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DFI Committee Project Funds (CPF)

Contract: ACIP Pile Committee Project on Verification of
Installation and Performance of ACIP Piles

Final Report
ACIP Pile Installation, Installation Monitoring, Full-scale Load Testing, and Extraction Program

Prepared for

Prepared by
Augered Cast-In-Place (ACIP) Pile Committee

December 2017

ACKNOWLEDGEMENTS

The DFI Augered Cast-In-Place (ACIP) Pile Committee would like to extend a special acknowledgement to the following for their financial, in-kind, and/or insightful contributions and support of the project. Without their contributions, this project would not have been possible.

- Argos Concrete
- Bauer Foundation Corp.
- Berkel and Company Contractors, Inc.
- Cajun Deep Foundations
- Deep Foundations Institute
- Farrel Design-Build, Inc.
- Florida Department of Transportation
- Goettle, Inc.
- HJ Foundations
- Langan Engineering and Environmental Services
- Loadtest USA
- Malcolm Drilling Company, Inc.
- Moretrench
- Nicholson Construction Company
- Pile Dynamics, Inc.
- Skyline Steel
- SpecCrete-IP, Inc.
- Terracon Consultants, Inc
- University of South Florida

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The financial support of the previously listed organizations should not be construed as an endorsement of this report.

Executive Summary

The Augered Cast-In-Place (ACIP) Pile Committee of the Deep Foundations Institute (DFI) performed a foundation installation, monitoring, performance and extraction program for ACIP piles in the fall of 2016. The purpose of the project was to demonstrate a fully monitored installation of instrumented 18 in (457 mm) and 24 in (610 mm) diameter ACIP piles, including automated monitoring equipment (AME); post-installation thermal integrity profiling (TIP) measurements; compression, tension, and lateral load testing (including monitoring of strain gages embedded along the compression pile shaft); and post-testing extraction of an installed pile for visual inspection.

The program was initially planned by the ACIP Pile Committee, and a program site in Okahumpka, FL was selected. Initial funding was provided by the DFI Committee Project Fund with additional funds and in-kind pledges contributed from DFI members and industry partners. In the summer of 2016, the Florida Department of Transportation (FDOT) and its research partners at the University of South Florida (USF) joined the program. Program details were finalized in the summer and fall of 2016.

The purposes of this research effort were to demonstrate

- The fully monitored installation of instrumented ACIP piles, including the use of automated monitoring equipment (AME)
- The use and accuracy of thermal integrity profiling (TIP) methods with ACIP piles
- The load-displacement behavior during compression, tension, and lateral load testing, including the use of and measurement by multiple strain gages embedded along the length of two piles
- The integrity and as-constructed geometry of an ACIP pile by extracting an installed pile for visual inspection.

To achieve the goals of the project, seven test piles were installed at a site in central Florida: two each for compression testing, tension testing, and lateral testing, and one pile for extraction and visual inspection.

The intent of this document is to make the data and information obtained during the demonstration program available to the members of the DFI ACIP Pile Committee, Florida DOT, University of South Florida, and other possible research partners for review, analysis/interpretation, and discussion. The ultimate goals of this endeavor are to advance the overall state-of-the-practice for ACIP piles and to develop documentation for review and use; installation, monitoring, and testing methods; and reporting procedures to allow for both the use of ACIP piles for structural support of bridges and the inclusion of ACIP piles in DOT and other agency specifications in the state of Florida and elsewhere.

All of the data presented and discussed herein can be made available in electronic format for additional analysis. Pertinent findings of the demonstration project include the following:

- The procedures and testing results described in the report highlight the successful installation, monitoring, and load carrying resistance provided by ACIP piles for structural support of bridges per the Florida DOT. The data can be used by the FL DOT as it develops a section for ACIP Piles for Bridges and Major Structures in its Standard Specifications.
- Grout volumes, as measured by an electromagnetic flowmeter and via manual counting of grout strokes, were in good agreement with each other.
- The overall grout volume of the extracted pile, when adjusted for the volume of grout observed flowing out of the top of the pile, was in good agreement with the volume calculated by manually measuring the circumference of the extracted pile at 1 ft (305 mm) intervals.
- Additional research into non-destructive testing (NDT) methods for ACIP piles, in particular Thermal Integrity Profiling, should produce a means to provide additional verification of pile integrity.

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INTRODUCTION

An augered cast-in-place (ACIP) pile, as it is referred in the U.S., is a deep foundation technology that encompasses drilling a hole into the ground using a hollow stem auger that forms the diameter of the pile, which is then filled with a sand-cement grout or concrete and steel reinforcement elements. In amenable ground conditions and for certain project applications, ACIP piles can be more economical, can be constructed more quickly, and are a viable foundation alternative to other deep foundation techniques (e.g., driven piles and drilled shafts). ACIP piles have been used for support of structures, for lateral earth retention applications, for embankment support and in ground improvement applications.

One of the last major markets in the United States where augered cast-in-place (ACIP) piles are not routinely considered is on publically funded transportation projects under the auspices of state and federal departments of transportation (DOTs), especially for structural support of bridge columns, abutments, and piers/bents. According to FHWA, nearly twenty state DOTs and the FHWA Federal Lands Highway Division have approved the use of the ACIP pile technology on a project-by-project (or project specific) basis. ACIP piles are well suited for a variety of transportation project applications, including structure support for new bridges, bridge widening, sound wall foundations, column support for embankment construction, and secant pile walls for lateral earth support. In addition, ACIP piles provide a viable and cost effective solution in environmentally sensitive areas requiring minimal disturbance.

Geotechnical Engineering Circular No. 8 (GEC-8): *Design and Construction of Continuous Flight Auger (CFA) Piles* (Brown et al, 2007), which was sponsored and published by the Federal Highway Administration (FHWA) provides an excellent framework for contractors to provide performance-based specification alternates for certain projects. However, feedback from state DOTs has indicated continued uncertainty or a lack of understanding about the monitoring methods available to ensure quality and repeatability of ACIP pile installation and its (subsequent) performance.

The purposes of this research project were to demonstrate

- The fully monitored installation of instrumented ACIP piles, including the use of Automated Monitoring Equipment (AME)
- The use and accuracy of thermal integrity profiling (TIP) methods with ACIP piles
- The load-displacement behavior during compression, tension, and lateral load testing, including the use of and measurement by multiple strain gages embedded along the length of two piles
- The integrity and as-constructed geometry of an ACIP pile by extracting an installed pile for visual inspection.

To achieve the goals of the project, seven test piles were installed at a site in central Florida: two each for compression testing, tension testing, and lateral testing, and one pile for extraction and visual inspection. Additional ACIP piles were installed and used as reaction piles in conjunction with the load testing assembly.

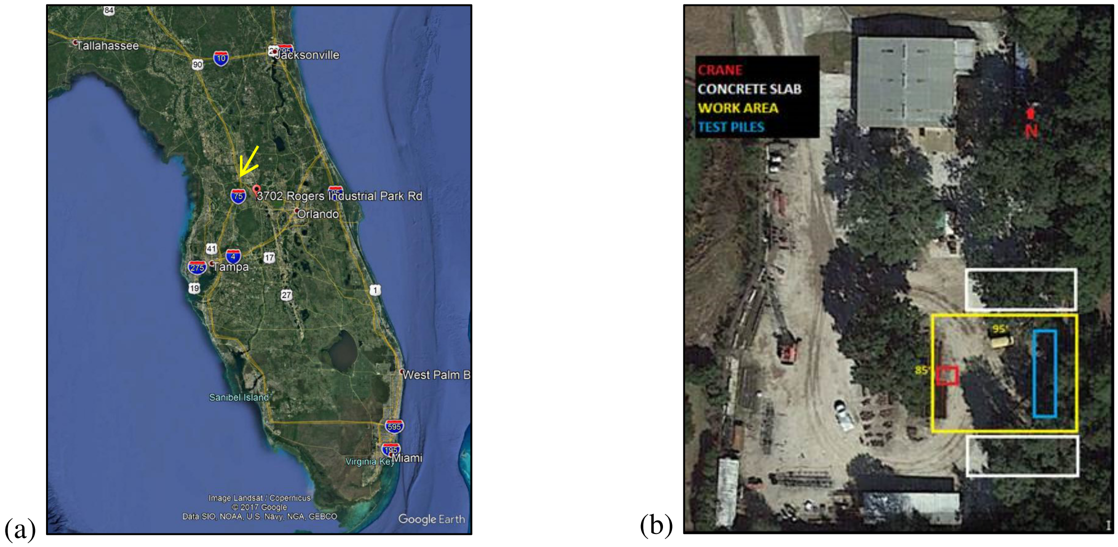
At the start of this research project in 2016, the University of Florida was developing a database of Load and Resistance Factor Design (LRFD) values for ACIP piles for the Florida DOT, which was to be incorporated into the FL DOT Standard Specifications for Road & Bridge Construction. As such, the value of this research is that the results of this project will provide additional information to that LRFD database and specifications development and will provide a formal document that federal and state/local DOTs can reference regarding the constructability of ACIP piles and their acceptability for use in transportation projects. Ultimately, the results of this research will enable federal and state/local DOTs to provide a potentially more efficient foundation alternative for their projects, while ensuring integrity and reliability along with reducing public expenditures (i.e., tax dollars) on their projects. Working with the Florida DOT to develop appropriate specifications for the use and inclusion of ACIP piles in FL DOT's

Standard Specifications for Road and Bridge Construction will provide a framework for other state/local DOTs to reevaluate their practice on the use (or non-use) of ACIP piles. With the continued focus on the rehabilitation, repair, and expansion of U.S. infrastructure, the availability and acceptability of ACIP piles as a suitable foundation system for public works and transportation projects will be of significant economic benefit to the industry and public.

EXPERIMENTAL PROGRAM

PROJECT LOCATION

The demonstration project was performed in the southeast corner of Berkel & Company Contractors' Central Florida facility located in Okahumpka, Florida, which is about 35 mi (56 km) northwest of downtown Orlando. A general location map and an aerial view of the property, with the test location outlined, are shown in Figure 1.



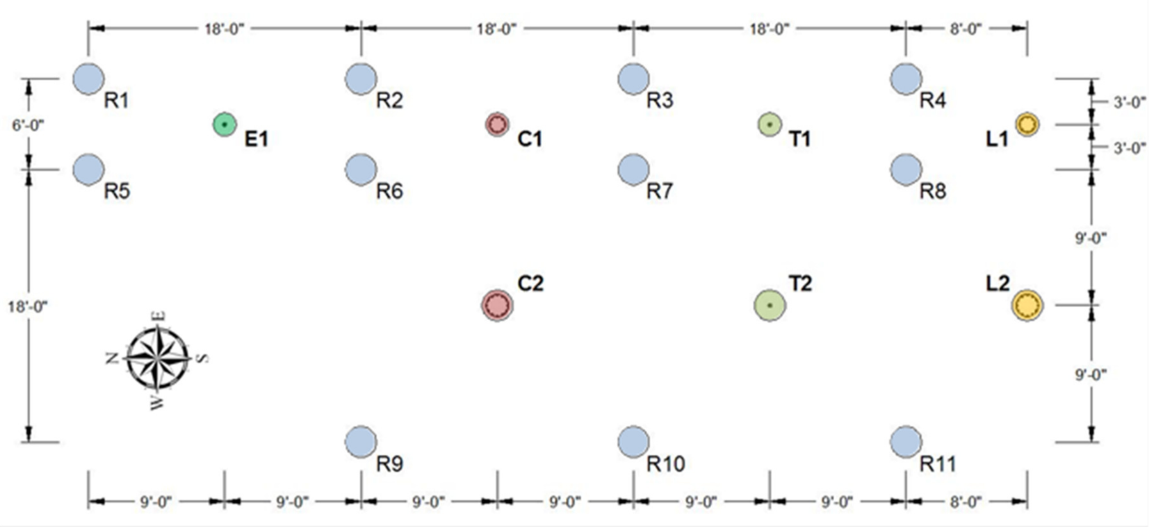
(a) (b)

Figure 1. Project location and aerial view of test area

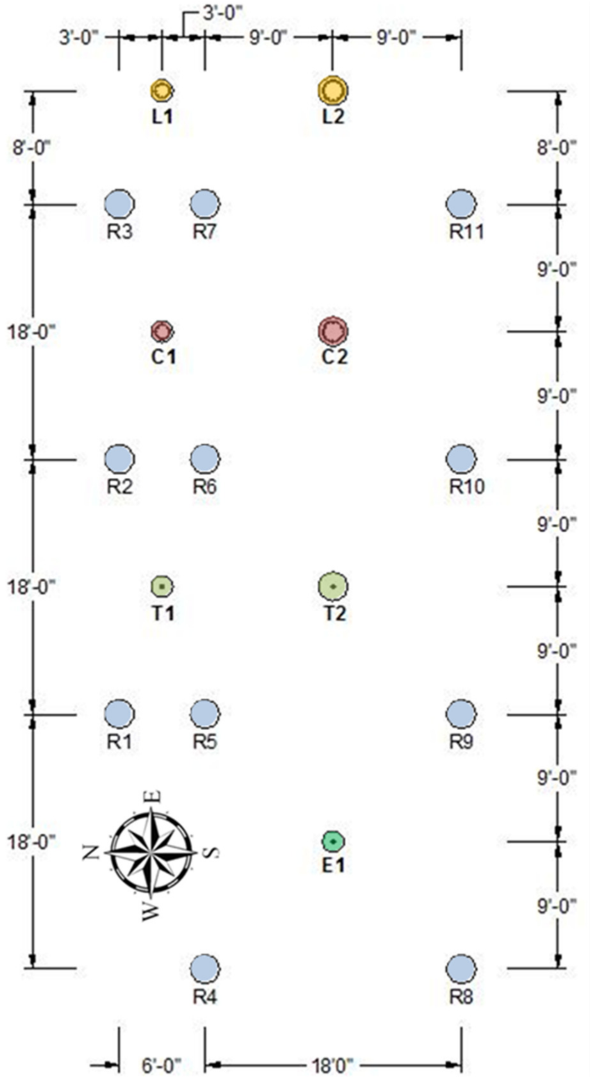
SUBSURFACE CONDITIONS

In August 2016, two cone penetration tests (CPTs) were performed at the initial reaction pile locations R-6 and R-8 (Figure 2a). From the CPTs, the generalized subsurface profile across this zone is mostly sands down to a depth of about 40 ft (12.2 m), with stiff fine-grained soil from a depth of 15 to 22 ft (4.6 to 6.7 m) at R-6 and clay and from a depth of 30 to 40 ft (9.1 to 12.2 m) at R-8. Below a depth of about 40 ft (12.2 m) down to about 75 ft (22.9 m), the subsurface profile consisted of alternating layers of varying thickness consisting of sands, clays, silts, and silt/sand mixtures, where silt/sand mixture and clay were more prominent at R-6 and sand and sand mixtures were more prominent at R-8.

At location R-6, the CPT results indicated very loose soil conditions below a depth of about 55 ft (16.8 m), indicating potential relic sinkhole conditions. To avoid possible problems around R-6, the testing configuration was rotated and repositioned to the southern extent of the test area (Figure 1), as shown in Figure 2b. In September 2016, soil borings were performed and standard penetration test (SPT) blow counts (N-values) using a manual safety hammer were obtained by personnel from FL DOT. Based on the descriptions from the soil borings logs, the general subsurface profile consists mainly of sand and silty sand. A strata of clay was noted in four of the six soil borings (B-1 [L-1], B-4 [L-2], B-5 [C-2], and B-6



(a)



(b)

Designation	Description
E1	Extraction Pile 18 in (457 mm) diam.
C1	Compression Load Pile 18 in (457 mm) diam.
T1	Tension Load Pile 18 in (457 mm) diam.
L1	Lateral Load Pile 18 in (457 mm) diam.
C2	Compression Load Pile 24 in (610 mm) diam.
T2	Tension Load Pile 24 in (610 mm) diam.
L2	Lateral Load Pile 24 in (610 mm) diam.
R1 – R11	Reaction Piles

Figure 2. Layout of ACIP test piles and reaction piles: (a) original and (b) revised

[T-2]), and it was present at different depths (from 25 to 55 ft [7.6 to 16.8 m]) but of almost constant thickness (about 10 ft [3 m]). The depth to the groundwater table was noted as about 13 ft (4.0 m) in soil boring B-1 (L-1) only.

The soil boring (hand written) logs include details about the drilling, on site visual soil classifications, and SPT N-values. A profile of the SPT N-value variation with depth is delineated in Figure 3. CPT sounding profiles and soil boring logs are provided in Appendix A.

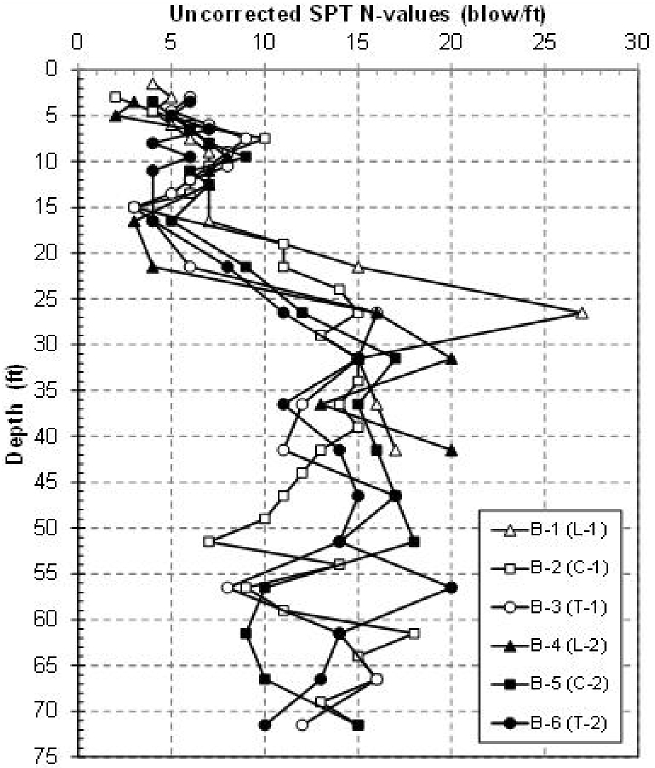


Figure 3. SPT N-value variation with depth

TEST PILES - DETAILS

Based on the results of the site characterization, the details of the testing program (e.g., geometry, layout, loading, and instrumentation) were finalized. Seven ACIP test piles and 11 ACIP reaction piles were installed at the site in October 2016 (Figure 3). The diameters of the test piles were either 18 or 24 in (457 or 610 mm) and the depths of embedment were either 40 or 60 ft (12.2 or 18.3 m). Design details and steel reinforcement details are provided in Tables 1 and 2, respectively.

INSTRUMENTATION

Thermal integrity profiling (TIP) methods were used in conjunction with the research project to evaluate their feasibility with ACIP piles, and, as such, were incorporated into each of the test piles. The TIP process involves monitoring and recording the temperature of the concrete or grout within a cast-in-place pile during its curing, especially near the peak heat of hydration. Two means of instrumentation can be used with the TIP method: (a) use of a thermal probe inserted into an access tube embedded within the pile, and/or (b) use of thermal wires containing thermistors located at intervals of about 12 in (0.3 m) along the spool length. The general concept of the TIP method is that a good quality and uniform pile will have a uniform temperature profile along its length.

Table 1. Details of the ACIP test piles

Pile Desig.	Pile Diameter inch [mm]	Embedment Depth ft [m]	Embeds and Instrumentation					Estimated Capacity ton [kN]	Max. Test Load to be Applied ton [kN]
			# TIP Wires	PVC Tube	Steel Tube	TIP Probe	Strain Gauge		
C1	18 [457]	40 [12.2]	4 Partial 1 Full	---	---		Yes	220 [1957]	600 [5338]
L1	18 [457]	40 [12.2]	4 Partial 1 Full	---	---		---	16 [142]	40 [356]
T1	18 [457]	40 [12.2]	0 Partial 1 Full	---	---		---	205 [1824]	400 [3559]
C2	24 [610]	60 [18.3]	4 Partial 1 Full	---	4	Partial Length	Yes	285 [2535]	900 [8007]
L2	24 [610]	60 [18.3]	4 Partial 1 Full	4	---	Partial Length	---	30 [267]	40 [356]
T2	24 [610]	60 [18.3]	0 Partial 1 Full	---	---		---	265 [2358]	400 [3559]
E1	18 [457]	40 [12.2]	4 Partial 1 Full	---	---		---	---	---

Table 2. Steel reinforcement details for test piles

Pile Desig.	Pile Diameter inch [mm]	Center Bar		Rebar Cage		
		Size and Grade	Length ft [m]	Longitudinal Bars	Length	Shear Reinforcement
C1	18 [457]	#11 (No. 36) Gr. 60 (Gr. 420)	40 [12.2]	8 - #8 [No. 25]	35 ft [10.7]	Top 6 ft (1.8 m): #3 (No. 10) ties at 4 in (102 mm) on center Remainder: #3 (No. 10) ties at 12 in (305 mm) on center
L1	18 [457]	#11 (No. 36) Gr. 60 (Gr. 420)	40 [12.2]	8 - #8 [No. 25]	35 ft [10.7]	Top 6 ft (1.8 m): #3 (No. 10) ties at 4 in (102 mm) on center Remainder: #3 (No. 10) ties at 12 in (305 mm) on center
T1	18 [457]	3 in [76 mm] Gr. 150	40 [12.2]	---	---	---
C2	24 [610]	#11 (No. 36) Gr. 60 (Gr. 420)	60 [18.3]	12 - #8 [No. 25]	35 ft [10.7]	Top 8 ft (2.4 m): #3 (No. 10) ties at 6 in (102 mm) on center Remainder: #3 (No. 10) ties at 12 in (305 mm) on center
L2	24 [610]	#11 (No. 36) Gr. 60 (Gr. 420)	60 [18.3]	12 - #8 [No. 25]	35 ft [10.7]	Top 8 ft (2.4 m): #3 (No. 10) ties at 6 in (102 mm) on center Remainder: #3 (No. 10) ties at 12 in (305 mm) on center
T2	24 [610]	3 in [76 mm] Gr. 150	60 [18.3]	---	---	---
E1	18 [457]	3 in [76 mm] Gr. 150	40 [12.2]	8 - #8 [No. 25]	40 ft [12.2]	#3 (No. 10) ties at 12 in (305 mm) on center

The expected temperature at any location is dependent on the diameter of the pile, grout or concrete mix design, time of measurement, and the distance from the TIP sensor to the center and edge of the pile (Figure 4). TIP measurements can be used to estimate the actual shape of the pile element, which can be compared with the concreting or grouting records to assess the overall quality of the pile. Because the method relies on the heat of hydration, TIP testing begins soon after placement of the grout or concrete, generally between 8 and 48 hours after placement. Smaller diameter piles are typically tested earlier in the range of testing times, as the heat of hydration in these elements is able to dissipate relatively quicker than larger diameter piles. TIP sensor measurements indicating temperatures that are cooler than normal indicate inclusions, necking or poor quality concrete, whereas measurements indicating temperatures warmer than normal are indicative of bulges outside of the cage diameter. Variations in temperature between diagonally opposite pairs of thermal wire cables reveal cage eccentricities (i.e., misalignment).

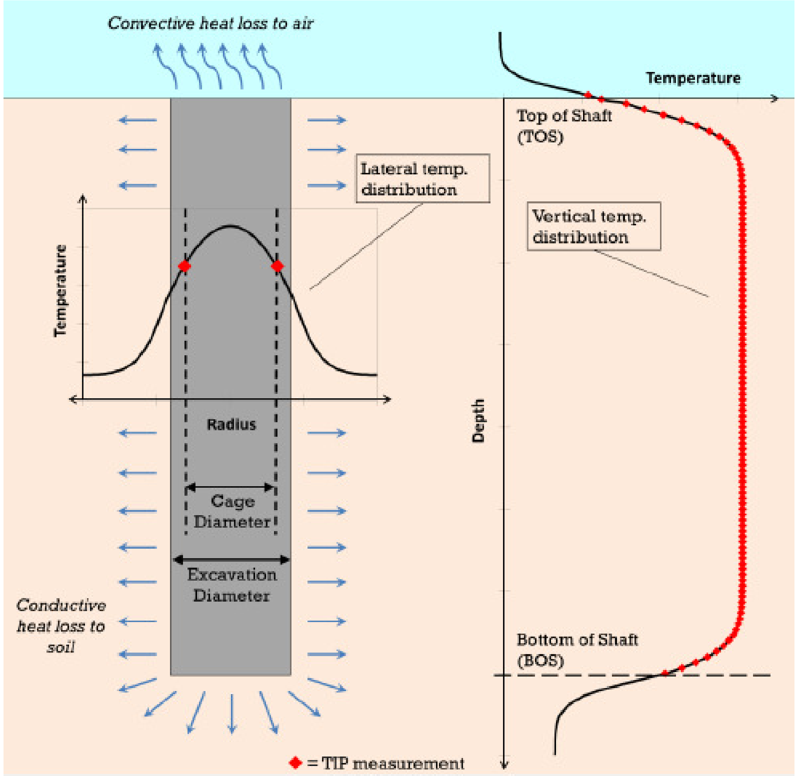
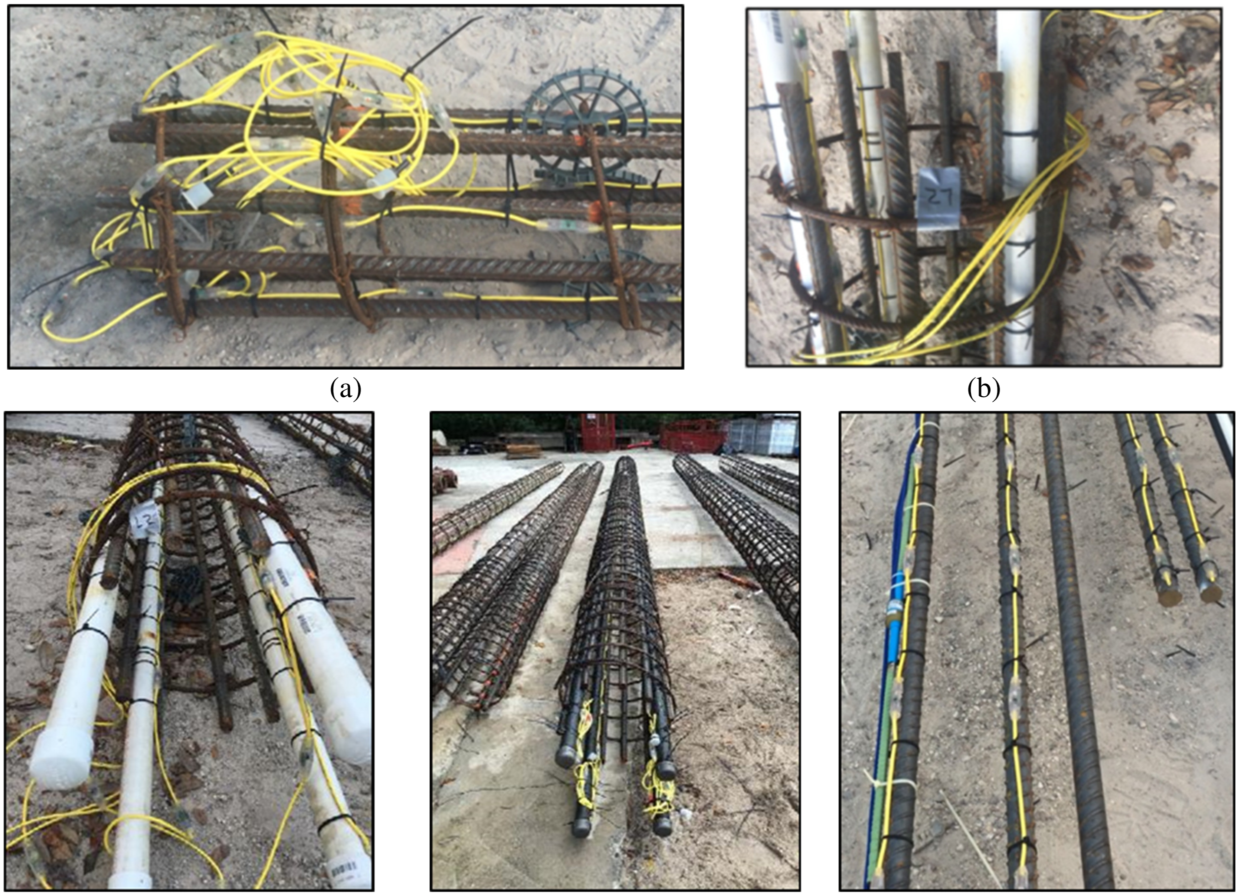


Figure 4. Distribution of temperature profile across and along an idealized uniform cast-in-place concrete pile (Mullins and Johnson, 2016)

In coordination with the University of South Florida under its contract with FDOT (BDV25 977-34), a combination of TIP methods (i.e., thermal wire and probe) were used to collect thermal data about the grout over time to compare the two instrumentation methods and analysis techniques. Thermal wires only were instrumented on test piles C1, L1, and E1 where they were secured with plastic wire ties to the center reinforcement bar and to longitudinal bars on the rebar cage at 12 in (305 mm) vertical intervals. For piles T1 and T2, thermal wires were secured to the center reinforcement bar. As indicated in Table 1, both thermal wires and access tubes for TIP probes were embedded in piles C2 and L2, where the thermal wires were attached to the center bar reinforcement and to the steel (C2) or PVC (L2) access tubes. In addition, pile E1 was extracted and was used to evaluate the construction installation methods, to assess the validity of quality control / quality assurance (QC/QA) methods, and to serve as a baseline or control for the TIP analysis comparison. Photographs of different TIP configurations used in the testing program are shown in Figure 5.



(a) (b)

(c) (d) (e)

Figure 5. Photographs of TIP configurations used: (a) thermal wires attached to rebar cage, (b,c) thermal wires attached to PVC tubes and rebar cage (L2), (d) thermal wires attached to steel tubes and rebar cage (C2), and (e) thermal wires and vibrating wire strain gages attached to No. 11 center bars. Source for (c) and (d): Mullins and Johnson (2017).

Vibrating wire strain gages were installed in the 18 in (457 mm) and 24 in (610 mm) diameter compression piles (C1 and C2, respectively). A photograph and schematics of an embedment strain gauge are shown in Figure 6. Sister-bar mounted gages were attached to the steel center bar near the top of the pile (depth of 2 ft [0.6 m], near the bottom of the pile (depth of 58 ft [17.7 m], and at 10 ft (3.05 m) intervals throughout the length of the pile, as shown in Figure 7. Calibration reports for each of the sister bar strain gages are provided in Appendix B.

As a late adjustment to the program, RIM-cells (bi-directional production load test cells) were installed in two reaction piles: R1 (18 in [457 mm] diameter) and R5 (24 in [610 mm] diameter). The RIM-cell is a tool used in conjunction with the QC/QA program and the results provide confirmation of performance (i.e., piles / shafts loaded up to about 30% greater than the design load). Given the large open center in the apparatus, the devices were attached to the bottom of the rebar cages and placed as a unit into the wet grout to a depth such that the bottom of each cell was about 6 in (152 mm) above the toe of its respective pile. Photographs of the cells and their connections are shown in Figure 8. A representative graph of the load-displacement behavior obtained using the RIM-cell is shown in Figure 9.

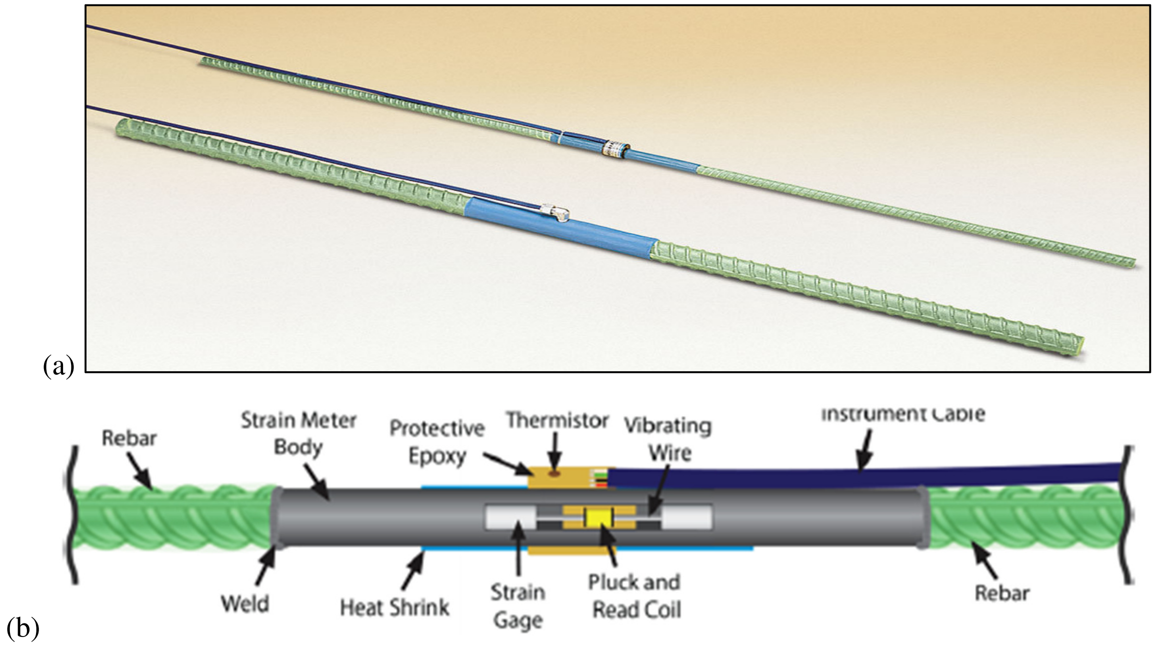
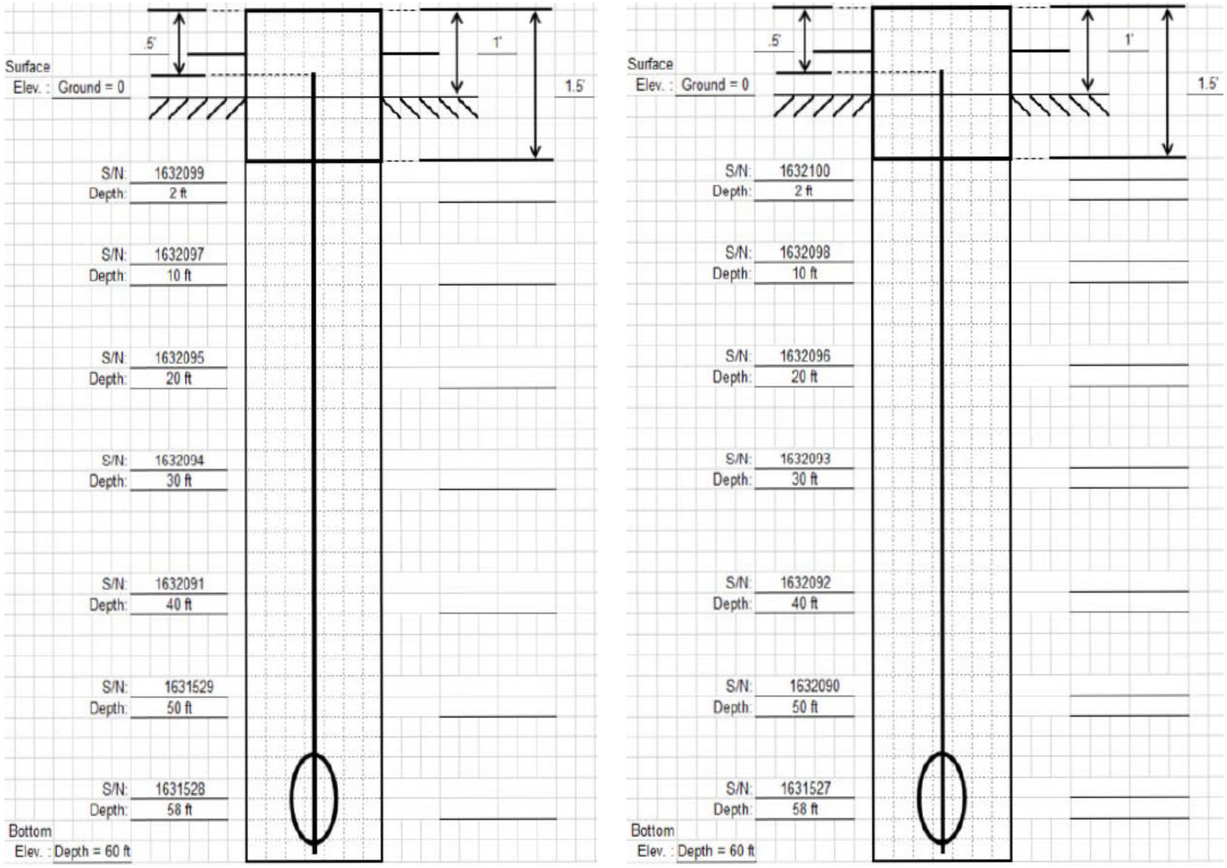


Figure 6. Geokon Model 4911 vibrating wire rebar strain meters: (a) photograph of a complete sister bar setup, and (b) schematic showing components of device (http://www.geokon.com)



(a) (b)

Figure 7. Arrangement of strain gages in test piles (a) C1 and (b) C2

(a) (b) (c)

Figure 8. Photographs of RIM-cell and connections: (a) 12 in (305 mm) and 18 in (457 mm) diameter RIM-cells installed in reaction piles R1 and R5, (b) hydraulic hoses and PVC casing from embedded RIM-cell, and (c) PVC casing from RIM-cell attached to steel reinforcement

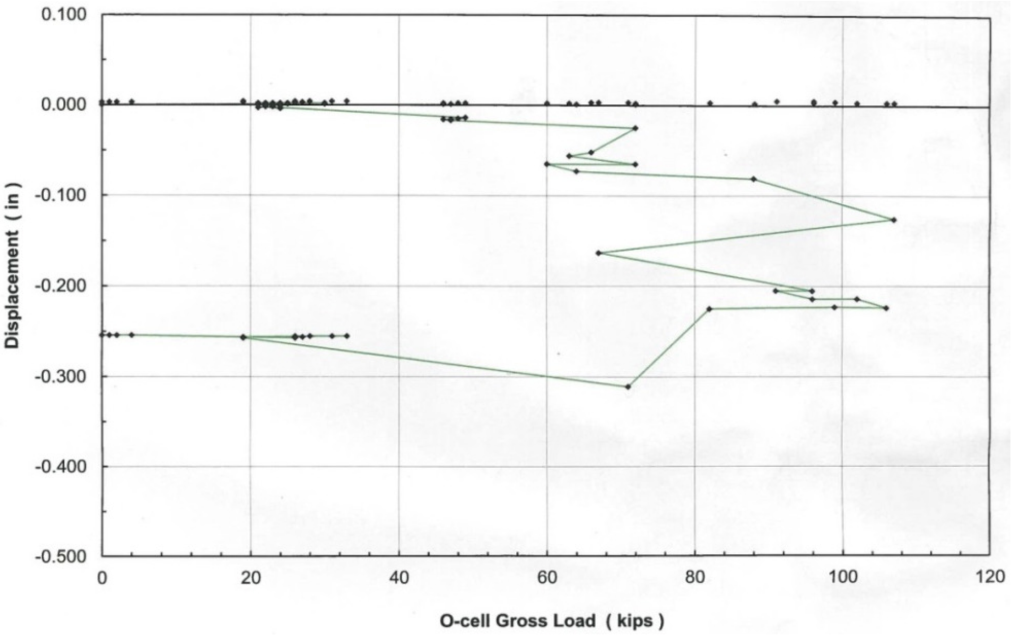


Figure 9. Representative load-displacement behavior obtained using the RIM-cell (courtesy of Fugro / LOADTEST, Inc.)

GROUT MIX

Based on the anticipated target test loads, the grout mix used for the test piles and reaction piles was designed for a minimum compressive strength of 6,000 psi (41.4 MPa). The grout mix consisted of Portland Type I/II cement, sand (fine aggregate), fly ash, water, and DSC Concentrate (a water reducing admixture). The design and components of the grout mix are provided in Table 3. The DSC Concentrate is a water reducing grout fluidifier that is especially designed for use with ACIP piling grouts, and it is intended to minimize bleeding and setting shrinkage while maintaining a fluid, yet cohesive grout. The description and material specifications for the DSC Concentrate are provided in Appendix C.

Table 3. Details of grout mix design

Parameters	Value
Compressive strength 28 days, psi (MPa)	6000 (41.4)
Cement content (Type I/II), lb (kg)	940 (426)
Fly ash, lb (kg)	180 (82)
Fine aggregate sand, lb (kg)	1900 (862)
Water content, gallon (liter)	45 to 50 (170 to 189)
Admixture, DSC Concentrate	7 lb (3.2 kg) per truck of grout
Maximum water/cement (w/c) ratio	0.42
Flow rate of fluid grout (sec)	17 to 20
Plastic unit weight, lb/ft^3 (kN/m^3)	134 (21.1)

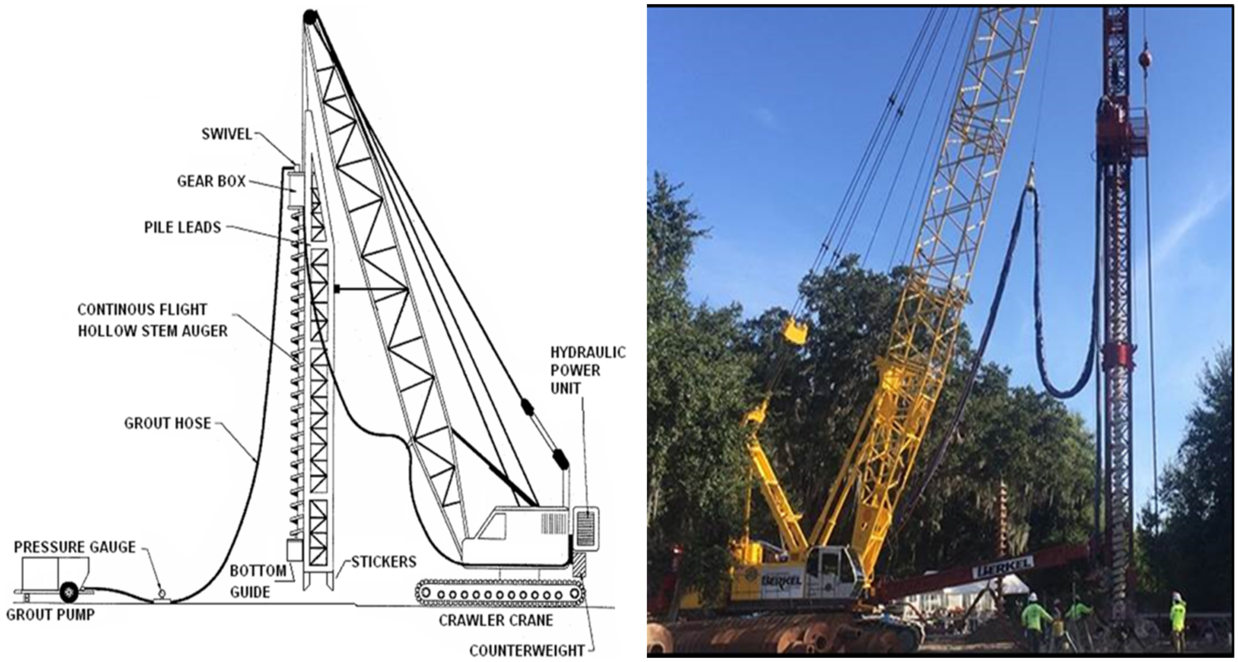
DRILLING EQUIPMENT AND MONITORING SYSTEM

A schematic of a typical pile rig used for ACIP pile installation and a photo of the fixed leads crane-mounted drilling platform used to drill the piles for this project are presented in Figure 10a and 10b, respectively. As part of the drilling platform, the specifications of the grout pump, gear box, and hydraulic power pack are provided in Appendix D.

Automated Monitoring Equipment (AME) was used to monitor and record various installation parameters, such as auger rotation rate, depth of penetration of the auger tooling, hydraulic fluid pressure supplied to the turntable, and incremental and total volume/flow of grout supplied. Manual monitoring and measurement recording was performed to provide the contractor and inspector(s) corroborating data of the installation parameters, supplemental information not captured by the AME, and a backup measurement of the installation parameters and data in the event of a malfunction with the AME. Typically, the data recorded by the AME is stored in electronic format and available for download for subsequent processing, and most modern AME systems have software that facilitate post-installation processing and report preparation.

The different AME used during the installation of the test piles and reaction piles is described below.

- A display unit/monitor with a real-time clock in the cab is used to show, numerically and/or graphically, the operator and/or inspector the parameters being monitored, measured, and recorded by the various sensors during installation.
- A depth sensor is used to measure the pile depth and the rates of penetration and withdrawal. The depth sensor may consist of (a) a rotary encoder on self-retracting cable spool attached to drill top or gear box, (b) a spring loaded rotary encoder mounted on the gear box and in constant contact with the leads to monitor auger tip depth at all times during installation, or (c) a proximity sensor mounted on the main winch calibrated to convert winch rotation to tool depth.
- Rotation sensors allow the rotation rate to be viewed on the display unit in the cab. These sensors consist of (a) a proximity switch on the rotary head/gearbox or (b) a flow measurement of the hydraulic fluid pressure that is applied to the rotary head and that is calibrated with rotation rate.
- Rotary head pressure sensors are used to monitor the hydraulic pressure provided to the gearbox. On some equipment, the hydraulic pressure can be converted to torque; on others, the torque is computed using hydraulic pressure and rotational pressure.
- A magnetic flow meter measures the volume of grout pumped through the system. A magnetic flow meter is installed in the grout line near the drilling platform, and is equipped with exposed electrodes that must be in contact with the conductive fluid (i.e., grout).



(a) (b)

Figure 10. (a) Typical ACIP pile rig components and (b) pile installation platform used for this project

INSTALLATION RECORDS

The grout volumes used in the test piles and reaction piles were measured using the AME (i.e., using a magnetic flow meter and calculated for each 2 ft (0.6 m) increment of the pile length. The increment length at the bottom of the pile was automatically adjusted based on the pile length recorded by the AME. Excerpts of the installation record for test pile C-2 recorded using AME are shown in Figures 11 (parameter versus time) and 12 (parameter versus depth). In addition, per agreement with FL DOT inspectors on site to witness the installation, the volume of grout was recorded manually using a count of the calibrated strokes of the grout pump. The records of the measurements taken using the AME and manually during installation are presented in Appendices E and F, respectively.

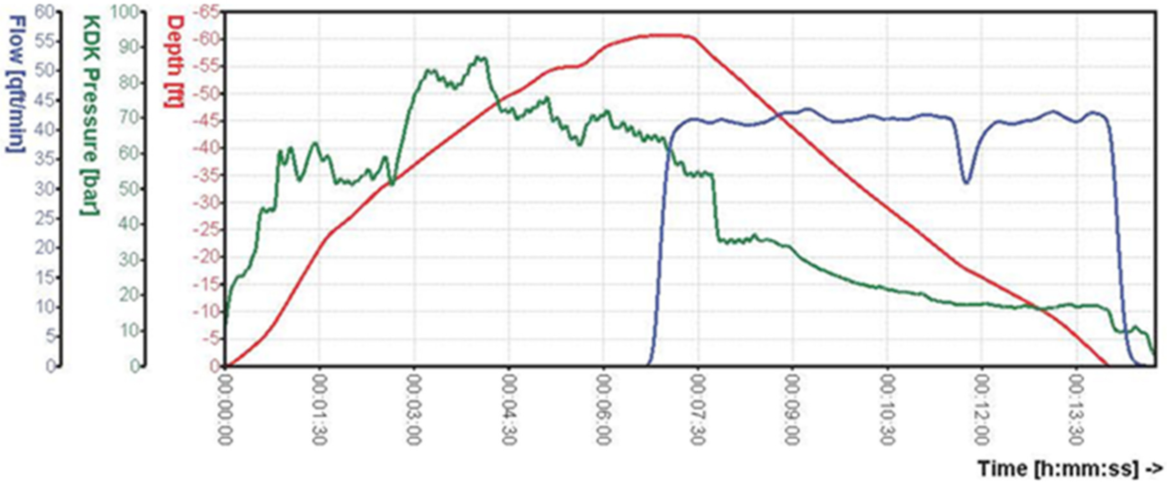


Figure 11. Excerpt of installation record for test pile C-2 – penetration depth, hydraulic pressure, and grout flow versus time recorded using AME

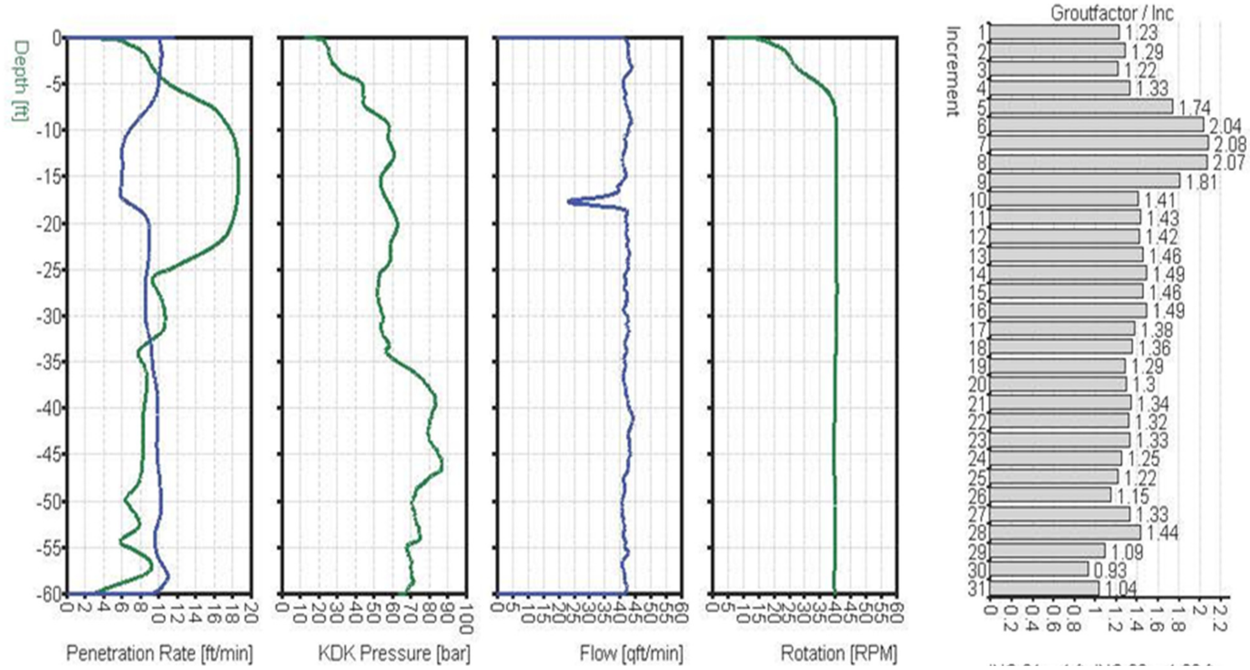


Figure 12. Excerpt of installation record for test pile C-2 – penetration rate, hydraulic pressure, grout flow, and increment grout factor versus depth recorded using AME

PRE-LOAD TESTING MONITORING

COMPRESSIVE STRENGTH TESTING OF GROUT

Grout samples were collected and tested according to ASTM C109 / C109M-16a (ASTM, 2016) for testing of the grout cubes at three different curing times. Two samples from each pile were tested at 7, 14, and 28 days after the pile was installed. The individual unconfined compressive strengths for each sample along with the average unconfined compressive strength for all of the samples at each curing time are presented in Table 4 and Figure 13.

Table 4. Compressive strength of grout at 7, 14, and 21 days of curing

Pile Desig.	Sample No.	Compressive Strength of Grout					
		7 day		14 day		21 day	
		(psi)	(MPa)	(psi)	(MPa)	(psi)	(MPa)
E1	2	6173	42.6	6430	44.3	7560	52.1
L1	3	5860	40.4	6750	46.5	7610	52.5
C1	4	5620	38.7	6650	45.9	7160	49.4
T1	5	6070	41.9	6910	47.6	7430	51.2
L2	6	5230	36.1	6220	42.9	6670	46.0
C2	7	6040	41.6	6070	41.9	8710	60.1
T2	8	5250	36.2	5800	40.0	7940	54.7
Average		5749.0	39.6	6404.3	44.2	7582.9	52.3
Standard Deviation		390.5	2.7	397.3	2.7	637.0	4.4

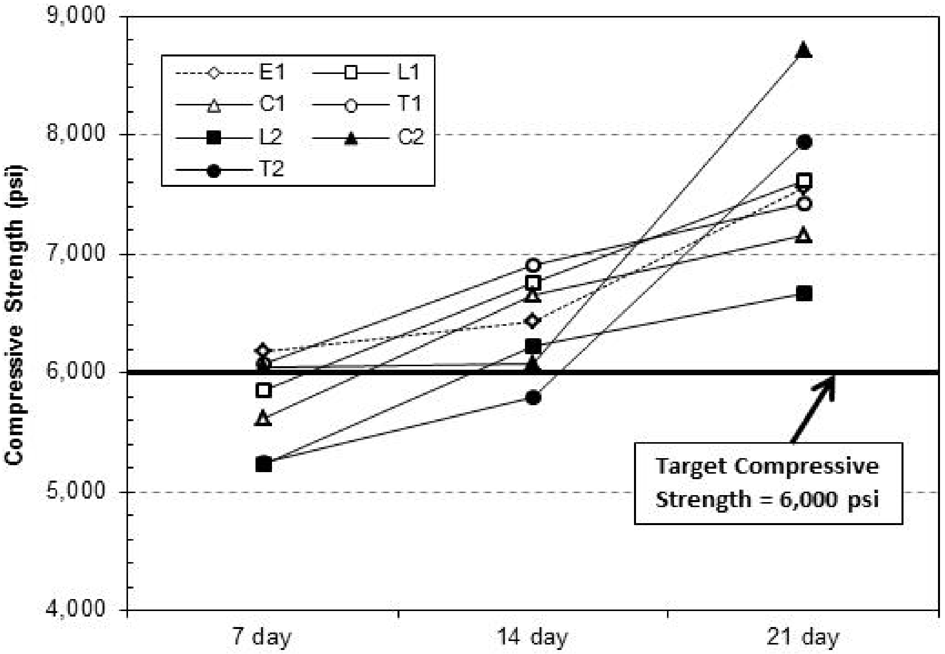


Figure 13. Compressive strength of grout at 7, 14, and 21 days

STRAIN GAGE MEASUREMENTS

Measurements recorded by the strain gages were collected after the instruments were attached to the steel reinforcement bars prior to insertion into the fresh grout. In addition, measurements from the embedded strain gages were collected soon after the bars were installed into the fresh grout, and then again on four subsequent dates but prior to the load testing of the piles (Tables 5 and 6). The gage (1632094) at a depth of about 30 ft (9.1 m) in pile C-1 and the top gage (1632100) in pile C-2 were apparently damaged during installation; consequently, no post-installation data is available for these two gages.

Table 5. Pre-testing strain gage readings for the strain gages used in pile C-1

Serial Number	Depth (ft)	27-Oct-2016		27-Oct-2016		04-Nov-2016		10-Nov-2016		16-Nov-2016		23-Nov-2016	
		Reading ($\mu\varepsilon$)	Temp (°C)	Reading ($\mu\varepsilon$)	Temp (°C)	Reading ($\mu\varepsilon$)	Temp (°C)	Reading ($\mu\varepsilon$)	Temp (°C)	Reading ($\mu\varepsilon$)	Temp (°C)	Reading ($\mu\varepsilon$)	Temp (°C)
1632099	2	6811	32.8	6827	31.4	6791	23.8	6792	21.6	6791	19.0	6777	16.4
1632097	10	6956	33.9	6957	34.0	6913	28.3	6912	27.6	6911	27.1	6901	26.5
1632095	20	6731	33.4	6720	34.3	6759	27.1	6745	27.0	6738	27	6732	26.8
1632094	30	6890	34.1	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a
1632091	40	6828	32.7	6833	33.2	6581	25.6	6589	25.4	6585	25.3	6573	25.2
1631529	50	6939	32.2	6938	31.9	6801	25.2	6791	25.0	6788	24.7	6778	24.5
1631528	58	6998	32.8	6991	33.1	6905	24.9	6910	24.6	6908	24.4	6898	24.3
		Pre-install		*Post-install*		*Embedded within the pile*							

Table 6. Pre-testing strain gage readings for the strain gages used in pile C-2

Serial Number	Depth (ft)	27-Oct-2016		27-Oct-2016		04-Nov-2016		10-Nov-2016		16-Nov-2016		23-Nov-2016	
		Reading ($\mu\varepsilon$)	Temp (°C)	Reading ($\mu\varepsilon$)	Temp (°C)	Reading ($\mu\varepsilon$)	Temp (°C)	Reading ($\mu\varepsilon$)	Temp (°C)	Reading ($\mu\varepsilon$)	Temp (°C)	Reading ($\mu\varepsilon$)	Temp (°C)
1632100	2	6764	22.6	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a
1632098	10	6744	23.5	6746	35.8	6711	29.9	6717	28.1	6714	27.5	6703	26.9
1632096	20	6767	27.2	6755	35.6	6663	28.8	6672	27.5	6669	27.2	6660	27.1
1632093	30	6593	34.2	6587	35.5	6462	27.6	6475	26.5	6475	26.3	6464	26.3
1632092	40	6964	32.6	6960	33.8	6683	25.5	6708	24.6	6718	24.4	6716	24.2
1632090	50	6935	34.2	6923	34.7	6703	26.2	6721	25.2	6721	24.9	6710	24.7
1631527	58	7010	31.4	6990	33.7	6722	25.5	6739	24.7	6742	24.5	6734	24.3
		Pre-install		*Post-install*		*Embedded within the pile*							

THERMAL MEASUREMENTS

Thermal integrity profiling (TIP) wire and probe readings were collected by researchers from the University of South Florida (USF) soon after the piles were installed and at different times within the first few days after installation and grout placement. The research study evaluated the type of measurement system (i.e., probe system vs. thermal wire), access tube material (i.e., steel tube vs. PVC tube), measurement location (i.e., at center bar vs at cage reinforcement), and prediction of pile radius based on temperature and grout volume. The following section will provide a brief synopsis of the results of the TIP setup, measurements, and results; however, complete details about the research, results, interpretations, and conclusions can be found in the two reports authored by Mullins and Johnson (2016, 2017) for FL DOT. Select photographs and records of the measurements made by the researchers are presented in Appendix G.

Thermal Probes

TIP measurements using the probe system were performed in general accordance with ASTM D7949 (2014), wherein thermal measurements were made using an automated, reel-type system as the probe descended at a prescribed rate of 0.3 to 0.5 ft/sec (9 to 15 cm/sec). As described by Mullins and Johnson (2017), TIP measurements using the probe were performed twice (at each interval) for each tube in the pile at 6, 12, 18, and 24 hours after each test pile was cast (i.e., grouted). Photographs of the components and field set up at each test pile are shown in Figure 14. Graphical delineations of temperature versus depth at 6, 12, 18, and 24 hours after casting for test piles C-2 and L-2 are shown in Figure 15.

Thermal Wires

Thermal wires containing multiple thermistors were attached to the center reinforcement bar and/or the steel reinforcement cage to capture and record continuous thermal data as the pile's grout cured. The thermal wires were connected at the surface to removable data collectors (i.e., thermal access ports or TAP units) onto which the data was recorded and stored for later processing and analysis. Photographs of the field set up (thermal wires and TAP units) for piles with center bar and reinforcement cage and with only center bar reinforcement are shown on Figure 16. Representative graphical delineations of temperature versus depth for test pile E-1 at t=15 hr after casting at the center bar and at the reinforcement cage are shown in Figure 17. Because thermal data can be collected continuously (by the TAP unit attached to a thermal wire), thermal generation and dissipation (versus time) can be determined and evaluated, as shown in Figure 18.

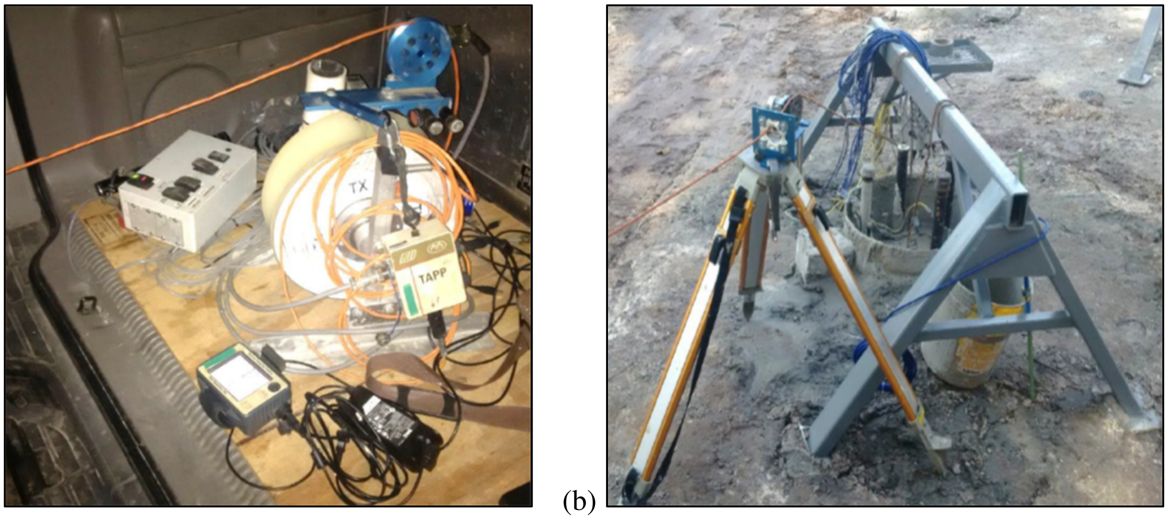
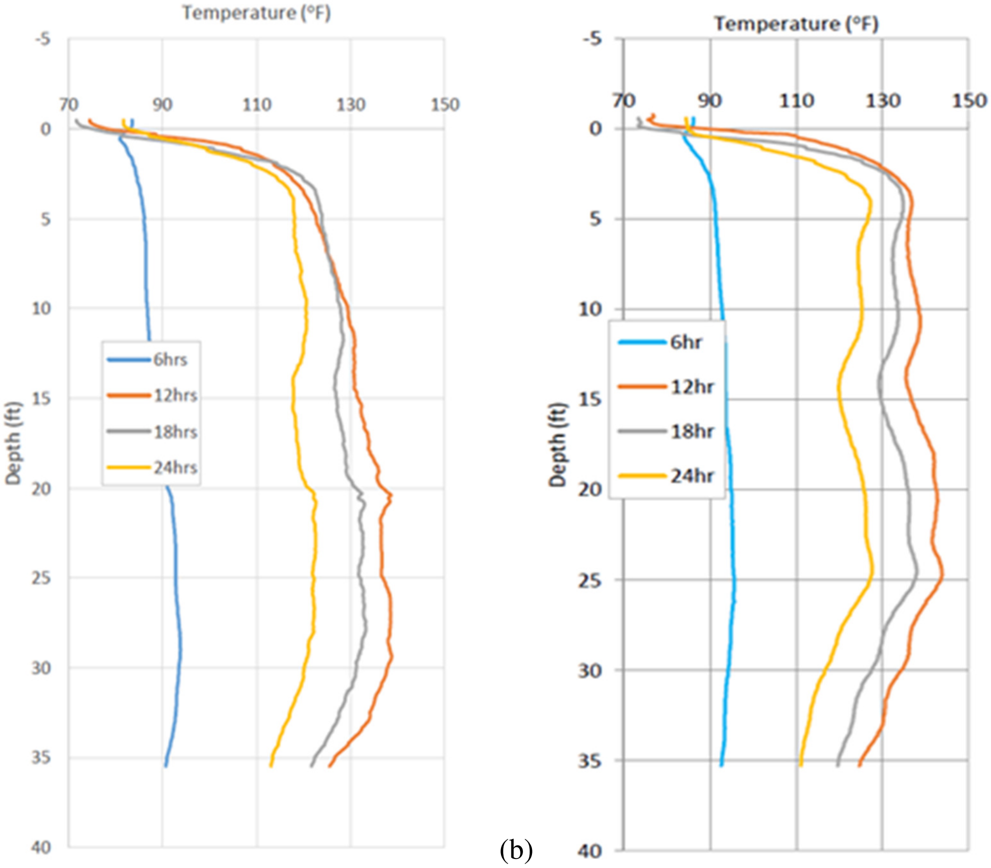
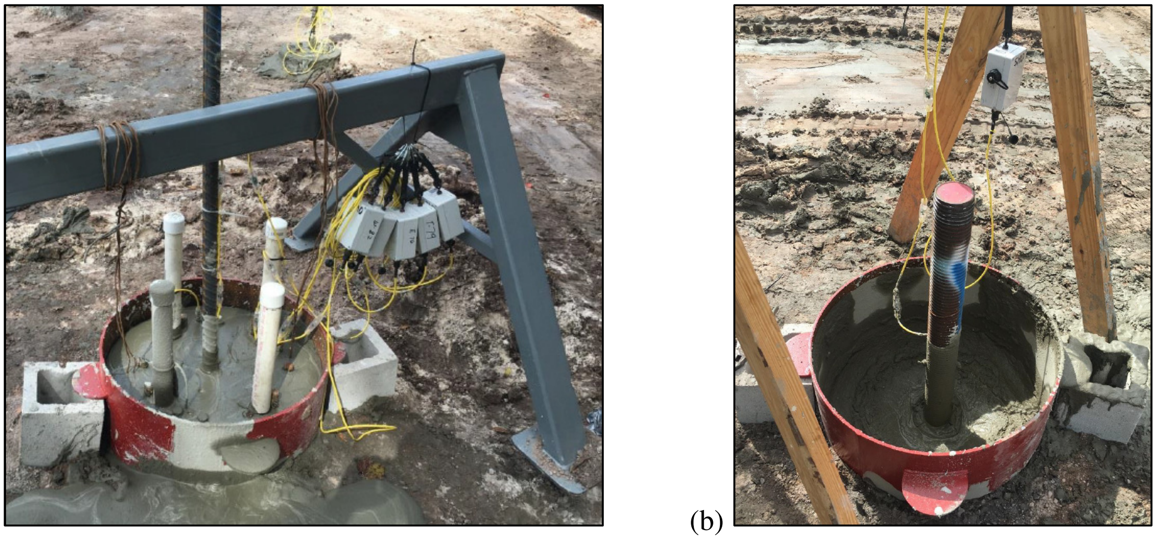

(a) (b)

Figure 14. (a) Components of the data collection system and (b) probe measurement field set up at each test pile (Mullins and Johnson, 2017)



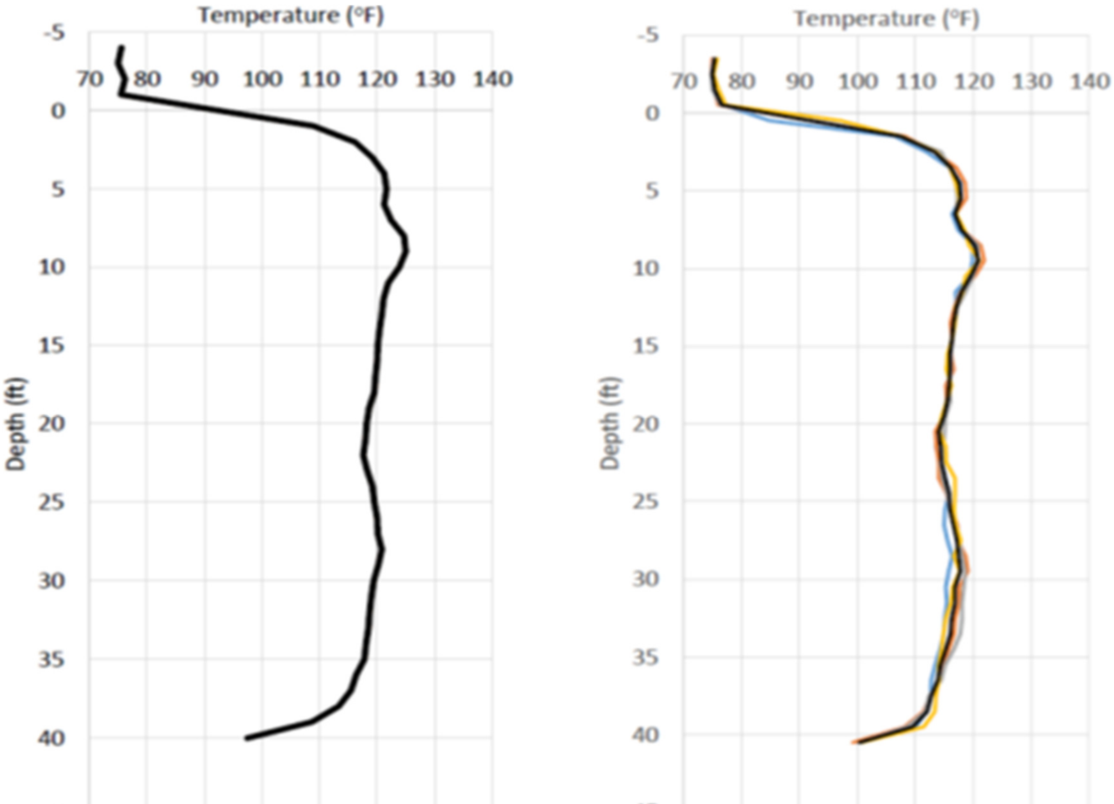
(a) (b)

Figure 15. Thermal profiles at 6-hr intervals during curing at (a) test pile C-2 and (b) test pile L-2 (Mullins and Johnson, 2017)



(a) (b)

Figure 16. Field set up with thermal wires and attached data collection system (TAP units) at (a) test pile L-2 with center bar and reinforcement cage and (b) test pile T-1 with center bar (Mullins and Johnson, 2017)



(a) (b)

Figure 17. Thermal profiles for test pile E-1 t=15 hr after casting at (a) center bar and (b) at the reinforcement cage (Mullins and Johnson, 2017)

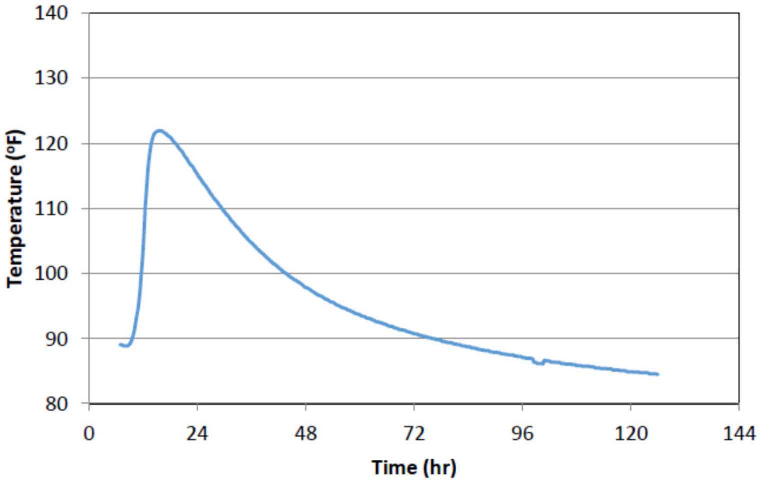


Figure 18. Thermal generation and dissipation at the center bar for test pile E-1 at a distance of about 10 ft (3.05 m) from top of pile (Mullins and Johnson, 2017)

Observations and Interpretations

Mullins and Johnson (2017) presented and discussed the various observations made during the testing and their subsequent interpretations of the recorded data and observations. The following provides a brief summary of the pertinent findings.

