



Geotechnical Base Line Report (GBLR)
Route S-20-214 Bridge Replacement over Little Creek
Fairfield County, South Carolina
SCDOT Project ID P038062
S&ME Project No. 1361-20-048

PREPARED FOR:

**South Carolina Department of Transportation
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PREPARED BY:

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March 19, 2021



March 19, 2021

South Carolina Department of Transportation
955 Park Street
Columbia, South Carolina 29201

Attention: Mr. Trapp Harris, P.E.

Reference: **Closed and Load-Restricted Bridge Package 2021-1**
Geotechnical Base Line Report (GBLR)
Route S-20-214 Bridge Replacement over Little Creek
Fairfield County, South Carolina
SCDOT Project ID P038062
S&ME Project No. 1361-20-048

Dear Mr. Harris:

The purpose of this report is to convey geotechnical information to the South Carolina Department of Transportation (SCDOT) for use by a contractor and is typically used with traditional design-build projects. Our services were performed in general accordance with the *Scope of Services* provided in the *On-Call Consultant Work Order Request* by SCDOT, dated September 10, 2020, and the SCDOT *Geotechnical Design Manual (GDM)*, Version 2.0, dated January 2019.

S&ME appreciates this opportunity to work with you as your geotechnical engineering consultant on this project. Please contact us at (803) 561-9024 if you have any questions or need any additional information regarding this report.

Sincerely,

S&ME, Inc.

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Project Engineer

Robert C. Bruorton, P.E.
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Matthew F. Cooke, P.G., P.E.
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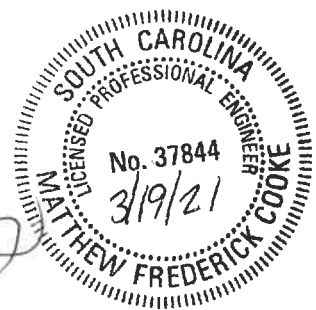




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1.0 Project Description

The proposed construction for this project includes replacement of the existing Two Creek Road (S-20-214) bridge over Little Creek located in Fairfield County, South Carolina as shown in the *Site Location Plan*, attached as Figure 1 in Appendix I.

Table 1-1 – Bridge Location Summary

Project ID	Route	Route Name	Crossing	County	Latitude	Longitude
P038062	S-20-214	Two Creek Road	Little Creek	Fairfield	34.54841	-81.18665

From our review of the provided information, the existing bridge was built in 1957 and is 56 feet in length with two travel lanes. The proposed replacement bridge will be 70 feet in length. Additional information regarding the proposed replacement bridge has not been provided at this time.

2.0 Objective

The objective of this project was to explore the subsurface conditions along the proposed alignment as they pertain to the proposed improvements, and in conjunction with field and laboratory testing, to provide geotechnical data to be utilized for project design.

3.0 Scope of Work

As requested, representatives of S&ME were present for on-site field activities between October 23 and 26, 2020, to conduct the following testing:

- Two (2) Standard Penetration Test (SPT) borings (B-1 and B-2), with one boring near each proposed abutment location.

Testing was conducted at or near the requested locations provided in the *Scope of Services*, provided by SCDOT, dated September 10, 2020. Testing locations were modified as necessary due to utilities, terrain, to minimize traffic control impacts, and to facilitate safe working conditions.

Additionally, laboratory testing was performed on disturbed split-spoon and rock core samples collected in the field. The laboratory testing program is described in more detail in the following sections.



4.0 Test Locations

Testing locations for the proposed new bridge abutments were determined by subtracting the existing bridge length from the proposed new bridge length, dividing that distance by two, and measuring that divided distance from the existing abutments. As-built survey of the testing locations was performed by Glenn Associates Surveying, Inc. The approximate testing locations are shown on the *Boring Location Plan*, included as Figure 2 in Appendix I. A summary of testing locations, including coordinates, elevation and alignment are presented in Table 1, *Test Location Summary*, in Appendix II. Surveyed coordinates are tabulated in decimal degree latitude and longitude as well as South Carolina State Plan northing and easting coordinates.

5.0 Exploration Procedures

The subsurface exploration for this project to date has included SPT borings. The following sections summarize the general outline of each test. The field testing data are organized into appendices of this report as follows:

- ◆ Appendix III – Soil Test Boring Records

5.1 Encroachment

S&ME contacted the Resident Maintenance Engineer for Fairfield County to coordinate the field testing and traffic control along the SCDOT right-of-way in lieu of applying for an encroachment permit.

5.2 Traffic Control

Traffic control for the project was provided by Area Wide Protective (AWP) under subcontract to S&ME. Traffic control was performed in accordance with SCDOT requirements for *Flagging Operations Two-Lane Two-Way Roadways without Intersections* – SCDOT Standard Drawing 610-005-10.

5.3 Standard Penetration Test (SPT) Borings

Two (2) soil test borings with SPT sampling were performed between the dates of October 23 and 26, 2020 using an ATV-mounted CME 550X drill rig. Soil test borings with SPT sampling were performed using mud rotary drilling techniques. The borings were performed to drill bit refusal, followed by wireline rock coring in Boring B-2 only to the termination depth. A summary of the SPT borings performed is provided in the table below:

Table 5-1 – Boring Summary

Route	Bridge ID	Boring No.	Refusal Depth (ft)	Total Boring Depth (ft)	Pavement	Purpose
S-20-214	2070021400100	B-1	77.6	77.6	Asphalt	Proposed Northwest Abutment
		B-2	70.3	80.3	Asphalt	Proposed Southeast Abutment



Soil sampling and penetration testing were performed in general accordance with ASTM D1586 *Standard Test Method for Penetration Test and Split Barrel Sampling of Soils*. SPT was performed in each boring continuously in the upper 10 feet, followed by approximate 5-foot centers, thereafter. The split-barrel sampler was opened at the drill site and sloughed material was identified and separated from the recovered sample. The recovered sample was visually described and classified by S&ME's rig engineer. A selected portion of the sample was placed in a glass jar with a moisture-proof lid. Where materials changed over the sample drive length, a sample of each material was retained. The sample jars were labeled, placed in cardboard boxes, and transported to the S&ME Columbia Office at the end of each workday.

5.3.1 Ground Water

Water level measurements were attempted immediately after completion of drilling and, where feasible, were repeated after a period of roughly 24 hours. We note that due to the use of drilling fluid additives in mud rotary borings, the water level readings recorded in the soil borings may not accurately reflect the ground water conditions at the site. Ground water readings were conducted in general accordance with ASTM D4750 *Standard Test Method for Determining Subsurface Liquid Levels in a Borehole or Monitoring Well (Observation Well)*. A summary of the measured ground water depths and rough elevations are provided in the table below:

Table 5-2 – Ground Water Measurement Summary

Boring No.	Existing Grade (ft.)	GW Depth at TOB (ft.)	GW Elevation at TOB (ft.)	24-hr GW Depth (ft.)	24-hr GW Elevation (ft.)
B-1	440.4	17.5	422.9	NM	-
B-2	438.5	NM	-	15.9	422.6

NM = Not Measured

After ground water measurements were complete, the borings were backfilled with bentonite chips, auger cuttings, or clean fill to within 20 feet of the existing ground surface then abandoned with Portland cement/bentonite grout. The surface pavements at each boring location were patched with commercially available bagged asphalt cold patch materials.

5.4 SPT Energy Measurements

SPT hammer energy measurements with a Pile Driving Analyzer (PDA) were performed by S&ME at an off-site location for the drill rig used on the project in general accordance with ASTM D4633 *Standard Test Method for Energy Measurement for Dynamic Penetrometers*. The SPT energy test results are summarized below and provided in Appendix VII. The N-values indicated on the soil test boring records are field values and were not corrected for overburden stress, rod length, borehole diameter or hammer efficiency.



Table 5-3 – S&ME Drilling Equipment Summary

Rig Make/Model	Serial No.	Carrier Type	Average SPT Energy Transfer Ratio (ETR), %
CME 550X	356573	ATV	83.9

5.5 Wireline Rock Coring

Upon encountering refusal at Boring B-2, wireline rock coring was performed to a termination depth of 80.3 feet below the existing ground surface to explore the refusal materials in general accordance with ASTM D2113 *Standard Practice for Rock Core Drilling and Sampling of Rock for Site Exploration*. Rock coring was performed using an NQ-size core barrel and wireline retrieval system. The recovered rock cores were visually logged by the S&ME rig geologist or engineer. The rock core samples were placed in cardboard core boxes and the boxes were labeled. Photographs were taken of each completed core box prior to any core being removed for laboratory testing. Completed core boxes were transported to the S&ME Columbia Office at the end of each workday. The rock cores were preserved, handled, and transported in general accordance with ASTM D5079.

6.0 Classification of Recovered Soil Samples

Recovered split-spoon samples were initially classified in general accordance with ASTM D2488 *Standard Practice for Description and Identification of Soils (Visual-Manual Method)*. After laboratory testing was completed, provisional field classifications were revised as necessary to provide a soil description that generally follows the terminology given by ASTM D2487 *Standard Practice for Classification of Soils for Engineering Purposes (Unified Soil Classification System)* and AASHTO M145 *Recommended Practice for Classification of Soils and Soil-Aggregate Mixtures for Highway Construction Purposes*.

Interpreted subsurface conditions encountered by the SPT borings are shown on the boring records in Appendix III. These records represent our interpretation of the subsurface conditions based on the test data. Stratification lines on the boring records represent approximate boundaries between soil types; however, the actual transition may be gradual, and the thicknesses of the strata will vary across the site. The soil samples will be retained at our laboratory for a period of seven years, or until completion of substructure installation, whichever is earlier.

7.0 Classification of Recovered Rock Samples

Recovered rock core samples were reviewed and classified in general accordance with the SCDOT GDM Chapter 6, Section 6.3. Upon return to our laboratory, the rock core samples were reviewed by a Professional Geologist (PG). Recovered cores examined in the laboratory were assigned descriptive terms using Tables 6-15 through 6-22 of the GDM where applicable to the rock type. Rock lithologic descriptions, and applicable descriptive information are included on the Soil Test Boring Records in Appendix III. Discontinuities in the recovered cores were evaluated using the terminology in GDM Tables 6-23 through 6-29. The results of the discontinuity examination are tabulated in the *Rock Core Discontinuity Worksheets* for each cored borehole, included in Appendix III. After logging, selected sections of rock core were removed and prepared for laboratory compressive strength testing.



After laboratory testing was completed, the Rock Mass Rating (RMR) and Geological Strength Index (GSI) were computed in general accordance with Sections 6.3.12 and 6.3.11, respectively, of the GDM. A summary of the rock core is provided in Table 4 *Rock Core – Laboratory Testing Summary*, in Appendix II.

Interpreted subsurface conditions encountered during rock coring activities are shown on the records in Appendix III. These records represent our interpretation of the subsurface conditions based on the test data. Stratification lines on the boring records represent approximate boundaries between rock types; however, the actual transition may be gradual, and the thicknesses of the strata will vary across the site. The rock samples will be retained at our laboratory for a period of seven years, or until completion of substructure installation, whichever is earlier.

8.0 Laboratory Physical Tests

Laboratory testing consisting of index property testing, and corrosion series testing was performed on selected split-spoon samples, while unconfined compressive strength testing was performed on selected rock core samples. The testing was performed in general accordance with ASTM, AASHTO, or SC state test procedures as follows:

- Atterberg limits – ASTM D4318 / AASHTO T89/90
- Particle-size distribution – ASTM D422 / ASTM D6913 / AASHTO T88
- Percent-finer 200 sieve – ASTM D1140 / AASHTO T11
- Natural moisture content – ASTM D2216 / AASHTO T265
- Corrosion Series:
 - pH – ASTM G51 / AASHTO T289
 - Chloride – AASHTO T291
 - Sulfate – ASTM C1580 / AASHTO T290
 - Resistivity – AASHTO T288
- Unconfined Compression – ASTM D7012

Tables summarizing the laboratory test results are provided in Appendix II as follows:

- Table 2: Split Spoon Samples – Laboratory Classification Results
- Table 3: Split Spoon Samples – Corrosion Series Testing Summary
- Table 4: Rock Core – Laboratory Testing Summary

The individual laboratory test data sheets are organized into appendices of this report as summarized below:

- Appendix IV: Laboratory Test Results – Split Spoon Samples
- Appendix V: Laboratory Test Data Sheets – Corrosion Series
- Appendix VI: Laboratory Test Data Sheets – Rock Cores



9.0 Subsurface Conditions

Assessment of the geotechnical conditions included review of available topographic, geologic and soils maps for relevant information.

9.1 Area Geology

The site is located within the Charlotte Terrane of the Piedmont Physiographic Province of South Carolina. The Piedmont Province generally consists of well-rounded hills and ridges, which are dissected by a well-developed system of draws and streams. The Piedmont Province is predominantly underlain by metamorphic rock (formed by heat, pressure and/or chemical action) and igneous rock (formed directly from molten material), which were initially formed during the Precambrian and Paleozoic eras. The volcanic and sedimentary rocks deposited in the Piedmont Province during the Precambrian eras were the host for the metamorphism and were changed to gneiss and schist. The more recent Paleozoic era had periods of igneous emplacement, with at least several episodes of regional metamorphism resulting in the majority of the rock types seen today.

The topography and relief of the Piedmont Province have developed from differential weathering of the igneous and metamorphic rock. Because of the continued chemical and physical weathering, the rocks in the Piedmont Province are now generally covered with a mantle of soil that has weathered in place from the parent bedrock. These soils have variable thicknesses and are referred to as residuum or residual soils. The residuum is typically finer grained and has higher clay content near the surface because of the advanced weathering. Similarly, the soils typically become coarser grained with increasing depth because of decreased weathering. As the degree of weathering decreases, the residual soils generally retain the overall appearance, texture, gradation and foliations of the parent rock.

The boundary between soil and rock in the Piedmont is not sharply defined. A transitional zone termed "Partially Weathered Rock" is normally found overlying the parent bedrock. Partially Weathered Rock (PWR) is defined for engineering purposes as residual material with Standard Penetration Resistances (N-values) exceeding 100 blows per foot. The transition between hard/dense residual soils and PWR occurs at irregular depths due to variations in degree of weathering.

Water is typically present in the residual soils and within fractures in the PWR or underlying bedrock in the Piedmont. On upland ridges in the Piedmont, water may or may not be present in the residual soils above the PWR and bedrock. Alluvial soils, which have been transported and deposited by water, are typically found in floodplains and are generally saturated to within a few feet of the ground surface. Fluctuations in water levels are typical in residual soils and PWR in the Piedmont, depending on variations in precipitation, evaporation and surface water runoff. Seasonal high-water levels are expected to occur during or just after the typically wetter months of the year (November through April).

The existing roadway right-of-way includes areas of previously placed fill. It has been our experience that previously placed fill soils can change abruptly in composition or consistency over short horizontal distances. Previously placed fills often may contain hidden zones of detrimental materials and unsuitable soils or may contain voids.



9.2 Soil and Rock Stratification

The generalized subsurface conditions at the site are described below. An interpreted subsurface cross-sectional profile is attached as Figure 3 in Appendix I. The discussed subsurface description is of a generalized nature to highlight the major subsurface stratification features and material characteristics. The boring records included in Appendix III should be reviewed for specific information at each boring location. The depth and thickness of the subsurface strata indicated on the boring records was estimated based on the drill cuttings and the samples recovered. The transition between materials may be more gradual than indicated on the boring records. Information on actual subsurface conditions exists only at the specific boring locations and is relevant to the time the exploration was performed. Variations may occur and should be expected at locations remote from the boring. The stratification lines were used for our analytical purposes and, unless specifically stated otherwise, should not be used as the basis for design or construction cost estimates.

Surface materials encountered at the existing ground surface in our borings consisted of 4 to 6 inches of asphalt pavement. A summary of the stratification across the bridge alignment is provided in the table below.

Table 9-1 – Soil Stratification Table

Geotechnical Strata Designation	Depth Interval Range (ft.)	USCS Soil Class or Rock Type	Range of Raw SPT N-values (bpf)	Comments
Existing Roadway Embankment Fill	0 to 6	SC, SM, MH and CH	4 to 16	Loose to medium dense, moist, fine to coarse SAND with little to some low plasticity fines. Soft to stiff, moist to wet, high plasticity SILT and CLAY with trace to some fine to medium sands.
Quaternary Alluvium (encountered at B-2 only)	6 to 13	SP and SC	4 to 7	Very loose to loose, wet, fine to medium SAND with trace to little non-plastic to medium plasticity fines, containing trace wood debris.
Piedmont Residuum	6 to 48	ML and SM	6 to 69	Loose to very dense, dry to moist, fine to coarse SAND with little low plasticity fines. Firm, moist, low plasticity SILT with some fine to coarse sands.



Geotechnical Strata Designation	Depth Interval Range (ft.)	USCS Soil Class or Rock Type	Range of Raw SPT N-values (bpf)	Comments
Partially Weathered Rock (PWR)	13½ to 70	SM	>100	Very dense, dry to moist, fine to coarse SAND with little low plasticity fines.
Metamorphic Bedrock (encountered at B-2 only)	70 to 80	Metagranodiorite	N/A	Slightly to moderately weathered, strong to very strong, fair to good quality rock.

The subsurface profile presented as Figure 3 in Appendix I illustrates interpolated conditions based on the boring data in the longitudinal direction. Interpolation of subsurface conditions between borings is an approximation based on reasonable engineering judgment and actual soil conditions beyond the test hole locations may vary substantially from those shown in the profiles.

10.0 Preliminary Design and Construction Considerations

Chapter 21 of the SCDOT GDM provides that the GBLR should provide limited (preliminary) geotechnical information on a D/B project, thus permitting the contractor to bid on the project with a certain degree of knowledge and acceptable risk. The preliminary design and construction considerations submitted herein are based, in part, upon data obtained from our preliminary field exploration and laboratory testing program. Subsurface conditions across the site will vary, as will grading and construction details. Additional geotechnical exploration and analysis will be required to provide detailed analysis and recommendations for the project.

10.1 Deep Foundations

Support for the bridge end bents appears possible with driven piles or drilled shafts. However, support of the bridge interior bents appears limited to drilled shafts.

10.1.1 Driven Piles

Driven steel H-pile foundations are anticipated to be driven to practical refusal to bear on very dense partially weathered rock or on material causing refusal to the borings. Driven steel H-piles are advantageous due primarily to their relative cost and ease for pile splicing and cutting. Piles are commonly paid for on an "in-place" basis and no charge is made for the length of steel cut off. The principal disadvantage associated with steel H-piles are their relatively small tip areas, which can result in very small end bearing resistance in residual soils since formation of a soil plug cannot be counted on in all cases to help with end bearing capacity development, hence piles will need to extend to sufficient depth to bear in PWR or rock. For piles driven to practical refusal in PWR or rock, factored pile resistance will be essentially the allowable stress of the steel pile cross sectional area.



10.1.2 Drilled Shafts

Drilled shaft foundations are anticipated to be socketed into the underlying PWR or bedrock to provide the required axial and lateral resistance. Drilled shafts are normally used when large loads are anticipated, where allowable deformation is small, where the losses due to scour are large, where slope instability cannot be maintained using conventional methods or where there is a limitation on water crossing work. Drilled shaft diameters should be a minimum 6 inches larger than the column above the shaft and the rock socket at the base of the shaft. Construction casing is required.

10.1.3 Driving Considerations

The following considerations are provided for the use of driven piles.

The contractor should take care not to overdrive or overstress the piles during driving. Prior to installing piles, a wave equation analysis should be performed to evaluate whether the Contractor's proposed driving system (i.e., hammer type and size) is capable of efficiently driving the piles to the desired depths without damaging the piles, and to establish driving criteria. Per the GDM, practical refusal is defined as 5 blows per quarter ($\frac{1}{4}$) inch or 20 blows per inch. Steel pile compressive stresses during driving should not exceed 0.9 times the yield strength of the steel section during driving. Because the PWR and metagranodiorite bedrock is anticipated to be very hard, we recommend that the piles be equipped with driving points or shoes to protect the pile from damage during driving. Lenses of PWR were encountered within the Piedmont residual soil in Boring B-1 from roughly 13 $\frac{1}{2}$ to 18 $\frac{1}{2}$ feet and 33 $\frac{1}{2}$ and 43 $\frac{1}{2}$ feet. It may be necessary to advance piles through these PWR lenses to achieve plan tip elevations.

10.1.4 Drilling Considerations

The PWR and bedrock elevation is fairly variable along the bridge alignment, varying up to roughly 12 and 5 $\frac{1}{2}$ feet, respectively, in elevation from bent to bent. The upper roughly 5 feet of bedrock at Boring B-2 was fair in quality while bedrock was not sampled in Boring B-1. Therefore, difficult drilling and deeper penetration into the bedrock may be required to achieve proper bearing and lateral stability for the bridge foundations. Individual drilled shafts may encounter ledges, boulders or seams of relatively hard rock within the partially weathered rock zone overlying competent bedrock, which may require special measures to permit advancement to the required bearing.

We anticipate drilled shafts will be installed using the casing method of construction. Steel casing should be advanced and seated into the PWR or top of rock to provide an effective seal against overburden material falling into the shaft. Water may still enter the shaft through seams in the rock. If the wet method is used, either mineral slurry or potable water may be used during excavation and construction of the shaft. The observed ground water along the bridge alignment ranged from roughly 16 to 17 $\frac{1}{2}$ feet below the existing ground surface. Therefore, ground water control is important during construction of drilled shafts.

The overburden soil materials consisting of existing fill, alluvial soils, and Piedmont residual soils can typically be excavated with a conventional earth auger. PWR or low quality rock will necessitate use of a rock auger advanced by a large foundation drilling rig. Contractor should be required to provide augering equipment with adequate



torque and power to install drilled shafts through very dense PWR and low quality rock using augers with hardened tungsten carbide bits. The speed of excavation depends upon the type of material being penetrated, size of foundation element and size of the drilling rig. The explored soil profile shows zones of PWR, ranging from roughly 5 to 54 feet in thickness. In addition, lenses of PWR were encountered within the Piedmont residual soil in Boring B-1 from roughly 13 ½ to 18 ½ feet and 33 ½ and 43 ½ feet. The rate of penetration through these materials could be very slow and could require rotary percussion drills or core barrels to penetrate to relatively continuous bedrock encountered in the borings. Specialized drilling equipment may be required due to the observed rock strengths, depending on required penetration depths. This may include, but not be limited to, rock augers, core barrels, or rotary percussion drilling equipment.

