT NUMBER 18026

PROJECT LOCATION Stephens County, Oklahoma

ELEVATION (ft)	DEPTH (ft)	GRAPHIC LOG	MATERIAL DESCRIPTION	SAMPLE TYPE	BLOW COUNTS N	BLOW COUNTS N60	MOISTURE CONTENT (%)	ATTERBERG LIMITS			PASSING #200 SIEVE (%)
								LIQUID LIMIT	PLASTIC LIMIT	PLASTICITY INDEX	
1010			<u>SANDSTONE</u> , gray, poorly cemented to very well cemented (continued)	1027'	▼ TC	50/0.8" 50/0.4"					
80					▼ TC	50/0.8" 50/0.3"					
1000					▼ TC	50/0.4" 50/0.1"					
			Boring Termination Depth = 88 feet Boring Completed on 5/30/18 and Grouted on 6/9/18	996.5'	▼ TC	50/0.5" 50/0.3"					
990											
980											
970											
960											
950											
940											

<b>CLIENT</b> SRB	<b>PROJECT NAME</b> SH 29 Bridge over Black Bear Creek
<b>PROJECT NUMBER</b> 18026	<b>PROJECT LOCATION</b> Stephens County, Oklahoma
<b>DATE STARTED</b> 5/29/18 <b>COMPLETED</b> 5/29/18	<b>GROUND ELEVATION</b> 1084.2 ft <b>STATION</b> 743+90 <b>OFFSET</b> 27' LT
<b>DRILLING CONTRACTOR</b> DSO - Drilling Services of Oklahoma	<b>GROUND WATER LEVELS:</b>
<b>DRILLING METHOD</b> wet rotary - CME 750 ATV	<b>DURING DRILLING</b> NA
<b>LOGGED BY</b> SAH <b>CHECKED BY</b> JWB	<b>192 hrs AFTER DRILLING</b> 12.0 ft / Elev 1072.2 ft
<b>NOTES</b> 29657(04)	<b>Cave In Depth</b> open

ELEVATION (ft)	DEPTH (ft)	GRAPHIC LOG	MATERIAL DESCRIPTION	SAMPLE TYPE	BLOW COUNTS N	BLOW COUNTS N60	MOISTURE CONTENT (%)	ATTERBERG LIMITS			PASSING #200 SIEVE (%)
								LIQUID LIMIT	PLASTIC LIMIT	PLASTICITY INDEX	
1080	0		<u>CLAYEY SAND</u> , brown, loose 1084.2'	⊗ SPT	7	9	11	25	16	9	48.0
			<u>SILTY, CLAYEY SAND</u> , reddish brown, very loose 1083.2'								
1070	10	▽		⊗ SPT	1	1	19	23	17	6	45.3
1060	20		<u>LEAN CLAY with SAND</u> , brown, very soft 1072.2'	▼ TC	9						
1050	30			⊗ SPT	0	0	28	32	15	17	81.8
1040	40		<u>SILTY, CLAYEY SAND</u> , reddish brown, loose 1067.2'	▼ TC	6						
1030	50			⊗ SPT	7	9	21	22	16	6	35.0
1020	60		<u>LEAN CLAY</u> , dark brown, very soft 1062.2'	▼ TC	7						
	70			⊗ SPT	0	0	27	30	16	14	86.5
			<u>SANDY LEAN CLAY</u> , dark brown, medium stiff 1057.2'	▼ TC	6						
			<u>LEAN CLAY with SAND</u> , dark brown, very soft to stiff 1052.2'	⊗ SPT	5	7	19	25	15	10	64.8
				▼ TC	15						
			<u>LEAN CLAY with SAND</u> , dark brown, very soft to stiff 1052.2'	⊗ SPT	11	15	20	34	13	21	72.0
				▼ TC	7						
				⊗ SPT	1	1	26	33	15	18	74.3
				▼ TC	13						
			<u>SANDY LEAN CLAY</u> , brown, stiff 1042.2'	⊗ SPT	11	15	28	31	13	18	65.8
			<u>SILTY SAND</u> , brown, loose to medium dense 1039.2'	⊗ SPT	11	15	24	0	0	NP	24.2
				⊗ SPT	19	25	22	0	0	NP	25.7
				⊗ SPT	10	13	17	19	15	4	34.0
			<u>SANDSTONE</u> , light gray, cemented to very well cemented 1027.2'	▼ SPT	50/4.5" 50/1" 50/0.4"		25	23	17	6	59.9
				▼ TC	50/0.5" 50/1"						
				▼ TC	50/0.4" 50/0.4"						

(Continued Next Page)

CLIENT SRB

PROJECT NAME SH 29 Bridge over Black Bear Creek

PROJECT NUMBER 18026

PROJECT LOCATION Stephens County, Oklahoma

ELEVATION (ft)	DEPTH (ft)	GRAPHIC LOG	MATERIAL DESCRIPTION	SAMPLE TYPE	BLOW COUNTS N	BLOW COUNTS N60	MOISTURE CONTENT (%)	ATTERBERG LIMITS			PASSING #200 SIEVE (%)
								LIQUID LIMIT	PLASTIC LIMIT	PLASTICITY INDEX	
1010			<u>SANDSTONE</u> light gray, cemented to very well cemented (continued) 1027.2'	▼ TC	50/1.5" 50/0.5"						
80				▼ TC	50/0.4" 50/0.3"						
1000				▼ TC	50/0.4" 50/0.3"						
			Boring Termination Depth = 88 feet Boring Completed on 5/29/18 and Grouted on 6/9/18 996.2'	▼ TC	50/0.4" 50/0.1"						
990											
980											
970											
960											
950											
940											
930											

<b>CLIENT</b> SRB	<b>PROJECT NAME</b> SH 29 Bridge over Black Bear Creek
<b>PROJECT NUMBER</b> 18026	<b>PROJECT LOCATION</b> Stephens County, Oklahoma
<b>DATE STARTED</b> 5/29/18 <b>COMPLETED</b> 5/29/18	<b>GROUND ELEVATION</b> 1084.2 ft <b>STATION</b> 743+90 <b>OFFSET</b> 27' LT
<b>DRILLING CONTRACTOR</b> DSO - Drilling Services of Oklahoma	<b>GROUND WATER LEVELS:</b>
<b>DRILLING METHOD</b> wet rotary - CME 750 ATV	<b>DURING DRILLING</b> NA
<b>LOGGED BY</b> SAH <b>CHECKED BY</b> JWB	<b>192 hrs AFTER DRILLING</b> 12.0 ft / Elev 1072.2 ft
<b>NOTES</b> 29657(04)	<b>Cave In Depth</b> open

ELEVATION (ft)	DEPTH (ft)	GRAPHIC LOG	MATERIAL DESCRIPTION	SAMPLE TYPE	BLOW COUNTS N	BLOW COUNTS N60	MOISTURE CONTENT (%)	ATTERBERG LIMITS			PASSING #200 SIEVE (%)
								LIQUID LIMIT	PLASTIC LIMIT	PLASTICITY INDEX	
0											
1080			CLAYEY SAND, brown, loose 1084.2'								
			SILTY, CLAYEY SAND, reddish brown, very loose 1083.2'								
1070			LEAN CLAY with SAND, brown, very soft 1072.2'								
			SILTY, CLAYEY SAND, reddish brown, loose 1067.2'								
1060			LEAN CLAY, dark brown, very soft 1062.2'								
			SANDY LEAN CLAY, dark brown, medium stiff 1057.2'								
1050			LEAN CLAY with SAND, dark brown, very soft to stiff 1052.2'								
			SANDY LEAN CLAY, brown, stiff 1042.2'								
1040			SILTY SAND, brown, loose to medium dense 1039.2'								
1030											
1020			SANDSTONE, light gray, cemented to very well cemented 1027.2'	SPT	50/3.4"						
				RC	Total= 5						
			*62.5 feet - Compressive Strength = 744 psi *	RC	Rec= 8%						
					RQD= 0%						
					Total= 23						
			*67.5 feet - Compressive Strength = 1,161 psi *	RC	Rec= 38%						
					RQD=						

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**PROJECT LOCATION** Stephens County, Oklahoma

DURING AFTER CAVE IN WITH N60 18026 LOGS.GPJ DATA TEMPLATE.GDT 7/19/18

<b>CLIENT</b> SRB	<b>PROJECT NAME</b> SH 29 Bridge over Black Bear Creek
<b>PROJECT NUMBER</b> 18026	<b>PROJECT LOCATION</b> Stephens County, Oklahoma
<b>DATE STARTED</b> 5/29/18 <b>COMPLETED</b> 5/29/18	<b>GROUND ELEVATION</b> 1084.2 ft <b>STATION</b> 744+67 <b>OFFSET</b> 35' LT
<b>DRILLING CONTRACTOR</b> DSO - Drilling Services of Oklahoma	<b>GROUND WATER LEVELS:</b>
<b>DRILLING METHOD</b> wet rotary - CME 750 ATV	<b>DURING DRILLING</b> NA
<b>LOGGED BY</b> SAH <b>CHECKED BY</b> JWB	<b>192 hrs AFTER DRILLING</b> 2.5 ft / Elev 1081.7 ft
<b>NOTES</b> 29657(04)	<b>Cave In Depth</b> open

ELEVATION (ft)	DEPTH (ft)	GRAPHIC LOG	MATERIAL DESCRIPTION	SAMPLE TYPE	BLOW COUNTS N	BLOW COUNTS N60	MOISTURE CONTENT (%)	ATTERBERG LIMITS			PASSING #200 SIEVE (%)
								LIQUID LIMIT	PLASTIC LIMIT	PLASTICITY INDEX	
0											
1080			<u>SILTY, CLAYEY SAND</u> , brown 1084.2'								
1070	10										
1060	20		<u>SILTY SAND</u> , brown 1066.2'								
1050	30		<u>LEAN CLAY with SAND</u> , brown 1061.7'								
1040	40										
1030	50		<u>SILTY, CLAYEY SAND</u> , brown 1041.2'								
1020	60		<u>SILTY SAND with GRAVEL</u> , brown 1024.2'	SPT	35		17	0	0	NP	33.8
			<u>SANDSTONE</u> , gray, poorly cemented to very well cemented 1023.7'	TC	50/5"						
					50/1.8"						
					50/1"						
				TC	50/0.8"						
					50/0.5"						
					50/1"						