- TIP probe system vs. thermal wires:
  - Recorded measurements for both systems were in relatively close agreement.
- PVC vs. steel access tubes:
  - PVC access tubes appeared to be better than steel access tubes for the smaller diameter elements (e.g., smaller volumes for ACIP piles than for larger diameter drilled shafts) where the steel access tubes may have acted as heat sinks during the hydration process.
- Center bar vs. reinforcement cage:
  - Thermal wires attached to the central bar reinforcement
    - The shape of the ACIP pile was estimated relatively accurately, but the predictions are highly dependent upon the grout volume pumped (i.e., flow or pump strokes per depth increment).
    - The deviation in the alignment of the installed center bar reinforcement may not be detected.
  - Measurements at the reinforcement cage:
    - The ACIP pile shape and offset / eccentricity of the cage was able to be determined using either system (i.e., probe or thermal wire) as long as four TIP sensors were used.
  - When performing thermal analyses for piles that are greater than 2 ft (610 mm) in diameter, thermal measurements (using a minimum of four probe or thermal wire locations) should be made at the reinforcement cage and not at the center bar (only).
- Automated monitoring equipment (AME):
  - Data recorded using AME included grout flow rate, grout volume pumped, penetration rate, depth of auger, and grout pressure; however, only the grout volume is required to perform the thermal analyses.
  - Radius profiles could be predicted from manual pump stroke counts, grout factor per depth interval, cumulative volume changes per depth interval, and flow rate divided by extraction rate.

    - The determination of the true amount of waste grout volume was difficult (e.g., initial pump strokes or some portion of grout volume after the grout return is observed).
- As-built data and radius predictions
    - Recommended not using traditional evaluation algorithms and best fit projections from hyperbolic temperature-radius (T-R) curves (for piles > 2 ft (610 mm) in diameter).
    - In general, lower temperature measurements result in a smaller predicted radius, whereas higher temperature measurements result in a larger predicted radius. Potential errors could result from misalignment or eccentricity of the center bar and/or reinforcement cage. When coupled with the injected grout volume, the potential errors could yield under and over predictions of the radius with depth.
    - There is typically minimal misalignment or eccentricity near the top of the pile. However, the reinforcement was misaligned noticeably (i.e., up to 5.5 in (140 mm) for the 18 in (457 mm) diameter piles and up to 7.5 in (190 mm) for 24 in (610 mm) diameter piles) deeper in the piles, which corresponded to potential errors in radius predictions of 1 to 2 in (25 to 51 mm).

LOAD TESTING RESULTS AND DISCUSSION

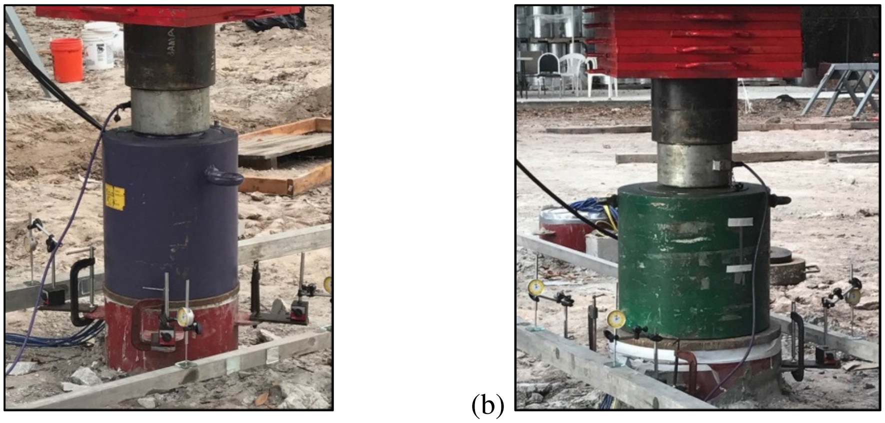
Full-scale compression, tension, and lateral load testing was performed on piles C-1, C-2, T-1, T-2, L-1, and L-2 in general accordance with the applicable ASTM standards. Calibration data for the strain gages, load cells and hydraulic jacks/gages used in this test program are included in Appendix H. Pile E-1 was extracted using a combination of drilled relief holes around the pile, partial extraction using the load frame setup, and pullout using a crane and attachments. The load testing and extraction of the installed test piles was performed from 30 November to 08 December.

COMPRESSION LOAD TESTS

The axial compression tests were performed in general accordance with ASTM D1143 / D1143M-07, Quick Load Method (ASTM, 2013a). As shown in Figures 19 and 20, axial compressive loads were applied manually using a hydraulic jack that was aligned concentrically with the installed piles (C-1 and C-2). During the loading phase, additional loads were applied in 15 ton (133 kN) increments at approximately 5 minute intervals. For each load increment, the applied load was increased to or above the target load (for that increment), and was maintained (i.e., no additional loads were applied) during the interval between readings. The applied loads were measured using a gage on the jack as well as an electronic load cell located between the pile and the reaction frame.


(a) (b) (c)

Figure 19. Compression load testing setup for (a,b) pile C-1 and (c) pile C-2

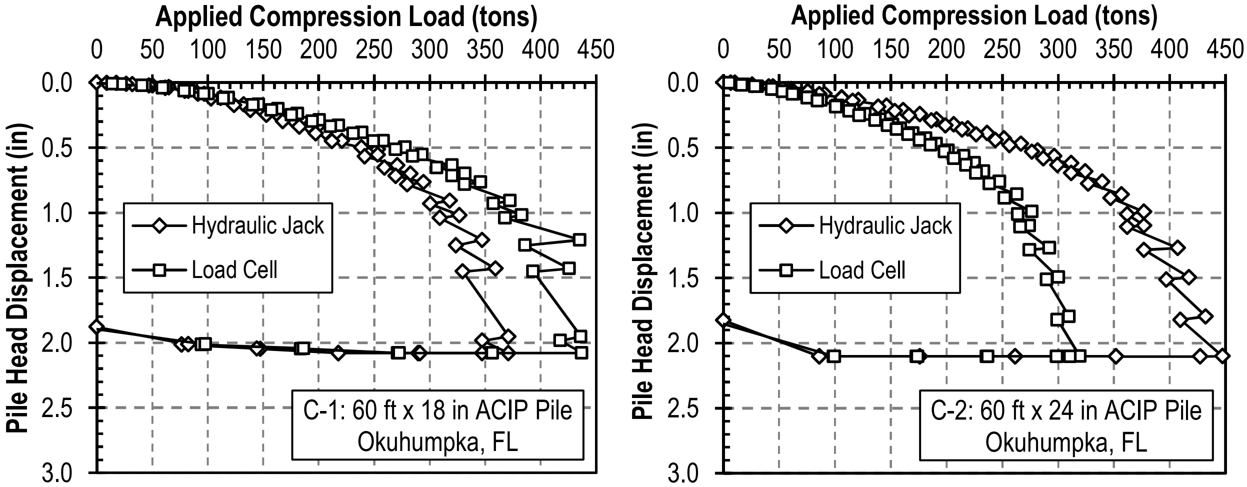


(a) (b)

Figure 20. Compression load testing setup (hydraulic jack, load cell, and dial gages) for (a) pile C-1 and (b) pile C-2

Measurements of the pressure in the hydraulic jack, the load in the cell, and displacements from the dial gages were made and recorded at the beginning and ending of each loading interval. Induced displacements at the top of pile (i.e., pile head) were measured and recorded using four dial gages, which were located at approximately equal spacing around the top of the pile. Before continuing to the next load increment, the loaded pile was allowed to achieve equilibrium under the applied loading during an interval, such that the applied load was not decreasing due to deflections either at the pile-head or in the reaction frame. Each pile was loaded until continuous downward vertical movement of the pile-head was observed (i.e., plunging was initiated) at a constant applied load (i.e., geotechnical failure was achieved).

The load-displacement responses of test piles C-1 and C-2 due to the applied axial compression loading are plotted in Figure 21. As observed in Figure 21 for both compression tests, there was poor agreement between loads determined using the hydraulic jack and the electronic load cell. This discrepancy was likely due to the electronic load cell, which is typically more precise in its measurements, but it is more susceptible to be negatively affected by changes in moisture and temperature and due to disturbance caused during transportation. Therefore, for the purposes of comparison for this demonstration project, only the results measured using the hydraulic jack will be considered (Figure 22); however, all of the data measured using the hydraulic jack and the electronic load cell during the testing are presented in Appendix I.



(a) (b)

Figure 21. Load-displacement behavior of test piles (a) C-1 and (b) C-2 due to axial compression loading

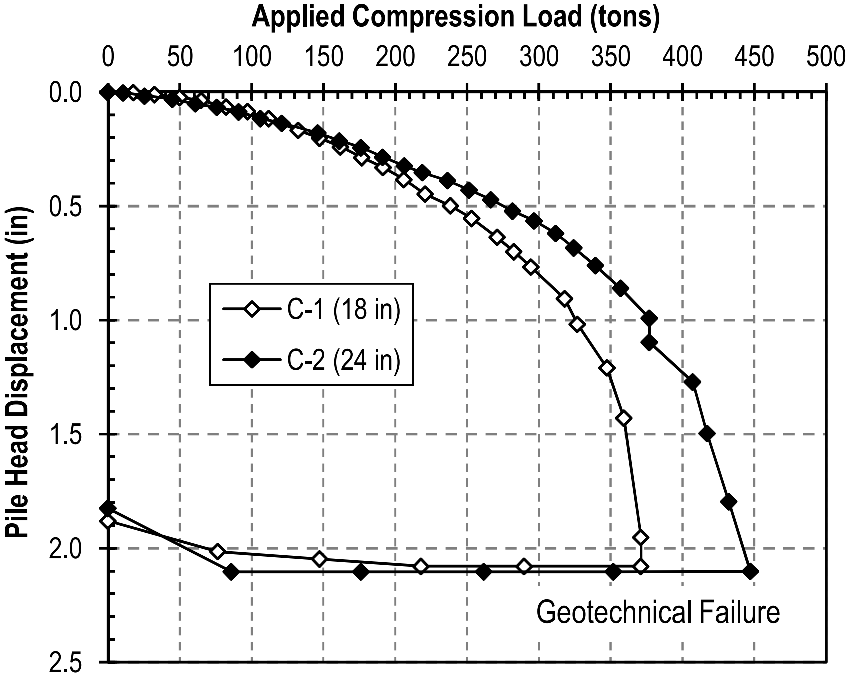


Figure 22. Load-displacement behavior and estimated static axial capacity of test piles C-1 and C-2 due to axial compression loading (using measurements from the hydraulic jack only)

Piles C-1 and C-2 were incrementally loaded until no additional load could be resisted; essentially resulting in a geotechnical failure (i.e., plunging) for each pile. As shown in Figure 22, the maximum applied load (i.e., maximum resistance) was about 447 ton (3980 kN) and 371 ton (3300 kN) for piles C-1 and C-2, respectively. Based on the method reported in the initial write up, the estimated capacity of test piles C-1 and C-2 were computed as 220 ton (1957 kN) and 285 ton (2535 kN), respectively.

Had geotechnical failure not been realized, the axial capacity or resistance of the tested piles C-1 and C-2 would have been determined using the Butler-Hoy criterion (Butler and Hoy, 1977). As described in Stuedlein et al. (2009), the Butler-Hoy failure criterion is one of the approaches approved in the International Building Code (IBC) for the determination of axial capacity of a pile when geotechnical failure (i.e., plunging) is not achieved during a static compression load test. The Butler-Hoy Criterion estimates the axial capacity of the pile at the intersection of two lines: the first of which is tangent to the initial slope of the load-displacement curve, and the second line has a slope equal to 0.05 inch/ton and is tangent to the load-displacement curve.

For pile C-1, the axial load ($Q_{ax,i}$) at each strain gauge location was determined by multiplying the measured / recorded strain ($\varepsilon_{ax,i}$) by the composite section modulus ($E_{comp,C1}$) and the estimated cross-sectional area (A_i) at the respective strain gauge location, as reflected in the following equation: $Q_{ax,i} = \varepsilon_{ax,i}E_{comp,C1}A_i$. The composite modulus, which incorporates contributions from the grout and steel reinforcement, was estimated by back calculating the modulus using the top strain gauge at each load increment and the adjusted pile diameter (based on the measured vs. planned circumferences of the extracted pile, E1). The computed axial loads and unit side resistance at the strain gauge locations in pile C-1 are shown in Table 7. The load transfer behavior for pile C-1 is shown in Figure 23 (additional evaluation of the strain dependent modulus will be performed after submission of this final report). Measurements of axial strain from the embedded strain gauges were recorded at each load increment throughout the load tests, and are provided in Appendix I.

Table 7. Computed axial loads and unit side resistance at the strain gauge locations in pile C-1

	Strain Gauge No.					
	1	2	3	4	5	6
Depth (ft)	2	10	20	40	50	60
Incremental Length (ft)		8	10	20	10	10
Load at Strain Gauge (ton)						
Measured	347	311	285	177	124	75
Predicted	0	27	54	144	194	234
Shaft Resistance (ton)						
Measured	---	36	26	108	53	49
Predicted	---	27	27	90	50	40
Unit Side Resistance (ton/sq ft)						
Measured	---	0.966	0.552	1.146	1.117	1.303
Predicted	---	0.716	0.573	0.955	1.061	1.061

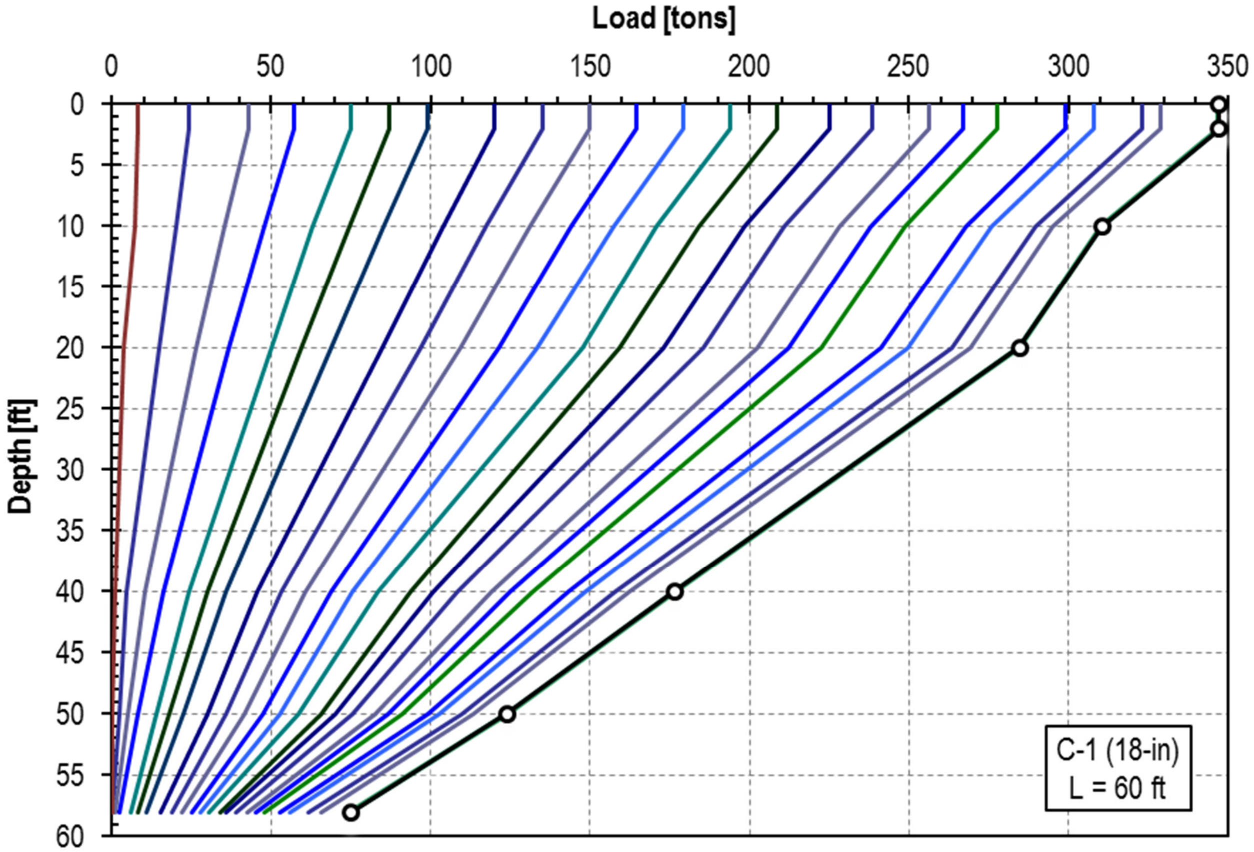


Figure 23. Load distribution (load transfer) curves for test pile C-1 due to compression loading based on strain gauge measurements during the axial compression loading

For pile C-2, the method just described for estimating the composite modulus for pile C-1 was not possible since the top strain gauge was not functioning properly after installation. Therefore, the composite modulus used for pile C-2 was estimated using material properties and strength characteristics, as described below. The composite modulus ($E_{comp,C2}$) incorporates contributions from the grout and steel reinforcement, and was estimated using the following relationship:

$$E_{comp,C2} = \frac{E_{grout}A_{grout} + E_{steel}A_{steel}}{A_{grout} + A_{steel}} \quad (1)$$

where: E_{grout} is the modulus of elasticity of a purely grouted section, A_{grout} is the cross-sectional area of grout for a given loaded diameter, E_{steel} is the modulus of elasticity of steel, and A_{steel} is the cross-sectional area of steel within the same diameter. As shown in Table 4, the compressive strength of the grout at 21 days was about 8,710 psi (60.1 MPa). The following relationship was used to determine the modulus of elasticity of a purely grouted section:

$$E_{grout} = 57000\sqrt{f_c'} = 5{,}319{,}661\, psi = 5{,}320\, ksi\ (36{,}678\, MPa) \quad (2)$$

For typical mild grade steel, the value of E_{steel} is 29,000 ksi (200,000 MPa). As described in a subsequent section, the average pile diameter in the upper 24 in (610 mm) of embedment was about 18.1 in (460 mm), resulting in a cross-sectional area of about 257.3 in^2 (1660 cm^2). The area of steel within the cross-section was about 11.05 in^2 (71.3 cm^2), resulting from 12- No. 8 longitudinal bars and 1- No. 11 center bar (Table 2). Therefore, the area of grout was about 246.25 in^2 (1589 cm^2). The composite modulus, $E_{comp,C2}$, was computed to be 6,337 ksi (43,692 MPa), as shown in the equation below.

$$E_{comp,C2} = \frac{(5{,}320\, ksi)(246.25\, in^2) + (29{,}000\ \text{ksi})(11.05\, in^2)}{(246.25\, in^2) + (11.05\, in^2)} = 6{,}337\, ksi\ (43{,}692\, MPa) \quad (3)$$

Based on the composite modulus, the axial load ($Q_{ax,i}$) at each strain gauge location was determined by multiplying the measured / recorded strain ($\varepsilon_{ax,i}$) by the composite section modulus ($E_{comp,C2}$) and the estimated cross-sectional area (A_i) at the respective strain gauge location, as reflected in the following equation: $Q_{ax,i} = \varepsilon_{ax,i}E_{comp,C1}A_i$. The computed axial loads and unit side resistance at the strain gauge locations in pile C-1 are shown in Table 8. The load transfer behavior for pile C-2 is shown in Figure 24 (additional evaluation of the strain dependent modulus will be performed after submission of this final report). Measurements of axial strain from the embedded strain gauges were recorded at each load increment throughout the load tests, and are provided in Appendix I.

Table 8. Computed axial loads and unit side resistance at the strain gauge locations in pile C-2

	Strain Gauge No.						
	1	2	3	4	5	6	7
Depth (ft)	2	10	20	30	40	50	58
Incremental Length (ft)		8	10	10	10	10	8
Load at Strain Gauge (ton)							
Measured	425	375	328	248	191	135	80
Predicted	0	36	72	132	194	261	315
Shaft Resistance (ton)							
Measured	---	50	46	80	58	56	55
Predicted	---	36	36	60	63	67	54
Unit Side Resistance (ton/sq ft)							
Measured	---	1.002	0.737	1.274	0.918	0.887	1.085
Predicted	---	0.722	0.568	0.947	0.996	1.058	1.082

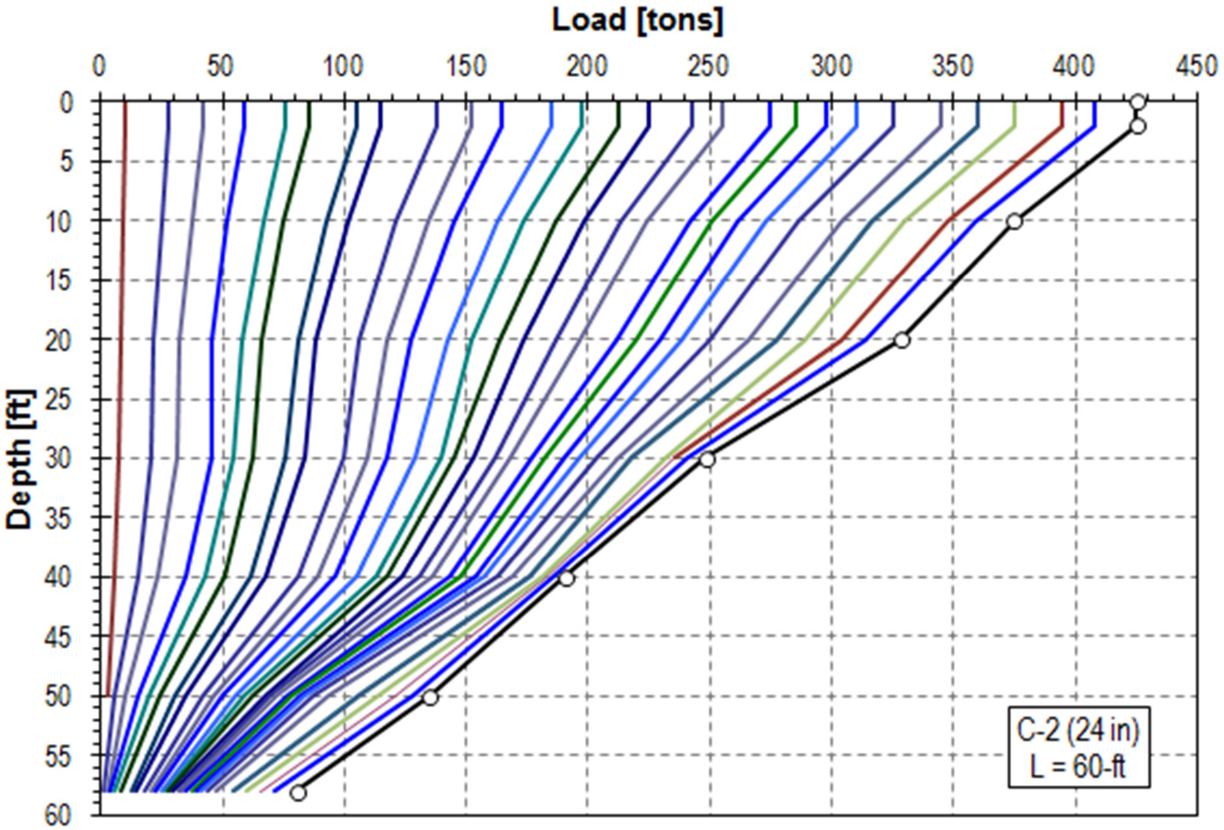


Figure 24. Load distribution (load transfer) curves for test pile C-2 due to compression loading based on strain gauge measurements during the axial compression loading

TENSION LOAD TESTS

The axial tension tests were performed in general accordance with ASTM D3689 / D3689M-07, Quick Load Method (ASTM, 2013b). As shown in Figure 25, the axial tension loads were applied manually using a hydraulic jack that pulled on an embedded center steel reinforcement bar in the installed piles (T-1 and T-2). During the loading phase, additional loads were applied in 10 ton (89 kN) increments for pile T-1 and in 15 ton (133 kN) increments for pile T-2 at approximately 5 minute intervals. For each load increment, the applied load was increased to or above the target load (for that increment), and was maintained (i.e., no additional loads were applied) during the interval between readings. The applied loads were measured using a gage on the jack as well as an electronic load cell located between the pile and the reaction frame.

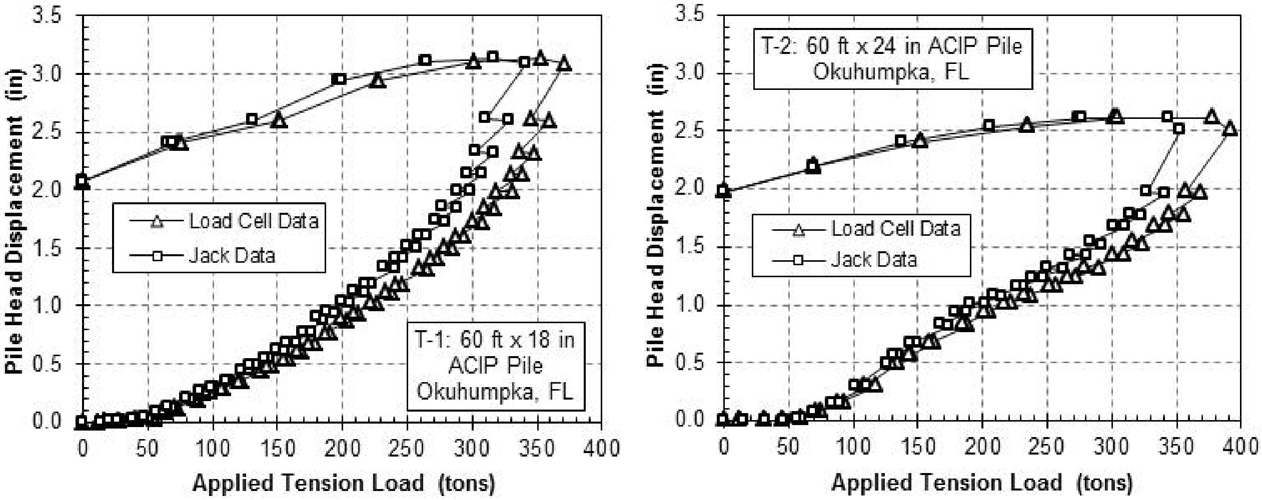
Measurements of the pressure in the hydraulic jack, the load in the cell, and displacements from the dial gages were made and recorded at the beginning and ending of each loading interval. Induced displacements at the top of pile (i.e., pile head) were measured and recorded using four dial gages, which were located at approximately equal spacing around the top of the pile. Before continuing to the next load increment, the loaded pile was allowed to achieve equilibrium under the applied loading during an interval, such that the applied load was not decreasing due to deflections either at the pile-head or in the reaction frame. Each pile was loaded until continuous upward vertical movement of the pile-head was observed (i.e., pullout was initiated) at a constant applied load (i.e., geotechnical failure had been achieved).

(a) (b) (c)

Figure 25. Tension load testing setup for (a) pile T-1 and (b,c) pile T-2

The load-displacement responses of test piles T-1 and T-2 due to the applied axial tension loading are plotted in Figure 26, and all of the data measured using the hydraulic jack and the electronic load cell during the tension testing are presented in Appendix J. The estimated capacity of test piles T-1 and T-2 were computed as 205 ton (1824 kN) and 265 ton (2538 kN), respectively. As observed in Figure 26 for both tension tests, there was better agreement between loads determined using the hydraulic jack and the electronic load cell than was observed for the compression tests (Figure 21).

It should be noted that the center steel bars that were installed in the test piles (Figure 25) were not sleeved; therefore, it is likely that the piles cracked at some distance below the ground surface during the tension testing. As observed in Figure 26, the measured pile-head deflections are likely a result of a short section of pile displacing or moving along with the elongation of the center bar as the tensile load was applied. Based on observations of the deflection of the center bars during the tension testing, it is estimated that at about 1 in (25 mm) of the observed pile-head deflections are due to the elongation of the center bar and not due to the upward movement of the pile. As such, this behavior should be considered when evaluating the behavior of these types of piles.



(a) (b)

Figure 26. Load-displacement behavior of test piles (a) T-1 and (b) T-2 due to tension loading

LATERAL LOAD TESTS

The lateral tests were performed in general accordance with ASTM D3966 / D3966M-07 (ASTM, 2013c), as shown in Figure 27. However, the applied loads that were in excess of 50% of the estimated free-head capacity were adjusted (and a special loading sequence was developed) to ensure the piles L-1 and L-2 were loaded until the deflection at the top of the pile was at least 1 in (25 mm). The lateral loads were applied manually using a hydraulic jack (Figure 27) and a collar connection (to ensure the hydraulic jack didn't slip). The applied loads were measured using a gage on the hydraulic jack as well as an electronic load cell located between the pile and the reaction frame. During the loading phase, additional loads were applied in increments of about 2 tons (18 kN) for pile L-1 and about 4 tons (36 kN) for pile L-2 in general accordance with ASTM D3966; however, the adjusted loading sequence used 20 min hold times (load duration) for the latter portion of the testing.

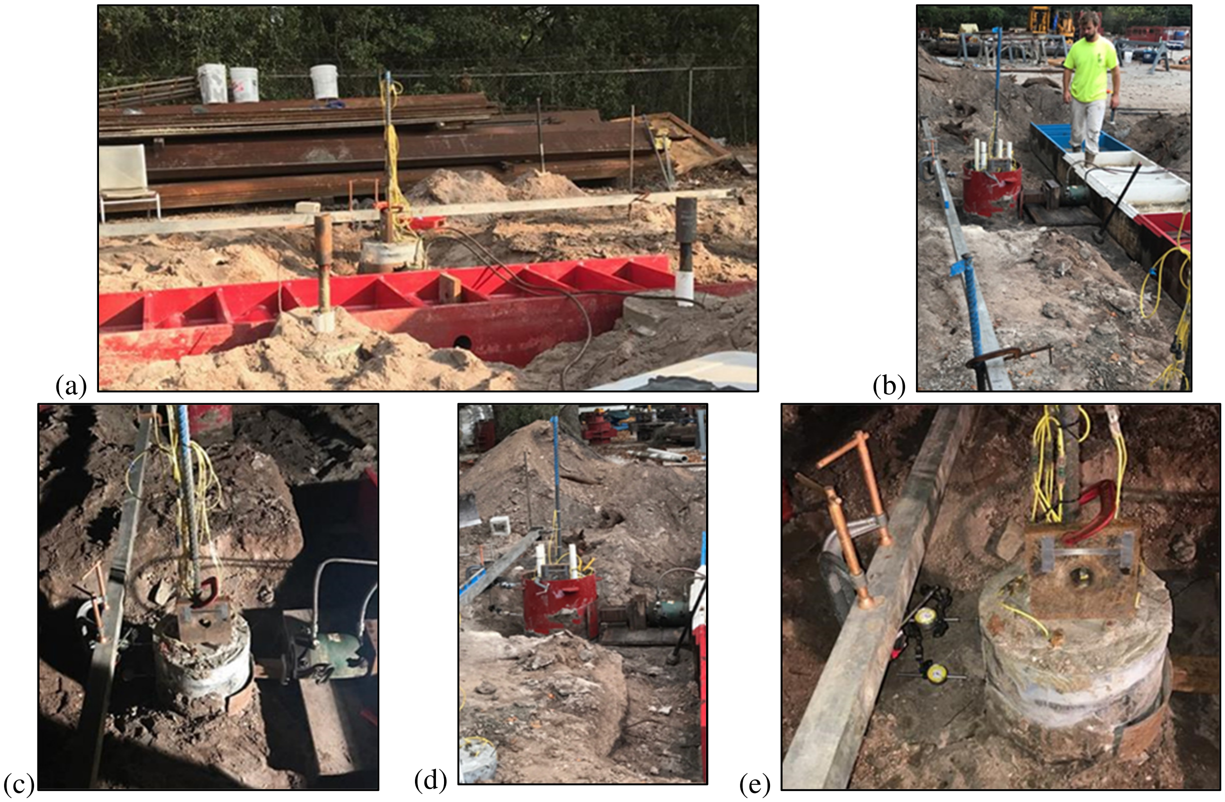
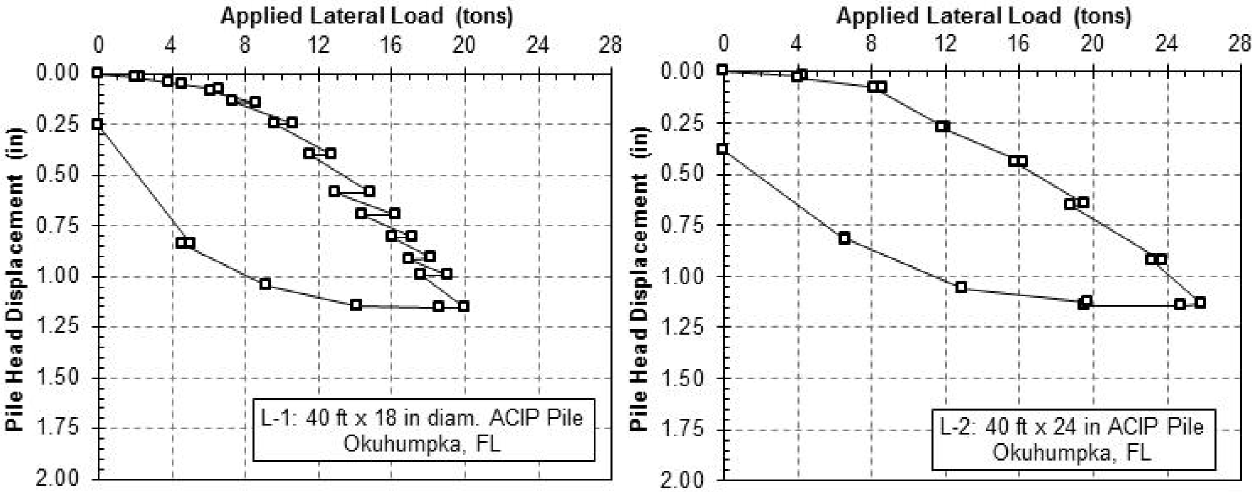


Figure 27. Lateral load testing setup for (a, b, c) pile C-1 and (d,e) pile C-2

Measurements of the pressure in the hydraulic jack, the load in the cell, and displacements from the dial gages were made and recorded at the beginning and ending of each loading interval. Induced displacements at the top of pile were measured and recorded using two dial gages, which were located at the same elevation of the load / hydraulic jack and above the location of load application. Before continuing to the next load increment, the loaded pile was allowed to achieve equilibrium under the applied loading during an interval, such that the applied load was not decreasing due to deflections either at the pile-head or in the reaction frame. For each load increment, the applied load was increased to or above the target load (for that increment), and was maintained (i.e., no additional loads were applied) during the interval between readings.

The load-displacement responses of test piles L-1 and L-2 due to the applied lateral loading are plotted in Figure 28, and all of the data measured using the hydraulic jack and the electronic load cell during the tension testing are presented in Appendix K. The estimated capacity of test piles T-1 and T-2 were computed as 16 ton (142 kN) and 30 ton (267 kN), respectively. However, piles L-1 and L-2 were loaded until a lateral displacement of about 1 in (25 mm) was achieved at the elevation of the load application, and not until geotechnical or structural capacity was reached; therefore, comparisons between estimated and measured capacity could not be made.



(a) (b)

Figure 28. Load-displacement behavior of test piles (a) L-1 and (b) L-2 due to lateral loading

PILE EXTRACTION AND MEASUREMENTS

Per the intent of the experimental and demonstration program, pile E-1 with a nominal diameter of 18 in (457 mm) was extracted on 08 December for visual inspection and measurement of the as-constructed condition of the pile. To assist in the extraction, a number of relief holes about 14 in (356 mm) in diameter were drilled (Figure 29a) around but in close proximity to the constructed pile. Initially, a hydraulic jack and tension test reaction arrangement (similar to that used for the axial tension test loading of piles T-1 and T-2) were begin the extraction process of pile E-1 (Figures 29b and 29c).

(a) (b) (c)

Figure 29. Preparation and setup for extraction of pile E-1: (a) drilling 14 in (356 mm) diameter relief holes around pile E-1, (b, c) reaction system setup for initial extraction

Once pile E-1 was extracted a distance out of the ground (about 2 to 3 ft (0.6 to 0.9 m)), a crawler-crane was employed to extract the pile the remainder of the length from the ground (Figure 30a and 30b). The pile was then pressure washed as it was extracted to remove any dirt or debris from its surface. After being placed horizontally on supports, the pile was visually inspected and its circumference was measured (Figure 30c) in increments of 12 in (305 mm), 40 increments, along the length of the pile to verify the as-built condition, to compare with measurements performed during installation, and to compare with measurements performed using the TIP method (Mullins and Johnson, 2017). The as-built measurements of the circumference of the extracted pile E-1 are provided in Appendix L. Mullins and Johnson (2017) indicated that the researchers used the measurements of the circumference (diameter) and corrected grout volumes as part of their analysis and data processing. The contractor used the overall grout factor, which was reduced for each pile based on the actual grout strokes (i.e., after head was observed at surface). That computed volume determined based on measurements of the extracted pile was in very close agreement with the computed volume based on values recorded using the AME and grout strokes.

Based on the measurements of the pile's circumference, the as-built diameter ranged from about 18.1 to 20.7 in (461 to 526 mm), with an average of about 19.4 in (494 mm). The theoretical or nominal diameter of pile E-1 was 18 in (457 mm). Therefore, the diameter of the as-built pile was greater than the nominal diameter (Table 9), thereby indicating there were no instances of necking or embedded inclusions in the pile. However, given that the as-constructed diameter was in excess of the nominal diameter as much as 2 in (50 mm) indicates that there may have been a looser than expected soil layer(s) or slight overmilling during construction. The increased diameter resulted in only more grout being used (i.e., additional cost to the contractor) but no compromise to the integrity or performance of the pile.

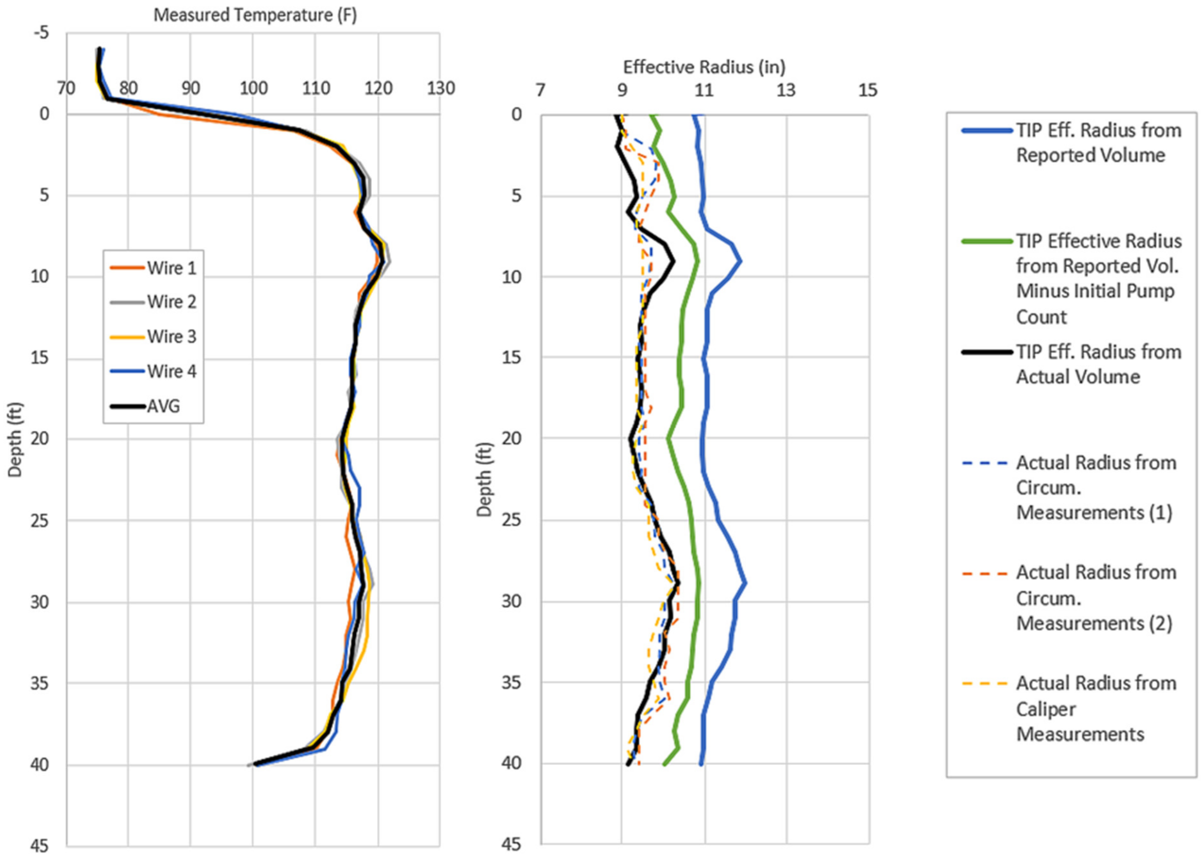
(a) (b) (c)

Figure 30. (a,b) Extraction of pile E-1 using a crane attachment, and (c) extracted pile and manual measurements of the pile circumference

Table 9. Measurement statistics about as-built construction of extracted pile E-1

	Calculated Diameter		Diff. from Theoretical Diameter		
	(in)	(mm)	(in)	(mm)	(%)
Average	19.4	494	1.4	36.6	8.0%
Maximum	20.7	526	2.7	69	14.9%
Minimum	18.1	461	0.1	4	0.8%
Stand. Dev.	0.7	17	0.7	16.8	3.7%

Analysis and interpretation of the measurements made using the TIP method were performed by the researchers at the University of South Florida. A profile of the thermal measurements made from four embedded TIP wires in pile E-1 is provided in Figure 31a, which indicates that the pile was relatively uniform in diameter throughout its length, which corresponds well with the as-constructed measurements of the pile's circumference. A comparison of the effective radius (estimated and measured) along the length of pile E-1 is provided in Figure 31b, which shows good agreement among the measurements made using the TIP method, caliper, and as-built measurements along with the grout volume recorded during casting, when corrected for the volume of grout observed to be flowing out of the top of the pile during construction (i.e., "TIP Eff. Radius from Actual Volume" on Figure 31). As observed in Figure 31, when corrected for the volume of grout observed coming out of the ground (black line), the predicted volume based on the measurements from the flow meter or grout strokes was in good agreement with the volume determined from the manual measurements. Additional details, discussion, and interpretation can be found in Mullins and Johnson (2017).



(a) (b)

Figure 31. (a) Measurements made from TIP wires and (b) estimated and measured radius of pile E-1

ADDITIONAL TESTS

RIM-cell tests (i.e., bi-directional smaller-scale proof load tests), which subject a load at the location of embedment similar to other bi-directional load test methods, were performed on reaction piles R1 and R5 on 09 December. R1 and R5 were approximately 18 in (457 mm) and 24 in (610 in) in diameter, and were constructed in a similar manner to the test piles. These tests were performed only for "proof of concept" for the Florida DOT, and were not incorporated into the previously discussed demonstration and experimental testing program. It should be noted that the RIM cell sizes (i.e., 12 in (305 mm) and 18 in

(457 mm) diameter, respectively) were selected with consideration to the installation success, rather than the anticipated design load of the piles. Additional investigation to appropriately size the RIM cell for a given production load vs. the size of RIM cell that could practically be installed within a given ACIP pile plan area should be considered. Reaction pile R1 was subjected to maximum load of about 43 tons (378 kN), which induced minimal / negligible movement of about 0.002 in (0.05 mm) of the pile in each direction. Reaction pile R5 was subjected to a maximum load of about 54 tons (476 kN), which induced a movement of about 0.31 in (8 mm) of the pile in the downward direction (Figure 32).

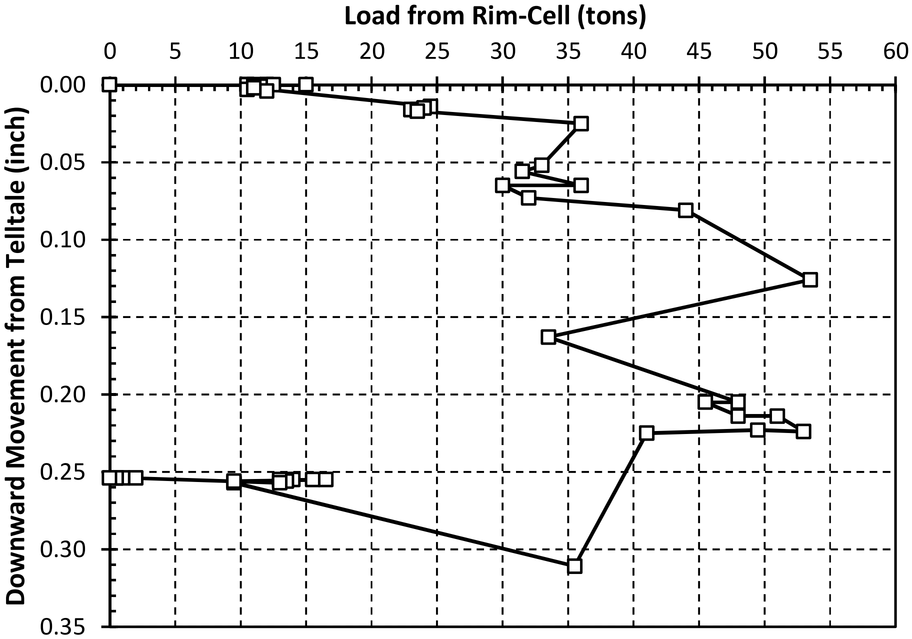


Figure 32. Load-displacement behavior for R-5 obtained using the RIM-cell

RECOMMENDATIONS

Additional research (data collection and dissemination) of single and multiple thermal measurements along with the comparison to measurements of the as-built circumference of (extracted) ACIP piles will enhance the usefulness of thermal profiling for verification of ACIP pile integrity. The use of bi-directional load cells for the verification of axial resistance of production ACIP piles appears to be potentially viable. However, additional evaluation and guidance is required to appropriately size a bi-directional device for a given production load considering the practicality of installing that device (diameter and depth considerations) into a freshly grouted / concreted ACIP pile.

CONCLUSIONS

The procedures described herein along with the results of the non-destructive and high strain load tests, measurements and observations made via the QC/QA program, and measurements performed on the extracted pile validate ACIP piles for consideration for the structural support of bridges per the Florida DOT. The results of this demonstration program provide physical substation to the Florida DOT, as it develops a section for ACIP Piles for Bridges and Major Structures in its Standard Specifications. Grout volumes, as measured by an electromagnetic flowmeter and via manual counting of grout strokes, showed good agreement on this particular project; however, it is noted that other systems for measuring grout flow (e.g., automated grout pump stroke measurements) are being developed, which may be better suited for the monitoring of ACIP piles. On this demonstration project, the overall grout volume of the extracted pile, when adjusted for the volume of grout observed flowing out of the top of the pile, was in good agreement with both the volume calculated by manually measuring the circumference of the pile at 1 ft (305 mm) intervals and the predicted volume determined using thermal measurements.

REFERENCES

ASTM C109 / C109M-16a. (2016). “Standard Test Method for Compressive Strength of Hydraulic Cement Mortars (Using 2-in. or [50-mm] Cube Specimens),” ASTM International, West Conshohocken, PA. www.astm.org.

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Butler, H.D., and H.E. Hoy (1977) “The Texas Quick-Load Method for Foundation Load Testing,” User's Manual. Report No. FHWA-IP-77-8.

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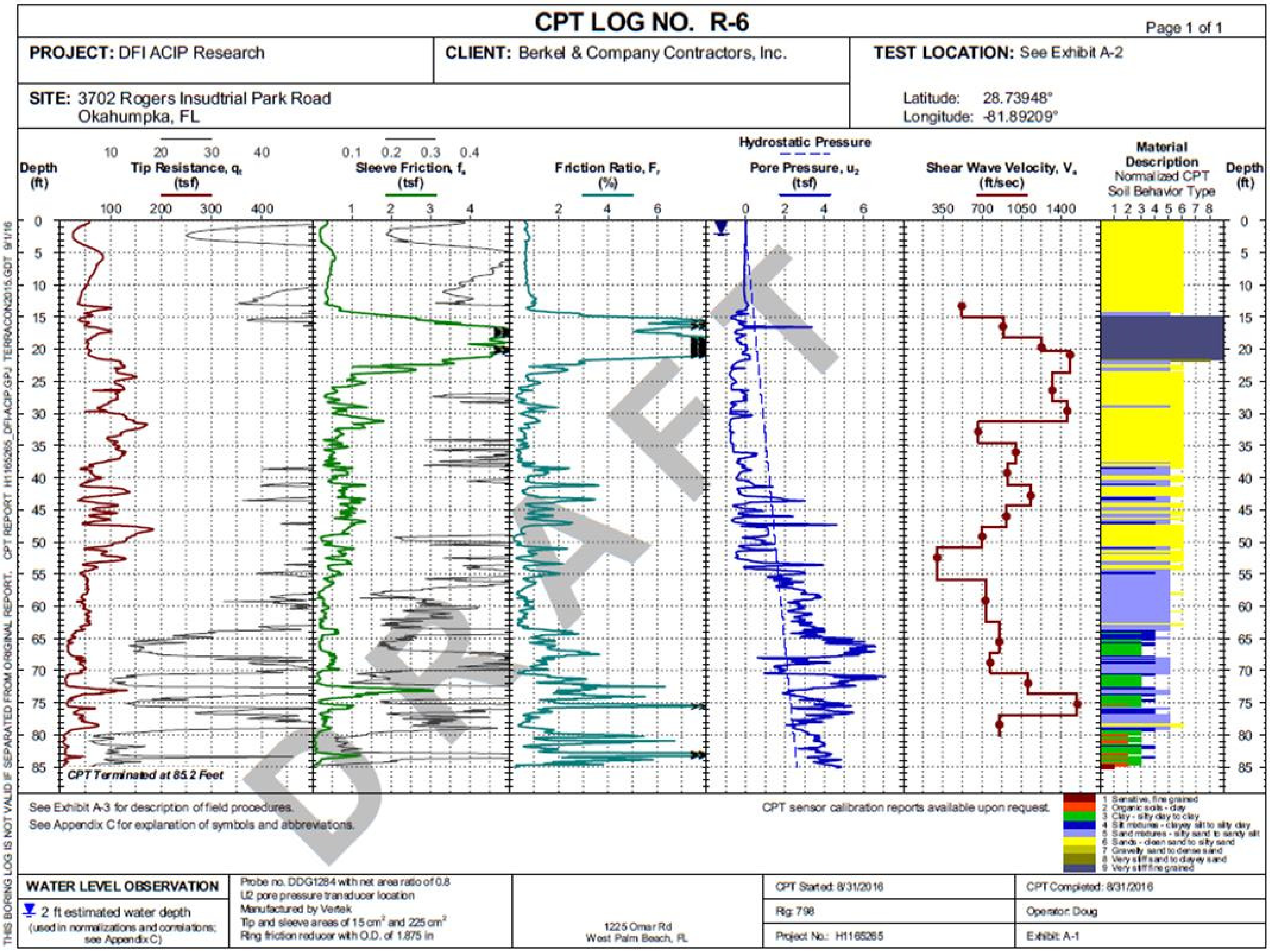
Mullins, G. and Johnson, K. (2017). “Thermal Integrity System for Augered Cast-In-Place Piles, Part II, Implementation Plan,” prepared for Florida Dep’t of Transportation. Report No. BDV25-977-34.

NeSmith, W.M. (2015). “Recent developments in ACIP and DD piling”. Proceedings of the Annual Conference of the Minnesota Geotechnical Society. February.

Stuedlein, A.W., Reddy, S.C., and Evans, T.M. (2014). “Interpretation of Augered Cast-in-Place Pile Capacity Using Static Loading Tests”. The Journal of the Deep Foundations Institute. Vol 8, No. 1, pp. 39–47.

APPENDIX A

SITE CHARACTERIZATION - CONE PENETRATION TESTS (CPT) SOUNDINGS, SOIL BORING LOGS, AND STANDARD PENETRATION TEST (SPT) N-VALUES



CPT LOG NO. R-6

Page 1 of 1

PROJECT: DFI ACIP Research

CLIENT: Berkel & Company Contractors, Inc.

TEST LOCATION: See Exhibit A-2

SITE: 3702 Rogers Insudtrial Park Road
Okahumpka, FL

Latitude: 28.73948°
Longitude: -81.89209°

See Exhibit A-3 for description of field procedures.
See Appendix C for explanation of symbols and abbreviations.

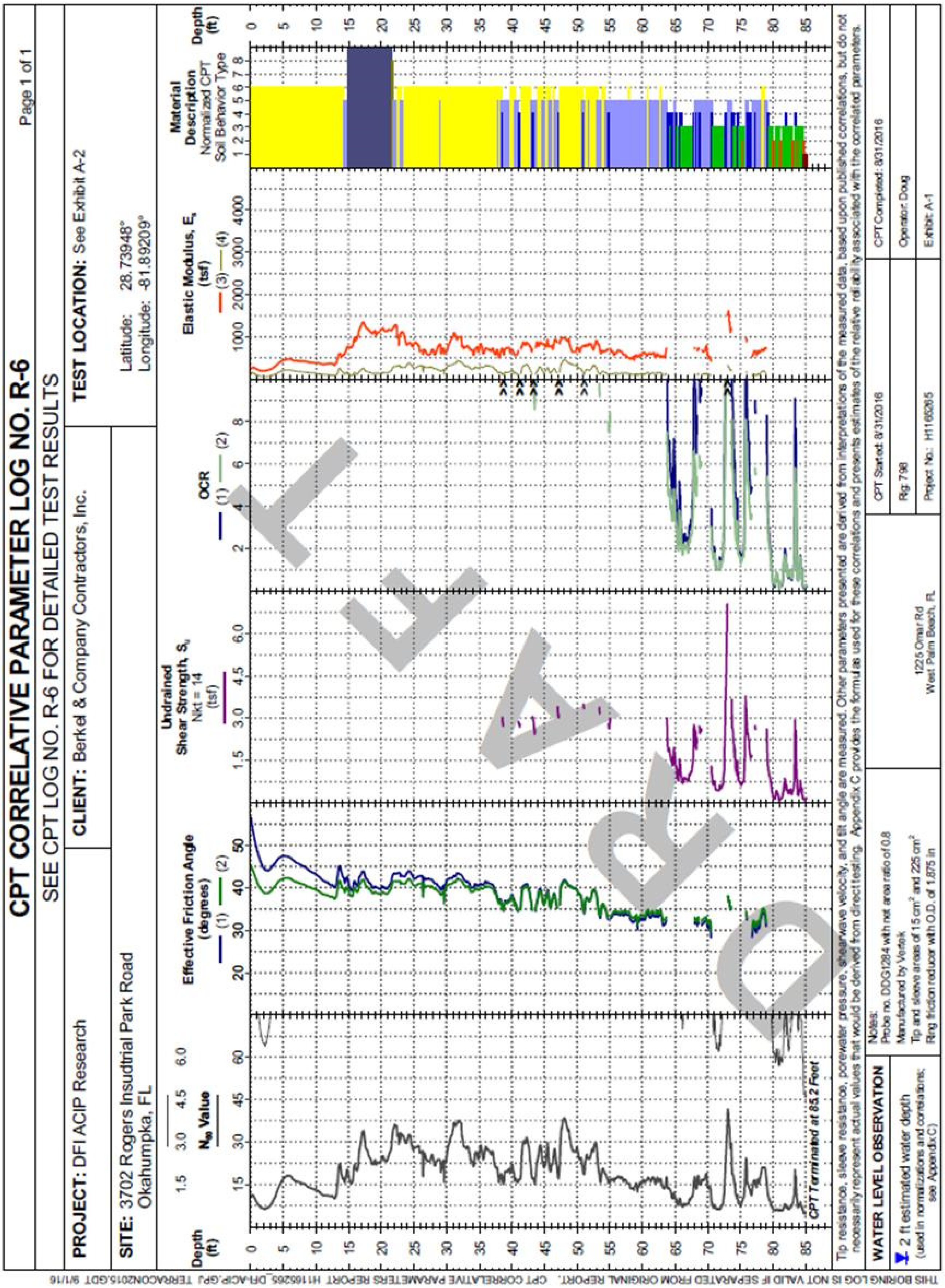
CPT sensor calibration reports available upon request.

1 Sensitive, fine grained
2 Organic soils - clay
3 Clay - silty clay to clay
4 Silt mixtures - clayey silt to silty clay
5 Sand mixtures - silty sand to sandy silt
6 Sands - clean sand to silty sand
7 Gravelly sand to dense sand
8 Very stiff sand to clayey sand
9 Very stiff fine grained

WATER LEVEL OBSERVATION	Probe no. DDG1284 with net area ratio of 0.8 U2 pore pressure transducer location Manufactured by Vertek Tip and sleeve areas of 15 cm^2 and 225 cm^2 Ring friction reducer with O.D. of 1.875 in	1225 Omar Rd West Palm Beach, FL	CPT Started: 8/31/2016	CPT Completed: 8/31/2016
▼ 2 ft estimated water depth (used in normalizations and correlations; see Appendix C)			Rig: 798	Operator: Doug
			Project No.: H1165265	Exhibit: A-1

THIS BORING LOG IS NOT VALID IF SEPARATED FROM ORIGINAL REPORT. CPT REPORT H1165265_DFI-ACIP.GPJ TERRACON2015.GDT 9/1/16

Figure A-1. CPT log R-6



CPT CORRELATIVE PARAMETER LOG NO. R-6

Page 1 of 1

SEE CPT LOG NO. R-6 FOR DETAILED TEST RESULTS

PROJECT: DFI ACIP Research

CLIENT: Berkel & Company Contractors, Inc.

SITE: 3702 Rogers Insudtrial Park Road
Okahumpka, FL

TEST LOCATION: See Exhibit A-2

Latitude: 28.73948°
Longitude: -81.89209°

Tip resistance, sleeve resistance, porewater pressure, shearwave velocity, and tilt angle are measured. Other parameters presented are derived from interpretations of the measured data, based upon published correlations, but do not necessarily represent actual values that would be derived from direct testing. Appendix C provides the formulas used for these correlations and presents estimates of the relative reliability associated with the correlated parameters.

WATER LEVEL OBSERVATION

▼ 2 ft estimated water depth
(used in normalizations and correlations; see Appendix C)

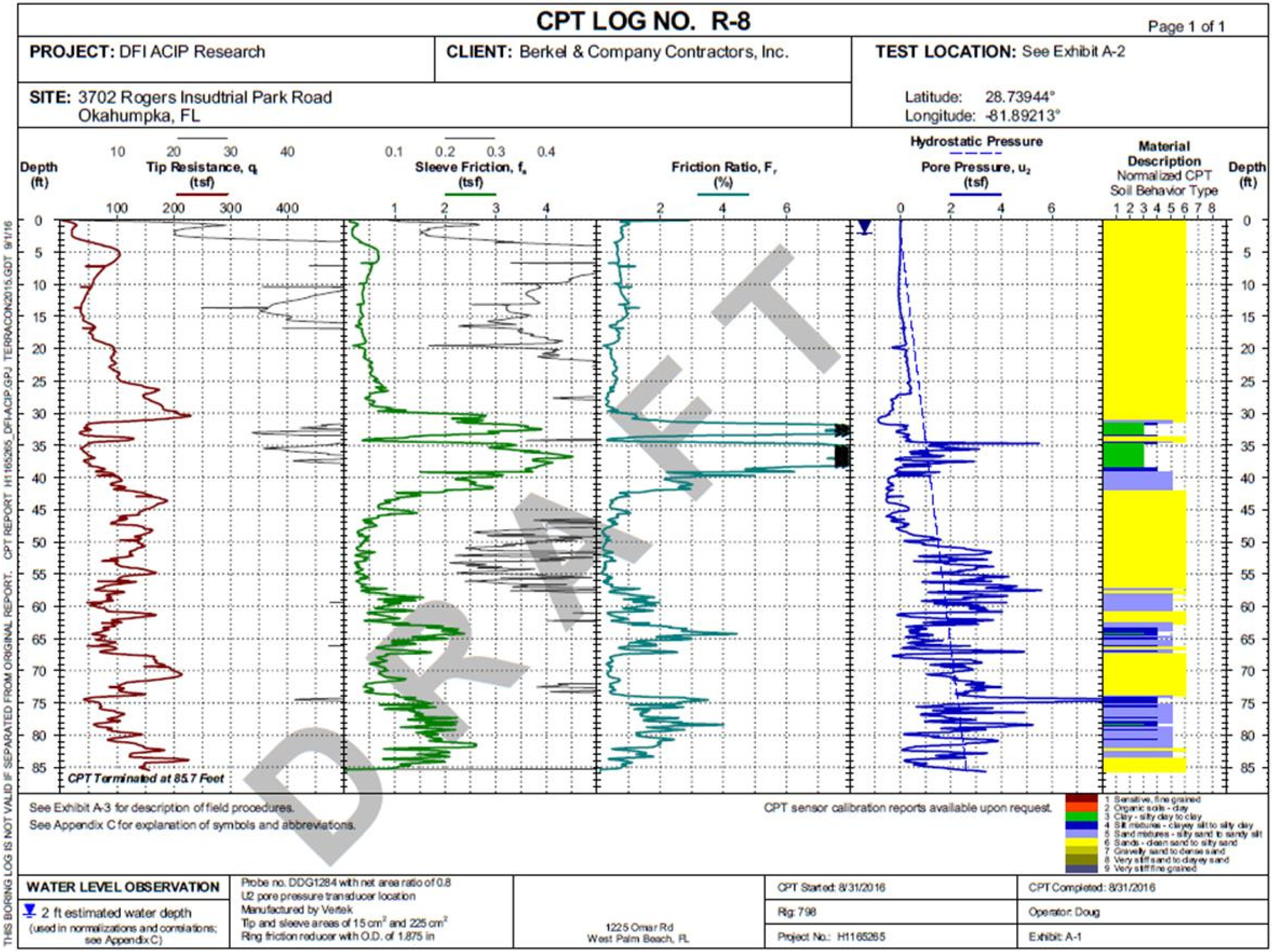
Notes:
Probe no. DDG1284 with net area ratio of 0.8
Manufactured by Vertek
Tip and sleeve areas of 15 cm^2 and 225 cm^2
Ring friction reducer with O.D. of 1.875 in

1225 Omar Rd
West Palm Beach, FL

CPT Started: 8/31/2016	CPT Completed: 8/31/2016
Rig: 798	Operator: Doug
Project No.: H1165265	Exhibit: A-1

THIS BORING LOG IS NOT VALID IF SEPARATED FROM ORIGINAL REPORT. CPT CORRELATIVE PARAMETERS REPORT H1165265_DFI-ACIP.GPJ TERRACON2015.GDT 9/1/16

Figure A-2. CPT correlative parameter log R-6



CPT LOG NO. R-8

Page 1 of 1

PROJECT: DFI ACIP Research

CLIENT: Berkel & Company Contractors, Inc.

TEST LOCATION: See Exhibit A-2

SITE: 3702 Rogers Insudtrial Park Road
Okahumpka, FL

Latitude: 28.73944°
Longitude: -81.89213°

See Exhibit A-3 for description of field procedures.
See Appendix C for explanation of symbols and abbreviations.

CPT sensor calibration reports available upon request.

WATER LEVEL OBSERVATION

2 ft estimated water depth
(used in normalizations and correlations; see Appendix C)

Probe no. DDG1284 with net area ratio of 0.8
U2 pore pressure transducer location
Manufactured by Vertek
Tip and sleeve areas of 15 cm^2 and 225 cm^2
Ring friction reducer with O.D. of 1.875 in

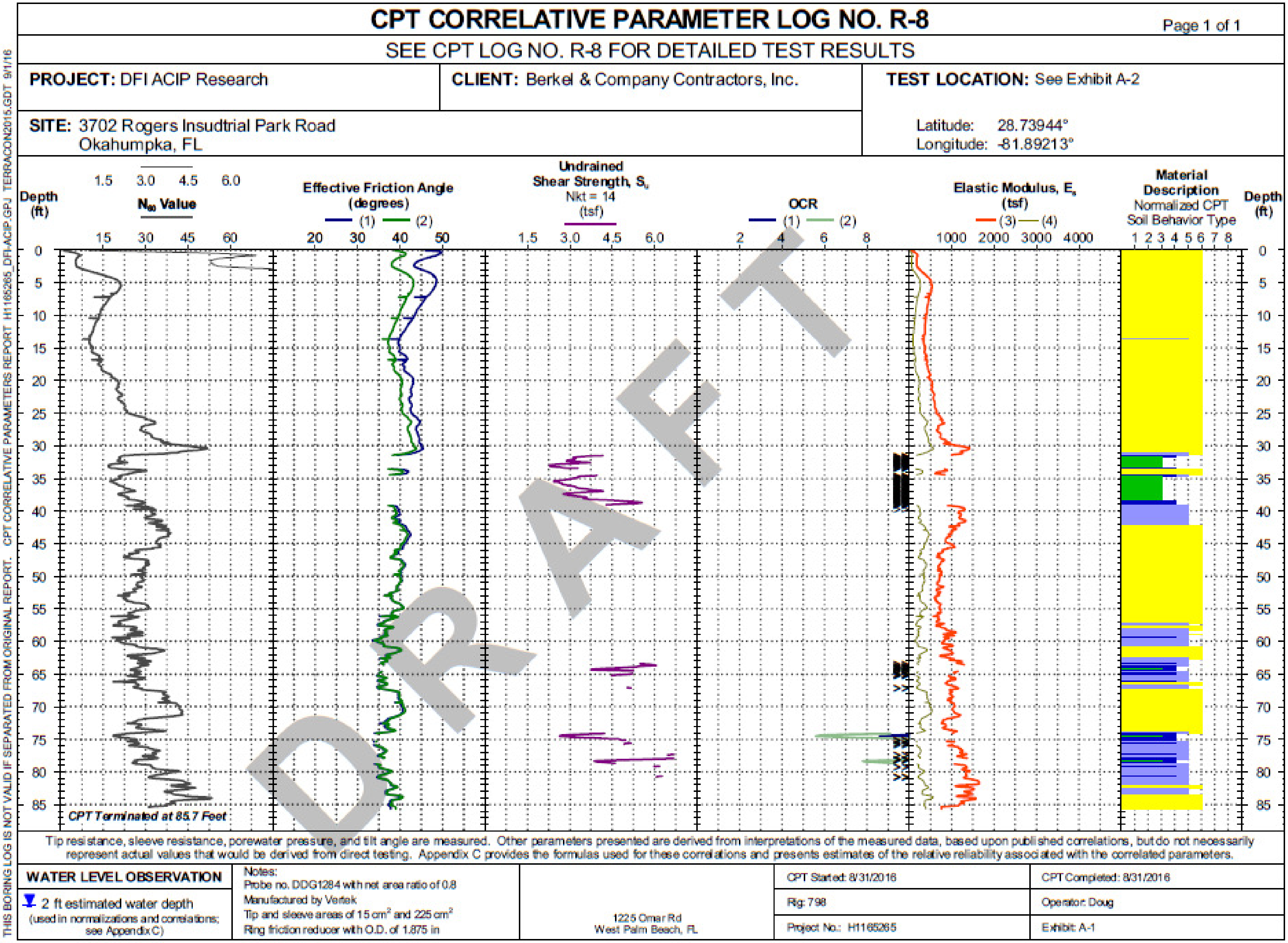
1225 Omar Rd
West Palm Beach, FL

CPT Started: 8/31/2016
Rig: 798
Project No.: H1165265

CPT Completed: 8/31/2016
Operator: Doug
Exhibit: A-1

THIS BORING LOG IS NOT VALID IF SEPARATED FROM ORIGINAL REPORT. CPT REPORT H1165265_DFI-ACIP.GPJ TERRACON2015.GDT 9/1/16

Figure A-3. CPT log R-8



CPT CORRELATIVE PARAMETER LOG NO. R-8

Page 1 of 1

SEE CPT LOG NO. R-8 FOR DETAILED TEST RESULTS

PROJECT: DFI ACIP Research

CLIENT: Berkel & Company Contractors, Inc.

TEST LOCATION: See Exhibit A-2

SITE: 3702 Rogers Insudtrial Park Road
Okahumpka, FL

Latitude: 28.73944°
Longitude: -81.89213°

Tip resistance, sleeve resistance, porewater pressure, and tilt angle are measured. Other parameters presented are derived from interpretations of the measured data, based upon published correlations, but do not necessarily represent actual values that would be derived from direct testing. Appendix C provides the formulas used for these correlations and presents estimates of the relative reliability associated with the correlated parameters.