Laboratory uniaxial strength test results performed on select cores from the southeastern end bent boring indicate compressive strengths as summarized in the table below:

Table 10-1 – Rock Core Compressive Strength Summary

Boring No.	Core Run	Core Interval (ft)	Sample No.	Sample Depth (ft)	Compressive Strength (psi)
B-2	RC-1	70.3-75.3	RS-1	71.1-71.5	15,847
	RC-2	75.3-80.3	RS-2	75.5-75.9	21,206

Coring was not performed in Boring B-2. However, compressive strengths obtained in the laboratory from samples obtained from Boring B-2 represent very strong, dense metamorphic rock which will pose substantial resistance to heavy duty drilling equipment. Diamond core barrels will be required to advance through hard rocks and contractor should be prepared to expend substantial time to advance the sockets in these materials.

10.1.5 Resistance Criteria

Axial resistance will likely govern the geotechnical foundation design and be developed in end bearing on the underlying PWR or bedrock. Development of lateral resistance of the pile foundations should be achievable in the Piedmont residuum and underlying PWR.

10.2 Corrosion Potential Results

Corrosion series testing was performed to determine the potential for material deterioration of the proposed foundations. One composite sample was taken from selected recovered samples of Boring B-2 to perform pH, resistivity, sulfate, and chloride geochemical tests. This boring is representative of the southeastern end bent. The sample was selected based on the proximity to the estimated soil/pile/ground water interface elevation.



Table 10-2 – Summary of Corrosion Series Testing

Sample	Depth (feet)	Minimum Resistivity (ohm-cm)	Sulfate Content (ppm)	Chloride Content (ppm)	pH
B-2 (SS-7 & 8)	18.5-25.0	23,450	9.9	7.4	7.1

The complete laboratory testing results of the corrosion series testing are provided in Appendix V and are summarized in Table 3 on Appendix II.

Section 7.19 of the GDM provides guidance on determining corrosion potential or aggressiveness. The following soil conditions from GDM Table 7-34 suggest aggressive conditions:

- pH less than 5.5;
- Sulfate concentrations greater than 1,000 ppm (mg/kg);
- Resistivity less than 2,000 ohm-cm;

Therefore, the site appears to be non-aggressive for foundations. However, interpretation of the data and corrosion protection of structural components shall be reviewed and provided by the structural engineer during the design phase of the project.

11.0 Closing

This report has been prepared in general accordance with procedures in SCDOT GDM Chapter 21 and with generally applicable standards of our practice in this geographic area at the time this report was prepared. No other warranty, express or implied, is made. The Geotechnical Engineer of Record for the project must review the data submitted in this report and develop their own interpretation of the testing results as they apply to design.

We relied on project information given to us to develop our exploration program. If project information described in this report is not accurate, or if it changes during project development, we should be notified of the changes.

This report presents data from a limited field exploration program. Subsurface conditions will vary widely between explored areas. Some variations may not become evident until further exploration or construction. If conditions are encountered which appear different than those described in our report, we should be notified. This report should not be construed to represent subsurface conditions for the entire site.

Unless specifically noted otherwise, our field exploration program did not include an assessment of regulatory compliance, environmental conditions or pollutants or presence of any biological materials (mold, fungi, bacteria). If there is a concern about these items, other studies should be performed.

Appendices

Appendix I – Figures



SOURCE: Google Maps



SITE LOCATION PLAN: S-20-214

JOB NAME: S-20-214 Replacement Bridge over Little Creek
LOCATION: S-20-214 (Two Creek Road)
CITY, STATE: Woodward, South Carolina
JOB NO.: 1361-20-048

FIGURE NO.

1

SCALE: NTS

CHECKED BY: MFC

DATE: 3/19/2021

DRAWN BY: AKS



Legend:

SOURCE: Google Earth



Approximate Boring Location



BORING LOCATION PLAN: S-20-214

JOB NAME: S-20-214 Replacement Bridge over Little Creek
LOCATION: S-20-214 (Two Creek Road)
CITY, STATE: Woodward, South Carolina
JOB NO.: 1361-20-048

FIGURE NO.

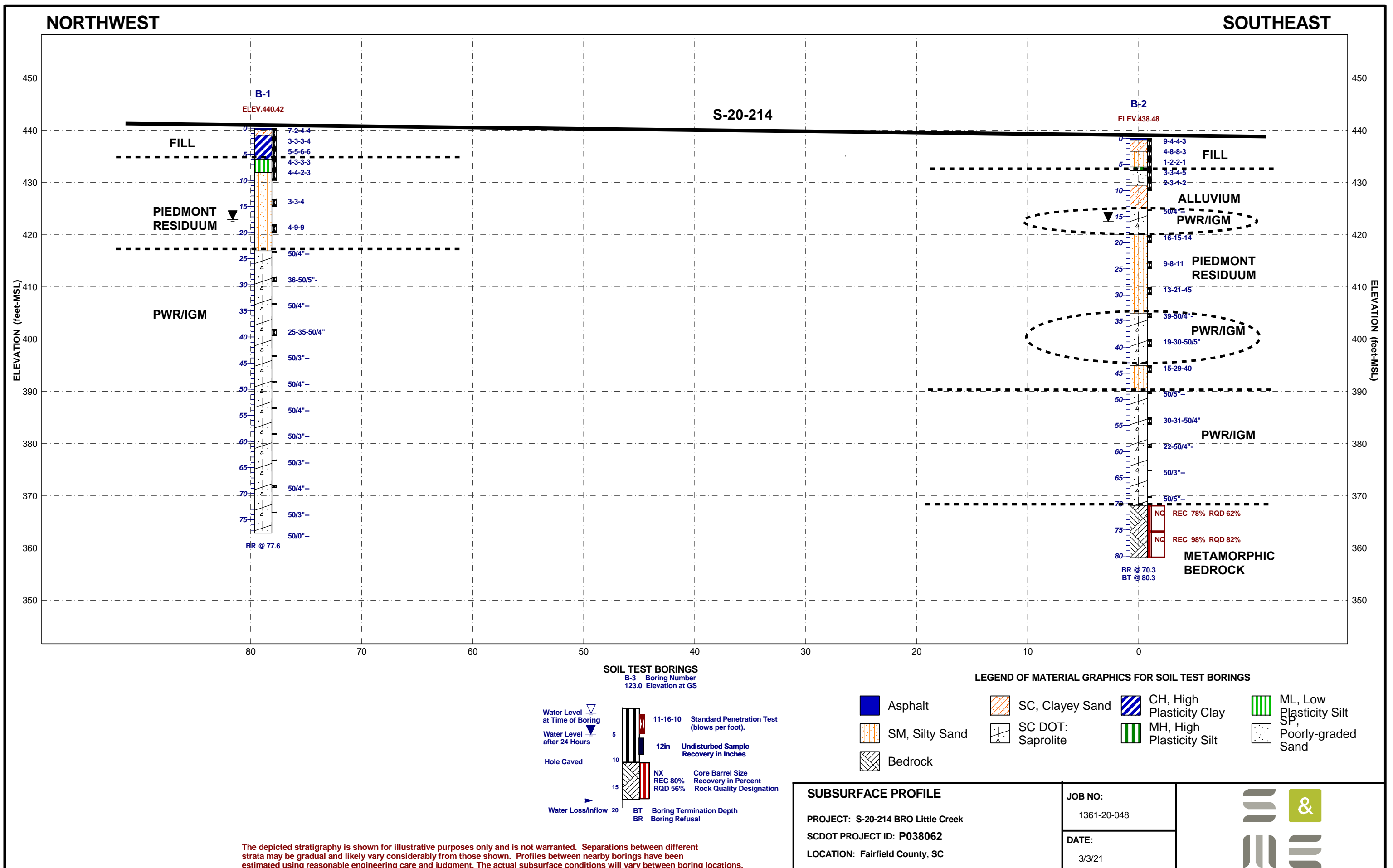
2

SCALE: NTS

CHECKED BY: MFC

DATE: 3/19/2021

DRAWN BY: JPL



Appendix II – Tables



Table 1: Test Location Summary

Bridge ID	Boring No.	Test/SampleType(s)						SC State Plane Northing (ft.)	SC State Plane Easting (ft.)	Latitude (degrees)	Longitude (degrees)	Elevation (ft-msl)	Alignment
		SPT	CPT	DMT	Seismic	Bulk	UD						
S-20-214	B-1	X						987947.3	1943772.2	34.54851	-81.18673	440.4	Existing
S-20-214	B-2	X						987886.6	1943822.1	34.54834	-81.18657	438.5	Existing



Table 2: Split Spoon Samples – Laboratory Classification Testing Summary

Route ID	Boring Number	Sample Number	Sample Depth (ft)	Natural Moisture (%)	Atterberg Limits			Percent Finer #10 (%)	Percent Finer #40 (%)	Percent Finer #200 (%)	Organic Content (%)	Soil Classification		
					LL	PL	PI					AASHTO	USCS	Strata
S-20-214	B-1	SS-1	0.0-2.0	6.3	-	-	-	94.3	64.7	29.3	-	-	SC	FILL
	B-1	SS-2/SS-3	2.0-6.0	19.3	50	21	29	-	-	61.8	-	-	CH	FILL
	B-1	SS-6/SS-7	13.5-20.0	25.1	37	25	12	94	72	32.0	-	A-2-6	SM	RESIDUUM
	B-2	SS-1	0.0-2.0	12.8	26	16	10	93.9	80.5	36.7	-	A-4	SC	FILL
	B-2	SS-2	2.0-4.0	13.4	-	-	-	-	-	44.2	-	-	SM	FILL
	B-2	SS-4	6.0-8.0	4.8	-	-	-	-	-	3.9	-	-	SP	ALLUVIUM

NT = Not Tested

NP = Non-plastic

Classification estimated based on test results and ASTM D2488 Visual Manual Procedure



Table 3: Split Spoon Samples - Corrosion Series Testing Summary

Route & Boring Number	Sample Depth (ft)	Sample Number	As-Rec'd Resistivity (Ohm-cm)	Minimum Resistivity (Ohm-cm)	Sulfates		Chlorides		pH
					(mg/kg)	(wt%)	(mg/kg)	(wt%)	
S-20-214 B-2	18.5 - 25.0	SS-7	49,580	23,450	9.9	0.0010	7.4	0.0007	7.1
		SS-8							



Table 4: Rock Core - Laboratory Testing Summary

Route & Boring Number	Core Run No.	Core Run Top Depth	Core Run Bottom Depth	Recovery (%)	RQD	Sample Top Depth (ft)	Sample Bottom Depth (ft)	Unit Weight (pcf)	Unconfined Compressive Strength (psi)	RMR ⁽¹⁾	GSI ⁽²⁾ Range
S-20-214 B-2	RC-1	70.3	75.3	78	62	71.1	71.5	174.2	15,847	47	75
	RC-2	75.3	80.3	98	82	75.5	75.9	172.7	21,206	51	85

Notes:

⁽¹⁾ RMR = Rock Mass Rating (Refer to SCDOT Geotechnical Design Manual, Chapter 6)

⁽²⁾ GSI = Geologic Strength Index (Refer to SCDOT Geotechnical Design Manual, Chapter 6)

Appendix III – Soil Test Boring Records

LEGEND TO SOIL CLASSIFICATION AND SYMBOLS

SOIL TYPES

(Shown in Graphic Log)



Fill



Asphalt



Concrete



Topsoil



Gravel



Sand



Silt



Clay



Organic



Silty Sand



Clayey Sand



Sandy Silt



Clayey Silt



Sandy Clay



Silty Clay



Partially Weathered Rock



Cored Rock

WATER LEVELS

(Shown in Water Level Column)

▽ = Water Level At Termination of Boring

▼ = Water Level Taken After 24 Hours

◀ = Loss of Drilling Water

HC = Hole Cave

CONSISTENCY OF COHESIVE SOILS

CONSISTENCY

Very Soft

Soft

Firm

Stiff

Very Stiff

Hard

Very Hard

STD. PENETRATION RESISTANCE BLOWS/FOOT

0 to 2

3 to 4

5 to 8

9 to 15

16 to 30

31 to 50

Over 50

RELATIVE DENSITY OF COHESIONLESS SOILS

RELATIVE DENSITY

Very Loose

Loose

Medium Dense

Dense

Very Dense

STD. PENETRATION RESISTANCE BLOWS/FOOT

0 to 4

5 to 10

11 to 30

31 to 50

Over 50

TERMS

Standard Penetration Resistance - The Number of Blows of 140 lb. Hammer Falling 30 in. Required to Drive 1.4 in. I.D. Split Spoon Sampler 1 Foot. As Specified in ASTM D-1586.

REC - Total Length of Rock Recovered in the Core Barrel Divided by the Total Length of the Core Run Times 100%.

RQD - Total Length of Sound Rock Segments Recovered that are Longer Than or Equal to 4" (mechanical breaks excluded) Divided by the Total Length of the Core Run Times 100%.



Soil Test Log Descriptors

k

Rock Type

Indicate type of rock encountered (i.e. granite, limestone, shale, slate, etc.)

l

Color

Describe the sample color while sample is still moist, using Munsell color chart.

m

Texture

Describe the nonfracture structural features. Stratification is the layering of sedimentary rock and foliation is the layering of metaphoric rock

Descriptive Term	Criteria
Very Thickly Bedded	> 1.0 m
Thickly Bedded	0.5 to 1.0 m
Thinly Bedded	50 to 500 mm
Very Thinly Bedded	10 to 50 mm
Laminated	2.5 to 10 mm
Thinly Laminated	< 2.5 mm

n

Grain Size and Shape

Describe the size and shape of all visible grains, typically used on sedimentary rock.

<u>Size</u>		<u>Sieve size</u>
<u>Descriptor</u>	<u>mm</u>	
Very coarse grained	> 4.75	Grain sizes greater than popcorn kernels
Coarse grained	2.00 – 4.75	Individual grains easy to distinguish by eye
Medium grained	0.425 – 2.00	Individual grains distinguished by eye
Fine grained	0.075 – 0.425	Individual grains distinguished with difficulty
Very Fine grained	< 0.075	Individual grains cannot be distinguished by unaided eye

<u>Shape</u>	
<u>Descriptive Term</u>	<u>Criteria</u>
Angular	Shows little wear; edges and corners are sharp
Subangular	Shows definite effects of wear; edges and corners are slightly rounded off
Subrounded	Shows considerable wear; edges and corners are rounded to smooth curves
Rounded	Shows extreme wear; edges and corners are smoother to broad curves
Well-rounded	Completely worn; edges and corners are not present

o

Weathering / Alteration

Weathering is the physical disintegration of the minerals by atmospheric processes. Alteration is disintegration of the minerals by geothermal processes.

<u>Description</u>	<u>Recognition</u>
Residual Soil	Original minerals of rock have been entirely decomposed to secondary minerals, and original rock fabric is not apparent; material can be easily broken by hand
Completely Weathered / Altered	Original minerals of rock have been almost entirely decomposed to secondary minerals, although the original fabric may be intact; material can be granulated by hand
Highly Weathered / Altered	More than half of the rock is decomposed; rock is weakened so that a minimum 1-7/8 inch diameter sample can be easily broken readily by hand across rock fabric
Moderately Weathered / Altered	Rock is discolored and noticeably weakened, but less than half is decomposed; a minimum 1-7/8 inch diameter sample cannot be broken readily by hand across rock fabric
Slightly Weathered / Altered	Rock is slightly discolored, but not noticeably lower in strength than fresh rock
Fresh	Rock shows no discoloration, loss of strength, or other effect of weathering / alteration

Figure 6-16, SCDOT Soil Test Log Descriptors – Rock

6-38

January 2019

SCDOT Soil Test Log Descriptors

p

Rock Strength

Provide a qualitative assessment of the rock strength using either a geologic hammer or knife.

Description	Recognition	Approximately Uniaxial Compressive Strength (psi)
Extremely Weak Rock	Can be indented by thumbnail	35 – 150
Very Weak Rock	Can be peeled by pocket knife	150 – 700
Weak Rock	Can be peeled with difficulty by pocket knife	700 – 3,500
Medium Strong Rock	Can be indented 3/16 inch with sharp end of pick	3,500 – 7,200
Strong Rock	Requires one hammer blow to fracture	7,200 – 14,500
Very Strong Rock	Requires many hammer blows to fracture	14,500 – 35,000
Extremely Strong Rock	Can only be chipped with hammer blows	> 35,000

q

Strike and Dip

Dip of fracture surface measured relative to horizontal with bearing and direction (i.e. N30°down, etc.)

r

Discontinuity Type

F - Fault
J - Joint
Sh - Shear
Fo - Foliation
V - Vein
B - Bedding

s

Discontinuity Width (millimeters)

W - Wide (12.5 – 50)
MW - Moderately Wide (2.5 – 12.5)
N - Narrow (1.25 – 2.5)
VN - Very Narrow (< 1.25)
T - Tight (0)

t

Amount of Infilling

Su - Surface Stain
Sp - Spotty
Pa - Partially Filled
Fi - Filled
No - None

u

Type of Infilling

Cl - Clay
Ca - Calcite
Ch - Chloride
Fe - Iron Oxide
Gy - Gypsum/Talc
H - Healed
No - None
Py - Pyrite
Qz - Quartz
Sd - Sand

v

Surface Shape of Joint

Wa - Wavy
Pl - Planar
St - Stepped
Ir - Irregular

w

Discontinuity Spacing (feet)

EW - Extremely Wide (> 65)
W - Wide (22 – 65)
M - Moderate (7.5 – 22)
C - Close (2 – 7.5)
VC - Very Close (< 2)

x

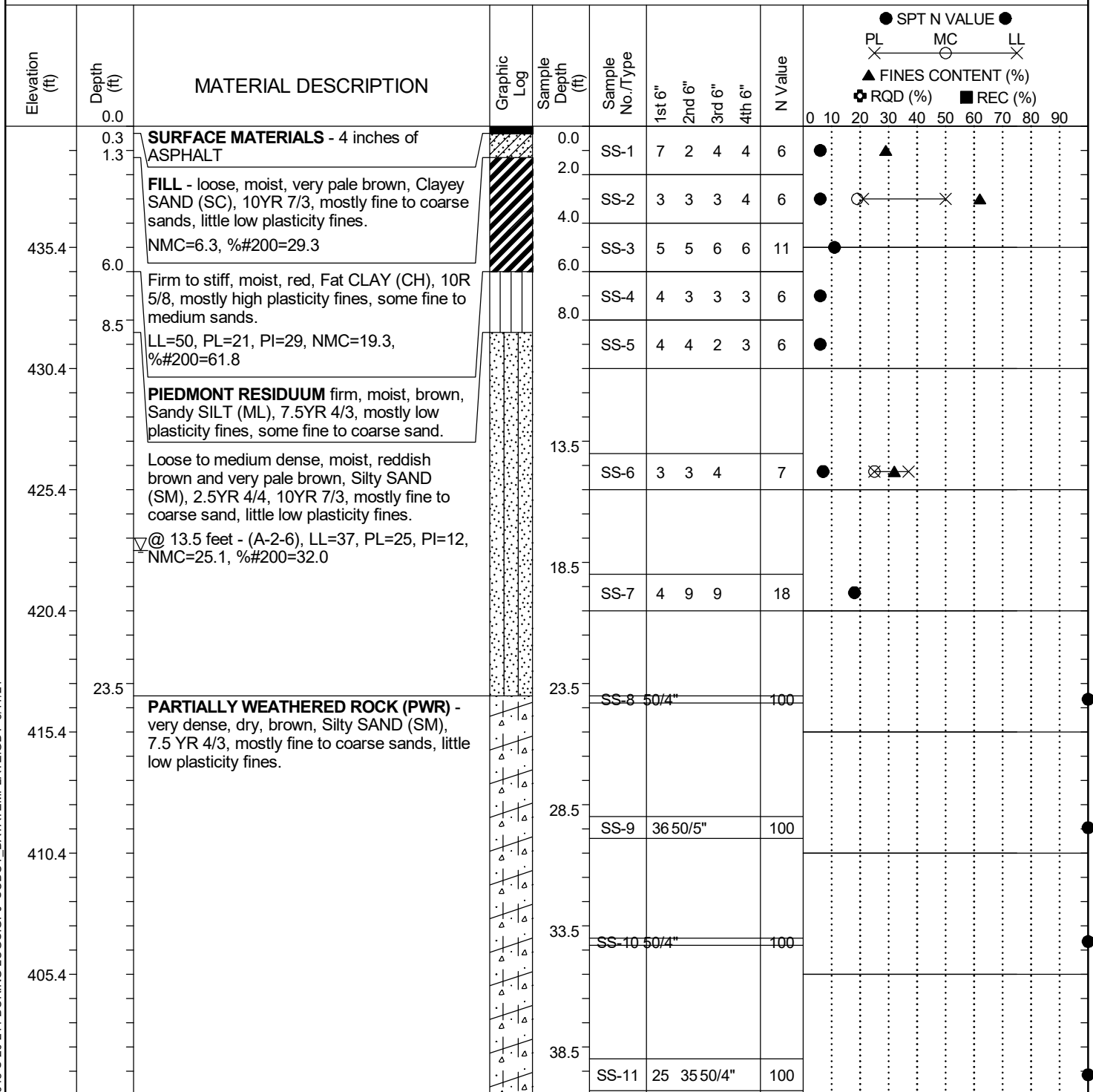
Roughness of Surface

Slk - Slickensided (surface has smooth, glassy finish with visual evidence of striations)
S - Smooth (surface appears smooth and feels so to the touch)
SR - Slightly Rough (asperities on the discontinuity surfaces are distinguishable and can be felt)
R - Rough (some ridges and side-angle steps are evident; asperities are clearly visible, and discontinuity surface feels very abrasive)
VR - Very Rough (near-vertical steps and ridges occur on the discontinuity surface)

Figure 6-17, SCDOT Soil Test Log Descriptors – Rock (con't)

SCDOT Soil Test Log

Project ID:	P038062	County:	Fairfield	Boring No.:	B-1
Site Description:	S-20-214 BRO Little Creek (S&ME Project 1361-20-048)			Route:	S-20-214
Eng./Geo.:	CP	Boring Location:	9.0' N of NEB	Offset:	5' E of CL
Elev.:	440.4 ft	Latitude:	34.54850566	Longitude:	-81.186733123
Date Started:	10/26/2020				
Total Depth:	77.6 ft	Soil Depth:	77.6 ft	Core Depth:	NA ft
Date Completed:	10/26/2020				
Bore Hole Diameter (in):	3 7/8	Sampler Configuration	Liner Required: Y (N)		Liner Used: Y (N)
Drill Machine:	CME 550X	Drill Method:	RW	Hammer Type:	Automatic
Energy Ratio:	83.9%				
Core Size:	NA	Driller:	J. Marlowe	Groundwater:	TOB 17.5 ft
24HR:	N.M.				