1 DURING AFTER CAVE IN WITH N60 18026 LOGS.GPJ DATA TEMPLATE.GDT 7/19/18

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<b>CLIENT</b> SRB	<b>PROJECT NAME</b> SH 29 Bridge over Black Bear Creek
<b>PROJECT NUMBER</b> 18026	<b>PROJECT LOCATION</b> Stephens County, Oklahoma
<b>DATE STARTED</b> 5/18/18 <b>COMPLETED</b> 5/18/18	<b>GROUND ELEVATION</b> 1085.7 ft <b>STATION</b> 745+40 <b>OFFSET</b> 37' LT
<b>DRILLING CONTRACTOR</b> DSO - Drilling Services of Oklahoma	<b>GROUND WATER LEVELS:</b>
<b>DRILLING METHOD</b> wet rotary - CME 55 Truck	<b>DURING DRILLING</b> NA
<b>LOGGED BY</b> SMA <b>CHECKED BY</b> JWB	<b>hrs AFTER DRILLING</b> NA
<b>NOTES</b> 29657(04)	<b>Cave In Depth</b> 2.0 ft / Elev 1083.7 ft

ELEVATION (ft)	DEPTH (ft)	GRAPHIC LOG	MATERIAL DESCRIPTION	SAMPLE TYPE	BLOW COUNTS N	BLOW COUNTS N60	MOISTURE CONTENT (%)	ATTERBERG LIMITS			PASSING #200 SIEVE (%)
0								LIQUID LIMIT	PLASTIC LIMIT	PLASTICITY INDEX	
			CLAYEY SAND with GRAVEL, light brown, loose 1085.7'	⊗ SPT	5	7	11	33	13	20	46.2
1080			SANDY LEAN CLAY, dark brown with reddish brown, medium stiff 1081.7'	⊗ SPT	5	7	17	33	14	19	60.2
			LEAN CLAY, brown, soft 1078.7'	⊗ SPT	4	5	24	37	15	22	88.6
1070			LEAN CLAY with SAND, brown, soft 1075.7'	⊗ SPT	3	4	18	35	13	22	71.9
			SANDY SILTY CLAY, brown, soft 1070.7'	⊗ SPT	2	3	23	21	14	7	62.2
20			LEAN CLAY, brown, soft 1065.7'	⊗ SPT	4	5	25	34	16	18	86.2
1060			SANDY LEAN CLAY, brown, very soft to soft 1060.7'	⊗ SPT	0	0	24	23	14	9	67.3
				⊗ SPT	3	4	20	23	15	8	65.1
1050			LEAN CLAY, brown, soft 1050.7'	⊗ SPT	3	4	25	33	15	18	96
40			LEAN CLAY with SAND, brown and light gray, stiff 1045.7'	⊗ SPT	10	13	19	41	15	26	73.9
1040			SILTY SAND, light brown, loose to medium dense 1040.7'	⊗ SPT	10	13	23	0	0	NP	45.6
50				⊗ SPT	21	28	23	0	0	NP	24.9
1030				⊗ SPT	17	23	23	18	13	5	44.1
60			SILTY, CLAYEY SAND, light brown, medium dense 1028.7'								
			CLAYEY SAND, light brown, dense 1025.7'	⊗ SPT	8		19	22	13	9	42
			SANDSTONE, gray, poorly cemented to very well cemented 1024.7'	▼ TC	29						
1020					50/5.5"						
					50/0.8"						
					50/0.4"						
70				▼ TC	50/0.5"						
					50/0.3"						

1 DURING AFTER CAVE IN WITH N60 18026 LOGS.GPJ DATA TEMPLATE.GDT 7/19/18

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CLIENT SRB

PROJECT NAME SH 29 Bridge over Black Bear Creek

PROJECT NUMBER 18026

PROJECT LOCATION Stephens County, Oklahoma

ELEVATION (ft)	DEPTH (ft)	GRAPHIC LOG	MATERIAL DESCRIPTION	SAMPLE TYPE	BLOW COUNTS N	BLOW COUNTS N60	MOISTURE CONTENT (%)	ATTERBERG LIMITS			PASSING #200 SIEVE (%)
								LIQUID LIMIT	PLASTIC LIMIT	PLASTICITY INDEX	
1010			<b>SANDSTONE</b> , gray, poorly cemented to very well cemented (continued) 1024.7'	▼ TC	50/0.9" 50/0.4"						
80				▼ TC	50/0.3" 50/0.3"						
1000				▼ TC	50/0.4" 50/0.1"						
90				▼ TC	50/0.4" 50/0.1"						
990			Boring Termination Depth = 92 feet Boring Completed on 5/18/18 and Grouted on 6/9/18 993.7'	▼ TC	50/0.3" 50/0.3"						
980											
970											
960											
950											
940											

**CLIENT** SRB **PROJECT NAME** SH 29 Bridge over Black Bear Creek  
**PROJECT NUMBER** 18026 **PROJECT LOCATION** Stephens County, Oklahoma  
**DATE STARTED** 5/21/18 **COMPLETED** 5/21/18 **GROUND ELEVATION** 1085.2 ft **STATION** 746+15 **OFFSET** 33' LT  
**DRILLING CONTRACTOR** DSO - Drilling Services of Oklahoma **GROUND WATER LEVELS:**  
**DRILLING METHOD** wet rotary - CME 55 Truck **DURING DRILLING** NA  
**LOGGED BY** SAH **CHECKED BY** JWB **hrs AFTER DRILLING** NA  
**NOTES** 29657(04) **Cave In Depth** 3.0 ft / Elev 1082.2 ft

ELEVATION (ft)	DEPTH (ft)	GRAPHIC LOG	MATERIAL DESCRIPTION	SAMPLE TYPE	BLOW COUNTS N	BLOW COUNTS N60	MOISTURE CONTENT (%)	ATTERBERG LIMITS			PASSING #200 SIEVE (%)
0								LIQUID LIMIT	PLASTIC LIMIT	PLASTICITY INDEX	
			<b>SILTY SAND</b> , brown and reddish brown, very loose 1085.2'								
1080				⊗ SPT	4	5	3	0	0	NP	16
10				⊗ SPT	2	3					
1070			<b>SANDY LEAN CLAY</b> , reddish brown, very soft 1070.2'	⊗ SPT	1	1	22	23	13	10	59.6
20			<b>LEAN CLAY with SAND</b> , reddish brown, very soft 1065.2'	⊗ SPT	2	3	23	24	14	10	81.1
1060			<b>SANDY LEAN CLAY</b> , reddish brown, very soft to soft 1060.2'	⊗ SPT	0	0	23	22	14	8	64.5
30				▼ TC	0						
1050				⊗ SPT	3	4	21	24	13	11	62.4
40			<b>LEAN CLAY</b> , brown, soft 1050.2'	⊗ SPT	4	5	24	33	16	17	95.6
				▼ TC	13						
1040			<b>LEAN CLAY with SAND</b> , dark brown and dark gray, stiff 1045.2'	⊗ SPT	12	16	16	38	12	26	81.6
				▼ TC	10						
1030			<b>CLAYEY SAND</b> , reddish brown, loose 1039.7'	⊗ SPT	8	11	19	23	15	8	45.2
50			<b>SILTY SAND</b> , brown, loose 1035.2'	⊗ SPT	6	8	23	19	17	2	46.1
1030			<b>SANDY SILT</b> , dark brown, very stiff 1030.2'	⊗ SPT	19	25	26	0	0	NP	55.6
60			<b>SILTY SAND</b> , light gray, dense to very dense 1025.2'	⊗ SPT	9		19	0	0	NP	29.3
1020			<b>SANDSTONE</b> , gray, poorly cemented to very well cemented 1024.2'	▼ TC	37	50/3.5"					
						50/2.8"					
						50/1.1"					
70				▼ TC	50/0.8"						
						50/0.4"					

1 DURING AFTER CAVE IN WITH N60 18026 LOGS.GPJ DATA TEMPLATE.GDT 7/19/18

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CLIENT SRB

PROJECT NAME SH 29 Bridge over Black Bear Creek

PROJECT NUMBER 18026

PROJECT LOCATION Stephens County, Oklahoma

ELEVATION (ft)	DEPTH (ft)	GRAPHIC LOG	MATERIAL DESCRIPTION	SAMPLE TYPE	BLOW COUNTS N	BLOW COUNTS N60	MOISTURE CONTENT (%)	ATTERBERG LIMITS			PASSING #200 SIEVE (%)
								LIQUID LIMIT	PLASTIC LIMIT	PLASTICITY INDEX	
1010			<b>SANDSTONE</b> , gray, poorly cemented to very well cemented 1024.2'	▼ TC	50/0.8" 50/0.3"						
			(continued)								
80				▼ TC	50/0.6" 50/0.4"						
1000				▼ TC	50/0.4" 50/0.3"						
90				▼ TC	50/0.3" 50/0.1"						
990			Boring Termination Depth = 92 feet Boring Completed on 5/21/18 and Grouted on 6/9/18 993.2'	▼ TC	50/0.3" 50/0.1"						
980											
970											
960											
950											
940											

<b>CLIENT</b> SRB	<b>PROJECT NAME</b> SH 29 Bridge over Black Bear Creek
<b>PROJECT NUMBER</b> 18026	<b>PROJECT LOCATION</b> Stephens County, Oklahoma
<b>DATE STARTED</b> 5/18/18 <b>COMPLETED</b> 5/18/18	<b>GROUND ELEVATION</b> 1086.1 ft <b>STATION</b> 746+87 <b>OFFSET</b> 45' LT
<b>DRILLING CONTRACTOR</b> DSO - Drilling Services of Oklahoma	<b>GROUND WATER LEVELS:</b>
<b>DRILLING METHOD</b> wet rotary - CME 750 ATV	<b>DURING DRILLING</b> NA
<b>LOGGED BY</b> SAH <b>CHECKED BY</b> JWB	<b>456 hrs AFTER DRILLING</b> 6.0 ft / Elev 1080.1 ft
<b>NOTES</b> 29657(04)	<b>Cave In Depth</b> open