WATER LEVEL OBSERVATION

2 ft estimated water depth
(used in normalizations and correlations; see Appendix C)

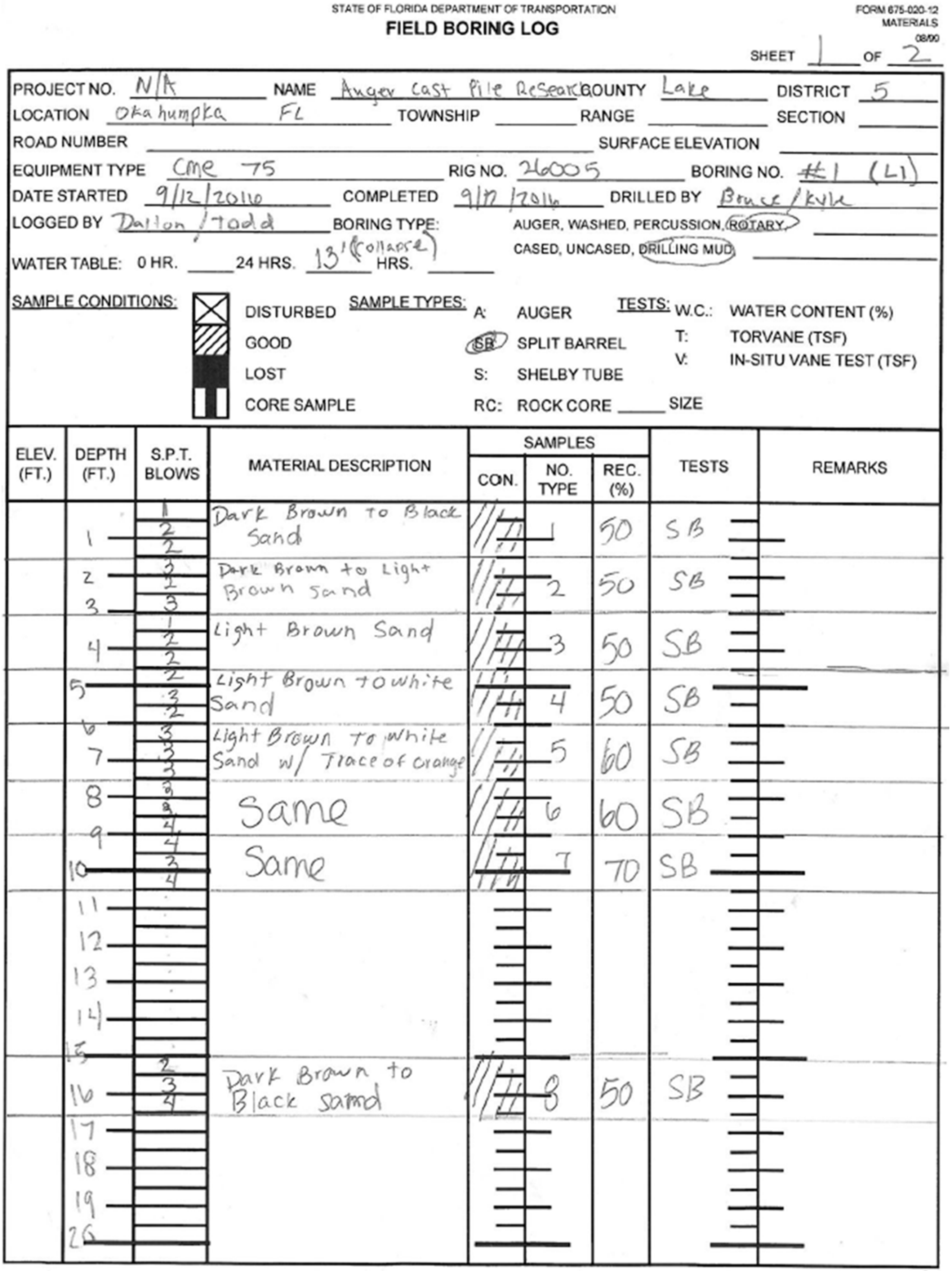
Notes:
Probe no. DDG1284 with net area ratio of 0.8
Manufactured by Vertek
Tip and sleeve areas of 15 cm^2 and 225 cm^2
Ring friction reducer with O.D. of 1.875 in

1225 Omar Rd
West Palm Beach, FL

CPT Started: 8/31/2016	CPT Completed: 8/31/2016
Rig: 798	Operator: Doug
Project No.: H1165265	Exhibit: A-1

THIS BORING LOG IS NOT VALID IF SEPARATED FROM ORIGINAL REPORT. CPT CORRELATIVE PARAMETERS REPORT H1165265_DFI-ACIP.GPJ TERRACON2015.GDT 9/1/16

Figure A-4. CPT correlative parameter log R-8



STATE OF FLORIDA DEPARTMENT OF TRANSPORTATION

FORM 675-020-12
MATERIALS
08/90

FIELD BORING LOG

SHEET 1 OF 2

PROJECT NO. N/A NAME Auger cast Pile Research COUNTY Lake DISTRICT 5
LOCATION Okahumpka FL TOWNSHIP ____ RANGE ____ SECTION ____
ROAD NUMBER ____ SURFACE ELEVATION ____
EQUIPMENT TYPE CME 75 RIG NO. 26005 BORING NO. #1 (L1)
DATE STARTED 9/12/2016 COMPLETED 9/12/2016 DRILLED BY Bruce/Kyle
LOGGED BY Dalton/Todd BORING TYPE: AUGER, WASHED, PERCUSSION, [✓ ROTARY]
CASED, UNCASED, [✓ DRILLING MUD]
WATER TABLE: 0 HR. ____ 24 HRS. 13' (collapse) HRS. ____

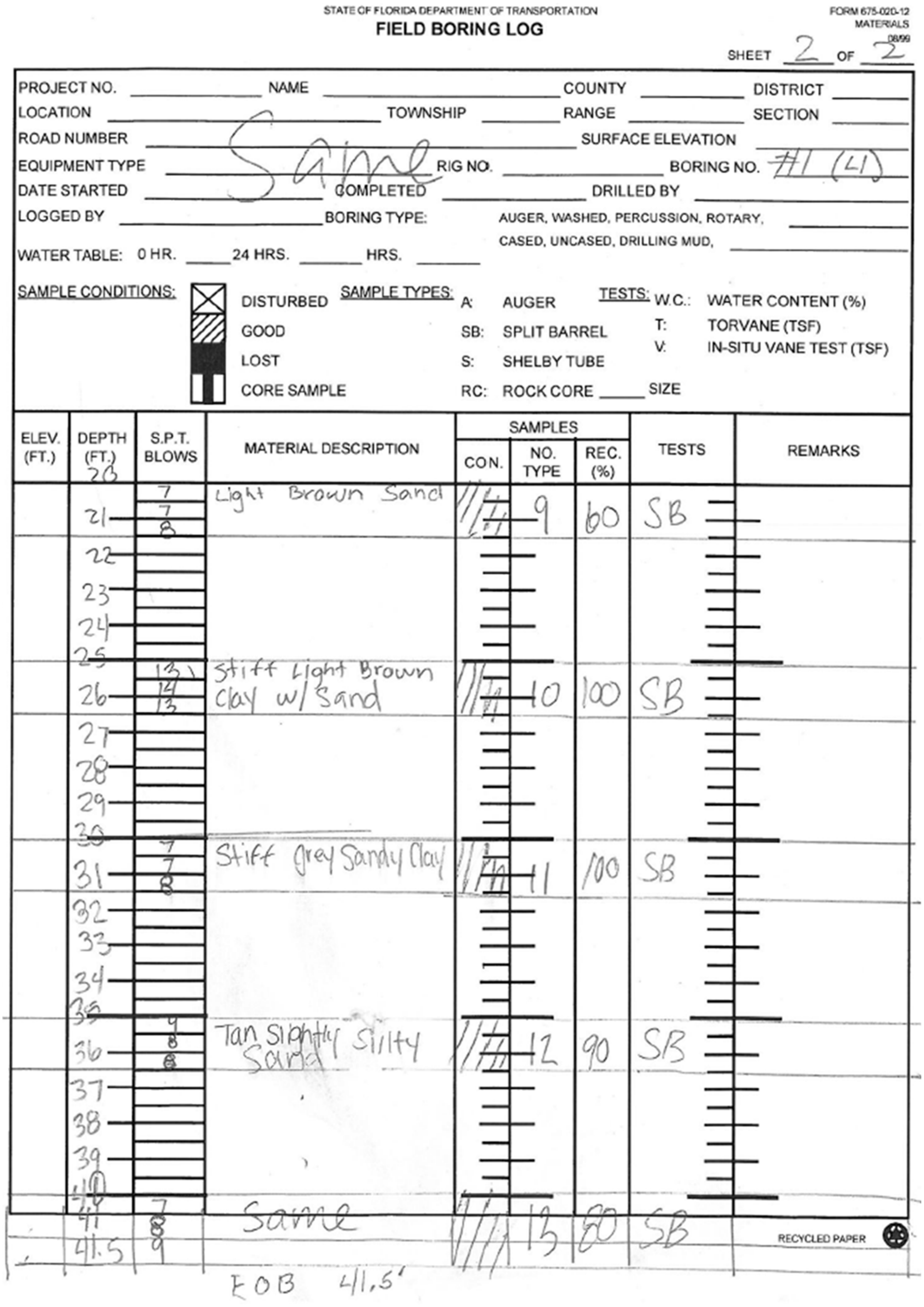
SAMPLE CONDITIONS:
☒ DISTURBED
▨ GOOD
■ LOST
▯ CORE SAMPLE

SAMPLE TYPES:
A: AUGER
[✓ SB]: SPLIT BARREL
S: SHELBY TUBE
RC: ROCK CORE ____ SIZE

TESTS:
W.C.: WATER CONTENT (%)
T: TORVANE (TSF)
V: IN-SITU VANE TEST (TSF)

ELEV. (FT.)	DEPTH (FT.)	S.P.T. BLOWS	MATERIAL DESCRIPTION	SAMPLES CON.	SAMPLES NO. TYPE	SAMPLES REC. (%)	TESTS	REMARKS
	1	1 2 2	Dark Brown to Black Sand	▨	1	50	SB	
	2 3	3 1 3	Dark Brown to Light Brown sand	▨	2	50	SB	
	4	1 2 2	Light Brown Sand	▨	3	50	SB	
	5	2 3 2	Light Brown to white Sand	▨	4	50	SB	
	6 7	3 3 3	Light Brown to white Sand w/ Trace of orange	▨	5	60	SB	
	8 9	3 3 4	Same	▨	6	60	SB	
	10	4 3 4	Same	▨	7	70	SB	
	11 12 13 14 15							
	16	2 3 4	Dark Brown to Black sand	▨	8	50	SB	
	17 18 19 20							

Figure A-5. Soil boring log B-1 (L-1)



STATE OF FLORIDA DEPARTMENT OF TRANSPORTATION

FIELD BORING LOG

FORM 675-020-12
MATERIALS
08/99

SHEET 2 OF 2

PROJECT NO. ______ NAME ______ COUNTY ______ DISTRICT ______
LOCATION ______ TOWNSHIP ______ RANGE ______ SECTION ______
ROAD NUMBER ______ SURFACE ELEVATION ______
EQUIPMENT TYPE Same RIG NO. ______ BORING NO. #1 (L1)
DATE STARTED ______ COMPLETED ______ DRILLED BY ______
LOGGED BY ______ BORING TYPE: AUGER, WASHED, PERCUSSION, ROTARY, CASED, UNCASED, DRILLING MUD, ______
WATER TABLE: 0 HR. ______ 24 HRS. ______ HRS. ______

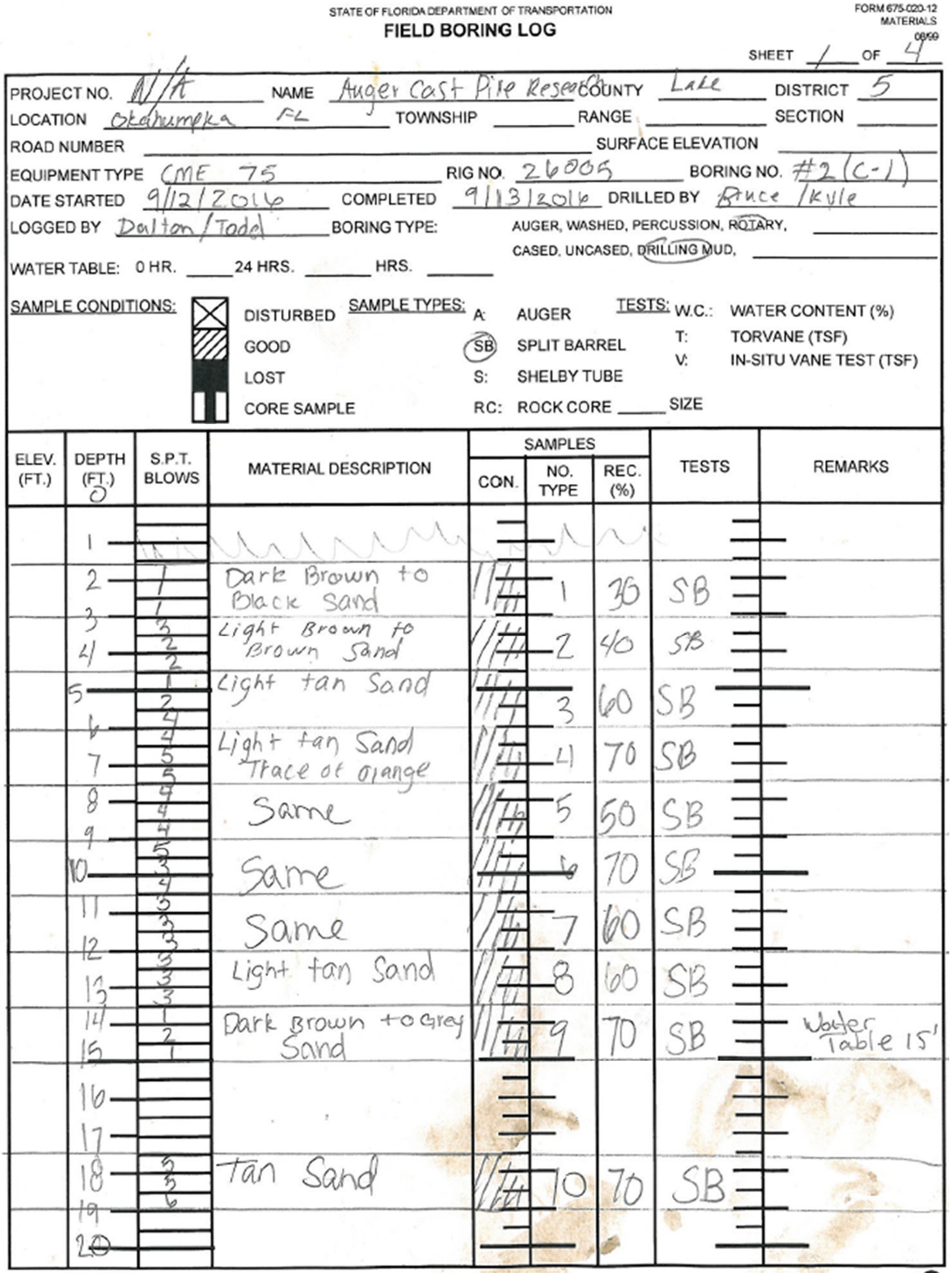
SAMPLE CONDITIONS:	☒ DISTURBED	SAMPLE TYPES:	A: AUGER	TESTS:	W.C.: WATER CONTENT (%)
	▨ GOOD		SB: SPLIT BARREL		T: TORVANE (TSF)
	■ LOST		S: SHELBY TUBE		V: IN-SITU VANE TEST (TSF)
	◧ CORE SAMPLE		RC: ROCK CORE ______ SIZE		

ELEV. (FT.)	DEPTH (FT.)	S.P.T. BLOWS	MATERIAL DESCRIPTION	SAMPLES CON.	SAMPLES NO. TYPE	SAMPLES REC. (%)	TESTS	REMARKS
	20							
	21	7 7 8	Light Brown Sand	▨	9	60	SB	
	22							
	23							
	24							
	25							
	26	13 14 13	Stiff Light Brown Clay w/ Sand	▨	10	100	SB	
	27							
	28							
	29							
	30							
	31	7 7 8	Stiff grey Sandy Clay	▨	11	100	SB	
	32							
	33							
	34							
	35							
	36	9 8 8	Tan Slightly Silty Sand	▨	12	90	SB	
	37							
	38							
	39							
	40							
	41	7 8	Same	▨	13	80	SB	
	41.5	9						

EOB 41.5'

RECYCLED PAPER

Figure A-5. Soil boring log B-1 (L-1) *continued*



STATE OF FLORIDA DEPARTMENT OF TRANSPORTATION

FIELD BORING LOG

FORM 675-020-12
MATERIALS
08/99

SHEET 1 OF 4

PROJECT NO. N/A NAME Auger Cast Pile Research COUNTY Lake DISTRICT 5

LOCATION Okahumpka FL TOWNSHIP ____ RANGE ____ SECTION ____

ROAD NUMBER ____ SURFACE ELEVATION ____

EQUIPMENT TYPE CME 75 RIG NO. 26005 BORING NO. #2 (C-1)

DATE STARTED 9/12/2016 COMPLETED 9/13/2016 DRILLED BY Bruce / Kyle

LOGGED BY Dalton / Todd BORING TYPE: AUGER, WASHED, PERCUSSION, [✓ ROTARY], CASED, UNCASED, [✓ DRILLING MUD], ____

WATER TABLE: 0 HR. ____ 24 HRS. ____ HRS. ____

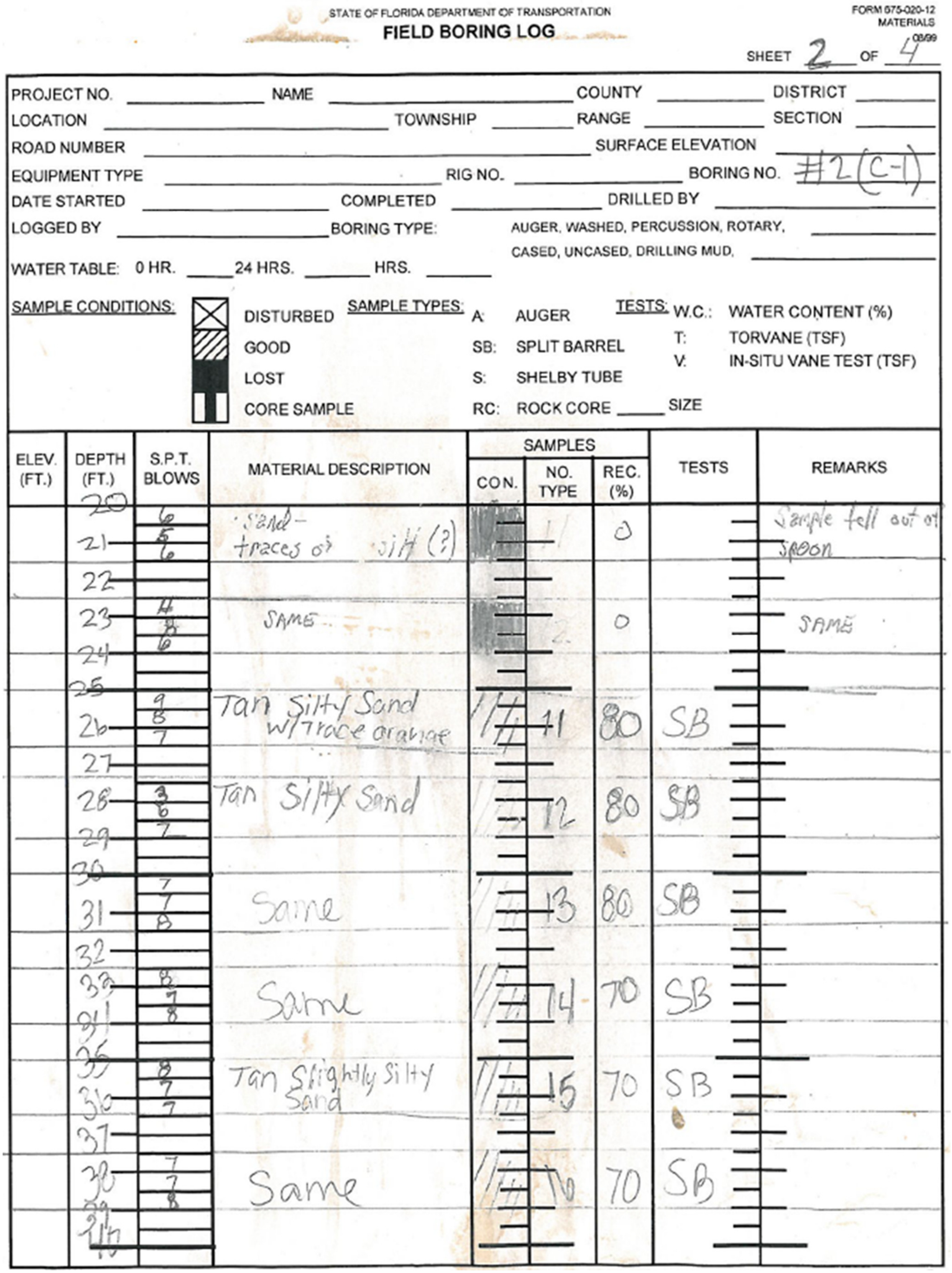
SAMPLE CONDITIONS:
☒ DISTURBED
▨ GOOD
■ LOST
▯ CORE SAMPLE

SAMPLE TYPES:
A: AUGER
[✓ SB]: SPLIT BARREL
S: SHELBY TUBE
RC: ROCK CORE ____ SIZE

TESTS:
W.C.: WATER CONTENT (%)
T: TORVANE (TSF)
V: IN-SITU VANE TEST (TSF)

ELEV. (FT.)	DEPTH (FT.) 0	S.P.T. BLOWS	MATERIAL DESCRIPTION	SAMPLES CON.	SAMPLES NO. TYPE	SAMPLES REC. (%)	TESTS	REMARKS
	1							
	2 3	1 1 1	Dark Brown to Black Sand	▨	1	30	SB	
	4	3 2 2	Light Brown to Brown Sand	▨	2	40	SB	
	5 6	1 2 4	Light tan Sand	▨	3	60	SB	
	7	4 5 5	Light tan Sand Trace of orange	▨	4	70	SB	
	8 9	4 4 4	Same	▨	5	50	SB	
	10	5 3 4	Same	▨	6	70	SB	
	11 12	3 3 3	Same	▨	7	60	SB	
	13	3 3 3	Light tan Sand	▨	8	60	SB	
	14 15	1 2 1	Dark Brown to Grey Sand	▨	9	70	SB	Water Table 15'
	16 17							
	18	3 3 6	Tan Sand	▨	10	70	SB	
	19 20							

Figure A-6. Soil boring log B-2 (C-1)



STATE OF FLORIDA DEPARTMENT OF TRANSPORTATION
FIELD BORING LOG

FORM 675-020-12
MATERIALS
08/99

SHEET 2 OF 4

PROJECT NO. ______ NAME ______ COUNTY ______ DISTRICT ______
LOCATION ______ TOWNSHIP ______ RANGE ______ SECTION ______
ROAD NUMBER ______ SURFACE ELEVATION ______
EQUIPMENT TYPE ______ RIG NO. ______ BORING NO. #2 (C-1)
DATE STARTED ______ COMPLETED ______ DRILLED BY ______
LOGGED BY ______ BORING TYPE: AUGER, WASHED, PERCUSSION, ROTARY, CASED, UNCASED, DRILLING MUD, ______
WATER TABLE: 0 HR. ______ 24 HRS. ______ HRS. ______

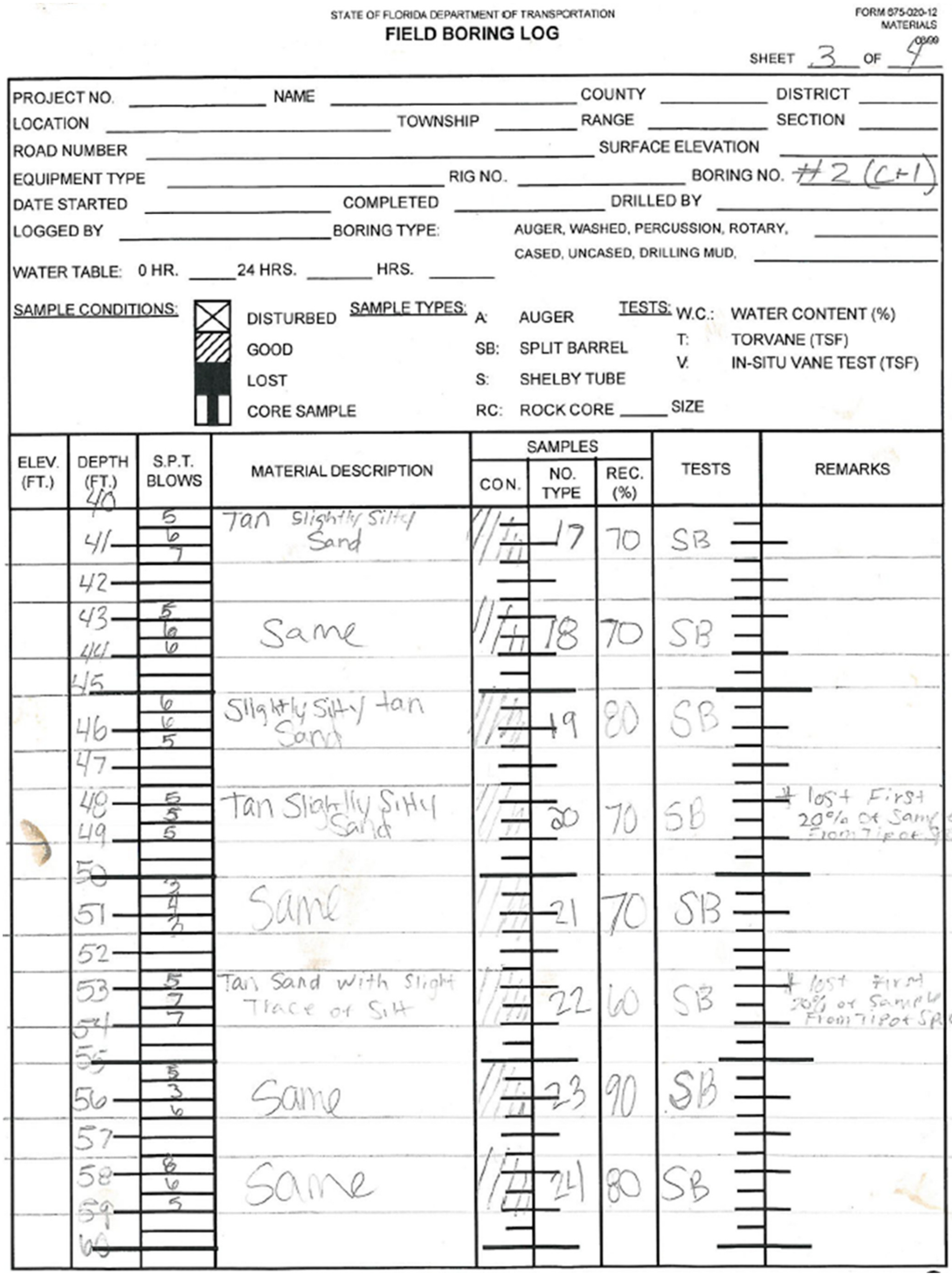
SAMPLE CONDITIONS:
☒ DISTURBED
▨ GOOD
■ LOST
▥ CORE SAMPLE

SAMPLE TYPES:
A: AUGER
SB: SPLIT BARREL
S: SHELBY TUBE
RC: ROCK CORE ______ SIZE

TESTS:
W.C.: WATER CONTENT (%)
T: TORVANE (TSF)
V: IN-SITU VANE TEST (TSF)

ELEV. (FT.)	DEPTH (FT.)	S.P.T. BLOWS	MATERIAL DESCRIPTION	SAMPLES			TESTS	REMARKS
				CON.	NO. TYPE	REC. (%)		
	20 21 22	6 5 6	sand - traces of silt (?)	■	1	0		Sample fell out of spoon
	23 24	4 8 6	SAME	■	2	0		SAME
	25 26 27	9 8 7	Tan Silty Sand w/ trace orange	▨	11	80	SB	
	28 29	3 6 7	Tan Silty Sand	▨	12	80	SB	
	30 31 32	7 7 8	Same	▨	13	80	SB	
	33 34	8 7 8	Same	▨	14	70	SB	
	35 36 37	8 7 7	Tan Slightly Silty Sand	▨	15	70	SB	
	38 39 40	7 7 8	Same	▨	16	70	SB	

Figure A-6. Soil boring log B-2 (C-1) *continued*



STATE OF FLORIDA DEPARTMENT OF TRANSPORTATION

FIELD BORING LOG

FORM 675-020-12
MATERIALS
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SHEET 3 OF 4

PROJECT NO. ______ NAME ______ COUNTY ______ DISTRICT ______
LOCATION ______ TOWNSHIP ______ RANGE ______ SECTION ______
ROAD NUMBER ______ SURFACE ELEVATION ______
EQUIPMENT TYPE ______ RIG NO. ______ BORING NO. #2 (C-1)
DATE STARTED ______ COMPLETED ______ DRILLED BY ______
LOGGED BY ______ BORING TYPE: AUGER, WASHED, PERCUSSION, ROTARY, CASED, UNCASED, DRILLING MUD, ______
WATER TABLE: 0 HR. ______ 24 HRS. ______ HRS. ______

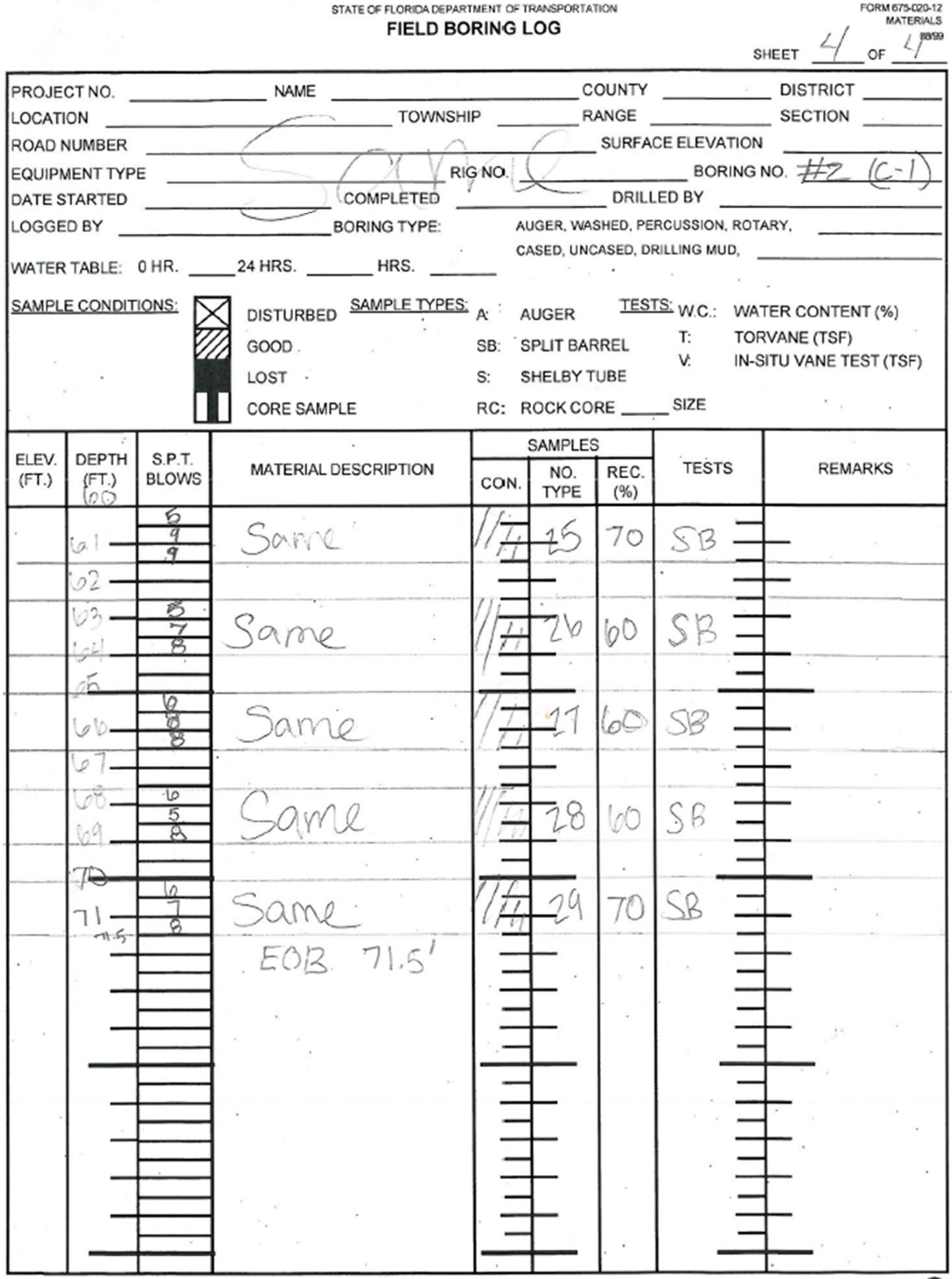
SAMPLE CONDITIONS: ☒ DISTURBED ▨ GOOD ■ LOST ▯ CORE SAMPLE

SAMPLE TYPES: A: AUGER; SB: SPLIT BARREL; S: SHELBY TUBE; RC: ROCK CORE ______ SIZE

TESTS: W.C.: WATER CONTENT (%); T: TORVANE (TSF); V: IN-SITU VANE TEST (TSF)

ELEV. (FT.)	DEPTH (FT.)	S.P.T. BLOWS	MATERIAL DESCRIPTION	SAMPLES CON.	SAMPLES NO. TYPE	SAMPLES REC. (%)	TESTS	REMARKS
	40 41	5 6 7	Tan slightly Silty Sand	▨	17	70	SB	
	42							
	43 44	5 6 6	Same	▨	18	70	SB	
	45							
	46	6 6 5	Slightly Silty tan Sand	▨	19	80	SB	
	47							
	48 49	5 5 5	Tan Slightlly Silty Sand	▨	20	70	SB	* lost First 20% of Sample From Tip of Spoon
	50 51	3 4 3	Same	▨	21	70	SB	
	52							
	53 54	5 7 7	Tan Sand with Slight Trace of Silt	▨	22	60	SB	* lost First 20% of Sample From Tip of Spoon
	55 56	5 3 6	Same	▨	23	90	SB	
	57							
	58 59	8 6 5	Same	▨	24	80	SB	
	60							

Figure A-6. Soil boring log B-2 (C-1) *continued*



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FIELD BORING LOG

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SHEET 4 OF 4

PROJECT NO. ______ NAME ______ COUNTY ______ DISTRICT ______
LOCATION ______ TOWNSHIP ______ RANGE ______ SECTION ______
ROAD NUMBER ______ SURFACE ELEVATION ______
EQUIPMENT TYPE ______ RIG NO. ______ BORING NO. #2 (C-1)
DATE STARTED ______ COMPLETED ______ DRILLED BY ______
LOGGED BY ______ BORING TYPE: AUGER, WASHED, PERCUSSION, ROTARY, CASED, UNCASED, DRILLING MUD, ______
WATER TABLE: 0 HR. ______ 24 HRS. ______ HRS. ______

Same

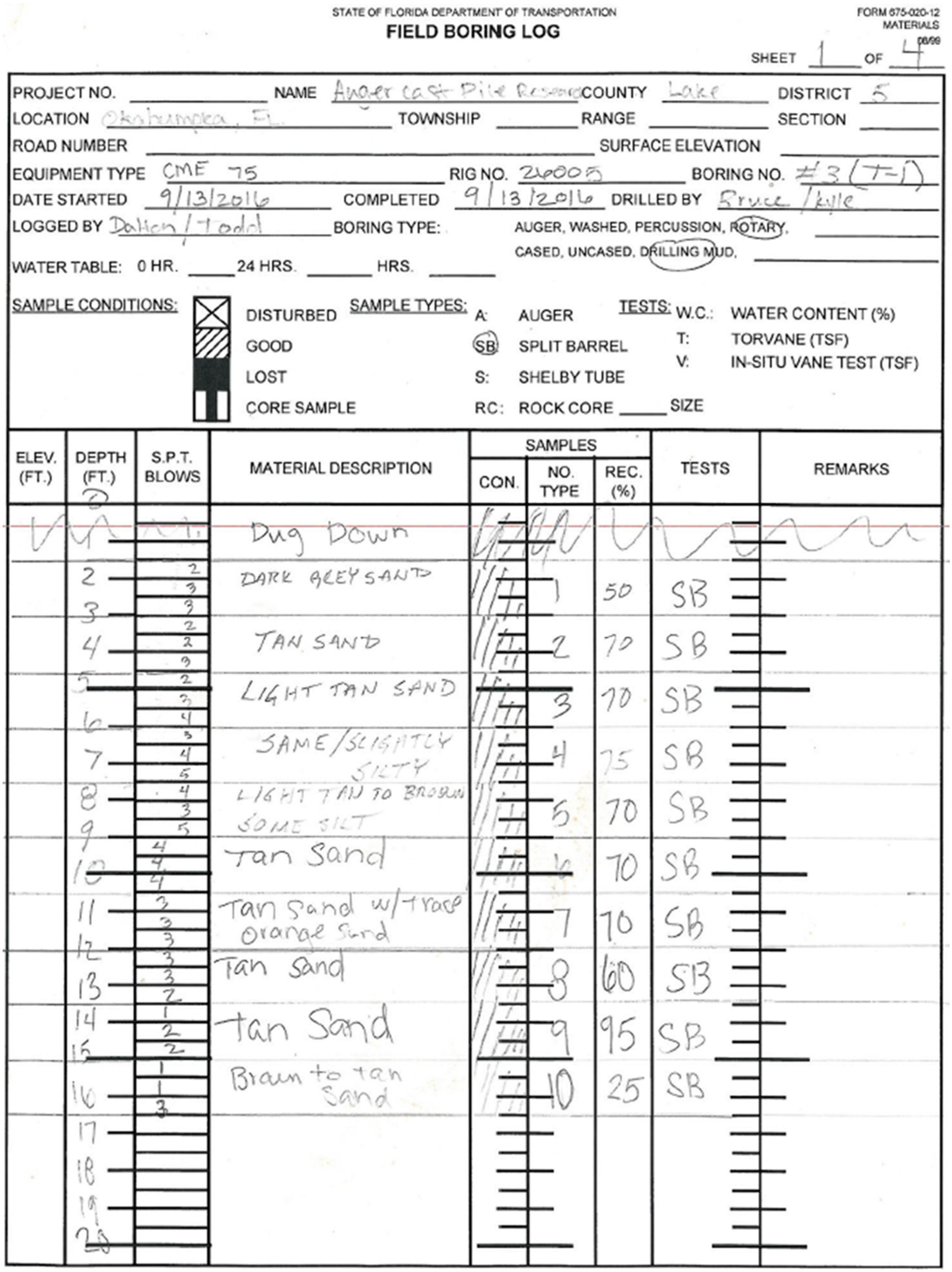
SAMPLE CONDITIONS: ☒ DISTURBED ▨ GOOD ■ LOST ▯ CORE SAMPLE

SAMPLE TYPES: A: AUGER SB: SPLIT BARREL S: SHELBY TUBE RC: ROCK CORE ______ SIZE

TESTS: W.C.: WATER CONTENT (%) T: TORVANE (TSF) V: IN-SITU VANE TEST (TSF)

ELEV. (FT.)	DEPTH (FT.)	S.P.T. BLOWS	MATERIAL DESCRIPTION	SAMPLES			TESTS	REMARKS
				CON.	NO. TYPE	REC. (%)		
	60							
	61	5 9 9	Same	▨	25	70	SB	
	62							
	63 64	8 7 8	Same	▨	26	60	SB	
	65							
	66	6 8 8	Same	▨	27	60	SB	
	67							
	68 69	6 5 8	Same	▨	28	60	SB	
	70							
	71 71.5	6 7 8	Same EOB 71.5'	▨	29	70	SB	

Figure A-6. Soil boring log B-2 (C-1) *continued*



STATE OF FLORIDA DEPARTMENT OF TRANSPORTATION

FIELD BORING LOG

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SHEET 1 OF 4

PROJECT NO. ____ NAME Auger cast Pile Research COUNTY Lake DISTRICT 5
LOCATION Okahumpka, FL TOWNSHIP ____ RANGE ____ SECTION ____
ROAD NUMBER ____ SURFACE ELEVATION ____
EQUIPMENT TYPE CME 75 RIG NO. 26005 BORING NO. #3 (T-1)
DATE STARTED 9/13/2016 COMPLETED 9/13/2016 DRILLED BY Bruce / kyle
LOGGED BY Dalton / Todd BORING TYPE: AUGER, WASHED, PERCUSSION, [✓ ROTARY], CASED, UNCASED, [✓ DRILLING MUD], ____
WATER TABLE: 0 HR. ____ 24 HRS. ____ HRS. ____

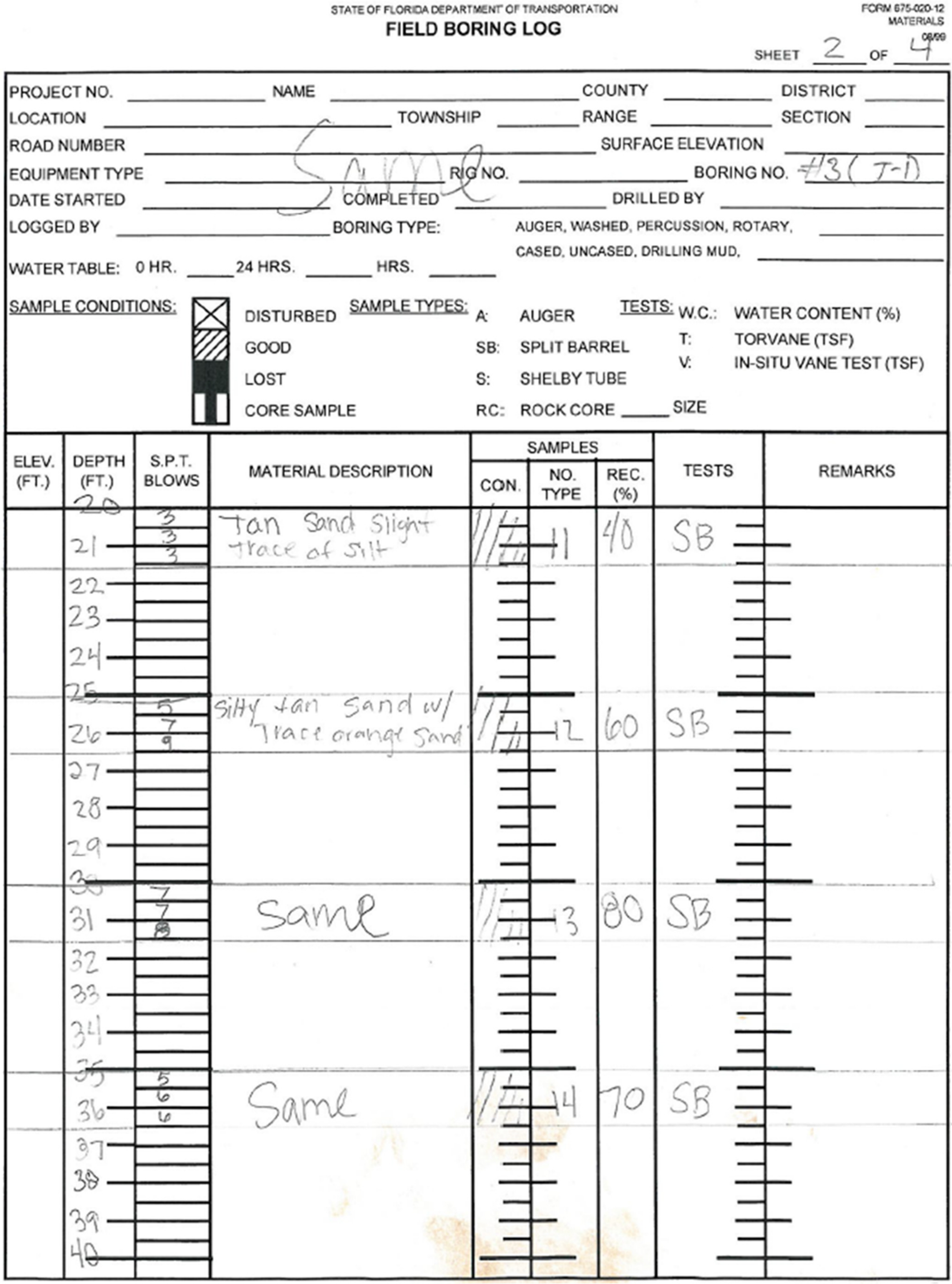
SAMPLE CONDITIONS:
☒ DISTURBED
▨ GOOD
■ LOST
▥ CORE SAMPLE

SAMPLE TYPES:
A: AUGER
[✓ SB:] SPLIT BARREL
S: SHELBY TUBE
RC: ROCK CORE ____ SIZE

TESTS:
W.C.: WATER CONTENT (%)
T: TORVANE (TSF)
V: IN-SITU VANE TEST (TSF)

ELEV. (FT.)	DEPTH (FT.) 2	S.P.T. BLOWS	MATERIAL DESCRIPTION	SAMPLES			TESTS	REMARKS
				CON.	NO. TYPE	REC. (%)		
			Dug Down					
	2 3	2 3 3	DARK GREY SAND		1	50	SB	
	4	2 2 3	TAN SAND		2	70	SB	
	5 6	2 3 4	LIGHT TAN SAND		3	70	SB	
	7	3 4 5	SAME/SLIGHTLY SILTY		4	75	SB	
	8 9	4 3 5	LIGHT TAN TO BROWN SOME SILT		5	70	SB	
	10	4 4 4	Tan Sand		6	70	SB	
	11 12	3 3 3	Tan Sand w/ trace orange Sand		7	70	SB	
	13	3 3 2	Tan sand		8	60	SB	
	14 15	1 2 2	Tan Sand		9	95	SB	
	16	1 1 3	Brawn to tan Sand		10	25	SB	
	17 18 19 20							

Figure A-7. Soil boring log B-3 (T-1)



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FORM 675-020-12
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FIELD BORING LOG

SHEET 2 OF 4

PROJECT NO. NAME COUNTY DISTRICT
LOCATION TOWNSHIP RANGE SECTION
ROAD NUMBER SURFACE ELEVATION
EQUIPMENT TYPE Same RIG NO. BORING NO. #3 (T-1)
DATE STARTED COMPLETED DRILLED BY
LOGGED BY BORING TYPE: AUGER, WASHED, PERCUSSION, ROTARY, CASED, UNCASED, DRILLING MUD,
WATER TABLE: 0 HR. 24 HRS. HRS.

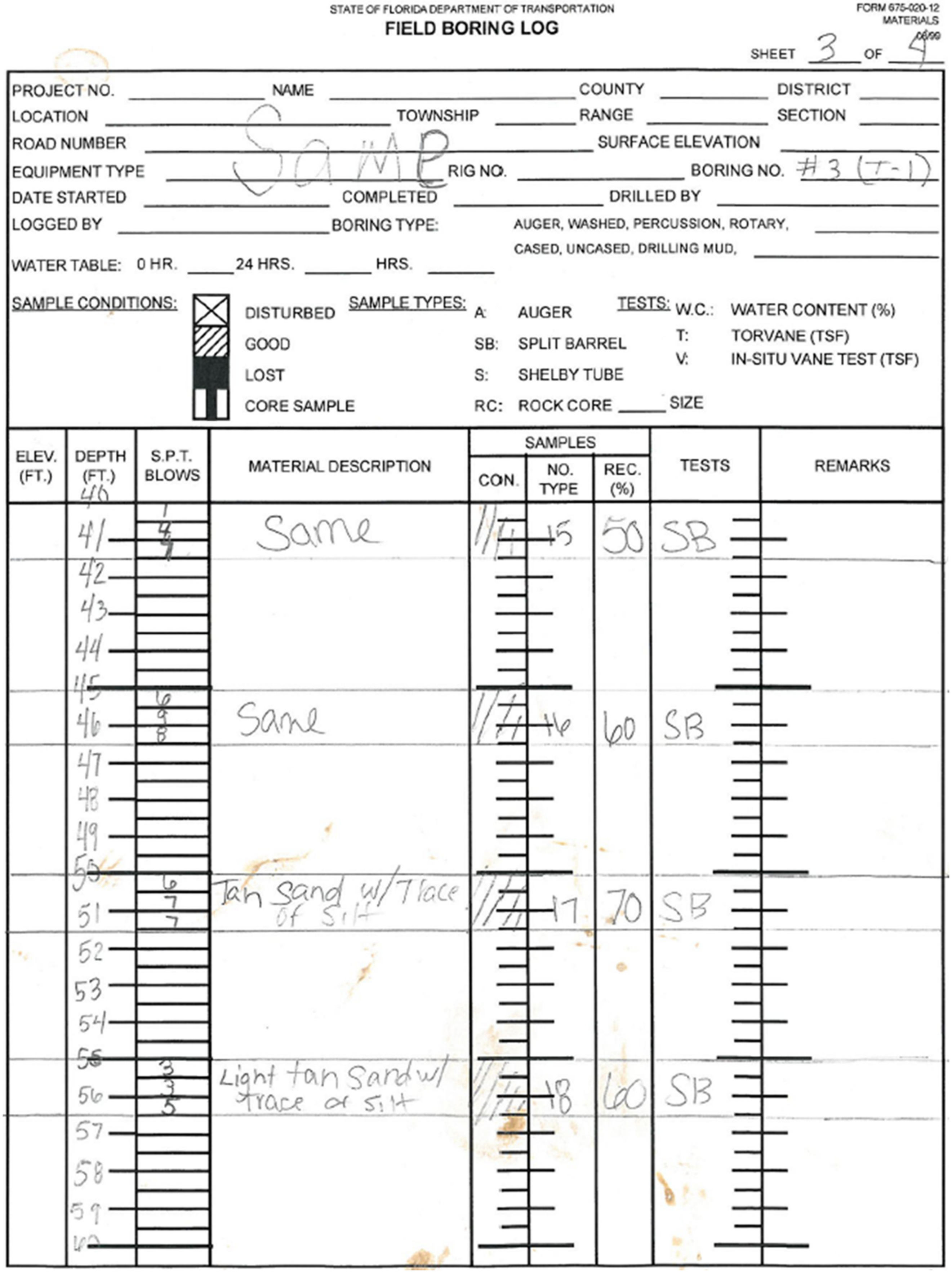
SAMPLE CONDITIONS:
- ☒ DISTURBED
- ▨ GOOD
- ■ LOST
- ▯ CORE SAMPLE

SAMPLE TYPES:
- A: AUGER
- SB: SPLIT BARREL
- S: SHELBY TUBE
- RC: ROCK CORE SIZE

TESTS:
- W.C.: WATER CONTENT (%)
- T: TORVANE (TSF)
- V: IN-SITU VANE TEST (TSF)

ELEV. (FT.)	DEPTH (FT.)	S.P.T. BLOWS	MATERIAL DESCRIPTION	SAMPLES CON.	SAMPLES NO. TYPE	SAMPLES REC. (%)	TESTS	REMARKS
	20							
	21	3 3 3	Tan Sand Slight Trace of Silt	▨	11	40	SB	
	22							
	23							
	24							
	25							
	26	5 7 9	Silty tan sand w/ Trace orange sand	▨	12	60	SB	
	27							
	28							
	29							
	30							
	31	7 7 8	Same	▨	13	80	SB	
	32							
	33							
	34							
	35							
	36	5 6 6	Same	▨	14	70	SB	
	37							
	38							
	39							
	40							

Figure A-7. Soil boring log B-3 (T-1) *continued*



STATE OF FLORIDA DEPARTMENT OF TRANSPORTATION

FIELD BORING LOG

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SHEET 3 OF 4

PROJECT NO. ____ NAME ____ COUNTY ____ DISTRICT ____
LOCATION ____ TOWNSHIP ____ RANGE ____ SECTION ____
ROAD NUMBER ____ SURFACE ELEVATION ____
EQUIPMENT TYPE ____ RIG NO. ____ BORING NO. #3 (T-1)
DATE STARTED ____ COMPLETED ____ DRILLED BY ____
LOGGED BY ____ BORING TYPE: AUGER, WASHED, PERCUSSION, ROTARY, CASED, UNCASED, DRILLING MUD, ____
WATER TABLE: 0 HR. ____ 24 HRS. ____ HRS. ____

Same

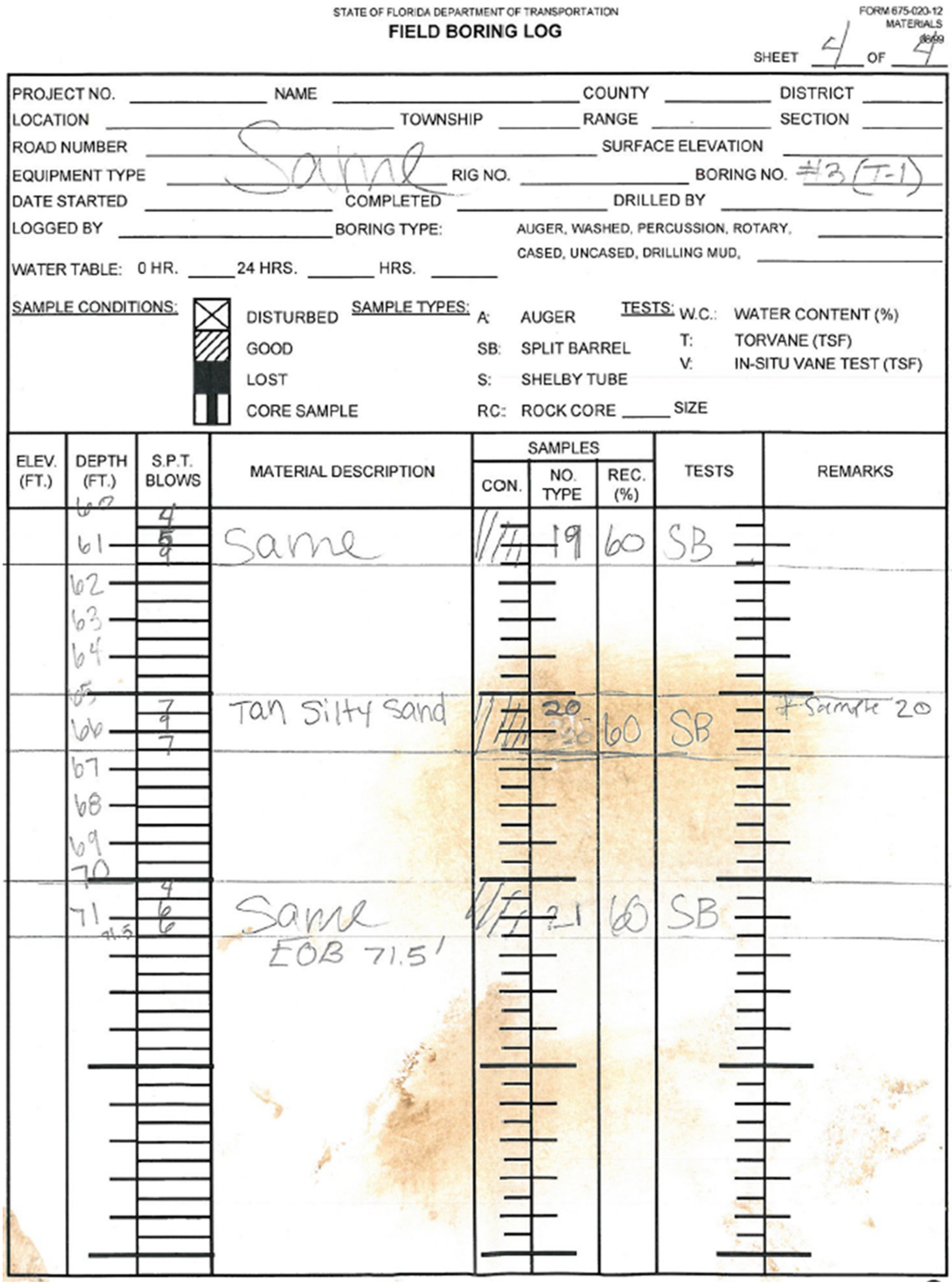
SAMPLE CONDITIONS:
☒ DISTURBED
▨ GOOD
■ LOST
◫ CORE SAMPLE

SAMPLE TYPES:
A: AUGER
SB: SPLIT BARREL
S: SHELBY TUBE
RC: ROCK CORE ____ SIZE

TESTS:
W.C.: WATER CONTENT (%)
T: TORVANE (TSF)
V: IN-SITU VANE TEST (TSF)

ELEV. (FT.)	DEPTH (FT.)	S.P.T. BLOWS	MATERIAL DESCRIPTION	SAMPLES			TESTS	REMARKS
				CON.	NO. TYPE	REC. (%)		
	40							
	41	7 4 4	Same	▨	15	50	SB	
	42							
	43							
	44							
	45							
	46	6 9 8	Same	▨	16	60	SB	
	47							
	48							
	49							
	50							
	51	6 7 7	Tan Sand w/ Trace of Silt	▨	17	70	SB	
	52							
	53							
	54							
	55							
	56	3 3 5	Light tan Sand w/ trace of silt	▨	18	60	SB	
	57							
	58							
	59							
	60							

Figure A-7. Soil boring log B-3 (T-1) *continued*



STATE OF FLORIDA DEPARTMENT OF TRANSPORTATION

FIELD BORING LOG

FORM 675-020-12
MATERIALS
08/99

SHEET 4 OF 4

PROJECT NO. ________ NAME ________ COUNTY ________ DISTRICT ________
LOCATION ________ TOWNSHIP ________ RANGE ________ SECTION ________
ROAD NUMBER Same SURFACE ELEVATION ________
EQUIPMENT TYPE ________ RIG NO. ________ BORING NO. #3 (T-1)
DATE STARTED ________ COMPLETED ________ DRILLED BY ________
LOGGED BY ________ BORING TYPE: AUGER, WASHED, PERCUSSION, ROTARY, CASED, UNCASED, DRILLING MUD, ________
WATER TABLE: 0 HR. ____ 24 HRS. ____ HRS. ____

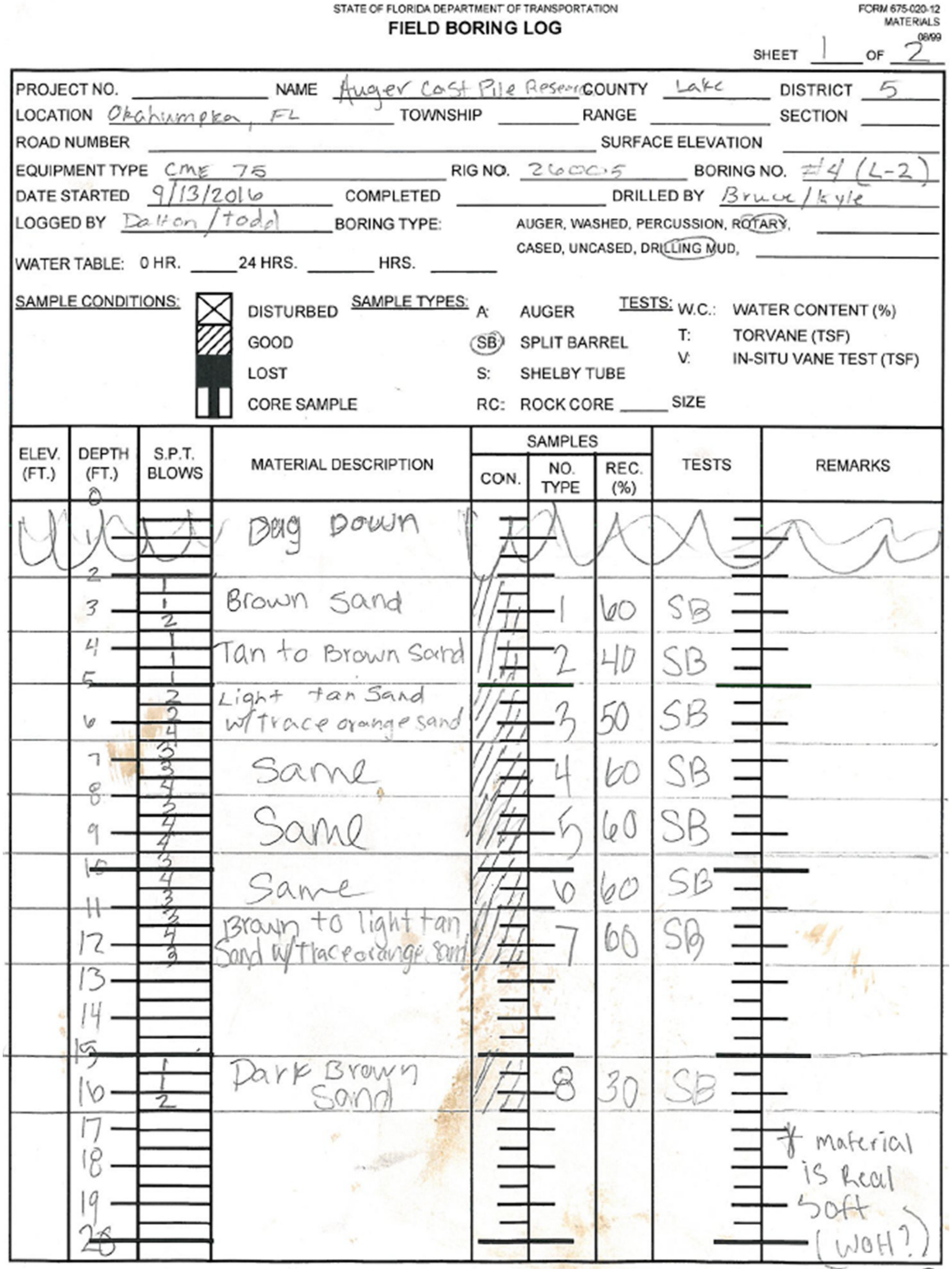
SAMPLE CONDITIONS:
☒ DISTURBED
▨ GOOD
■ LOST
▯ CORE SAMPLE

SAMPLE TYPES:
A: AUGER
SB: SPLIT BARREL
S: SHELBY TUBE
RC: ROCK CORE ____ SIZE

TESTS:
W.C.: WATER CONTENT (%)
T: TORVANE (TSF)
V: IN-SITU VANE TEST (TSF)

ELEV. (FT.)	DEPTH (FT.)	S.P.T. BLOWS	MATERIAL DESCRIPTION	SAMPLES CON.	SAMPLES NO. TYPE	SAMPLES REC. (%)	TESTS	REMARKS
	60 61	4 5 9	Same	▨	19	60	SB	
	62 63 64							
	65 66	7 9 7	Tan Silty Sand	▨	20	60	SB	# Sample 20
	67 68 69 70							
	71 71.5	4 6 6	Same EOB 71.5'	▨	21	60	SB	

Figure A-7. Soil boring log B-3 (T-1) *continued*



STATE OF FLORIDA DEPARTMENT OF TRANSPORTATION

FIELD BORING LOG

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SHEET 1 OF 2

PROJECT NO. ______ NAME Auger Cast Pile Research COUNTY Lake DISTRICT 5
LOCATION Okahumpka, FL TOWNSHIP ______ RANGE ______ SECTION ______
ROAD NUMBER ______ SURFACE ELEVATION ______
EQUIPMENT TYPE CME 75 RIG NO. 260005 BORING NO. #4 (L-2)
DATE STARTED 9/13/2016 COMPLETED ______ DRILLED BY Bruce/kyle
LOGGED BY Dalton/todd BORING TYPE: AUGER, WASHED, PERCUSSION, [✓ ROTARY], CASED, UNCASED, [✓ DRILLING MUD],
WATER TABLE: 0 HR. ______ 24 HRS. ______ HRS. ______

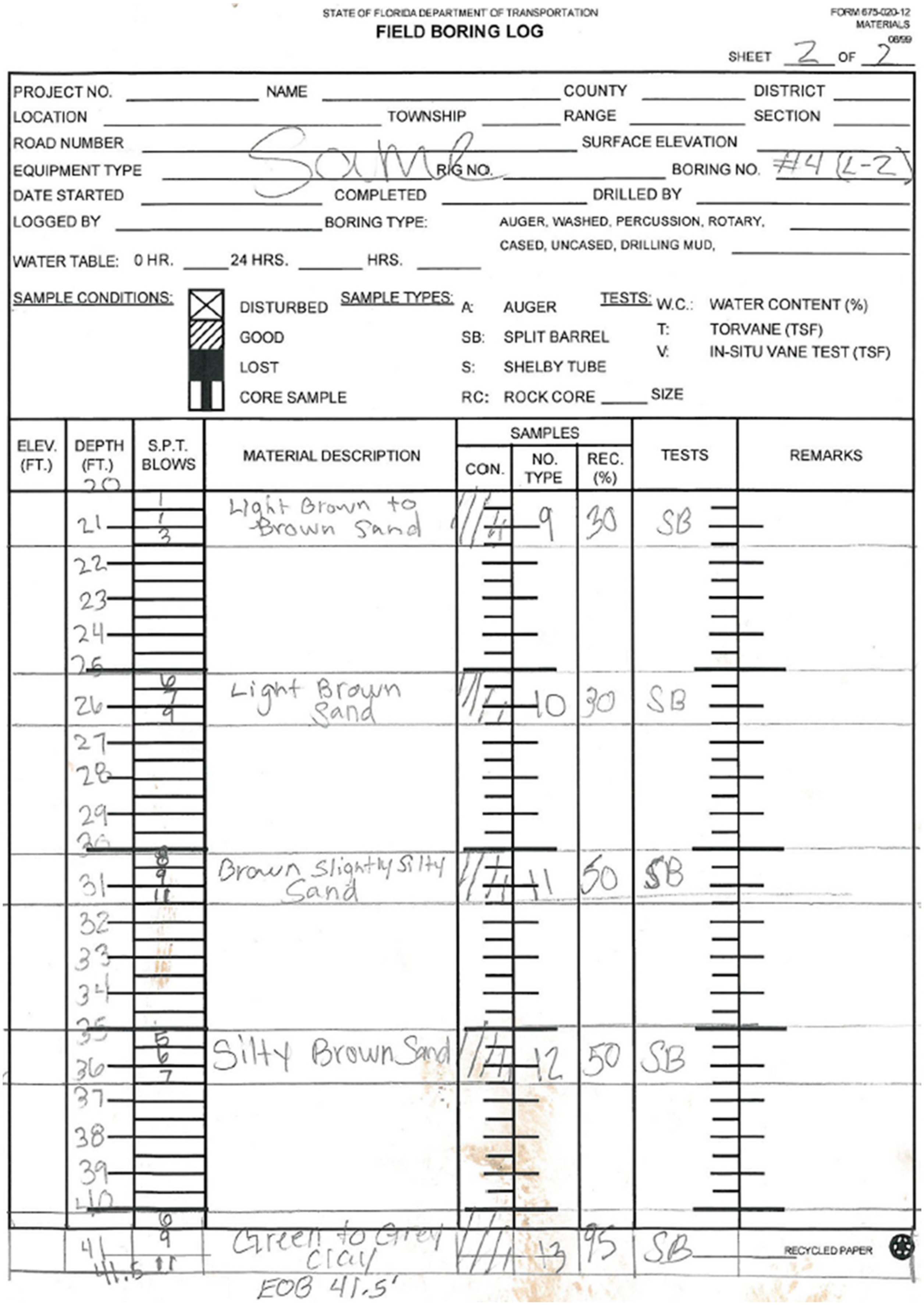
SAMPLE CONDITIONS:
☒ DISTURBED
▨ GOOD
■ LOST
▯ CORE SAMPLE

SAMPLE TYPES:
A: AUGER
[✓ SB]: SPLIT BARREL
S: SHELBY TUBE
RC: ROCK CORE ______ SIZE

TESTS:
W.C.: WATER CONTENT (%)
T: TORVANE (TSF)
V: IN-SITU VANE TEST (TSF)

ELEV. (FT.)	DEPTH (FT.)	S.P.T. BLOWS	MATERIAL DESCRIPTION	SAMPLES CON.	SAMPLES NO. TYPE	SAMPLES REC. (%)	TESTS	REMARKS
	0–2		Dug Down					
	3	1 1 2	Brown Sand	▨	1	60	SB	
	4–5	1 1 1	Tan to Brown Sand	▨	2	40	SB	
	6	2 2 4	Light tan Sand w/trace orange sand	▨	3	50	SB	
	7–8	3 3 4	Same	▨	4	60	SB	
	9	3 4 4	Same	▨	5	60	SB	
	10–11	3 4 3	Same	▨	6	60	SB	
	12	3 4 3	Brown to light tan Sand w/trace orange sand	▨	7	60	SB	
	13							
	14							
	15–16	1 1 2	Dark Brown Sand	▨	8	30	SB	
	17							* material is Real Soft (WOH?)
	18							
	19							
	20							

Figure A-8. Soil boring log B-4 (L-2)



STATE OF FLORIDA DEPARTMENT OF TRANSPORTATION
FIELD BORING LOG

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SHEET 2 OF 2

PROJECT NO. ______ NAME ______ COUNTY ______ DISTRICT ______
LOCATION ______ TOWNSHIP ______ RANGE ______ SECTION ______
ROAD NUMBER ______ SURFACE ELEVATION ______
EQUIPMENT TYPE Same RIG NO. ______ BORING NO. #4 (L-2)
DATE STARTED ______ COMPLETED ______ DRILLED BY ______
LOGGED BY ______ BORING TYPE: AUGER, WASHED, PERCUSSION, ROTARY, CASED, UNCASED, DRILLING MUD, ______
WATER TABLE: 0 HR. ______ 24 HRS. ______ HRS. ______

SAMPLE CONDITIONS: ☒ DISTURBED; ▨ GOOD; ■ LOST; ▯ CORE SAMPLE

SAMPLE TYPES: A: AUGER; SB: SPLIT BARREL; S: SHELBY TUBE; RC: ROCK CORE ______ SIZE

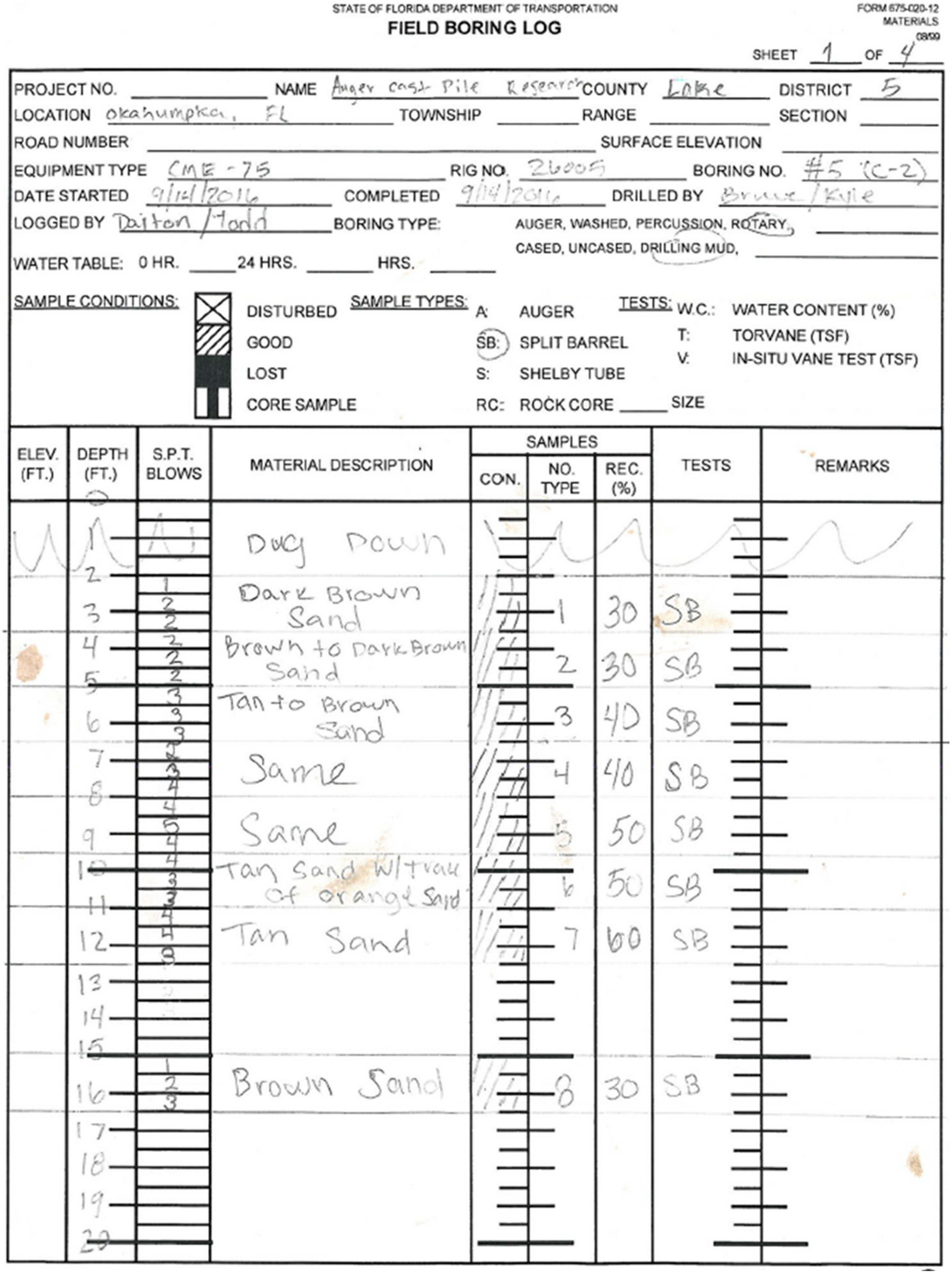
TESTS: W.C.: WATER CONTENT (%); T: TORVANE (TSF); V: IN-SITU VANE TEST (TSF)