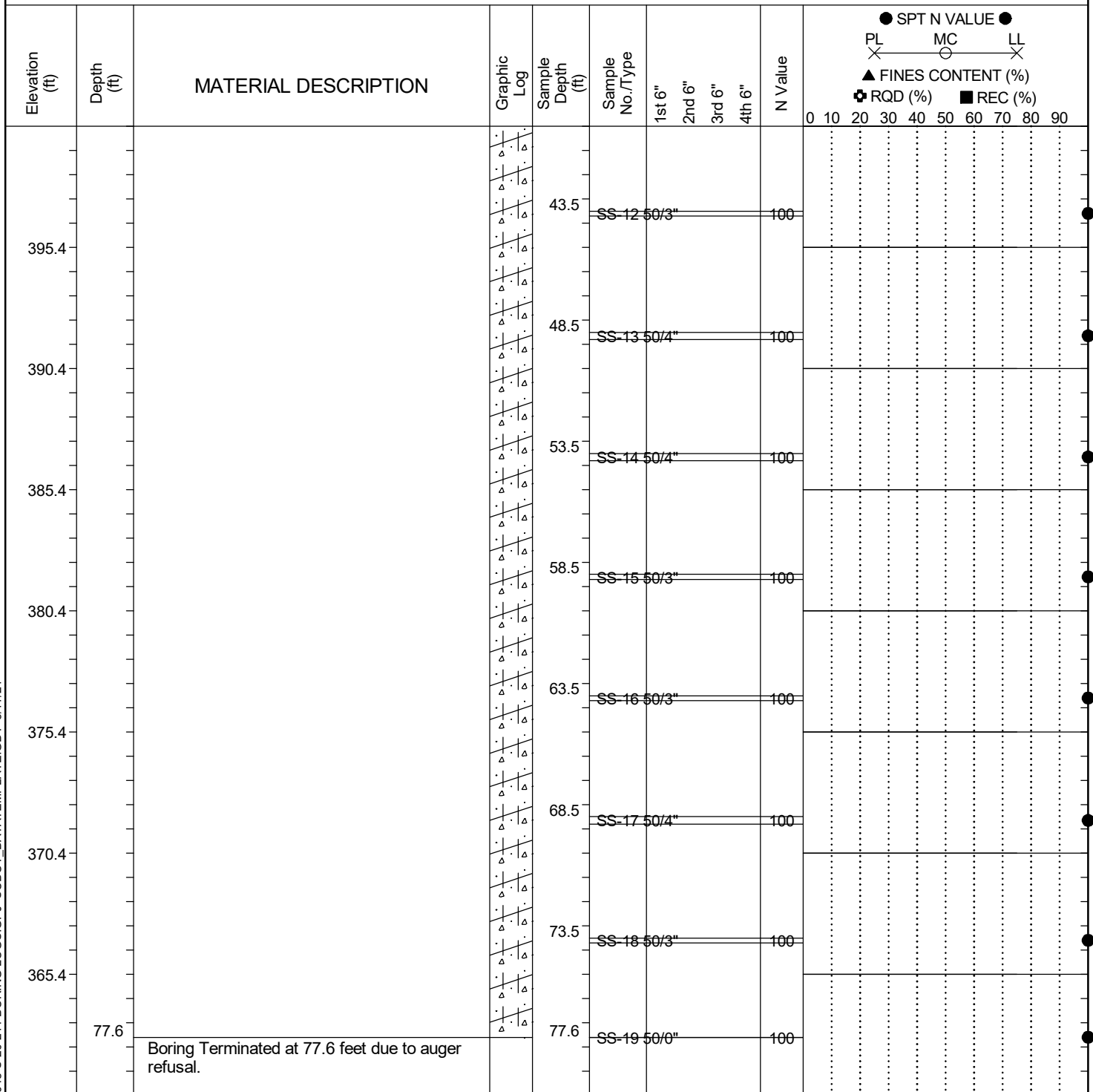
LEGEND

Continued Next Page

SAMPLER TYPE		DRILLING METHOD	
SS - Split Spoon	NQ - Rock Core, 1-7/8"	HSA - Hollow Stem Auger	RW - Rotary Wash
UD - Undisturbed Sample	CU - Cuttings	CFA - Continuous Flight Augers	RC - Rock Core
AWG - Rock Core, 1-1/8"	CT - Continuous Tube	DC - Driving Casing	

SCDOT Soil Test Log

Project ID:	P038062	County:	Fairfield	Boring No.:	B-1
Site Description:	S-20-214 BRO Little Creek (S&ME Project 1361-20-048)			Route:	S-20-214
Eng./Geo.:	CP	Boring Location:	9.0' N of NEB	Offset:	5' E of CL
Elev.:	440.4 ft	Latitude:	34.54850566	Longitude:	-81.186733123
Date Started:	10/26/2020				
Total Depth:	77.6 ft	Soil Depth:	77.6 ft	Core Depth:	NA ft
Date Completed:	10/26/2020				
Bore Hole Diameter (in):	3 7/8	Sampler Configuration	Liner Required: Y (N)		Liner Used: Y (N)
Drill Machine:	CME 550X	Drill Method:	RW	Hammer Type:	Automatic
Energy Ratio:	83.9%				
Core Size:	NA	Driller:	J. Marlowe	Groundwater:	TOB 17.5 ft
24HR	N.M.				



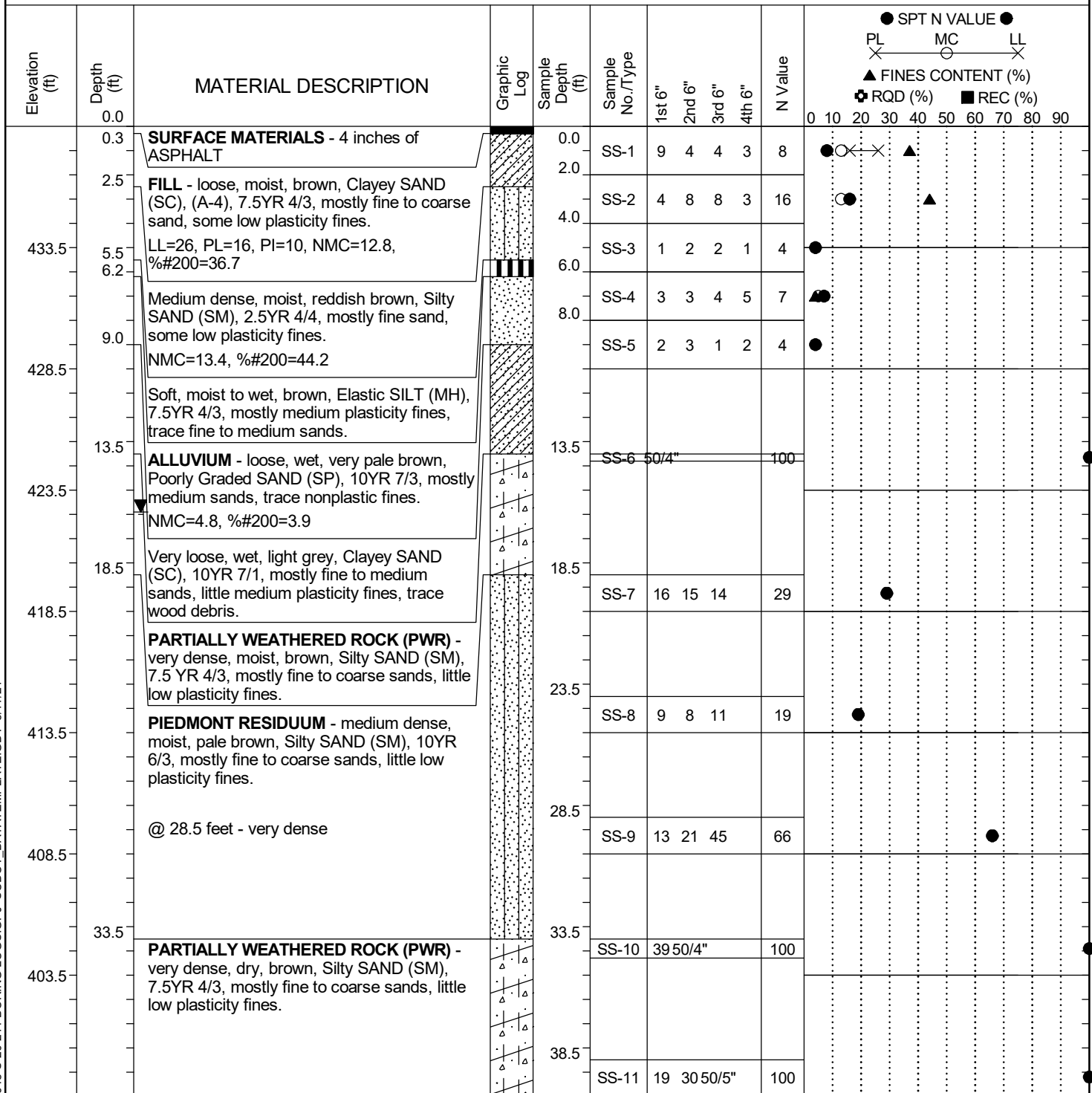
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SAMPLER TYPE		DRILLING METHOD	
SS - Split Spoon	NQ - Rock Core, 1-7/8"	HSA - Hollow Stem Auger	RW - Rotary Wash
UD - Undisturbed Sample	CU - Cuttings	CFA - Continuous Flight Augers	RC - Rock Core
AWG - Rock Core, 1-1/8"	CT - Continuous Tube	DC - Driving Casing	

SC DOT 1361-20-048 S-20-214 BORING LOGS.GPJ SCDOT_DATATEMPLATE.GDT 3/17/21

SCDOT Soil Test Log

Project ID:	P038062	County:	Fairfield	Boring No.:	B-2
Site Description:	S-20-214 BRO Little Creek (S&ME Project 1361-20-048)			Route:	S-20-214
Eng./Geo.:	CP	Boring Location:	7.0' S of SEB	Offset:	5' E of CL
Elev.:	438.5 ft	Latitude:	34.548338949	Longitude:	-81.186566836
Date Started:	10/23/2020				
Total Depth:	80.3 ft	Soil Depth:	70.3 ft	Core Depth:	10 ft
Date Completed:	10/23/2020				
Bore Hole Diameter (in):	3 7/8	Sampler Configuration	Liner Required: Y (N)		Liner Used: Y (N)
Drill Machine:	CME 550X	Drill Method:	RW / DC / RC	Hammer Type:	Automatic
Energy Ratio:	83.9%				
Core Size:	NQ	Driller:	J. Marlowe	Groundwater:	TOB N.M.
24HR	15.9 ft				



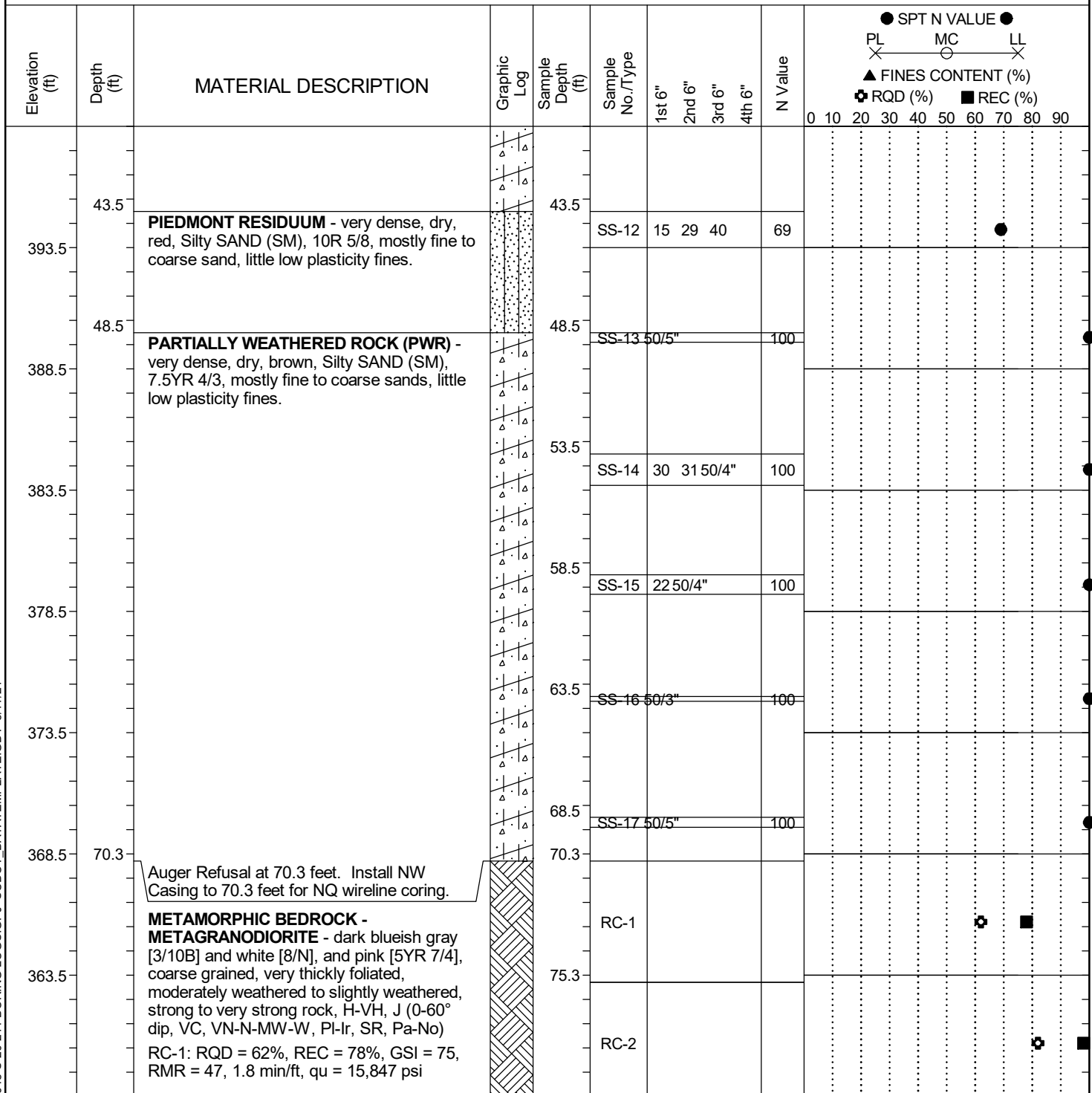
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Continued Next Page

SAMPLER TYPE		DRILLING METHOD	
SS - Split Spoon	NQ - Rock Core, 1-7/8"	HSA - Hollow Stem Auger	RW - Rotary Wash
UD - Undisturbed Sample	CU - Cuttings	CFA - Continuous Flight Augers	RC - Rock Core
AWG - Rock Core, 1-1/8"	CT - Continuous Tube	DC - Driving Casing	

SCDOT Soil Test Log

Project ID:	P038062	County:	Fairfield	Boring No.:	B-2
Site Description:	S-20-214 BRO Little Creek (S&ME Project 1361-20-048)			Route:	S-20-214
Eng./Geo.:	CP	Boring Location:	7.0' S of SEB	Offset:	5' E of CL
Elev.:	438.5 ft	Latitude:	34.548338949	Longitude:	-81.186566836
Date Started:	10/23/2020				
Total Depth:	80.3 ft	Soil Depth:	70.3 ft	Core Depth:	10 ft
Date Completed:	10/23/2020				
Bore Hole Diameter (in):	3 7/8	Sampler Configuration	Liner Required: Y (N)		Liner Used: Y (N)
Drill Machine:	CME 550X	Drill Method:	RW / DC / RC	Hammer Type:	Automatic
Energy Ratio:	83.9%				
Core Size:	NQ	Driller:	J. Marlowe	Groundwater:	TOB N.M.
24HR	15.9 ft				



LEGEND

Continued Next Page

SAMPLER TYPE		DRILLING METHOD	
SS - Split Spoon	NQ - Rock Core, 1-7/8"	HSA - Hollow Stem Auger	RW - Rotary Wash
UD - Undisturbed Sample	CU - Cuttings	CFA - Continuous Flight Augers	RC - Rock Core
AWG - Rock Core, 1-1/8"	CT - Continuous Tube	DC - Driving Casing	

SC.DOT 1361-20-048 S-20-214 BORING LOGS.GPJ SCDOT_DATATEMPLATE.GDT 3/17/21

SCDOT Soil Test Log

Project ID:	P038062	County:	Fairfield	Boring No.:	B-2
Site Description:	S-20-214 BRO Little Creek (S&ME Project 1361-20-048)			Route:	S-20-214
Eng./Geo.:	CP	Boring Location:	7.0' S of SEB	Offset:	5' E of CL
Elev.:	438.5 ft	Latitude:	34.548338949	Longitude:	-81.186566836
Date Started:	10/23/2020				
Total Depth:	80.3 ft	Soil Depth:	70.3 ft	Core Depth:	10 ft
Date Completed:	10/23/2020				
Bore Hole Diameter (in):	3 7/8	Sampler Configuration	Liner Required: Y (N)		Liner Used: Y (N)
Drill Machine:	CME 550X	Drill Method:	RW / DC / RC	Hammer Type:	Automatic
Energy Ratio:	83.9%				
Core Size:	NQ	Driller:	J. Marlowe	Groundwater:	TOB N.M.
24HR	15.9 ft				

Elevation (ft)	Depth (ft)	MATERIAL DESCRIPTION	Graphic Log	Sample Depth (ft)	Sample No./Type	1st 6"	2nd 6"	3rd 6"	4th 6"	N Value	● SPT N VALUE ● PL X — MC — LL X ▲ FINES CONTENT (%) + RQD (%) ■ REC (%)
80.3		RC-2: RQD = 82%, REC = 98%, GSI = 85, RMR = 51, 1.9 min/ft, qu = 21,206 psi Boring Terminated at 80.3 feet.									0 10 20 30 40 50 60 70 80 90
353.5											
348.5											
343.5											
338.5											
333.5											
328.5											
323.5											

LEGEND

SAMPLER TYPE		DRILLING METHOD	
SS - Split Spoon	NQ - Rock Core, 1-7/8"	HSA - Hollow Stem Auger	RW - Rotary Wash
UD - Undisturbed Sample	CU - Cuttings	CFA - Continuous Flight Augers	RC - Rock Core
AWG - Rock Core, 1-1/8"	CT - Continuous Tube	DC - Driving Casing	

SC.DOT 1361-20-048 S-20-214 BORING LOGS.GPJ SCDOT_DATATEMPLATE.GDT 3/17/21



Rock Core Discontinuity Worksheet

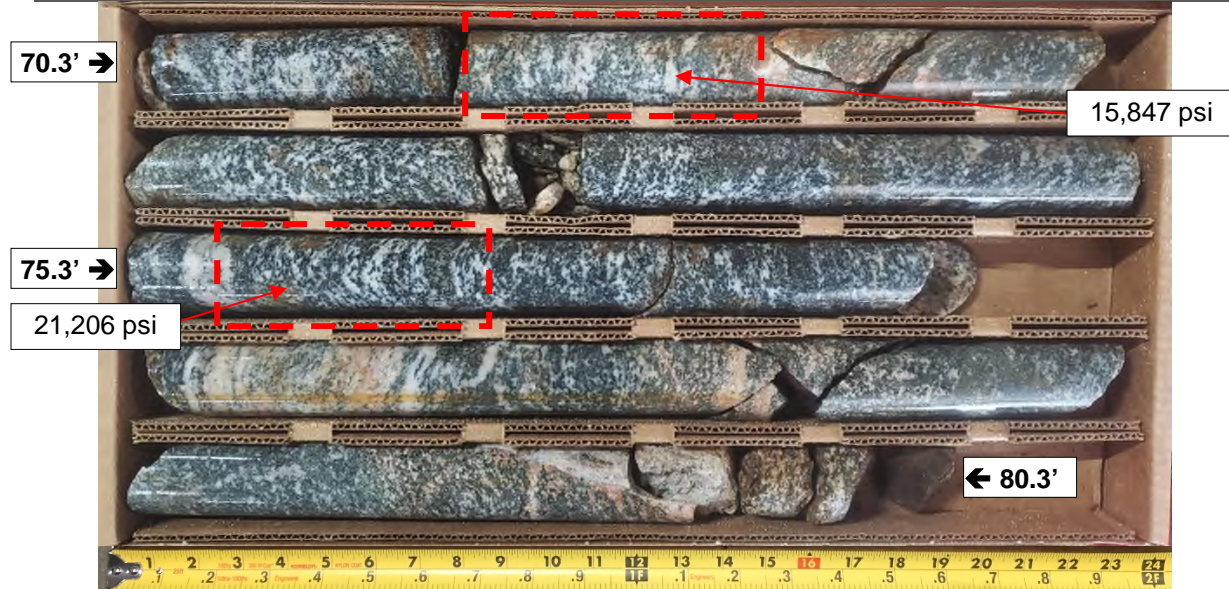
Project Name: S-20-214 over Little Creek
 Project Number: 1361-20-048
 Driller (Company/Name): S&ME/J. Marlowe
 Logged By: JCP
 Date: 10/23/2020

Boring Number: B-2
 Core Barrel Type: NQ2
 Core Barrel Length: 5.0'
 Coring Technique: wireline
 Number of Core Boxes: 1

Depth (ft)	Disc. No.	Disc. Type	Dip Angle (deg)	Disc. Width (mm)	Infill Amount	Infill Type	Surface Shape	Surface Roughness	Notes
71.1	1	J	NA	N	No	No	Pl	Sr	
72	2	J	NA	N	No	No	Pl	Sr	
72.5	3	J	NA	N	Pa	Sd	Pl	Sr	
73.5	4	J	NA	W	No	No	Pl	R	
74.6	5	J	NA	N	No	No	Pl	Sr	
75.7	6	J	NA	VN	No	No	Pl	Sr	
76.3	7	J	NA	N	No	No	Pl	Sr	
77.6	8	J	NA	VN	No	No	Pl	Sr	
78.4	9	J	NA	VN	No	No	Pl	Sr	
79.3	10	J	NA	MW	Pa	Sd	Ir	Sr	
79.5	11	J	NA	MW	Pa	Sd	Ir	Sr	

Rock Core Photo Log

Boring: B-2	Box: 1 of 1	Date: 10/23/2020	Driller: J. Marlowe	Geologist: C. Phillips
Run: RC-1	Length: 5.0	Depth Int: 70.3-75.3	Recovery: 78%	RQD: 62%
Run: RC-2	Length: 5.0	Depth Int: 75.3-80.3	Recovery: 98%	RQD: 82%