ELEVATION (ft)	DEPTH (ft)	GRAPHIC LOG	MATERIAL DESCRIPTION	SAMPLE TYPE	BLOW COUNTS N	BLOW COUNTS N60	MOISTURE CONTENT (%)	ATTERBERG LIMITS			PASSING #200 SIEVE (%)
								LIQUID LIMIT	PLASTIC LIMIT	PLASTICITY INDEX	
0											
1080			<b>SILTY SAND</b> , reddish brown 1086.1'								
10			<b>CLAYEY SAND</b> , reddish brown 1081.1'								
1070			<b>LEAN CLAY with SAND</b> , reddish brown 1074.1'								
20			<b>SILTY SAND</b> , brown 1064.1'								
1060			<b>LEAN CLAY with SAND</b> , brown 1054.1'								
30			<b>SILTY SAND</b> , brown 1038.6'								
1050			<b>SANDSTONE</b> , gray, poorly cemented to very well cemented 1025.1'								
40											
1040											
50											
1030											
60											
1020											
70											

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**PROJECT LOCATION** Stephens County, Oklahoma

DURING AFTER CAVE IN WITH N60 18026 LOGS.GPJ DATA TEMPLATE.GDT 7/19/18

<b>CLIENT</b> SRB	<b>PROJECT NAME</b> SH 29 Bridge over Black Bear Creek
<b>PROJECT NUMBER</b> 18026	<b>PROJECT LOCATION</b> Stephens County, Oklahoma
<b>DATE STARTED</b> 5/30/18 <b>COMPLETED</b> 5/30/18	<b>GROUND ELEVATION</b> 1085.3 ft <b>STATION</b> 747+63 <b>OFFSET</b> 35' LT
<b>DRILLING CONTRACTOR</b> DSO - Drilling Services of Oklahoma	<b>GROUND WATER LEVELS:</b>
<b>DRILLING METHOD</b> wet rotary - CME 750 ATV	<b>DURING DRILLING</b> ---
<b>LOGGED BY</b> SAH <b>CHECKED BY</b> JWB	<b>168 hrs AFTER DRILLING</b> 2.5 ft / Elev 1082.8 ft
<b>NOTES</b> 29657(04)	<b>Cave In Depth</b> ---

ELEVATION (ft)	DEPTH (ft)	GRAPHIC LOG	MATERIAL DESCRIPTION	SAMPLE TYPE	BLOW COUNTS N	BLOW COUNTS N60	MOISTURE CONTENT (%)	ATTERBERG LIMITS			PASSING #200 SIEVE (%)
								LIQUID LIMIT	PLASTIC LIMIT	PLASTICITY INDEX	
0											
			<b>LEAN CLAY with SAND</b> , brown to reddish brown 1085.3'								
1080			<b>SILTY SAND</b> , brown 1080.3'								
10			<b>LEAN CLAY with SAND</b> , reddish brown 1075.3'								
1070			<b>SILTY SAND with GRAVEL</b> , brown 1067.8'								
20											
1060											
30											
1050			<b>SANDY LEAN CLAY</b> , brown 1050.3'								
40											
1040			<b>SILTY SAND with GRAVEL</b> , brown 1040.3'								
50											
1030											
60			<b>SANDSTONE</b> , gray, well cemented to very well cemented 1025.8'	▼ SPT TC	50/0.4" 50/0.8" 50/0.5"		15	0	0	NP	23.2
1020				▼ TC	50/0.4" 50/0.4"						
70				▼ TC	50/0.8"						

1 DURING AFTER CAVE IN WITH N60 18026 LOGS.GPJ DATA TEMPLATE.GDT 7/19/18

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**CLIENT** SRB **PROJECT NAME** SH 29 Bridge over Black Bear Creek  
**PROJECT NUMBER** 18026 **PROJECT LOCATION** Stephens County, Oklahoma

ELEVATION (ft)	DEPTH (ft)	GRAPHIC LOG	MATERIAL DESCRIPTION	SAMPLE TYPE	BLOW COUNTS N	BLOW COUNTS N60	MOISTURE CONTENT (%)	ATTERBERG LIMITS			PASSING #200 SIEVE (%)
								LIQUID LIMIT	PLASTIC LIMIT	PLASTICITY INDEX	
1010			<b>SANDSTONE</b> gray, well cemented to very well cemented (continued) 1025.8'	▼ TC	50/0.5"						
					50/0.8"						
					50/0.4"						
80				▼ TC	50/0.4"						
					50/0.3"						
1000				▼ TC	50/0.4"						
					50/0.4"						
90			Boring Termination Depth = 90 feet Boring Completed on 5/30/18 and Grouted on 6/9/18 995.3'	▼ TC	50/0.3"						
					50/0.3"						
990											
980											
970											
960											
950											
940											

<b>CLIENT</b> SRB	<b>PROJECT NAME</b> SH 29 Bridge over Black Bear Creek
<b>PROJECT NUMBER</b> 18026	<b>PROJECT LOCATION</b> Stephens County, Oklahoma
<b>DATE STARTED</b> 6/5/18 <b>COMPLETED</b> 6/5/18	<b>GROUND ELEVATION</b> 1083.4 ft <b>STATION</b> 748+40 <b>OFFSET</b> 45' LT
<b>DRILLING CONTRACTOR</b> DSO - Drilling Services of Oklahoma	<b>GROUND WATER LEVELS:</b>
<b>DRILLING METHOD</b> wet rotary - CME 750 ATV	<b>DURING DRILLING</b> ---
<b>LOGGED BY</b> SAH <b>CHECKED BY</b> JWB	<b>▼ 24 hrs AFTER DRILLING</b> 8.0 ft / Elev 1075.4 ft
<b>NOTES</b> 29657(04)	<b>Cave In Depth</b> ---

ELEVATION (ft)	DEPTH (ft)	GRAPHIC LOG	MATERIAL DESCRIPTION	SAMPLE TYPE	BLOW COUNTS N	BLOW COUNTS N60	MOISTURE CONTENT (%)	ATTERBERG LIMITS			PASSING #200 SIEVE (%)
								LIQUID LIMIT	PLASTIC LIMIT	PLASTICITY INDEX	
0											
1080			<u>SILTY SAND</u> , brown 1083.4'								
			<u>LEAN CLAY with SAND</u> , brown 1078.4'								
1070			<u>SILTY SAND</u> , brown 1070.9'								
			<u>SANDY LEAN CLAY</u> , brown 1061.4'								
1050			<u>SILTY, CLAYEY SAND</u> , brown 1051.4'								
			<u>SILTY SAND with GRAVEL</u> , reddish brown and brown 1036.4'								
1030			<u>SILTY SAND with GRAVEL</u> , reddish brown and brown 1028.4'								
1020			<u>SANDSTONE</u> , gray, poorly cemented to very well cemented 1024.4'	▼ SPT TC	50/5" 50/1" 50/0.4"		18	0	0	NP	21.7
				▼ TC	50/1" 50/0.4"						
				▼ TC	50/0.8" 50/0.5"						

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CLIENT SRB

PROJECT NAME SH 29 Bridge over Black Bear Creek

PROJECT NUMBER 18026

PROJECT LOCATION Stephens County, Oklahoma

ELEVATION (ft)	DEPTH (ft)	GRAPHIC LOG	MATERIAL DESCRIPTION	SAMPLE TYPE	BLOW COUNTS N	BLOW COUNTS N60	MOISTURE CONTENT (%)	ATTERBERG LIMITS			PASSING #200 SIEVE (%)
								LIQUID LIMIT	PLASTIC LIMIT	PLASTICITY INDEX	
1010			<b>SANDSTONE</b> , gray, poorly cemented to very well cemented 1024.4'								
			(continued)	▼ TC	50/0.8"						
					50/0.4"						
80				▼ TC	50/1"						
					50/0.6"						
1000				▼ TC	50/0.8"						
					50/0.5"						
90				▼ TC	50/0.8"						
					50/0.4"						
990				▼ TC	50/1"						
					50/0.4"						
100			Boring Termination Depth = 99.5 feet Boring Completed on 6/5/18 and Grouted on 6/9/18 983.9'	▼ TC	50/0.5"						
					50/0.4"						
980											
970											
960											
950											
940											
930											

<b>CLIENT</b> SRB	<b>PROJECT NAME</b> SH 29 Bridge over Black Bear Creek
<b>PROJECT NUMBER</b> 18026	<b>PROJECT LOCATION</b> Stephens County, Oklahoma
<b>DATE STARTED</b> 6/5/18 <b>COMPLETED</b> 6/6/18	<b>GROUND ELEVATION</b> 1084 ft <b>STATION</b> 749+15 <b>OFFSET</b> 30' LT
<b>DRILLING CONTRACTOR</b> DSO - Drilling Services of Oklahoma	<b>GROUND WATER LEVELS:</b>
<b>DRILLING METHOD</b> wet rotary - CME 750 ATV	<b>DURING DRILLING</b> ---
<b>LOGGED BY</b> SAH <b>CHECKED BY</b> JWB	<b>0 hrs AFTER DRILLING</b> 2.5 ft / Elev 1081.5 ft
<b>NOTES</b> 29657(04)	<b>Cave In Depth</b> ---