ELEV. (FT.)	DEPTH (FT.)	S.P.T. BLOWS	MATERIAL DESCRIPTION	SAMPLES CON.	SAMPLES NO. TYPE	SAMPLES REC. (%)	TESTS	REMARKS
	20							
	21	1 1 3	Light Brown to Brown Sand	▨	9	30	SB	
	22							
	23							
	24							
	25							
	26	6 7 9	Light Brown Sand	▨	10	30	SB	
	27							
	28							
	29							
	30							
	31	8 9 11	Brown Slightly Silty Sand	▨	11	50	SB	
	32							
	33							
	34							
	35							
	36	5 6 7	Silty Brown Sand	▨	12	50	SB	
	37							
	38							
	39							
	40							
	41 41.5	6 9 11	Green to Grey Clay	▨	13	95	SB	

EOB 41.5'

RECYCLED PAPER

Figure A-8. Soil boring log B-4 (L-2) *continued*



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FIELD BORING LOG

SHEET 1 OF 4

PROJECT NO. ______ NAME Auger cast Pile Research COUNTY Lake DISTRICT 5
LOCATION Okahumpka, FL TOWNSHIP ______ RANGE ______ SECTION ______
ROAD NUMBER ______ SURFACE ELEVATION ______
EQUIPMENT TYPE CME-75 RIG NO. 26005 BORING NO. #5 (C-2)
DATE STARTED 9/14/2016 COMPLETED 9/14/2016 DRILLED BY Bruce/Kyle
LOGGED BY Dalton/Todd BORING TYPE: AUGER, WASHED, PERCUSSION, [✓ ROTARY], CASED, UNCASED, [✓ DRILLING MUD], ______
WATER TABLE: 0 HR. ______ 24 HRS. ______ HRS. ______

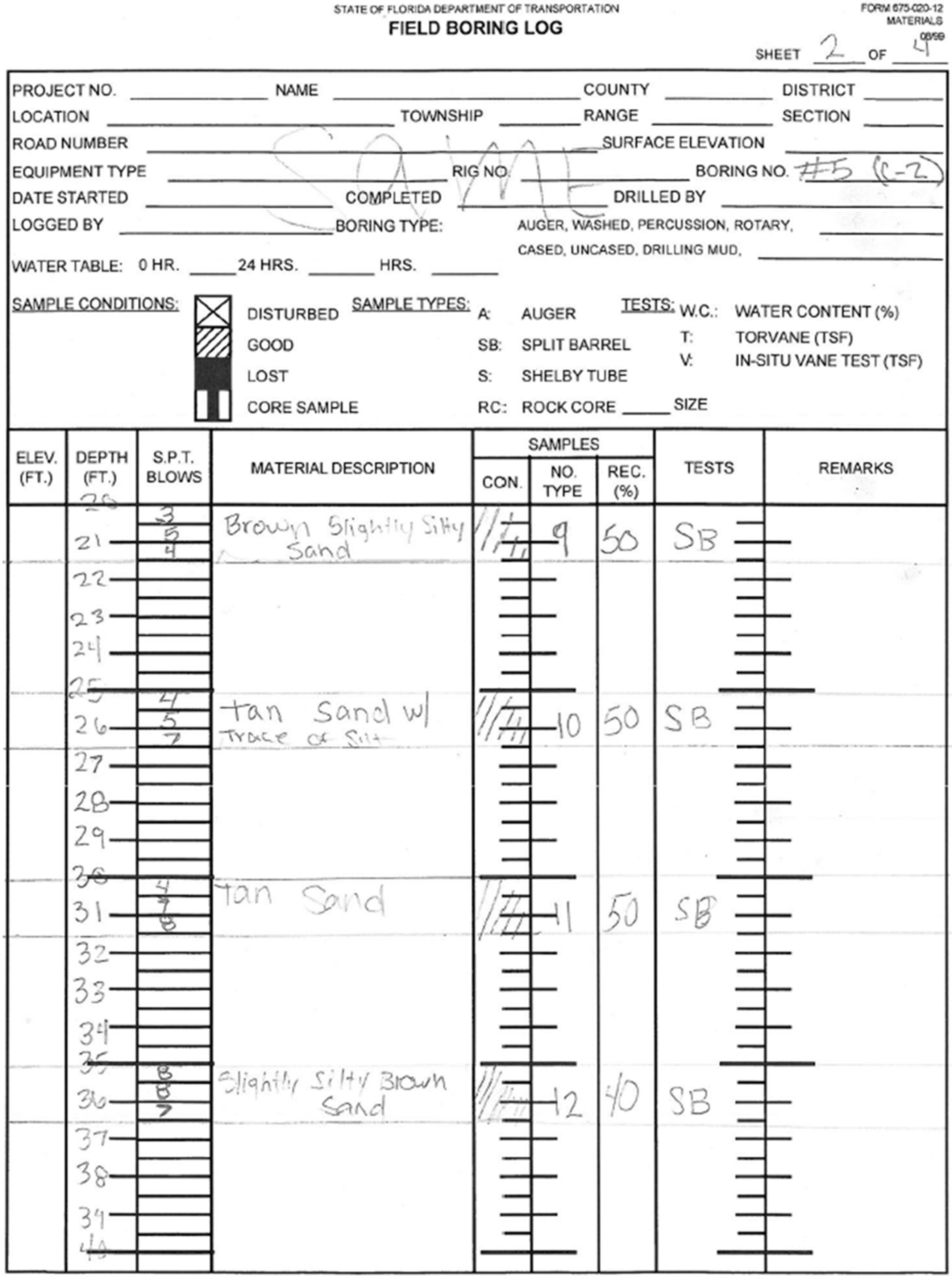
SAMPLE CONDITIONS:
☒ DISTURBED
▨ GOOD
■ LOST
◫ CORE SAMPLE

SAMPLE TYPES:
A: AUGER
[✓ SB:] SPLIT BARREL
S: SHELBY TUBE
RC: ROCK CORE ______ SIZE

TESTS:
W.C.: WATER CONTENT (%)
T: TORVANE (TSF)
V: IN-SITU VANE TEST (TSF)

ELEV. (FT.)	DEPTH (FT.)	S.P.T. BLOWS	MATERIAL DESCRIPTION	SAMPLES CON.	SAMPLES NO. TYPE	SAMPLES REC. (%)	TESTS	REMARKS
	1		Dug Down					
	2 3	1 2 2	Dark Brown Sand	▨	1	30	SB	
	4 5	2 2 2	Brown to Dark Brown Sand	▨	2	30	SB	
	6	3 3 3	Tan to Brown Sand	▨	3	40	SB	
	7 8	2 3 4	Same	▨	4	40	SB	
	9	4 5 4	Same	▨	5	50	SB	
	10 11	4 3 3	Tan Sand W/ trace of orange Sand	▨	6	50	SB	
	12	4 4 10	Tan Sand	▨	7	60	SB	
	13 14 15							
	16	1 2 3	Brown Sand	▨	8	30	SB	
	17 18 19 20							

Figure A-9. Soil boring log B-5 (C-2) *continued*



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FIELD BORING LOG

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SHEET 2 OF 4

PROJECT NO. ______ NAME ______ COUNTY ______ DISTRICT ______
LOCATION ______ TOWNSHIP ______ RANGE ______ SECTION ______
ROAD NUMBER ______ SURFACE ELEVATION ______
EQUIPMENT TYPE ______ RIG NO. ______ BORING NO. #5 (C-2)
DATE STARTED ______ COMPLETED ______ DRILLED BY ______
LOGGED BY ______ BORING TYPE: AUGER, WASHED, PERCUSSION, ROTARY, CASED, UNCASED, DRILLING MUD, ______
WATER TABLE: 0 HR. ______ 24 HRS. ______ HRS. ______

SAME

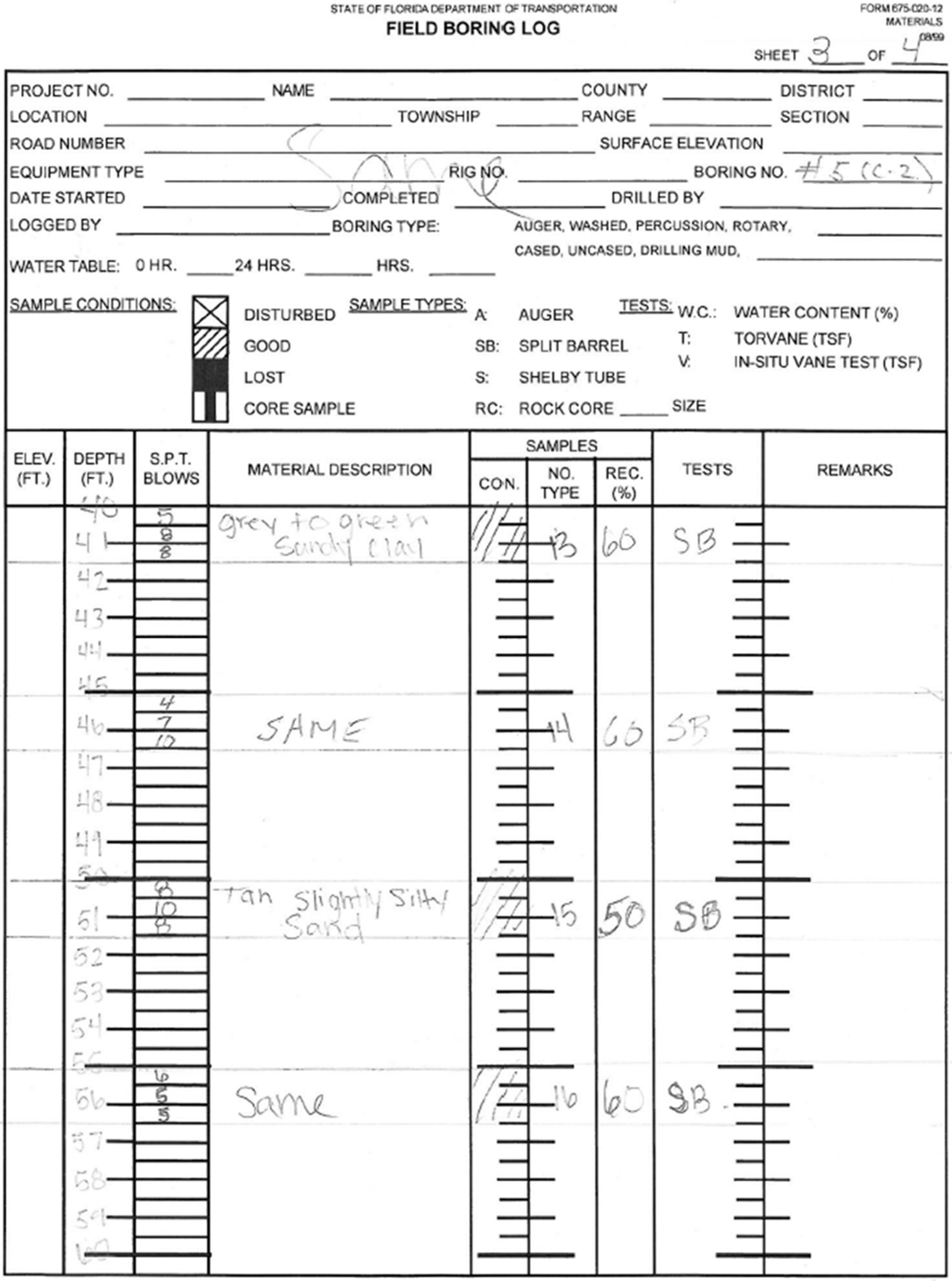
SAMPLE CONDITIONS:
☒ DISTURBED
▨ GOOD
■ LOST
▯ CORE SAMPLE

SAMPLE TYPES:
A: AUGER
SB: SPLIT BARREL
S: SHELBY TUBE
RC: ROCK CORE ______ SIZE

TESTS:
W.C.: WATER CONTENT (%)
T: TORVANE (TSF)
V: IN-SITU VANE TEST (TSF)

ELEV. (FT.)	DEPTH (FT.)	S.P.T. BLOWS	MATERIAL DESCRIPTION	SAMPLES CON.	SAMPLES NO. TYPE	SAMPLES REC. (%)	TESTS	REMARKS
	20	3 5 4	Brown Slightly Silty Sand	▨	9	50	SB	
	21							
	22							
	23							
	24							
	25	4 5 7	tan Sand w/ Trace of Silt	▨	10	50	SB	
	26							
	27							
	28							
	29							
	30	4 7 8	Tan Sand	▨	11	50	SB	
	31							
	32							
	33							
	34							
	35	8 8 7	Slightly Silty Brown Sand	▨	12	40	SB	
	36							
	37							
	38							
	39							
	40							

Figure A-9. Soil boring log B-5 (C-2) *continued*



STATE OF FLORIDA DEPARTMENT OF TRANSPORTATION

FIELD BORING LOG

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SHEET 3 OF 4

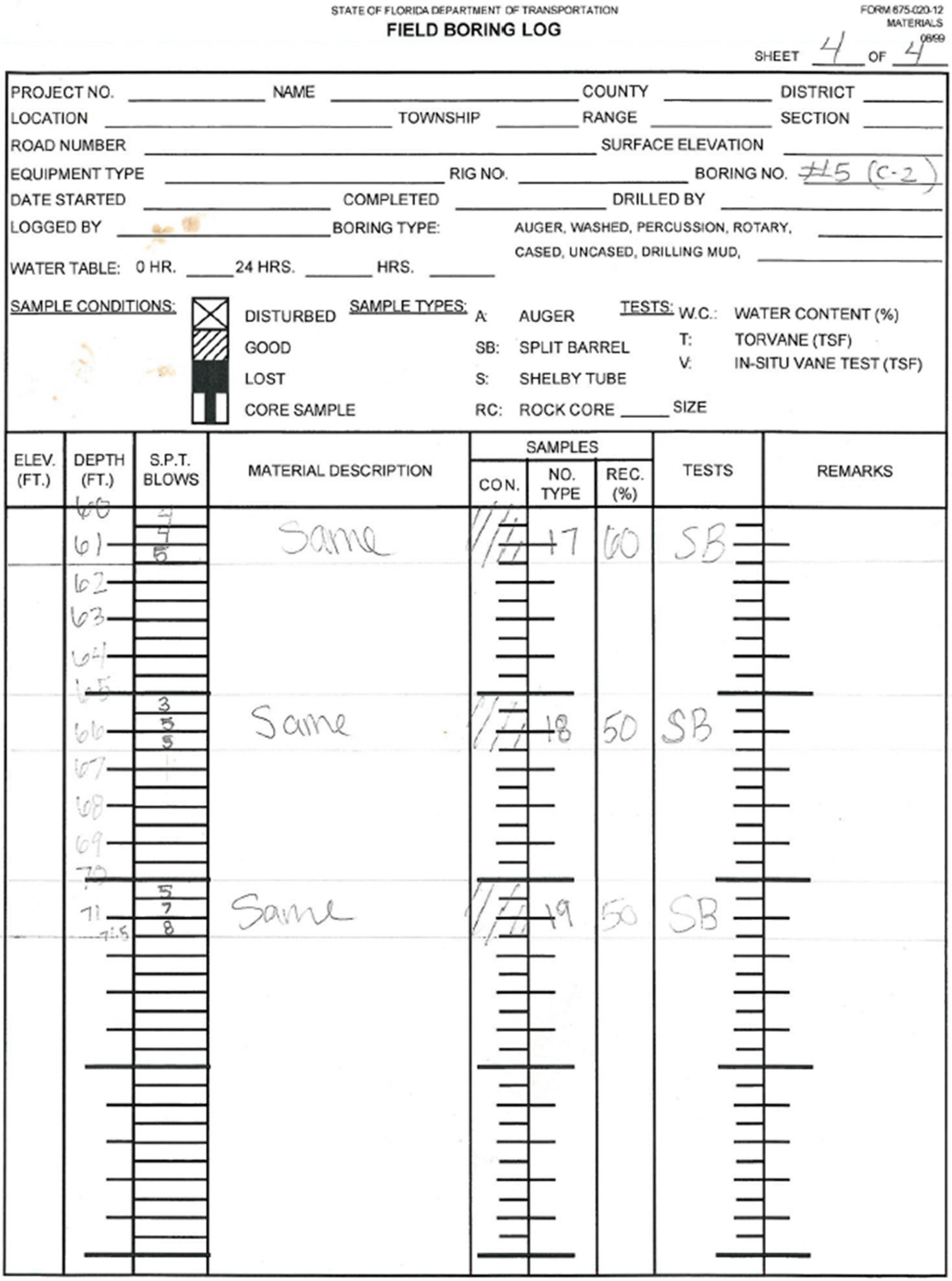
Same

PROJECT NO. ______ NAME ______ COUNTY ______ DISTRICT ______
LOCATION ______ TOWNSHIP ______ RANGE ______ SECTION ______
ROAD NUMBER ______ SURFACE ELEVATION ______
EQUIPMENT TYPE ______ RIG NO. ______ BORING NO. #5 (C-2)
DATE STARTED ______ COMPLETED ______ DRILLED BY ______
LOGGED BY ______ BORING TYPE: AUGER, WASHED, PERCUSSION, ROTARY, CASED, UNCASED, DRILLING MUD, ______
WATER TABLE: 0 HR. ______ 24 HRS. ______ HRS. ______

SAMPLE CONDITIONS:		SAMPLE TYPES:		TESTS:	
☒	DISTURBED	A:	AUGER	W.C.:	WATER CONTENT (%)
▨	GOOD	SB:	SPLIT BARREL	T:	TORVANE (TSF)
■	LOST	S:	SHELBY TUBE	V:	IN-SITU VANE TEST (TSF)
◫	CORE SAMPLE	RC:	ROCK CORE ______ SIZE		

ELEV. (FT.)	DEPTH (FT.)	S.P.T. BLOWS	MATERIAL DESCRIPTION	SAMPLES CON.	SAMPLES NO. TYPE	SAMPLES REC. (%)	TESTS	REMARKS
	40	5 8 8	grey to green Sandy Clay	▨	13	60	SB	
	41							
	42							
	43							
	44							
	45	4 7 10	SAME		14	66	SB	
	46							
	47							
	48							
	49							
	50	8 10 8	Tan slightly Silty Sand	▨	15	50	SB	
	51							
	52							
	53							
	54							
	55	6 5 5	Same	▨	16	60	SB	
	56							
	57							
	58							
	59							
	60							

Figure A-9. Soil boring log B-5 (C-2) *continued*



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PROJECT NO. ______ NAME ______ COUNTY ______ DISTRICT ______
LOCATION ______ TOWNSHIP ______ RANGE ______ SECTION ______
ROAD NUMBER ______ SURFACE ELEVATION ______
EQUIPMENT TYPE ______ RIG NO. ______ BORING NO. #5 (C-2)
DATE STARTED ______ COMPLETED ______ DRILLED BY ______
LOGGED BY ______ BORING TYPE: AUGER, WASHED, PERCUSSION, ROTARY, CASED, UNCASED, DRILLING MUD, ______
WATER TABLE: 0 HR. ______ 24 HRS. ______ HRS. ______

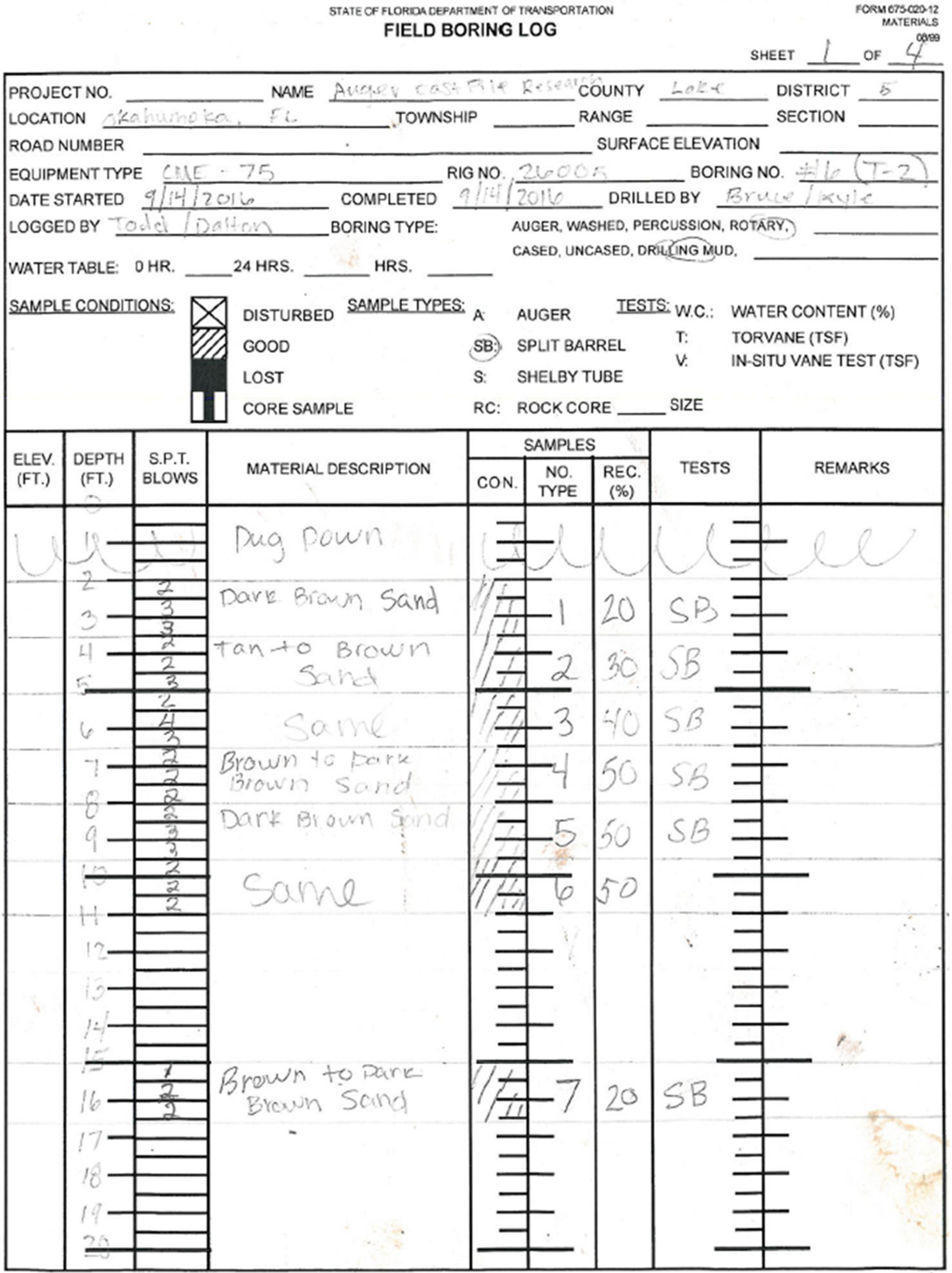
SAMPLE CONDITIONS:
- ☒ DISTURBED
- ▨ GOOD
- ■ LOST
- ▯ CORE SAMPLE

SAMPLE TYPES:
- A: AUGER
- SB: SPLIT BARREL
- S: SHELBY TUBE
- RC: ROCK CORE ______ SIZE

TESTS:
- W.C.: WATER CONTENT (%)
- T: TORVANE (TSF)
- V: IN-SITU VANE TEST (TSF)

ELEV. (FT.)	DEPTH (FT.)	S.P.T. BLOWS	MATERIAL DESCRIPTION	SAMPLES CON.	SAMPLES NO. TYPE	SAMPLES REC. (%)	TESTS	REMARKS
	60	4 4 5	Same	▨	17	60	SB	
	61							
	62							
	63							
	64							
	65	3 5 5	Same	▨	18	50	SB	
	66							
	67							
	68							
	69							
	70	5 7 8	Same	▨	19	50	SB	
	71							
	71.5							

Figure A-9. Soil boring log B-5 (C-2) *continued*



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SHEET 1 OF 4

PROJECT NO. ______ NAME Auger cast Pile Research COUNTY Lake DISTRICT 5
LOCATION Okahumpka, FL TOWNSHIP ______ RANGE ______ SECTION ______
ROAD NUMBER ______ SURFACE ELEVATION ______
EQUIPMENT TYPE CME - 75 RIG NO. 26005 BORING NO. #6 (T-2)
DATE STARTED 9/14/2016 COMPLETED 9/14/2016 DRILLED BY Bruce / Kyle
LOGGED BY Todd / Dalton BORING TYPE: AUGER, WASHED, PERCUSSION, [✓ ROTARY,] CASED, UNCASED, [✓ DRILLING MUD,]
WATER TABLE: 0 HR. ______ 24 HRS. ______ HRS. ______

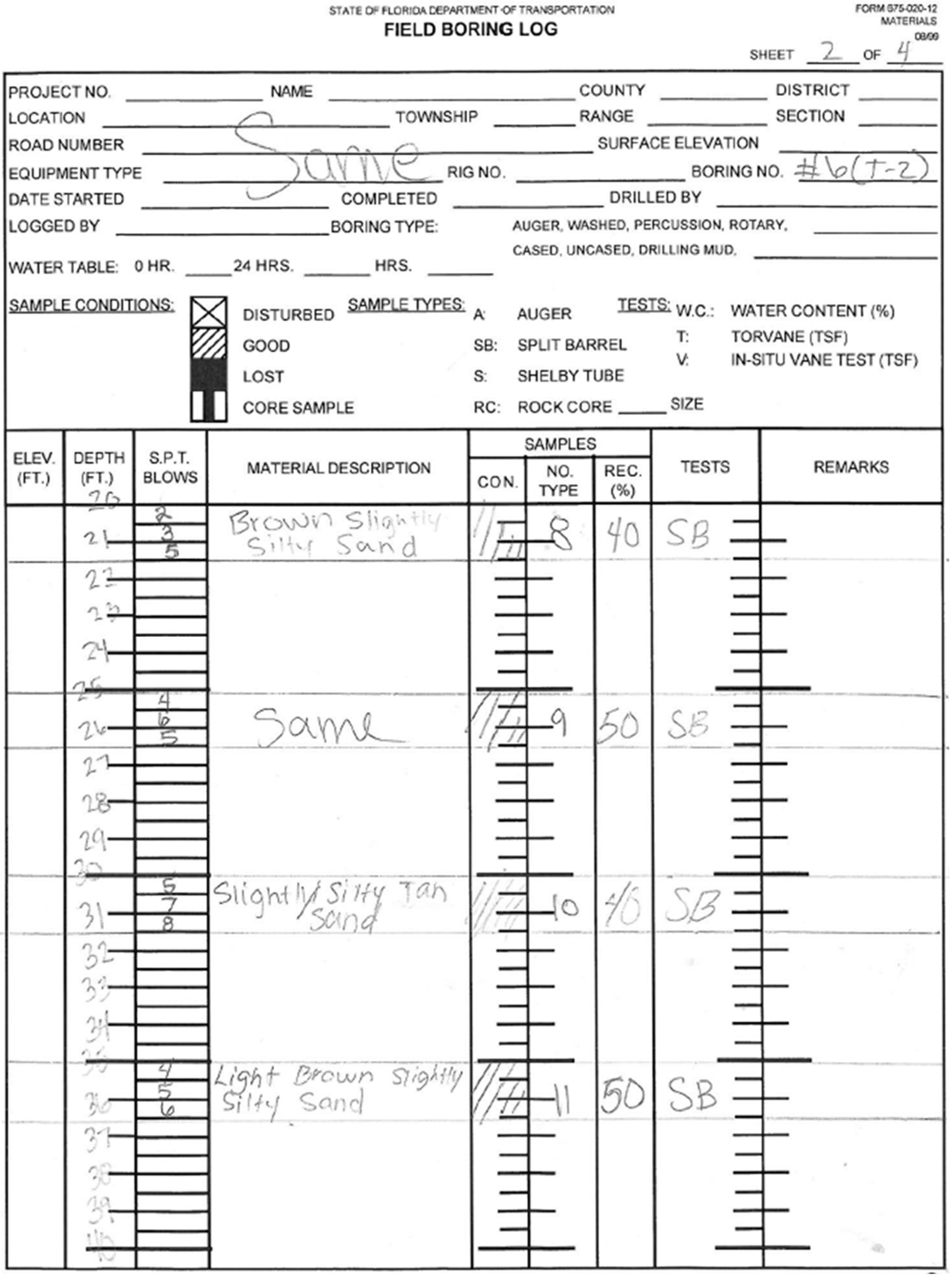
SAMPLE CONDITIONS:
☒ DISTURBED
▨ GOOD
■ LOST
◫ CORE SAMPLE

SAMPLE TYPES:
A: AUGER
[✓ SB:] SPLIT BARREL
S: SHELBY TUBE
RC: ROCK CORE ______ SIZE

TESTS:
W.C.: WATER CONTENT (%)
T: TORVANE (TSF)
V: IN-SITU VANE TEST (TSF)

ELEV. (FT.)	DEPTH (FT.)	S.P.T. BLOWS	MATERIAL DESCRIPTION	SAMPLES CON.	SAMPLES NO. TYPE	SAMPLES REC. (%)	TESTS	REMARKS
	0 1		Dug Down					
	2 3	2 3 3	Dark Brown Sand	▨	1	20	SB	
	4 5	2 2 3	tan to Brown Sand	▨	2	30	SB	
	6	2 4 3	Same	▨	3	40	SB	
	7 8	2 2 2	Brown to Dark Brown Sand	▨	4	50	SB	
	9	2 3 3	Dark Brown Sand	▨	5	50	SB	
	10 11	2 2 2	Same	▨	6	50		
	12 13 14 15							
	16	1 2 2	Brown to Dark Brown Sand	▨	7	20	SB	
	17 18 19 20							

Figure A-9. Soil boring log B-6 (T-2)



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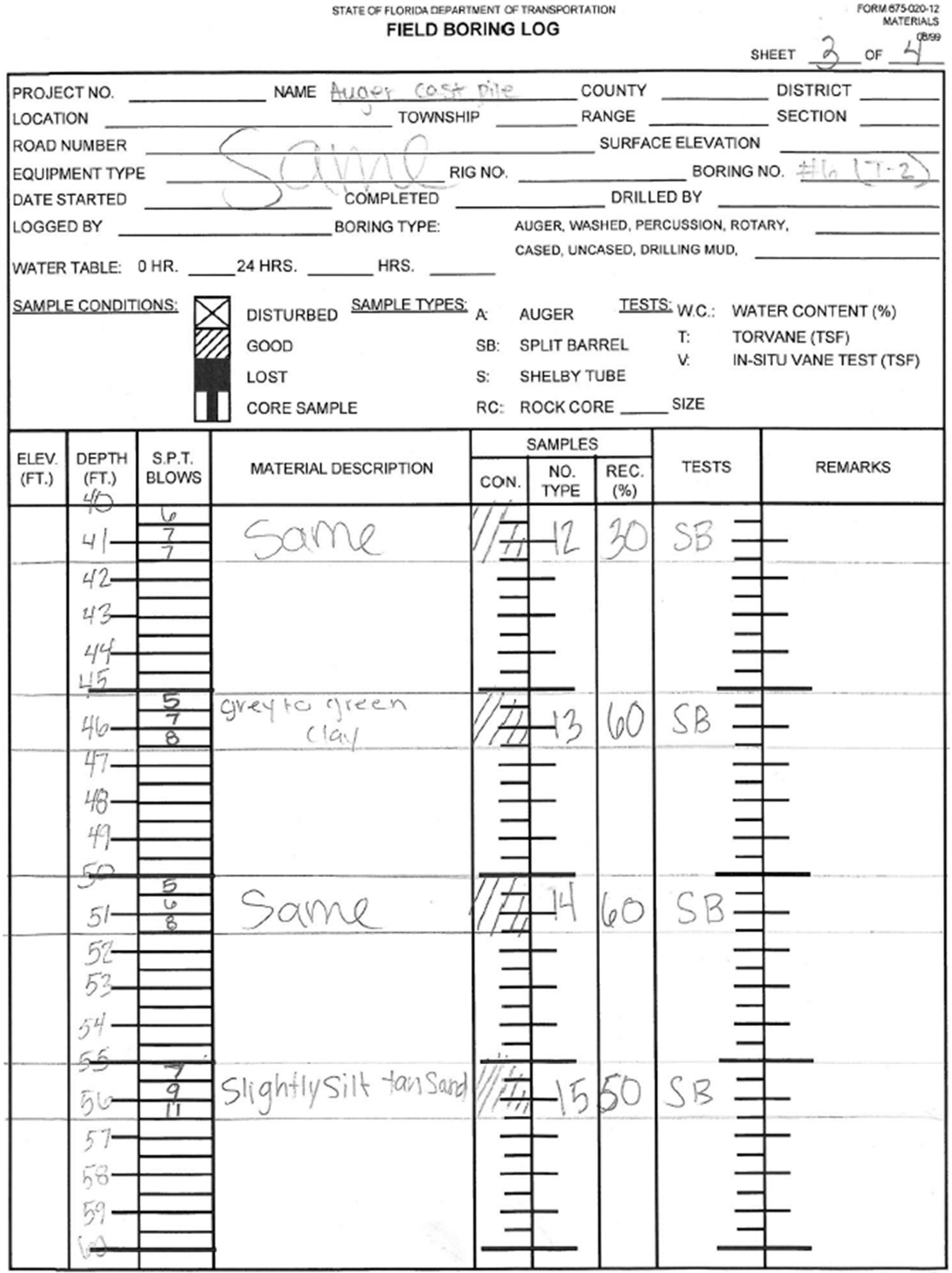
SHEET 2 OF 4

PROJECT NO. NAME COUNTY DISTRICT
LOCATION TOWNSHIP RANGE SECTION
ROAD NUMBER SURFACE ELEVATION
EQUIPMENT TYPE Same RIG NO. BORING NO. #6 (T-2)
DATE STARTED COMPLETED DRILLED BY
LOGGED BY BORING TYPE: AUGER, WASHED, PERCUSSION, ROTARY, CASED, UNCASED, DRILLING MUD,
WATER TABLE: 0 HR. 24 HRS. HRS.

SAMPLE CONDITIONS:		SAMPLE TYPES:		TESTS:	
☒	DISTURBED	A:	AUGER	W.C.:	WATER CONTENT (%)
▨	GOOD	SB:	SPLIT BARREL	T:	TORVANE (TSF)
■	LOST	S:	SHELBY TUBE	V:	IN-SITU VANE TEST (TSF)
◫	CORE SAMPLE	RC:	ROCK CORE ____ SIZE		

ELEV. (FT.)	DEPTH (FT.)	S.P.T. BLOWS	MATERIAL DESCRIPTION	SAMPLES CON.	SAMPLES NO. TYPE	SAMPLES REC. (%)	TESTS	REMARKS
	20	2 3 5	Brown Slightly Silty Sand	▨	8	40	SB	
	21							
	22							
	23							
	24							
	25	4 6 5	Same	▨	9	50	SB	
	26							
	27							
	28							
	29							
	30	5 7 8	Slightly Silty Tan Sand	▨	10	46	SB	
	31							
	32							
	33							
	34							
	35	4 5 6	Light Brown Slightly Silty Sand	▨	11	50	SB	
	36							
	37							
	38							
	39							
	40							

Figure A-9. Soil boring log B-6 (T-2) *continued*



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FIELD BORING LOG

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SHEET 2 OF 4

PROJECT NO. ____ NAME Auger cast pile COUNTY ____ DISTRICT ____
LOCATION ____ TOWNSHIP ____ RANGE ____ SECTION ____
ROAD NUMBER Same SURFACE ELEVATION ____
EQUIPMENT TYPE ____ RIG NO. ____ BORING NO. #6 (T-2)
DATE STARTED ____ COMPLETED ____ DRILLED BY ____
LOGGED BY ____ BORING TYPE: AUGER, WASHED, PERCUSSION, ROTARY, CASED, UNCASED, DRILLING MUD, ____
WATER TABLE: 0 HR. ____ 24 HRS. ____ HRS. ____

SAMPLE CONDITIONS:
☒ DISTURBED
▨ GOOD
■ LOST
◫ CORE SAMPLE

SAMPLE TYPES:
A: AUGER
SB: SPLIT BARREL
S: SHELBY TUBE
RC: ROCK CORE ____ SIZE

TESTS:
W.C.: WATER CONTENT (%)
T: TORVANE (TSF)
V: IN-SITU VANE TEST (TSF)

ELEV. (FT.)	DEPTH (FT.)	S.P.T. BLOWS	MATERIAL DESCRIPTION	SAMPLES CON.	SAMPLES NO. TYPE	SAMPLES REC. (%)	TESTS	REMARKS
	40	6 7 7	Same	▨	12	30	SB	
	41							
	42							
	43							
	44							
	45	5 7 8	grey to green clay	▨	13	60	SB	
	46							
	47							
	48							
	49							
	50	5 6 8	Same	▨	14	60	SB	
	51							
	52							
	53							
	54							
	55	7 9 11	Slightly Silt tan Sand	▨	15	50	SB	
	56							
	57							
	58							
	59							
	60							

Figure A-9. Soil boring log B-6 (T-2) *continued*

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FIELD BORING LOG

SHEET 4 OF 4

PROJECT NO. ______ NAME ______ COUNTY ______ DISTRICT ______
LOCATION ______ TOWNSHIP ______ RANGE ______ SECTION ______
ROAD NUMBER ______ SURFACE ELEVATION ______
EQUIPMENT TYPE Same RIG NO. ______ BORING NO. #6 (T-2)
DATE STARTED ______ COMPLETED ______ DRILLED BY ______
LOGGED BY ______ BORING TYPE: AUGER, WASHED, PERCUSSION, ROTARY, ______
CASED, UNCASED, DRILLING MUD, ______
WATER TABLE: 0 HR. ______ 24 HRS. ______ HRS. ______

SAMPLE CONDITIONS:
☒ DISTURBED
▨ GOOD
■ LOST
▯ CORE SAMPLE

SAMPLE TYPES:
A: AUGER
SB: SPLIT BARREL
S: SHELBY TUBE
RC: ROCK CORE ______ SIZE

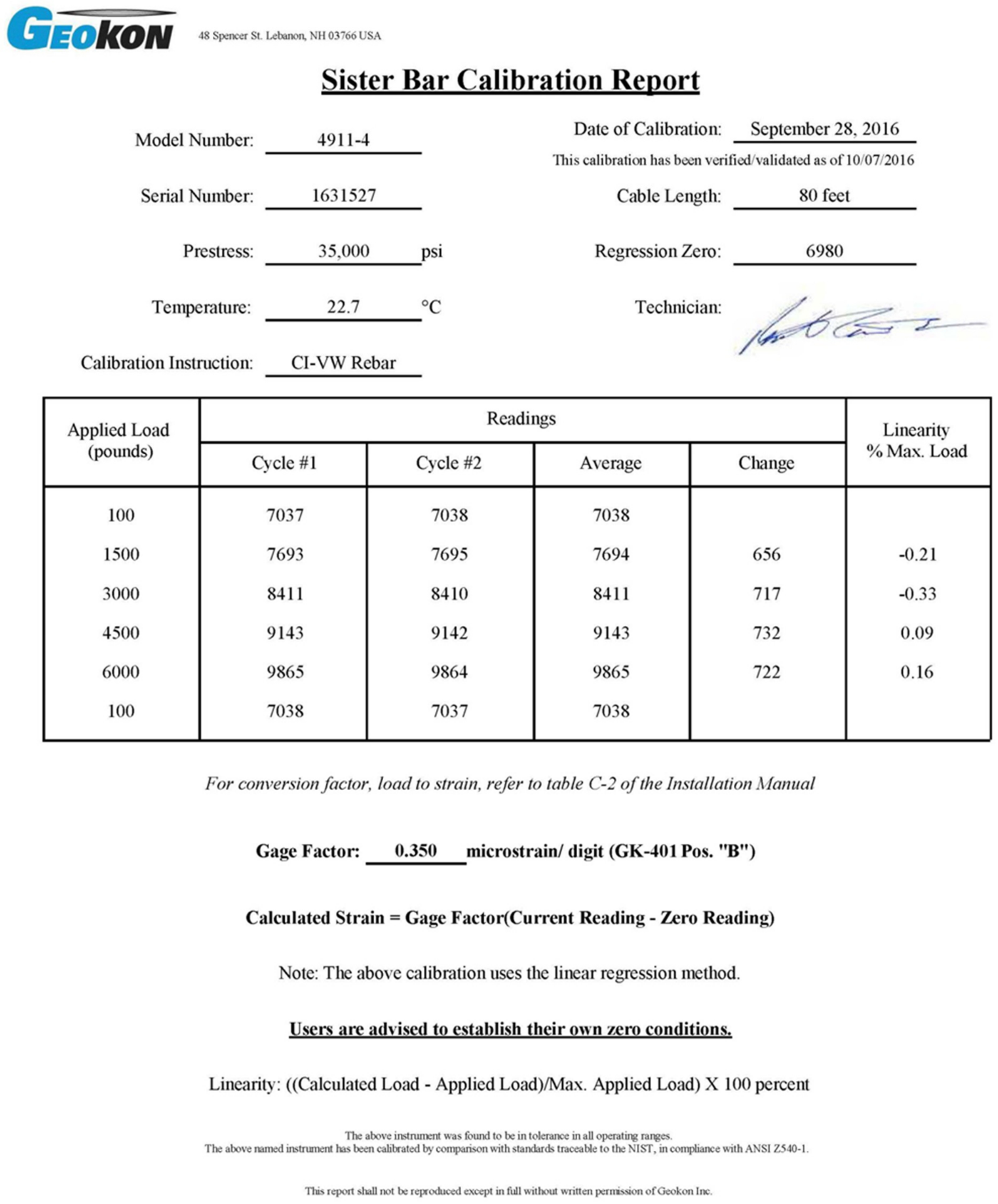
TESTS:
W.C.: WATER CONTENT (%)
T: TORVANE (TSF)
V: IN-SITU VANE TEST (TSF)

ELEV. (FT.)	DEPTH (FT.)	S.P.T. BLOWS	MATERIAL DESCRIPTION	SAMPLES CON.	SAMPLES NO. TYPE	SAMPLES REC. (%)	TESTS	REMARKS
	60	6						
	61	7 7	Slightly silty tan sand	▨	16	60	SB	
	62							
	63							
	64							
	65	5						
	66	5 8	Same	▨	17	50	SB	
	67							
	68							
	69							
	70	3						
	71	4 6	Same	▨	18	70	SB	
	71.5		EOB 71.5'					

Figure A-9. Soil boring log B-6 (T-2) *continued*

APPENDIX B

CALIBRATION REPORTS - GEOKON SISTER BAR STRAIN GAGES



GEOKON 48 Spencer St. Lebanon, NH 03766 USA

Sister Bar Calibration Report

Model Number: 4911-4

Date of Calibration: September 28, 2016

This calibration has been verified/validated as of 10/07/2016

Serial Number: 1631527

Cable Length: 80 feet

Prestress: 35,000 psi

Regression Zero: 6980

Temperature: 22.7 °C

Technician:

Calibration Instruction: CI-VW Rebar

Applied Load (pounds)	Readings				Linearity % Max. Load
	Cycle #1	Cycle #2	Average	Change	
100	7037	7038	7038		
1500	7693	7695	7694	656	-0.21
3000	8411	8410	8411	717	-0.33
4500	9143	9142	9143	732	0.09
6000	9865	9864	9865	722	0.16
100	7038	7037	7038		

For conversion factor, load to strain, refer to table C-2 of the Installation Manual

Gage Factor: 0.350 microstrain/ digit (GK-401 Pos. "B")

Calculated Strain = Gage Factor(Current Reading - Zero Reading)

Note: The above calibration uses the linear regression method.

Users are advised to establish their own zero conditions.

Linearity: ((Calculated Load - Applied Load)/Max. Applied Load) X 100 percent

The above instrument was found to be in tolerance in all operating ranges.
The above named instrument has been calibrated by comparison with standards traceable to the NIST, in compliance with ANSI Z540-1.

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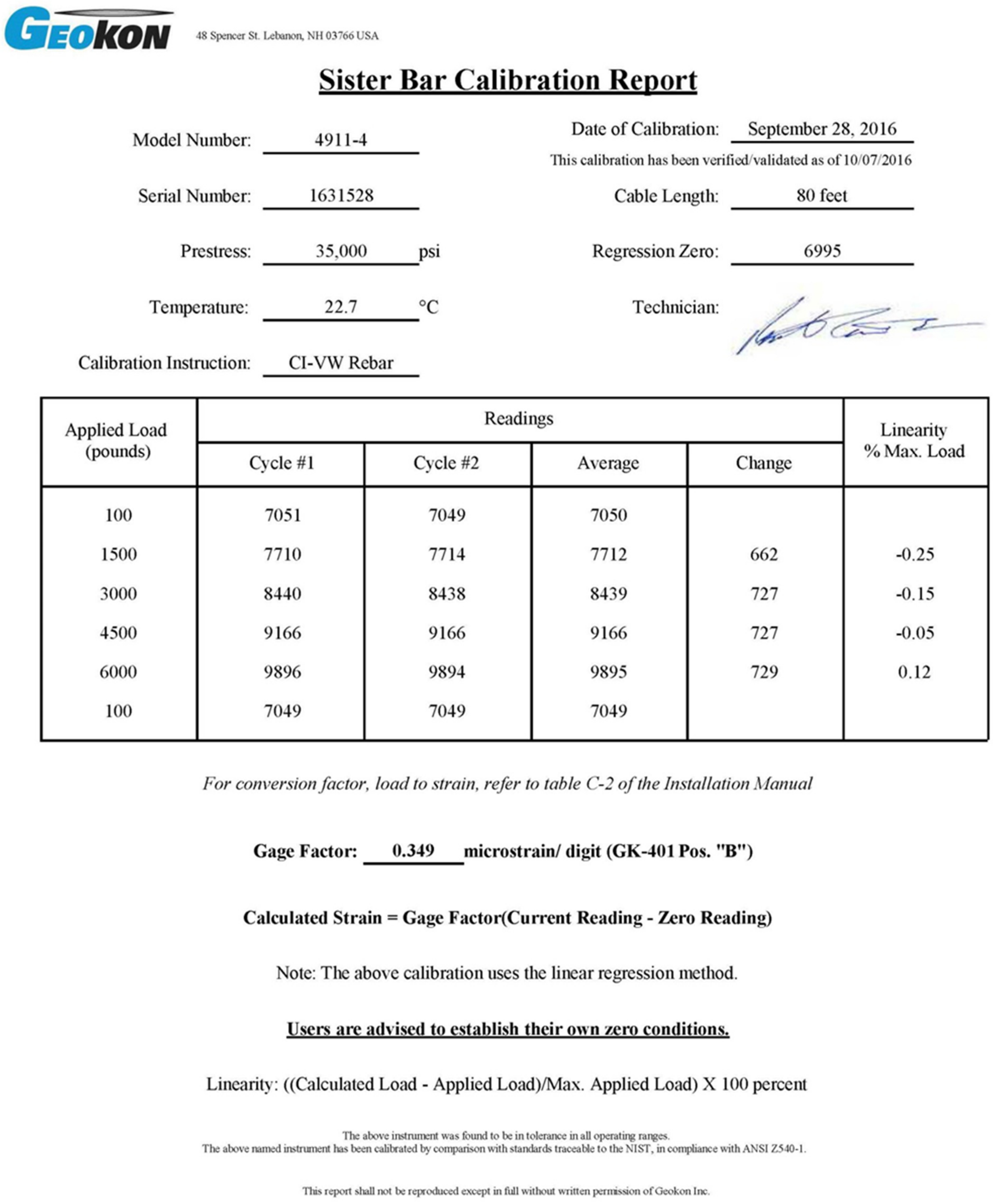
Figure B-1. Sister bar calibration report: S/N 1631527



GEOKON 48 Spencer St. Lebanon, NH 03766 USA

Sister Bar Calibration Report

Model Number: 4911-4

Date of Calibration: September 28, 2016

This calibration has been verified/validated as of 10/07/2016

Serial Number: 1631528

Cable Length: 80 feet

Prestress: 35,000 psi

Regression Zero: 6995

Temperature: 22.7 °C

Technician:

Calibration Instruction: CI-VW Rebar

Applied Load (pounds)	Readings				Linearity % Max. Load
	Cycle #1	Cycle #2	Average	Change	
100	7051	7049	7050		
1500	7710	7714	7712	662	-0.25
3000	8440	8438	8439	727	-0.15
4500	9166	9166	9166	727	-0.05
6000	9896	9894	9895	729	0.12
100	7049	7049	7049		

For conversion factor, load to strain, refer to table C-2 of the Installation Manual

Gage Factor: 0.349 microstrain/ digit (GK-401 Pos. "B")

Calculated Strain = Gage Factor(Current Reading - Zero Reading)

Note: The above calibration uses the linear regression method.

Users are advised to establish their own zero conditions.

Linearity: ((Calculated Load - Applied Load)/Max. Applied Load) X 100 percent

The above instrument was found to be in tolerance in all operating ranges.
The above named instrument has been calibrated by comparison with standards traceable to the NIST, in compliance with ANSI Z540-1.

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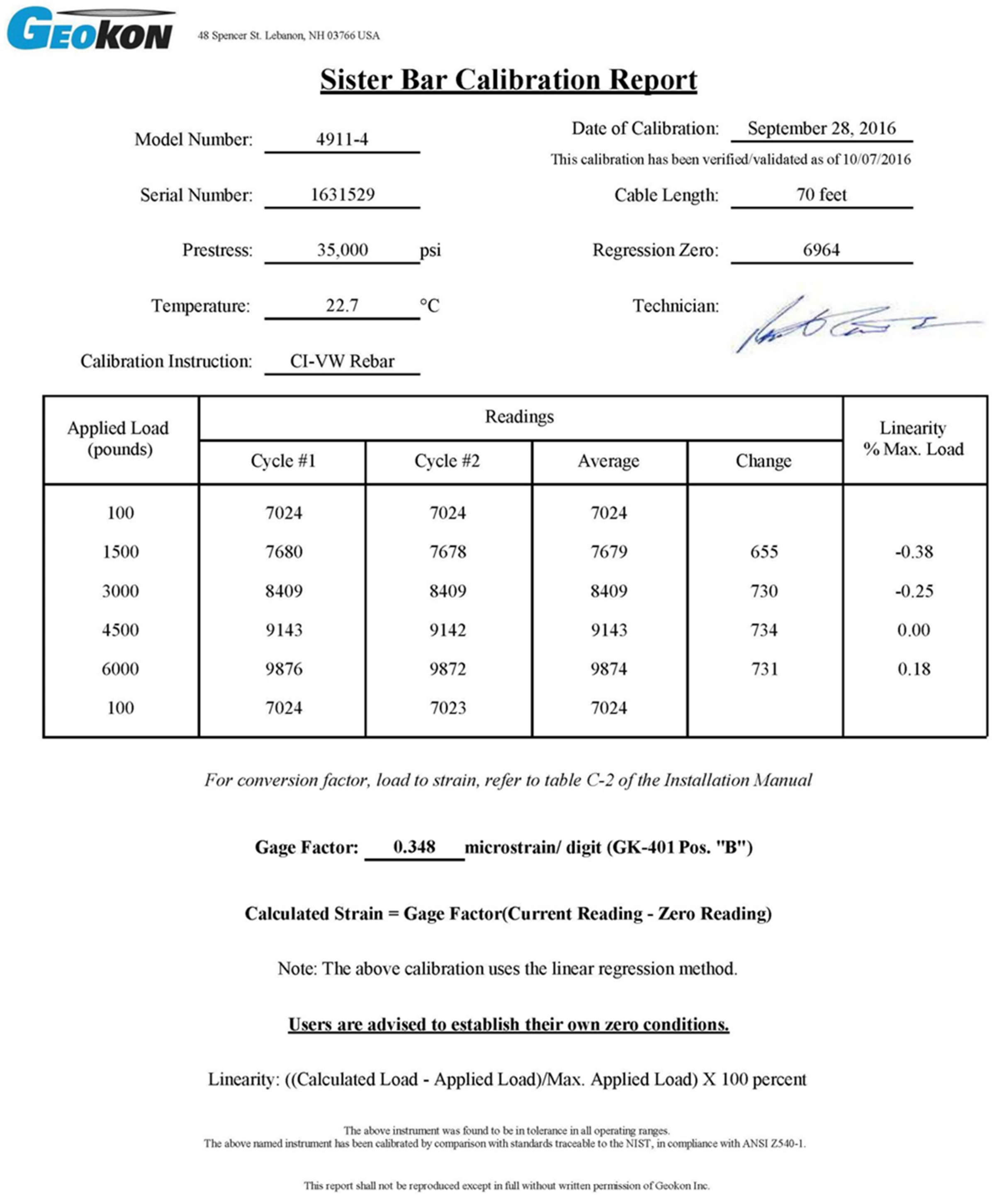
Figure B-2. Sister bar calibration report: S/N 1631528



GEOKON 48 Spencer St. Lebanon, NH 03766 USA

Sister Bar Calibration Report

Model Number: 4911-4

Date of Calibration: September 28, 2016

This calibration has been verified/validated as of 10/07/2016

Serial Number: 1631529

Cable Length: 70 feet

Prestress: 35,000 psi

Regression Zero: 6964

Temperature: 22.7 °C

Technician:

Calibration Instruction: CI-VW Rebar

Applied Load (pounds)	Readings				Linearity % Max. Load
	Cycle #1	Cycle #2	Average	Change	
100	7024	7024	7024		
1500	7680	7678	7679	655	-0.38
3000	8409	8409	8409	730	-0.25
4500	9143	9142	9143	734	0.00
6000	9876	9872	9874	731	0.18
100	7024	7023	7024		

For conversion factor, load to strain, refer to table C-2 of the Installation Manual

Gage Factor: 0.348 microstrain/ digit (GK-401 Pos. "B")

Calculated Strain = Gage Factor(Current Reading - Zero Reading)

Note: The above calibration uses the linear regression method.

Users are advised to establish their own zero conditions.

Linearity: ((Calculated Load - Applied Load)/Max. Applied Load) X 100 percent

The above instrument was found to be in tolerance in all operating ranges.
The above named instrument has been calibrated by comparison with standards traceable to the NIST, in compliance with ANSI Z540-1.

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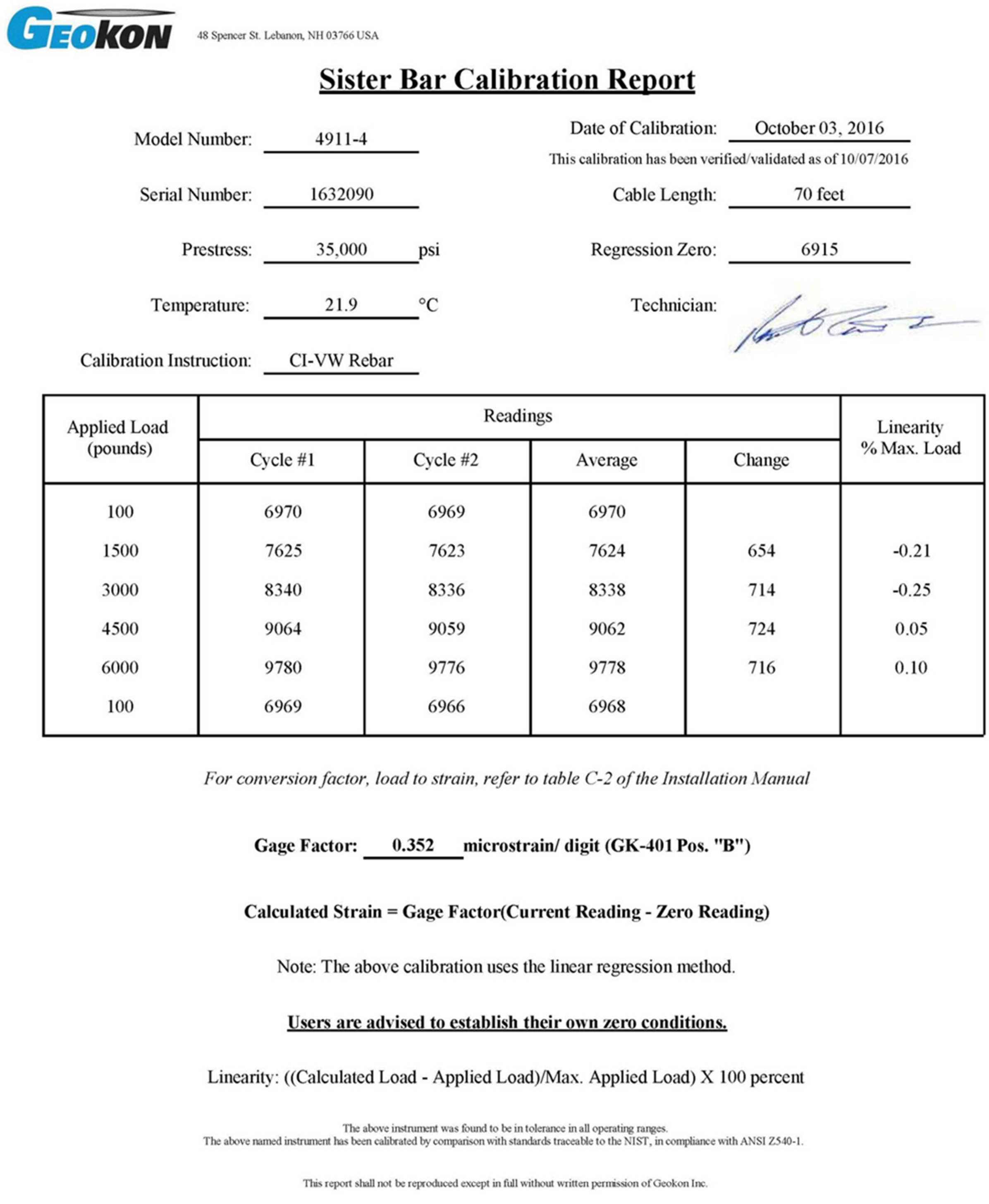
Figure B-3. Sister bar calibration report: S/N 1631529



GEOKON 48 Spencer St. Lebanon, NH 03766 USA

Sister Bar Calibration Report

Model Number: 4911-4

Date of Calibration: October 03, 2016

This calibration has been verified/validated as of 10/07/2016

Serial Number: 1632090

Cable Length: 70 feet

Prestress: 35,000 psi

Regression Zero: 6915

Temperature: 21.9 °C

Technician:

Calibration Instruction: CI-VW Rebar

Applied Load (pounds)	Readings				Linearity % Max. Load
	Cycle #1	Cycle #2	Average	Change	
100	6970	6969	6970		
1500	7625	7623	7624	654	-0.21
3000	8340	8336	8338	714	-0.25
4500	9064	9059	9062	724	0.05
6000	9780	9776	9778	716	0.10
100	6969	6966	6968		

For conversion factor, load to strain, refer to table C-2 of the Installation Manual

Gage Factor: 0.352 microstrain/ digit (GK-401 Pos. "B")

Calculated Strain = Gage Factor(Current Reading - Zero Reading)

Note: The above calibration uses the linear regression method.

Users are advised to establish their own zero conditions.

Linearity: ((Calculated Load - Applied Load)/Max. Applied Load) X 100 percent

The above instrument was found to be in tolerance in all operating ranges.
The above named instrument has been calibrated by comparison with standards traceable to the NIST, in compliance with ANSI Z540-1.

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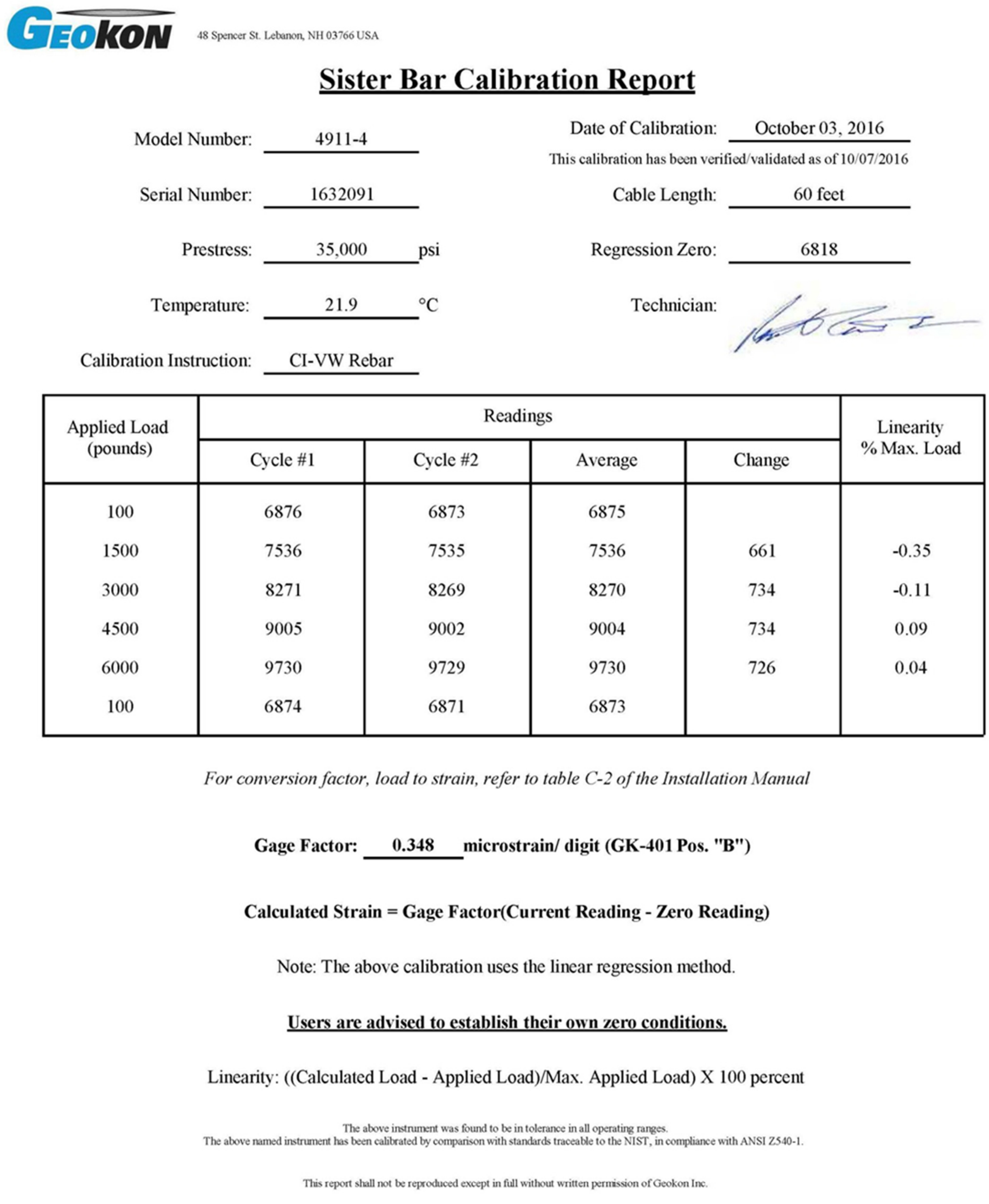
Figure B-4. Sister bar calibration report: S/N 1632090



GEOKON 48 Spencer St. Lebanon, NH 03766 USA

Sister Bar Calibration Report

Model Number: 4911-4

Date of Calibration: October 03, 2016

This calibration has been verified/validated as of 10/07/2016

Serial Number: 1632091

Cable Length: 60 feet

Prestress: 35,000 psi

Regression Zero: 6818

Temperature: 21.9 °C

Technician:

Calibration Instruction: CI-VW Rebar

Applied Load (pounds)	Readings				Linearity % Max. Load
	Cycle #1	Cycle #2	Average	Change	
100	6876	6873	6875		
1500	7536	7535	7536	661	-0.35
3000	8271	8269	8270	734	-0.11
4500	9005	9002	9004	734	0.09
6000	9730	9729	9730	726	0.04
100	6874	6871	6873		

For conversion factor, load to strain, refer to table C-2 of the Installation Manual

Gage Factor: 0.348 microstrain/ digit (GK-401 Pos. "B")

Calculated Strain = Gage Factor(Current Reading - Zero Reading)

Note: The above calibration uses the linear regression method.

Users are advised to establish their own zero conditions.

Linearity: ((Calculated Load - Applied Load)/Max. Applied Load) X 100 percent

The above instrument was found to be in tolerance in all operating ranges.
The above named instrument has been calibrated by comparison with standards traceable to the NIST, in compliance with ANSI Z540-1.

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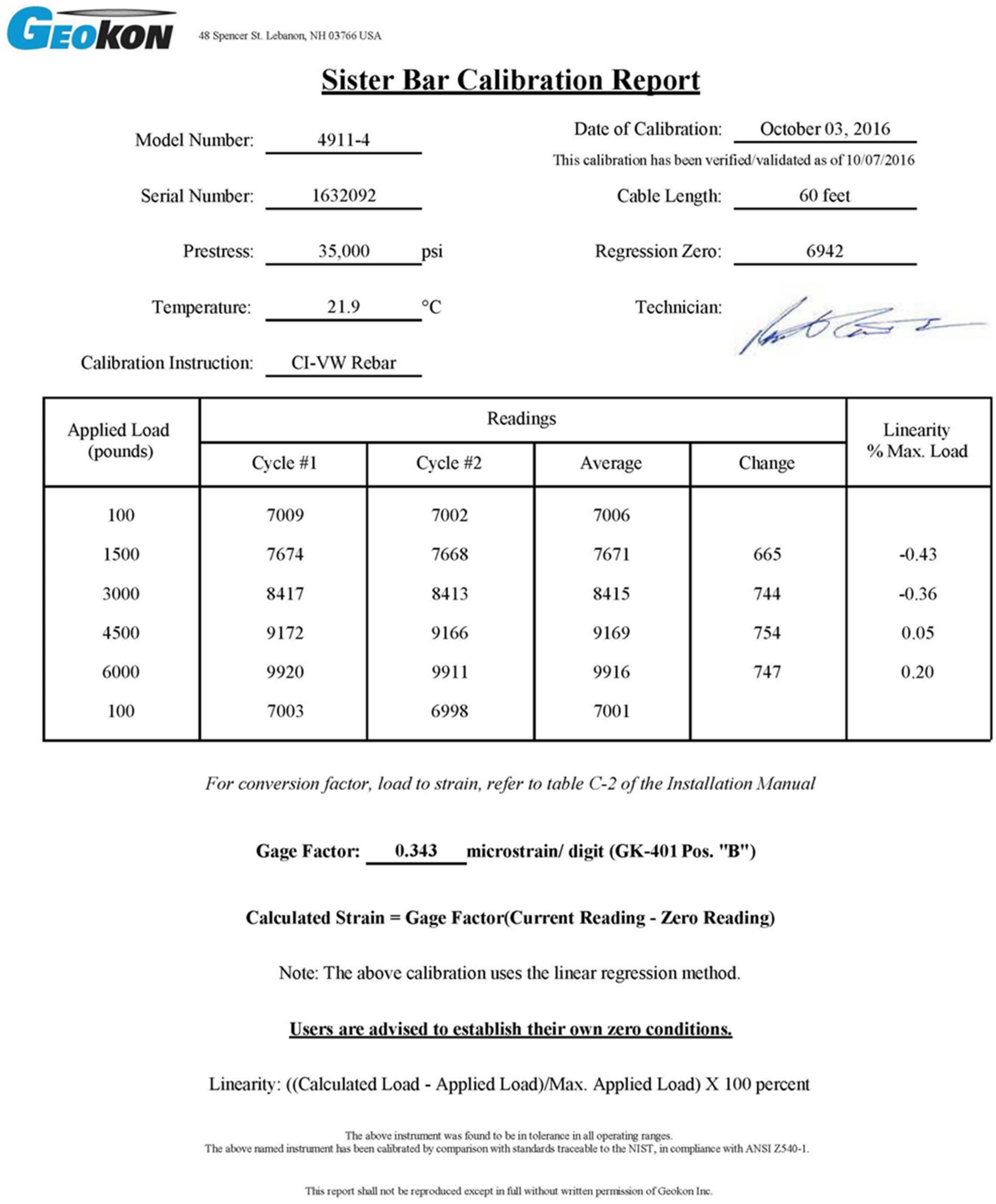
Figure B-5. Sister bar calibration report: S/N 1632091



GEOKON 48 Spencer St. Lebanon, NH 03766 USA

Sister Bar Calibration Report

Model Number: 4911-4

Date of Calibration: October 03, 2016

This calibration has been verified/validated as of 10/07/2016

Serial Number: 1632092

Cable Length: 60 feet

Prestress: 35,000 psi

Regression Zero: 6942

Temperature: 21.9 °C

Technician:

Calibration Instruction: CI-VW Rebar

Applied Load (pounds)	Readings				Linearity % Max. Load
	Cycle #1	Cycle #2	Average	Change	
100	7009	7002	7006		
1500	7674	7668	7671	665	-0.43
3000	8417	8413	8415	744	-0.36
4500	9172	9166	9169	754	0.05
6000	9920	9911	9916	747	0.20
100	7003	6998	7001		

For conversion factor, load to strain, refer to table C-2 of the Installation Manual

Gage Factor: 0.343 microstrain/ digit (GK-401 Pos. "B")

Calculated Strain = Gage Factor(Current Reading - Zero Reading)

Note: The above calibration uses the linear regression method.

Users are advised to establish their own zero conditions.

Linearity: ((Calculated Load - Applied Load)/Max. Applied Load) X 100 percent

The above instrument was found to be in tolerance in all operating ranges.
The above named instrument has been calibrated by comparison with standards traceable to the NIST, in compliance with ANSI Z540-1.