Appendix IV – Laboratory Test Results – Split-Spoon Samples



INDEX PROPERTIES VERSUS DEPTH

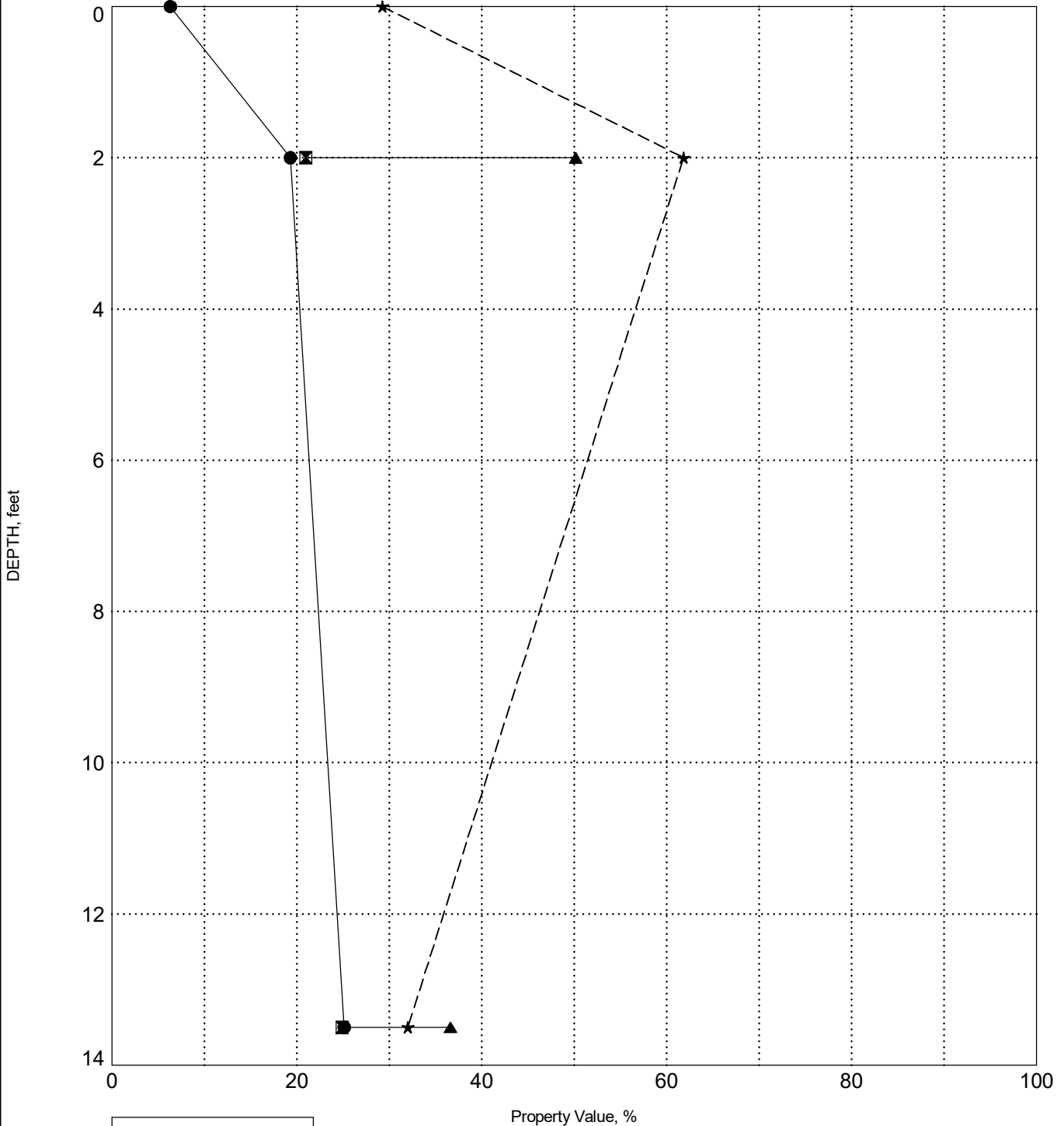
PROJECT ID P038062

PROJECT NAME S-20-214 BRO Little Creek (S&ME Project 1361-20-048)

PROJECT COUNTY Fairfield

SURFACE ELEVATION: 440.4

BORING B-1



LEGEND	
●	Water Content
⊠	Plastic Limit
▲	Liquid Limit
★	Fines



INDEX PROPERTIES VERSUS DEPTH

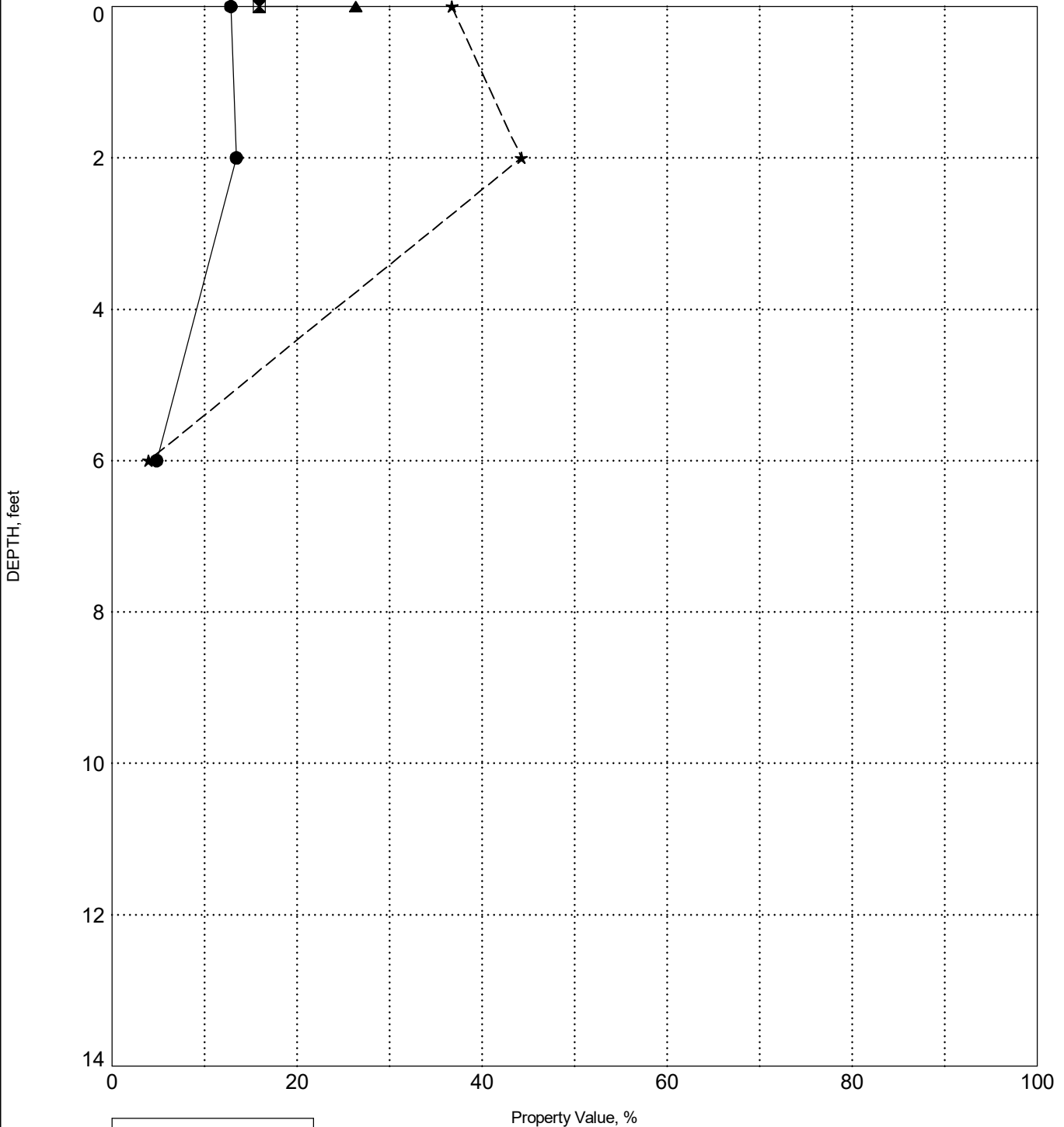
PROJECT ID P038062

PROJECT NAME S-20-214 BRO Little Creek (S&ME Project 1361-20-048)

PROJECT COUNTY Fairfield

BORING B-2

SURFACE ELEVATION: 438.5



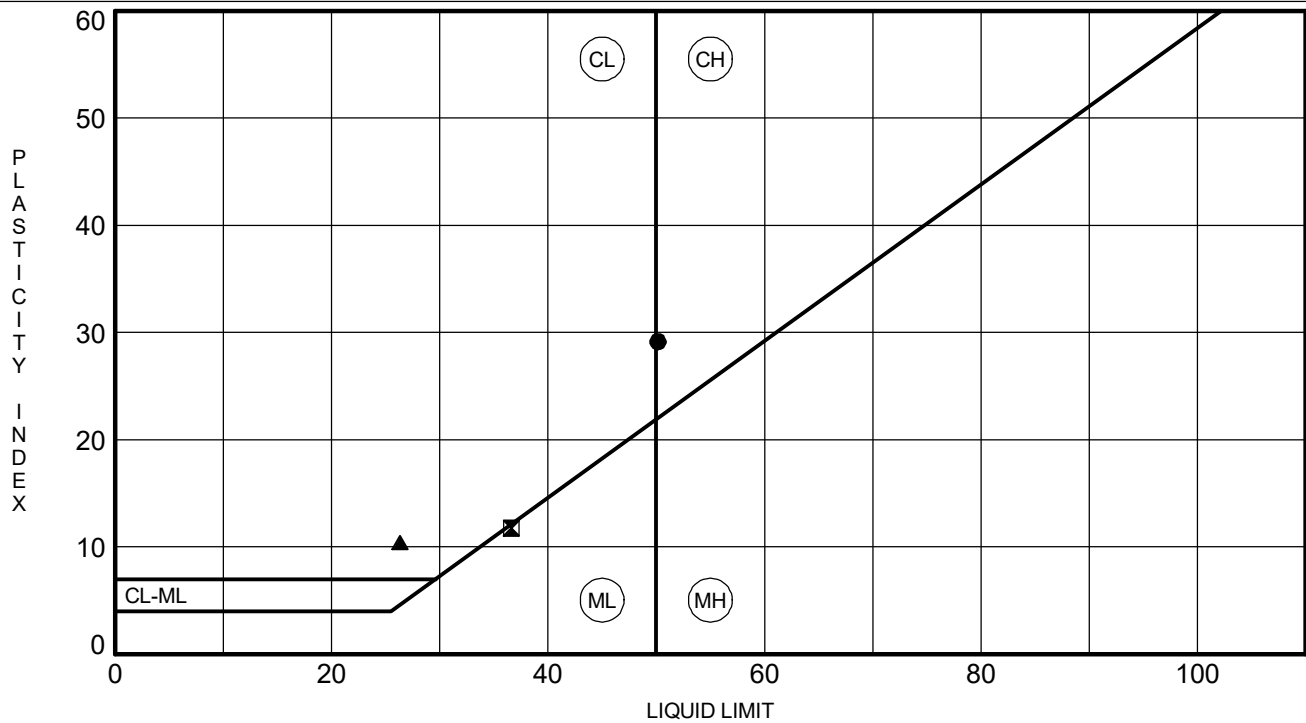
LEGEND	
●	Water Content
⊠	Plastic Limit
▲	Liquid Limit
★	Fines

ATTERBERG LIMITS' RESULTS

PROJECT ID P038062

PROJECT NAME S-20-214 BRO Little Creek (S&ME Project 1361-20-048)

PROJECT COUNTY Fairfield

[illegible]

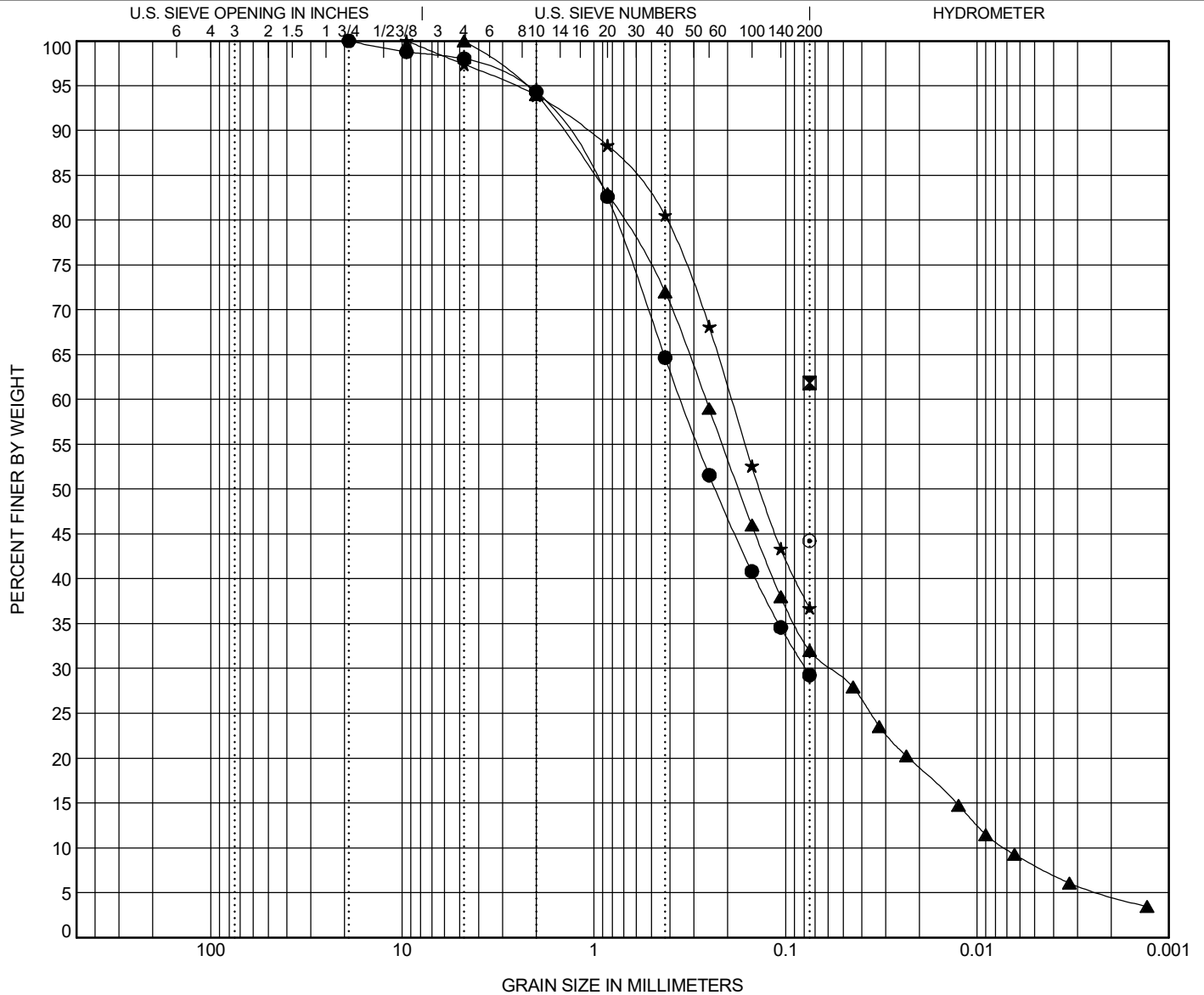


GRAIN SIZE DISTRIBUTION

PROJECT ID P038062

PROJECT NAME S-20-214 BRO Little Creek (S&ME Project 1361-20-048)

PROJECT COUNTY Fairfield



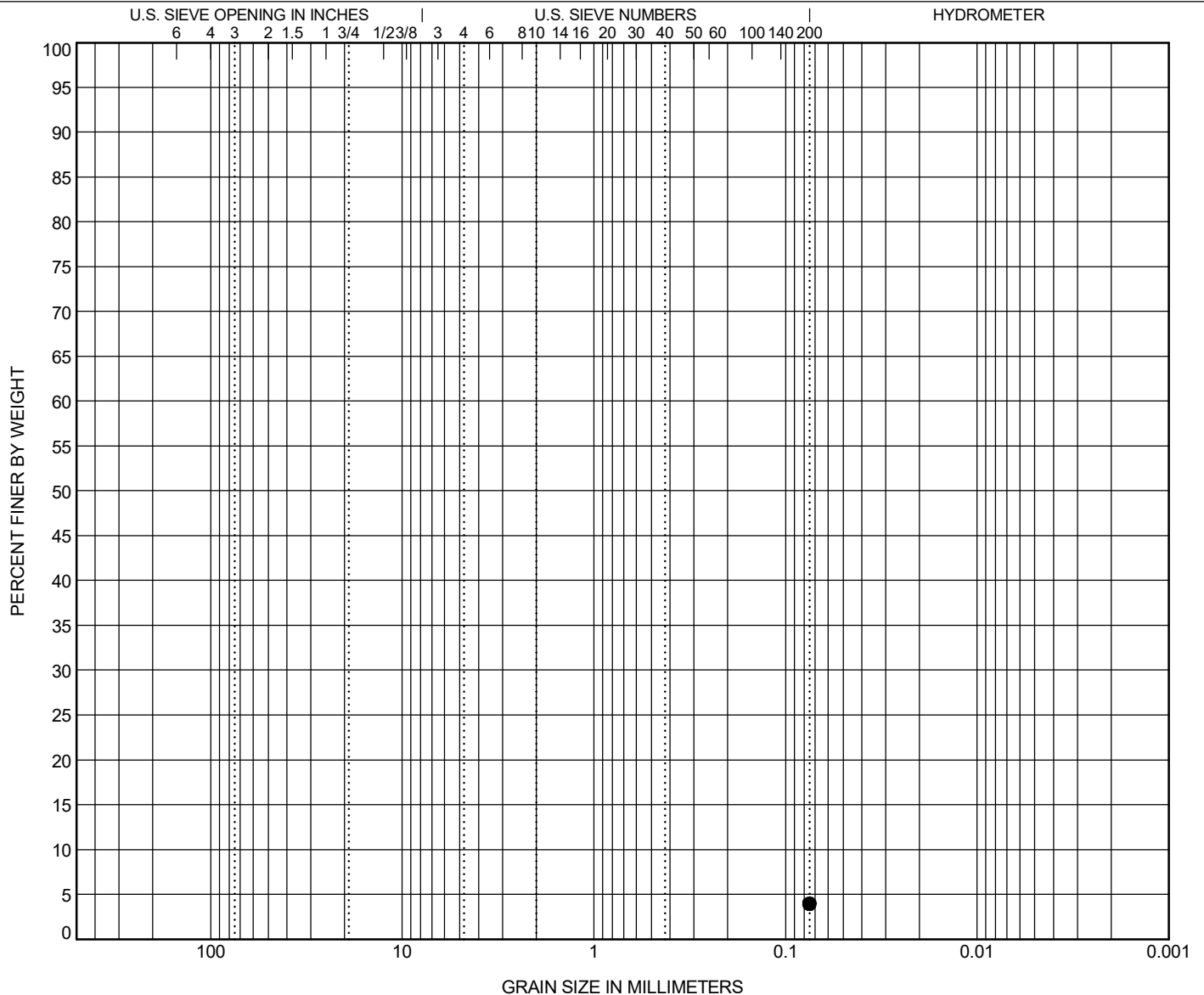


GRAIN SIZE DISTRIBUTION

PROJECT ID P038062

PROJECT NAME S-20-214 BRO Little Creek (S&ME Project 1361-20-048)

PROJECT COUNTY Fairfield



COBBLES	GRAVEL		SAND			SILT OR CLAY
	coarse	fine	coarse	medium	fine	

BOREHOLE	DEPTH	Classification					LL	PL	PI	Cc	Cu
● B-2	6.0	POORLY GRADED SAND (SP)									
BOREHOLE	DEPTH	D100	D60	D30	D10	%Gravel	%Sand	%Silt	%Clay		
● B-2	6.0	0.075							3.9		

GRAIN SIZE 1361-20-048 S-20-214 BORING LOGS.GPJ SCDOT DATA TEMPLATE_01_30_2015.GDT 2/8/21

Appendix V – Laboratory Test Data Sheets – Corrosion Series Testing



Results Only Soil Testing for SCDOT Bridge Package 2021-01 DB Prep

December 8, 2020

**Prepared for:
Matthew F. Cooke
S&ME, Inc.
134 Suber Road
Columbia, SC 29210
mcooke@smeinc.com**

**Project X Job#: S201125D
Client Job or PO#: 1361-20-48**

Respectfully Submitted,

Eduardo Hernandez, M.Sc., P.E.
Sr. Corrosion Consultant
NACE Corrosion Technologist #16592
Professional Engineer
California No. M37102
ehernandez@projectxcorrosion.com





Soil Analysis Lab Results

Client: S&ME, Inc.

Job Name: SCDOT Bridge Package 2021-01 DB Prep

Client Job Number: 1361-20-48

Project X Job Number: S201125D

December 8, 2020

	Method	AASHTO T290		AASHTO T291		AASHTO T288		AASHTO T289
Bore# / Description	Depth	Sulfates SO ₄ ²⁻		Chlorides Cl ⁻		Resistivity As Rec'd Minimum		pH
	(ft)	(mg/kg)	(wt%)	(mg/kg)	(wt%)	(Ohm-cm)	(Ohm-cm)	
SS-7 B-2; S-11-97 Bridge	18.5-20.0	34.8	0.0035	8.2	0.0008	31,490	26,800	6.7
SS-6/SS-7 B-2; S-11-119 Bridge	8.2-14.4	8.7	0.0009	21.4	0.0021	13,400	8,710	6.7
SS-5 B-2; S-11-265 Bridge	8.5-10.0	35.6	0.0036	109.9	0.0110	2,881	2,345	6.4
SS-4 B-1; S-12-58 Bridge	6.0-8.0	31.1	0.0031	23.9	0.0024	25,460	18,760	6.4
SS-4/SS-5 B-2; S-12-300 (2310) Bridge	6.0-10.0	19.3	0.0019	103.7	0.0104	3,283	2,479	6.5
SS-6 B-1; S-12-300 (2490) Bridge	13.5-15.0	36.1	0.0036	21.0	0.0021	9,380	8,040	6.7
SS-7/SS-8 B-2; S-20-214 Bridge	18.5-25.0	9.9	0.0010	7.4	0.0007	49,580	23,450	7.1
SS-6 B-1; S-29-97 Bridge	13.4-14.90	4.6	0.0005	1.9	0.0002	10,050	6,700	7.1
SS-4/SS-5 B-2; S-44-87 Bridge	7.0-11.0	45.9	0.0046	15.3	0.0015	16,080	15,410	6.2

Cations and Anions, except Sulfide and Bicarbonate, tested with Ion Chromatography

mg/kg = milligrams per kilogram (parts per million) of dry soil weight

ND = 0 = Not Detected | NT = Not Tested | Unk = Unknown

Chemical Analysis performed on 1:3 Soil-To-Water extract



Ship Samples To: 29990 Technology Dr, Suite 13, Murrieta, CA 92563

[illegible]

Appendix VI – Laboratory Test Data Sheets – Rock Cores

UNCONFINED COMPRESSION (ASTM D7012 Method C)



S&ME, Inc. - Knoxville 1413 Topside Road, Louisville, TN 37777

Project Name: SCDOT Bridge Package 2021-1

Project Number: 1361-20-048

Report Date: February 25, 2021

Reviewed By: N. Randy Rainwater

Boring No.	Sample No.	Depth (ft)	Dimensions, in.		Shape (See Key)	Area (in ²)	Unit Weight (lbs/ft ³)	Loading Rate (psi/sec)	Maximum Load (lbs)	Strength (psi)	Moisture (%)
			Length	Diameter							
S-20-214, B-2	RS-1	71.1 - 71.5	4.50	1.99	A	3.11	174.2	74	49,285	15,847	0.0
S-20-214, B-2	RS-2	75.5 - 75.9	4.41	1.99	A	3.11	172.7	81	65,952	21,206	0.2

NOTES: Effective (as received) unit weight as determined by RTH 109-93.