ELEVATION (ft)	DEPTH (ft)	GRAPHIC LOG	MATERIAL DESCRIPTION		SAMPLE TYPE	BLOW COUNTS N	BLOW COUNTS N60	MOISTURE CONTENT (%)	ATTERBERG LIMITS			PASSING #200 SIEVE (%)
0									LIQUID LIMIT	PLASTIC LIMIT	PLASTICITY INDEX	
			<u>SANDY SILT</u> , brown, loose	1084'	⊗ SPT	7	9	13	0	0	NP	61.9
1080												
			<u>LEAN CLAY with SAND</u> , brown, soft to stiff	1079'	⊗ SPT	2	3		0	0	NP	
10												
					▼ TC	1						
1070					⊗ SPT	9	12	23	28	13	15	70.3
					▼ TC	10						
			<u>SANDY SILTY CLAY</u> , brown, medium stiff	1067'	⊗ SPT	7	9	26	22	15	7	68.9
20					▼ TC	3						
1060			<u>LEAN CLAY</u> , brown, soft	1062'	⊗ SPT	4	5	26	30	14	16	88.0
					▼ TC	5						
			<u>LEAN CLAY with SAND</u> , brown, soft	1057'	⊗ SPT	3	4	23	24	13	11	70.1
30												
			<u>SANDY LEAN CLAY</u> , brown, medium stiff	1054'	⊗ SPT	6	8	19	27	11	16	67.4
1050												
					▼ TC	14						
			<u>LEAN CLAY with SAND</u> , brown and light gray, medium stiff to stiff	1047'	⊗ SPT	8	11	21	36	13	23	81.5
40					▼ TC	10						
1040					⊗ SPT	9	12	20	27	16	11	78.7
			<u>SILTY SAND</u> , brown, medium dense	1039'	⊗ SPT	11	15	21	0	0	NP	42.0
50												
					⊗ SPT	15	20	21	0	0	NP	12.1
1030												
					⊗ SPT	27	36	22	0	0	NP	32.0
60												
			<u>SANDSTONE</u> , gray, well cemented to very well cemented	1025'	▼ SPT	50/3.5" 50/0.4" 50/1"						
1020					▼ TC	50/0.6" 50/0.4"						
					▼ TC	50/0.8" 50/0.4"						
70												

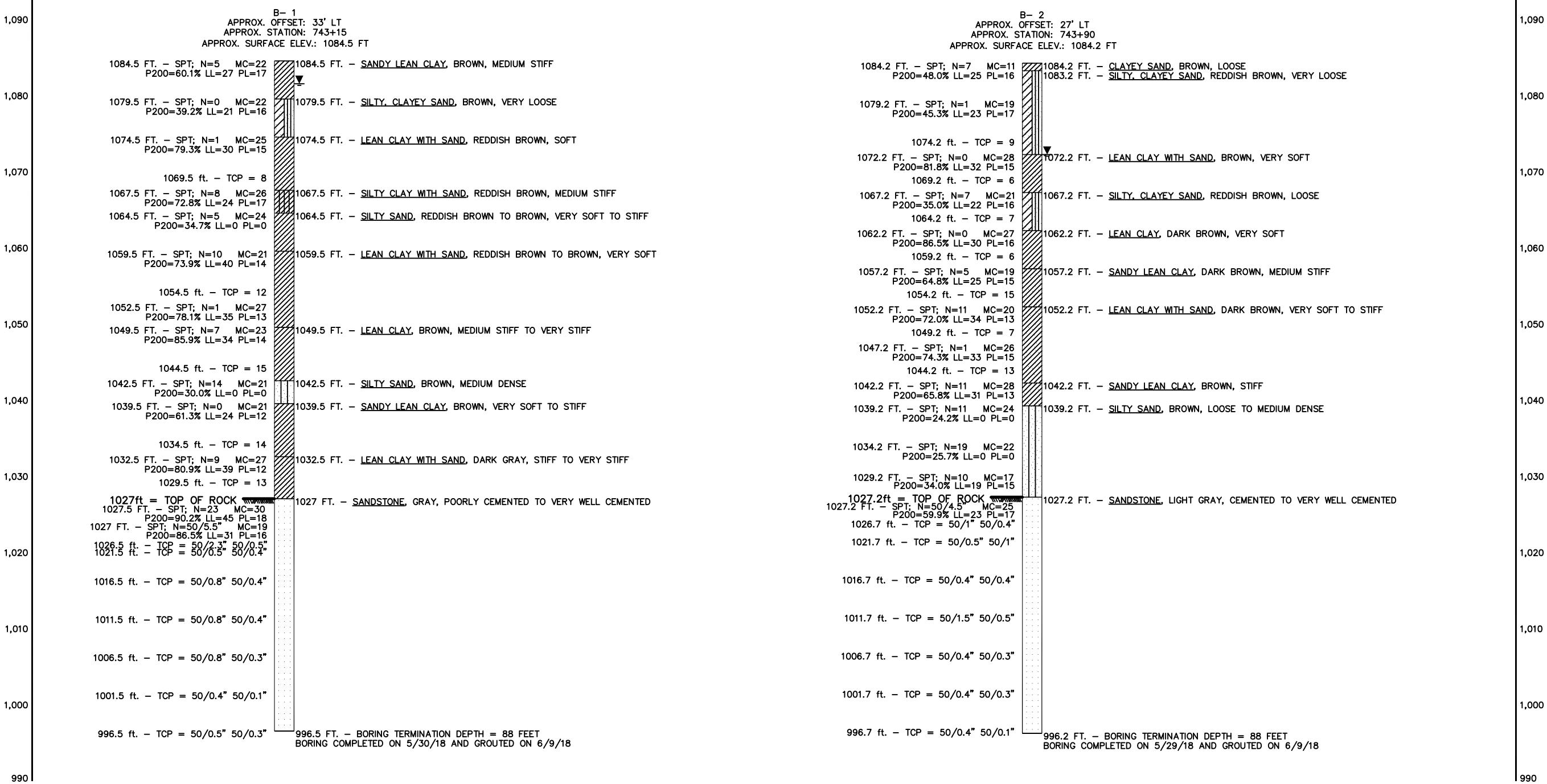
1 DURING AFTER CAVE IN WITH N60 18026 LOGS.GPJ DATA TEMPLATE.GDT 7/19/18

(Continued Next Page)

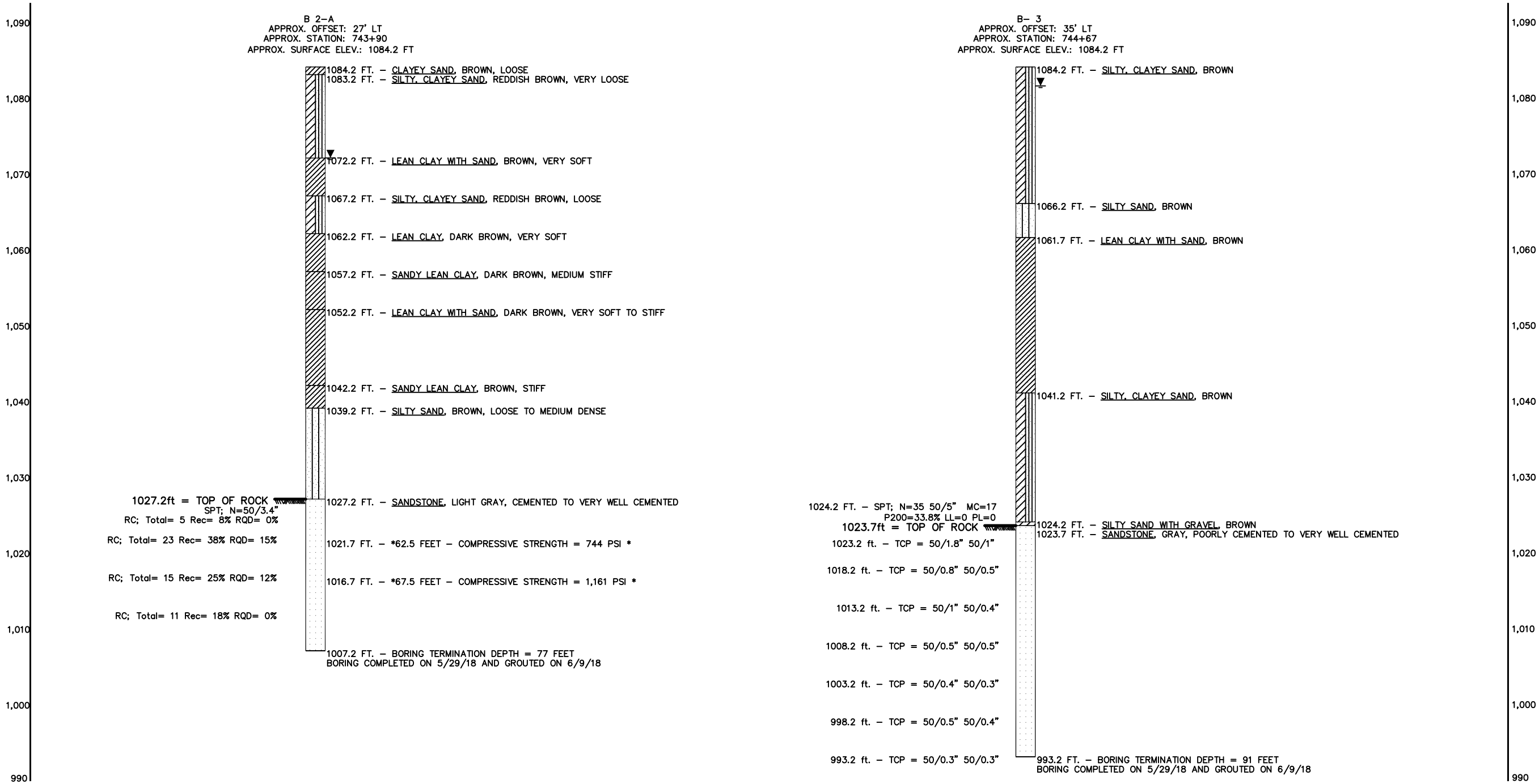
**CLIENT** SRB **PROJECT NAME** SH 29 Bridge over Black Bear Creek  
**PROJECT NUMBER** 18026 **PROJECT LOCATION** Stephens County, Oklahoma

ELEVATION (ft)	DEPTH (ft)	GRAPHIC LOG	MATERIAL DESCRIPTION	SAMPLE TYPE	BLOW COUNTS N	BLOW COUNTS N60	MOISTURE CONTENT (%)	ATTERBERG LIMITS			PASSING #200 SIEVE (%)
								LIQUID LIMIT	PLASTIC LIMIT	PLASTICITY INDEX	
1010			<u>SANDSTONE</u> gray, well cemented to very well cemented (continued)	1025'	▼ TC	50/0.5" 50/0.4"					
80					▼ TC	50/0.5" 50/0.3"					
1000					▼ TC	50/0.5" 50/0.4"					
90			Boring Termination Depth = 89.5 feet Boring Completed on 6/6/18 and Grouted on 6/9/18	994.5'	▼ TC	50/0.4" 50/0.3"					
990											
980											
970											
960											
950											
940											
930											

REVISIONS		
REV. NO.	DESCRIPTION	DATE



REVISIONS		
REV. NO.	DESCRIPTION	DATE



**SITE GEOLOGY**  
ODOT PUBLICATION

The ODOT publication Indicates the project site is underlain by the El Reno Unit (Per).