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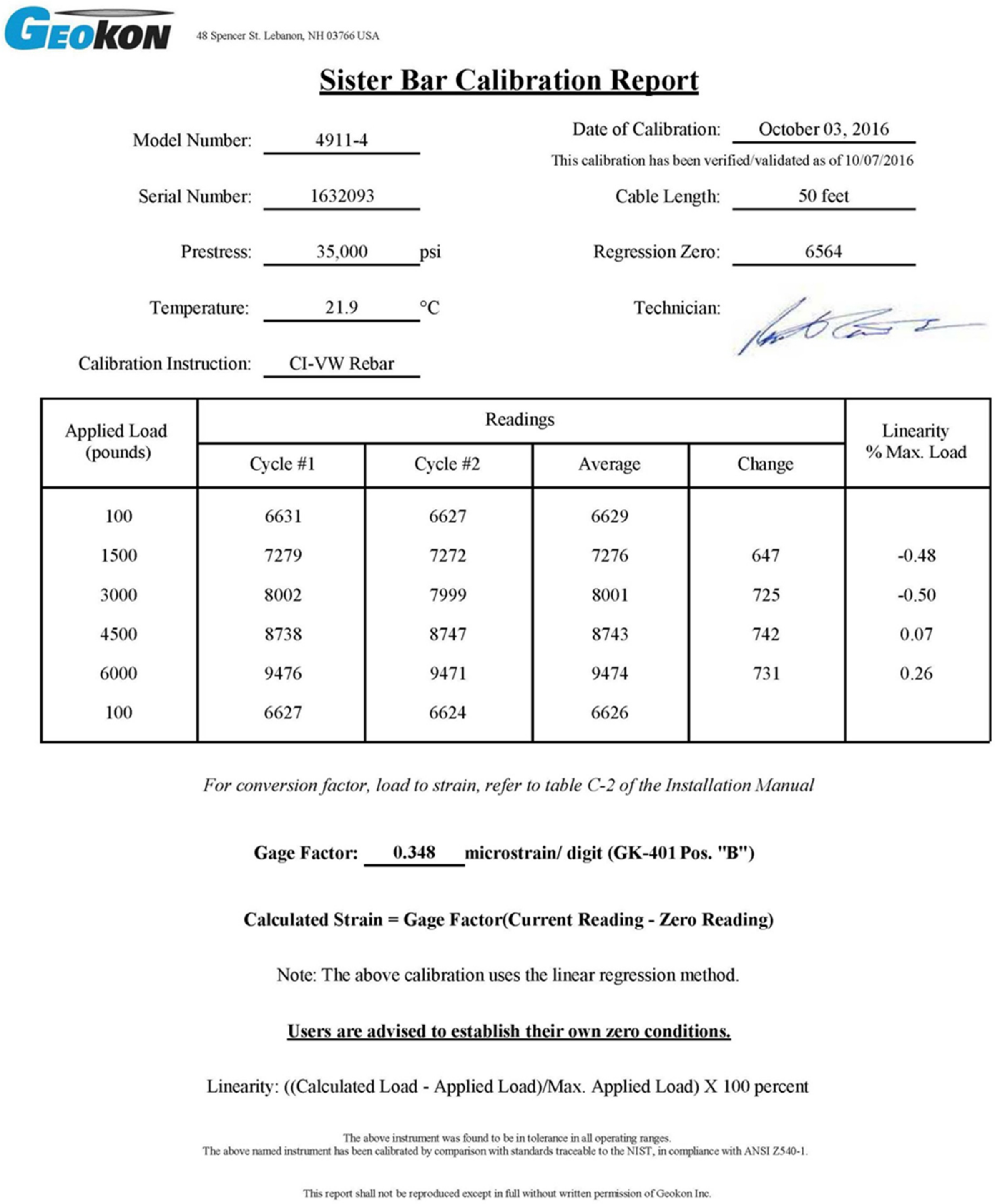
Figure B-6. Sister bar calibration report: S/N 1632092



48 Spencer St. Lebanon, NH 03766 USA

Sister Bar Calibration Report

Model Number: 4911-4

Date of Calibration: October 03, 2016

This calibration has been verified/validated as of 10/07/2016

Serial Number: 1632093

Cable Length: 50 feet

Prestress: 35,000 psi

Regression Zero: 6564

Temperature: 21.9 °C

Technician:

Calibration Instruction: CI-VW Rebar

Applied Load (pounds)	Readings				Linearity % Max. Load
	Cycle #1	Cycle #2	Average	Change	
100	6631	6627	6629		
1500	7279	7272	7276	647	-0.48
3000	8002	7999	8001	725	-0.50
4500	8738	8747	8743	742	0.07
6000	9476	9471	9474	731	0.26
100	6627	6624	6626		

For conversion factor, load to strain, refer to table C-2 of the Installation Manual

Gage Factor: 0.348 microstrain/ digit (GK-401 Pos. "B")

Calculated Strain = Gage Factor(Current Reading - Zero Reading)

Note: The above calibration uses the linear regression method.

Users are advised to establish their own zero conditions.

Linearity: ((Calculated Load - Applied Load)/Max. Applied Load) X 100 percent

The above instrument was found to be in tolerance in all operating ranges.
The above named instrument has been calibrated by comparison with standards traceable to the NIST, in compliance with ANSI Z540-1.

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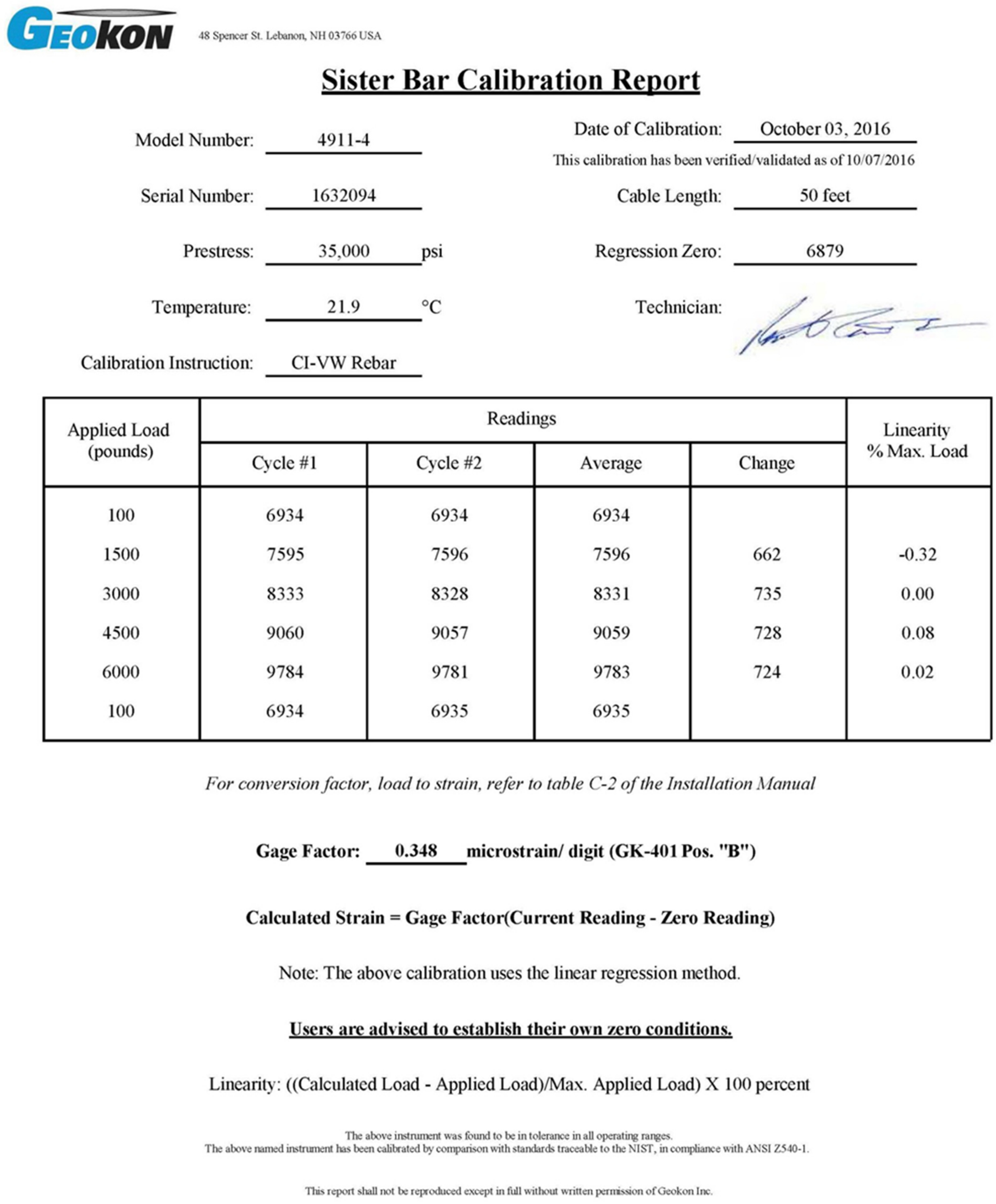
Figure B-7. Sister bar calibration report: S/N 1632093



GEOKON 48 Spencer St. Lebanon, NH 03766 USA

Sister Bar Calibration Report

Model Number: 4911-4

Serial Number: 1632094

Prestress: 35,000 psi

Temperature: 21.9 °C

Calibration Instruction: CI-VW Rebar

Date of Calibration: October 03, 2016

This calibration has been verified/validated as of 10/07/2016

Cable Length: 50 feet

Regression Zero: 6879

Technician:

Applied Load (pounds)	Readings				Linearity % Max. Load
	Cycle #1	Cycle #2	Average	Change	
100	6934	6934	6934		
1500	7595	7596	7596	662	-0.32
3000	8333	8328	8331	735	0.00
4500	9060	9057	9059	728	0.08
6000	9784	9781	9783	724	0.02
100	6934	6935	6935		

For conversion factor, load to strain, refer to table C-2 of the Installation Manual

Gage Factor: 0.348 microstrain/ digit (GK-401 Pos. "B")

Calculated Strain = Gage Factor(Current Reading - Zero Reading)

Note: The above calibration uses the linear regression method.

Users are advised to establish their own zero conditions.

Linearity: ((Calculated Load - Applied Load)/Max. Applied Load) X 100 percent

The above instrument was found to be in tolerance in all operating ranges.
The above named instrument has been calibrated by comparison with standards traceable to the NIST, in compliance with ANSI Z540-1.

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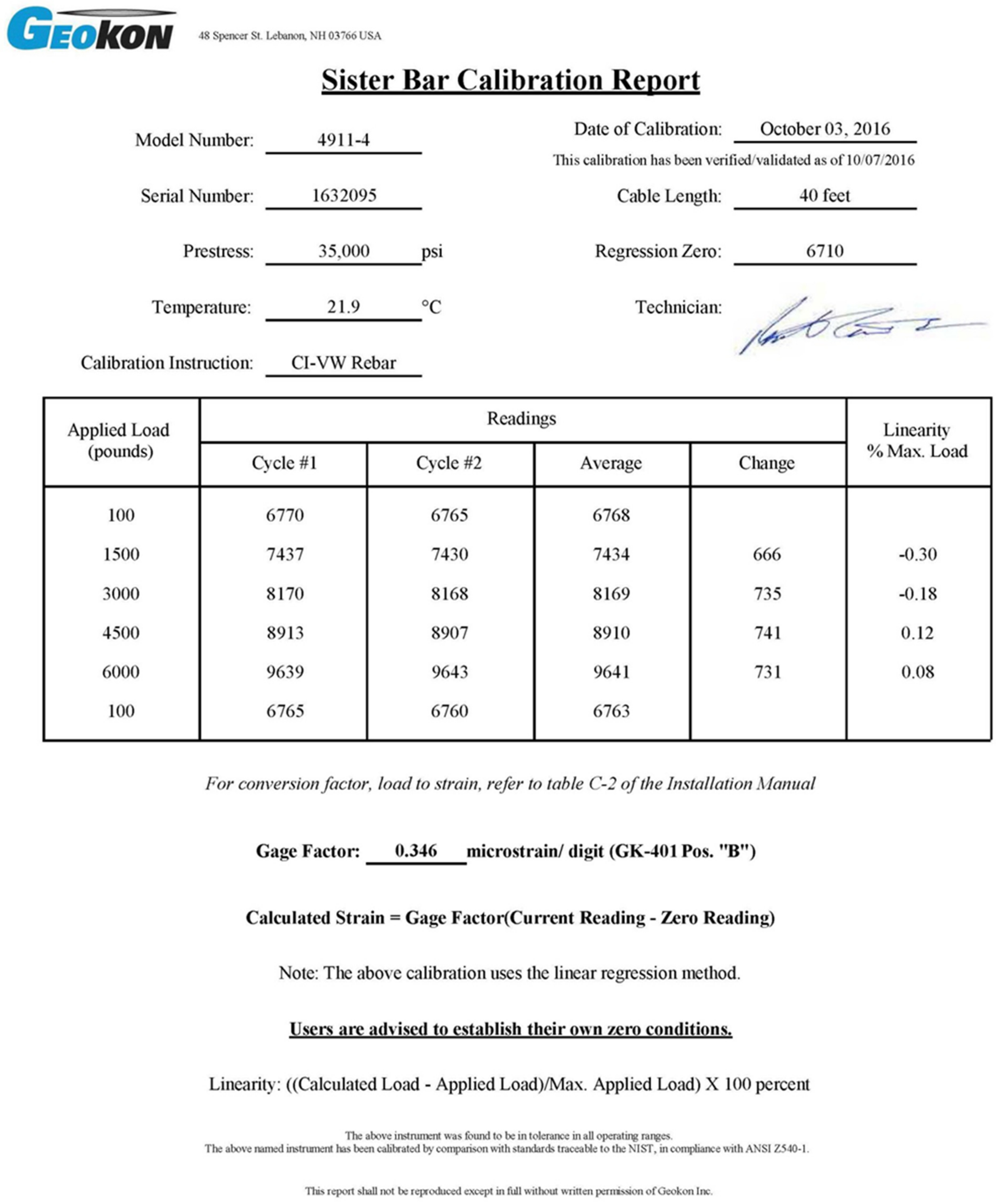
Figure B-8. Sister bar calibration report: S/N 1632094



GEOKON 48 Spencer St. Lebanon, NH 03766 USA

Sister Bar Calibration Report

Model Number: 4911-4

Date of Calibration: October 03, 2016

This calibration has been verified/validated as of 10/07/2016

Serial Number: 1632095

Cable Length: 40 feet

Prestress: 35,000 psi

Regression Zero: 6710

Temperature: 21.9 °C

Technician:

Calibration Instruction: CI-VW Rebar

Applied Load (pounds)	Readings				Linearity % Max. Load
	Cycle #1	Cycle #2	Average	Change	
100	6770	6765	6768		
1500	7437	7430	7434	666	-0.30
3000	8170	8168	8169	735	-0.18
4500	8913	8907	8910	741	0.12
6000	9639	9643	9641	731	0.08
100	6765	6760	6763		

For conversion factor, load to strain, refer to table C-2 of the Installation Manual

Gage Factor: 0.346 microstrain/ digit (GK-401 Pos. "B")

Calculated Strain = Gage Factor(Current Reading - Zero Reading)

Note: The above calibration uses the linear regression method.

Users are advised to establish their own zero conditions.

Linearity: ((Calculated Load - Applied Load)/Max. Applied Load) X 100 percent

The above instrument was found to be in tolerance in all operating ranges.
The above named instrument has been calibrated by comparison with standards traceable to the NIST, in compliance with ANSI Z540-1.

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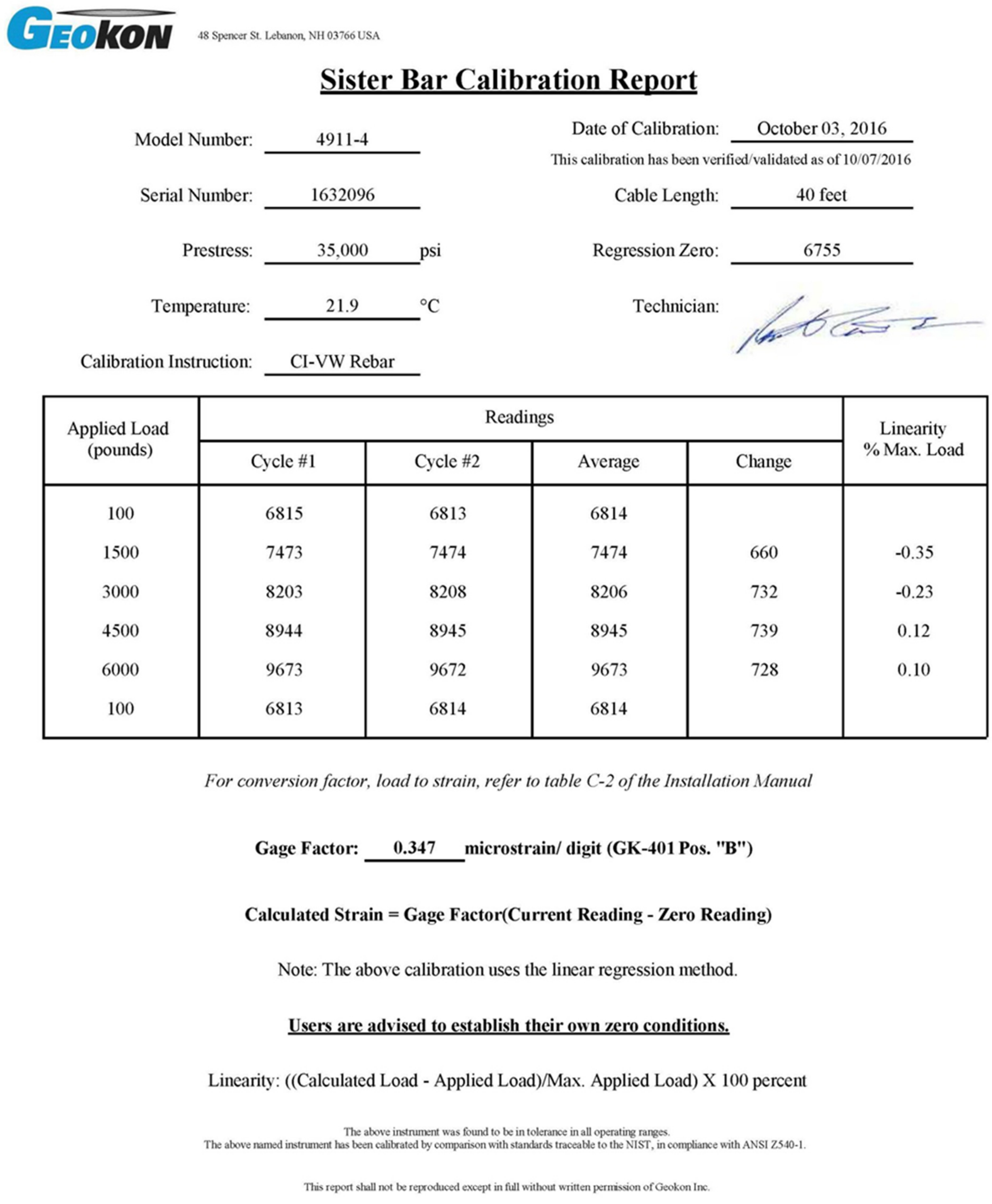
Figure B-9. Sister bar calibration report: S/N 1632095



GEOKON 48 Spencer St. Lebanon, NH 03766 USA

Sister Bar Calibration Report

Model Number: 4911-4

Date of Calibration: October 03, 2016

This calibration has been verified/validated as of 10/07/2016

Serial Number: 1632096

Cable Length: 40 feet

Prestress: 35,000 psi

Regression Zero: 6755

Temperature: 21.9 °C

Technician:

Calibration Instruction: CI-VW Rebar

Applied Load (pounds)	Readings				Linearity % Max. Load
	Cycle #1	Cycle #2	Average	Change	
100	6815	6813	6814		
1500	7473	7474	7474	660	-0.35
3000	8203	8208	8206	732	-0.23
4500	8944	8945	8945	739	0.12
6000	9673	9672	9673	728	0.10
100	6813	6814	6814		

For conversion factor, load to strain, refer to table C-2 of the Installation Manual

Gage Factor: 0.347 microstrain/ digit (GK-401 Pos. "B")

Calculated Strain = Gage Factor(Current Reading - Zero Reading)

Note: The above calibration uses the linear regression method.

Users are advised to establish their own zero conditions.

Linearity: ((Calculated Load - Applied Load)/Max. Applied Load) X 100 percent

The above instrument was found to be in tolerance in all operating ranges.
The above named instrument has been calibrated by comparison with standards traceable to the NIST, in compliance with ANSI Z540-1.

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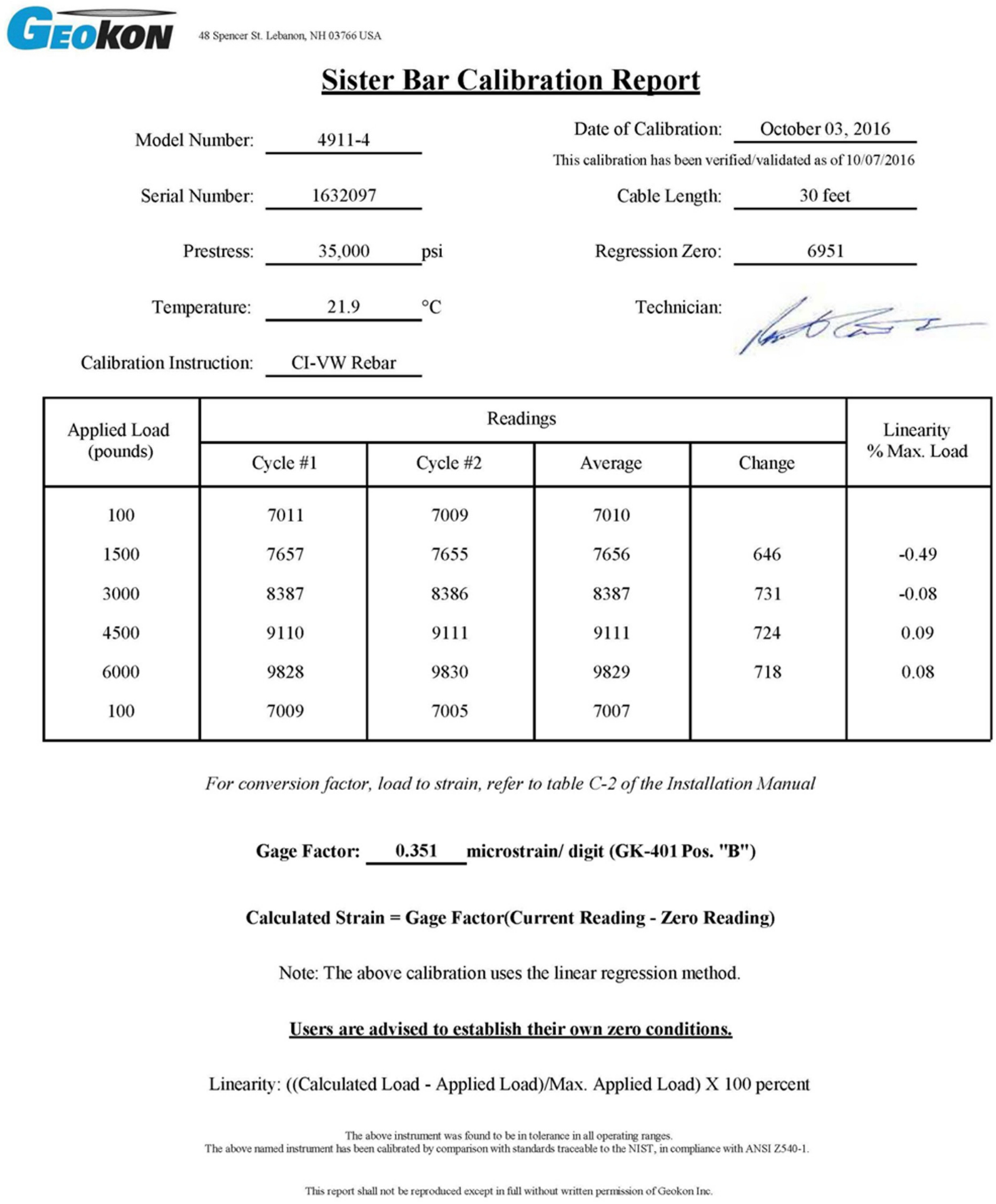
Figure B-10. Sister bar calibration report: S/N 1632096



GEOKON 48 Spencer St. Lebanon, NH 03766 USA

Sister Bar Calibration Report

Model Number: 4911-4

Date of Calibration: October 03, 2016

This calibration has been verified/validated as of 10/07/2016

Serial Number: 1632097

Cable Length: 30 feet

Prestress: 35,000 psi

Regression Zero: 6951

Temperature: 21.9 °C

Technician:

Calibration Instruction: CI-VW Rebar

Applied Load (pounds)	Readings				Linearity % Max. Load
	Cycle #1	Cycle #2	Average	Change	
100	7011	7009	7010		
1500	7657	7655	7656	646	-0.49
3000	8387	8386	8387	731	-0.08
4500	9110	9111	9111	724	0.09
6000	9828	9830	9829	718	0.08
100	7009	7005	7007		

For conversion factor, load to strain, refer to table C-2 of the Installation Manual

Gage Factor: 0.351 microstrain/ digit (GK-401 Pos. "B")

Calculated Strain = Gage Factor(Current Reading - Zero Reading)

Note: The above calibration uses the linear regression method.

Users are advised to establish their own zero conditions.

Linearity: ((Calculated Load - Applied Load)/Max. Applied Load) X 100 percent

The above instrument was found to be in tolerance in all operating ranges.
The above named instrument has been calibrated by comparison with standards traceable to the NIST, in compliance with ANSI Z540-1.

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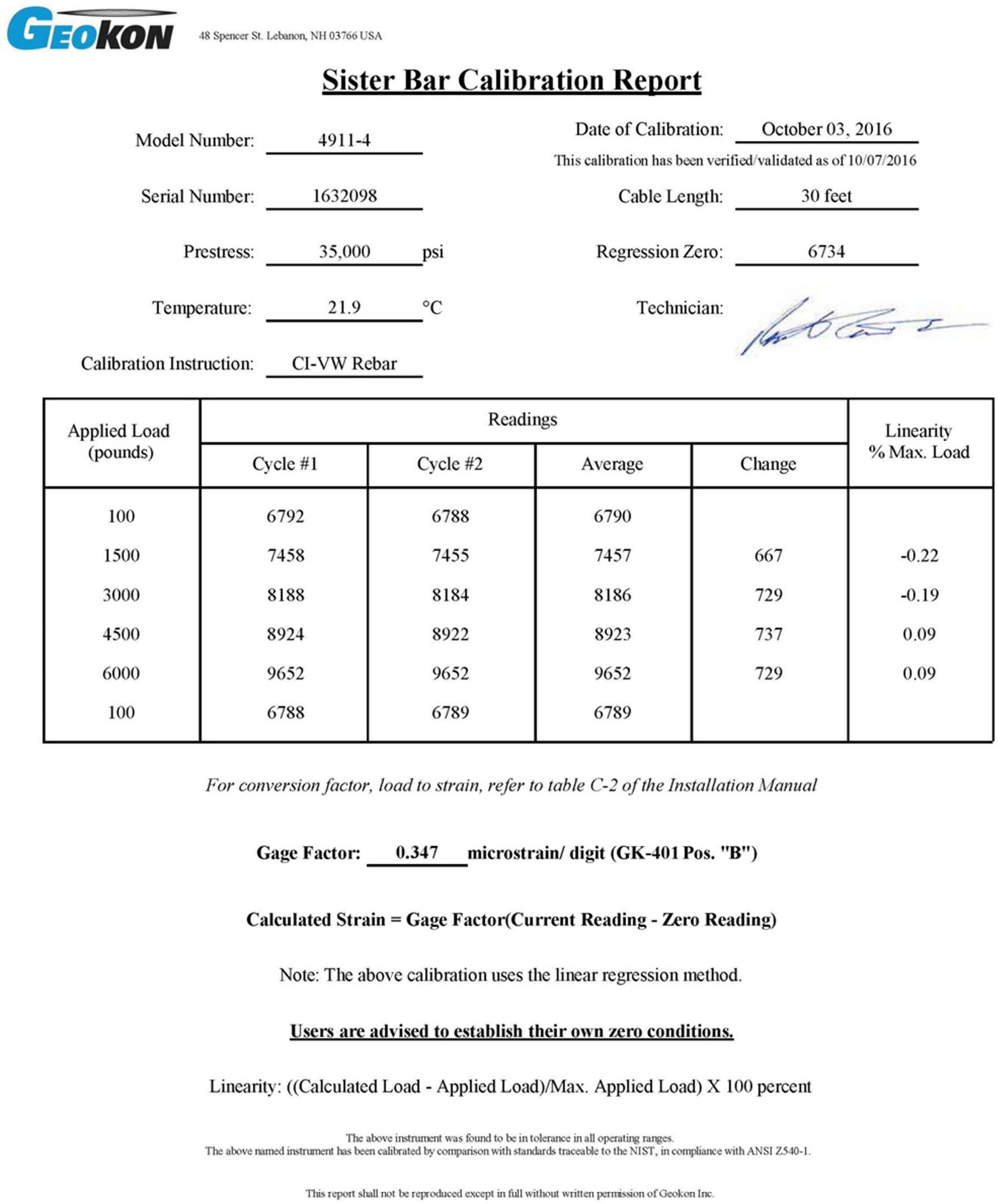
Figure B-11. Sister bar calibration report: S/N 1632097



GEOKON 48 Spencer St. Lebanon, NH 03766 USA

Sister Bar Calibration Report

Model Number: 4911-4

Date of Calibration: October 03, 2016

This calibration has been verified/validated as of 10/07/2016

Serial Number: 1632098

Cable Length: 30 feet

Prestress: 35,000 psi

Regression Zero: 6734

Temperature: 21.9 °C

Technician:

Calibration Instruction: CI-VW Rebar

Applied Load (pounds)	Readings				Linearity % Max. Load
	Cycle #1	Cycle #2	Average	Change	
100	6792	6788	6790		
1500	7458	7455	7457	667	-0.22
3000	8188	8184	8186	729	-0.19
4500	8924	8922	8923	737	0.09
6000	9652	9652	9652	729	0.09
100	6788	6789	6789		

For conversion factor, load to strain, refer to table C-2 of the Installation Manual

Gage Factor: 0.347 microstrain/ digit (GK-401 Pos. "B")

Calculated Strain = Gage Factor(Current Reading - Zero Reading)

Note: The above calibration uses the linear regression method.

Users are advised to establish their own zero conditions.

Linearity: ((Calculated Load - Applied Load)/Max. Applied Load) X 100 percent

The above instrument was found to be in tolerance in all operating ranges.
The above named instrument has been calibrated by comparison with standards traceable to the NIST, in compliance with ANSI Z540-1.

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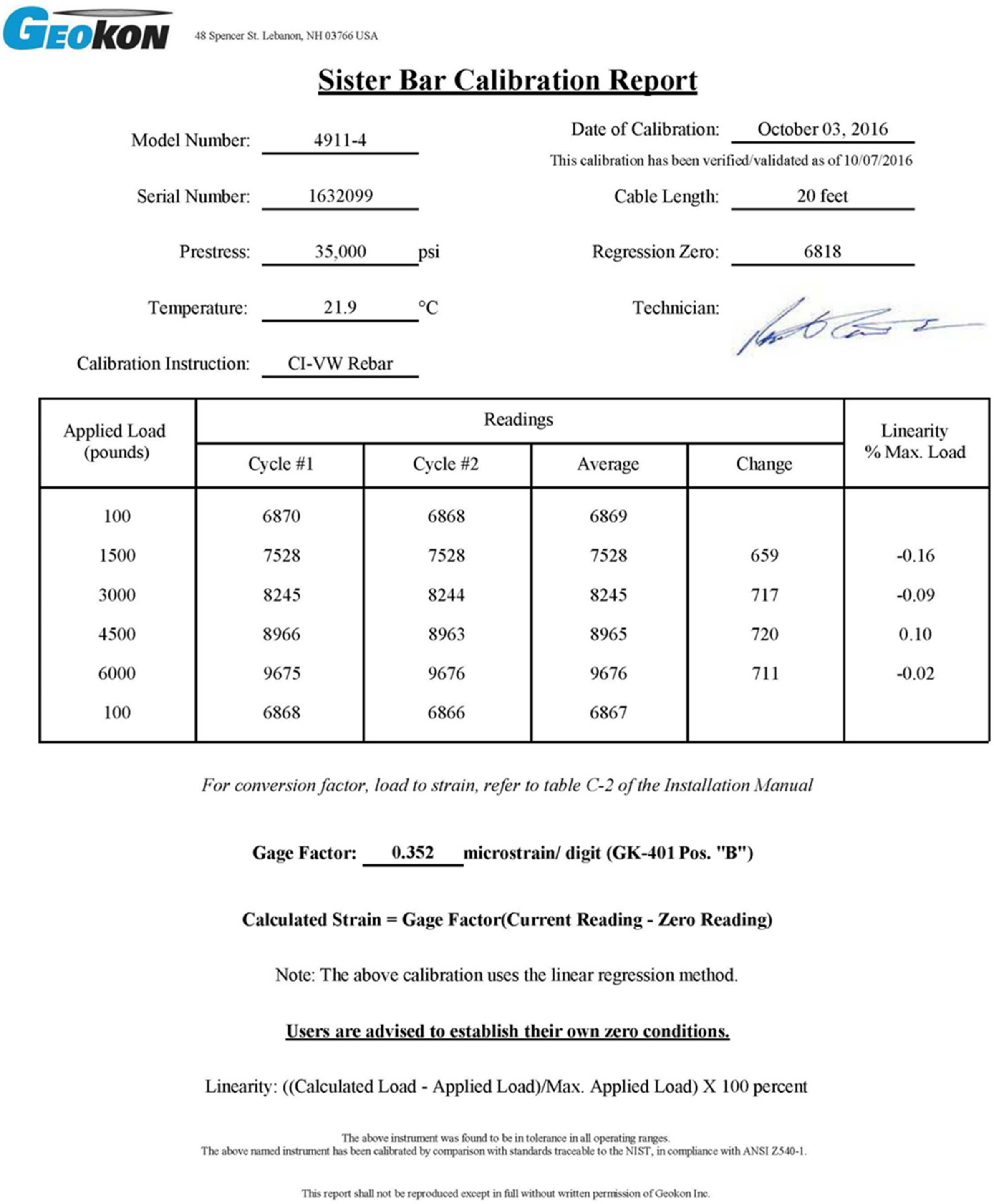
Figure B-12. Sister bar calibration report: S/N 1632098



GEOKON 48 Spencer St. Lebanon, NH 03766 USA

Sister Bar Calibration Report

Model Number: 4911-4

Date of Calibration: October 03, 2016

This calibration has been verified/validated as of 10/07/2016

Serial Number: 1632099

Cable Length: 20 feet

Prestress: 35,000 psi

Regression Zero: 6818

Temperature: 21.9 °C

Technician:

Calibration Instruction: CI-VW Rebar

Applied Load (pounds)	Readings				Linearity % Max. Load
	Cycle #1	Cycle #2	Average	Change	
100	6870	6868	6869		
1500	7528	7528	7528	659	-0.16
3000	8245	8244	8245	717	-0.09
4500	8966	8963	8965	720	0.10
6000	9675	9676	9676	711	-0.02
100	6868	6866	6867		

For conversion factor, load to strain, refer to table C-2 of the Installation Manual

Gage Factor: 0.352 microstrain/ digit (GK-401 Pos. "B")

Calculated Strain = Gage Factor(Current Reading - Zero Reading)

Note: The above calibration uses the linear regression method.

Users are advised to establish their own zero conditions.

Linearity: ((Calculated Load - Applied Load)/Max. Applied Load) X 100 percent

The above instrument was found to be in tolerance in all operating ranges.
The above named instrument has been calibrated by comparison with standards traceable to the NIST, in compliance with ANSI Z540-1.

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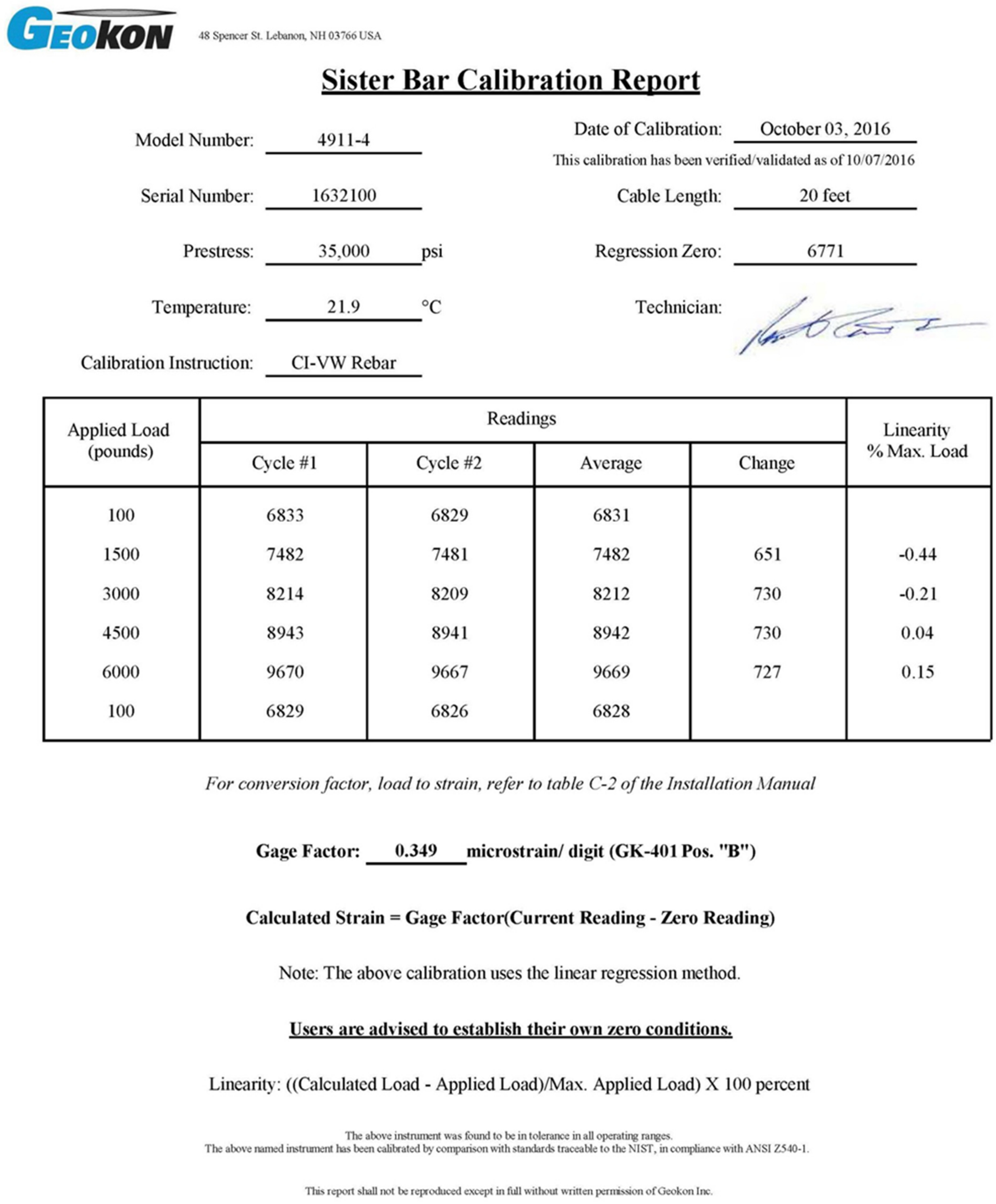
Figure B-13. Sister bar calibration report: S/N 1632099



GEOKON 48 Spencer St. Lebanon, NH 03766 USA

Sister Bar Calibration Report

Model Number: 4911-4

Date of Calibration: October 03, 2016

This calibration has been verified/validated as of 10/07/2016

Serial Number: 1632100

Cable Length: 20 feet

Prestress: 35,000 psi

Regression Zero: 6771

Temperature: 21.9 °C

Technician:

Calibration Instruction: CI-VW Rebar

Applied Load (pounds)	Readings				Linearity % Max. Load
	Cycle #1	Cycle #2	Average	Change	
100	6833	6829	6831		
1500	7482	7481	7482	651	-0.44
3000	8214	8209	8212	730	-0.21
4500	8943	8941	8942	730	0.04
6000	9670	9667	9669	727	0.15
100	6829	6826	6828		

For conversion factor, load to strain, refer to table C-2 of the Installation Manual

Gage Factor: 0.349 microstrain/ digit (GK-401 Pos. "B")

Calculated Strain = Gage Factor(Current Reading - Zero Reading)

Note: The above calibration uses the linear regression method.

Users are advised to establish their own zero conditions.

Linearity: ((Calculated Load - Applied Load)/Max. Applied Load) X 100 percent

The above instrument was found to be in tolerance in all operating ranges.
The above named instrument has been calibrated by comparison with standards traceable to the NIST, in compliance with ANSI Z540-1.

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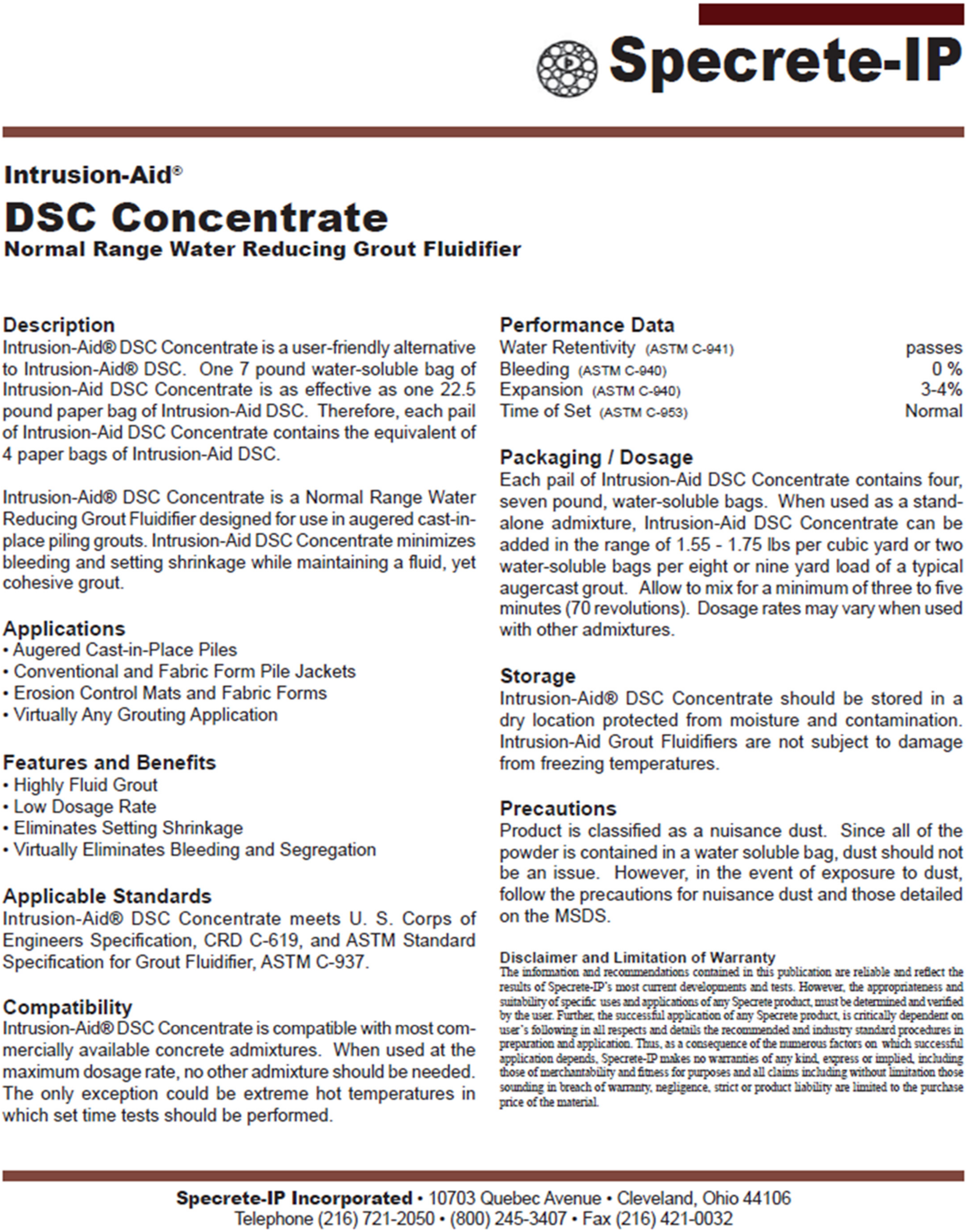
Figure B-14. Sister bar calibration report: S/N 1632100

APPENDIX C

MATERIAL SPECIFICATION - INTRUSION-AID® DSC CONCENTRATE NORMAL RANGE WATER REDUCING GROUT FLUIDIFIER



Specrete-IP

Intrusion-Aid®

DSC Concentrate

Normal Range Water Reducing Grout Fluidifier

Description

Intrusion-Aid® DSC Concentrate is a user-friendly alternative to Intrusion-Aid® DSC. One 7 pound water-soluble bag of Intrusion-Aid DSC Concentrate is as effective as one 22.5 pound paper bag of Intrusion-Aid DSC. Therefore, each pail of Intrusion-Aid DSC Concentrate contains the equivalent of 4 paper bags of Intrusion-Aid DSC.

Intrusion-Aid® DSC Concentrate is a Normal Range Water Reducing Grout Fluidifier designed for use in augered cast-in-place piling grouts. Intrusion-Aid DSC Concentrate minimizes bleeding and setting shrinkage while maintaining a fluid, yet cohesive grout.

Applications

- Augered Cast-in-Place Piles
- Conventional and Fabric Form Pile Jackets
- Erosion Control Mats and Fabric Forms
- Virtually Any Grouting Application

Features and Benefits

- Highly Fluid Grout
- Low Dosage Rate
- Eliminates Setting Shrinkage
- Virtually Eliminates Bleeding and Segregation

Applicable Standards

Intrusion-Aid® DSC Concentrate meets U. S. Corps of Engineers Specification, CRD C-619, and ASTM Standard Specification for Grout Fluidifier, ASTM C-937.

Compatibility

Intrusion-Aid® DSC Concentrate is compatible with most commercially available concrete admixtures. When used at the maximum dosage rate, no other admixture should be needed. The only exception could be extreme hot temperatures in which set time tests should be performed.

Performance Data

Water Retentivity (ASTM C-941)	passes
Bleeding (ASTM C-940)	0 %
Expansion (ASTM C-940)	3-4%
Time of Set (ASTM C-953)	Normal

Packaging / Dosage

Each pail of Intrusion-Aid DSC Concentrate contains four, seven pound, water-soluble bags. When used as a stand-alone admixture, Intrusion-Aid DSC Concentrate can be added in the range of 1.55 - 1.75 lbs per cubic yard or two water-soluble bags per eight or nine yard load of a typical augercast grout. Allow to mix for a minimum of three to five minutes (70 revolutions). Dosage rates may vary when used with other admixtures.

Storage

Intrusion-Aid® DSC Concentrate should be stored in a dry location protected from moisture and contamination. Intrusion-Aid Grout Fluidifiers are not subject to damage from freezing temperatures.

Precautions

Product is classified as a nuisance dust. Since all of the powder is contained in a water soluble bag, dust should not be an issue. However, in the event of exposure to dust, follow the precautions for nuisance dust and those detailed on the MSDS.

Disclaimer and Limitation of Warranty

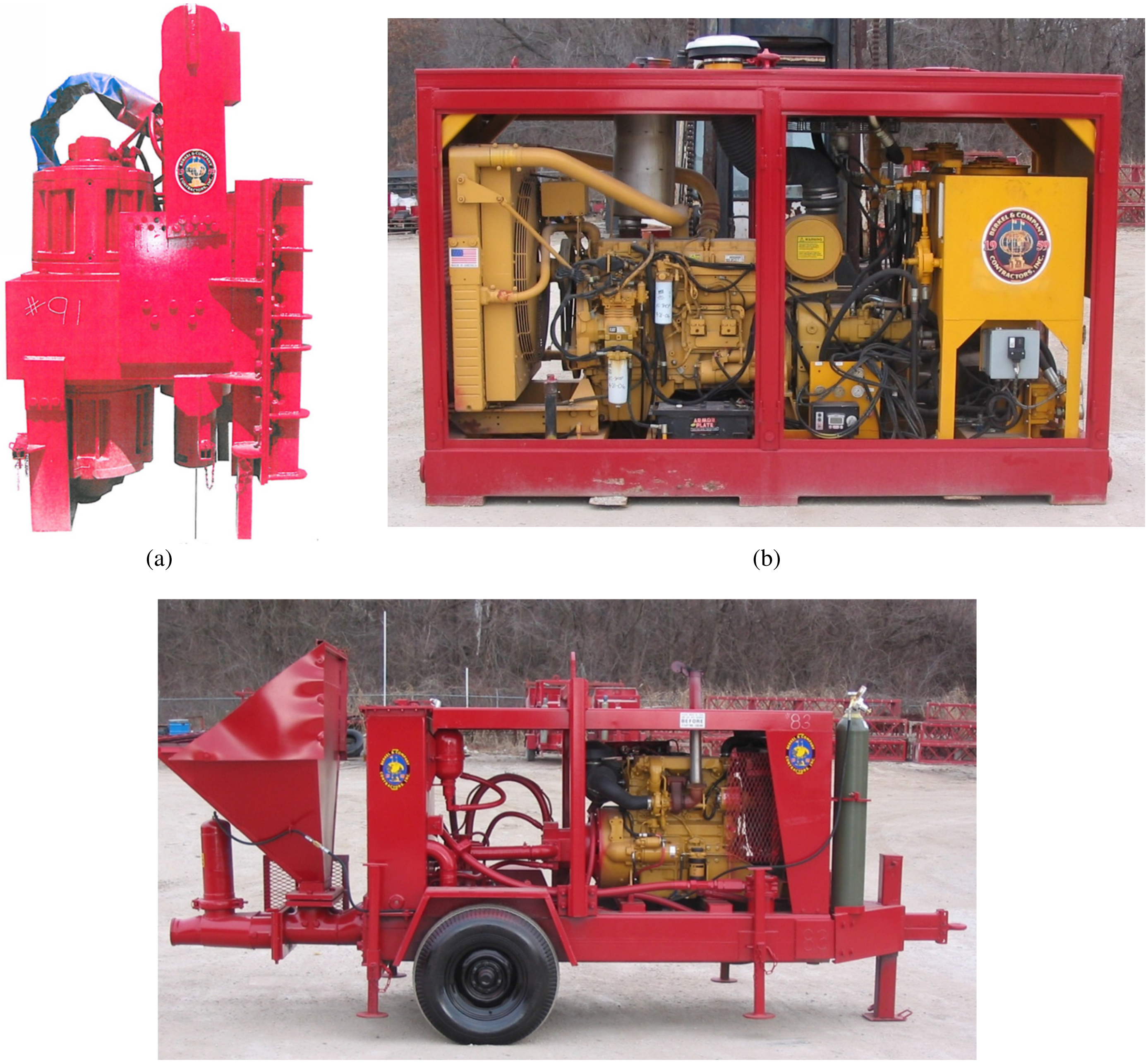
The information and recommendations contained in this publication are reliable and reflect the results of Specrete-IP's most current developments and tests. However, the appropriateness and suitability of specific uses and applications of any Specrete product, must be determined and verified by the user. Further, the successful application of any Specrete product, is critically dependent on user's following in all respects and details the recommended and industry standard procedures in preparation and application. Thus, as a consequence of the numerous factors on which successful application depends, Specrete-IP makes no warranties of any kind, express or implied, including those of merchantability and fitness for purposes and all claims including without limitation those sounding in breach of warranty, negligence, strict or product liability are limited to the purchase price of the material.

Specrete-IP Incorporated • 10703 Quebec Avenue • Cleveland, Ohio 44106
Telephone (216) 721-2050 • (800) 245-3407 • Fax (216) 421-0032

Figure C-1. Material specification sheet for DSC Concentrate

APPENDIX D

DRILLING EQUIPMENT DETAILS - GEAR BOX AND POWER UNIT



(a)

(b)

(c)

Figure D-1. Photographs of drilling platform components : (a) gear box, (b) hydraulic power unit, and (c) grout pump

Table D-1. Specifications for drilling platform components: (a) gear box, (b) hydraulic power unit, and (c) grout pump

(a) General description of unit – gear box

- Hydraulically operated top head drive
- Travels up and down the leads
- Torques range from about 15,000 ft-lbs to 90,000 ft-lbs (20 to 122 kN-m)
- Weighs 2,000 to 13,000 lbs (905 to 5900 kg) - additional downward force
- Rotational speed ranges from 30 to 60 rpm

Equipment No.	90-1060
Equipment Date:	03 October 2007 by Berkel and Co., Bonner Springs, KS
Dimensions:	60 in (length) x 42 in (width) x 8 ft 10 in (height)
Weight:	13,600 lb
Motor	Rotary Power (x2 unit)
Output:	Torque = 74,300 ft-lb
(*before reduction*)	Speed = 44 rpm
Shaft:	5 in (ID) x 7 in (OD) x 55 in (OA length)

(b) General description of unit – hydraulic power unit

- Provides hydraulic power to turn the gearbox and auger
- Horsepower ratings range from about 200 hp to 850 hp

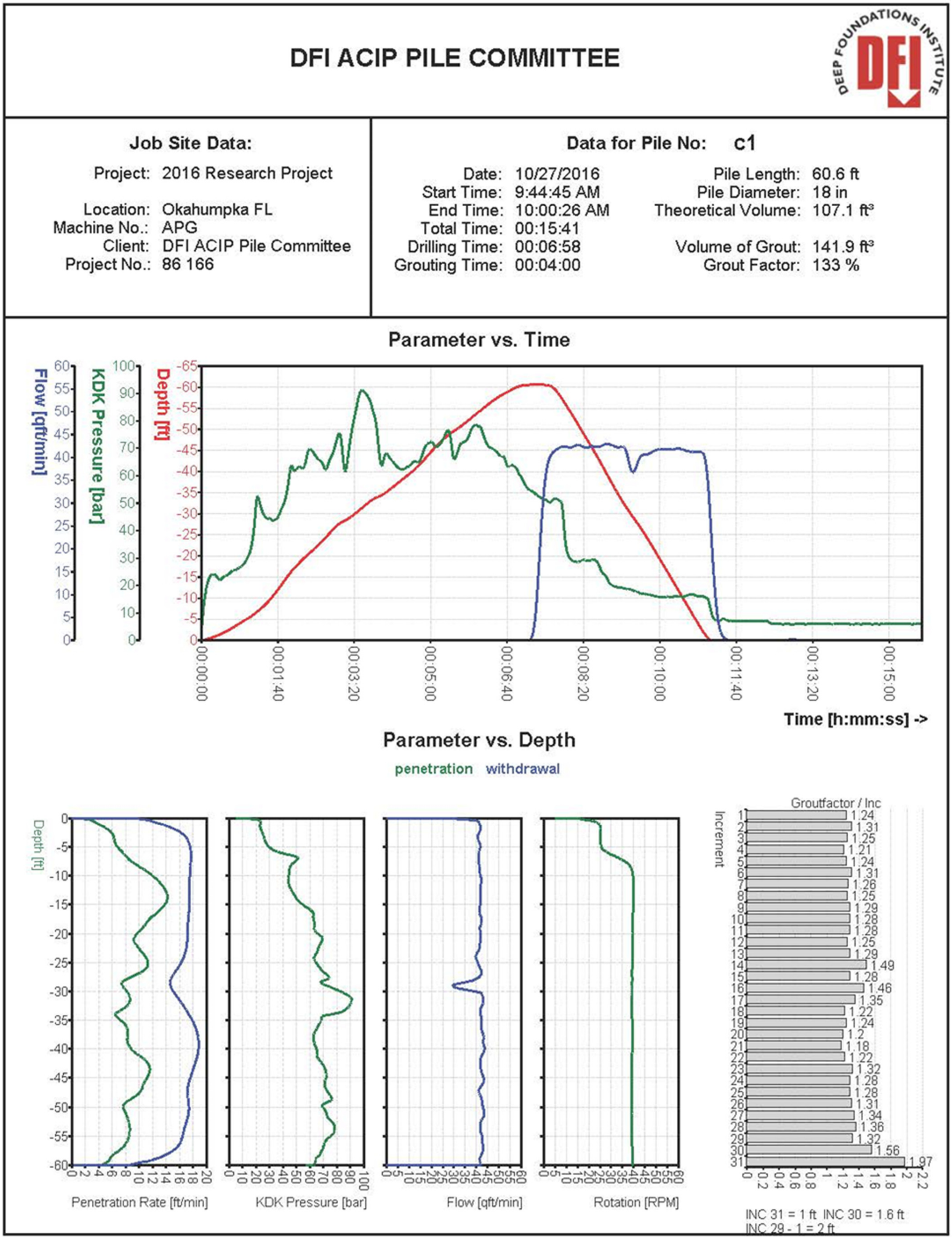
Equipment No.	63-C18
Equipment Date:	10 October 2007 by Berkel and Co., Bonner Springs, KS
Dimensions:	17 ft (length) x 50 in (width) x 7 ft 9 in (height)
Engine:	Caterpillar C18
Horsepower:	700 hp @ 2100 rpm

(c) General description of unit – grout pump

- Hydraulically operated, positive displacement piston-ball valve pump
- Pump pressures typically around 350 psi at pump outlet
- Stroke vols. typically range from about 0.4 to 1.0 cubic feet per stroke (up to 1.7)
- Grout hoses typically 2 to 3 inch diameter
- Can pump grout several hundred feet
- Grout typically delivered by ready mix trucks

APPENDIX E

INSTALLATION MEASUREMENTS - DATA FROM AUTOMATED MONITORING EQUIPMENT



DFI ACIP PILE COMMITTEE

Job Site Data:

Project: 2016 Research Project

Location: Okahumpka FL
Machine No.: APG
Client: DFI ACIP Pile Committee
Project No.: 86 166

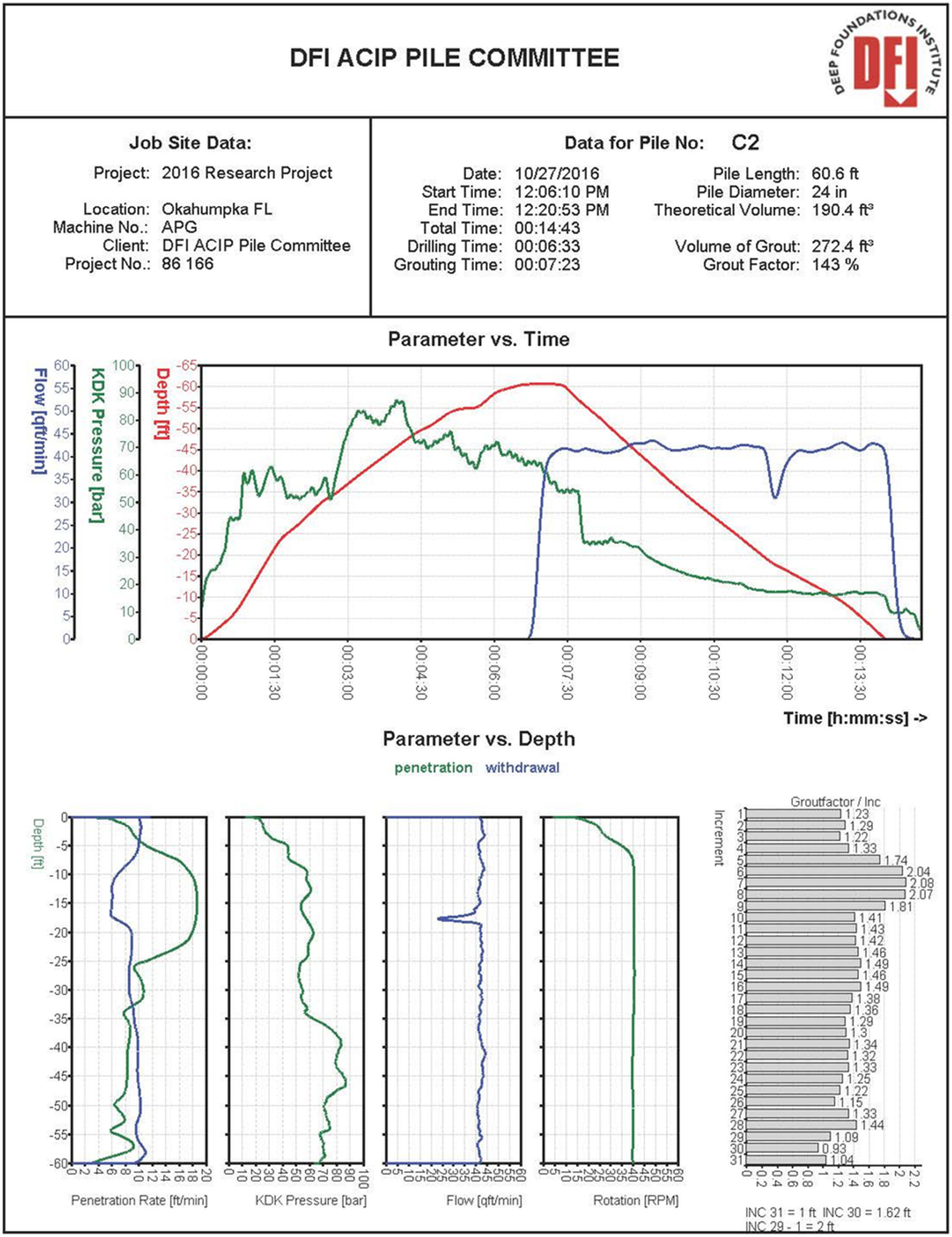
Data for Pile No: c1

Date: 10/27/2016
Start Time: 9:44:45 AM
End Time: 10:00:26 AM
Total Time: 00:15:41
Drilling Time: 00:06:58
Grouting Time: 00:04:00

Pile Length: 60.6 ft
Pile Diameter: 18 in
Theoretical Volume: 107.1 ft³

Volume of Grout: 141.9 ft³
Grout Factor: 133 %

Figure E-1. Installation record for test pile C-1 using AME



DFI ACIP PILE COMMITTEE

Job Site Data:

Project: 2016 Research Project

Location: Okahumpka FL
Machine No.: APG
Client: DFI ACIP Pile Committee
Project No.: 86 166

Data for Pile No: C2

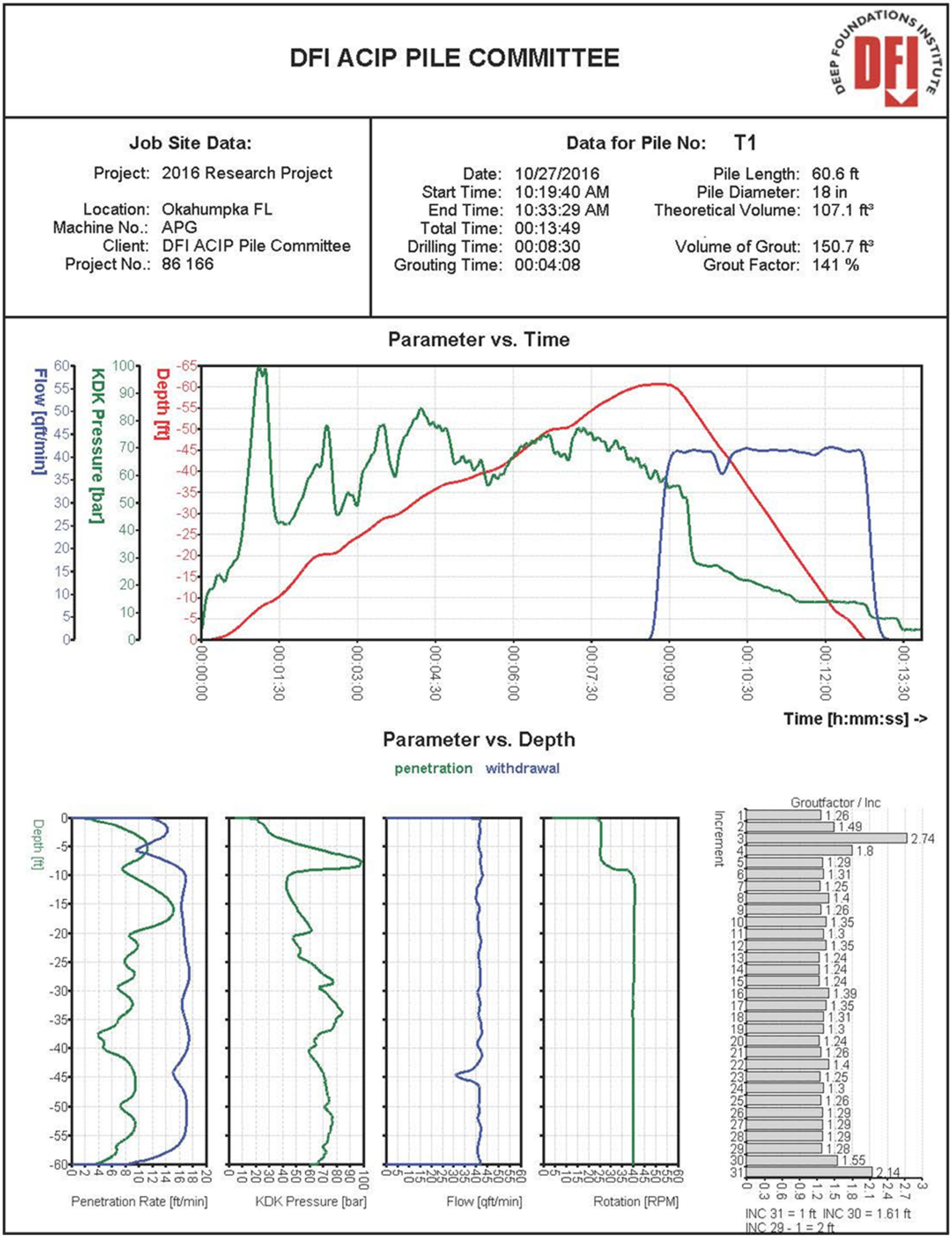
Date: 10/27/2016
Start Time: 12:06:10 PM
End Time: 12:20:53 PM
Total Time: 00:14:43
Drilling Time: 00:06:33
Grouting Time: 00:07:23

Pile Length: 60.6 ft
Pile Diameter: 24 in
Theoretical Volume: 190.4 ft³

Volume of Grout: 272.4 ft³
Grout Factor: 143 %

INC 31 = 1 ft INC 30 = 1.62 ft
INC 29 - 1 = 2 ft

Figure E-2. Installation record for test pile C-2 using AME



DFI ACIP PILE COMMITTEE

Job Site Data:

Project: 2016 Research Project

Location: Okahumpka FL
Machine No.: APG
Client: DFI ACIP Pile Committee
Project No.: 86 166

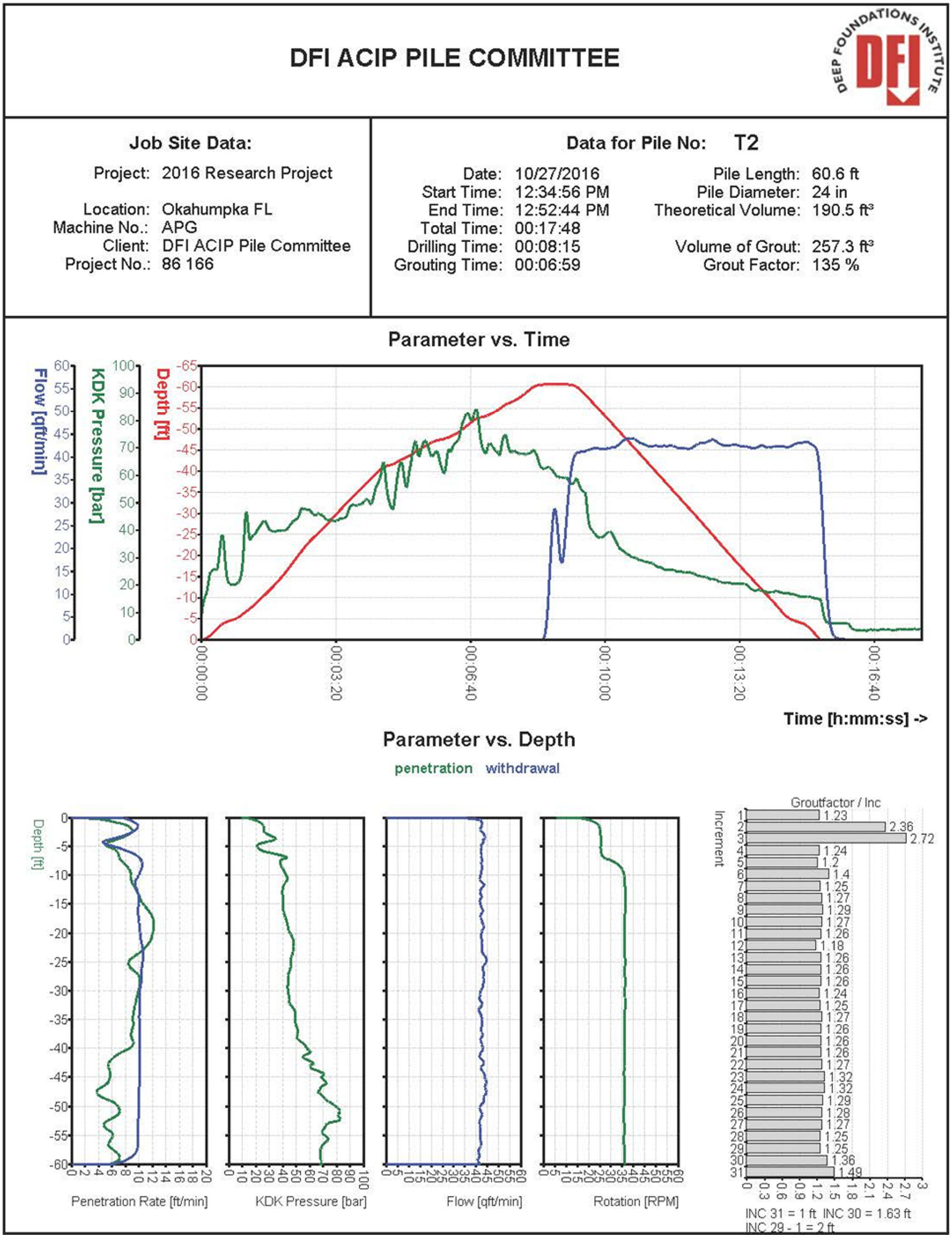
Data for Pile No: T1

Date: 10/27/2016
Start Time: 10:19:40 AM
End Time: 10:33:29 AM
Total Time: 00:13:49
Drilling Time: 00:08:30
Grouting Time: 00:04:08

Pile Length: 60.6 ft
Pile Diameter: 18 in
Theoretical Volume: 107.1 ft³

Volume of Grout: 150.7 ft³
Grout Factor: 141 %

Figure E-3. Installation record for test pile T-1 using AME



DFI ACIP PILE COMMITTEE

Job Site Data:

Project: 2016 Research Project

Location: Okahumpka FL
Machine No.: APG
Client: DFI ACIP Pile Committee
Project No.: 86 166

Data for Pile No: T2

Date: 10/27/2016
Start Time: 12:34:56 PM
End Time: 12:52:44 PM
Total Time: 00:17:48
Drilling Time: 00:08:15
Grouting Time: 00:06:59