Loading rates were selected to target reaching failure between 2 and 15 minutes.

Test results for specimens not meeting the requirements of ASTM D4543-19 may differ from a test specimen that meets the requirements of ASTM D4543.

SHAPE KEY

ASTM D4543-19 Standard Practice for Preparing Rock Core as Cylindrical Test Specimens and Verifying Conformance to Dimensional and Shape Tolerance Section 1.2 - "Rock is a complex engineering material that can vary greatly as a function of lithology, stress history, weathering, moisture content and chemistry, and other natural geologic processes. As such, it is not always possible to obtain or prepare rock core specimens that satisfy the desirable tolerances given in this practice. Most commonly, this situation presents itself with weaker, more porous, and poorly cemented rock types and rock types containing significant or weak (or both) structural features. For rock types which are difficult to prepare, all reasonable efforts shall be made to prepare a specimen in accordance with this practice and for the intended test procedure. However, when it has been determined by trial and error that this is not possible, prepare the rock specimen to the closest tolerances practicable and consider this to be the best effort and report it as such and if allowable or necessary for the intended test, capping the ends of the specimen as discussed in this practice is permitted."

- A Test specimen measurements met the desired shape tolerances of ASTM D4543-19 (side straightness, end flatness & parallelism, and end perpendicularity to axis)
- B Test specimen measurements met the desired shape tolerances of ASTM D4543-19 for end flatness & parallelism, and end perpendicularity to axis. Specimen did not meet the desired tolerance for side straightness. Specimen prepared to closest tolerances practicable.
- C Test specimen measurements met the desired shape tolerances of ASTM D4543-19 for end flatness & parallelism. Specimen did not meet the desired tolerances for side straightness and end perpendicularity to axis. Specimen prepared to closest tolerances practicable.
- D Test specimen measurements met the desired shape tolerances of ASTM D4543-19 for end flatness. Specimen did not meet the desired tolerances for side straightness, parallelism and end perpendicularity to axis. Specimen prepared to closest tolerances practicable.
- E Test specimen measurements met the desired shape tolerances of ASTM D4543-19 for end flatness and end perpendicularity to axis. Specimen did not meet the desired tolerance for side straightness and parallelism. Specimen prepared to closest tolerances practicable.

This report shall not be reproduced, except in full, without the written approval of S&ME, Inc.

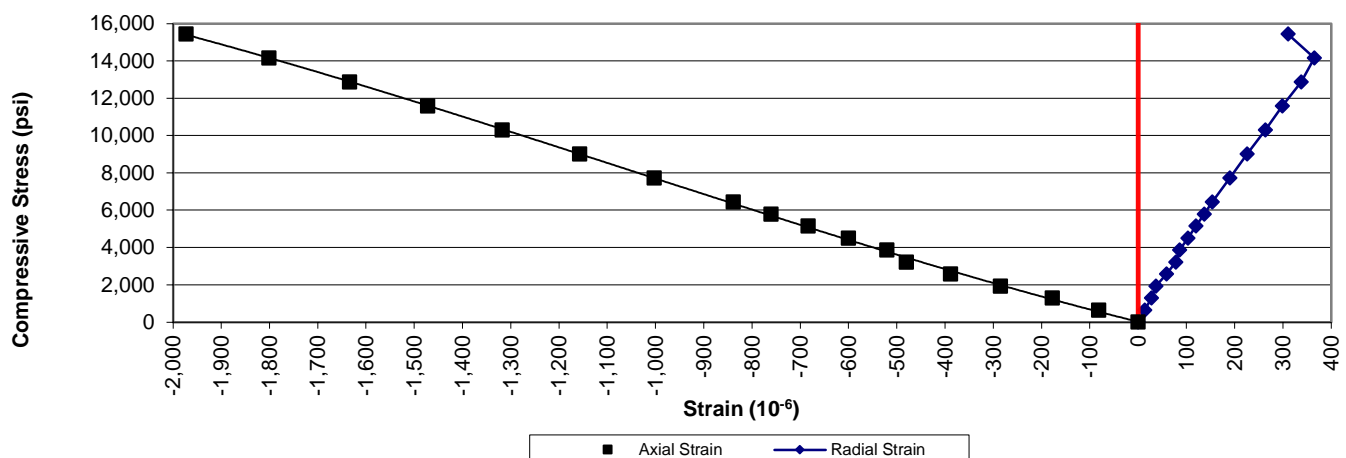
Project:	SCDOT Bridge Package 2021-1	Diameter, in.:	1.99	Date:	1/23/2021
Project No.:	1361-20-048	Length, in.:	4.50	Tested by:	Tori Igoe
Boring Id:	S-20-214, B-2	Unit Weight, pcf:	174.2	Reviewed by:	N. Randy Rainwater
Sample No:	RS-1	Moisture Content, %:	0.0		
Depth (ft):	71.1 - 71.5	Load Rate, psi/sec:	74		

[illegible]

TNR - Test Not Requested

Comments:	Loading rate was selected to target reaching failure between 2 and 15 minutes. Test specimen measurements met the desired shape tolerances of ASTM D4543-19 (side straightness, end flatness & parallelism, and end perpendicularity to axis)
-----------	--

Stress vs. Strain



UNCONFINED COMPRESSION WITH YOUNG'S MODULUS AND POISSON'S RATIO
(ASTM D7012 Method C and D)



1413 Topside Road, Louisville, TN 37777

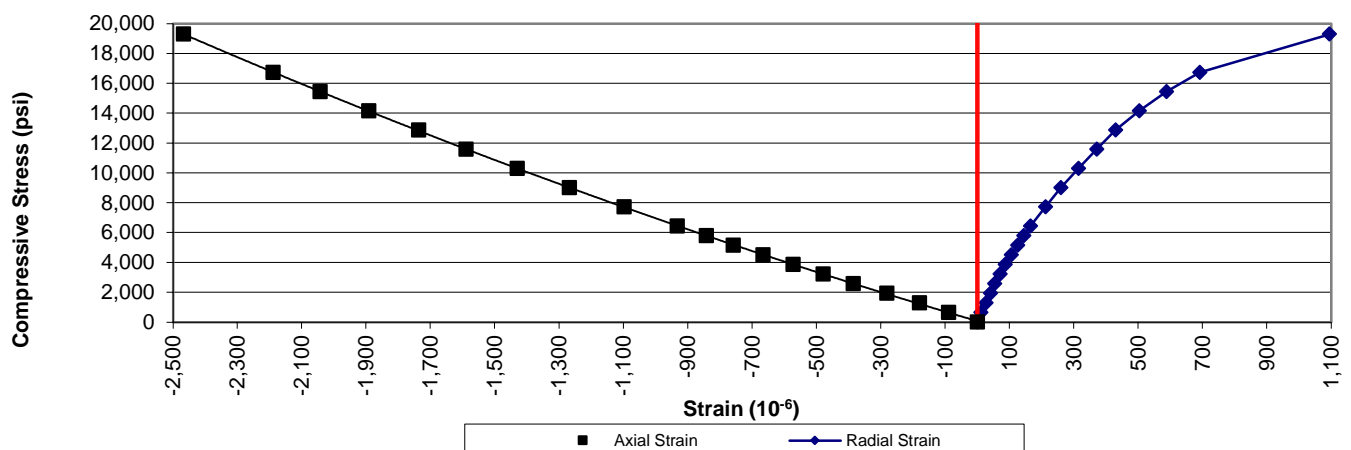
Project:	SCDOT Bridge Package 2021-1	Diameter, in.:	1.99	Date:	1/23/2021
Project No.:	1361-20-048	Length, in.:	4.41	Tested by:	Tori Igoe
Boring Id:	S-20-214, B-2	Unit Weight, pcf:	172.7	Reviewed by:	N. Randy Rainwater
Sample No:	RS-2	Moisture Content, %:	0.2		
Depth (ft):	75.5 - 75.9	Load Rate, psi/sec:	81		

Data Point	Strain (10^{-6})		Load (lb)	Compressive Stress (psi)	Secant Modulus $\times 10^6$ (psi)	Poisson's Ratio	Remarks Failure
	axial	radial					
1	0	0	0	0	0.00	0.00	
2	-89	11	2,000	643	7.22	0.12	
3	-180	27	4,000	1,286	7.14	0.15	
4	-281	41	6,000	1,929	6.86	0.15	
5	-385	54	8,000	2,572	6.68	0.14	
6	-479	71	10,000	3,215	6.71	0.15	
7	-572	87	12,000	3,859	6.75	0.15	
8	-666	106	14,000	4,502	6.76	0.16	
9	-758	126	16,000	5,145	6.79	0.17	
10	-842	145	18,000	5,788	6.87	0.17	
11	-933	166	20,000	6,431	6.89	0.18	
12	-1,098	212	24,000	7,717	7.03	0.19	
13	-1,268	260	28,000	9,003	7.10	0.21	
14	-1,430	315	32,000	10,289	7.20	0.22	
15	-1,589	371	36,000	11,576	7.29	0.23	
16	-1,736	430	40,000	12,862	7.41	0.25	
17	-1,891	504	44,000	14,148	7.48	0.27	
18	-2,043	588	48,000	15,434	7.55	0.29	
19	-2,189	692	52,000	16,720	7.64	0.32	
20	-2,467	1,095	60,000	19,293	7.82	0.44	
			65,952	21,206			Failure

TNR - Test Not Requested

Comments: Loading rate was selected to target reaching failure between 2 and 15 minutes.
Test specimen measurements met the desired shape tolerances of ASTM D4543-19 (side straightness, end flatness & parallelism, and end perpendicularity to axis)

Stress vs. Strain



**PREPARING ROCK CORE AS CYLINDRICAL TEST SPECIMENS AND VERIFYING
CONFORMANCE TO DIMENSIONAL AND SHAPE TOLERANCES
(ASTM D4543)**



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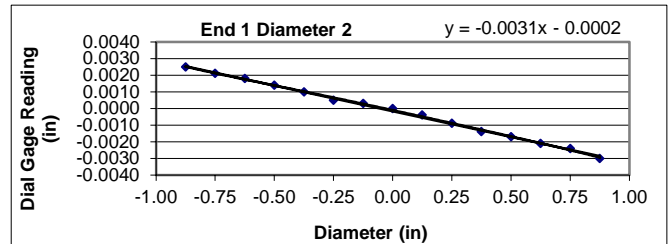
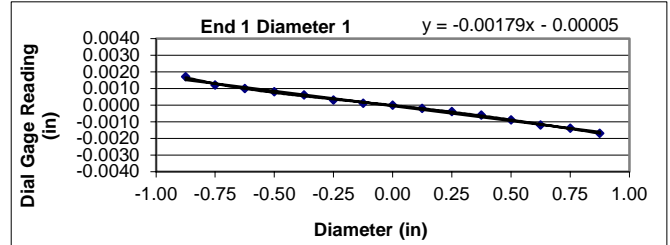
Project: SCDOT Bridge Package 2021-1	Diameter (in): 1.99	Date: 2/9/2021
Project No.: 1361-20-048	Length (in): 4.50	Tested by: Tori Igoue
Boring Id: S-20-214, B-2	Unit Weight (pcf): 174.2	Reviewed by: N. Randy Rainwater
Sample No.: RS-1	Moisture Content (%): 0.0	
Depth (ft): 71.1 - 71.5		

Deviation From Straightness (Procedure S1)

Is the maximum gap ≤ 0.02 in. ? YES Straightness Tolerance Met? YES

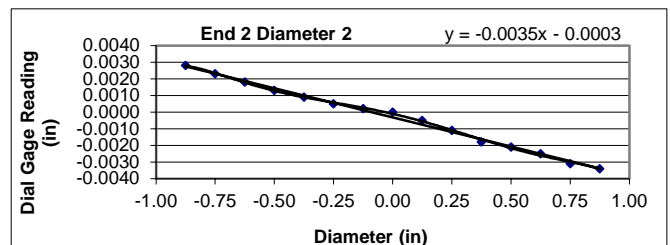
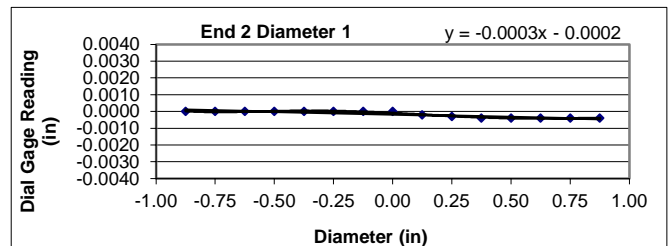
End Flatness and Parallelism Readings (Procedure FP1)

Position	End 1	End 1(90)	End 2	End 2(90)
- 7/8	0.0017	0.0025	0.0000	0.0028
- 6/8	0.0012	0.0021	0.0000	0.0023
- 5/8	0.0010	0.0018	0.0000	0.0018
- 4/8	0.0008	0.0014	0.0000	0.0013
- 3/8	0.0006	0.0010	0.0000	0.0009
- 2/8	0.0003	0.0005	0.0000	0.0005
- 1/8	0.0001	0.0003	0.0000	0.0002
0	0.0000	0.0000	0.0000	0.0000
1/8	-0.0002	-0.0004	-0.0002	-0.0005
2/8	-0.0004	-0.0009	-0.0003	-0.0011
3/8	-0.0006	-0.0014	-0.0004	-0.0018
4/8	-0.0009	-0.0017	-0.0004	-0.0021
5/8	-0.0012	-0.0021	-0.0004	-0.0025
6/8	-0.0014	-0.0024	-0.0004	-0.0031
7/8	-0.0017	-0.0030	-0.0004	-0.0034



Flatness is met when the difference at any point between a smooth curve drawn through points and a visual best fit line is ≤ 0.001 in.

Flatness Tolerance Met? YES



Parallelism is met when the angular difference between best fit lines on opposing ends is $\leq 0.25^\circ$.

Parallelism Diameter 1

End 1:	Slope of Best Fit Line:	-0.00179
	Angle of Best Fit Line:	-0.10231
End 2:	Slope of Best Fit Line:	-0.00031
	Angle of Best Fit Line:	-0.01768
	Max Angular Difference:	-0.08

Parallelism Diameter 2

End 1:	Slope of Best Fit Line:	-0.00309
	Angle of Best Fit Line:	-0.17696
End 2:	Slope of Best Fit Line:	-0.00351
	Angle of Best Fit Line:	-0.20119
	Max Angular Difference:	0.02

Parallelism Tolerance Met? YES

Perpendicularity (Procedure P1) is met when the difference between max and min readings along each line divided by the diameter is ≤ 0.0043 .

	Difference b/w max & min	Divide by Diameter	Meets Tolerance
End 1 Diam 1	0.0034	0.0017	YES
End 1 Diam 2	0.0055	0.0028	YES
End 2 Diam 1	0.0004	0.0002	YES
End 2 Diam 2	0.0062	0.0031	YES

Perpendicularity Tolerance Met? YES

**PREPARING ROCK CORE AS CYLINDRICAL TEST SPECIMENS AND VERIFYING
CONFORMANCE TO DIMENSIONAL AND SHAPE TOLERANCES
(ASTM D4543)**



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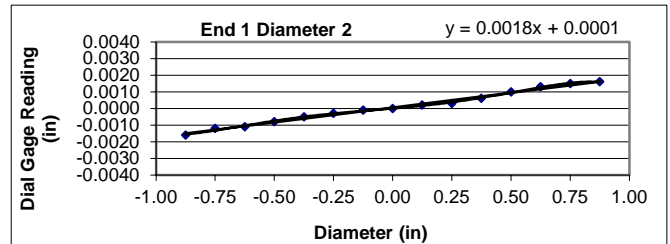
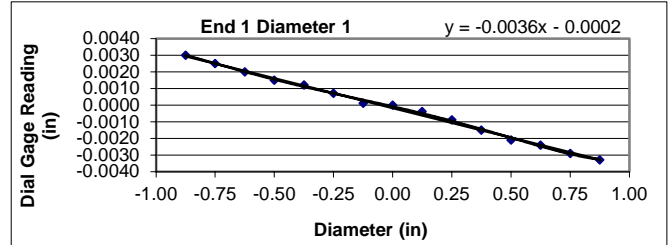
Project: SCDOT Bridge Package 2021-1	Diameter (in): 1.99	Date: 2/9/2021
Project No.: 1361-20-048	Length (in): 4.41	Tested by: Tori Igoo
Boring Id: S-20-214, B-2	Unit Weight (pcf): 172.7	Reviewed by: N. Randy Rainwater
Sample No.: RS-2	Moisture Content (%): 0.2	
Depth (ft): 75.5 - 75.9		

Deviation From Straightness (Procedure S1)

Is the maximum gap ≤ 0.02 in. ? YES Straightness Tolerance Met? YES

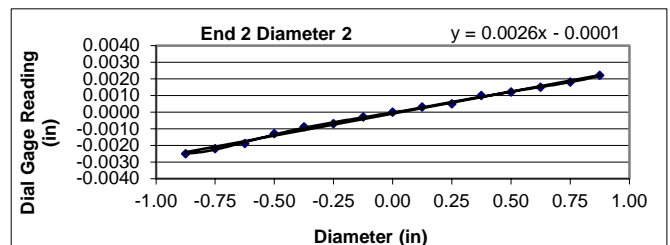
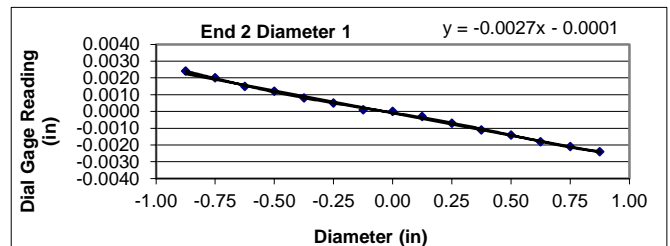
End Flatness and Parallelism Readings (Procedure FP1)

Position	End 1	End 1(90)	End 2	End 2(90)
- 7/8	0.0030	-0.0016	0.0024	-0.0025
- 6/8	0.0025	-0.0012	0.0020	-0.0022
- 5/8	0.0020	-0.0011	0.0015	-0.0019
- 4/8	0.0015	-0.0008	0.0012	-0.0013
- 3/8	0.0012	-0.0005	0.0008	-0.0009
- 2/8	0.0007	-0.0003	0.0005	-0.0007
- 1/8	0.0001	-0.0001	0.0001	-0.0003
0	0.0000	0.0000	0.0000	0.0000
1/8	-0.0004	0.0002	-0.0003	0.0003
2/8	-0.0009	0.0003	-0.0007	0.0005
3/8	-0.0015	0.0006	-0.0011	0.0010
4/8	-0.0021	0.0010	-0.0014	0.0012
5/8	-0.0024	0.0013	-0.0018	0.0015
6/8	-0.0029	0.0015	-0.0021	0.0018
7/8	-0.0033	0.0016	-0.0024	0.0022



Flatness is met when the difference at any point between a smooth curve drawn through points and a visual best fit line is ≤ 0.001 in.

Flatness Tolerance Met? YES



Parallelism is met when the angular difference between best fit lines on opposing ends is $\leq 0.25^\circ$.

Parallelism Diameter 1

End 1:	Slope of Best Fit Line:	-0.00356
	Angle of Best Fit Line:	-0.20414
End 2:	Slope of Best Fit Line:	-0.00267
	Angle of Best Fit Line:	-0.15323
	Max Angular Difference:	-0.05

Parallelism Diameter 2



End 1:	Slope of Best Fit Line:	0.00179
	Angle of Best Fit Line:	0.10248
End 2:	Slope of Best Fit Line:	0.00265
	Angle of Best Fit Line:	0.15159
	Max Angular Difference:	-0.05



Parallelism Tolerance Met? YES

Perpendicularity (Procedure P1) is met when the difference between max and min readings along each line divided by the diameter is ≤ 0.0043 .

	Difference b/w max & min	Divide by Diameter	Meets Tolerance
End 1 Diam 1	0.0063	0.0032	YES
End 1 Diam 2	0.0032	0.0016	YES
End 2 Diam 1	0.0048	0.0024	YES
End 2 Diam 2	0.0047	0.0024	YES

Perpendicularity Tolerance Met? YES

 		Date: 2/12/2021 - 2/23/2021
		Photographer: Tori Igoo
3	Location / Orientation	S-20-214, B-2, RS-1 (71.1' – 71.5')
	Remarks	Unconfined Compressive Strength of Rock Core Specimen Before/After (ASTM D7012 Method D)

 		Date: 2/12/2021 - 2/23/2021
		Photographer: Tori Igoo
4	Location / Orientation	S-20-214, B-2, RS-2 (75.5' – 75.9')
	Remarks	Unconfined Compressive Strength of Rock Core Specimen Before/After (ASTM D7012 Method D)

Appendix VII – SPT Hammer Energy Measurements



Report of SPT Energy Measurements
S&ME CME 550X ATV (Serial No. 356573)
Asheville, North Carolina
S&ME Project No. 1535-20-200

PREPARED FOR:

**North Carolina Department of Transportation
Geotechnical Engineering Unit
1589 Mail Service Center
Raleigh, North Carolina 27699**

PREPARED BY:

**S&ME, Inc.
9751 Southern Pine Boulevard
Charlotte, North Carolina 28273**

October 9, 2020



October 9, 2020

North Carolina Department of Transportation
Geotechnical Engineering Unit
1589 Mail Service Center
Raleigh, North Carolina 27699

Attention: Dr. Shunyi (Chris) Chen, Ph.D., P.E.

Cc: Ms. Cheryl A. Youngblood, L.G.
Ms. Christina M. Bruinsma, L.G.

Reference: **Report of SPT Energy Measurements**
S&ME CME 550X ATV (SN 356573)
Asheville, North Carolina
S&ME Project No. 1535-20-200

Dear Dr. Chen:

We have completed the Standard Penetration Test (SPT) energy measurements on the automatic hammer used with our CME-550X ATV-mounted drill rig (Serial No. 356573). This service was performed by Mr. Joseph Williamson, P.E. of our firm on October 1, 2020, in general accordance with ASTM D4633 and the most recent revision of the North Carolina Department of Transportation (NCDOT) Geotechnical Engineering Unit's requirements. Review of the data quality and analyses was performed by Mr. Gregory Canivan, P.E. of our firm. Copies of the Certificates of Proficiency issued by Pile Dynamics based on the Dynamic Measurement and Analysis Proficiency Test for Mr. Williamson and Mr. Canivan are included in Appendix I. The testing procedures, equipment used during testing, and detailed results are presented in this report.