The El Reno unit consists of a heterogeneous mixture of sandstones, shale, siltstone, and siltstone conglomerate. In northeastern Stephens County, the lowermost 40 to 100 feet of the unit consists dominantly of sandstones which are coarse-grained, nearly white to buff, and moderately soft; but a few hard massive sandstone beds up to six feet thick occur near the base of the unit. Northward, across Grady County, the sandstones of this lower section become red, progressively finer grained, and moderately hard to hard.

The upper portion of the unit is known as "The Purple Series" in Stephens and Grady Counties. Here, some 80 feet of soft purple sandstone, 50 feet of soft pink sandstones, and 50 feet of moderately soft purple mudstone conglomerate are present in descending order. Westward, in Comanche and southern Caddo counties, the sandstones grade into red shales with minor amounts of gypsum and siltstones. Locally, in southeastern Grady County, near Cox City, a few sandstone beds in the upper portion are hard, limy, and occur in beds up to seven feet thick.

The unit thickens northward from 420 feet in Stephens County to 460 feet in Western Caddo County to 660 feet in northern Grady County.

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USGS MAP

According to the USGS geologic map, the project site is underlain by the Duncan Sandstone Member (Pd) of the El Reno Group.

Sandstone, white to buff, fine- to coarse-grained, moderately indurated, with interbedded mudstone conglomerates and siltstones; thickness, 100 to 400 feet, decreasing southeastward. Yields small to moderate amounts of water of fair quality.

**LEGEND**

- SPT DENOTES STANDARD PENETRATION TEST, ASTM D1586
- N DENOTES NUMBER OF BLOW COUNTS PER 12 INCHES
- TCP DENOTES TEXAS CONE PENETRATION TESTS
- REC DENOTES RECOVERY IN ROCK CORING
- RQD DENOTES ROCK QUALITY DESIGNATION
- MC DENOTES MOISTURE CONTENT TESTS
- P200 DENOTES PERCENT PASSING NO 200 SIEVE
- LL DENOTES LIQUID LIMIT TESTS (NV=NO VALUE)
- PL DENOTES PLASTIC LIMIT TESTS (NP=NO PLASTICITY)
- ▽ DENOTES WATER ELEVATION IMMEDIATELY AFTER DRILLING
- ▽ DENOTES WATER ELEVATION HOURS AFTER DRILLING
- DENOTES TOP OF ROCK

- \* NOTE: WATER ELEVATIONS SHOWN WERE OBTAINED AT THE TIME BORINGS WERE DRILLED AND MAY FLUCTUATE THROUGHOUT THE YEAR.
- \*\* NOTE: TOP OF ROCK LINE SHOWN FOR ESTIMATING PURPOSE ONLY
- \*\*\* NOTE: ROCK CLASSIFICATION IS BASED ON DRILLING CHARACTERISTICS AND VISUAL OBSERVATION. PTEROGRAPHIC ANALYSIS OF THIN SECTIONS OF THE ROCK CORE SAMPLES MAY REVEAL OTHER TYPES.

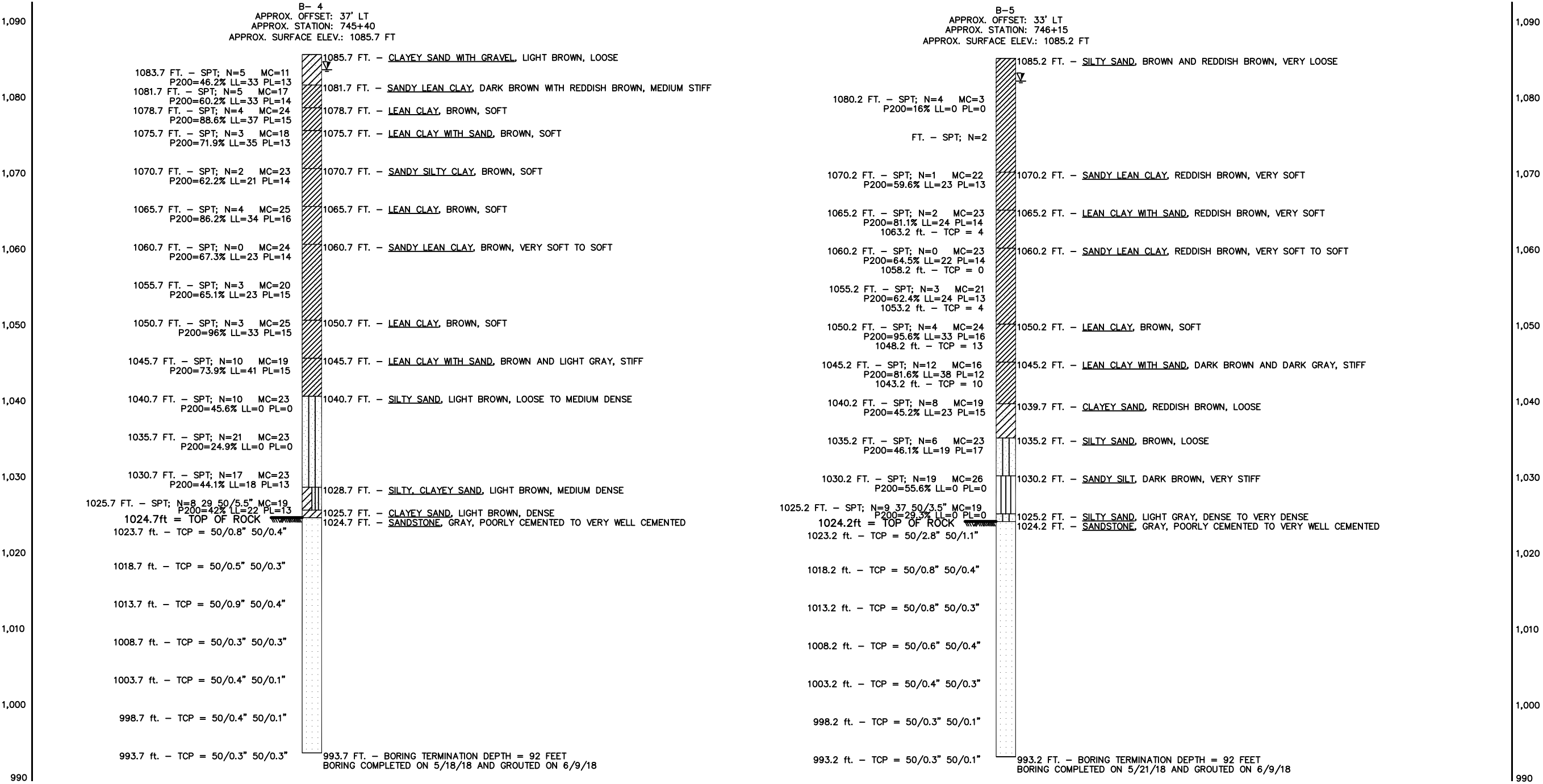
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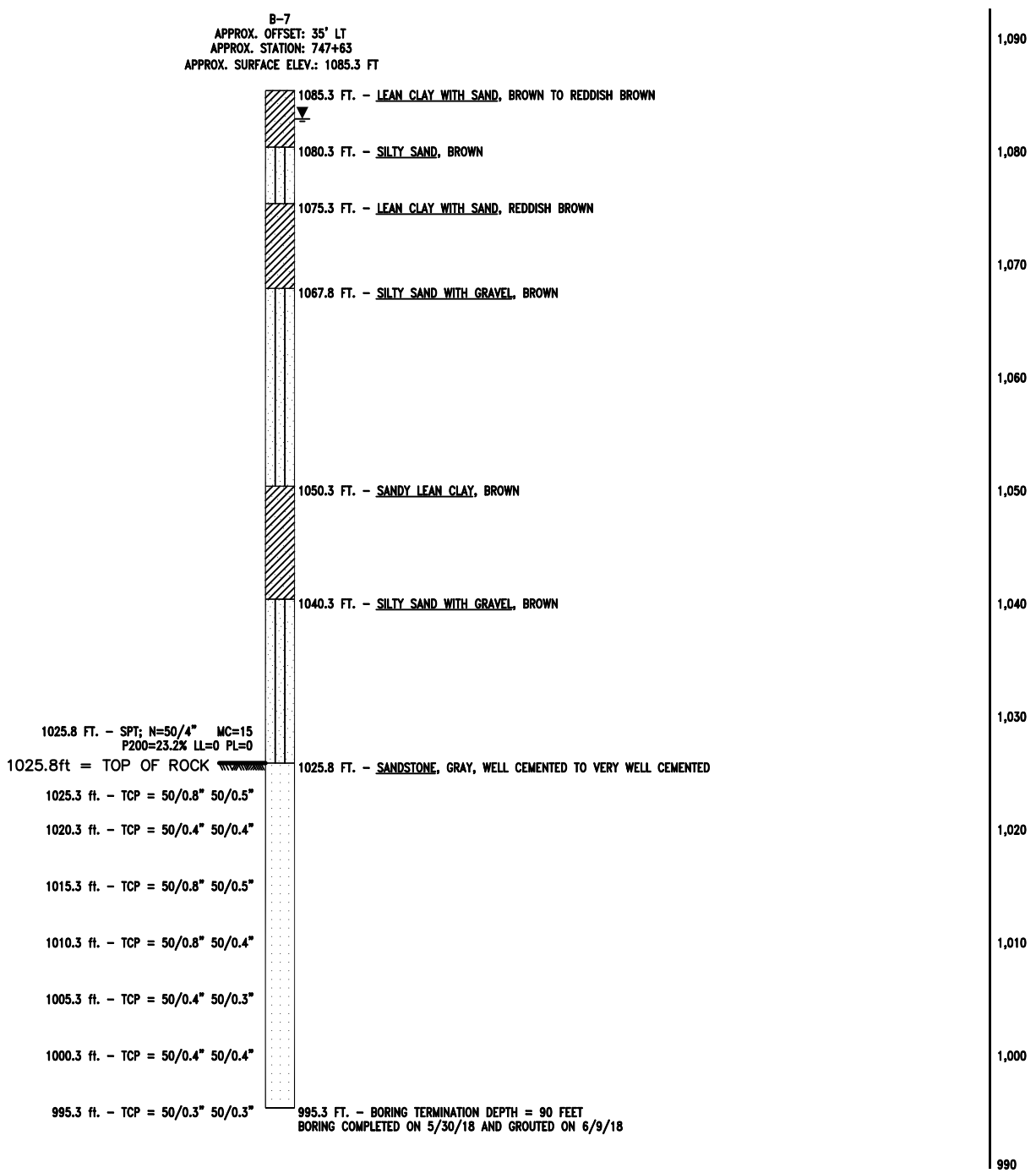
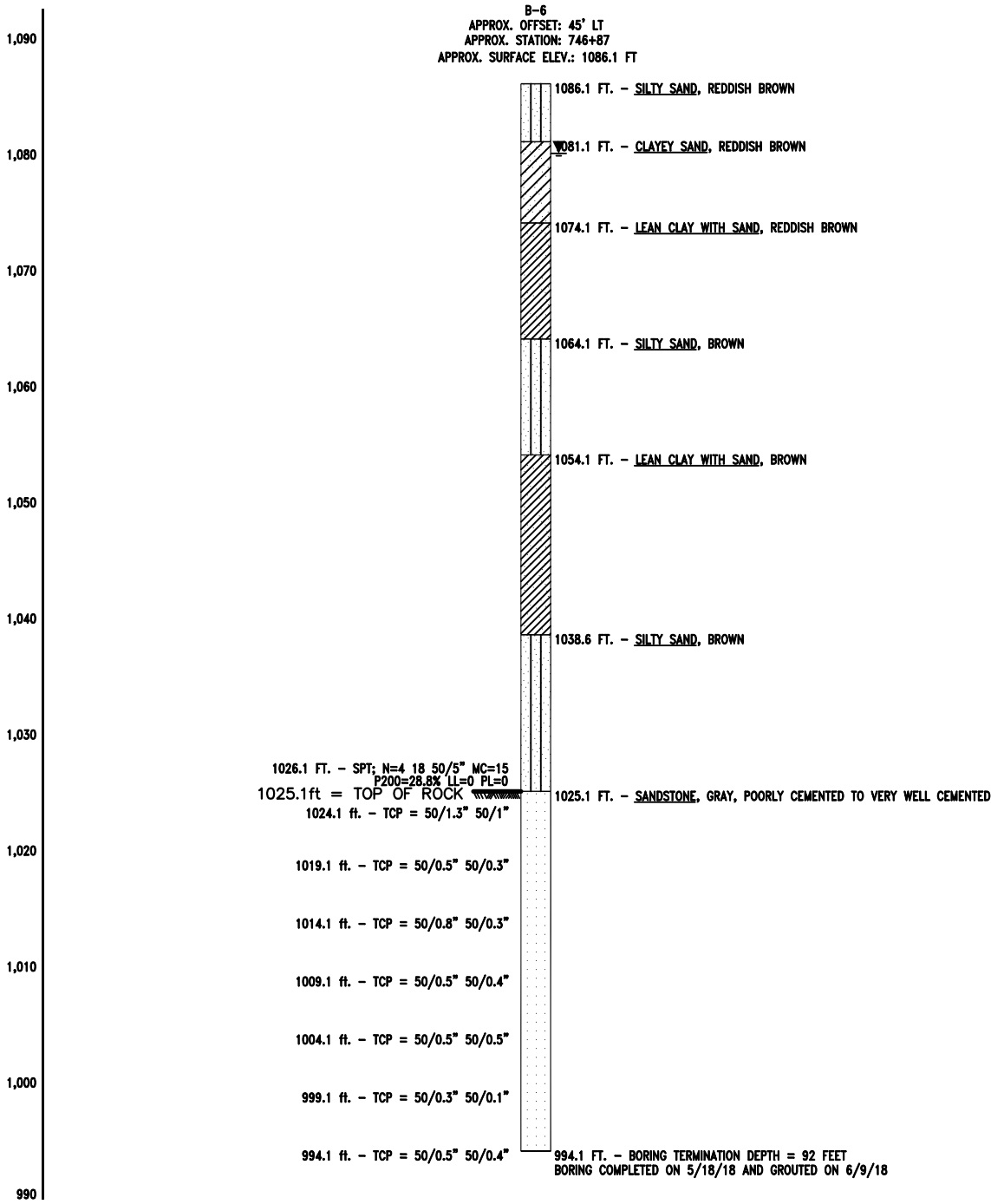
**RED ROCK CONSULTING**