Pile Length: 60.6 ft
Pile Diameter: 24 in
Theoretical Volume: 190.5 ft³

Volume of Grout: 257.3 ft³
Grout Factor: 135 %

Parameter vs. Time

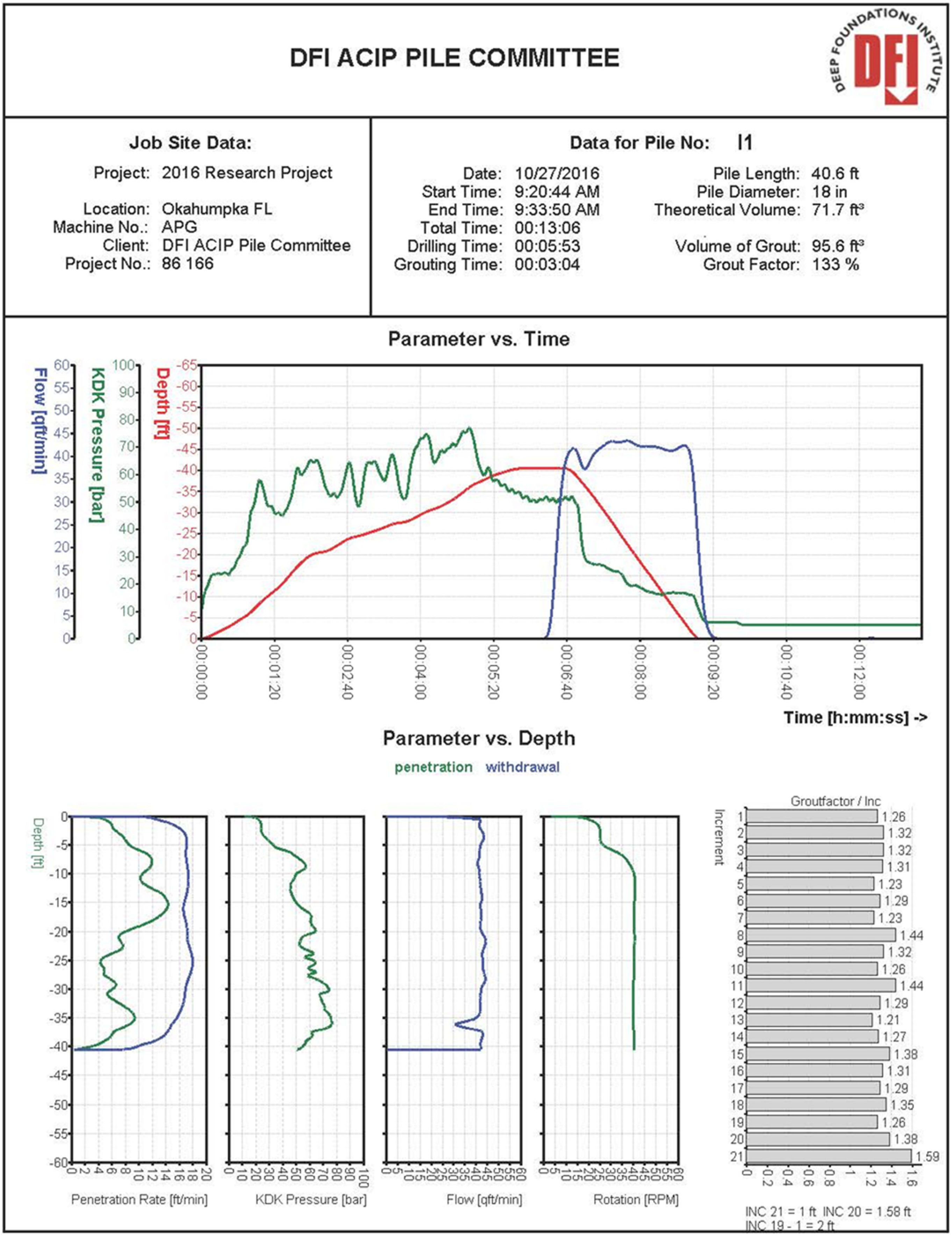
Parameter vs. Depth

penetration withdrawal

1	1.23
2	2.36
3	2.72
4	1.24
5	1.2
6	1.4
7	1.25
8	1.27
9	1.29
10	1.27
11	1.26
12	1.18
13	1.26
14	1.26
15	1.26
16	1.24
17	1.25
18	1.27
19	1.26
20	1.26
21	1.26
22	1.27
23	1.32
24	1.32
25	1.29
26	1.28
27	1.27
28	1.25
29	1.25
30	1.36
31	1.49

INC 31 = 1 ft INC 30 = 1.63 ft
INC 29 - 1 = 2 ft

Figure E-4. Installation record for test pile T-2 using AME



DFI ACIP PILE COMMITTEE

Job Site Data:

Project: 2016 Research Project

Location: Okahumpka FL
Machine No.: APG
Client: DFI ACIP Pile Committee
Project No.: 86 166

Data for Pile No: I1

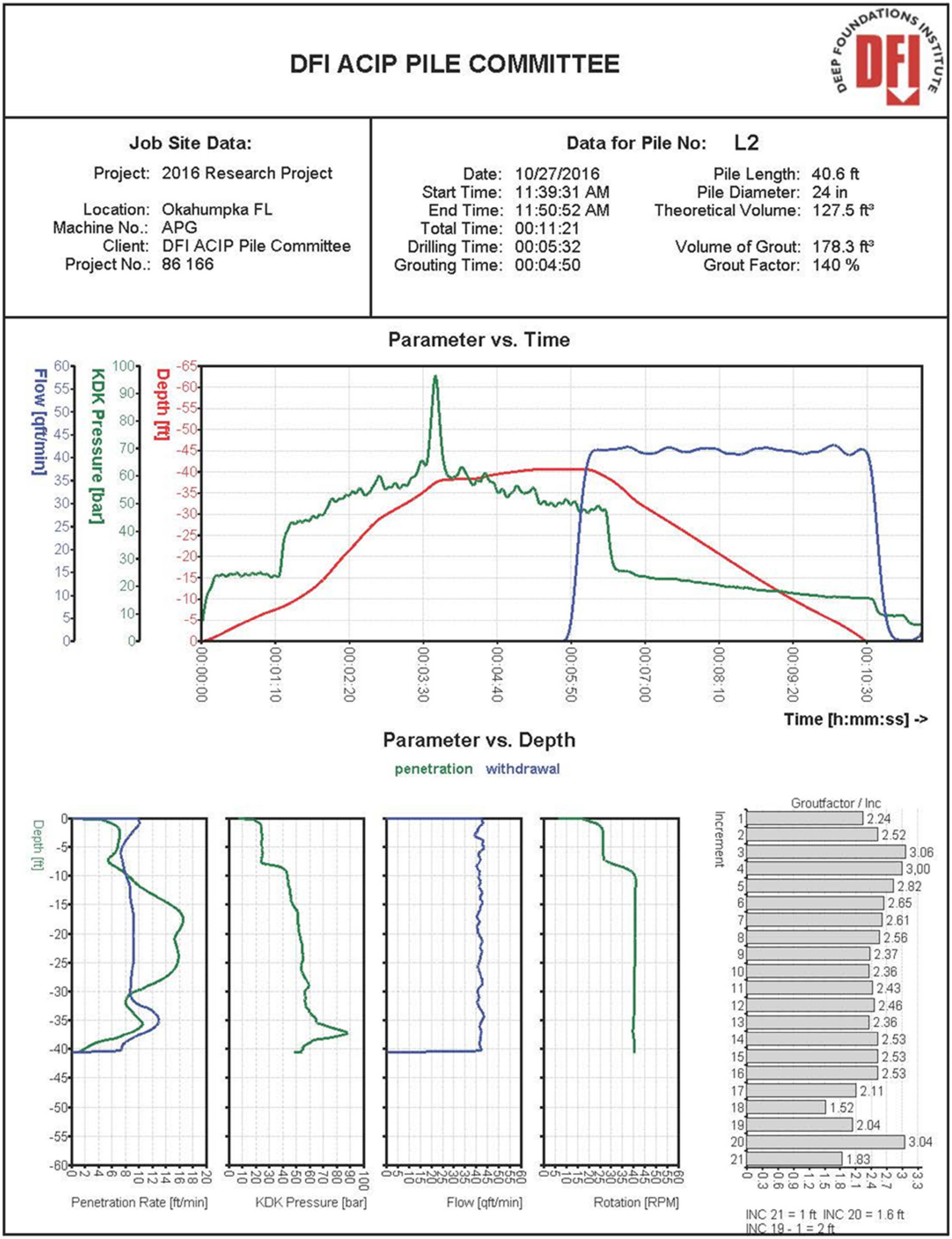
Date: 10/27/2016
Start Time: 9:20:44 AM
End Time: 9:33:50 AM
Total Time: 00:13:06
Drilling Time: 00:05:53
Grouting Time: 00:03:04

Pile Length: 40.6 ft
Pile Diameter: 18 in
Theoretical Volume: 71.7 ft³

Volume of Grout: 95.6 ft³
Grout Factor: 133 %

INC 21 = 1 ft INC 20 = 1.58 ft
INC 19 - 1 = 2 ft

Figure E-5. Installation record for test pile L-1 using AME



DFI ACIP PILE COMMITTEE

Job Site Data:

Project: 2016 Research Project

Location: Okahumpka FL
Machine No.: APG
Client: DFI ACIP Pile Committee
Project No.: 86 166

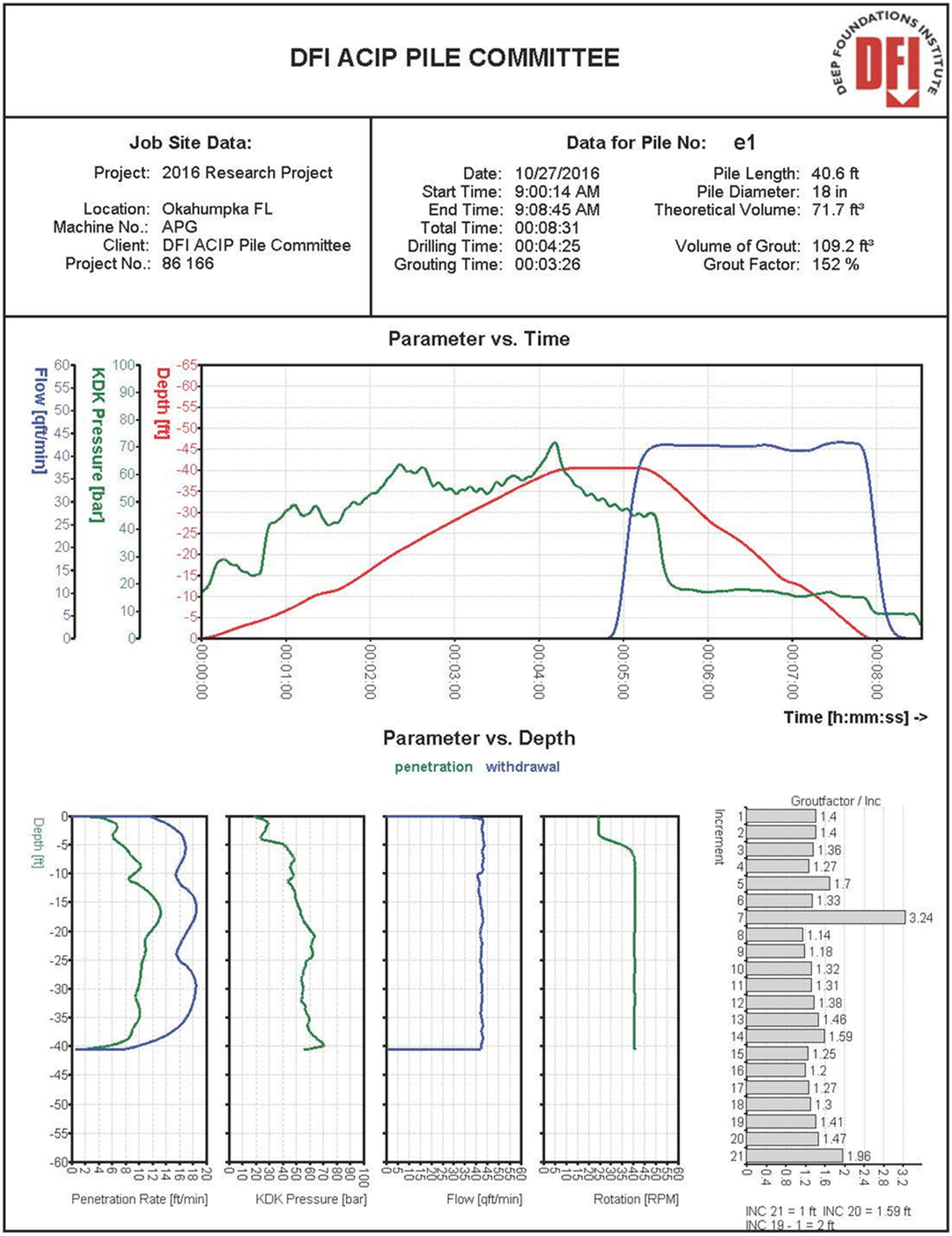
Data for Pile No: L2

Date: 10/27/2016
Start Time: 11:39:31 AM
End Time: 11:50:52 AM
Total Time: 00:11:21
Drilling Time: 00:05:32
Grouting Time: 00:04:50

Pile Length: 40.6 ft
Pile Diameter: 24 in
Theoretical Volume: 127.5 ft³

Volume of Grout: 178.3 ft³
Grout Factor: 140 %

Figure E-6. Installation record for test pile L-2 using AME



DFI ACIP PILE COMMITTEE

Job Site Data:

Project: 2016 Research Project

Location: Okahumpka FL
Machine No.: APG
Client: DFI ACIP Pile Committee
Project No.: 86 166

Data for Pile No: e1

Date: 10/27/2016
Start Time: 9:00:14 AM
End Time: 9:08:45 AM
Total Time: 00:08:31
Drilling Time: 00:04:25
Grouting Time: 00:03:26

Pile Length: 40.6 ft
Pile Diameter: 18 in
Theoretical Volume: 71.7 ft³

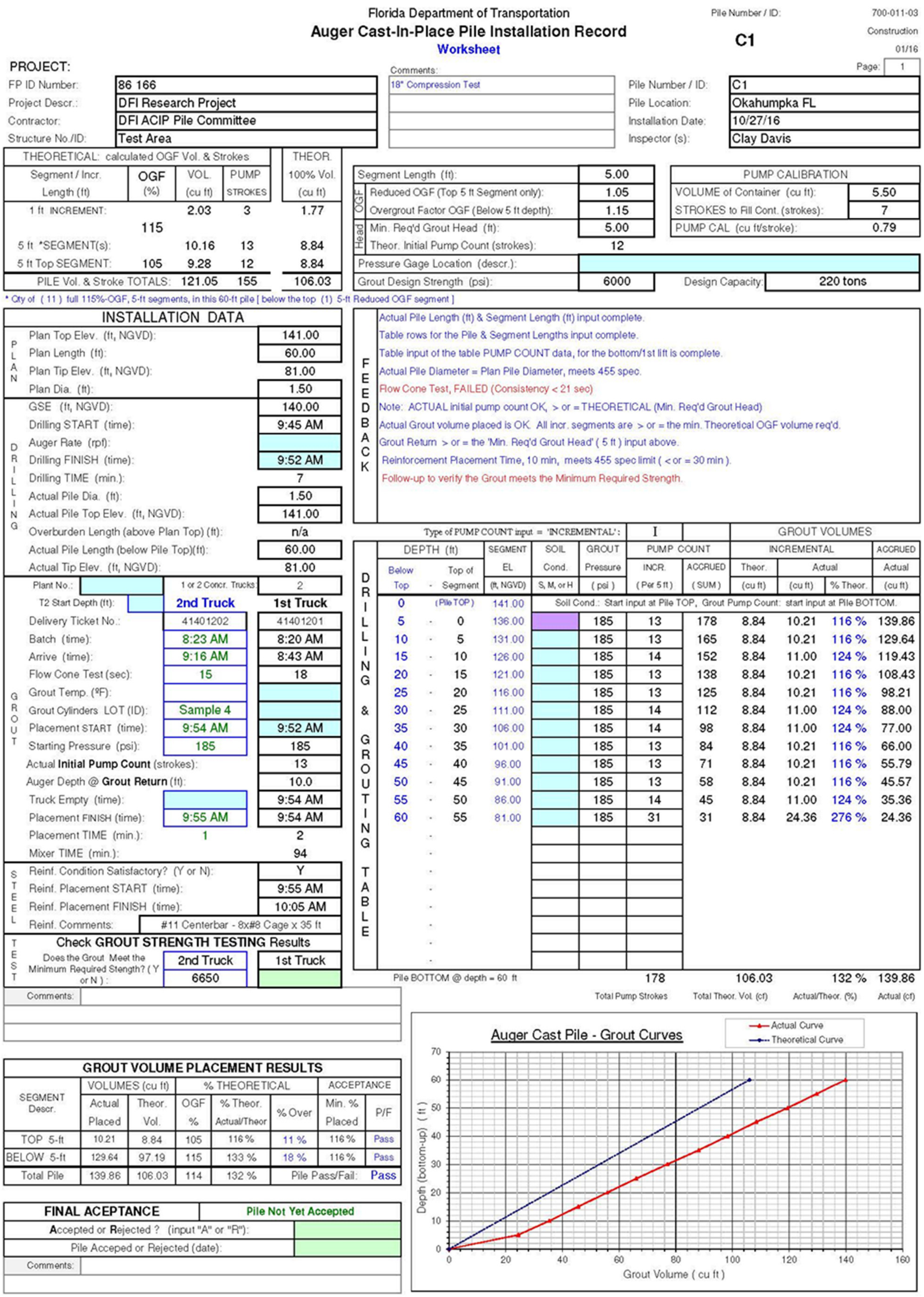
Volume of Grout: 109.2 ft³
Grout Factor: 152 %

INC 21 = 1 ft INC 20 = 1.59 ft
INC 19 - 1 = 2 ft

Figure E-7. Installation record for test pile E-1 using AME

APPENDIX F

INSTALLATION MEASUREMENTS - DATA FROM MANUAL RECORDINGS



Florida Department of Transportation

Auger Cast-In-Place Pile Installation Record

Worksheet

Pile Number / ID: **C1**

700-011-03
Construction
01/16

Page: 1

PROJECT:

FP ID Number: 86 166
Project Descr.: DFI Research Project
Contractor: DFI ACIP Pile Committee
Structure No./ID: Test Area

Comments: 18" Compression Test

Pile Number / ID: C1
Pile Location: Okahumpka FL
Installation Date: 10/27/16
Inspector (s): Clay Davis

THEORETICAL: calculated OGF Vol. & Strokes				THEOR.
Segment / Incr. Length (ft)	OGF (%)	VOL. (cu ft)	PUMP STROKES	100% Vol. (cu ft)
1 ft INCREMENT:		2.03	3	1.77
	115			
5 ft *SEGMENT(s):		10.16	13	8.84
5 ft Top SEGMENT:	105	9.28	12	8.84
PILE Vol. & Stroke TOTALS:		121.05	155	106.03

* Qty of (11) full 115%-OGF, 5-ft segments, in this 60-ft pile [below the top (1) 5-ft Reduced OGF segment]

Segment Length (ft): 5.00
OGF Reduced OGF (Top 5 ft Segment only): 1.05
OGF Overgrout Factor OGF (Below 5 ft depth): 1.15
Head Min. Req'd Grout Head (ft): 5.00
Head Theor. Initial Pump Count (strokes): 12
Pressure Gage Location (descr.):
Grout Design Strength (psi): 6000
Design Capacity: 220 tons

PUMP CALIBRATION
VOLUME of Container (cu ft): 5.50
STROKES to Fill Cont. (strokes): 7
PUMP CAL (cu ft/stroke): 0.79

INSTALLATION DATA

PLAN
Plan Top Elev. (ft, NGVD): 141.00
Plan Length (ft): 60.00
Plan Tip Elev. (ft, NGVD): 81.00
Plan Dia. (ft): 1.50

DRILLING
GSE (ft, NGVD): 140.00
Drilling START (time): 9:45 AM
Auger Rate (rpf):
Drilling FINISH (time): 9:52 AM
Drilling TIME (min.): 7
Actual Pile Dia. (ft): 1.50
Actual Pile Top Elev. (ft, NGVD): 141.00
Overburden Length (above Plan Top) (ft): n/a
Actual Pile Length (below Pile Top)(ft): 60.00
Actual Tip Elev. (ft, NGVD): 81.00

FEEDBACK
Actual Pile Length (ft) & Segment Length (ft) input complete.
Table rows for the Pile & Segment Lengths input complete.
Table input of the table PUMP COUNT data, for the bottom/1st lift is complete.
Actual Pile Diameter = Plan Pile Diameter, meets 455 spec.
Flow Cone Test, FAILED (Consistency < 21 sec)
Note: ACTUAL initial pump count OK, > or = THEORETICAL (Min. Req'd Grout Head)
Actual Grout volume placed is OK. All incr. segments are > or = the min. Theoretical OGF volume req'd.
Grout Return > or = the 'Min. Req'd Grout Head' (5 ft) input above.
Reinforcement Placement Time, 10 min, meets 455 spec limit (< or = 30 min).
Follow-up to verify the Grout meets the Minimum Required Strength.

GROUT

Plant No.:	1 or 2 Concr. Trucks:	2
T2 Start Depth (ft):	**2nd Truck**	**1st Truck**
Delivery Ticket No.:	41401202	41401201
Batch (time):	8:23 AM	8:20 AM
Arrive (time):	9:16 AM	8:43 AM
Flow Cone Test (sec):	15	18
Grout Temp. (ºF):		
Grout Cylinders LOT (ID):	Sample 4	
Placement START (time):	9:54 AM	9:52 AM
Starting Pressure (psi):	185	185
Actual **Initial Pump Count** (strokes):		13
Auger Depth @ **Grout Return** (ft):		10.0
Truck Empty (time):		9:54 AM
Placement FINISH (time):	9:55 AM	9:54 AM
Placement TIME (min.):	1	2
Mixer TIME (min.):		94

STEEL
Reinf. Condition Satisfactory? (Y or N): Y
Reinf. Placement START (time): 9:55 AM
Reinf. Placement FINISH (time): 10:05 AM
Reinf. Comments: #11 Centerbar - 8x#8 Cage x 35 ft

TEST

Check **GROUT STRENGTH TESTING** Results

Does the Grout Meet the Minimum Required Stength? (Y or N):	2nd Truck	1st Truck
	6650	

Comments:

DRILLING & GROUTING TABLE

Type of PUMP COUNT input = 'INCREMENTAL': I

DEPTH (ft) Below Top	-	Top of Segment	SEGMENT EL (ft, NGVD)	SOIL Cond. S, M, or H	GROUT Pressure (psi)	PUMP COUNT INCR. (Per 5 ft)	PUMP COUNT ACCRUED (SUM)	GROUT VOLUMES INCREMENTAL Theor. (cu ft)	INCREMENTAL Actual (cu ft)	INCREMENTAL Actual % Theor.	ACCRUED Actual (cu ft)
0		(Pile TOP)	141.00	Soil Cond.: Start input at Pile TOP, Grout Pump Count: start input at Pile BOTTOM.							
5	-	0	136.00		185	13	178	8.84	10.21	116 %	139.86
10	-	5	131.00		185	13	165	8.84	10.21	116 %	129.64
15	-	10	126.00		185	14	152	8.84	11.00	124 %	119.43
20	-	15	121.00		185	13	138	8.84	10.21	116 %	108.43
25	-	20	116.00		185	13	125	8.84	10.21	116 %	98.21
30	-	25	111.00		185	14	112	8.84	11.00	124 %	88.00
35	-	30	106.00		185	14	98	8.84	11.00	124 %	77.00
40	-	35	101.00		185	13	84	8.84	10.21	116 %	66.00
45	-	40	96.00		185	13	71	8.84	10.21	116 %	55.79
50	-	45	91.00		185	13	58	8.84	10.21	116 %	45.57
55	-	50	86.00		185	14	45	8.84	11.00	124 %	35.36
60	-	55	81.00		185	31	31	8.84	24.36	276 %	24.36
	-										
	-										
	-										
	-										
	-										
	-										
	-										
	-										
Pile BOTTOM @ depth = 60 ft						178 Total Pump Strokes		106.03 Total Theor. Vol. (cf)		132 % Actual/Theor. (%)	139.86 Actual (cf)

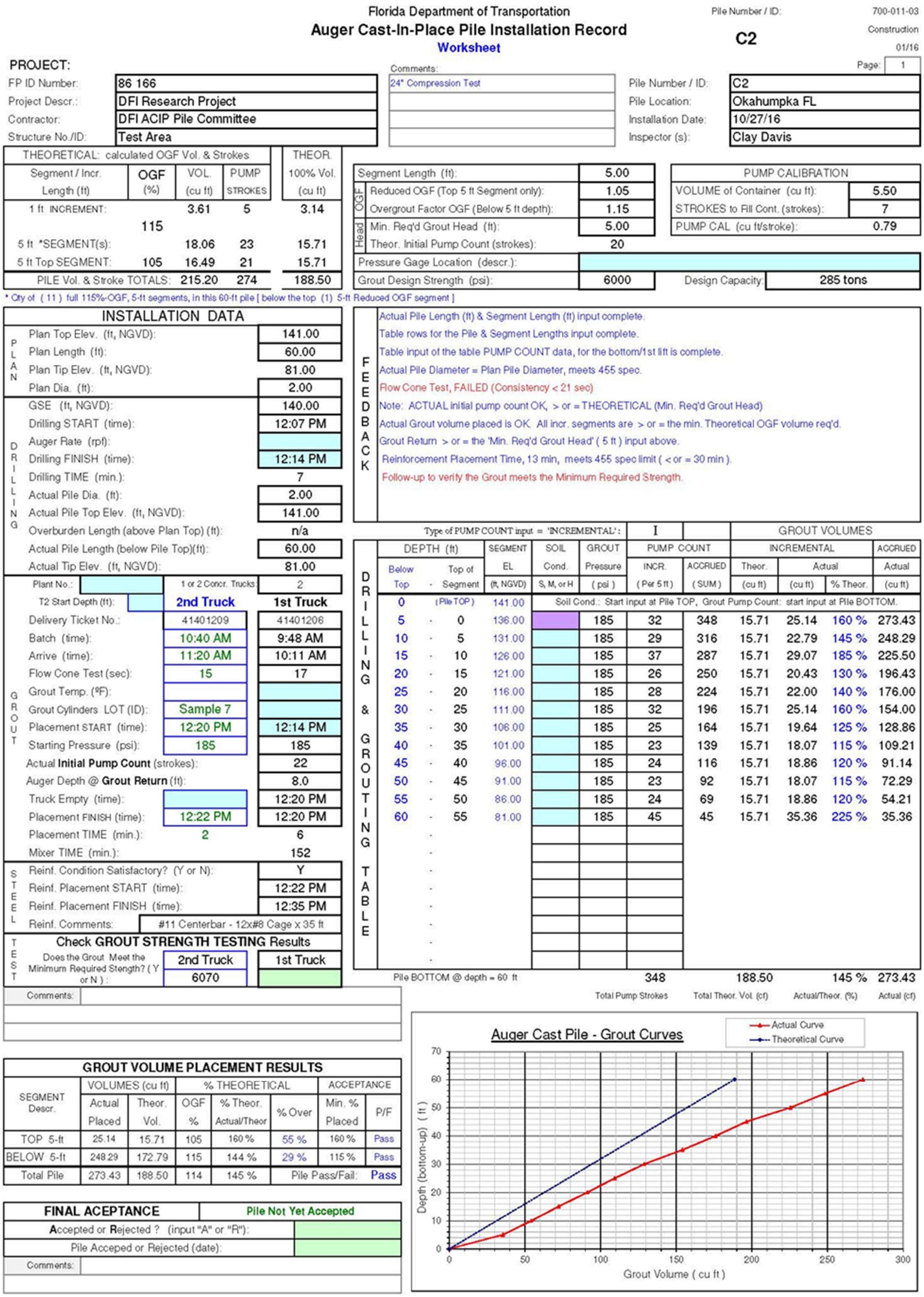
GROUT VOLUME PLACEMENT RESULTS

SEGMENT Descr.	VOLUMES (cu ft) Actual Placed	VOLUMES (cu ft) Theor. Vol.	% THEORETICAL OGF %	% THEORETICAL % Theor. Actual/Theor	% THEORETICAL % Over	ACCEPTANCE Min. % Placed	ACCEPTANCE P/F
TOP 5-ft	10.21	8.84	105	116 %	11 %	116 %	Pass
BELOW 5-ft	129.64	97.19	115	133 %	18 %	116 %	Pass
Total Pile	139.86	106.03	114	132 %		Pile Pass/Fail:	Pass

FINAL ACEPTANCE	Pile Not Yet Accepted
Accepted or **R**ejected ? (input "A" or "R"):	
Pile Acceped or Rejected (date):	

Comments:

Figure F-1. Manual installation record for test pile C-1



Florida Department of Transportation

Auger Cast-In-Place Pile Installation Record

Worksheet

Pile Number / ID: **C2**

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PROJECT:

FP ID Number: 86 166
Project Descr.: DFI Research Project
Contractor: DFI ACIP Pile Committee
Structure No./ID: Test Area

Comments: 24" Compression Test

Pile Number / ID: C2
Pile Location: Okahumpka FL
Installation Date: 10/27/16
Inspector (s): Clay Davis

THEORETICAL: calculated OGF Vol. & Strokes				THEOR.
Segment / Incr. Length (ft)	OGF (%)	VOL. (cu ft)	PUMP STROKES	100% Vol. (cu ft)
1 ft INCREMENT:		3.61	5	3.14
	115			
5 ft *SEGMENT(s):		18.06	23	15.71
5 ft Top SEGMENT:	105	16.49	21	15.71
PILE Vol. & Stroke TOTALS:		215.20	274	188.50

	Segment Length (ft):	5.00
OGF	Reduced OGF (Top 5 ft Segment only):	1.05
OGF	Overgrout Factor OGF (Below 5 ft depth):	1.15
Head	Min. Req'd Grout Head (ft):	5.00
Head	Theor. Initial Pump Count (strokes):	20
	Pressure Gage Location (descr.):	
	Grout Design Strength (psi):	6000

PUMP CALIBRATION	
VOLUME of Container (cu ft):	5.50
STROKES to Fill Cont. (strokes):	7
PUMP CAL (cu ft/stroke):	0.79

Design Capacity: 285 tons

* Qty of (11) full 115%-OGF, 5-ft segments, in this 60-ft pile [below the top (1) 5-ft Reduced OGF segment]

INSTALLATION DATA

PLAN	Plan Top Elev. (ft, NGVD):		141.00
PLAN	Plan Length (ft):		60.00
PLAN	Plan Tip Elev. (ft, NGVD):		81.00
PLAN	Plan Dia. (ft):		2.00
DRILLING	GSE (ft, NGVD):		140.00
DRILLING	Drilling START (time):		12:07 PM
DRILLING	Auger Rate (rpf):		
DRILLING	Drilling FINISH (time):		12:14 PM
DRILLING	Drilling TIME (min.):		7
DRILLING	Actual Pile Dia. (ft):		2.00
DRILLING	Actual Pile Top Elev. (ft, NGVD):		141.00
DRILLING	Overburden Length (above Plan Top) (ft):		n/a
DRILLING	Actual Pile Length (below Pile Top)(ft):		60.00
DRILLING	Actual Tip Elev. (ft, NGVD):		81.00
	Plant No.:	1 or 2 Concr. Trucks:	2
	T2 Start Depth (ft):	**2nd Truck**	**1st Truck**
GROUT	Delivery Ticket No.:	41401209	41401206
GROUT	Batch (time):	10:40 AM	9:48 AM
GROUT	Arrive (time):	11:20 AM	10:11 AM
GROUT	Flow Cone Test (sec):	15	17
GROUT	Grout Temp. (ºF):		
GROUT	Grout Cylinders LOT (ID):	Sample 7	
GROUT	Placement START (time):	12:20 PM	12:14 PM
GROUT	Starting Pressure (psi):	185	185
GROUT	Actual **Initial Pump Count** (strokes):		22
GROUT	Auger Depth @ **Grout Return** (ft):		8.0
GROUT	Truck Empty (time):		12:20 PM
GROUT	Placement FINISH (time):	12:22 PM	12:20 PM
GROUT	Placement TIME (min.):	2	6
GROUT	Mixer TIME (min.):		152
STEEL	Reinf. Condition Satisfactory? (Y or N):		Y
STEEL	Reinf. Placement START (time):		12:22 PM
STEEL	Reinf. Placement FINISH (time):		12:35 PM
STEEL	Reinf. Comments:	#11 Centerbar - 12x#8 Cage x 35 ft	

TEST	**Check GROUT STRENGTH TESTING Results**		
	Does the Grout Meet the Minimum Required Stength? (Y or N):	**2nd Truck**	**1st Truck**
		6070	

Comments:

FEEDBACK

Actual Pile Length (ft) & Segment Length (ft) input complete.
Table rows for the Pile & Segment Lengths input complete.
Table input of the table PUMP COUNT data, for the bottom/1st lift is complete.
Actual Pile Diameter = Plan Pile Diameter, meets 455 spec.
Flow Cone Test, FAILED (Consistency < 21 sec)
Note: ACTUAL initial pump count OK, > or = THEORETICAL (Min. Req'd Grout Head)
Actual Grout volume placed is OK. All incr. segments are > or = the min. Theoretical OGF volume req'd.
Grout Return > or = the 'Min. Req'd Grout Head' (5 ft) input above.
Reinforcement Placement Time, 13 min, meets 455 spec limit (< or = 30 min).
Follow-up to verify the Grout meets the Minimum Required Strength.

DRILLING & GROUTING TABLE

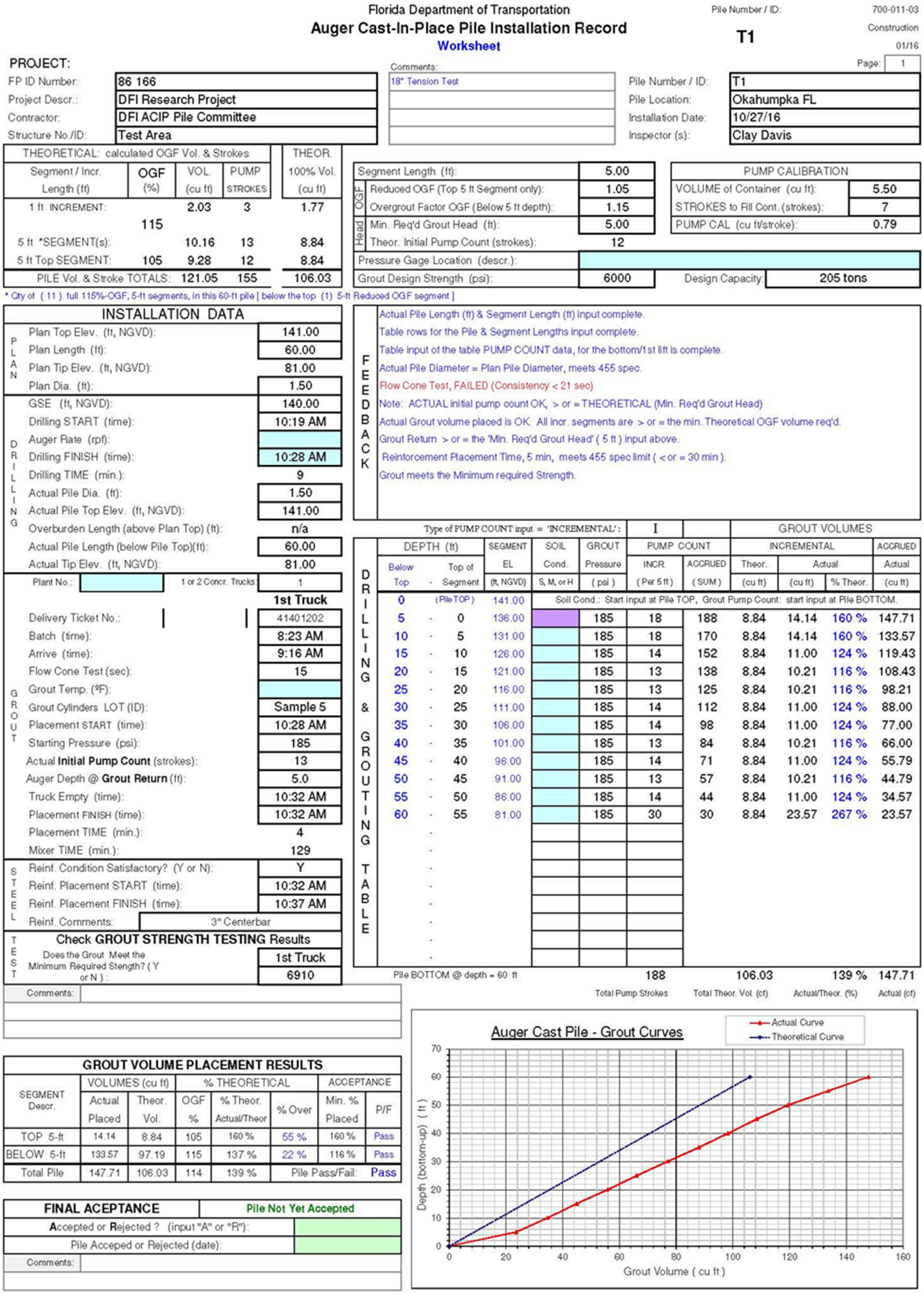
Type of PUMP COUNT input = 'INCREMENTAL': I

DEPTH (ft)			SEGMENT	SOIL	GROUT	PUMP COUNT		GROUT VOLUMES			
								INCREMENTAL			ACCRUED
Below Top	-	Top of Segment	EL (ft, NGVD)	Cond. S, M, or H	Pressure (psi)	INCR. (Per 5 ft)	ACCRUED (SUM)	Theor. (cu ft)	Actual (cu ft)	% Theor.	Actual (cu ft)
0		(Pile TOP)	141.00	Soil Cond.: Start input at Pile TOP, Grout Pump Count: start input at Pile BOTTOM.							
5	-	0	136.00		185	32	348	15.71	25.14	160 %	273.43
10	-	5	131.00		185	29	316	15.71	22.79	145 %	248.29
15	-	10	126.00		185	37	287	15.71	29.07	185 %	225.50
20	-	15	121.00		185	26	250	15.71	20.43	130 %	196.43
25	-	20	116.00		185	28	224	15.71	22.00	140 %	176.00
30	-	25	111.00		185	32	196	15.71	25.14	160 %	154.00
35	-	30	106.00		185	25	164	15.71	19.64	125 %	128.86
40	-	35	101.00		185	23	139	15.71	18.07	115 %	109.21
45	-	40	96.00		185	24	116	15.71	18.86	120 %	91.14
50	-	45	91.00		185	23	92	15.71	18.07	115 %	72.29
55	-	50	86.00		185	24	69	15.71	18.86	120 %	54.21
60	-	55	81.00		185	45	45	15.71	35.36	225 %	35.36
	-										
	-										
	-										
	-										
	-										
	-										
	-										
	-										
Pile BOTTOM @ depth = 60 ft							348	188.50		145 %	273.43
							Total Pump Strokes	Total Theor. Vol. (cf)		Actual/Theor. (%)	Actual (cf)

GROUT VOLUME PLACEMENT RESULTS							
SEGMENT Descr.	VOLUMES (cu ft)		% THEORETICAL			ACCEPTANCE	
	Actual Placed	Theor. Vol.	OGF %	% Theor. Actual/Theor	% Over	Min. % Placed	P/F
TOP 5-ft	25.14	15.71	105	160 %	55 %	160 %	Pass
BELOW 5-ft	248.29	172.79	115	144 %	29 %	115 %	Pass
Total Pile	273.43	188.50	114	145 %		Pile Pass/Fail:	Pass

FINAL ACEPTANCE	Pile Not Yet Accepted
Accepted or **R**ejected ? (input "A" or "R"):	
Pile Acceped or Rejected (date):	
Comments:	

Figure F-2. Manual installation record for test pile C-2



Florida Department of Transportation

Auger Cast-In-Place Pile Installation Record

Worksheet

Pile Number / ID: **T1**

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PROJECT:

FP ID Number:	86 166	Comments: 18" Tension Test	Pile Number / ID:	T1
Project Descr.:	DFI Research Project		Pile Location:	Okahumpka FL
Contractor:	DFI ACIP Pile Committee		Installation Date:	10/27/16
Structure No./ID:	Test Area		Inspector (s):	Clay Davis

THEORETICAL: calculated OGF Vol. & Strokes				THEOR.
Segment / Incr. Length (ft)	OGF (%)	VOL. (cu ft)	PUMP STROKES	100% Vol. (cu ft)
1 ft INCREMENT:		2.03	3	1.77
	115			
5 ft *SEGMENT(s):		10.16	13	8.84
5 ft Top SEGMENT:	105	9.28	12	8.84
PILE Vol. & Stroke TOTALS:		121.05	155	106.03

	Segment Length (ft):	5.00
OGF	Reduced OGF (Top 5 ft Segment only):	1.05
OGF	Overgrout Factor OGF (Below 5 ft depth):	1.15
Head	Min. Req'd Grout Head (ft):	5.00
Head	Theor. Initial Pump Count (strokes):	12
	Pressure Gage Location (descr.):	
	Grout Design Strength (psi):	6000

Design Capacity: 205 tons

PUMP CALIBRATION	
VOLUME of Container (cu ft):	5.50
STROKES to Fill Cont. (strokes):	7
PUMP CAL (cu ft/stroke):	0.79

* Qty of (11) full 115%-OGF, 5-ft segments, in this 60-ft pile [below the top (1) 5-ft Reduced OGF segment]

INSTALLATION DATA

PLAN	Plan Top Elev. (ft, NGVD):	141.00
	Plan Length (ft):	60.00
	Plan Tip Elev. (ft, NGVD):	81.00
	Plan Dia. (ft):	1.50
DRILLING	GSE (ft, NGVD):	140.00
	Drilling START (time):	10:19 AM
	Auger Rate (rpf):	
	Drilling FINISH (time):	10:28 AM
	Drilling TIME (min.):	9
	Actual Pile Dia. (ft):	1.50
	Actual Pile Top Elev. (ft, NGVD):	141.00
	Overburden Length (above Plan Top) (ft):	n/a
	Actual Pile Length (below Pile Top)(ft):	60.00
	Actual Tip Elev. (ft, NGVD):	81.00
	Plant No.: 1 or 2 Concr. Trucks:	1
		1st Truck
GROUT	Delivery Ticket No.:	41401202
	Batch (time):	8:23 AM
	Arrive (time):	9:16 AM
	Flow Cone Test (sec):	15
	Grout Temp. (ºF):	
	Grout Cylinders LOT (ID):	Sample 5
	Placement START (time):	10:28 AM
	Starting Pressure (psi):	185
	Actual **Initial Pump Count** (strokes):	13
	Auger Depth @ **Grout Return** (ft):	5.0
	Truck Empty (time):	10:32 AM
	Placement FINISH (time):	10:32 AM
	Placement TIME (min.):	4
	Mixer TIME (min.):	129
STEEL	Reinf. Condition Satisfactory? (Y or N):	Y
	Reinf. Placement START (time):	10:32 AM
	Reinf. Placement FINISH (time):	10:37 AM
	Reinf. Comments:	3" Centerbar
TEST	Check **GROUT STRENGTH TESTING** Results	
	Does the Grout Meet the Minimum Required Stength? (Y or N) :	1st Truck 6910

Comments:

FEEDBACK

Actual Pile Length (ft) & Segment Length (ft) input complete.
Table rows for the Pile & Segment Lengths input complete.
Table input of the table PUMP COUNT data, for the bottom/1st lift is complete.
Actual Pile Diameter = Plan Pile Diameter, meets 455 spec.
Flow Cone Test, FAILED (Consistency < 21 sec)
Note: ACTUAL initial pump count OK, > or = THEORETICAL (Min. Req'd Grout Head)
Actual Grout volume placed is OK. All incr. segments are > or = the min. Theoretical OGF volume req'd.
Grout Return > or = the 'Min. Req'd Grout Head' (5 ft) input above.
Reinforcement Placement Time, 5 min, meets 455 spec limit (< or = 30 min).
Grout meets the Minimum required Strength.

DRILLING & GROUTING TABLE

Type of PUMP COUNT input = 'INCREMENTAL': I

DEPTH (ft)			SEGMENT	SOIL	GROUT	PUMP COUNT		GROUT VOLUMES			
								INCREMENTAL			ACCRUED
Below Top	-	Top of Segment	EL (ft, NGVD)	Cond. S, M, or H	Pressure (psi)	INCR. (Per 5 ft)	ACCRUED (SUM)	Theor. (cu ft)	Actual (cu ft)	% Theor.	Actual (cu ft)
0		(Pile TOP)	141.00	Soil Cond.: Start input at Pile TOP, Grout Pump Count: start input at Pile BOTTOM.							
5	-	0	136.00		185	18	188	8.84	14.14	160 %	147.71
10	-	5	131.00		185	18	170	8.84	14.14	160 %	133.57
15	-	10	126.00		185	14	152	8.84	11.00	124 %	119.43
20	-	15	121.00		185	13	138	8.84	10.21	116 %	108.43
25	-	20	116.00		185	13	125	8.84	10.21	116 %	98.21
30	-	25	111.00		185	14	112	8.84	11.00	124 %	88.00
35	-	30	106.00		185	14	98	8.84	11.00	124 %	77.00
40	-	35	101.00		185	13	84	8.84	10.21	116 %	66.00
45	-	40	96.00		185	14	71	8.84	11.00	124 %	55.79
50	-	45	91.00		185	13	57	8.84	10.21	116 %	44.79
55	-	50	86.00		185	14	44	8.84	11.00	124 %	34.57
60	-	55	81.00		185	30	30	8.84	23.57	267 %	23.57
Pile BOTTOM @ depth = 60 ft							188 Total Pump Strokes	106.03 Total Theor. Vol. (cf)		139 % Actual/Theor. (%)	147.71 Actual (cf)

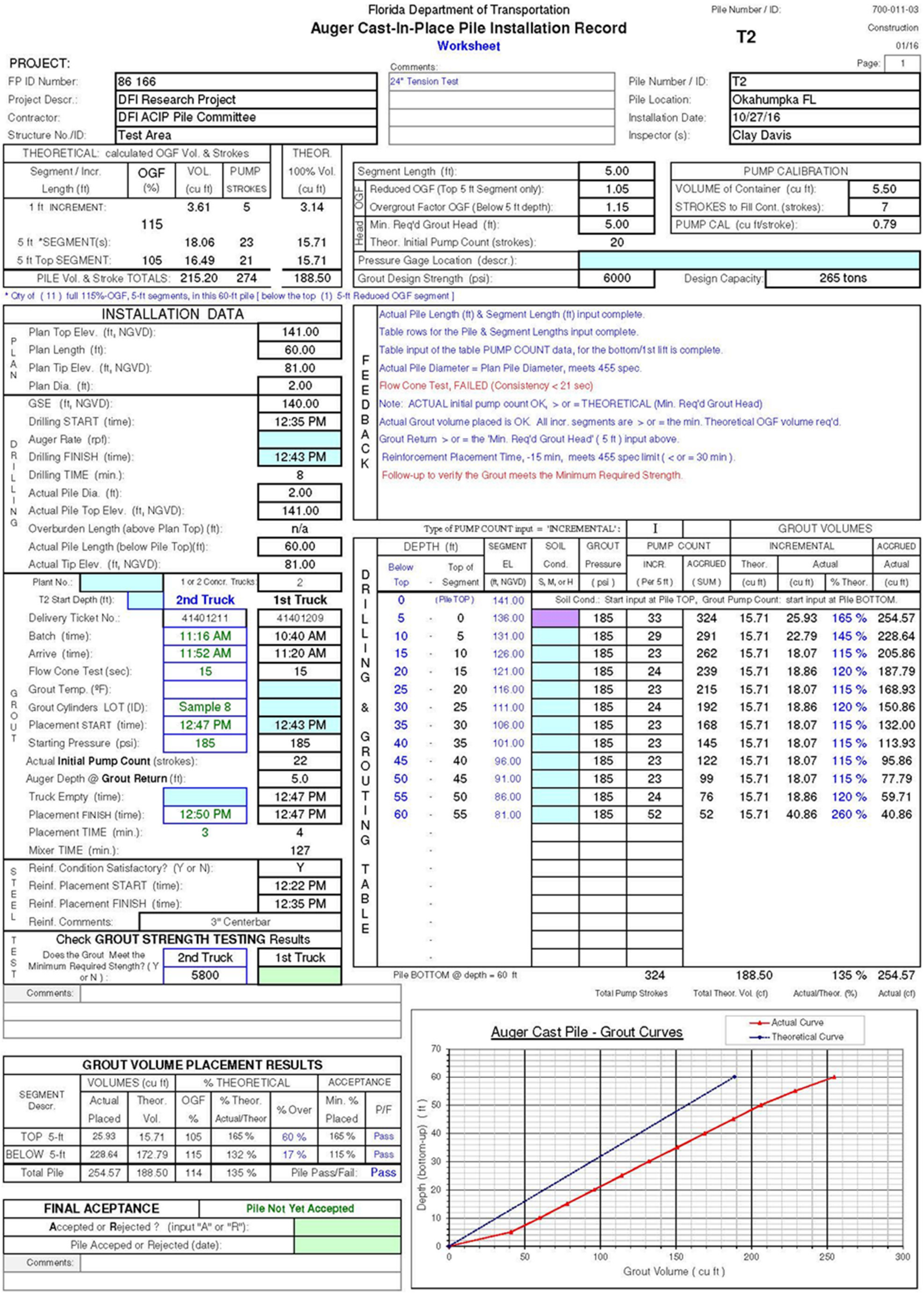
GROUT VOLUME PLACEMENT RESULTS

SEGMENT Descr.	VOLUMES (cu ft)		% THEORETICAL			ACCEPTANCE	
	Actual Placed	Theor. Vol.	OGF %	% Theor. Actual/Theor	% Over	Min. % Placed	P/F
TOP 5-ft	14.14	8.84	105	160 %	55 %	160 %	Pass
BELOW 5-ft	133.57	97.19	115	137 %	22 %	116 %	Pass
Total Pile	147.71	106.03	114	139 %	Pile Pass/Fail:		Pass

FINAL ACEPTANCE	Pile Not Yet Accepted
Accepted or **R**ejected ? (input "A" or "R"):	
Pile Acceped or Rejected (date):	
Comments:	

Auger Cast Pile - Grout Curves

Figure F-3. Manual installation record for test pile T-1



Florida Department of Transportation
Auger Cast-In-Place Pile Installation Record
Worksheet

Pile Number / ID: **T2**

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PROJECT:

FP ID Number:	86 166
Project Descr.:	DFI Research Project
Contractor:	DFI ACIP Pile Committee
Structure No./ID:	Test Area

Comments: 24" Tension Test

Pile Number / ID:	T2
Pile Location:	Okahumpka FL
Installation Date:	10/27/16
Inspector (s):	Clay Davis

THEORETICAL: calculated OGF Vol. & Strokes				THEOR.
Segment / Incr. Length (ft)	OGF (%)	VOL. (cu ft)	PUMP STROKES	100% Vol. (cu ft)
1 ft INCREMENT:		3.61	5	3.14
	115			
5 ft *SEGMENT(s):		18.06	23	15.71
5 ft Top SEGMENT:	105	16.49	21	15.71
PILE Vol. & Stroke TOTALS:		215.20	274	188.50

* Qty of (11) full 115%-OGF, 5-ft segments, in this 60-ft pile [below the top (1) 5-ft Reduced OGF segment]

	Segment Length (ft):	5.00
OGF	Reduced OGF (Top 5 ft Segment only):	1.05
	Overgrout Factor OGF (Below 5 ft depth):	1.15
Head	Min. Req'd Grout Head (ft):	5.00
	Theor. Initial Pump Count (strokes):	20
	Pressure Gage Location (descr.):	
	Grout Design Strength (psi):	6000

Design Capacity: 265 tons

PUMP CALIBRATION	
VOLUME of Container (cu ft):	5.50
STROKES to Fill Cont. (strokes):	7
PUMP CAL (cu ft/stroke):	0.79

INSTALLATION DATA

		2nd Truck	1st Truck
PLAN	Plan Top Elev. (ft, NGVD):		141.00
	Plan Length (ft):		60.00
	Plan Tip Elev. (ft, NGVD):		81.00
	Plan Dia. (ft):		2.00
DRILLING	GSE (ft, NGVD):		140.00
	Drilling START (time):		12:35 PM
	Auger Rate (rpf):		
	Drilling FINISH (time):		12:43 PM
	Drilling TIME (min.):		8
	Actual Pile Dia. (ft):		2.00
	Actual Pile Top Elev. (ft, NGVD):		141.00
	Overburden Length (above Plan Top) (ft):		n/a
	Actual Pile Length (below Pile Top)(ft):		60.00
	Actual Tip Elev. (ft, NGVD):		81.00
	Plant No.:	1 or 2 Concr. Trucks:	2
	T2 Start Depth (ft):	**2nd Truck**	**1st Truck**
GROUT	Delivery Ticket No.:	41401211	41401209
	Batch (time):	11:16 AM	10:40 AM
	Arrive (time):	11:52 AM	11:20 AM
	Flow Cone Test (sec):	15	15
	Grout Temp. (ºF):		
	Grout Cylinders LOT (ID):	Sample 8	
	Placement START (time):	12:47 PM	12:43 PM
	Starting Pressure (psi):	185	185
	Actual **Initial Pump Count** (strokes):		22
	Auger Depth @ **Grout Return** (ft):		5.0
	Truck Empty (time):		12:47 PM
	Placement FINISH (time):	12:50 PM	12:47 PM
	Placement TIME (min.):	3	4
	Mixer TIME (min.):		127
STEEL	Reinf. Condition Satisfactory? (Y or N):		Y
	Reinf. Placement START (time):		12:22 PM
	Reinf. Placement FINISH (time):		12:35 PM
	Reinf. Comments:	3" Centerbar	
TEST	Check **GROUT STRENGTH TESTING** Results		
	Does the Grout Meet the Minimum Required Stength? (Y or N):	2nd Truck 5800	1st Truck

Comments:

FEEDBACK

Actual Pile Length (ft) & Segment Length (ft) input complete.
Table rows for the Pile & Segment Lengths input complete.
Table input of the table PUMP COUNT data, for the bottom/1st lift is complete.
Actual Pile Diameter = Plan Pile Diameter, meets 455 spec.
Flow Cone Test, FAILED (Consistency < 21 sec)
Note: ACTUAL initial pump count OK, > or = THEORETICAL (Min. Req'd Grout Head)
Actual Grout volume placed is OK. All incr. segments are > or = the min. Theoretical OGF volume req'd.
Grout Return > or = the 'Min. Req'd Grout Head' (5 ft) input above.
Reinforcement Placement Time, -15 min, meets 455 spec limit (< or = 30 min).
Follow-up to verify the Grout meets the Minimum Required Strength.

DRILLING & GROUTING TABLE

Type of PUMP COUNT input = 'INCREMENTAL': I

DEPTH (ft)			SEGMENT	SOIL	GROUT	PUMP COUNT		GROUT VOLUMES			
								INCREMENTAL			ACCRUED
Below Top	-	Top of Segment	EL (ft, NGVD)	Cond. S, M, or H	Pressure (psi)	INCR. (Per 5 ft)	ACCRUED (SUM)	Theor. (cu ft)	Actual (cu ft)	% Theor.	Actual (cu ft)
0		(Pile TOP)	141.00	Soil Cond.: Start input at Pile TOP, Grout Pump Count: start input at Pile BOTTOM.							
5	-	0	136.00		185	33	324	15.71	25.93	165 %	254.57
10	-	5	131.00		185	29	291	15.71	22.79	145 %	228.64
15	-	10	126.00		185	23	262	15.71	18.07	115 %	205.86
20	-	15	121.00		185	24	239	15.71	18.86	120 %	187.79
25	-	20	116.00		185	23	215	15.71	18.07	115 %	168.93
30	-	25	111.00		185	24	192	15.71	18.86	120 %	150.86
35	-	30	106.00		185	23	168	15.71	18.07	115 %	132.00
40	-	35	101.00		185	23	145	15.71	18.07	115 %	113.93
45	-	40	96.00		185	23	122	15.71	18.07	115 %	95.86
50	-	45	91.00		185	23	99	15.71	18.07	115 %	77.79
55	-	50	86.00		185	24	76	15.71	18.86	120 %	59.71
60	-	55	81.00		185	52	52	15.71	40.86	260 %	40.86
Pile BOTTOM @ depth = 60 ft							324 Total Pump Strokes	188.50 Total Theor. Vol. (cf)		135 % Actual/Theor. (%)	254.57 Actual (cf)

GROUT VOLUME PLACEMENT RESULTS

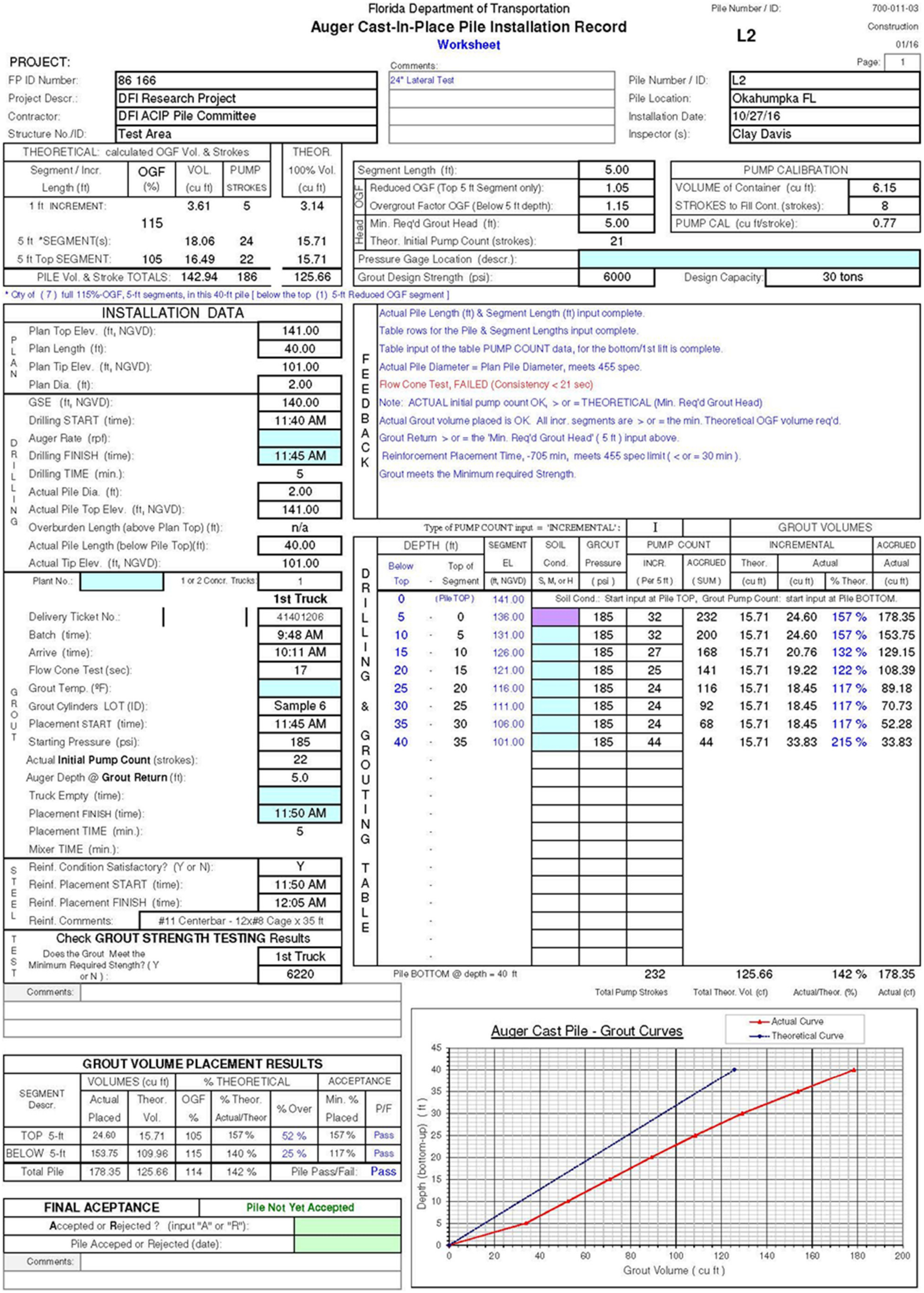
SEGMENT Descr.	VOLUMES (cu ft)		% THEORETICAL			ACCEPTANCE	
	Actual Placed	Theor. Vol.	OGF %	% Theor. Actual/Theor	% Over	Min. % Placed	P/F
TOP 5-ft	25.93	15.71	105	165 %	60 %	165 %	Pass
BELOW 5-ft	228.64	172.79	115	132 %	17 %	115 %	Pass
Total Pile	254.57	188.50	114	135 %	Pile Pass/Fail:		Pass

FINAL ACEPTANCE	Pile Not Yet Accepted
Accepted or **R**ejected ? (input "A" or "R"):	
Pile Acceped or Rejected (date):	

Comments:

Auger Cast Pile - Grout Curves

Figure F-4. Manual installation record for test pile T-2



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Auger Cast-In-Place Pile Installation Record

Worksheet

Pile Number / ID: **L2**

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PROJECT:

FP ID Number: 86 166
Project Descr.: DFI Research Project
Contractor: DFI ACIP Pile Committee
Structure No./ID: Test Area

Comments: 24" Lateral Test

Pile Number / ID: L2
Pile Location: Okahumpka FL
Installation Date: 10/27/16
Inspector (s): Clay Davis

THEORETICAL: calculated OGF Vol. & Strokes				THEOR.
Segment / Incr. Length (ft)	OGF (%)	VOL. (cu ft)	PUMP STROKES	100% Vol. (cu ft)
1 ft INCREMENT:		3.61	5	3.14
	115			
5 ft *SEGMENT(s):		18.06	24	15.71
5 ft Top SEGMENT:	105	16.49	22	15.71
PILE Vol. & Stroke TOTALS:		142.94	186	125.66

* Qty of (7) full 115%-OGF, 5-ft segments, in this 40-ft pile [below the top (1) 5-ft Reduced OGF segment]

Segment Length (ft): 5.00
OGF Reduced OGF (Top 5 ft Segment only): 1.05
OGF Overgrout Factor OGF (Below 5 ft depth): 1.15
Head Min. Req'd Grout Head (ft): 5.00
Head Theor. Initial Pump Count (strokes): 21
Pressure Gage Location (descr.):
Grout Design Strength (psi): 6000
Design Capacity: 30 tons

PUMP CALIBRATION
VOLUME of Container (cu ft): 6.15
STROKES to Fill Cont. (strokes): 8
PUMP CAL (cu ft/stroke): 0.77

INSTALLATION DATA

PLAN
Plan Top Elev. (ft, NGVD): 141.00
Plan Length (ft): 40.00
Plan Tip Elev. (ft, NGVD): 101.00
Plan Dia. (ft): 2.00

DRILLING
GSE (ft, NGVD): 140.00
Drilling START (time): 11:40 AM
Auger Rate (rpf):
Drilling FINISH (time): 11:45 AM
Drilling TIME (min.): 5
Actual Pile Dia. (ft): 2.00
Actual Pile Top Elev. (ft, NGVD): 141.00
Overburden Length (above Plan Top) (ft): n/a
Actual Pile Length (below Pile Top)(ft): 40.00
Actual Tip Elev. (ft, NGVD): 101.00

Plant No.:
1 or 2 Concr. Trucks: 1

GROUT
1st Truck
Delivery Ticket No.: 41401206
Batch (time): 9:48 AM
Arrive (time): 10:11 AM
Flow Cone Test (sec): 17
Grout Temp. (ºF):
Grout Cylinders LOT (ID): Sample 6
Placement START (time): 11:45 AM
Starting Pressure (psi): 185
Actual **Initial Pump Count** (strokes): 22
Auger Depth @ **Grout Return** (ft): 5.0
Truck Empty (time):
Placement FINISH (time): 11:50 AM
Placement TIME (min.): 5
Mixer TIME (min.):

STEEL
Reinf. Condition Satisfactory? (Y or N): Y
Reinf. Placement START (time): 11:50 AM
Reinf. Placement FINISH (time): 12:05 AM
Reinf. Comments: #11 Centerbar - 12x#8 Cage x 35 ft

TEST
Check **GROUT STRENGTH TESTING** Results
Does the Grout Meet the Minimum Required Stength? (Y or N): 1st Truck 6220

Comments:

FEEDBACK
Actual Pile Length (ft) & Segment Length (ft) input complete.
Table rows for the Pile & Segment Lengths input complete.
Table input of the table PUMP COUNT data, for the bottom/1st lift is complete.
Actual Pile Diameter = Plan Pile Diameter, meets 455 spec.
Flow Cone Test, FAILED (Consistency < 21 sec)
Note: ACTUAL initial pump count OK, > or = THEORETICAL (Min. Req'd Grout Head)
Actual Grout volume placed is OK. All incr. segments are > or = the min. Theoretical OGF volume req'd.
Grout Return > or = the 'Min. Req'd Grout Head' (5 ft) input above.
Reinforcement Placement Time, -705 min, meets 455 spec limit (< or = 30 min).
Grout meets the Minimum required Strength.

DRILLING & GROUTING TABLE

Type of PUMP COUNT input = 'INCREMENTAL': I

DEPTH (ft)			SEGMENT	SOIL	GROUT	PUMP COUNT		GROUT VOLUMES			
								INCREMENTAL			ACCRUED
Below Top	-	Top of Segment	EL (ft, NGVD)	Cond. S, M, or H	Pressure (psi)	INCR. (Per 5 ft)	ACCRUED (SUM)	Theor. (cu ft)	Actual (cu ft)	% Theor.	Actual (cu ft)
0		(Pile TOP)	141.00	Soil Cond.: Start input at Pile TOP, Grout Pump Count: start input at Pile BOTTOM.							
5	-	0	136.00		185	32	232	15.71	24.60	157 %	178.35
10	-	5	131.00		185	32	200	15.71	24.60	157 %	153.75
15	-	10	126.00		185	27	168	15.71	20.76	132 %	129.15
20	-	15	121.00		185	25	141	15.71	19.22	122 %	108.39
25	-	20	116.00		185	24	116	15.71	18.45	117 %	89.18
30	-	25	111.00		185	24	92	15.71	18.45	117 %	70.73
35	-	30	106.00		185	24	68	15.71	18.45	117 %	52.28
40	-	35	101.00		185	44	44	15.71	33.83	215 %	33.83

Pile BOTTOM @ depth = 40 ft

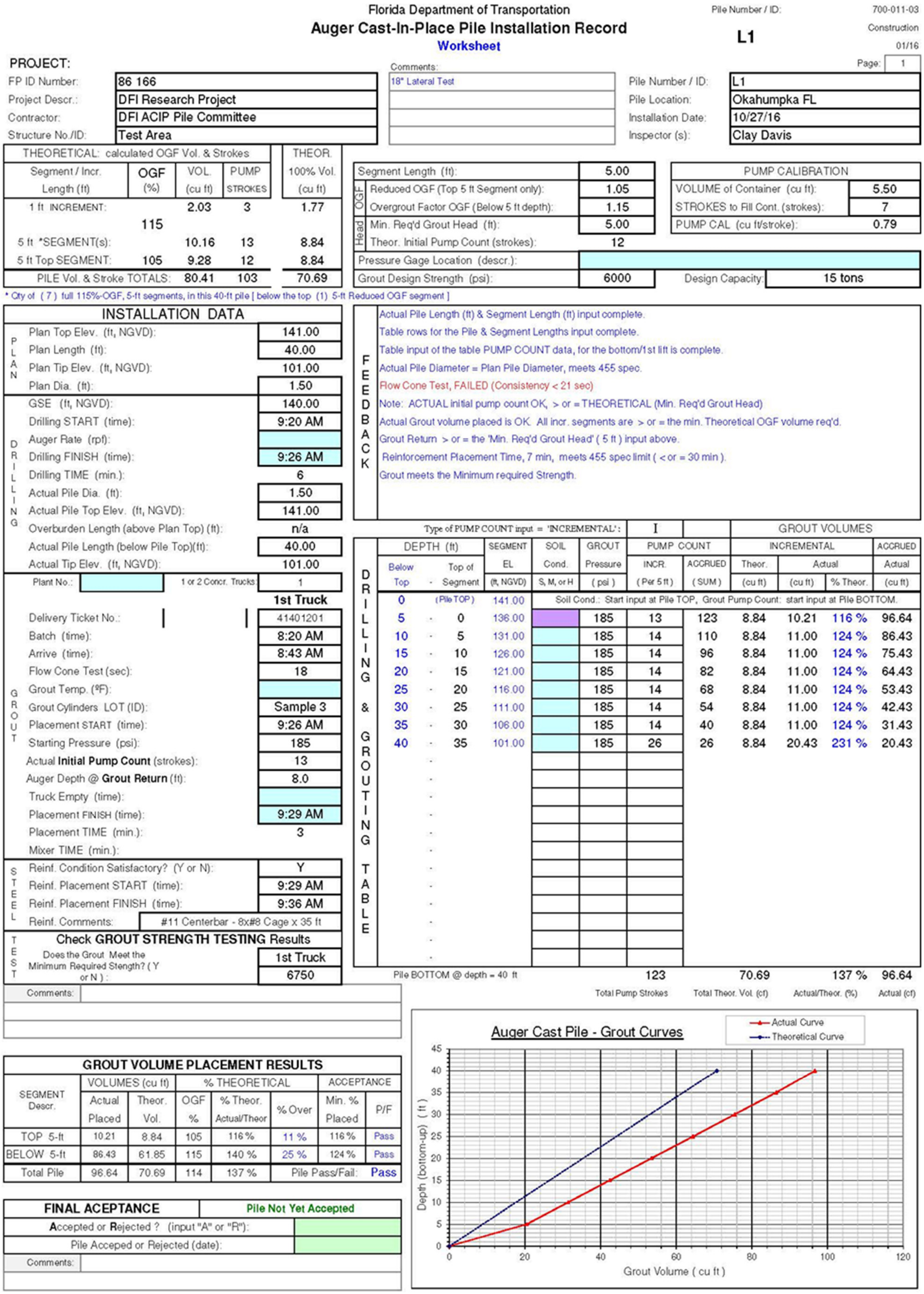
Total Pump Strokes	Total Theor. Vol. (cf)	Actual/Theor. (%)	Actual (cf)
232	125.66	142 %	178.35

GROUT VOLUME PLACEMENT RESULTS

SEGMENT Descr.	VOLUMES (cu ft)		% THEORETICAL			ACCEPTANCE	
	Actual Placed	Theor. Vol.	OGF %	% Theor. Actual/Theor	% Over	Min. % Placed	P/F
TOP 5-ft	24.60	15.71	105	157 %	52 %	157 %	Pass
BELOW 5-ft	153.75	109.96	115	140 %	25 %	117 %	Pass
Total Pile	178.35	125.66	114	142 %	Pile Pass/Fail:		Pass

FINAL ACEPTANCE Pile Not Yet Accepted
Accepted or **R**ejected ? (input "A" or "R"):
Pile Acceped or Rejected (date):
Comments:

Figure F-5. Manual installation record for test pile L-1



Florida Department of Transportation

Auger Cast-In-Place Pile Installation Record

Worksheet

Pile Number / ID: **L1**

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PROJECT:

FP ID Number:	86 166	Comments:	18" Lateral Test	Pile Number / ID:	L1
Project Descr.:	DFI Research Project			Pile Location:	Okahumpka FL
Contractor:	DFI ACIP Pile Committee			Installation Date:	10/27/16
Structure No./ID:	Test Area			Inspector (s):	Clay Davis

THEORETICAL: calculated OGF Vol. & Strokes				THEOR.
Segment / Incr. Length (ft)	OGF (%)	VOL. (cu ft)	PUMP STROKES	100% Vol. (cu ft)
1 ft INCREMENT:		2.03	3	1.77
	115			
5 ft *SEGMENT(s):		10.16	13	8.84
5 ft Top SEGMENT:	105	9.28	12	8.84
PILE Vol. & Stroke TOTALS:		80.41	103	70.69

	Segment Length (ft):	5.00
OGF	Reduced OGF (Top 5 ft Segment only):	1.05
OGF	Overgrout Factor OGF (Below 5 ft depth):	1.15
Head	Min. Req'd Grout Head (ft):	5.00
Head	Theor. Initial Pump Count (strokes):	12
	Pressure Gage Location (descr.):	
	Grout Design Strength (psi):	6000

PUMP CALIBRATION	
VOLUME of Container (cu ft):	5.50
STROKES to Fill Cont. (strokes):	7
PUMP CAL (cu ft/stroke):	0.79

Design Capacity: 15 tons

* Qty of (7) full 115%-OGF, 5-ft segments, in this 40-ft pile [below the top (1) 5-ft Reduced OGF segment]

INSTALLATION DATA

PLAN	Plan Top Elev. (ft, NGVD):	141.00
PLAN	Plan Length (ft):	40.00
PLAN	Plan Tip Elev. (ft, NGVD):	101.00
PLAN	Plan Dia. (ft):	1.50
DRILLING	GSE (ft, NGVD):	140.00
DRILLING	Drilling START (time):	9:20 AM
DRILLING	Auger Rate (rpf):	
DRILLING	Drilling FINISH (time):	9:26 AM
DRILLING	Drilling TIME (min.):	6
DRILLING	Actual Pile Dia. (ft):	1.50
DRILLING	Actual Pile Top Elev. (ft, NGVD):	141.00
DRILLING	Overburden Length (above Plan Top) (ft):	n/a
DRILLING	Actual Pile Length (below Pile Top)(ft):	40.00
DRILLING	Actual Tip Elev. (ft, NGVD):	101.00
	Plant No.: 1 or 2 Concr. Trucks:	1
		1st Truck
GROUT	Delivery Ticket No.:	41401201
GROUT	Batch (time):	8:20 AM
GROUT	Arrive (time):	8:43 AM
GROUT	Flow Cone Test (sec):	18
GROUT	Grout Temp. (ºF):	
GROUT	Grout Cylinders LOT (ID):	Sample 3
GROUT	Placement START (time):	9:26 AM
GROUT	Starting Pressure (psi):	185
GROUT	Actual **Initial Pump Count** (strokes):	13
GROUT	Auger Depth @ **Grout Return** (ft):	8.0
GROUT	Truck Empty (time):	
GROUT	Placement FINISH (time):	9:29 AM
GROUT	Placement TIME (min.):	3
GROUT	Mixer TIME (min.):	
STEEL	Reinf. Condition Satisfactory? (Y or N):	Y
STEEL	Reinf. Placement START (time):	9:29 AM
STEEL	Reinf. Placement FINISH (time):	9:36 AM
STEEL	Reinf. Comments:	#11 Centerbar - 8x#8 Cage x 35 ft
TEST	Check **GROUT STRENGTH TESTING** Results	
TEST		1st Truck
TEST	Does the Grout Meet the Minimum Required Stength? (Y or N):	6750

Comments:

FEEDBACK

Actual Pile Length (ft) & Segment Length (ft) input complete.
Table rows for the Pile & Segment Lengths input complete.
Table input of the table PUMP COUNT data, for the bottom/1st lift is complete.
Actual Pile Diameter = Plan Pile Diameter, meets 455 spec.
Flow Cone Test, FAILED (Consistency < 21 sec)
Note: ACTUAL initial pump count OK, > or = THEORETICAL (Min. Req'd Grout Head)
Actual Grout volume placed is OK. All incr. segments are > or = the min. Theoretical OGF volume req'd.
Grout Return > or = the 'Min. Req'd Grout Head' (5 ft) input above.
Reinforcement Placement Time, 7 min, meets 455 spec limit (< or = 30 min).
Grout meets the Minimum required Strength.