1.0 Dynamic Testing Methodology

Testing was performed using a model PAX (Serial No. 3726L) Pile Driving Analyzer™ (PDA) manufactured by Pile Dynamics, Inc. The PDA was used to record and interpret data from two piezoresistive accelerometers (Serial Nos. K5642 and K1533) bolted to a 2.0-foot long AWJ drill rod (Serial No. 203) internally instrumented with two strain transducers. Calibration sheets for the accelerometers and the instrumented rod are included in Appendix II. The instrumented AWJ drill rod has a cross-sectional area of 1.19 square inches and an outside diameter of approximately 1.75 inches. Therefore, we calculate the inside diameter to be approximately 1.24 inches at the gauge location. The accelerometers and strain gauges, which are diametrically opposed near the middle of the instrumented rod, monitor acceleration and strain for each hammer blow. The analyzer converts the data to velocities and forces and computes the maximum transferred hammer energies with the "EFV" method described in ASTM D4633. Preliminary results are recorded and displayed in real time for each blow.



2.0 Testing and Observations

S&ME personnel were on site October 1, 2020, to observe and perform high-strain dynamic testing during SPT sampling on the CME 550X ATV-mounted drill rig operated by Justin Marlowe of S&ME. The measurements were taken during drilling of borehole BH-7.1 associated with S&ME Project No. 7435-18-003 in Asheville, North Carolina. SPT energy measurements were recorded during seven sampling intervals at depths of approximately 28.5, 33.5, 38.5, 43.5, 48.5, 53.5, and 58.5 ft below the ground surface. The N-values recorded at the 28.5, 33.5, and 58.5-ft sampling intervals did not meet the increment requirements and were not used in our analysis. The information presented in the tables below summarizes the equipment and tooling used during the SPT energy measurements. The SPT Energy Evaluation Form and the BH-7.1 Boring Log are included in Appendix III.

Table 2-1: Drill Rig Information

Manufacturer	CME
Model	550X
Serial Number	356573
Operator	J. Marlowe
Carrier	ATV

Table 2-2: Hammer Information

Model / Type	CME / Auto
Serial Number	356573
Anvil Height (inches)	12
Anvil Diameter (inches)	2.5
Typical Drop Height (inches)	30
Typical Ram Weight (pounds)	140
Ram Serial Number	N/A

Table 2-3: Drilling and Instrumented Rod Information

Drill Rod Type	AWJ
OD (inches)	1.75
ID (inches)	1.25
Cross-Sectional Area (in²)	1.20
Typical Lengths (feet)	5
Instrumented Rod Type	AWJ (SN 203)
OD (inches)	1.75
ID (inches)	1.24
Cross-Sectional Area (in²)	1.19
Total Instrumented Rod Length (feet)	2.00
Length Below Gages (feet)	0.8
Split-Spoon Length (feet)	2.85



3.0 Dynamic Testing Results

The total rod length from the instrumentation to the tip of the split-spoon sampler was determined by adding 3.65 ft to the drill rod length at each sample depth. The SPT Energy Measurement Data Summary tables in the Appendix present the test data from every hammer blow at each sampling interval, along with representative force and velocity traces for each test interval. Per ASTM D4633, only the blows from the final foot of each sample interval (i.e. the blows that determine the N-value) are considered when computing the average measurement values of each test interval.

The reported blow counts obtained by the drill rig personnel, a summary of the test data, and average computed hammer energy and transfer ratio values are provided in Table 3-1. Based on the test data, the automatic hammer on the CME 550X operated at an average rate of about 53 blows per minute (bpm) during dynamic testing. The measured average transferred hammer energy (EFV) of the four sample intervals ranged from 292 to 298 ft-lbs, which corresponds to Energy Transfer Ratio (ETR) values of 83.4 to 85.0%, respectively. Plots and tables of the following are also included in the Appendix and present the test data with depth for each test interval:

- Penetration vs. BLC¹
- Penetration vs. FMX²
- Penetration vs. EFV³
- Penetration vs. CSX⁴
- Penetration vs. VMX⁵
- Penetration vs. ETR⁶
- Average ETR vs. Rod Length
- ETR vs. Rod Length

Table 3-1: Summary of Dynamic Testing Results

Data Set ID	Sample Depth (ft)	Drill Rod Length (ft)	Instrumentation to Sampler Tip Length (ft)	Blows per 6" Increment / N-value	Soil Sample Description (Piedmont Residual)	Avg. BPM	Avg. EFV (ft-lbs)	Avg. ETR (%)
1	38.5 – 40.0	40	43.65	1-4-6 / 10	SILTY SAND	52.8	292	83.4
2	43.5 – 45.0	45	48.65	3-4-8 / 12	SILTY SAND	52.6	298	85.0
3	48.5 – 50.0	50	53.65	4-8-13 / 21	SANDY SILT	52.5	292	83.4
4	53.5 – 55.0	55	58.65	9-11-12 / 23	SILTY SAND	52.5	294	84.0
Overall Average						52.6	294	83.9

The overall average transferred hammer energy for the automatic hammer on the CME 550X ATV-mounted drill rig was 294 foot-pounds, with an average ETR of 83.9%.

¹ BLC – Blow Count per 6-in. increment

² FMX – Maximum Compressive Force

³ EFV – Maximum Transferred Energy

⁴ CSX – Maximum Compressive Stress

⁵ VMX – Maximum Velocity

⁶ ETR – Energy Transfer Ratio – Ratio of Calculated Energy to Theoretical Energy of 140 lb hammer falling 30 inches



4.0 Limitations of Report

This report has been prepared in accordance with generally accepted geotechnical engineering practice for specific application to this project. The conclusions contained in this report were based on the applicable standards of our profession in this geographic area at the time this report was prepared. No other warranty, express or implied, is made.

5.0 Closing

S&ME appreciates the opportunity to provide this report to the North Carolina Department of Transportation, Geotechnical Engineering Unit. Please let us know if you have any questions concerning this report.

Sincerely,

S&ME, Inc.

A handwritten signature in blue ink that reads "Joseph Williamson".

Joseph R. Williamson, P.E.
Project Engineer

Gregory J. Canivan, P.E.
Technical Principal
N.C. Registration No. 028593



Appendices:

- Appendix I - Certificates of Proficiency
- Appendix II - Accelerometer and Instrumented Rod Calibration Sheets
- Appendix III - SPT Energy Evaluation Form (Field Log) & BH-7.1 Boring Log
- Appendix IV - CME-550X ATV (SN 356573) SPT Energy Measurements Summary Plots and Tables

Appendices

Appendix I



This documents that

**Joseph Williamson
S&ME**

has on October 31, 2017 achieved the rank of


INTERMEDIATE

on the Dynamic Measurement and Analysis Proficiency Test.

The individual identified on this document demonstrated to the degree granted above an understanding of theory, data quality evaluation, interpretation and signal matching for high strain dynamic testing of deep foundations. ***It is recommended that Individuals at the Intermediate level seek Advanced, Master or Expert levels through additional study within four years of the date of this document.***

The ability of the individual named to provide appropriate knowledge and advice on a specific project is not implied or warranted by the Pile Driving Contractors Association or Pile Dynamics, Inc. The Pile Driving Contractors Association or Pile Dynamics, Inc. assumes no liability for foundation testing and analysis work performed by the bearer of this certificate. This certificate can be verified at www.PDAproficiencytest.com.


Steven A. Hall, Executive Director
Pile Driving Contractors Association


Garland Likins, Senior Partner
Pile Dynamics, Inc.

No. 2426





This documents that

**Greg Canivan
S&ME Inc.**

has on October 8, 2014 achieved the rank of

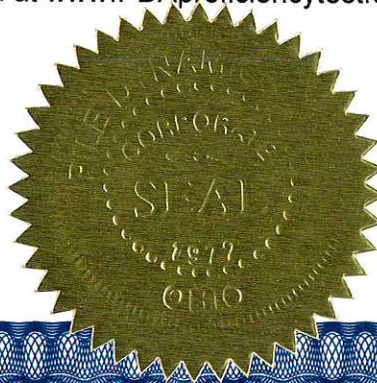
MASTER

on the Dynamic Measurement and Analysis Proficiency Test.

The individual identified on this document demonstrated to the degree granted above an understanding of theory, data quality evaluation, interpretation and signal matching for high strain dynamic testing of deep foundations. ***It is recommended that individuals at the Master level seek to attain Expert level through additional study within five years of the date of this document***

The ability of the individual named to provide appropriate knowledge and advice on a specific project is not implied or warranted by the Pile Driving Contractors Association or Pile Dynamics, Inc. The Pile Driving Contractors Association or Pile Dynamics, Inc. assumes no liability for foundation testing and analysis work performed by the bearer of this certificate. This certificate can be verified at www.PDAproficiencytest.com.


Steven A. Hall, Executive Director
Pile Driving Contractors Association




Garland Likins, President
Pile Dynamics, Inc

No. 721

Appendix II

OBTA: ON [ALT-F1/BB=60]

File Dynamics, Inc.

File Dynamics
2020-03-27 10:08

FS — BN 2149
10 SL 1125/ 3440/ 2 PJ:
PN: HOPBAR

TG F2 DPF
A 4 -- US
F 2 3.3

LE 17.0 ft
AR 1.7 in2
EM 30000 Ksi
SP 0.492 K/ft3
WS 16810 ft/s
WC 7234 ft/s

JC 0.40
FM 1.00
UM 1.00

EA/C 30.3 Ks/ft
UN KIPS*0.1
FR 20000 MB 90

DL -30
UT -1 IP 0.00
PK 1 TM-PEAK

F1/2 500/ 213
F3/4 213/ 213
A1/2 999/ 999
A3/4 999/ 328

TS 12 E B PD: K5642 LP 0.00 ft
TB 8.0 T1 9.6 2L/C 4.7 UA 1000 UE 1024 LI 1.0

VMX= 4.4 FMX= 68 AMX= 169
EMX= 0.3 MEX= 133 FVP= 0.99

ACCEPT SQ-OFF FL-OFF PR-OFF

ACCEPT



ACCELEROMETER CALIBRATION N.I.S.T. Traceable

SERIAL NUMBER: K5642

CALIBRATION FACTOR: .0656 MV/G

PAK (*5000): 328

DATE: 27MAR20

PDA OPERATOR:


OP: LAINE [ver:5.01]

AT:PIEZOELECTRIC->

Smart Sensor

Programmed By: X.N.

CRC Value A730

QBTA: ON [ALT-F1/BB=60]		Pile Dynamics, Inc.		TG F2	DPF
File Dynamics 2018-12-17 09:07		FS —	BN 260 775 515	PJ:	A 4 -- US
		10	SL 801/ 3440/ 2	PN: HOPBAR	F 2 3.3
LE 17.0 ft					
AR 1.7 in2					
EM 30000 Ksi					
SP 0.492 K/ft3					
WS 16810 ft/s					
WC 7312 ft/s					
JC 0.40					
FM 1.00					
UM 1.00					
EA/C 30.3 Ks/ft					
UN KIPS*0.1					
FR 20000 MB 90					
DL -29					
UT -1 IP 0.00					
PK 1 TM-PEAK					
F1/2 500/ 213					
F3/4 213/ 213					
A1/2 999/ 999					
A3/4 999/ 374					
TS 12	E B	PD: k1533	LP 5.00 ft		
TB 8.0	T1 9.6	2L/C 4.7	LI 1.0	VA 1000	VE 1024
ACCEPT SQ-OFF FL-OFF PR-OFF		UMX= 4.5 FMX= 70 AMX= 169 EMX= 0.3 MEX= 137 FVP= 1.00			
ACCEPT		ACCELEROMETER CALIBRATION N.I.S.T. Traceable			
		SERIAL NUMBER: <u>K1533</u>			
		CALIBRATION FACTOR: <u>.0748 MV/G</u>			
		PAK (*5000): <u>374</u> DATE: <u>17DEC18</u>			
		PDA OPERATOR: <u>[Signature]</u>			
<-AT:PIEZORESISTIVE		OP: laine [ver:5.01]		AT:PIEZOELECTRIC->	

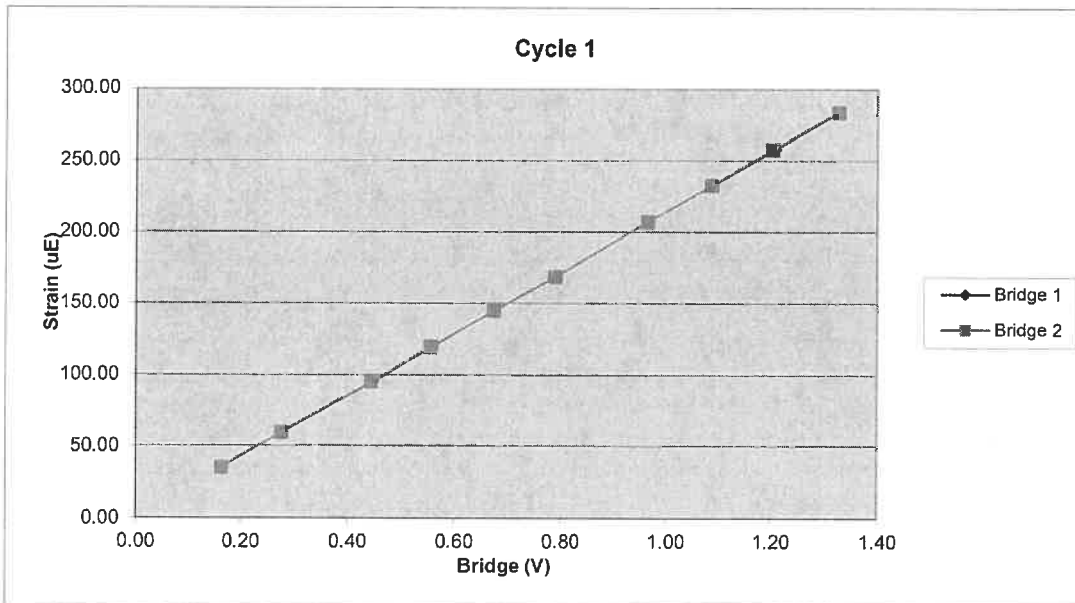
Smart Sensor

Smart Chip Programmed By A.W. on 17DEC18 CRC Value EC00

203AWJ		Cycle 1		
Sample	Force (lb)	Strain (μ E)	Bridge 1 (V)	Bridge 2 (V)
1	0.00	0.00	0.00	0.00
2	1238.45	35.09	0.16	0.16
3	2101.82	59.39	0.28	0.28
4	3386.54	94.77	0.44	0.44
5	4235.08	119.35	0.56	0.56
6	5136.73	144.58	0.67	0.67
7	6021.00	168.91	0.79	0.79
8	7359.61	207.34	0.97	0.97
9	8298.94	232.84	1.09	1.09
10	9187.31	257.76	1.21	1.20
11	10120.00	284.12	1.33	1.33

Bridge 1		Bridge 2	
Force Calibration (lb/V)	7630.77	Force Calibration (lb/V)	7630.97
Offset	-7.83	Offset	-3.17
Correlation	1.000000	Correlation	0.999999
Strain Calibration (μ E/V)	213.97	Strain Calibration (μ E/V)	213.98
Offset	0.12	Offset	0.25
Correlation	0.999992	Correlation	0.999995

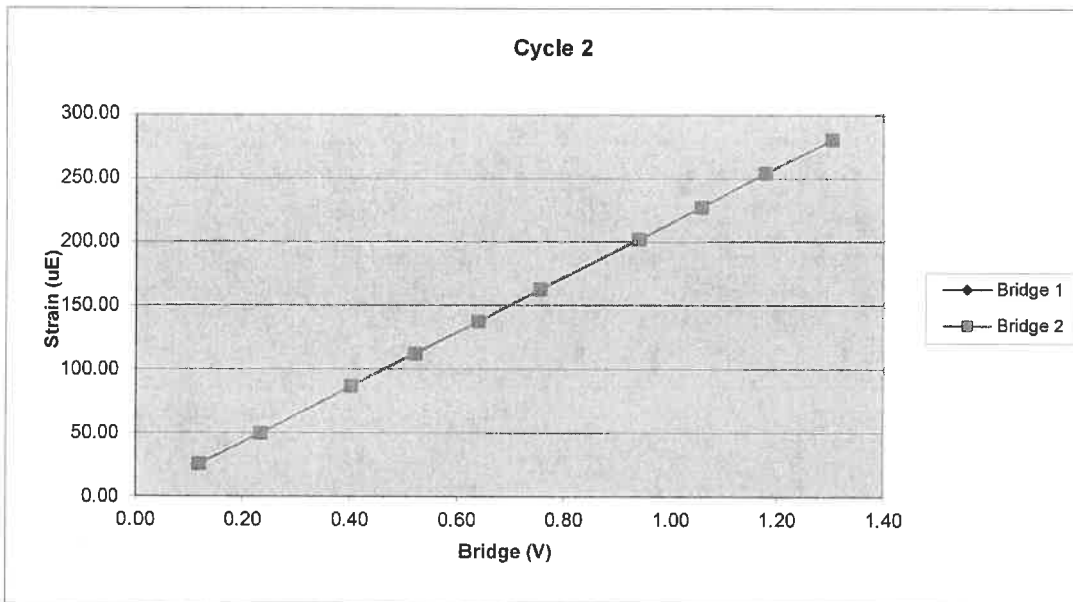
Force Strain Calibration	
EA (Kips)	35662.28
Offset	-12.17
Correlation	0.999993



203AWJ		Cycle 2		
Sample	Force (lb)	Strain (μE)	Bridge 1 (V)	Bridge 2 (V)
1	0.00	0.00	0.00	0.00
2	883.29	25.21	0.12	0.12
3	1765.61	49.65	0.23	0.23
4	3049.75	86.59	0.40	0.40
5	3958.42	112.20	0.52	0.52
6	4857.33	137.43	0.64	0.64
7	5743.75	162.78	0.76	0.76
8	7145.42	202.15	0.94	0.94
9	8044.14	227.44	1.06	1.06
10	8969.22	253.99	1.18	1.18
11	9924.95	280.34	1.30	1.30

Bridge 1		Bridge 2	
Force Calibration (lb/V)	7617.86	Force Calibration (lb/V)	7627.07
Offset	-11.91	Offset	-18.36
Correlation	0.999998	Correlation	1.000000
Strain Calibration ($\mu\text{E/V}$)	215.30	Strain Calibration ($\mu\text{E/V}$)	215.56
Offset	-0.14	Offset	-0.33
Correlation	0.999995	Correlation	0.999996

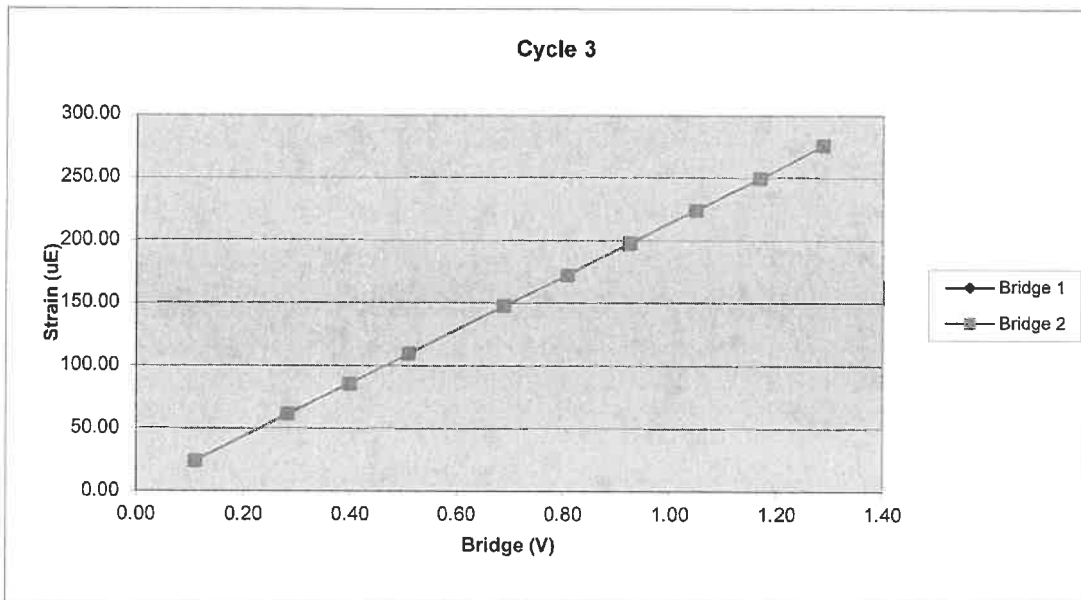
Force Strain Calibration	
EA (Kips)	35381.61
Offset	-6.76
Correlation	0.999996



203AWJ		Cycle 3		
Sample	Force (lb)	Strain (μE)	Bridge 1 (V)	Bridge 2 (V)
1	0.00	0.00	0.00	0.00
2	843.85	23.93	0.11	0.11
3	2145.36	61.00	0.28	0.28
4	3029.63	85.25	0.40	0.40
5	3880.71	109.47	0.51	0.51
6	5241.19	147.71	0.69	0.69
7	6147.33	172.47	0.81	0.81
8	7034.72	198.06	0.92	0.92
9	7979.71	224.33	1.05	1.05
10	8906.15	249.58	1.17	1.17
11	9817.56	275.86	1.29	1.29

Bridge 1		Bridge 2	
Force Calibration (lb/V)	7623.93	Force Calibration (lb/V)	7629.88
Offset	-3.49	Offset	-9.59
Correlation	0.999999	Correlation	0.999999
Strain Calibration ($\mu\text{E}/\text{V}$)	213.65	Strain Calibration ($\mu\text{E}/\text{V}$)	213.81
Offset	0.47	Offset	0.30
Correlation	0.999992	Correlation	0.999991

Force Strain Calibration	
EA (Kips)	35684.19
Offset	-20.08
Correlation	0.999992




Bridge Excitation (V) 5
Shunt Resistor (ohm) 60.4k

Calibration Factors	203AWJ		
Bridge 1 ($\mu\text{E/V}$)	214.31	Bridge 2 ($\mu\text{E/V}$)	214.45
EA Factor (Kips)	35576.02	Area (in^2)	1.19

Calibrated by:

Calibrated Date:


2/26/2019

Pile Dynamics Inc
30725 Aurora Rd
Solon, OH 44139

Traceable to N.I.S.T.