SH 29 Bridge over Black Bear Creek		Stephens County, Oklahoma		Design	DMB	7/19
SUBSURFACE PROFILE SHEET 2 OF 5				Detail	DMB	7/19
				Check	DMB	7/19
				Squad:		
				Engr.:		
STATE OF OKLAHOMA		DEPARTMENT OF TRANSPORTATION				
JOB PIECE NO. 29657(04)				SHEET NO.		

REVISIONS		
REV. NO.	DESCRIPTION	DATE



REVISIONS		
REV. NO.	DESCRIPTION	DATE



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RED ROCK  
CONSULTING

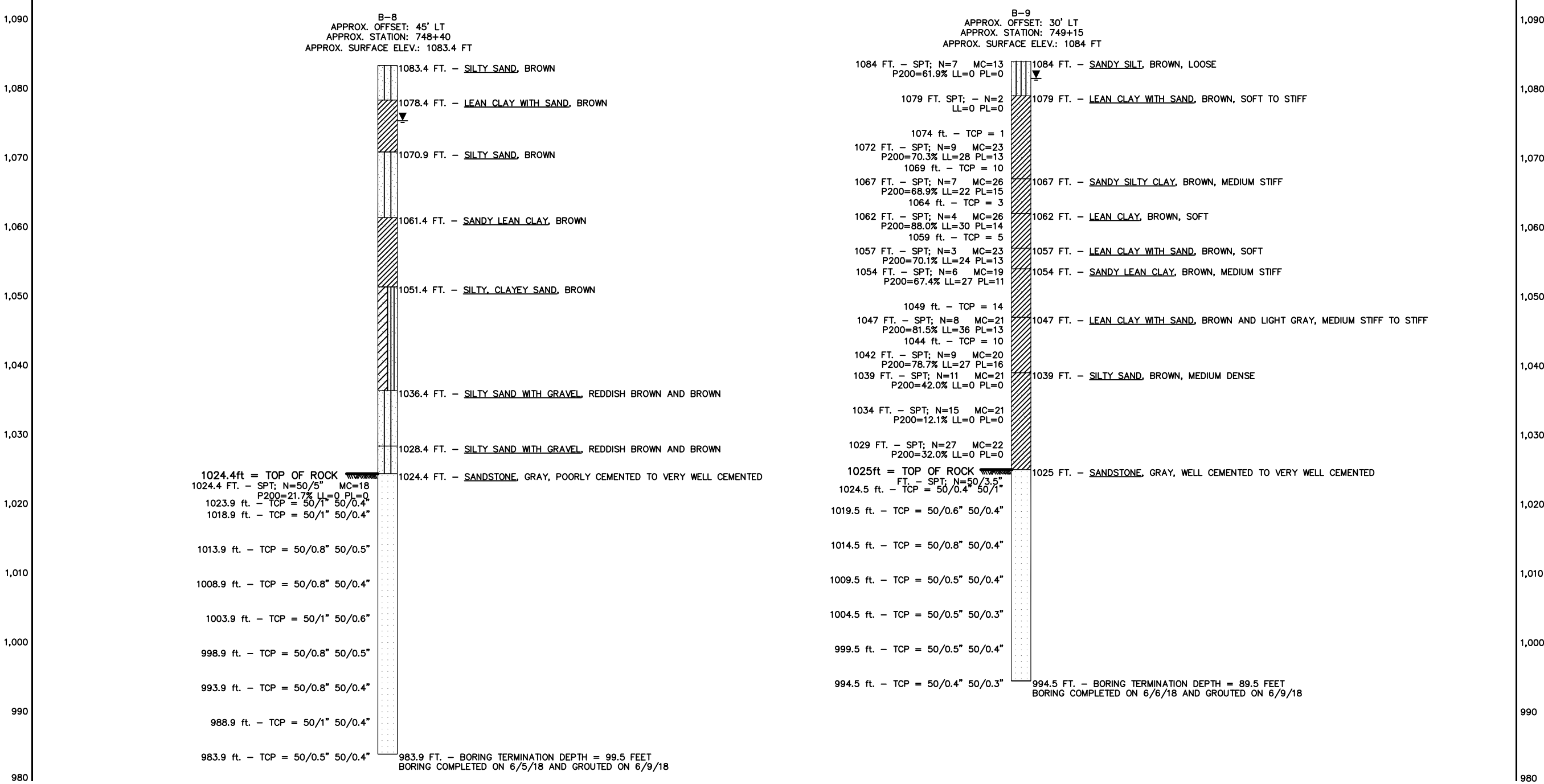
SH 29 Bridge over Stephens County, Oklahoma  
Black Bear Creek

SUBSURFACE PROFILE  
SHEET 4 OF 5

STATE OF OKLAHOMA	DEPARTMENT OF TRANSPORTATION
JOB PIECE NO. 29657(04)	SHEET NO.