DRILLING & GROUTING TABLE

Type of PUMP COUNT input = 'INCREMENTAL': I

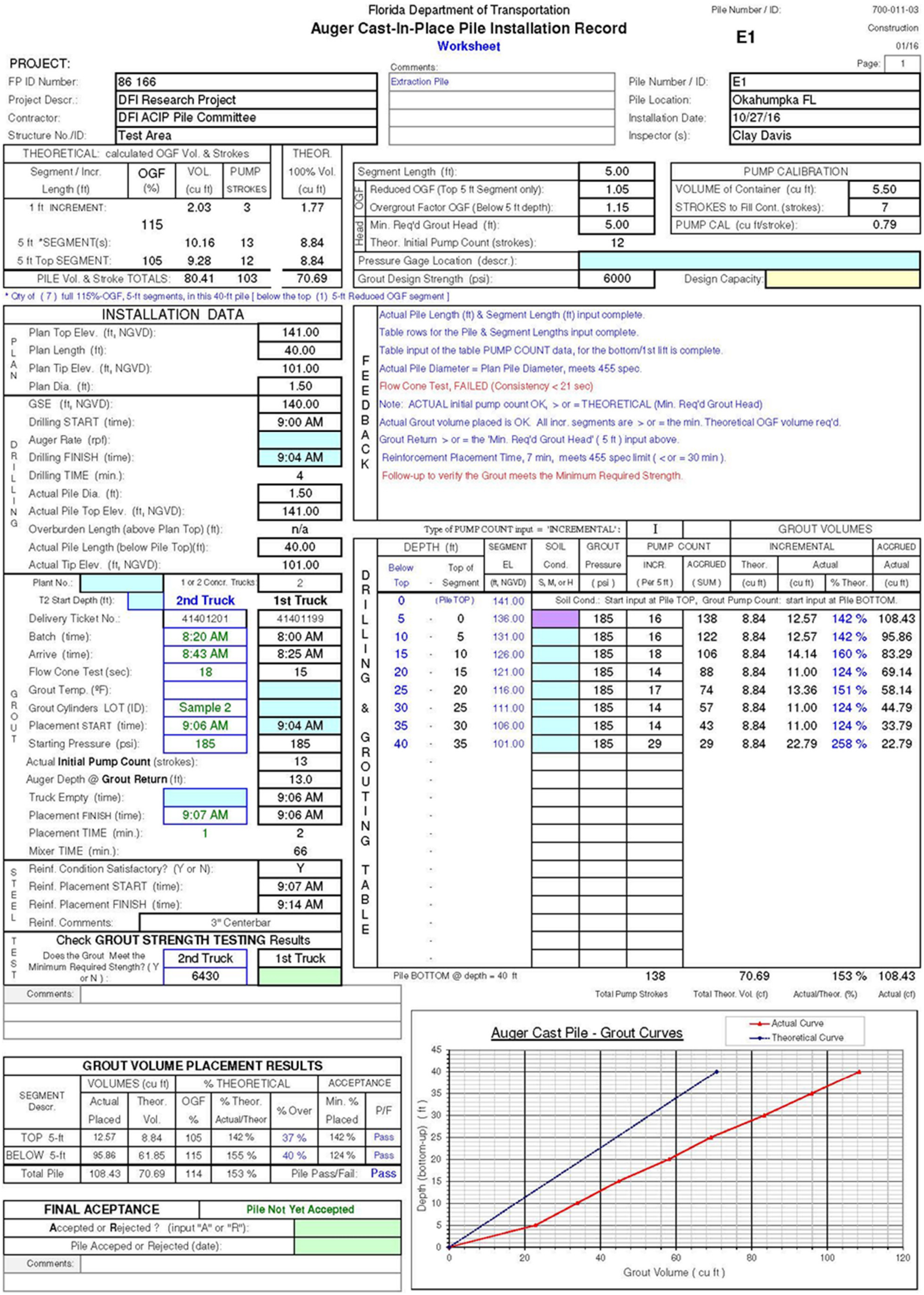
DEPTH (ft)		SEGMENT	SOIL	GROUT	PUMP COUNT		GROUT VOLUMES INCREMENTAL			ACCRUED
Below Top	Top of Segment	EL (ft, NGVD)	Cond. S, M, or H	Pressure (psi)	INCR. (Per 5 ft)	ACCRUED (SUM)	Theor. (cu ft)	Actual (cu ft)	% Theor.	Actual (cu ft)
0	(Pile TOP)	141.00	Soil Cond.: Start input at Pile TOP, Grout Pump Count: start input at Pile BOTTOM.							
5	0	136.00		185	13	123	8.84	10.21	116 %	96.64
10	5	131.00		185	14	110	8.84	11.00	124 %	86.43
15	10	126.00		185	14	96	8.84	11.00	124 %	75.43
20	15	121.00		185	14	82	8.84	11.00	124 %	64.43
25	20	116.00		185	14	68	8.84	11.00	124 %	53.43
30	25	111.00		185	14	54	8.84	11.00	124 %	42.43
35	30	106.00		185	14	40	8.84	11.00	124 %	31.43
40	35	101.00		185	26	26	8.84	20.43	231 %	20.43
Pile BOTTOM @ depth = 40 ft					123		70.69		137 %	96.64
					Total Pump Strokes		Total Theor. Vol. (cf)		Actual/Theor. (%)	Actual (cf)

GROUT VOLUME PLACEMENT RESULTS

SEGMENT Descr.	VOLUMES (cu ft) Actual Placed	Theor. Vol.	OGF %	% THEORETICAL % Theor. Actual/Theor	% Over	ACCEPTANCE Min. % Placed	P/F
TOP 5-ft	10.21	8.84	105	116 %	11 %	116 %	Pass
BELOW 5-ft	86.43	61.85	115	140 %	25 %	124 %	Pass
Total Pile	96.64	70.69	114	137 %		Pile Pass/Fail:	Pass

FINAL ACEPTANCE	**Pile Not Yet Accepted**
Accepted or Rejected ? (input "A" or "R"):	
Pile Acceped or Rejected (date):	
Comments:	

Figure F-6. Manual installation record for test pile L-2



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Auger Cast-In-Place Pile Installation Record

Worksheet

Pile Number / ID: **E1**

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PROJECT:

FP ID Number: 86 166
Project Descr.: DFI Research Project
Contractor: DFI ACIP Pile Committee
Structure No./ID: Test Area

Comments: Extraction Pile

Pile Number / ID: E1
Pile Location: Okahumpka FL
Installation Date: 10/27/16
Inspector (s): Clay Davis

THEORETICAL: calculated OGF Vol. & Strokes				THEOR.
Segment / Incr. Length (ft)	OGF (%)	VOL. (cu ft)	PUMP STROKES	100% Vol. (cu ft)
1 ft INCREMENT:		2.03	3	1.77
	115			
5 ft *SEGMENT(s):		10.16	13	8.84
5 ft Top SEGMENT:	105	9.28	12	8.84
PILE Vol. & Stroke TOTALS:		80.41	103	70.69

* Qty of (7) full 115%-OGF, 5-ft segments, in this 40-ft pile [below the top (1) 5-ft Reduced OGF segment]

Segment Length (ft): 5.00
OGF — Reduced OGF (Top 5 ft Segment only): 1.05
OGF — Overgrout Factor OGF (Below 5 ft depth): 1.15
Head — Min. Req'd Grout Head (ft): 5.00
Head — Theor. Initial Pump Count (strokes): 12
Pressure Gage Location (descr.):
Grout Design Strength (psi): 6000
Design Capacity:

PUMP CALIBRATION	
VOLUME of Container (cu ft):	5.50
STROKES to Fill Cont. (strokes):	7
PUMP CAL (cu ft/stroke):	0.79

INSTALLATION DATA

PLAN	Plan Top Elev. (ft, NGVD):		141.00
	Plan Length (ft):		40.00
	Plan Tip Elev. (ft, NGVD):		101.00
	Plan Dia. (ft):		1.50
DRILLING	GSE (ft, NGVD):		140.00
	Drilling START (time):		9:00 AM
	Auger Rate (rpf):		
	Drilling FINISH (time):		9:04 AM
	Drilling TIME (min.):		4
	Actual Pile Dia. (ft):		1.50
	Actual Pile Top Elev. (ft, NGVD):		141.00
	Overburden Length (above Plan Top) (ft):		n/a
	Actual Pile Length (below Pile Top)(ft):		40.00
	Actual Tip Elev. (ft, NGVD):		101.00
GROUT	Plant No.:	1 or 2 Concr. Trucks:	2
	T2 Start Depth (ft):	**2nd Truck**	**1st Truck**
	Delivery Ticket No.:	41401201	41401199
	Batch (time):	8:20 AM	8:00 AM
	Arrive (time):	8:43 AM	8:25 AM
	Flow Cone Test (sec):	18	15
	Grout Temp. (ºF):		
	Grout Cylinders LOT (ID):	Sample 2	
	Placement START (time):	9:06 AM	9:04 AM
	Starting Pressure (psi):	185	185
	Actual **Initial Pump Count** (strokes):		13
	Auger Depth @ **Grout Return** (ft):		13.0
	Truck Empty (time):		9:06 AM
	Placement FINISH (time):	9:07 AM	9:06 AM
	Placement TIME (min.):	1	2
	Mixer TIME (min.):		66
STEEL	Reinf. Condition Satisfactory? (Y or N):		Y
	Reinf. Placement START (time):		9:07 AM
	Reinf. Placement FINISH (time):		9:14 AM
	Reinf. Comments:	3" Centerbar	
TEST	**Check GROUT STRENGTH TESTING Results**		
	Does the Grout Meet the Minimum Required Stength? (Y or N):	2nd Truck	1st Truck
		6430	

Comments:

FEEDBACK

Actual Pile Length (ft) & Segment Length (ft) input complete.
Table rows for the Pile & Segment Lengths input complete.
Table input of the table PUMP COUNT data, for the bottom/1st lift is complete.
Actual Pile Diameter = Plan Pile Diameter, meets 455 spec.
Flow Cone Test, FAILED (Consistency < 21 sec)
Note: ACTUAL initial pump count OK, > or = THEORETICAL (Min. Req'd Grout Head)
Actual Grout volume placed is OK. All incr. segments are > or = the min. Theoretical OGF volume req'd.
Grout Return > or = the 'Min. Req'd Grout Head' (5 ft) input above.
Reinforcement Placement Time, 7 min, meets 455 spec limit (< or = 30 min).
Follow-up to verify the Grout meets the Minimum Required Strength.

DRILLING & GROUTING TABLE

Type of PUMP COUNT input = 'INCREMENTAL': I

DEPTH (ft) Below Top		DEPTH (ft) Top of Segment	SEGMENT EL (ft, NGVD)	SOIL Cond. S, M, or H	GROUT Pressure (psi)	PUMP COUNT INCR. (Per 5 ft)	PUMP COUNT ACCRUED (SUM)	GROUT VOLUMES INCREMENTAL Theor. (cu ft)	GROUT VOLUMES INCREMENTAL Actual (cu ft)	GROUT VOLUMES INCREMENTAL Actual % Theor.	GROUT VOLUMES ACCRUED Actual (cu ft)
0		(Pile TOP)	141.00	Soil Cond.: Start input at Pile TOP, Grout Pump Count: start input at Pile BOTTOM.							
5	-	0	136.00		185	16	138	8.84	12.57	142 %	108.43
10	-	5	131.00		185	16	122	8.84	12.57	142 %	95.86
15	-	10	126.00		185	18	106	8.84	14.14	160 %	83.29
20	-	15	121.00		185	14	88	8.84	11.00	124 %	69.14
25	-	20	116.00		185	17	74	8.84	13.36	151 %	58.14
30	-	25	111.00		185	14	57	8.84	11.00	124 %	44.79
35	-	30	106.00		185	14	43	8.84	11.00	124 %	33.79
40	-	35	101.00		185	29	29	8.84	22.79	258 %	22.79
	-										
	-										
	-										
	-										
	-										
	-										
	-										
	-										
	-										
	-										
	-										
	-										
Pile BOTTOM @ depth = 40 ft							138	70.69		153 %	108.43
							Total Pump Strokes	Total Theor. Vol. (cf)		Actual/Theor. (%)	Actual (cf)

GROUT VOLUME PLACEMENT RESULTS

SEGMENT Descr.	VOLUMES (cu ft) Actual Placed	VOLUMES (cu ft) Theor. Vol.	% THEORETICAL OGF %	% THEORETICAL % Theor. Actual/Theor	% THEORETICAL % Over	ACCEPTANCE Min. % Placed	ACCEPTANCE P/F
TOP 5-ft	12.57	8.84	105	142 %	37 %	142 %	Pass
BELOW 5-ft	95.86	61.85	115	155 %	40 %	124 %	Pass
Total Pile	108.43	70.69	114	153 %	Pile Pass/Fail:		Pass

FINAL ACEPTANCE — Pile Not Yet Accepted

Accepted or Rejected ? (input "A" or "R"):
Pile Acceped or Rejected (date):
Comments:

Figure F-7. Manual installation record for test pile E-1

APPENDIX G

SELECT THERMAL INTEGRITY PROFILING (TIP) TEST RESULTS – THERMAL PROBES AND THERMAL WIRES

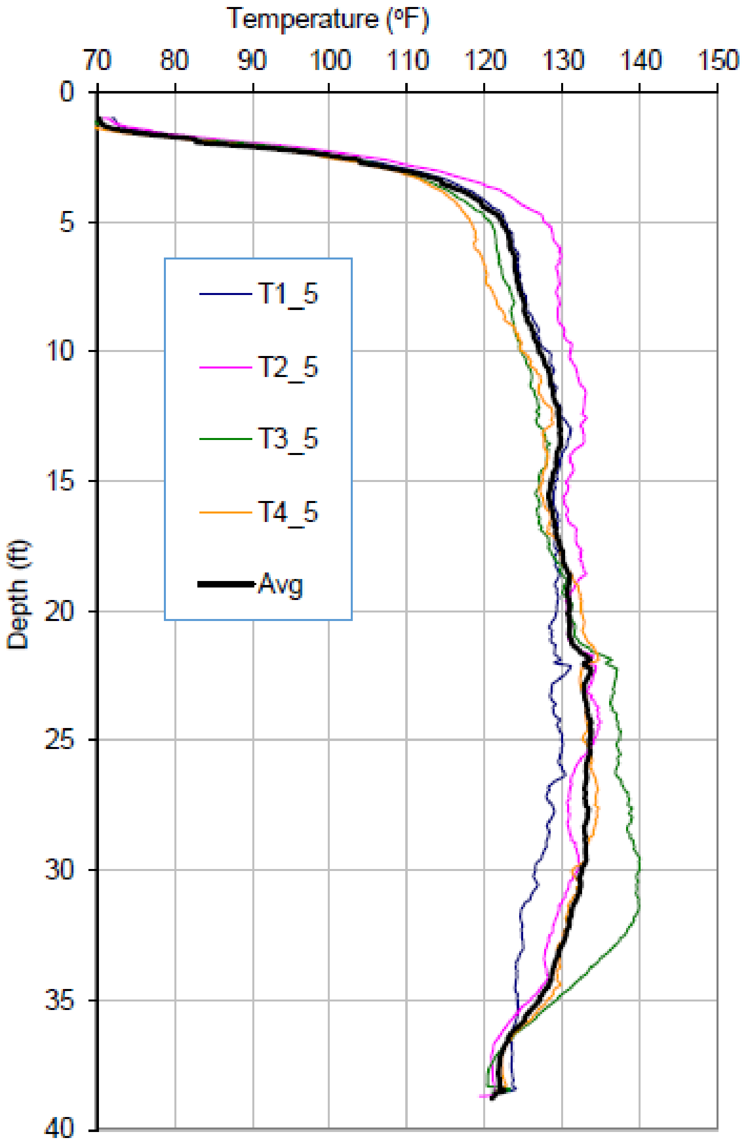
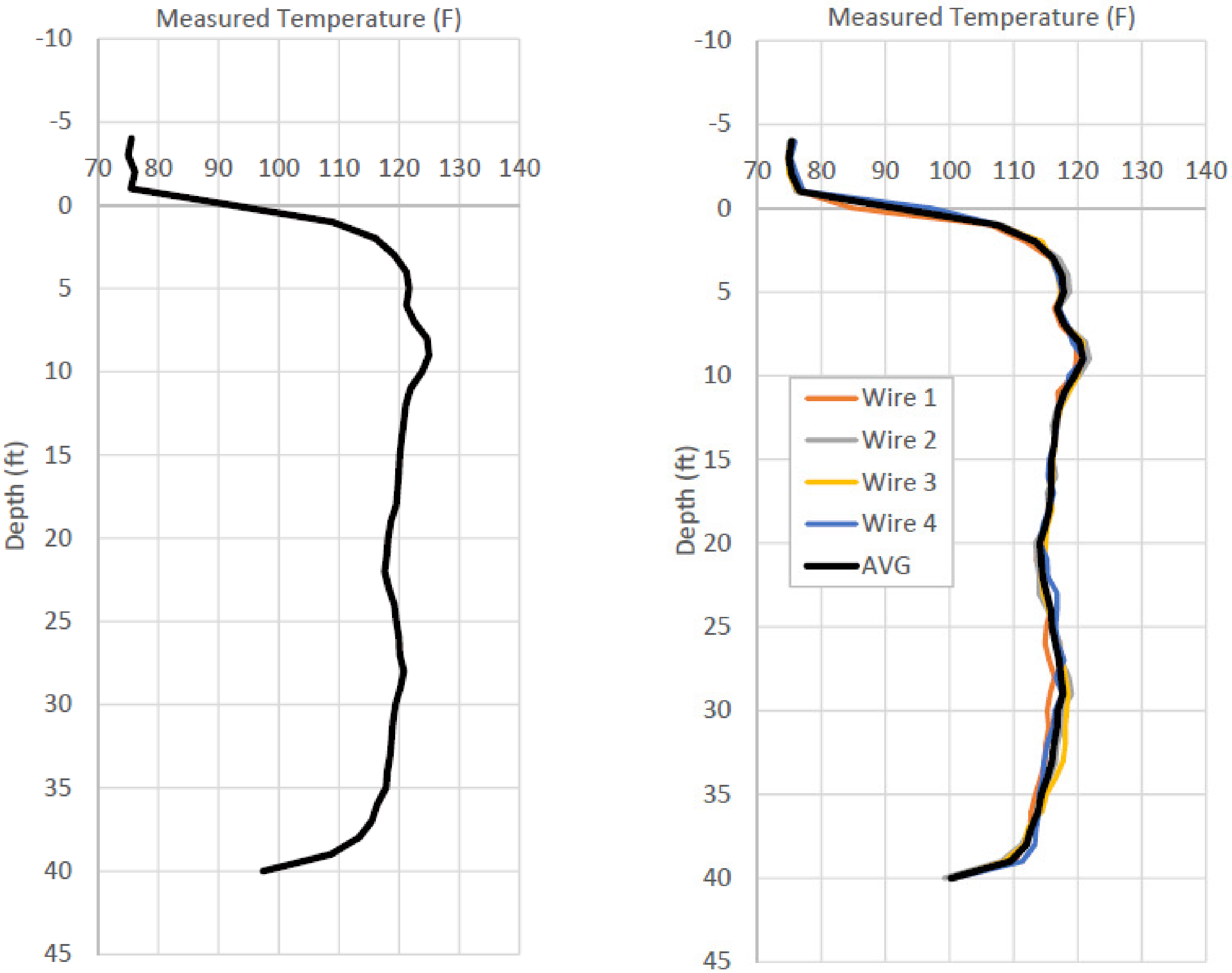


Figure G-1. Temperature profile for pile C2 at peak temperature taken via probe system (Mullins and Johnson, 2017)



(a) (b)

Figure G-2. Thermal profile of pile E-1 (extracted) at (a) center bar reinforcement and (b) reinforcement cage (Mullins and Johnson, 2017)

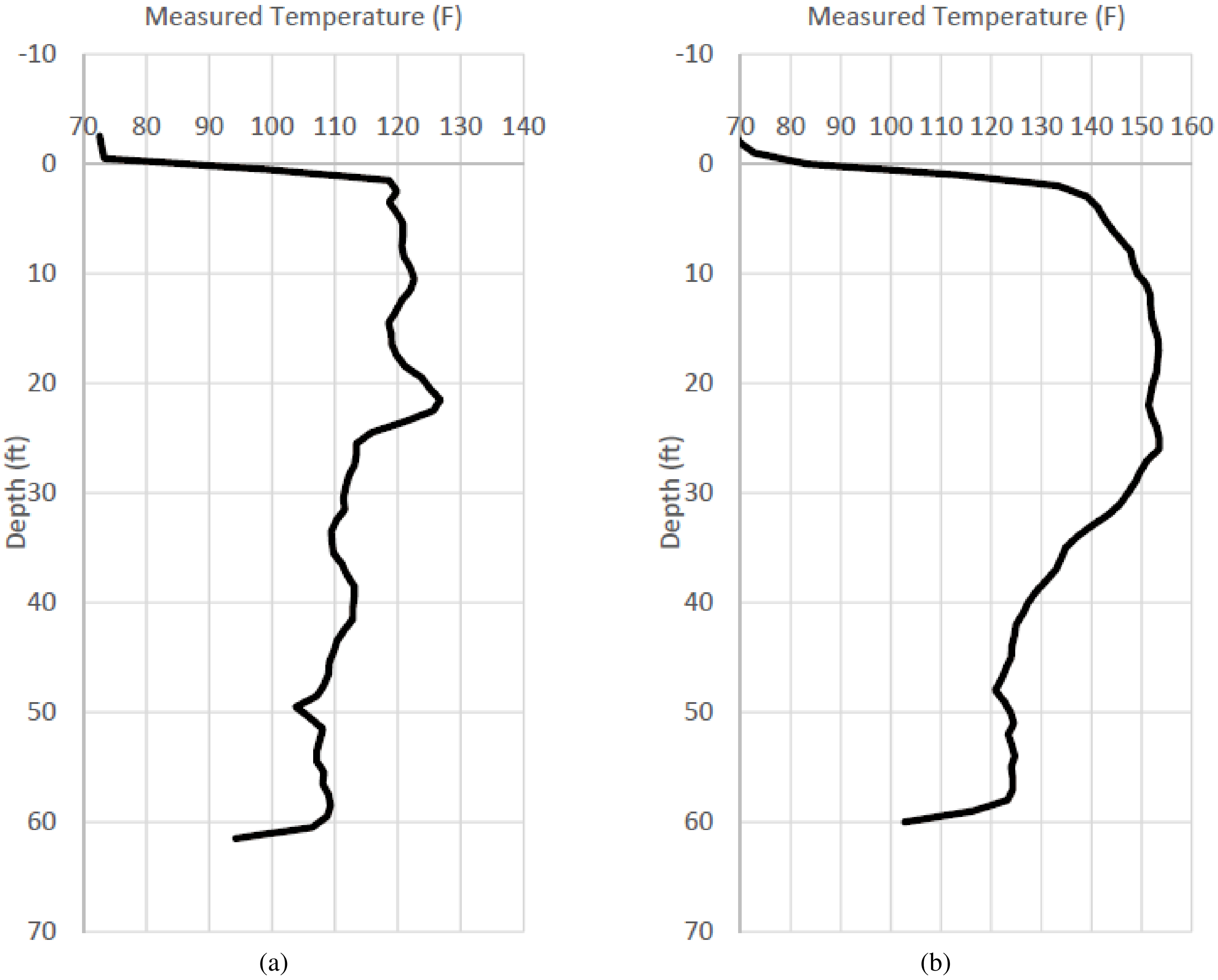
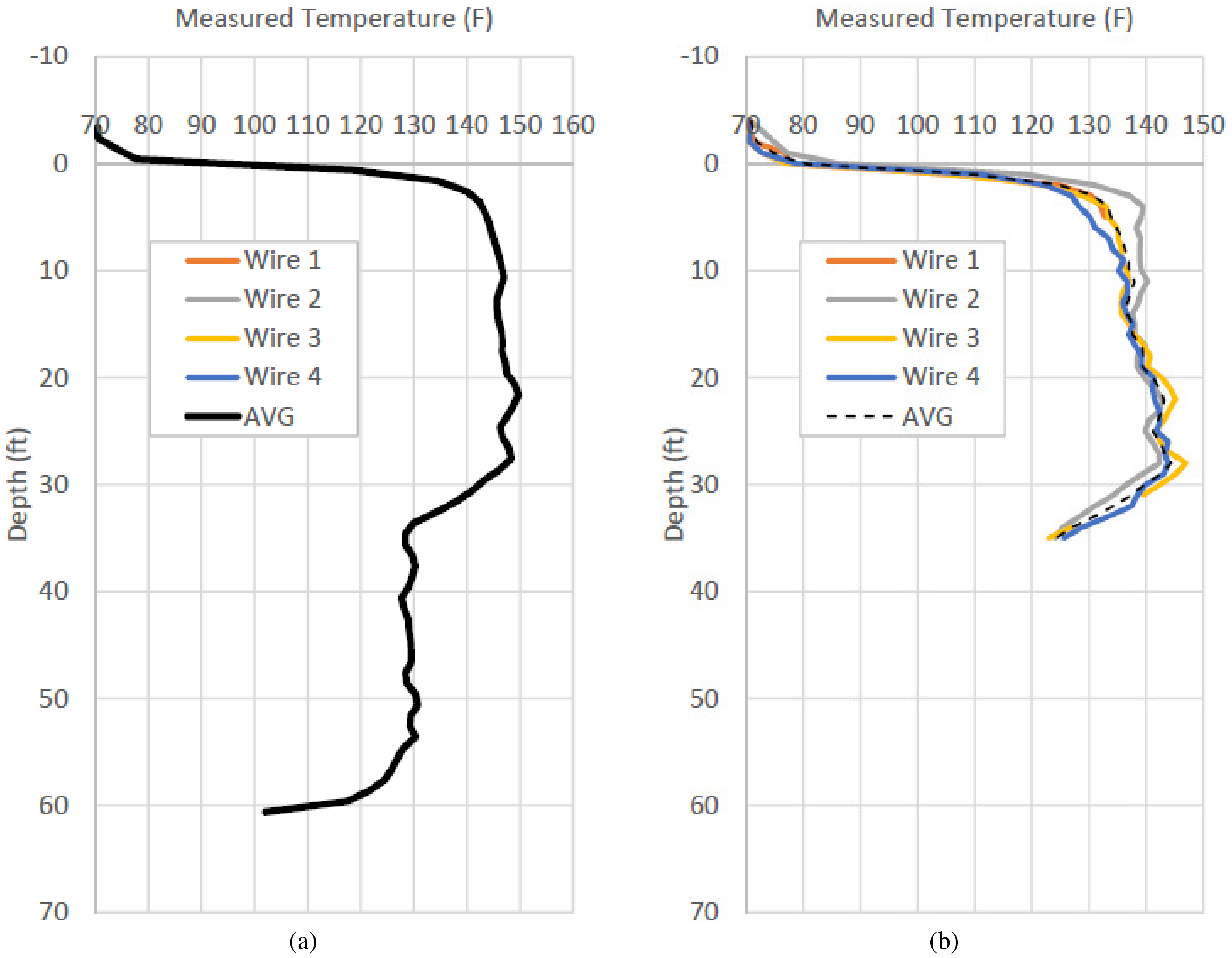
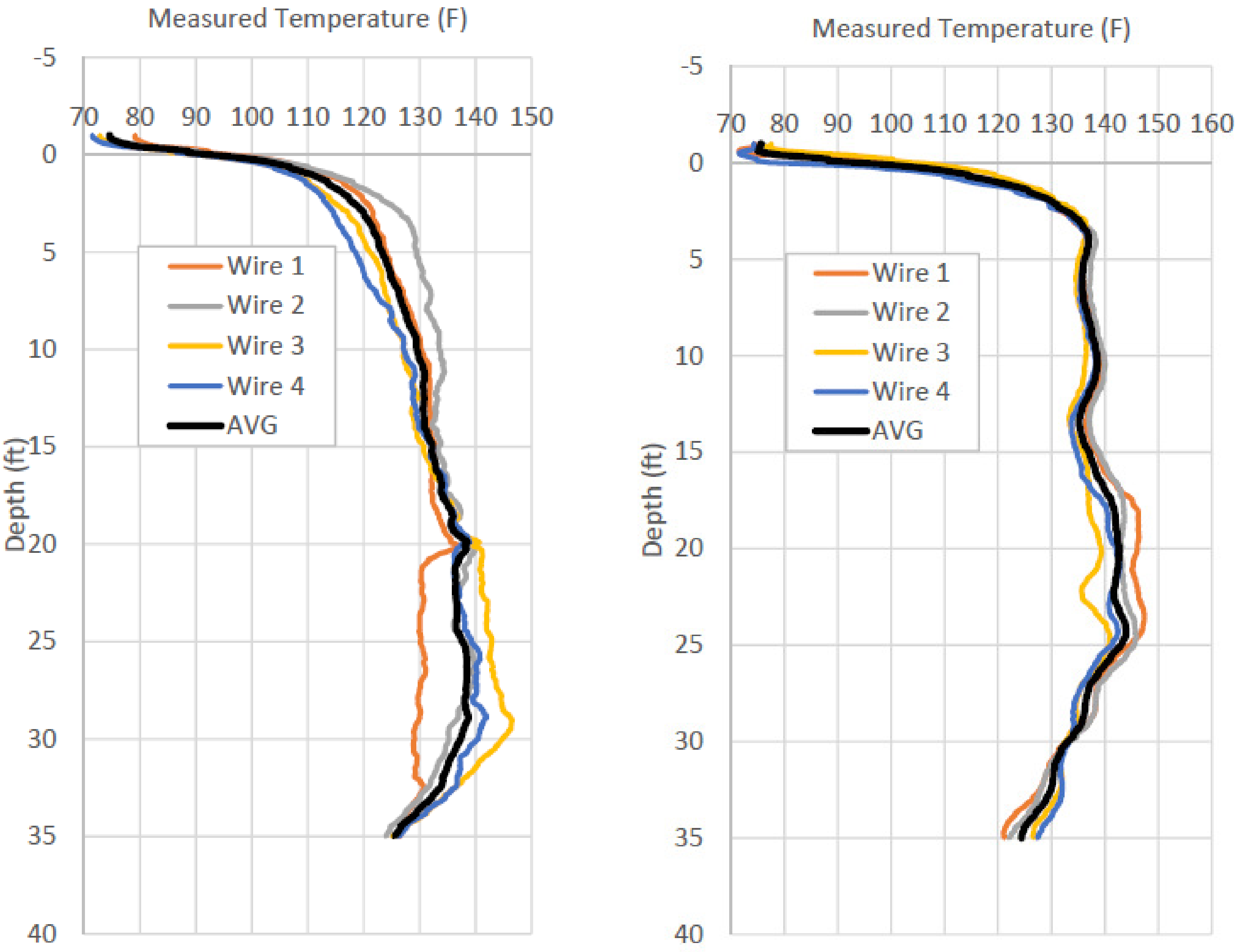


Figure G-3. Thermal profile of (a) pile T-1 and (b) pile T-2 at the center bar reinforcement (Mullins and Johnson, 2017)



(a) (b)

Figure G-4. Thermal profile of pile C-2 at (a) center bar reinforcement and (b) reinforcement cage (Mullins and Johnson, 2017)



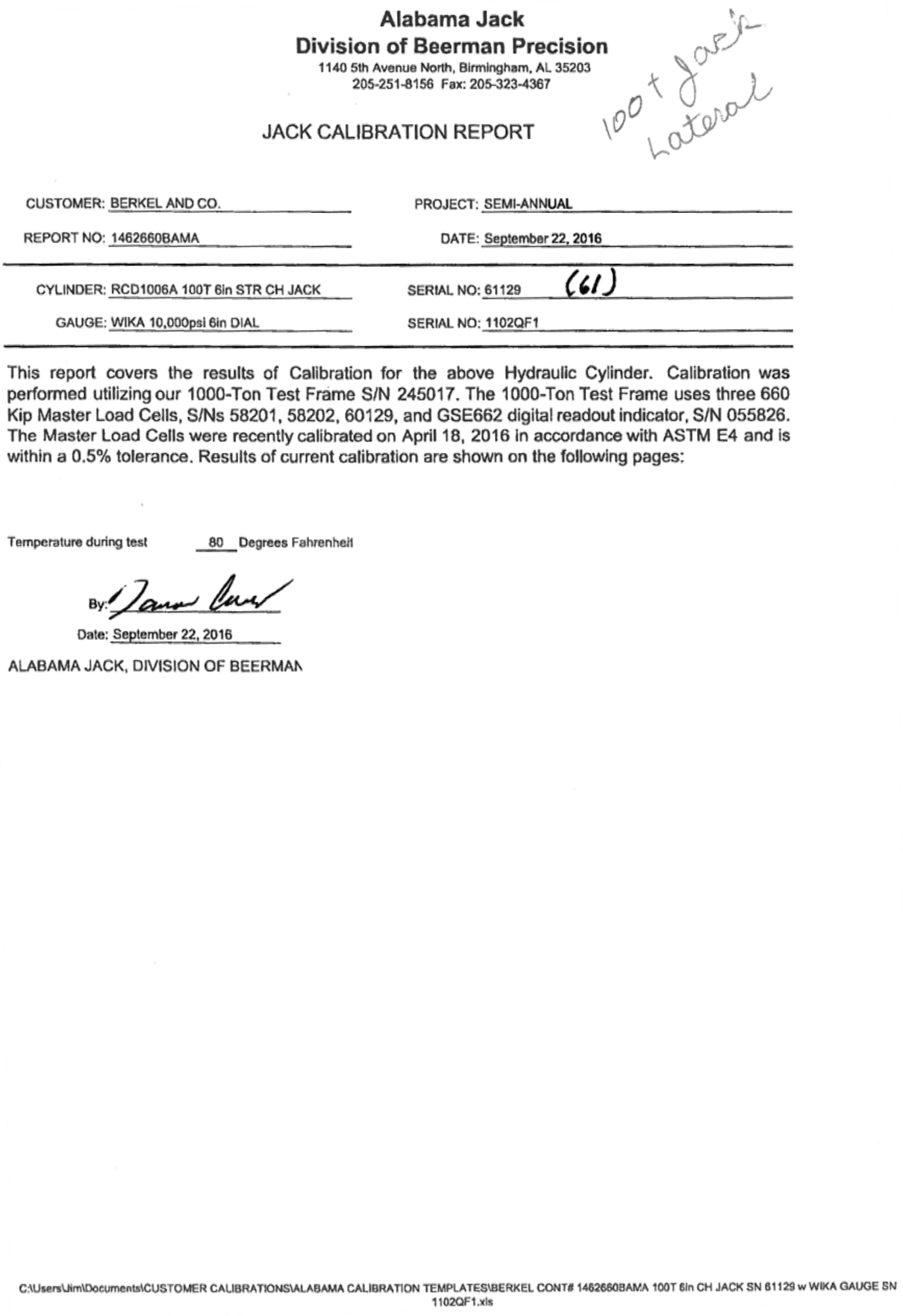
(a)

(b)

Figure G-5. Thermal profile of pile C-2 at (a) center bar reinforcement and (b) reinforcement cage (Mullins and Johnson, 2017)

APPENDIX H

CALIBRATION DATA - HYDRAULIC JACK AND LOAD CELL



Alabama Jack
Division of Beerman Precision
1140 5th Avenue North, Birmingham, AL 35203
205-251-8156 Fax: 205-323-4367

100 t Jack
Lateral

JACK CALIBRATION REPORT

CUSTOMER: BERKEL AND CO.

PROJECT: SEMI-ANNUAL

REPORT NO: 1462660BAMA

DATE: September 22, 2016

CYLINDER: RCD1006A 100T 6in STR CH JACK

SERIAL NO: 61129 (61)

GAUGE: WIKA 10,000psi 6in DIAL

SERIAL NO: 1102QF1

This report covers the results of Calibration for the above Hydraulic Cylinder. Calibration was performed utilizing our 1000-Ton Test Frame S/N 245017. The 1000-Ton Test Frame uses three 660 Kip Master Load Cells, S/Ns 58201, 58202, 60129, and GSE662 digital readout indicator, S/N 055826. The Master Load Cells were recently calibrated on April 18, 2016 in accordance with ASTM E4 and is within a 0.5% tolerance. Results of current calibration are shown on the following pages:

Temperature during test 80 Degrees Fahrenheit

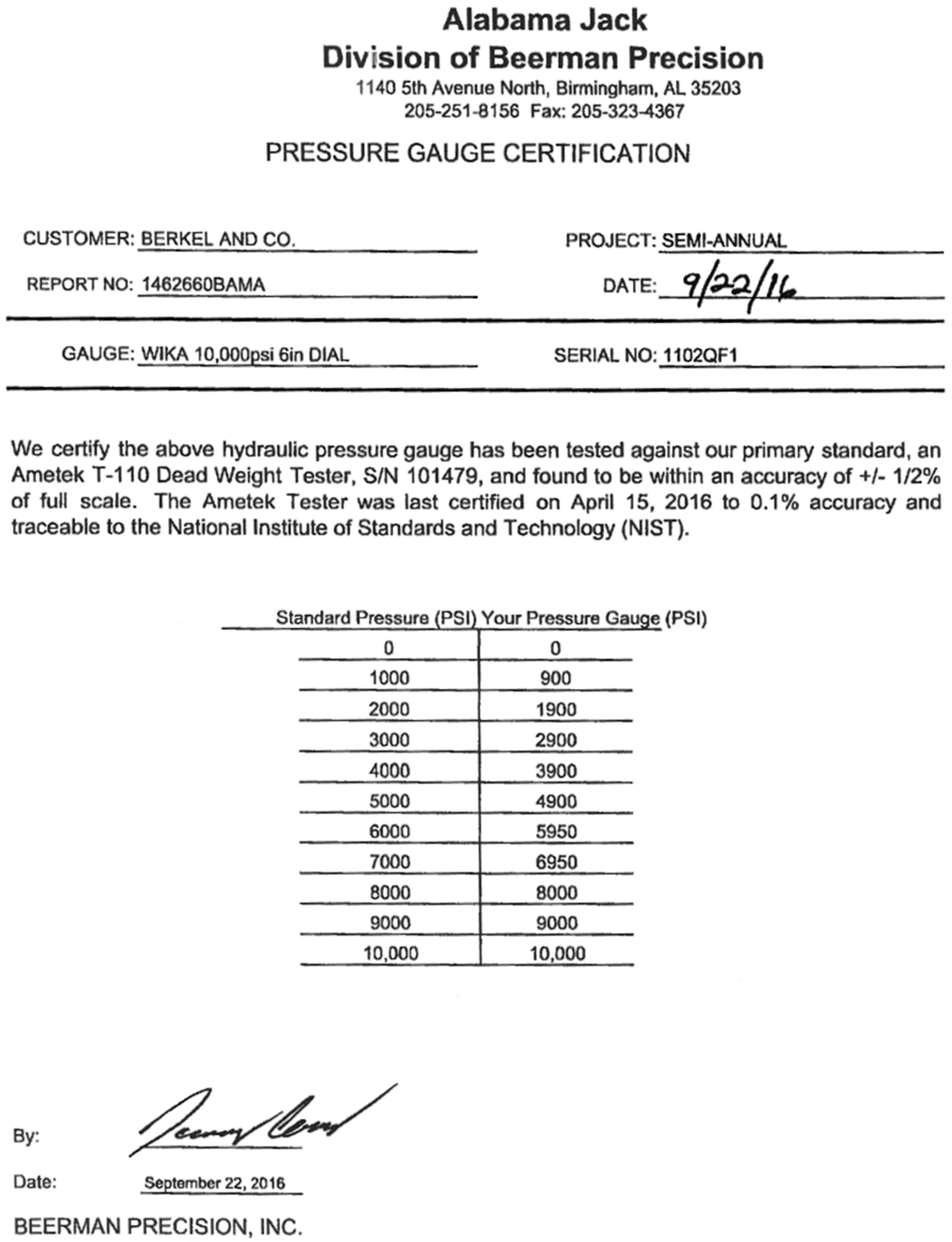
By:

Date: September 22, 2016

ALABAMA JACK, DIVISION OF BEERMAN

C:\Users\Jim\Documents\CUSTOMER CALIBRATIONS\ALABAMA CALIBRATION TEMPLATES\BERKEL CONT# 1462660BAMA 100T 6in CH JACK SN 61129 w WIKA GAUGE SN 1102QF1.xls

Figure H-1. Calibration report for 100 ton hydraulic jack



Alabama Jack
Division of Beerman Precision

1140 5th Avenue North, Birmingham, AL 35203
205-251-8156 Fax: 205-323-4367

PRESSURE GAUGE CERTIFICATION

CUSTOMER: BERKEL AND CO.

PROJECT: SEMI-ANNUAL

REPORT NO: 1462660BAMA

DATE: 9/22/16

GAUGE: WIKA 10,000psi 6in DIAL

SERIAL NO: 1102QF1

We certify the above hydraulic pressure gauge has been tested against our primary standard, an Ametek T-110 Dead Weight Tester, S/N 101479, and found to be within an accuracy of +/- 1/2% of full scale. The Ametek Tester was last certified on April 15, 2016 to 0.1% accuracy and traceable to the National Institute of Standards and Technology (NIST).

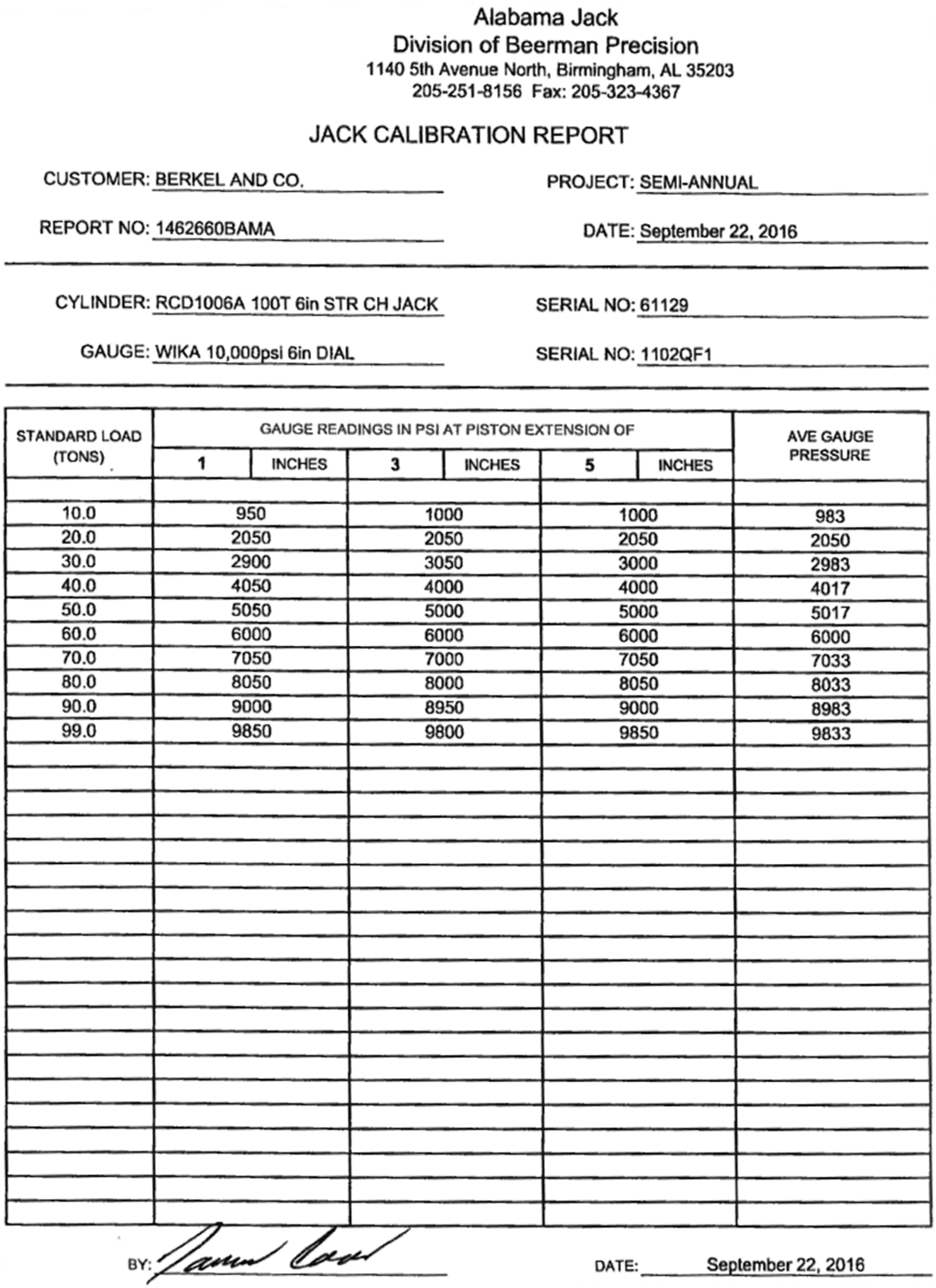
Standard Pressure (PSI)	Your Pressure Gauge (PSI)
0	0
1000	900
2000	1900
3000	2900
4000	3900
5000	4900
6000	5950
7000	6950
8000	8000
9000	9000
10,000	10,000

By:

Date: September 22, 2016

BEERMAN PRECISION, INC.

Figure H-1. Calibration report for 100 ton hydraulic jack *continued*



Alabama Jack
Division of Beerman Precision
1140 5th Avenue North, Birmingham, AL 35203
205-251-8156 Fax: 205-323-4367

JACK CALIBRATION REPORT

CUSTOMER: BERKEL AND CO.

PROJECT: SEMI-ANNUAL

REPORT NO: 1462660BAMA

DATE: September 22, 2016

CYLINDER: RCD1006A 100T 6in STR CH JACK

SERIAL NO: 61129

GAUGE: WIKA 10,000psi 6in DIAL

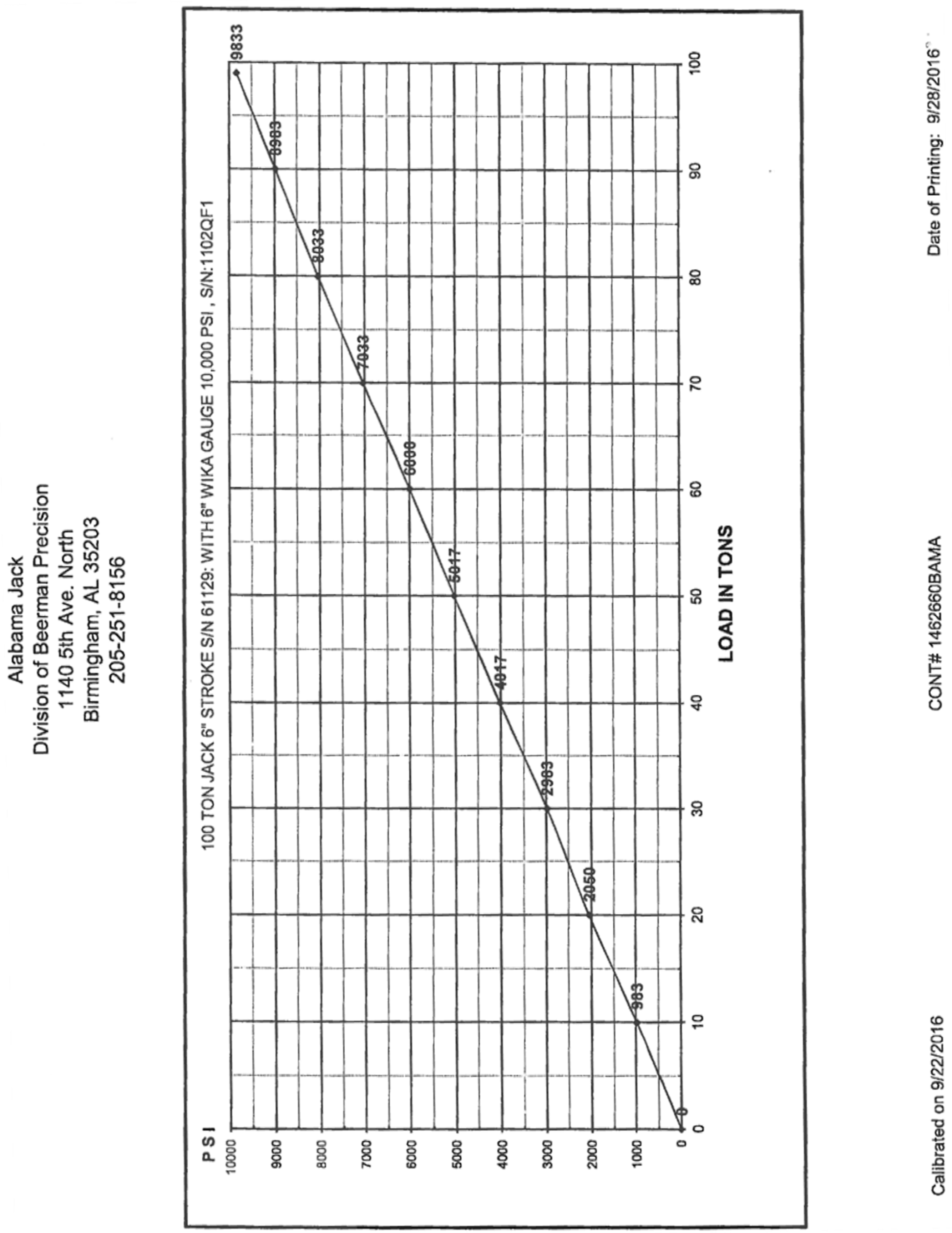
SERIAL NO: 1102QF1

STANDARD LOAD (TONS)	GAUGE READINGS IN PSI AT PISTON EXTENSION OF			AVE GAUGE PRESSURE
	1 INCHES	3 INCHES	5 INCHES	
10.0	950	1000	1000	983
20.0	2050	2050	2050	2050
30.0	2900	3050	3000	2983
40.0	4050	4000	4000	4017
50.0	5050	5000	5000	5017
60.0	6000	6000	6000	6000
70.0	7050	7000	7050	7033
80.0	8050	8000	8050	8033
90.0	9000	8950	9000	8983
99.0	9850	9800	9850	9833

BY:

DATE: September 22, 2016

Figure H-1. Calibration report for 100 ton hydraulic jack *continued*



Alabama Jack
Division of Beerman Precision
1140 5th Ave. North
Birmingham, AL 35203
205-251-8156

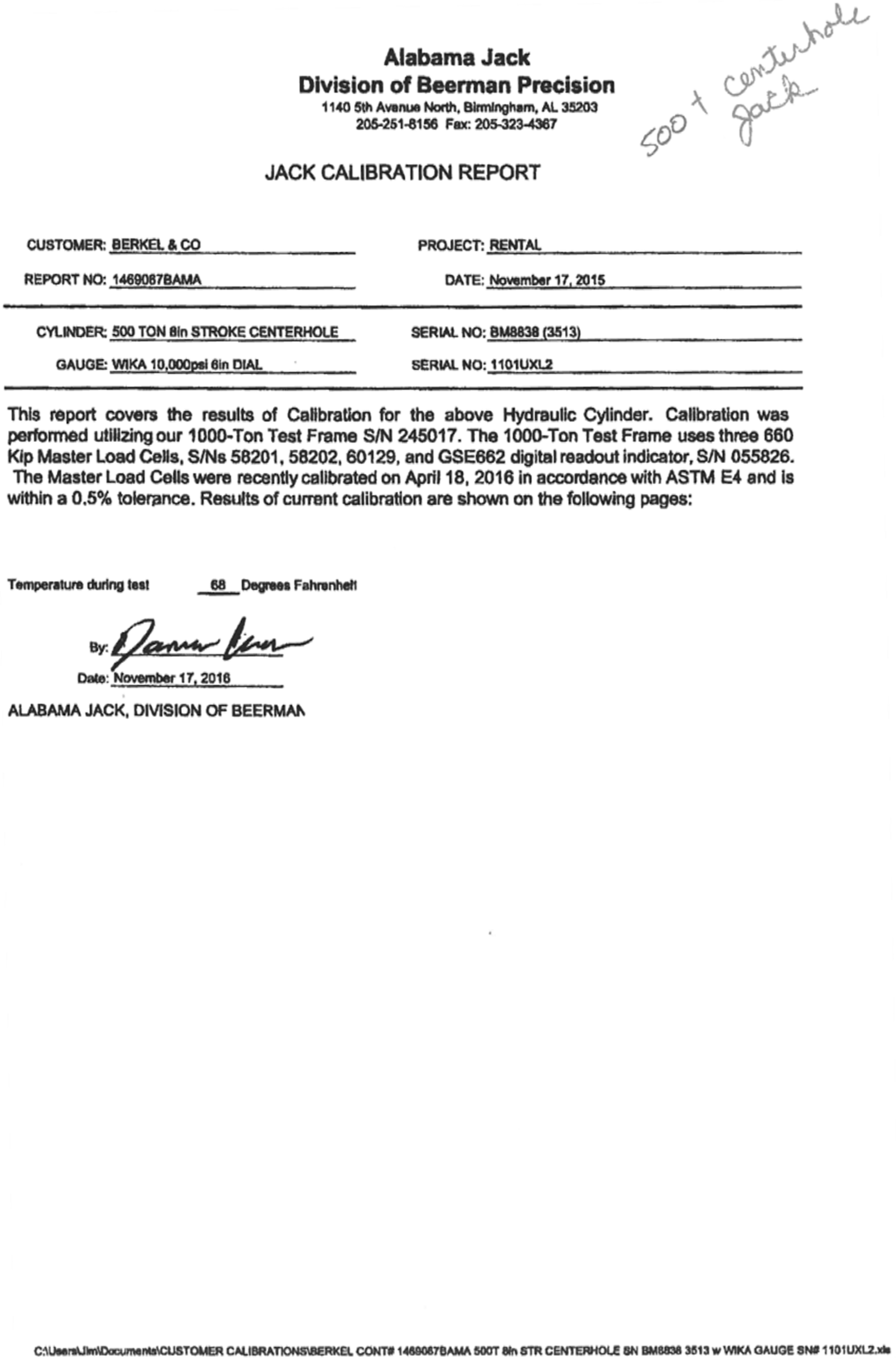
100 TON JACK 6" STROKE S/N 61129: WITH 6" WIKA GAUGE 10,000 PSI , S/N:1102QF1

Calibrated on 9/22/2016

CONT# 1462660BAMA

Date of Printing: 9/28/2016

Figure H-1. Calibration report for 100 ton hydraulic jack *continued*



500 t centerhole jack

Alabama Jack
Division of Beerman Precision
1140 5th Avenue North, Birmingham, AL 35203
205-251-8156 Fax: 205-323-4367

JACK CALIBRATION REPORT

CUSTOMER:	BERKEL & CO	PROJECT:	RENTAL
REPORT NO:	1469067BAMA	DATE:	November 17, 2015
CYLINDER:	500 TON 8in STROKE CENTERHOLE	SERIAL NO:	BM8838 (3513)
GAUGE:	WIKA 10,000psi 6in DIAL	SERIAL NO:	1101UXL2

This report covers the results of Calibration for the above Hydraulic Cylinder. Calibration was performed utilizing our 1000-Ton Test Frame S/N 245017. The 1000-Ton Test Frame uses three 660 Kip Master Load Cells, S/Ns 58201, 58202, 60129, and GSE662 digital readout indicator, S/N 055826. The Master Load Cells were recently calibrated on April 18, 2016 in accordance with ASTM E4 and is within a 0.5% tolerance. Results of current calibration are shown on the following pages:

Temperature during test 68 Degrees Fahrenheit

By:

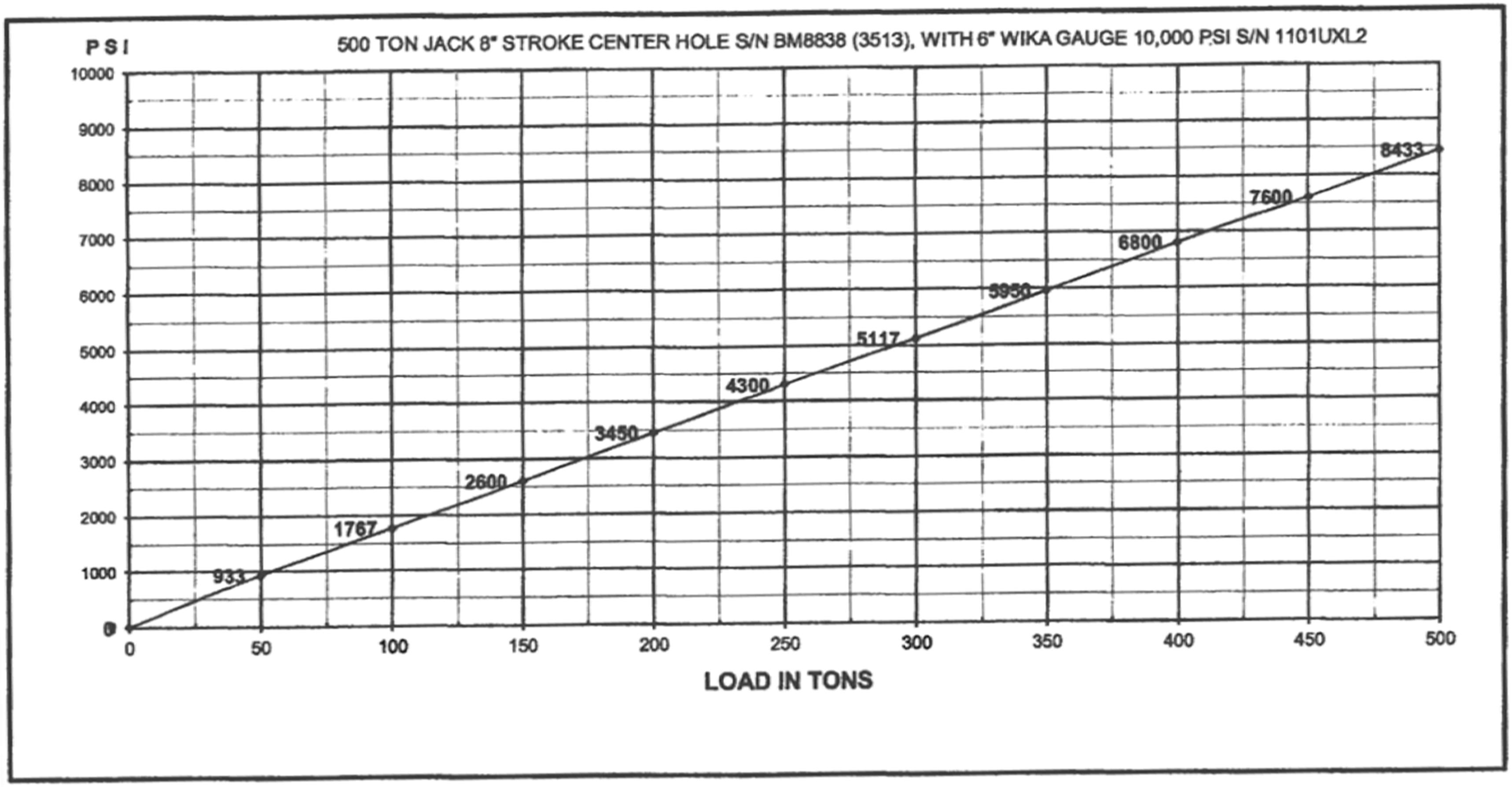
Date: November 17, 2016

ALABAMA JACK, DIVISION OF BEERMAN

C:\Users\Jim\Documents\CUSTOMER CALIBRATIONS\BERKEL CONT# 1469067BAMA 500T 8in STR CENTERHOLE SN BM8838 3513 w WIKA GAUGE SN# 1101UXL2.xls

Figure H-2. Calibration report for 500 ton center hole hydraulic jack

Alabama Jack
Division of Beerman Precision
1140 5th Ave. North
Birmingham, AL 35203
205-251-8156



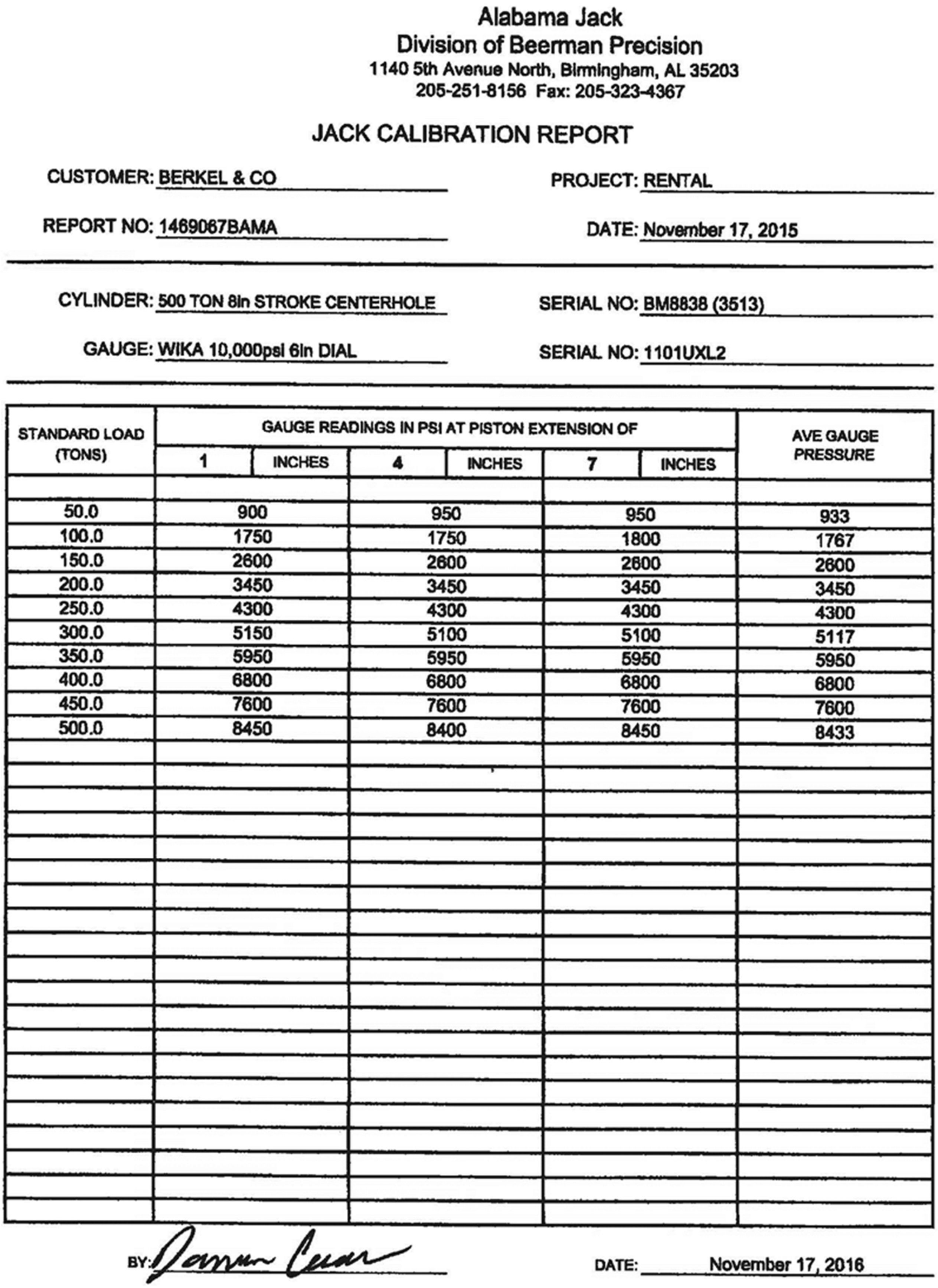
500 TON JACK 8" STROKE CENTER HOLE S/N BM8838 (3513), WITH 6" WIKA GAUGE 10,000 PSI S/N 1101UXL2

Calibrated on 11/17/2016

CONT# 1469067BAMA

Date of Printing: 11/21/2016

Figure H-2. Calibration report for 500 ton center hole hydraulic jack *continued*



Alabama Jack
Division of Beerman Precision
1140 5th Avenue North, Birmingham, AL 35203
205-251-8156 Fax: 205-323-4367

JACK CALIBRATION REPORT

CUSTOMER: BERKEL & CO

PROJECT: RENTAL

REPORT NO: 1469067BAMA

DATE: November 17, 2015

CYLINDER: 500 TON 8in STROKE CENTERHOLE

SERIAL NO: BM8838 (3513)

GAUGE: WIKA 10,000psi 6in DIAL

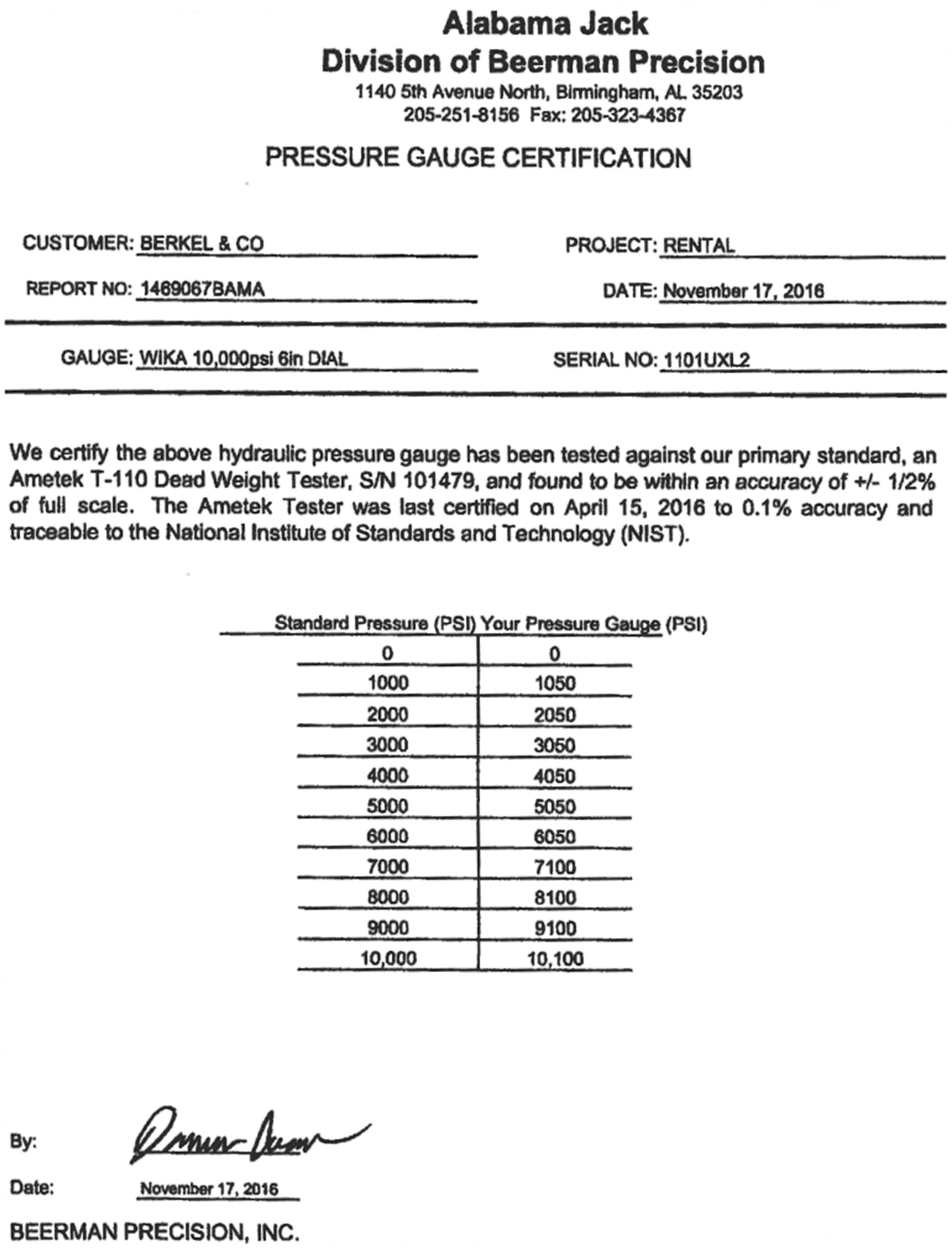
SERIAL NO: 1101UXL2

STANDARD LOAD (TONS)	GAUGE READINGS IN PSI AT PISTON EXTENSION OF			AVE GAUGE PRESSURE
	1 INCHES	4 INCHES	7 INCHES	
50.0	900	950	950	933
100.0	1750	1750	1800	1767
150.0	2600	2600	2600	2600
200.0	3450	3450	3450	3450
250.0	4300	4300	4300	4300
300.0	5150	5100	5100	5117
350.0	5950	5950	5950	5950
400.0	6800	6800	6800	6800
450.0	7600	7600	7600	7600
500.0	8450	8400	8450	8433

BY:

DATE: November 17, 2016

Figure H-2. Calibration report for 500 ton center hole hydraulic jack *continued*



Alabama Jack
Division of Beerman Precision

1140 5th Avenue North, Birmingham, AL 35203
205-251-8156 Fax: 205-323-4367

PRESSURE GAUGE CERTIFICATION

CUSTOMER: BERKEL & CO

PROJECT: RENTAL

REPORT NO: 1469067BAMA

DATE: November 17, 2016

GAUGE: WIKA 10,000psi 6in DIAL

SERIAL NO: 1101UXL2

We certify the above hydraulic pressure gauge has been tested against our primary standard, an Ametek T-110 Dead Weight Tester, S/N 101479, and found to be within an accuracy of +/- 1/2% of full scale. The Ametek Tester was last certified on April 15, 2016 to 0.1% accuracy and traceable to the National Institute of Standards and Technology (NIST).