Appendix III

PROJECT: T-072 Pipeline Asheville, North Carolina S&ME Project No. 7435-18-003				BORING LOG BH-7.1					
DATE DRILLED: 9/30/20		ELEVATION:		NOTES: Borehole backfilled by tremie grouting to within 5 ft of the surface. Soil cuttings backfilled to ground surface.					
DRILL RIG: CME 550X		BORING DEPTH: 80.3 ft							
DRILLER: J. Marlowe, Z. Rodriguez		WATER LEVEL: 24.6 ft @ 24 hrs							
HAMMER TYPE: 140-lb Autohammer		LOGGED BY: P. Gunnell							
SAMPLING METHOD: Split Spoon									
DRILLING METHOD: Mud Rotary, NQ Core									
DEPTH (feet)	GRAPHIC LOG	MATERIAL DESCRIPTION	WATER LEVEL	ELEVATION (feet)	SAMPLE NO.	SAMPLE TYPE	BLOW COUNT / CORE DATA	STANDARD PENETRATION TEST DATA (blows/ft) / REMARKS	N VALUE
							1st 6in / RUN # 2nd 6in / REC 3rd 6in / RQD	10 20 30 60 80	
		FILL: SILTY SAND (SM) loose, orange red tan, trace mica, fine to coarse, moist			SS-1	▲	1 3 2		5
5		FILL: SILTY SAND (SM) loose, brown tan, trace mica, fine to medium, wet			SS-2	▲	1 4 5		9
					SS-3	▲	2 4 4		8
10		FILL: SILTY SAND (SM) very dense, brown tan, trace mica, fine to medium, moist, Rock fragments at 9.5 ft increased blow count			SS-4	▲	5 22 50/0.2		50/0.2
15		ALLUVIUM: SANDY CLAY (CL) very soft, brown, trace mica, fine, wet			SS-5	▲	WOHWOH 1		1
20		ALLUVIUM: SILTY SAND (SM) very loose, brown, trace mica, fine, wet			SS-6	▲	WOHWOHWOH		WOH
25		ALLUVIUM: SANDY CLAY (CL) very soft, brown, trace mica, fine, wet			SS-7	▲	WOHWOHWOH		WOH
30		ALLUVIUM: SILTY SAND (SM) very loose, gray white, trace mica, fine to coarse, wet			SS-8	▲	4 2 1		3
35		RESIDUUM: SILTY SAND (SM) loose to medium dense, green white, trace mica, fine, moist			SS-9	▲	1 2 3		5
40					SS-10	▲	1 4 6		10
45					SS-11	▲	3 4 8		12
					SS-12	▲	4 8 13		21

NOTES:

- THIS LOG IS ONLY A PORTION OF A REPORT PREPARED FOR THE NAMED PROJECT AND MUST ONLY BE USED TOGETHER WITH THAT REPORT.
- BORING, SAMPLING AND PENETRATION TEST DATA IN GENERAL ACCORDANCE WITH ASTM D-1586.
- STRATIFICATION AND GROUNDWATER DEPTHS ARE NOT EXACT.
- WATER LEVEL IS AT TIME OF EXPLORATION AND WILL VARY.



PROJECT: T-072 Pipeline Asheville, North Carolina S&ME Project No. 7435-18-003				BORING LOG BH-7.1													
DATE DRILLED: 9/30/20		ELEVATION:		NOTES: Borehole backfilled by tremie grouting to within 5 ft of the surface. Soil cuttings backfilled to ground surface.													
DRILL RIG: CME 550X		BORING DEPTH: 80.3 ft															
DRILLER: J. Marlowe, Z. Rodriguez		WATER LEVEL: 24.6 ft @ 24 hrs															
HAMMER TYPE: 140-lb Autohammer		LOGGED BY: P. Gunnell															
SAMPLING METHOD: Split Spoon																	
DRILLING METHOD: Mud Rotary, NQ Core																	
DEPTH (feet)	GRAPHIC LOG	MATERIAL DESCRIPTION	WATER LEVEL	ELEVATION (feet)	SAMPLE NO.	SAMPLE TYPE	BLOW COUNT / CORE DATA			STANDARD PENETRATION TEST DATA (blows/ft) / REMARKS					N VALUE		
							1st 6in / RUN #	2nd 6in / REC	3rd 6in / RQD		10	20	30	60	80		
		SANDY SILT (ML) very stiff, orange brown, trace mica, fine to coarse, moist (continued)															
55		SILTY SAND (SM) medium dense to very dense, brown tan orange, trace mica, fine to medium, moist			SS-13	⚡	9	11	12								23
60					SS-14	⚡	11	24	44								68
65		PARTIALLY WEATHERED ROCK: SILTY SAND (SM) very dense, brown tan orange, trace mica, fine to medium, moist			SS-15	⚡	9	33	50/0.4								50/0.4
70		BIOTITE GNEISS - black gray white, hard to very hard, continuous, excellent rock quality, very slight to fresh weathering, Moh's Hardness of 4 to 8			RC-1			100%	100%								
75		BIOTITE GNEISS - black gray white, hard to very hard, continuous, excellent rock quality, fresh weathering, Moh's Hardness of 4 to 8			RC-2			100%	100%								
80		BIOTITE GNEISS - black gray white, hard to very hard, continuous, excellent rock quality, very slight to fresh weathering, Moh's Hardness of 4 to 8			RC-3			100%	94%								
		Auger refusal at 67.5 ft Boring terminated at 80.3 ft															

NOTES:

- THIS LOG IS ONLY A PORTION OF A REPORT PREPARED FOR THE NAMED PROJECT AND MUST ONLY BE USED TOGETHER WITH THAT REPORT.
- BORING, SAMPLING AND PENETRATION TEST DATA IN GENERAL ACCORDANCE WITH ASTM D-1586.
- STRATIFICATION AND GROUNDWATER DEPTHS ARE NOT EXACT.
- WATER LEVEL IS AT TIME OF EXPLORATION AND WILL VARY.





SPT Energy Evaluation Form

Project: T-72 Pipeline (PH 12)
Project No.: 7435-18-003
Boring No.: BH-7.1

Date: 10/1/2020
Weather: CLEAR / 60s
Drill Rod Type: 5-FT LONG AWJ

On-site Personnel

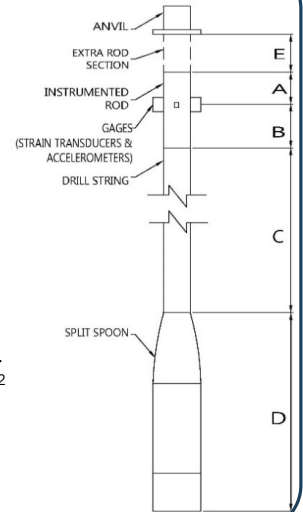
Drilling Company: S&ME, INC.
Rig Operator: J. MARLOWE
Engr/Geologist: P. GUNNELL
Client Rep.: N/A
Analyzer Oper.: J. WILLIAMSON

Rig/Hammer Info

Drill Rig Make/Model: CME 550X
Carrier Type: ATV
Rig Serial No.: 356573
Hammer Type/Model: AUTO/CME
Hammer Serial No.: N/A
Hammer Drop System: CHAIN DRIVE
Lubrication Condition: PER MANUFACTURER
Manufacturer Recommended
Operation Rate (bpm): 50-55
Typical Drop Height (in.): 30
Typical Hammer Weight (lbs): 140
Anvil Dimension (in.): 12
Drilling Method: MUD ROTARY

Rod Info

(A + E) Impact Surface to Gages Length: 1.2 ft
(B) Instr. Rod Length below Gages: 0.8 ft
(A) + (B) Instr. Rod Length: 2.0 ft
(D) Spoon Length: 2.85 ft
(E) Rod Length Above Instr. Rod (if applicable): N/A ft
Instr. Rod S/N: 203AWJ
Instr. Rod Outside Dia.: 1.75 in.
Instr. Rod Area: 1.19 in²
PDA Make/Model: PAX
PDA Serial No.: 3733L
Calib. Pulse Test (y/n): Y



Gage Info

Gage		Serial No.	Calibration No.
Accel.	A3	K5642	328.0
	A4	K1533	374.0
Strain	F3	203AWJ-1	214.31
	F4	203AWJ-2	214.45

Date of Test	Test Depth Increment (ft to ft)	Test Time Start / Stop (military)	Length of Drill String (ft) (C)	(LE) Length below Gages (ft) (B) + (C) + (D)	Avg. Meas. Hammer Rate (BPM)	SPT Blow Counts				Drop Height in Tolerance (y/n)
						6"	12"	18"	N-Value	
10/1/2020	28.5 - 30.0	10:15	30	33.65	53	4	2	1	3	Y
	33.5 - 35.0	10:37	35	38.65	53	1	2	3	5	Y
	38.5 - 40.0	10:45	40	43.65	53	1	4	6	10	Y
	43.5 - 45.0	11:01	45	48.65	53	3	4	8	12	Y
	48.5 - 50.0	11:10	50	53.65	53	4	8	13	21	Y
	53.5 - 55.0	11:20	55	58.65	53	9	11	12	23	Y
	58.5 - 60.0	11:38	60	63.65	53	11	24	44	68	Y

SM
SM
SM
SM
ML
SM
SM

Notes:

NOTE: (1) Note any unusual hammer operating conditions that affect the hammer performance, or changes in operating conditions (e.g. verticality, weather, or lubrication between trials). (2) Note any changes in rod diameter along drill string and record locations of short rod sections.

Joseph Williamson

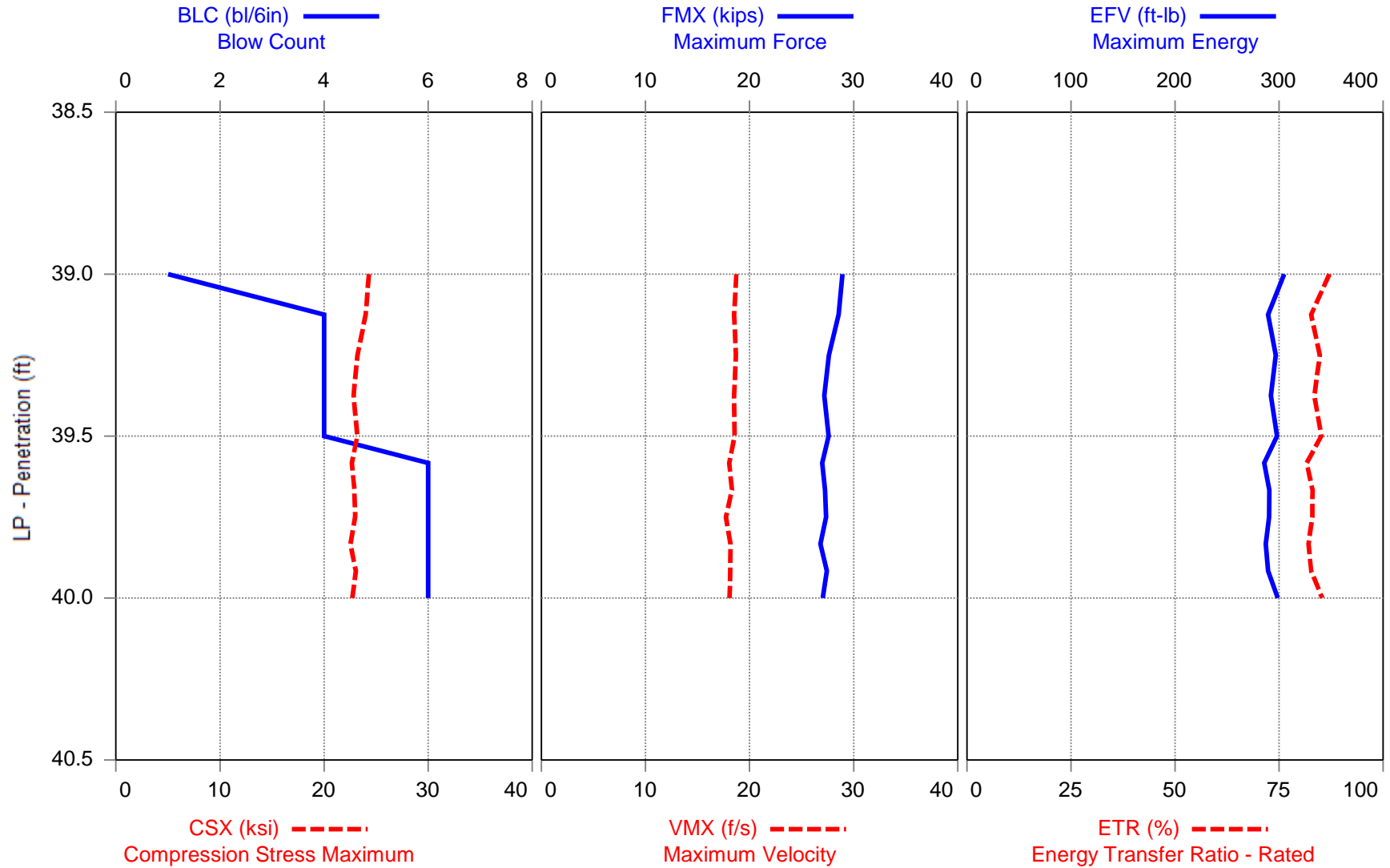
Prepared By (print/signature)

10/1/2020
Date

Appendix IV



CME-550X (SN 356573) - 38.5-40.0 FEET BH-7.1

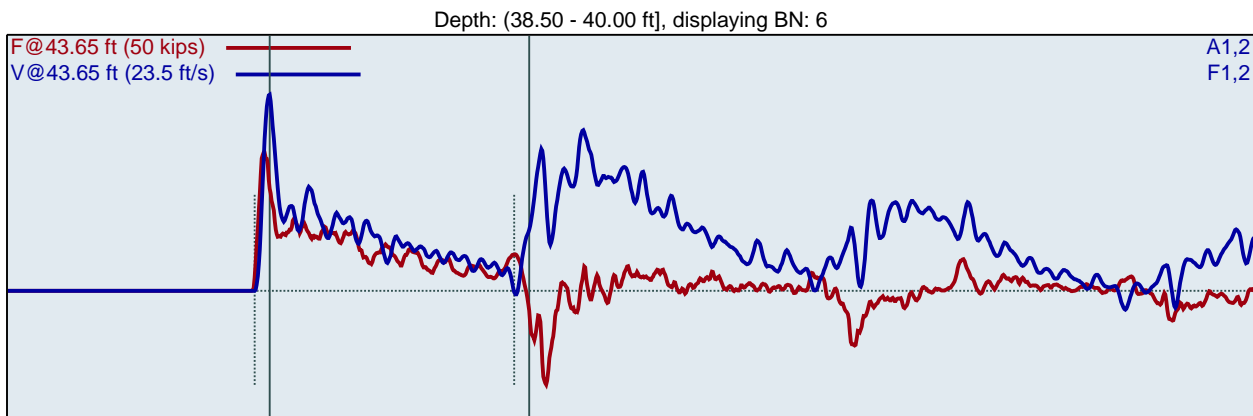


CME-550X (SN 356573)
JRW
BH-7.1

38.5-40.0 FEET
Test date: 10/1/2020

AR: 1.19 in²
LE: 43.65 ft
WS: 16807.9 ft/s

SP: 0.492 k/ft³
EM: 30000 ksi



F1 : [203 AWJ-1] 214.31 PDICAL (1) FF1
F2 : [203 AWJ-2] 214.45 PDICAL (1) FF1

A1 (PR): [K5642] 328 mv/6.4v/5000g (1) VF1
A2 (PR): [K1533] 374 mv/6.4v/5000g (1) VF1

BPM: Blows/Minute

FMX: Maximum Force

VMX: Maximum Velocity

DMX: Maximum Displacement

CSX: Compression Stress Maximum

DFN: Final Displacement

EFV: Maximum Energy

ETR: Energy Transfer Ratio - Rated

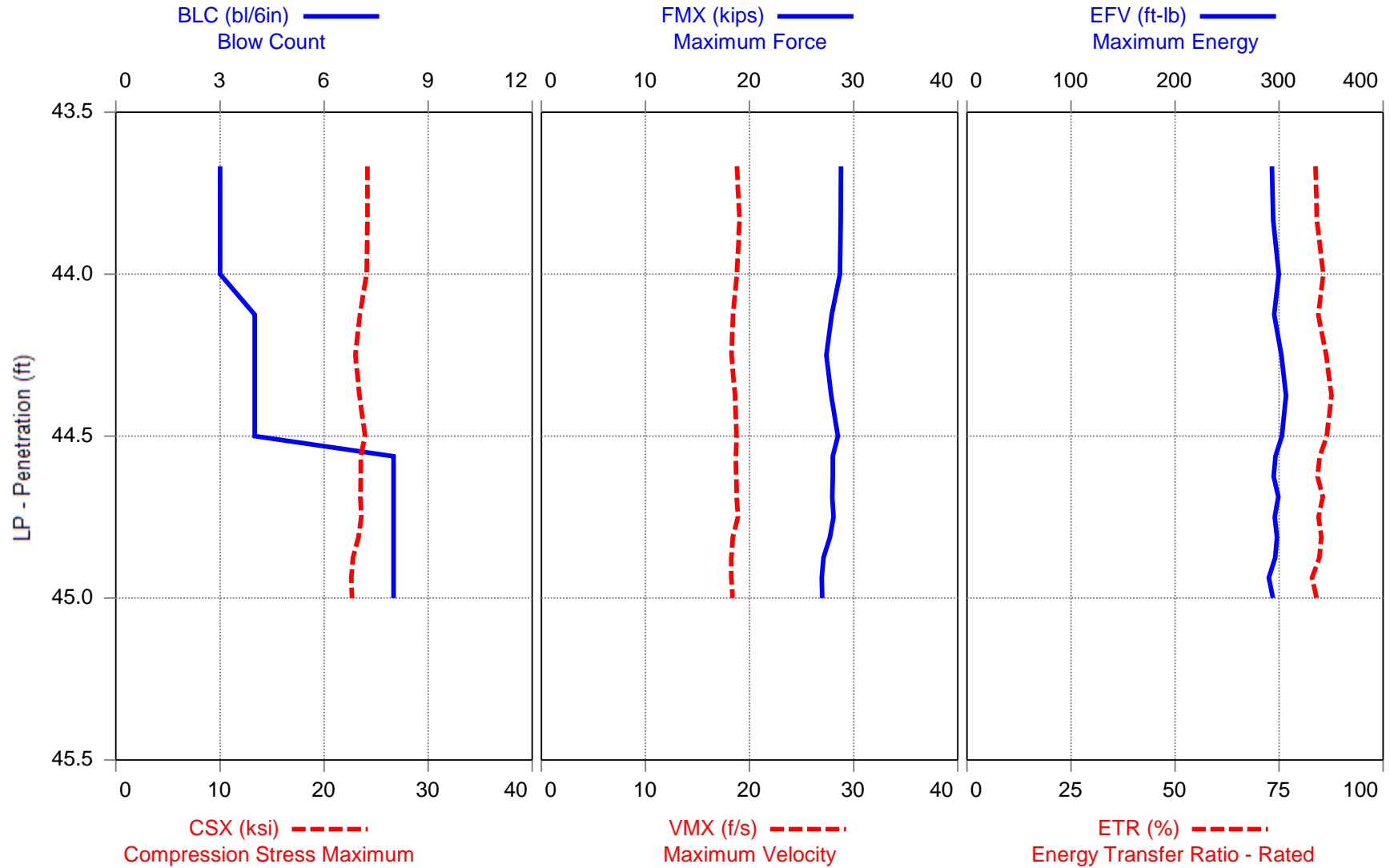
BL#	LP	BC	BPM	FMX	VMX	DMX	CSX	DFN	EFV	ETR
	ft	/6"	bpm	kips	ft/s	in	ksi	in	ft-lb	%
1	39.00	1	1.9	29	18.7	6.00	24.3	6.00	305	87.1
2	39.13	4	52.9	29	18.5	1.68	24.0	1.50	289	82.7
3	39.25	4	52.9	28	18.7	1.58	23.2	1.50	297	84.8
4	39.38	4	52.7	27	18.5	1.54	22.8	1.50	292	83.5
5	39.50	4	52.3	28	18.6	1.54	23.2	1.50	298	85.1
6	39.58	6	53.5	27	18.0	1.21	22.7	1.00	286	81.6
7	39.67	6	52.7	27	18.3	1.19	22.9	1.00	291	83.0
8	39.75	6	52.9	27	17.7	1.15	23.0	1.00	290	83.0
9	39.83	6	52.4	27	18.2	1.10	22.5	1.00	287	82.0
10	39.92	6	52.6	27	18.1	1.03	23.0	1.00	289	82.7
11	40.00	6	52.6	27	18.1	1.05	22.7	1.00	299	85.3
Average			52.8	27	18.3	1.31	23.0	1.20	292	83.4
Std Dev			0.3	0	0.3	0.23	0.4	0.24	4	1.2
Maximum			53.5	29	18.7	1.68	24.0	1.50	299	85.3
Minimum			52.3	27	17.7	1.03	22.5	1.00	286	81.6

N-value: 10

Sample Interval Time: 11.36 seconds.