Design	DMB	7/19
Detail	DMB	7/19
Check	DMB	7/19
Squad Engr.		

REVISIONS		
REV. NO.	DESCRIPTION	DATE



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**RED ROCK CONSULTING**

SH 29 Bridge over Black Bear Creek		Stephens County, Oklahoma		Design	DMB	7/19
				Detail	DMB	7/19
				Check	DMB	7/19
				Squad Engr.		
STATE OF OKLAHOMA		DEPARTMENT OF TRANSPORTATION				
		JOB PIECE NO. 29657(04)				SHEET NO.

## **APPENDIX B**



PO Box 30591  
Edmond, OK 73003  
405-562-3328

## SUMMARY OF LABORATORY RESULTS

Project No: 18026

Project Name: SH 29 Bridge over Black Bear Creek

CLIENT: SRB

Borehole	Depth (ft)	% Moist.	Liquid Limit	Plastic Limit	Plastic Index	-3" Sieve	-3/4" Sieve	-1/2" Sieve	-4 Sieve	-10 Sieve	-40 Sieve	-200 Sieve
B-1	0	21.5	27	17	10	100	100	100	100	100	99	60.1
B-1	5	22.1	21	16	5	100	100	100	100	100	98	39.2
B-1	10	24.5	30	15	15	100	100	100	100	99	97	79.3
B-1	17	25.8	24	17	7	100	100	100	100	98	96	72.8
B-1	20	24.3	NV	NP	NP	100	100	100	99	98	97	34.7
B-1	25	20.8	40	14	26	100	100	100	100	100	99	73.9
B-1	32	26.9	35	13	22	100	100	100	100	100	99	78.1
B-1	35	22.8	34	14	20	100	100	100	99	98	97	85.9
B-1	42	20.8	NV	NP	NP	100	100	100	100	100	99	30.0
B-1	45	21.2	24	12	12	100	100	100	100	100	98	61.3
B-1	52	26.9	39	12	27	100	100	100	100	99	99	80.9
B-1	57	29.7	45	18	27	100	100	100	100	100	100	90.2
B-1	57.5	18.8	31	16	15	100	100	100	100	100	99	86.5
B-2	0	10.6	25	16	9	100	100	100	99	98	96	48.0
B-2	5	18.7	23	17	6	100	100	100	100	100	100	45.3
B-2	12	28.2	32	15	17	100	100	100	100	99	96	81.8
B-2	17	20.9	22	16	6	100	100	100	100	100	100	35.0
B-2	22	26.9	30	16	14	100	100	100	100	100	100	86.5
B-2	27	19.3	25	15	10	100	100	100	100	100	98	64.8
B-2	32	19.5	34	13	21	100	100	100	100	100	99	72.0
B-2	37	26.0	33	15	18	100	100	100	100	99	95	74.3
B-2	42	28.2	31	13	18	100	100	100	99	99	97	65.8
B-2	45	23.7	NV	NP	NP	100	100	100	100	100	95	24.2
B-2	50	21.9	NV	NP	NP	100	100	100	100	98	95	25.7
B-2	55	17.2	19	15	4	100	100	100	91	82	67	34.0
B-2	57	24.6	23	17	6	100	100	100	98	93	79	59.9
B-3	60	16.5	NV	NP	NP	100	100	96	81	76	73	33.8
B-4	2	10.7	33	13	20	100	88	83	70	66	63	46.2
B-4	4	16.6	33	14	19	100	100	100	97	95	93	60.2
B-4	7	23.6	37	15	22	100	100	100	100	100	99	88.6
B-4	10	17.5	35	13	22	100	100	100	98	96	93	71.9
B-4	15	23.2	21	14	7	100	100	100	100	100	97	62.2
B-4	20	25.1	34	16	18	100	100	100	100	100	97	86.2
B-4	25	24.0	23	14	9	100	100	100	100	100	98	67.3
B-4	30	20.2	23	15	8	100	100	100	100	100	97	65.1
B-4	35	25.2	33	15	18	100	100	100	100	99	98	96.0
B-4	40	19.2	41	15	26	100	100	100	100	99	98	73.9
B-4	45	23.2	NV	NP	NP	100	100	100	96	95	94	45.6
B-4	50	23.0	NV	NP	NP	100	100	100	100	100	100	24.9



PO Box 30591  
Edmond, OK 73003  
405-562-3328

SUMMARY OF LABORATORY RESULTS

Project No: 18026

Project Name: SH 29 Bridge over Black Bear Creek  
CLIENT: SRB

Borehole	Depth (ft)	% Moist.	Liquid Limit	Plastic Limit	Plastic Index	-3" Sieve	-3/4" Sieve	-1/2" Sieve	-4 Sieve	-10 Sieve	-40 Sieve	-200 Sieve
B-4	55	23.0	18	13	5	100	100	100	99	98	80	44.1
B-4	60	19.4	22	13	9	100	100	92	89	88	84	42.0
B-5	5	3.3	NV	NP	NP	100	74	65	45	36	29	15.8
B-5	15	22.1	23	13	10	100	100	100	100	100	98	59.6
B-5	20	23.2	24	14	10	100	100	100	100	98	95	81.1
B-5	25	23.1	22	14	8	100	100	100	100	100	99	64.5
B-5	30	20.6	24	13	11	100	100	100	100	100	97	62.4
B-5	35	24.3	33	16	17	100	100	100	100	98	97	95.6
B-5	40	16.0	38	12	26	100	100	100	100	100	99	81.6
B-5	45	19.4	23	15	8	100	100	100	100	99	99	45.2
B-5	50	22.5	19	17	2	100	100	100	100	100	99	46.1
B-5	55	26.4	NV	NP	NP	100	100	100	95	93	88	55.6
B-5	60	18.9	NV	NP	NP	100	100	100	99	98	95	29.3
B-6	60	14.7	NV	NP	NP	100	100	100	87	80	73	28.8
B-7	59.5	15.1	NV	NP	NP	100	100	100	77	65	48	23.2
B-8	59	18.3	NV	NP	NP	100	100	96	83	74	63	21.7
B-9	0	13.2	NV	NP	NP	100	100	100	100	100	100	61.9
B-9	5		NV	NP	NP							
B-9	12	22.8	28	13	15	100	100	100	100	98	95	70.3
B-9	17	26.4	22	15	7	100	100	100	97	96	93	68.9
B-9	22	25.6	30	14	16	100	100	100	100	100	99	88.0
B-9	27	22.5	24	13	11	100	100	100	100	100	98	70.1
B-9	30	19.2	27	11	16	100	100	100	100	100	98	67.4
B-9	37	21.1	36	13	23	100	100	100	100	100	97	81.5
B-9	42	20.4	27	16	11	100	100	100	98	96	95	78.7
B-9	45	21.4	NV	NP	NP	100	100	100	100	100	100	42.0
B-9	50	21.4	NV	NP	NP	100	100	100	100	100	98	12.1
B-9	55	21.8	NV	NP	NP	100	100	100	98	96	88	32.0

# SUMMARY OF UNIAXIAL COMPRESSIVE STRENGTH TEST RESULTS



PO Box 30591  
Edmond, OK 73003  
405-562-3328

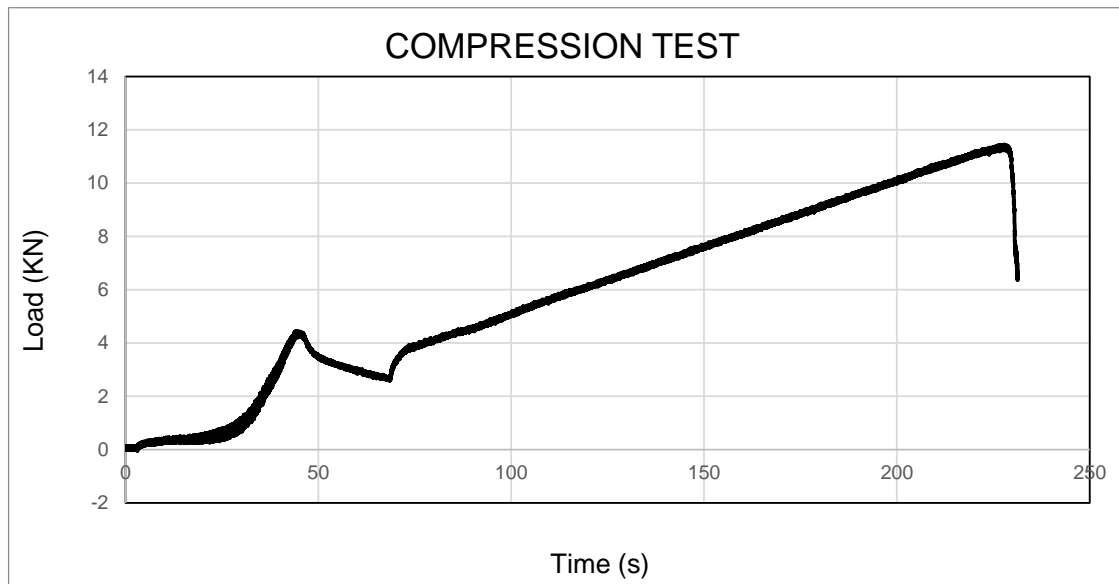
RRC PROJECT NO 18026



PROJECT NAME SH 29 Bridge over Black Bear Creek  
CLIENT SRB

Boring	Depth	Length	Diameter	L/D	Moisture	Unit Weight	Loading Rate	Un Comp Strength	Un Comp Strength	Correction Factor Applied	Straight	Flat	Perpend
	(ft)	(in)	(in)		%	(pcf)	(KN/sec)	(Mpa)	(psi)		Pass / Fail		
B2-A	62.5	3.96	2.1	2	1.4%	135.7	0.05	5.1	744	1	Pass	Pass	Pass
	67.5	4	1.97	2	1.1%	150.0	0.01	8.0	1,161	1	Pass	Pass	Pass

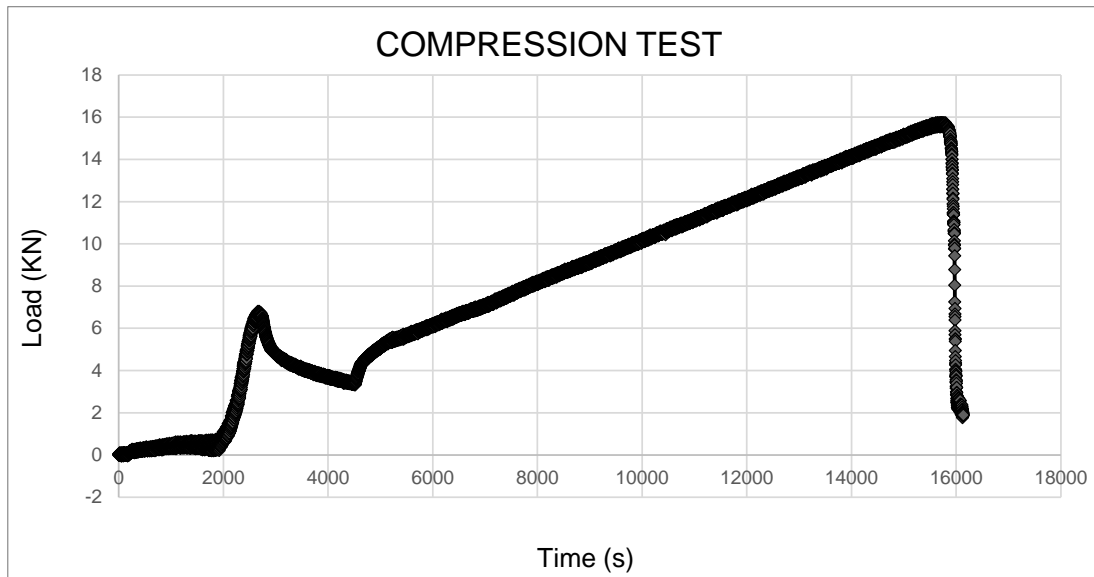
# UC Compressive Strength

## ASTM D 7012 Method C



<b>Compressive Strength = 744 psi</b>		<b>Photo After Test</b>	
<b>Test Conditions</b>  Procedure S1 - Side Staightness = Pass Procedure FP2 - Flatness = Pass Procedure P2 - Perpendicularity = Pass Load Direction = Verical Loading Rate = 0.05 KN/sec Time of Failure = 231 seconds Temperature at Testing = 25 °C			
<b>ASTM Tolerance Limits</b> Prcedures: S1, FP2, P2 Side Tolerance (Straightness): Not to exceed 0.020 inch Perpendicularity Deviation: Not to exceed 0.250° Deviation from Flatness: Not to exceed 0.001 inch Parallelism Deviation: Not to exceed 0.25°			
<b>Equipment Used</b> Cut Saw - Chicago Electric 46225 Caliper - General No. 143 Feeler Gauge Compression Machine - Humboldt 1348			
<b>SAMPLE DATA</b>		<b>PROJECT INFORMATION</b>	
SAMPLE LOCATION:	B2-A at 62.5 feet	PROJECT:	SH 29 Bridge over Black Bear Creek
SAMPLE DESCRIPTION:	Gray Sandstone	LOCATION:	Stephens County, OK
MOISTURE CONTENT:	1.4%	PROJECT NO.:	18026
UNIT WEIGHT (PCF):	135.7	CLIENT:	SRB
DIAMETER (IN):	2.1	TESTED BY:	SAH
LENGTH (IN):	3.96	DATE:	7/19/2018
L/D RATIO:	2		

# UC Compressive Strength ASTM D 7012 Method C



**Compressive Strength = 1,161 psi**

**Photo After Test**

## Test Conditions

Procedure S1 - Side Straightness = Pass  
 Procedure FP2 - Flatness = Pass  
 Procedure P2 - Perpendicularity = Pass  
 Load Direction = Vertical  
 Loading Rate = 0.1 KN/sec  
 Time of Failure = 161 seconds  
 Temperature at Testing = 25 °C

## ASTM Tolerance Limits

Procedures: S1, FP2, P2  
 Side Tolerance (Straightness): Not to exceed 0.020 inch  
 Perpendicularity Deviation: Not to exceed 0.250°  
 Deviation from Flatness: Not to exceed 0.001 inch  
 Parallelism Deviation: Not to exceed 0.25°

## Equipment Used

Cut Saw - Chicago Electric 46225  
 Caliper - General No. 143  
 Feeler Gauge  
 Compression Machine - Humboldt 1348



## SAMPLE DATA

SAMPLE LOCATION: B2-A at 67.5 feet  
 SAMPLE DESCRIPTION: Gray Sandstone  
 MOISTURE CONTENT: 1.1%  
 UNIT WEIGHT (PCF): 150.0  
 DIAMETER (IN): 1.97  
 LENGTH (IN): 4  
 L/D RATIO: 2

## PROJECT INFORMATION

PROJECT: SH 29 Bridge over Black Bear Creek  
 LOCATION: Stephens County, OK  
 PROJECT NO.: 18026  
 CLIENT: SRB  
 TESTED BY: SAH  
 DATE: 7/19/2018

**RED ROCK  
CONSULTING**

## **APPENDIX C**

Rock Core Photographs



**Photo # 1** Run 1 of boring B2-A was from 57 to 62 feet. Run 1 had a recovery of 8% and a RQD 0%.



**Photo # 2** Run 2 of boring B2-A was from 62 to 67 feet. Run 2 had a recovery of 38% and a RQD of 15%.



**Photo # 3** Run 3 of boring B2-A was from 67 to 72 feet. Run 3 had a recovery of 25% and a RQD of 12%.

SH 29 Bridge over Black Bear Creek, Stephens County, OK  
29657(04)  
RRC Project No. 18026  
July 19, 2018

**RED ROCK**  
**CONSULTING**

### Rock Core Photographs



**Photo # 4** Run 4 of boring B2-A was from 72 to 77 feet. Run 4 had a recovery of 18% and a RQD of 0%.

## **APPENDIX D**

## GENERAL NOTES

### SOIL PROPERTY ABBREVIATIONS

N	Uncorrected SPT Penetration, blows per foot
N <sub>60</sub>	Corrected SPT Penetration, blows per foot
Q <sub>u</sub>	Unconfined Compressive Strength, psf
Mc	Moisture Content, %
LL	Liquid Limit, %
PL	Plastic Limit, %
PI	Plasticity Index, %

### DRILLING & SAMPLING ABBREVIATIONS

BS	Bag Sample
SPT	Split Spoon Sample
ST	Shelby Tube Sample
AU	Auger Sample
TC	Texas Cone Penetrometer
DCP	Dynamic Cone Penetrometer

### UNIFIED SOIL CLASSIFICATION SYSTEM (ASTM D 2487)

-- used to classify all soils unless otherwise noted --

Major Divisions			Group Symbol	Typical Names
<b>Course-Grained Soils</b>  >50% retained on #200 sieve	<b>Gravels</b>  50% + of course fraction retained on #4 sieve	Clean Gravels	GW	Well-graded gravels and gravel-sand mixtures, little or no fines
			GP	Poorly graded gravels and gravel-sand mixtures, little or no fines
		Gravels with Fines	GM	Silty gravels, gravel-sand-silt mixtures
			GC	Clayey gravels, gravel-sand-clay mixtures
	<b>Sands</b>  50% + of course fraction passes #4 sieve	Clean Sands	SW	Well-graded sands and gravelly sands, little or no fines
			SP	Poorly graded sands and gravelly sands, little or no fines
		Sands with Fines	SM	Silty sands, sand-silt mixtures
			SC	Clayey sands, sand-clay mixtures
<b>Fine-Grained Soils</b>  <50% passes #200 sieve	<b>Silts and Clays</b>  Liquid Limit ≤ 50%		ML	Inorganic silts, very fine sands, rock four, silty or clayey fine sands
			CL	Inorganic clays of low to medium plasticity, gravelly/sandy/silty/lean clays
			OL	Organic silts and organic silty clays of low plasticity
	<b>Silts and Clays</b>  Liquid Limit > 50%		MH	Inorganic silts, micaceous or diatomaceous fine sands or silts, elastic silts
			CH	Inorganic clays or high plasticity, fat clays
			OH	Organic clays of medium to high plasticity
<b>Highly Organic Soils</b>			PT	Peat, muck, and other highly organic soils

**Prefix:** G = Gravel, S = Sand, M = Silt, C = Clay, O = Organic    **Suffix:** W = Well Graded, P = Poorly Graded, M = Silty, L = Clay, LL < 50%, H = Clay, LL > 50%

### PLASTICITY OF COHESIVE SOIL

Degree of Plasticity	Plasticity Index	Swell Potential
None	0 to 4	Very Low
Slight	5 to 9	Low
Medium	10 to 19	Low to Medium
High	20 to 39	Medium to High
Very High	40+	Very High

### CONSISTENCY - COHESIVE SOILS

Consistency	SPT
Very Soft	<2
Soft	2 to 4
Medium Stiff	5 to 8
Stiff	9 to 14
Very Stiff	15 to 30
Hard	31+

### ROCK HARDNESS

SPT (in/50)	TCP (in/100)	Rock Description
6+	6+	Very Soft / Very Poorly Cemented
5 - 6	3 - 6	Soft / Poorly Cemented
4 - 5	2 - 3	Moderately Hard / Cemented
3 - 4	1 - 2	Hard / Well Cemented
<3	<1	Very Hard / Very Well Cemented

### MOISTURE OF COHESIVE SOIL

Description	Condition	Moisture Content
Dry, Dusty	Dry	0 to 10%
Damp	Moist	10 to 30%
Free Water	Wet	30 to 70%

### DENSITY - COHESIONLESS SOILS

Relative Density	SPT
Very Loose	<4
Loose	4 to 10
Medium Dense	11 to 30
Dense	31 to 50
Very Dense	51+

### ROCK CORE QUALITY

Core Quality	RQD
Excellent Quality	90 – 100%
Good Quality	75 – 90%
Fair Quality	50 – 75%
Poor Quality	25 – 50%
Very Poor Quality	<25%