CME-550X (SN 356573) - 43.5-45.0 FEET BH-7.1

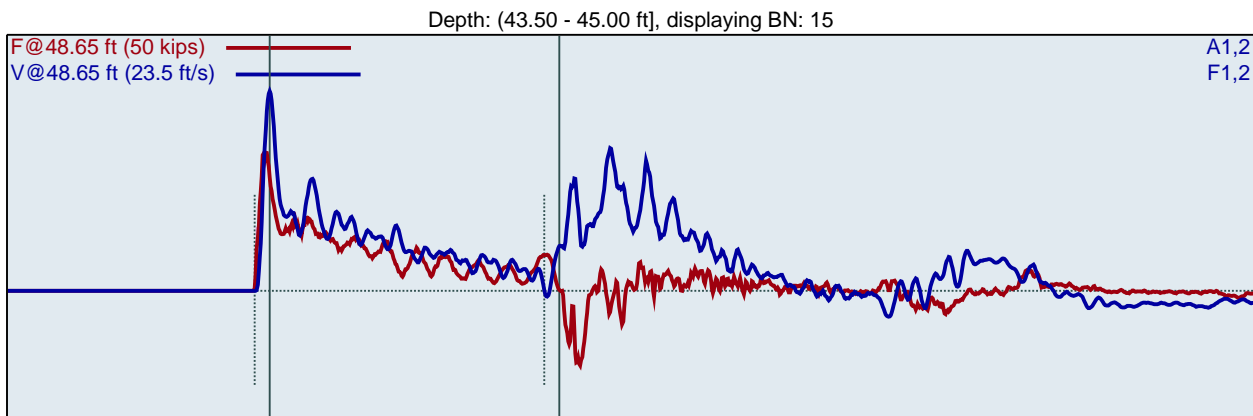


CME-550X (SN 356573)
JRW
BH-7.1

43.5-45.0 FEET
Test date: 10/1/2020

AR: 1.19 in²
LE: 48.65 ft
WS: 16807.9 ft/s

SP: 0.492 k/ft³
EM: 30000 ksi



F1 : [203 AWJ-1] 214.31 PDICAL (1) FF1
F2 : [203 AWJ-2] 214.45 PDICAL (1) FF1

A1 (PR): [K5642] 328 mv/6.4v/5000g (1) VF1
A2 (PR): [K1533] 374 mv/6.4v/5000g (1) VF1

BPM: Blows/Minute

FMX: Maximum Force

VMX: Maximum Velocity

DMX: Maximum Displacement

CSX: Compression Stress Maximum

DFN: Final Displacement

EFV: Maximum Energy

ETR: Energy Transfer Ratio - Rated

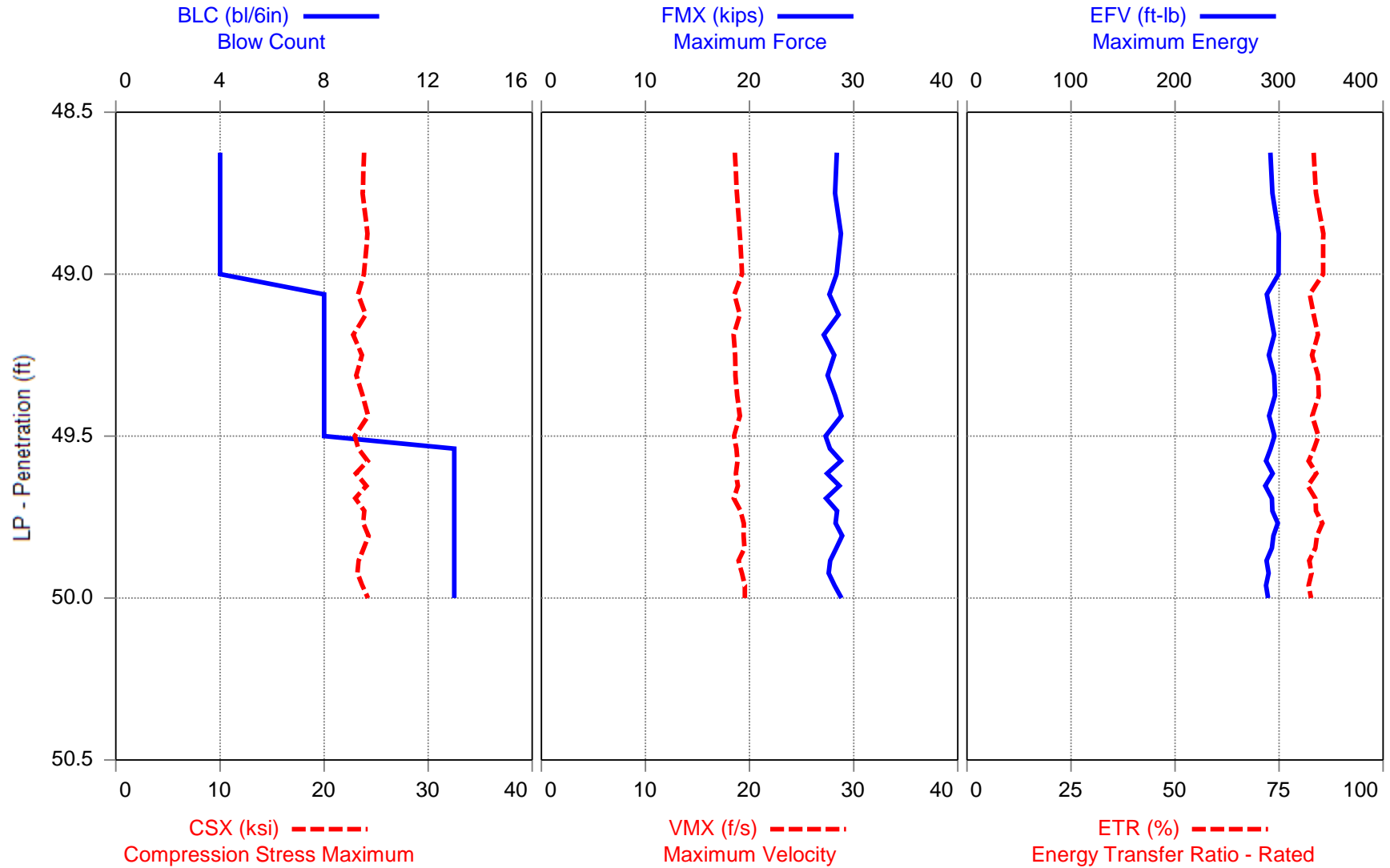
BL#	LP ft	BC /6"	BPM bpm	FMX kips	VMX ft/s	DMX in	CSX ksi	DFN in	EFV ft-lb	ETR %
1	43.67	3	1.9	29	18.8	2.16	24.2	2.00	293	83.7
2	43.83	3	52.5	29	19.0	2.00	24.2	2.00	294	84.1
3	44.00	3	53.3	29	18.8	2.00	24.1	2.00	300	85.6
4	44.13	4	53.3	28	18.4	1.54	23.4	1.50	295	84.4
5	44.25	4	51.9	27	18.3	1.50	23.0	1.50	302	86.3
6	44.38	4	53.0	28	18.6	1.50	23.4	1.50	306	87.6
7	44.50	4	52.5	28	18.7	1.50	23.9	1.50	303	86.4
8	44.56	8	52.6	28	18.7	0.89	23.5	0.75	297	84.7
9	44.63	8	52.6	28	18.7	0.84	23.5	0.75	295	84.2
10	44.69	8	53.0	28	18.8	0.84	23.5	0.75	299	85.5
11	44.75	8	52.3	28	18.9	0.79	23.6	0.75	296	84.5
12	44.81	8	52.3	28	18.4	0.79	23.3	0.75	298	85.1
13	44.88	8	52.5	27	18.2	0.80	22.8	0.75	296	84.7
14	44.94	8	52.2	27	18.2	0.80	22.6	0.75	290	82.9
15	45.00	8	52.7	27	18.4	0.80	22.7	0.75	294	84.0
Average			52.6	28	18.5	1.05	23.3	1.00	298	85.0
Std Dev			0.4	0	0.2	0.33	0.4	0.35	4	1.2
Maximum			53.3	28	18.9	1.54	23.9	1.50	306	87.6
Minimum			51.9	27	18.2	0.79	22.6	0.75	290	82.9

N-value: 12

Sample Interval Time: 15.93 seconds.



CME-550X (SN 356573) - 48.5-50.0 FEET BH-7.1



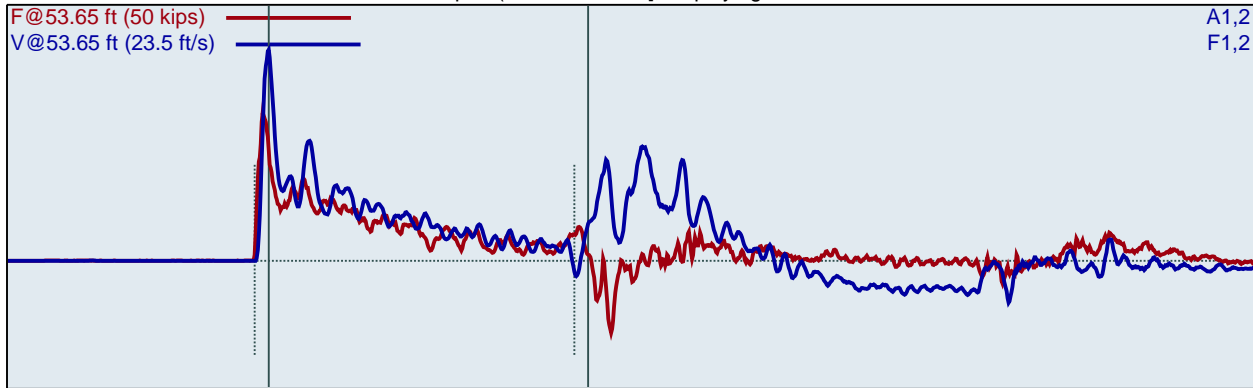
CME-550X (SN 356573)
JRW
BH-7.1

48.5-50.0 FEET
Test date: 10/1/2020

AR: 1.19 in²
LE: 53.65 ft
WS: 16807.9 ft/s

SP: 0.492 k/ft³
EM: 30000 ksi

Depth: (48.50 - 50.00 ft), displaying BN: 20



F1 : [203 AWJ-1] 214.31 PDICAL (1) FF1
F2 : [203 AWJ-2] 214.45 PDICAL (1) FF1

A1 (PR): [K5642] 328 mv/6.4v/5000g (1) VF1
A2 (PR): [K1533] 374 mv/6.4v/5000g (1) VF1

BPM: Blows/Minute

FMX: Maximum Force

VMX: Maximum Velocity

DMX: Maximum Displacement

CSX: Compression Stress Maximum

DFN: Final Displacement

EFV: Maximum Energy

ETR: Energy Transfer Ratio - Rated

BL#	LP ft	BC /6"	BPM bpm	FMX kips	VMX ft/s	DMX in	CSX ksi	DFN in	EFV ft-lb	ETR %
1	48.63	4	1.9	28	18.6	1.82	23.8	1.50	292	83.3
2	48.75	4	52.7	28	18.8	1.51	23.7	1.50	293	83.9
3	48.88	4	52.8	29	19.1	1.50	24.2	1.50	300	85.6
4	49.00	4	52.7	28	19.3	1.50	23.8	1.50	299	85.5
5	49.06	8	52.8	28	18.5	1.02	23.3	0.75	288	82.3
6	49.13	8	52.2	29	19.1	0.96	24.0	0.75	291	83.3
7	49.19	8	52.7	27	18.5	0.92	22.8	0.75	295	84.3
8	49.25	8	52.4	28	18.6	0.82	23.6	0.75	290	82.9
9	49.31	8	52.9	27	18.6	0.80	23.1	0.75	295	84.3
10	49.38	8	52.4	28	18.8	0.78	23.7	0.75	296	84.5
11	49.44	8	52.5	29	19.1	0.75	24.2	0.75	290	82.9
12	49.50	8	52.0	27	18.5	0.79	23.0	0.75	296	84.4
13	49.54	13	52.4	28	18.7	0.60	23.3	0.46	292	83.4
14	49.58	13	52.8	29	18.8	0.57	24.2	0.46	287	82.1
15	49.62	13	52.8	27	18.7	0.59	23.1	0.46	294	84.0
16	49.65	13	52.0	29	18.9	0.56	24.1	0.46	287	81.9
17	49.69	13	53.2	27	18.5	0.57	23.0	0.46	293	83.7
18	49.73	13	52.4	28	19.1	0.56	23.9	0.46	293	83.9
19	49.77	13	52.4	28	19.4	0.55	23.8	0.46	299	85.4
20	49.81	13	52.6	29	19.4	0.54	24.3	0.46	294	84.1
21	49.85	13	52.4	28	19.5	0.53	23.8	0.46	293	83.7
22	49.88	13	53.0	28	18.9	0.52	23.3	0.46	288	82.2
23	49.92	13	52.4	28	19.3	0.51	23.2	0.46	290	82.8
24	49.96	13	52.4	28	19.6	0.50	23.7	0.46	287	82.1
25	50.00	13	52.4	29	19.5	0.49	24.2	0.46	289	82.7

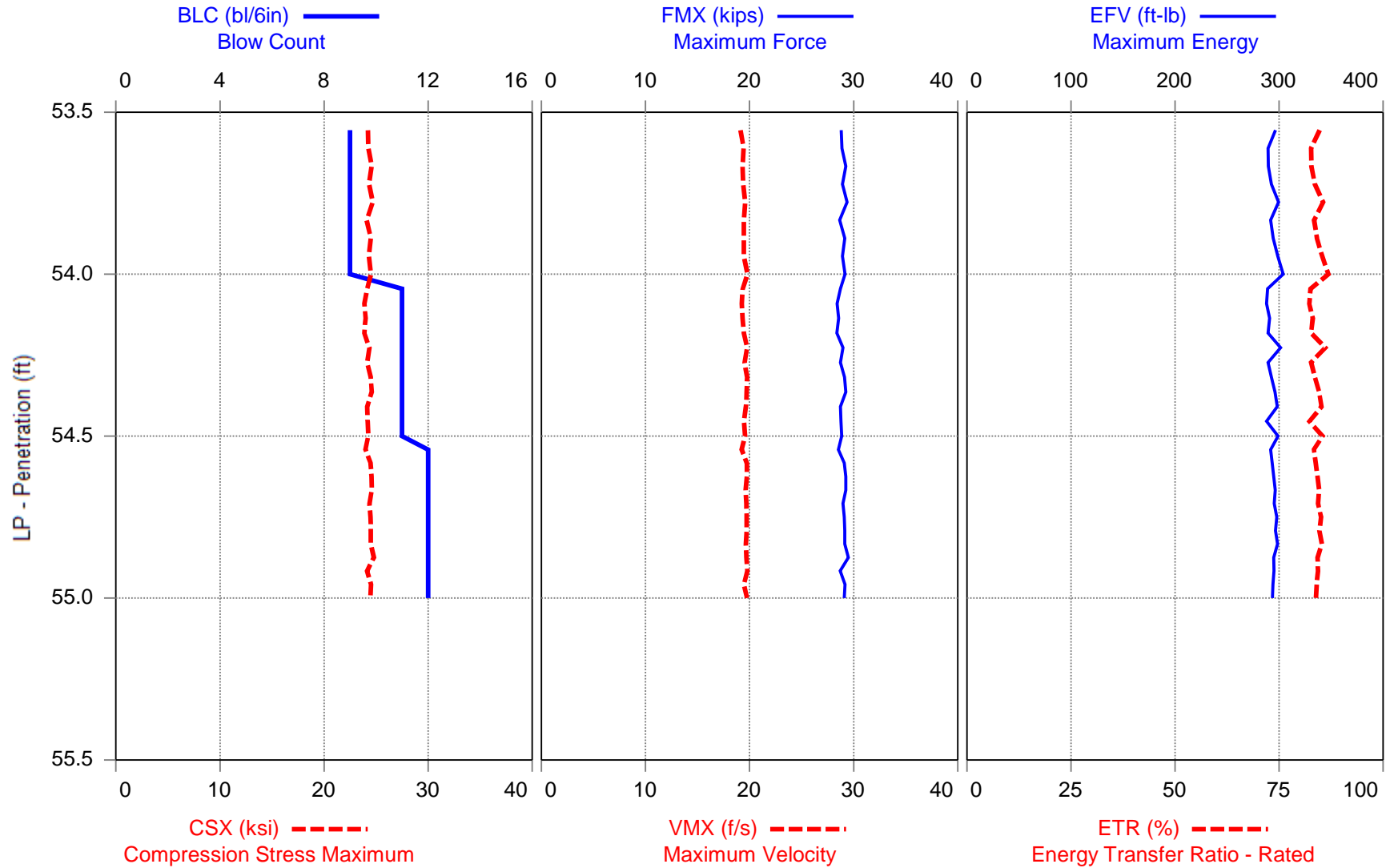
Average	52.5	28	19.0	0.66	23.6	0.57	292	83.4
Std Dev	0.3	1	0.4	0.16	0.5	0.14	3	0.9
Maximum	53.2	29	19.6	1.02	24.3	0.75	299	85.4
Minimum	52.0	27	18.5	0.49	22.8	0.46	287	81.9

N-value: 21

Sample Interval Time: 27.36 seconds.



CME-550X (SN 356573) - 53.5-55.0 FEET BH-7.1



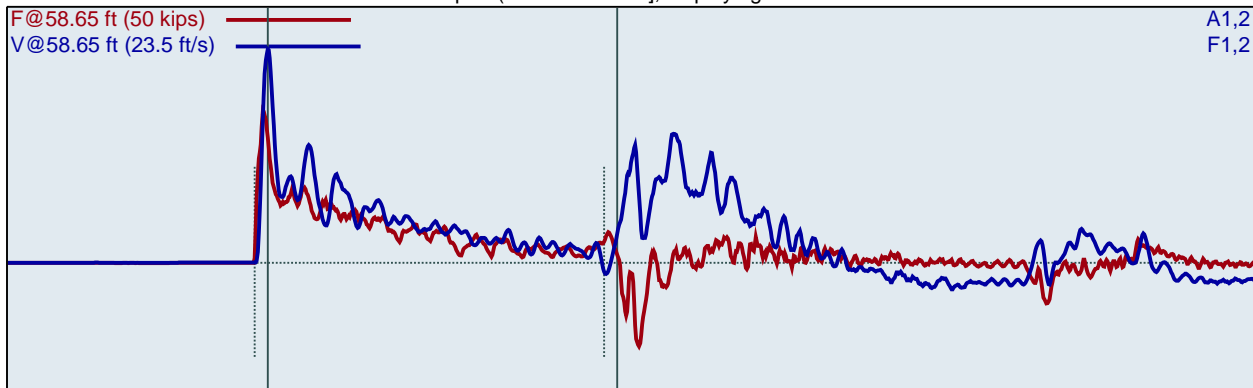
CME-550X (SN 356573)
JRW
BH-7.1

53.5-55.0 FEET
Test date: 10/1/2020

AR: 1.19 in²
LE: 58.65 ft
WS: 16807.9 ft/s

SP: 0.492 k/ft³
EM: 30000 ksi

Depth: (53.50 - 55.00 ft), displaying BN: 28



F1 : [203 AWJ-1] 214.31 PDICAL (1) FF1
F2 : [203 AWJ-2] 214.45 PDICAL (1) FF1

A1 (PR): [K5642] 328 mv/6.4v/5000g (1) VF1
A2 (PR): [K1533] 374 mv/6.4v/5000g (1) VF1

BPM: Blows/Minute

FMX: Maximum Force

VMX: Maximum Velocity

DMX: Maximum Displacement

CSX: Compression Stress Maximum

DFN: Final Displacement

EFV: Maximum Energy

ETR: Energy Transfer Ratio - Rated

BL#	LP ft	BC /6"	BPM bpm	FMX kips	VMX ft/s	DMX in	CSX ksi	DFN in	EFV ft-lb	ETR %
1	53.56	9	1.9	29	19.1	1.07	24.2	0.67	297	84.7
2	53.61	9	52.7	29	19.4	0.96	24.3	0.67	289	82.7
3	53.67	9	52.4	29	19.3	0.81	24.6	0.67	290	82.7
4	53.72	9	52.6	29	19.4	0.70	24.3	0.67	292	83.6
5	53.78	9	52.4	29	19.6	0.69	24.7	0.67	299	85.6
6	53.83	9	52.6	29	19.4	0.67	24.1	0.67	292	83.4
7	53.89	9	53.2	29	19.5	0.68	24.5	0.67	294	84.1
8	53.94	9	52.2	29	19.4	0.67	24.3	0.67	299	85.3
9	54.00	9	52.4	29	19.8	0.69	24.5	0.67	304	86.8
10	54.05	11	52.2	29	19.3	0.59	24.1	0.55	289	82.5
11	54.09	11	52.6	28	19.2	0.60	23.9	0.55	288	82.2
12	54.14	11	52.6	29	19.3	0.61	24.0	0.55	291	83.1
13	54.18	11	52.6	28	19.4	0.61	23.9	0.55	289	82.7
14	54.23	11	52.5	29	19.8	0.64	24.3	0.55	301	86.1
15	54.27	11	52.5	29	19.5	0.63	24.1	0.55	289	82.7
16	54.32	11	52.2	29	19.8	0.65	24.5	0.55	293	83.6
17	54.36	11	52.6	29	19.7	0.66	24.6	0.55	296	84.6
18	54.41	11	52.7	29	19.6	0.66	24.1	0.55	298	85.2
19	54.45	11	53.0	29	19.4	0.63	24.2	0.55	288	82.3
20	54.50	11	52.0	29	19.6	0.64	24.2	0.55	299	85.4
21	54.54	12	52.7	29	19.2	0.62	24.0	0.50	292	83.3
22	54.58	12	52.4	29	19.7	0.61	24.5	0.50	293	83.8
23	54.63	12	52.2	29	19.7	0.61	24.6	0.50	295	84.2
24	54.67	12	52.9	29	19.6	0.61	24.6	0.50	296	84.6
25	54.71	12	52.3	29	19.7	0.61	24.4	0.50	295	84.3
26	54.75	12	52.4	29	19.7	0.61	24.5	0.50	298	85.1
27	54.79	12	52.4	29	19.7	0.61	24.5	0.50	296	84.7

28	54.83	12	52.7	29	19.6	0.61	24.5	0.50	298	85.3
29	54.88	12	52.2	29	19.7	0.59	24.8	0.50	295	84.2
30	54.92	12	52.4	29	19.8	0.59	24.1	0.50	295	84.3
31	54.96	12	52.4	29	19.4	0.57	24.5	0.50	294	84.0
32	55.00	12	52.3	29	19.8	0.57	24.5	0.50	294	83.9
Average			52.5	29	19.6	0.61	24.3	0.52	294	84.0
Std Dev			0.2	0	0.2	0.02	0.2	0.02	4	1.0
Maximum			53.0	29	19.8	0.66	24.8	0.55	301	86.1
Minimum			52.0	28	19.2	0.57	23.9	0.50	288	82.2
N-value: 23										

Sample Interval Time: 35.37 seconds.

Summary of SPT Test Results

Project: CME-550X (SN 356573), Test Date: 10/1/2020

BPM: Blows/Minute											CSX: Compression Stress Maximum		
FMX: Maximum Force											DFN: Final Displacement		
VMX: Maximum Velocity											EFV: Maximum Energy		
DMX: Maximum Displacement											ETR: Energy Transfer Ratio - Rated		
Instr. Length ft	Start Depth ft	Final Depth ft	Blows Applied /6"	N Value	N60 Value	Average BPM bpm	Average FMX kips	Average VMX ft/s	Average DMX in	Average CSX ksi	Average DFN in	Average EFV ft-lb	Average ETR %
43.65	38.50	40.00	1-4-6	10	13	52.8	27	18.3	1.31	23.0	1.20	292	83.4
48.65	43.50	45.00	3-4-8	12	16	52.6	28	18.5	1.05	23.3	1.00	298	85.0
53.65	48.50	50.00	4-8-13	21	29	52.5	28	19.0	0.66	23.6	0.57	292	83.4
58.65	53.50	55.00	9-11-12	23	32	52.5	29	19.6	0.61	24.3	0.52	294	84.0
Overall Average Values:						52.6	28	19.0	0.81	23.7	0.73	294	83.9
Standard Deviation:						0.3	1	0.6	0.32	0.6	0.33	4	1.2
Overall Maximum Value:						53.5	29	19.8	1.68	24.8	1.50	306	87.6
Overall Minimum Value:						51.9	27	17.7	0.49	22.5	0.46	286	81.6