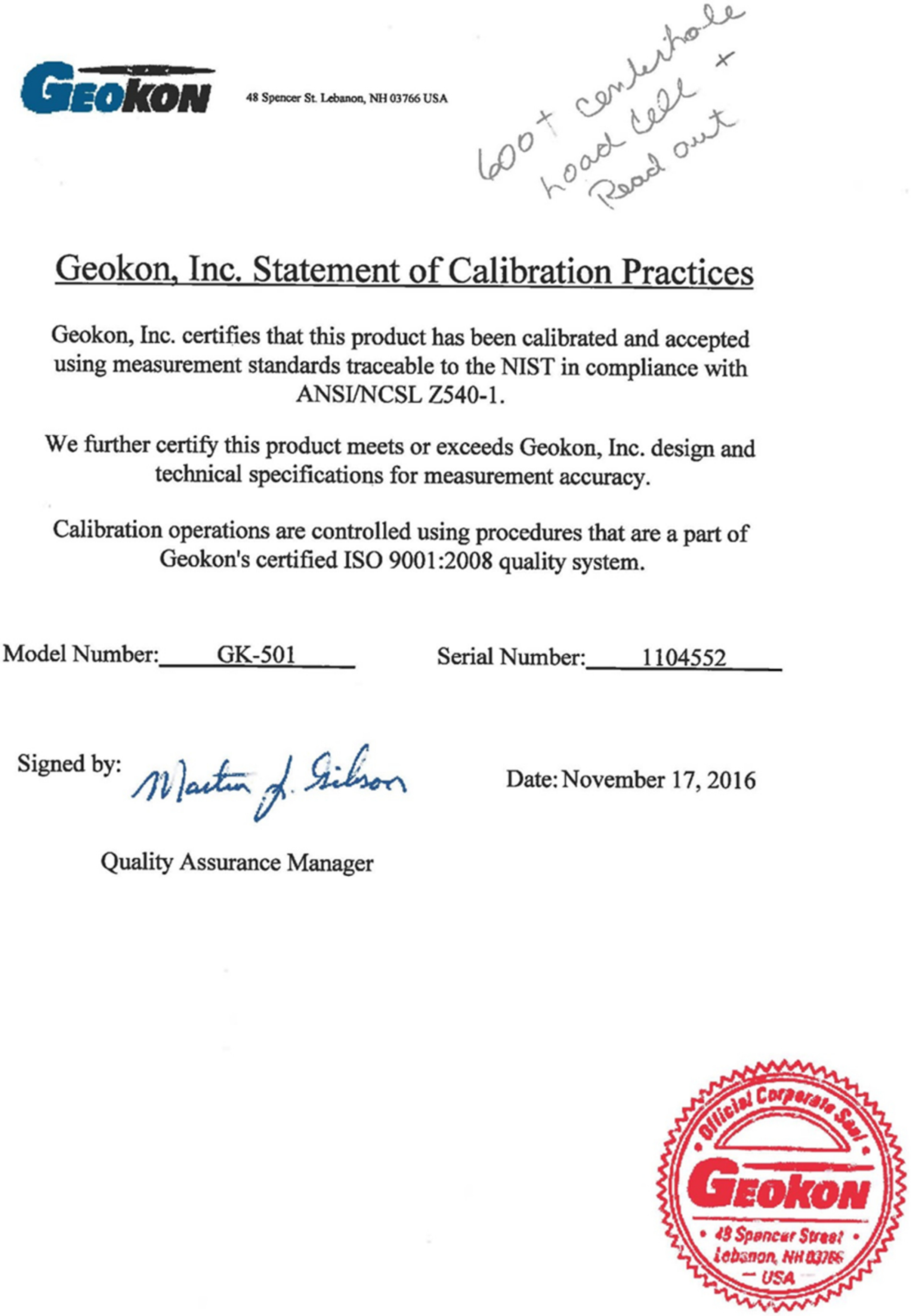
Standard Pressure (PSI)	Your Pressure Gauge (PSI)
0	0
1000	1050
2000	2050
3000	3050
4000	4050
5000	5050
6000	6050
7000	7100
8000	8100
9000	9100
10,000	10,100

By:

Date: November 17, 2016

BEERMAN PRECISION, INC.

Figure H-2. Calibration report for 500 ton center hole hydraulic jack *continued*



GEOKON

48 Spencer St. Lebanon, NH 03766 USA

600t centerhole
load cell +
Read out

Geokon, Inc. Statement of Calibration Practices

Geokon, Inc. certifies that this product has been calibrated and accepted using measurement standards traceable to the NIST in compliance with ANSI/NCSL Z540-1.

We further certify this product meets or exceeds Geokon, Inc. design and technical specifications for measurement accuracy.

Calibration operations are controlled using procedures that are a part of Geokon's certified ISO 9001:2008 quality system.

Model Number: GK-501

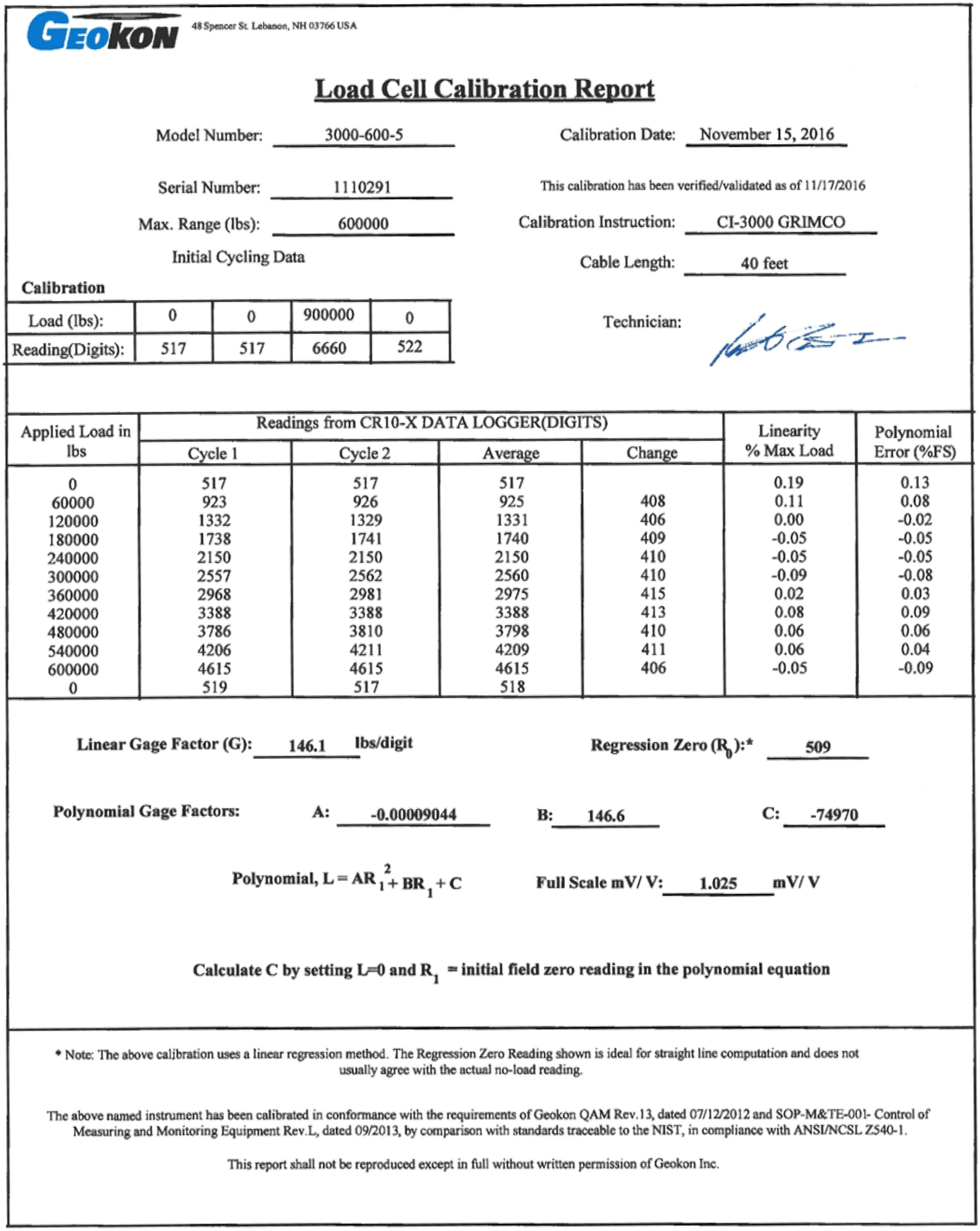
Serial Number: 1104552

Signed by: Martin J. Gibson

Date: November 17, 2016

Quality Assurance Manager

Figure H-3. Calibration report for 600 ton center hole load cell



GEOKON 48 Spencer St. Lebanon, NH 03766 USA

Load Cell Calibration Report

Model Number: 3000-600-5

Calibration Date: November 15, 2016

Serial Number: 1110291

This calibration has been verified/validated as of 11/17/2016

Max. Range (lbs): 600000

Calibration Instruction: CI-3000 GRIMCO

Initial Cycling Data

Cable Length: 40 feet

Calibration

Load (lbs):	0	0	900000	0
Reading(Digits):	517	517	6660	522

Technician:

Applied Load in lbs	Readings from CR10-X DATA LOGGER(DIGITS)				Linearity % Max Load	Polynomial Error (%FS)
	Cycle 1	Cycle 2	Average	Change		
0	517	517	517		0.19	0.13
60000	923	926	925	408	0.11	0.08
120000	1332	1329	1331	406	0.00	-0.02
180000	1738	1741	1740	409	-0.05	-0.05
240000	2150	2150	2150	410	-0.05	-0.05
300000	2557	2562	2560	410	-0.09	-0.08
360000	2968	2981	2975	415	0.02	0.03
420000	3388	3388	3388	413	0.08	0.09
480000	3786	3810	3798	410	0.06	0.06
540000	4206	4211	4209	411	0.06	0.04
600000	4615	4615	4615	406	-0.05	-0.09
0	519	517	518			

Linear Gage Factor (G): 146.1 **lbs/digit**

Regression Zero (R_0):* 509

Polynomial Gage Factors: **A:** -0.00009044 **B:** 146.6 **C:** -74970

Polynomial, $L = AR_1^2 + BR_1 + C$ **Full Scale mV/ V:** 1.025 **mV/ V**

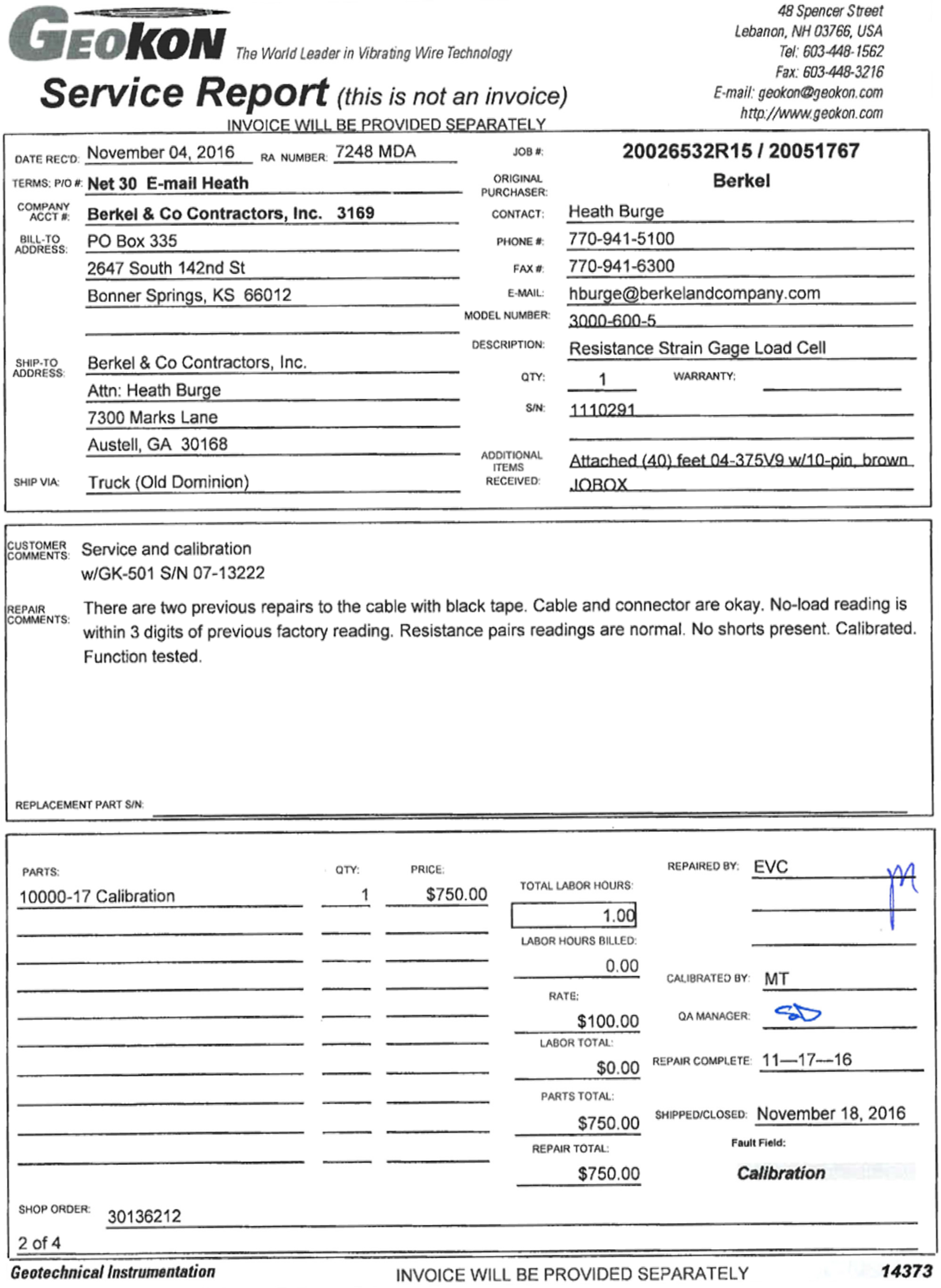
Calculate C by setting L=0 and R_1 = initial field zero reading in the polynomial equation

* Note: The above calibration uses a linear regression method. The Regression Zero Reading shown is ideal for straight line computation and does not usually agree with the actual no-load reading.

The above named instrument has been calibrated in conformance with the requirements of Geokon QAM Rev.13, dated 07/12/2012 and SOP-M&TE-001- Control of Measuring and Monitoring Equipment Rev.L, dated 09/2013, by comparison with standards traceable to the NIST, in compliance with ANSI/NCSL Z540-1.

This report shall not be reproduced except in full without written permission of Geokon Inc.

Figure H-3. Calibration report for 600 ton center hole load cell *continued*



GEOKON The World Leader in Vibrating Wire Technology

48 Spencer Street
Lebanon, NH 03766, USA
Tel: 603-448-1562
Fax: 603-448-3216
E-mail: geokon@geokon.com
http://www.geokon.com

Service Report (this is not an invoice)

INVOICE WILL BE PROVIDED SEPARATELY

DATE REC'D: November 04, 2016
RA NUMBER: 7248 MDA
JOB #: **20026532R15 / 20051767**
TERMS: P/O #: **Net 30 E-mail Heath**
ORIGINAL PURCHASER: **Berkel**
COMPANY ACCT #: **Berkel & Co Contractors, Inc. 3169**
CONTACT: Heath Burge
BILL-TO ADDRESS:
PO Box 335
2647 South 142nd St
Bonner Springs, KS 66012
PHONE #: 770-941-5100
FAX #: 770-941-6300
E-MAIL: hburge@berkelandcompany.com
MODEL NUMBER: 3000-600-5
DESCRIPTION: Resistance Strain Gage Load Cell
SHIP-TO ADDRESS:
Berkel & Co Contractors, Inc.
Attn: Heath Burge
7300 Marks Lane
Austell, GA 30168
QTY: 1
WARRANTY:
S/N: 1110291
ADDITIONAL ITEMS RECEIVED: Attached (40) feet 04-375V9 w/10-pin, brown JOBOX
SHIP VIA: Truck (Old Dominion)

CUSTOMER COMMENTS: Service and calibration
w/GK-501 S/N 07-13222

REPAIR COMMENTS: There are two previous repairs to the cable with black tape. Cable and connector are okay. No-load reading is within 3 digits of previous factory reading. Resistance pairs readings are normal. No shorts present. Calibrated. Function tested.

REPLACEMENT PART S/N:

PARTS:	QTY:	PRICE:
10000-17 Calibration	1	$750.00

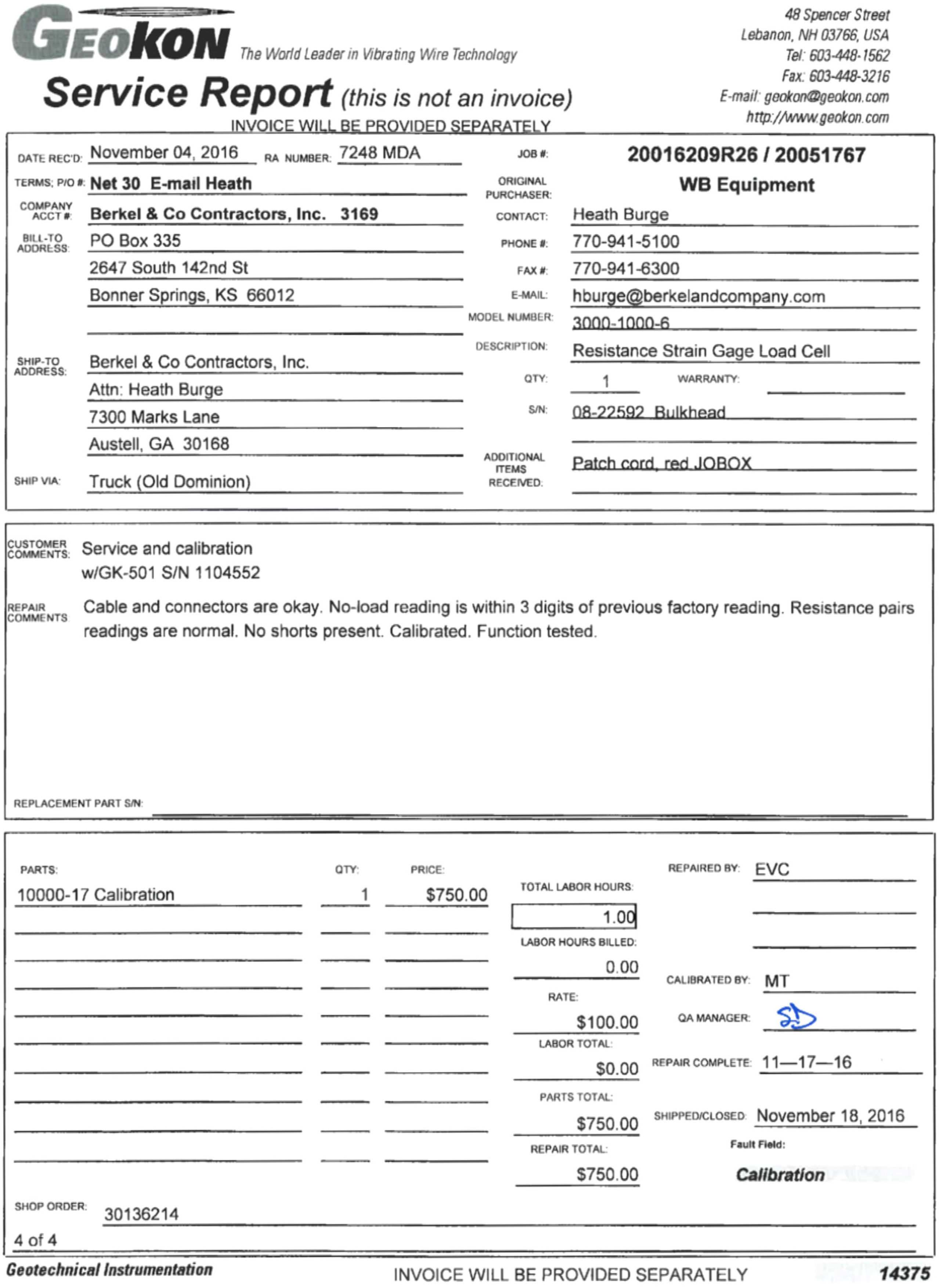
TOTAL LABOR HOURS: 1.00
LABOR HOURS BILLED: 0.00
RATE: $100.00
LABOR TOTAL: $0.00
PARTS TOTAL: $750.00
REPAIR TOTAL: $750.00

REPAIRED BY: EVC
CALIBRATED BY: MT
QA MANAGER:
REPAIR COMPLETE: 11—17—16
SHIPPED/CLOSED: November 18, 2016
Fault Field: ***Calibration***

SHOP ORDER: 30136212
2 of 4

Geotechnical Instrumentation INVOICE WILL BE PROVIDED SEPARATELY ***14373***

Figure H-3. Calibration report for 600 ton center hole load cell *continued*



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48 Spencer Street
Lebanon, NH 03766, USA
Tel: 603-448-1562
Fax: 603-448-3216
E-mail: geokon@geokon.com
http://www.geokon.com

Service Report (this is not an invoice)

INVOICE WILL BE PROVIDED SEPARATELY

DATE REC'D: November 04, 2016 RA NUMBER: 7248 MDA

JOB #: **20016209R26 / 20051767**

TERMS; P/O #: **Net 30 E-mail Heath**

ORIGINAL PURCHASER: **WB Equipment**

COMPANY ACCT #: **Berkel & Co Contractors, Inc. 3169**

BILL-TO ADDRESS:
PO Box 335
2647 South 142nd St
Bonner Springs, KS 66012

CONTACT: Heath Burge
PHONE #: 770-941-5100
FAX #: 770-941-6300
E-MAIL: hburge@berkelandcompany.com
MODEL NUMBER: 3000-1000-6
DESCRIPTION: Resistance Strain Gage Load Cell
QTY: 1 WARRANTY:
S/N: 08-22592 Bulkhead

SHIP-TO ADDRESS:
Berkel & Co Contractors, Inc.
Attn: Heath Burge
7300 Marks Lane
Austell, GA 30168

ADDITIONAL ITEMS RECEIVED: Patch cord, red JOBOX

SHIP VIA: Truck (Old Dominion)

CUSTOMER COMMENTS: Service and calibration
w/GK-501 S/N 1104552

REPAIR COMMENTS: Cable and connectors are okay. No-load reading is within 3 digits of previous factory reading. Resistance pairs readings are normal. No shorts present. Calibrated. Function tested.

REPLACEMENT PART S/N:

PARTS:	QTY:	PRICE:
10000-17 Calibration	1	$750.00

TOTAL LABOR HOURS: 1.00
LABOR HOURS BILLED: 0.00
RATE: $100.00
LABOR TOTAL: $0.00
PARTS TOTAL: $750.00
REPAIR TOTAL: $750.00

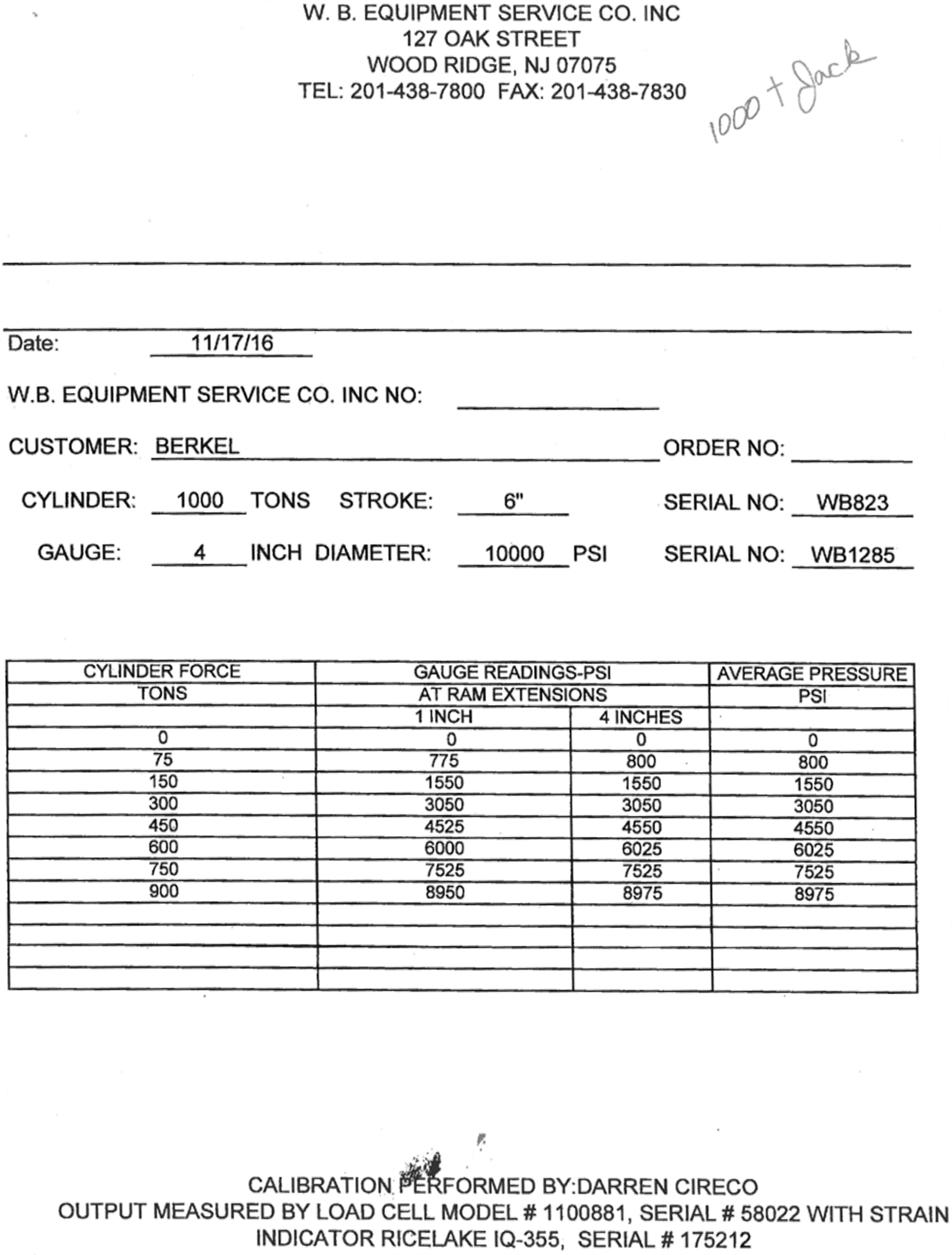
REPAIRED BY: EVC
CALIBRATED BY: MT
QA MANAGER: SD
REPAIR COMPLETE: 11—17—16
SHIPPED/CLOSED: November 18, 2016
Fault Field: **Calibration**

SHOP ORDER: 30136214

4 of 4

Geotechnical Instrumentation INVOICE WILL BE PROVIDED SEPARATELY **14375**

Figure H-3. Calibration report for 600 ton center hole load cell *continued*



W. B. EQUIPMENT SERVICE CO. INC
127 OAK STREET
WOOD RIDGE, NJ 07075
TEL: 201-438-7800 FAX: 201-438-7830

1000 t Jack

Date: 11/17/16

W.B. EQUIPMENT SERVICE CO. INC NO:

CUSTOMER: BERKEL ORDER NO:

CYLINDER: 1000 TONS STROKE: 6" SERIAL NO: WB823

GAUGE: 4 INCH DIAMETER: 10000 PSI SERIAL NO: WB1285

CYLINDER FORCE TONS	GAUGE READINGS-PSI AT RAM EXTENSIONS		AVERAGE PRESSURE PSI
	1 INCH	4 INCHES	
0	0	0	0
75	775	800	800
150	1550	1550	1550
300	3050	3050	3050
450	4525	4550	4550
600	6000	6025	6025
750	7525	7525	7525
900	8950	8975	8975

CALIBRATION PERFORMED BY:DARREN CIRECO
OUTPUT MEASURED BY LOAD CELL MODEL # 1100881, SERIAL # 58022 WITH STRAIN INDICATOR RICELAKE IQ-355, SERIAL # 175212

Figure H-4. Calibration report for 1,000 ton hydraulic jack

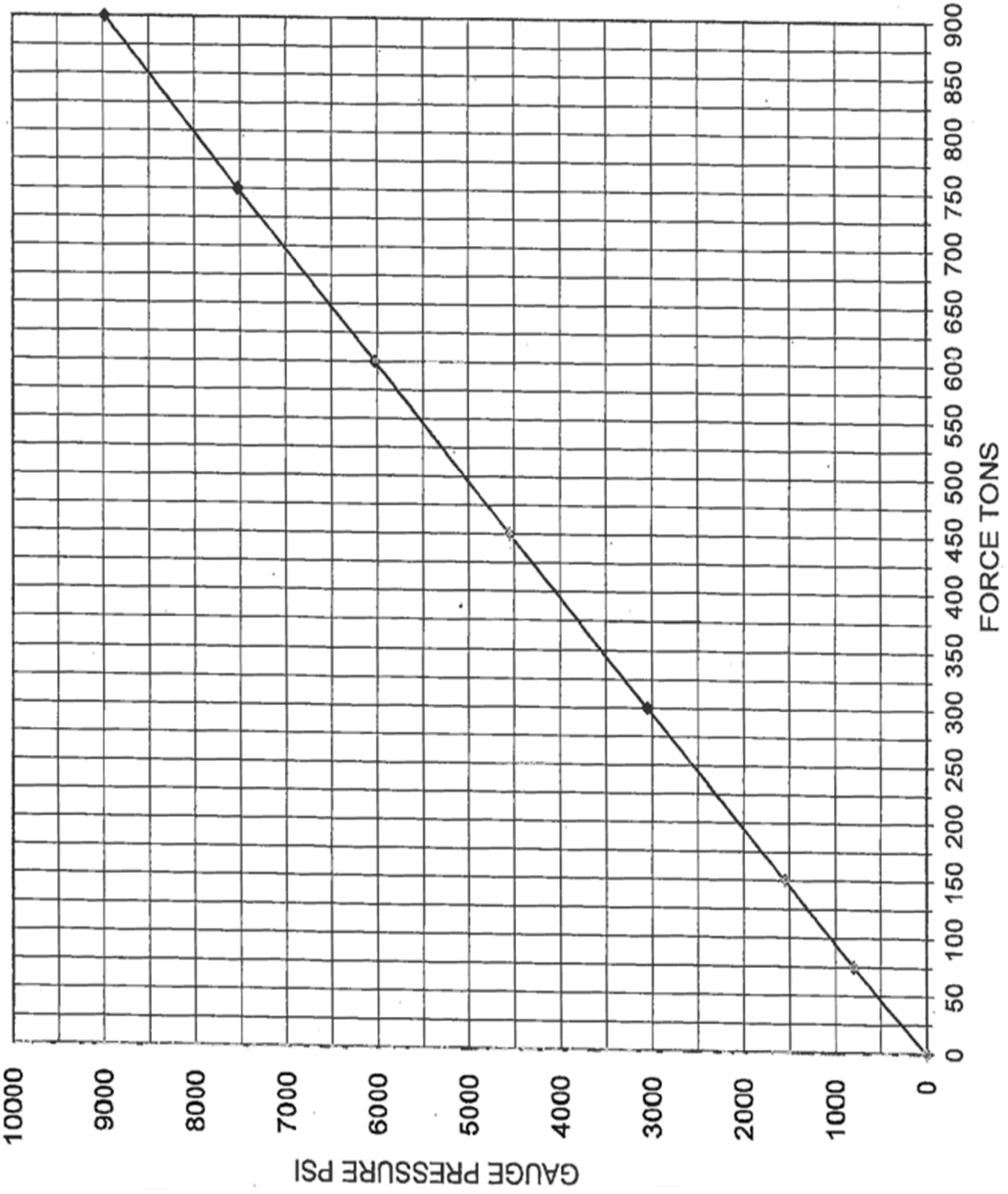
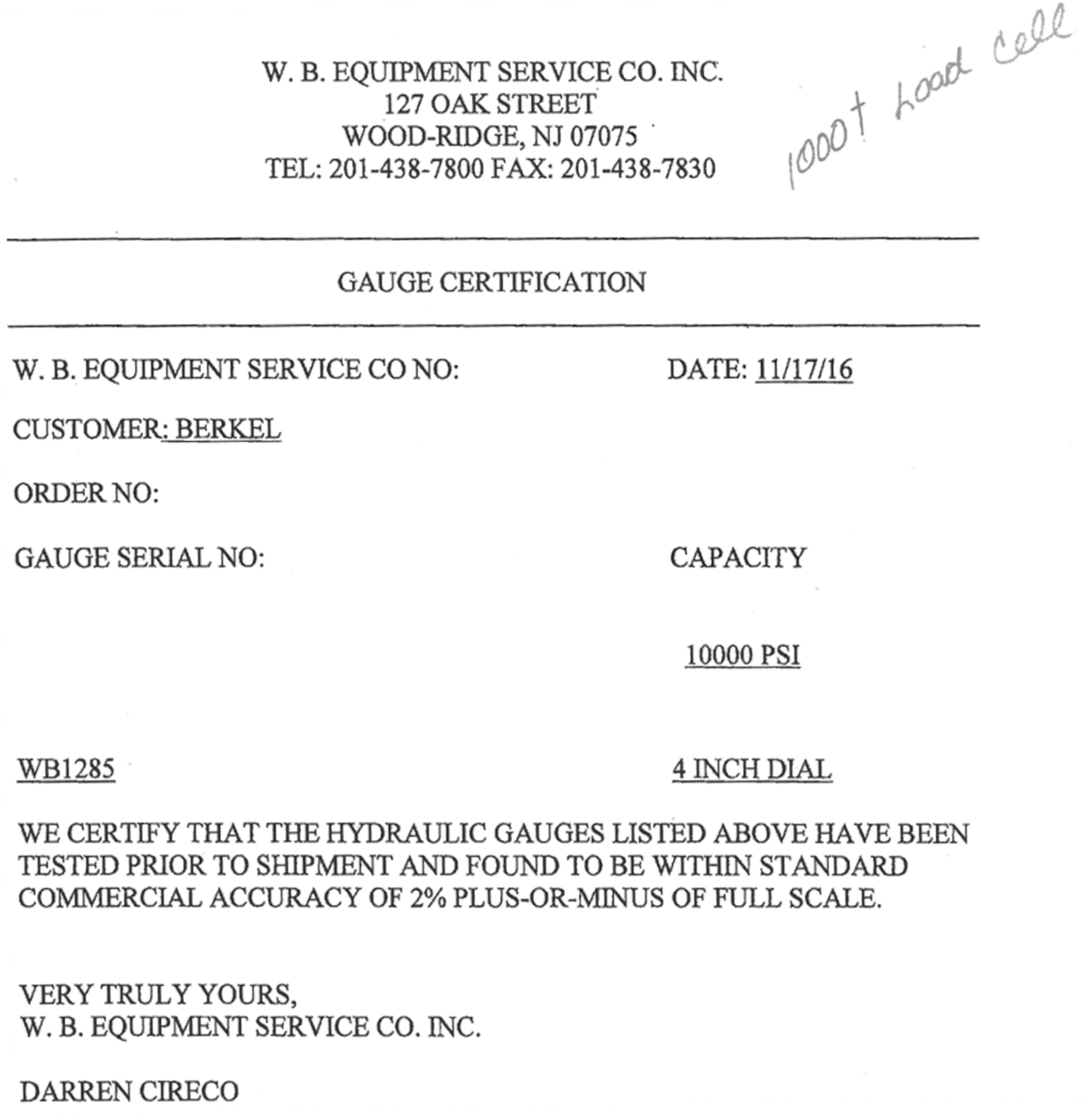


Figure H-4. Calibration report for 1,000 ton hydraulic jack *continued*



1000t Load cell

W. B. EQUIPMENT SERVICE CO. INC.
127 OAK STREET
WOOD-RIDGE, NJ 07075
TEL: 201-438-7800 FAX: 201-438-7830

GAUGE CERTIFICATION

W. B. EQUIPMENT SERVICE CO NO: DATE: 11/17/16

CUSTOMER: BERKEL

ORDER NO:

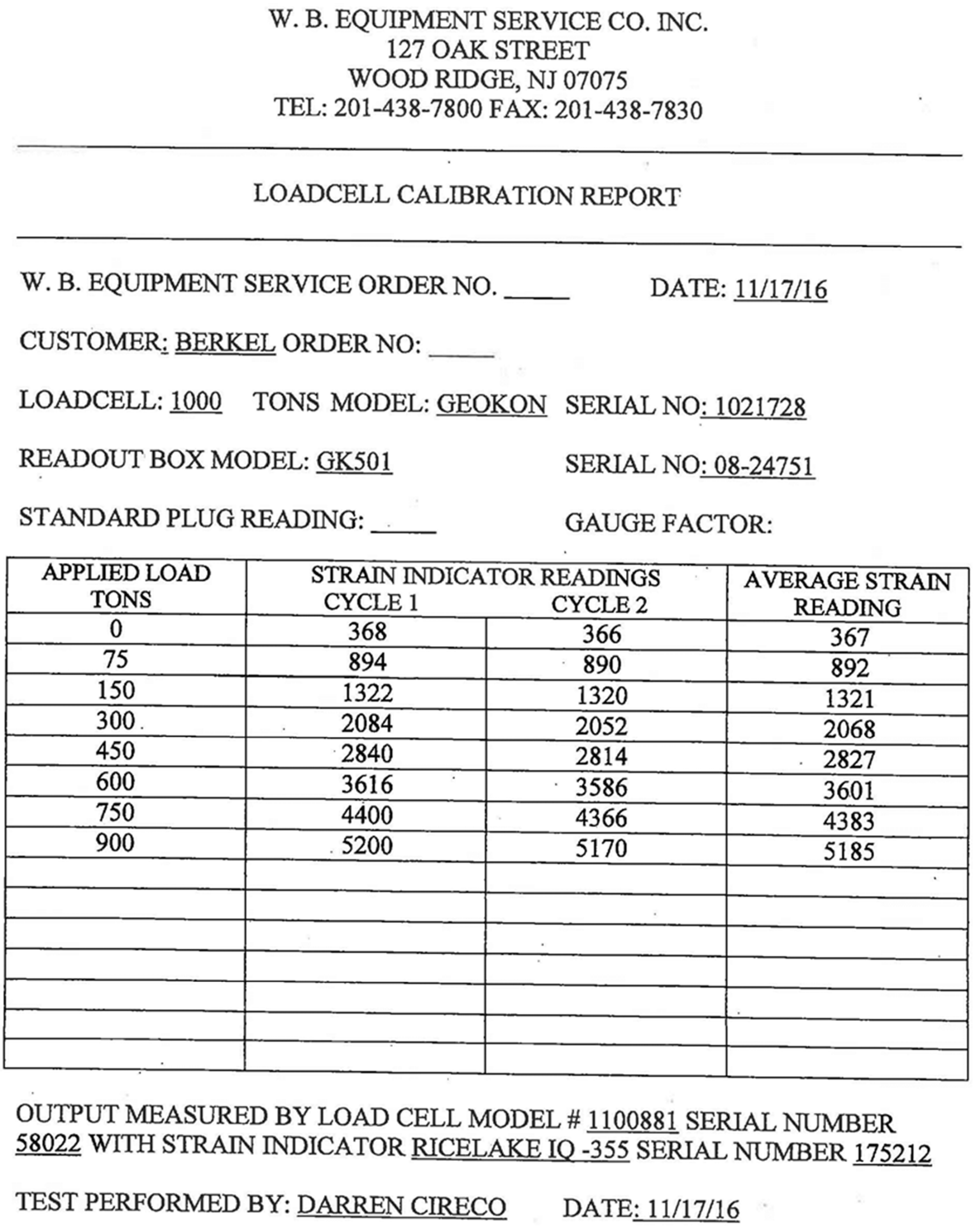
GAUGE SERIAL NO:	CAPACITY
	10000 PSI
WB1285	4 INCH DIAL

WE CERTIFY THAT THE HYDRAULIC GAUGES LISTED ABOVE HAVE BEEN TESTED PRIOR TO SHIPMENT AND FOUND TO BE WITHIN STANDARD COMMERCIAL ACCURACY OF 2% PLUS-OR-MINUS OF FULL SCALE.

VERY TRULY YOURS,
W. B. EQUIPMENT SERVICE CO. INC.

DARREN CIRECO

Figure H-5. Calibration report for 1,000 ton load cell



W. B. EQUIPMENT SERVICE CO. INC.
127 OAK STREET
WOOD RIDGE, NJ 07075
TEL: 201-438-7800 FAX: 201-438-7830

LOADCELL CALIBRATION REPORT

W. B. EQUIPMENT SERVICE ORDER NO. _____ DATE: 11/17/16

CUSTOMER: BERKEL ORDER NO: _____

LOADCELL: 1000 TONS MODEL: GEOKON SERIAL NO: 1021728

READOUT BOX MODEL: GK501 SERIAL NO: 08-24751

STANDARD PLUG READING: _____ GAUGE FACTOR:

APPLIED LOAD TONS	STRAIN INDICATOR READINGS		AVERAGE STRAIN READING
	CYCLE 1	CYCLE 2	
0	368	366	367
75	894	890	892
150	1322	1320	1321
300	2084	2052	2068
450	2840	2814	2827
600	3616	3586	3601
750	4400	4366	4383
900	5200	5170	5185

OUTPUT MEASURED BY LOAD CELL MODEL # 1100881 SERIAL NUMBER 58022 WITH STRAIN INDICATOR RICELAKE IQ -355 SERIAL NUMBER 175212

TEST PERFORMED BY: DARREN CIRECO DATE: 11/17/16

Figure H-5. Calibration report for 1,000 ton load cell *continued*

APPENDIX I

COMPRESSION LOAD TEST SETUP AND TEST RESULTS

Table I-1. Load – displacement measurements during axial compression loading test of pile C-1

PILE DIAMETER:	18 IN	CONTRACTOR:	BERKEL	PILE ID:	C1
PILE LENGTH:	60 FT	PILE TYPE :	ACIP	JACK S/N:	BM8838
LOAD TEST TYPE:	COMPRESSION	WEATHER:	WINDY/SUNNY	GAUGE S/N:	1101UXL2
BERKEL REP:	Tanner Swafford			LOAD CELL S/N:	1021728
				BEGIN DATE:	12/1/2016
				END DATE:	12/1/2016

TIME	JACK		LOAD CELL		PILE HEAD MOVEMENT				
	PRESSURE (psi)	LOAD (tons)	(dgs)	Load (tons)	DIAL 1 (in)	DIAL 2 (in)	DIAL 3 (in)	DIAL 4 (in)	AVG (in)
12:40 PM	0 / 0	0.0	367 / 396	4.1	0.000	0.000	0.000	0.000	0.000
12:40 PM	280 / 300	16.1	472 / 453	12.3	0.002	0.002	0.001	0.002	0.002
12:44 PM	280 / 150	8.0	472 / 418	7.3	0.001	0.002	0.001	0.002	0.002
12:45 PM	560 / 550	29.5	577 / 580	30.4	0.011	0.013	0.012	0.011	0.012
12:49 PM	560 / 450	24.1	577 / 538	24.4	0.018	0.009	0.008	0.008	0.011
12:50 PM	840 / 850	45.6	682 / 694	46.7	0.022	0.026	0.025	0.020	0.023
12:54 PM	840 / 800	42.9	682 / 680	44.7	0.022	0.026	0.022	0.027	0.024
12:55 PM	1100 / 1100	60.0	787 / 790	60.4	0.037	0.043	0.036	0.030	0.037
12:59 PM	1100 / 1050	57.0	787 / 776	58.4	0.040	0.045	0.042	0.035	0.041
1:00 PM	1350 / 1400	78.0	892 / 901	76.6	0.065	0.071	0.066	0.057	0.065
1:04 PM	1350 / 1350	75.0	892 / 878	73.0	0.065	0.071	0.066	0.056	0.065
1:05 PM	1600 / 1650	93.0	977 / 991	92.3	0.087	0.095	0.087	0.076	0.086
1:09 PM	1600 / 1550	87.0	977 / 971	88.8	0.090	0.097	0.088	0.076	0.088
1:10 PM	1850 / 1900	108.0	1063 / 1087	109.1	0.119	0.126	0.117	0.104	0.117
1:14 PM	1850 / 1750	99.0	1063 / 1064	105.1	0.124	0.130	0.120	0.117	0.123
1:15 PM	2100 / 2250	129.0	1149 / 1230	134.1	0.170	0.179	0.169	0.154	0.168
1:19 PM	2100 / 2100	120.0	1149 / 1203	129.4	0.177	0.185	0.174	0.158	0.174
1:20 PM	2350 / 2500	144.0	1235 / 1323	150.4	0.205	0.212	0.204	0.186	0.202
1:24 PM	2350 / 2350	135.0	1235 / 1292	144.9	0.213	0.220	0.219	0.192	0.211
1:25 PM	2600 / 2750	158.8	1321 / 1414	168.7	0.245	0.253	0.241	0.223	0.241
1:29 PM	2600 / 2600	150.0	1321 / 1386	163.1	0.254	0.261	0.25	0.232	0.249
1:30 PM	2855 / 3000	173.5	1395 / 1518	189.6	0.292	0.300	0.286	0.269	0.287
1:34 PM	2855 / 2850	164.7	1395 / 1485	182.9	0.302	0.309	0.298	0.277	0.297
1:35 PM	3110 / 3250	188.2	1470 / 1609	207.8	0.335	0.343	0.332	0.311	0.330
1:39 PM	3110 / 3100	179.4	1470 / 1571	200.2	0.346	0.351	0.340	0.319	0.339
1:40 PM	3365 / 3500	202.9	1545 / 1718	229.7	0.389	0.395	0.385	0.363	0.383
1:44 PM	3365 / 3350	194.1	1545 / 1677	221.5	0.400	0.405	0.394	0.372	0.393
1:45 PM	3620 / 3750	217.6	1619 / 1821	250.4	0.455	0.459	0.450	0.426	0.448
1:49 PM	3620 / 3600	208.8	1619 / 1774	241.0	0.459	0.464	0.451	0.427	0.450
1:50 PM	3875 / 4050	235.3	1694 / 1923	270.9	0.506	0.513	0.501	0.476	0.499
1:54 PM	3875 / 4300	250.0	1694 / 1878	261.8	0.521	0.526	0.515	0.490	0.513
1:55 PM	4130 / 4300	250.0	1769 / 2004	287.1	0.564	0.569	0.554	0.530	0.554
1:59 PM	4130 / 4100	238.2	1769 / 1960	278.3	0.578	0.581	0.568	0.542	0.567
2:00 PM	4381 / 4600	268.4	1843 / 2145	315.2	0.645	0.650	0.640	0.612	0.637
2:04 PM	4381 / 4400	256.1	1843 / 2073	301.0	0.667	0.670	0.654	0.620	0.653
2:05 PM	4626 / 4800	280.6	1918 / 2206	327.3	0.712	0.718	0.699	0.670	0.700
2:09 PM	4626 / 4575	266.8	1918 / 2146	315.4	0.731	0.734	0.716	0.686	0.717
2:10 PM	4871 / 5000	292.8	1993 / 2280	341.9	0.778	0.784	0.766	0.737	0.766
2:14 PM	4871 / 4750	277.5	1993 / 2205	327.1	0.797	0.799	0.782	0.753	0.783
2:15 PM	5117 / 5400	317.0	2068 / 2420	369.6	0.917	0.926	0.907	0.879	0.907
2:19 PM	5117 / 5100	299.0	2068 / 2341	354.0	0.947	0.949	0.930	0.900	0.932
2:20 PM	5366 / 5550	326.0	2143 / 2475	380.4	1.030	1.035	1.021	0.990	1.019
2:24 PM	5366 / 5250	308.0	2143 / 2397	365.0	1.055	1.058	1.043	1.008	1.041
2:25 PM	5616 / 5900	347.0	2219 / 2750	434.8	1.215	1.224	1.215	1.185	1.210
2:29 PM	5616 / 5500	323.0	2219 / 2490	383.4	1.263	1.268	1.255	1.220	1.252
2:30 PM	5866 / 6100	358.8	2295 / 2700	424.9	1.440	1.447	1.434	1.400	1.430
2:31 PM	5866 / 5600	329.0	2295 / 2529	391.1	1.465	1.468	1.458	1.420	1.453
2:35 PM	6120 / 6300	370.6	2371 / 2755	435.8	1.965	1.970	1.956	1.918	1.952
2:39 PM	6120 / 5900	347.0	2371 / 2657	416.4	2.005	2.010	1.984	1.941	1.985
2:40 PM	6375 / 6300	311.0	2447 / 2759	436.6	2.077	2.080	2.092	2.070	2.080
2:44 PM	6375 / 5900	347.0	2447 / 2333	352.4	2.077	2.080	2.092	2.070	2.080
2:45 PM	4920 / 4920	287.9	2008 / 2333	352.4	2.077	2.080	2.092	2.070	2.080
2:49 PM	4920 / 4950	289.8	2008 / 2336	353.0	2.077	2.080	2.092	2.070	2.080
2:50 PM	3722 / 3700	214.7	1650 / 1888	263.9	2.077	2.080	2.092	2.070	2.080
2:54 PM	3722 / 3700	214.7	1650 / 1896	265.5	2.077	2.080	2.092	2.070	2.080
2:55 PM	2500 / 2500	144.0	1286 / 1429	171.7	2.050	2.054	2.050	2.035	2.047
2:59 PM	2500 / 2450	141.0	1286 / 1443	174.5	2.046	2.051	2.047	2.032	2.044
3:00 PM	1300 / 1300	72.0	871 / 960	86.9	2.018	2.031	2.016	1.994	2.015
3:04 PM	1300 / 1400	78.0	871 / 979	90.2	2.015	2.028	2.014	1.992	2.012
3:05 PM	0 / 0	0.0	367 / 396	4.1	1.885	1.894	1.879	1.865	1.881
3:09 PM	0 / 0	0.0	367 / 395	4.0	1.880	1.890	1.875	1.861	1.877
	Target/Actual		Target/Actual						

Table I-2. Strain gauge readings during axial compression loading test of pile C-1

PILE DIAMETER: 18 IN
PILE LENGTH: 60 FT
LOAD TEST TYPE: COMPRESSION
BERKEL REP: Tanner Swafford

CONTRACTOR: BERKEL
PILE TYPE : ACIP
WEATHER: WINDY/SUNNY

PILE ID: C1
JACK S/N: BM8838
GAUGE S/N: 1101UXL2
LOAD CELL S/N: 1021728
BEGIN DATE: 12/1/2016
END DATE: 12/1/2016

TIME	JACK	LOAD CELL	STRAIN GAGE READINGS						
	LOAD (tons)	Load (tons)	2' (1632099)	10' (1632097)	20' (1632095)	30' (1632094)	40' (1632091)	50' (1631529)	58' (1631528)
12:40 PM	0.0	4.1	6782	6881	6702	-	6557	6762	6884
12:40 PM	16.1	12.3	x	x	x	-	x	x	x
12:44 PM	8.0	7.3	6771	6872	6697	-	6556	6762	6885
12:45 PM	29.5	30.4	x	x	x	-	x	x	x
12:49 PM	24.1	24.4	6704	6816	6647	-	6545	6755	6885
12:50 PM	45.6	46.7	x	x	x	-	x	x	x
12:54 PM	42.9	44.7	6619	6746	6588	-	6525	6744	6880
12:55 PM	60.0	60.4	x	x	x	-	x	x	x
12:59 PM	57.0	58.4	6561	6696	6540	-	6505	6733	6875
1:00 PM	78.0	76.6	x	x	x	-	x	x	x
1:04 PM	75.0	73.0	6499	6642	6488	-	6482	6714	6864
1:05 PM	93.0	92.3	x	x	x	-	x	x	x
1:09 PM	87.0	88.8	6445	6592	6442	-	6461	6699	6855
1:10 PM	108.0	109.1	x	x	x	-	x	x	x
1:14 PM	99.0	105.1	6387	6540	6392	-	6439	6681	6844
1:15 PM	129.0	134.1	x	x	x	-	x	x	x
1:19 PM	120.0	129.4	6297	6460	6314	-	6404	6652	6827
1:20 PM	144.0	150.4	x	x	x	-	x	x	x
1:24 PM	135.0	144.9	6241	6409	6262	-	6380	6631	6815
1:25 PM	158.8	168.7	x	x	x	-	x	x	x
1:29 PM	150.0	163.1	6179	6352	6205	-	6355	6610	6804
1:30 PM	173.5	189.6	x	x	x	-	x	x	x
1:34 PM	164.7	182.9	6112	6294	6143	-	6325	6587	6791
1:35 PM	188.2	207.8	x	x	x	-	x	x	x
1:39 PM	179.4	200.2	6052	6238	6087	-	6303	6566	6782
1:40 PM	202.9	229.7	x	x	x	-	x	x	x
1:44 PM	194.1	221.5	5980	6173	6011	-	6271	6542	6769
1:45 PM	217.6	250.4	x	x	x	-	x	x	x
1:49 PM	208.8	241.0	5912	6112	5950	-	6234	6512	6755
1:50 PM	235.3	270.9	x	x	x	-	x	x	x
1:54 PM	250.0	261.8	5834	6042	5876	-	6206	6493	6746
1:55 PM	250.0	287.1	x	x	x	-	x	x	x
1:59 PM	238.2	278.3	5777	5989	5816	-	6179	6472	6735
2:00 PM	268.4	315.2	x	x	x	-	x	x	x
2:04 PM	256.1	301.0	5696	5910	5730	-	6139	6443	6720
2:05 PM	280.6	327.3	x	x	x	-	x	x	x
2:09 PM	266.8	315.4	5643	5862	5676	-	6115	6424	6709
2:10 PM	292.8	341.9	x	x	x	-	x	x	x
2:14 PM	277.5	327.1	5604	5822	5632	-	6093	6409	6700
2:15 PM	317.0	369.6	x	x	x	-	x	x	x
2:19 PM	299.0	354.0	5501	5730	5530	-	6049	6374	6679
2:20 PM	326.0	380.4	x	x	x	-	x	x	x
2:24 PM	308.0	365.0	5452	5686	5481	-	6026	6357	6664
2:25 PM	347.0	434.8	x	x	x	-	x	x	x
2:29 PM	323.0	383.4	5389	5628	5414	-	5993	6330	6642
2:30 PM	358.8	424.9	x	x	x	-	x	x	x
2:31 PM	329.0	391.1	5348	5591	5372	-	5971	6311	6624
2:35 PM	370.6	435.8	x	x	x	-	x	x	x
2:39 PM	347.0	416.4	5249	5505	5171	-	5911	6262	6583
2:40 PM	311.0	436.6	x	x	x	-	x	x	x
2:44 PM	347.0	352.4	5148	5422	5092	-	5919	6264	6579
2:45 PM	287.9	352.4	x	x	x	-	x	x	x
2:49 PM	289.8	353.0	5440	5655	5366	-	5920	6266	6578
2:50 PM	214.7	263.9	x	x	x	-	x	x	x
2:54 PM	214.7	265.5	5725	5903	5582	-	5974	6301	6594
2:55 PM	144.0	171.7	x	x	x	-	x	x	x
2:59 PM	141.0	174.5	6033	6182	5886	-	6079	6380	6639
3:00 PM	72.0	86.9	x	x	x	-	x	x	x
3:04 PM	78.0	90.2	6334	6468	6180	-	6200	6468	6668
3:05 PM	0.0	4.1	x	x	x	-	x	x	x
3:09 PM	0.0	4.0	6694	6789	6533	-	6390	6632	6775

Table I-3. Load – displacement measurements during axial compression loading test of pile C-2

PILE DIAMETER:	24 IN	CONTRACTOR:	BERKEL	PILE ID:	C2
PILE LENGTH:	60 FT	PILE TYPE :	ACIP	JACK S/N:	WB823
LOAD TEST TYPE:	COMPRESSION	WEATHER:	WINDY/SUNNY	GAUGE S/N:	WB1285
BERKEL REP:	Tanner Swafford			LOAD CELL S/N:	1021728
				BEGIN DATE:	11/30/2016
				END DATE:	11/30/2016

TIME	JACK		LOAD CELL		PILE HEAD MOVEMENT				
	PRESSURE (psi)	LOAD (tons)	(dgs)	Load (tons)	DIAL 1 (in)	DIAL 2 (in)	DIAL 3 (in)	DIAL 4 (in)	AVERAGE (in)
	0 / 0	0.0	367 / 448	0.0	0.000	0.000	0.000	0.000	0.000
3:58 PM	160 / 150	14.1	472 / 499	9.8	0.003	0.004	0.002	0.002	0.003
4:02 PM	160 / 110	10.3	472 / 493	8.7	0.004	0.005	0.003	0.004	0.004
4:03 PM	320 / 300	28.1	577 / 558	21.2	0.016	0.018	0.016	0.018	0.017
4:07 PM	320 / 300	28.1	577 / 551	19.8	0.019	0.019	0.021	0.023	0.021
4:08 PM	480 / 490	46.0	682 / 624	33.8	0.030	0.030	0.031	0.034	0.031
4:12 PM	480 / 450	42.2	682 / 613	31.7	0.031	0.031	0.032	0.036	0.033
4:13 PM	640 / 650	61.3	787 / 704	48.4	0.052	0.053	0.050	0.052	0.052
4:17 PM	640 / 625	58.9	787 / 693	46.7	0.054	0.055	0.051	0.052	0.053
4:18 PM	800 / 800	75.6	892 / 757	56.4	0.069	0.070	0.062	0.064	0.066
4:22 PM	800 / 800	75.6	892 / 744	54.5	0.074	0.074	0.065	0.066	0.070
4:23 PM	950 / 950	90.0	977 / 804	63.6	0.090	0.092	0.082	0.083	0.087
4:27 PM	950 / 900	85.2	977 / 792	61.8	0.094	0.095	0.085	0.085	0.090
4:28 PM	1100 / 1100	105.0	1063 / 877	74.7	0.122	0.125	0.110	0.108	0.116
4:32 PM	1100 / 1100	105.0	1063 / 861	72.3	0.127	0.130	0.110	0.110	0.119
4:33 PM	1250 / 1250	120.0	1149 / 924	81.9	0.144	0.146	0.129	0.126	0.136
4:37 PM	1250 / 1200	115.0	1149 / 908	79.5	0.150	0.152	0.131	0.128	0.140
4:38 PM	1400 / 1500	145.0	1235 / 1002	94.4	0.190	0.193	0.172	0.162	0.179
4:42 PM	1400 / 1425	137.5	1235 / 994	93.0	0.198	0.200	0.178	0.173	0.187
4:43 PM	1550 / 1650	160.0	1321 / 1076	107.3	0.221	0.227	0.207	0.200	0.214
4:47 PM	1550 / 1575	152.5	1321 / 1057	104.0	0.231	0.235	0.211	0.206	0.221
4:48 PM	1700 / 1800	175.0	1395 / 1130	116.7	0.252	0.257	0.236	0.230	0.244
4:52 PM	1700 / 1700	165.0	1395 / 1104	112.2	0.264	0.267	0.243	0.236	0.253
4:53 PM	1850 / 1950	190.0	1470 / 1200	128.9	0.296	0.300	0.278	0.268	0.286
4:57 PM	1850 / 1900	185.0	1470 / 1178	125.1	0.304	0.309	0.284	0.275	0.293
4:58 PM	2000 / 2100	205.0	1545 / 1262	140.2	0.334	0.341	0.315	0.305	0.324
5:02 PM	2000 / 2025	197.5	1545 / 1238	135.6	0.342	0.347	0.321	0.309	0.330
5:03 PM	2150 / 2225	217.5	1619 / 1298	147.1	0.364	0.371	0.344	0.332	0.353
5:07 PM	2150 / 2175	212.5	1619 / 1281	143.8	0.375	0.380	0.351	0.340	0.362
5:08 PM	2300 / 2400	235.0	1694 / 1356	158.2	0.400	0.409	0.380	0.365	0.389
5:12 PM	2300 / 2300	225.0	1694 / 1334	154.0	0.412	0.420	0.388	0.374	0.399
5:13 PM	2450 / 2550	250.0	1769 / 1416	169.7	0.442	0.452	0.420	0.406	0.430
5:17 PM	2450 / 2475	242.5	1769 / 1388	164.3	0.456	0.464	0.431	0.417	0.442
5:18 PM	2600 / 2700	265.0	1843 / 1467	179.4	0.485	0.495	0.460	0.445	0.471
5:22 PM	2600 / 2600	255.0	1843 / 1439	174.1	0.495	0.506	0.469	0.453	0.481
5:23 PM	2750 / 2850	280.0	1918 / 1521	190.2	0.536	0.548	0.510	0.495	0.522
5:27 PM	2750 / 2800	275.0	1918 / 1506	187.2	0.548	0.558	0.520	0.500	0.532
5:28 PM	2900 / 3000	295.0	1993 / 1596	205.3	0.583	0.595	0.545	0.537	0.565
5:32 PM	2900 / 2900	285.0	1993 / 1549	195.9	0.603	0.610	0.570	0.551	0.584
5:33 PM	3050 / 3150	310.0	2068 / 1645	215.2	0.638	0.648	0.605	0.587	0.620
5:37 PM	3050 / 3025	297.5	2068 / 1607	207.5	0.654	0.660	0.620	0.600	0.634
5:38 PM	3200 / 3275	322.5	2143 / 1689	224.0	0.703	0.713	0.668	0.648	0.683
5:42 PM	3200 / 3150	310.0	2143 / 1653	216.8	0.718	0.728	0.680	0.658	0.696
5:43 PM	3350 / 3425	337.5	2219 / 1763	238.9	0.780	0.793	0.747	0.724	0.761
5:47 PM	3350 / 3300	325.0	2219 / 1717	229.6	0.799	0.810	0.760	0.737	0.777
5:48 PM	3500 / 3600	355.0	2295 / 1845	255.3	0.885	0.880	0.850	0.826	0.860
5:52 PM	3500 / 3500	345.0	2295 / 1787	243.7	0.912	0.922	0.867	0.843	0.886
5:53 PM	3650 / 3800	375.0	2371 / 1917	269.8	1.015	1.030	0.975	0.950	0.993
5:57 PM	3650 / 3650	360.0	2371 / 1851	256.5	1.040	1.050	0.990	0.965	1.011
5:58 PM	3800 / 3800	375.0	2447 / 1904	267.2	1.125	1.135	1.080	1.052	1.098
6:02 PM	3800 / 3650	360.0	2447 / 1862	258.8	1.138	1.147	1.089	1.060	1.109
6:03 PM	3950 / 4100	405.0	2523 / 1998	286.0	1.299	1.314	1.250	1.222	1.271
6:07 PM	3950 / 3800	375.0	2523 / 1905	267.4	1.315	1.329	1.262	1.233	1.285
6:12 PM	4100 / 4200	415.0	2599 / 2040	294.4	1.530	1.542	1.470	1.443	1.496
6:16 PM	4100 / 4000	395.0	2599 / 1986	283.6	1.550	1.559	1.484	1.456	1.512
6:17 PM	4250 / 4350	430.0	2675 / 2091	304.6	1.829	1.845	1.770	1.738	1.796
6:21 PM	4250 / 4125	407.5	2675 / 2036	293.6	1.860	1.875	1.792	1.760	1.822
6:22 PM	4400 / 4500	445.0	2751 / 2141	314.6	2.080	2.199	2.076	2.053	2.102
6:26 PM	4400 / 4300	425.0	2751 / 2095	305.4	2.080	2.199	2.076	2.060	2.104
6:48 PM	3530 / 3550	350.0	2310 / 2036	293.6	2.080	2.199	2.076	2.060	2.104
6:52 PM	3530 / 3550	350.0	2310 / 2033	293.0	2.080	2.197	2.076	2.060	2.103
6:53 PM	2660 / 2650	260.0	1873 / 1703	226.8	2.080	2.197	2.076	2.060	2.103
6:57 PM	2660 / 2650	260.0	1873 / 1708	227.8	2.080	2.197	2.076	2.060	2.103
6:58 PM	1790 / 1800	175.0	1440 / 1373	161.4	2.080	2.197	2.076	2.060	2.103
7:02 PM	1790 / 1800	175.0	1440 / 1379	162.6	2.080	2.197	2.076	2.060	2.103
7:03 PM	920 / 900	85.2	960 / 984	91.2	2.080	2.197	2.076	2.060	2.103
7:07 PM	920 / 900	85.2	960 / 986	91.6	2.080	2.197	2.076	2.058	2.103
7:08 PM	0 / 0	0.0	367 / 406	0.0	1.197	2.045	2.040	2.021	1.826
7:12 PM	0 / 0	0.0	367 / 402	0.0	1.197	2.045	2.040	2.021	1.826
	Target/Actual		*Target/Actual*						

Table I-4. Strain gauge readings during axial compression loading test of pile C-2

PILE DIAMETER: 24 IN
PILE LENGTH: 60 FT
LOAD TEST TYPE: COMPRESSION
BERKEL REP: Tanner Swafford

CONTRACTOR: BERKEL
PILE TYPE : ACIP
WEATHER: WINDY/SUNNY

PILE ID: C2
JACK S/N: WB823
GAUGE S/N: WB1285
LOAD CELL S/N: 1021728
BEGIN DATE: 11/30/2016
END DATE: 11/30/2016

TIME			STRAIN GAGE READINGS					
	LOAD (tons)	Load (tons)	10' (1632098)	20' (1632096)	30' (1632093)	40' (1632092)	50' (1632090)	58' (1631527)
	0.0	0.0	6694	6652	6455	6711	6702	6730
3:58 PM	14.1	9.8	x	x	x	x	x	x
4:02 PM	10.3	8.7	6664	6632	6437	6685	6697	6729
4:03 PM	28.1	21.2	x	x	x	x	x	x
4:07 PM	28.1	19.8	6643	6618	6424	6653	6693	6728
4:08 PM	46.0	33.8	x	x	x	x	x	x
4:12 PM	42.2	31.7	6618	6601	6406	6608	6686	6724
4:13 PM	61.3	48.4	x	x	x	x	x	x
4:17 PM	58.9	46.7	6587	6577	6382	6554	6677	6723
4:18 PM	75.6	56.4	x	x	x	x	x	x
4:22 PM	75.6	54.5	6565	6561	6364	6522	6669	6718
4:23 PM	90.0	63.6	x	x	x	x	x	x
4:27 PM	85.2	61.8	6543	6545	6346	6498	6661	6712
4:28 PM	105.0	74.7	x	x	x	x	x	x
4:32 PM	105.0	72.3	6513	6521	6321	6465	6650	6703
4:33 PM	120.0	81.9	x	x	x	x	x	x
4:37 PM	115.0	79.5	6493	6505	6306	6446	6642	6699
4:38 PM	145.0	94.4	x	x	x	x	x	x
4:42 PM	137.5	93.0	6454	6474	6274	6409	6629	6690
4:43 PM	160.0	107.3	x	x	x	x	x	x
4:47 PM	152.5	104.0	6429	6454	6252	6383	6619	6684
4:48 PM	175.0	116.7	x	x	x	x	x	x
4:52 PM	165.0	112.2	6406	6437	6234	6361	6612	6679
4:53 PM	190.0	128.9	x	x	x	x	x	x
4:57 PM	185.0	125.1	6374	6412	6209	6329	6601	6672
4:58 PM	205.0	140.2	x	x	x	x	x	x
5:02 PM	197.5	135.6	6348	6389	6187	6301	6592	6666
5:03 PM	217.5	147.1	x	x	x	x	x	x
5:07 PM	212.5	143.8	6328	6376	6172	6281	6585	6663
5:08 PM	235.0	158.2	x	x	x	x	x	x
5:12 PM	225.0	154.0	6303	6356	6152	6254	6573	6659
5:13 PM	250.0	169.7	x	x	x	x	x	x
5:17 PM	242.5	164.3	6277	6334	6131	6225	6568	6651
5:18 PM	265.0	179.4	x	x	x	x	x	x
5:22 PM	255.0	174.1	6257	6318	6114	6201	6560	6648
5:23 PM	280.0	190.2	x	x	x	x	x	x
5:27 PM	275.0	187.2	6226	6295	6089	6166	6550	6642
5:28 PM	295.0	205.3	x	x	x	x	x	x
5:32 PM	285.0	195.9	6204	6278	6073	6141	6544	6635
5:33 PM	310.0	215.2	x	x	x	x	x	x
5:37 PM	297.5	207.5	6175	6256	6052	6111	6535	6629
5:38 PM	322.5	224.0	x	x	x	x	x	x
5:42 PM	310.0	216.8	6153	6239	6036	6087	6528	6622
5:43 PM	337.5	238.9	x	x	x	x	x	x
5:47 PM	325.0	229.6	6124	6217	6016	6058	6518	6613
5:48 PM	355.0	255.3	x	x	x	x	x	x
5:52 PM	345.0	243.7	6087	6192	5992	6025	6502	6601
5:53 PM	375.0	269.8	x	x	x	x	x	x
5:57 PM	360.0	256.5	6052	6170	5973	6002	6484	6589
5:58 PM	375.0	267.2	x	x	x	x	x	x
6:02 PM	360.0	258.8	6046	6163	5966	5994	6472	6582
6:03 PM	405.0	286.0	x	x	x	x	x	x
6:07 PM	375.0	267.4	6008	6135	** n/a **	5966	6451	6564
6:12 PM	415.0	294.4	x	x	x	x	x	x
6:16 PM	395.0	283.6	5987	6120	5933	5592	6433	6546
6:17 PM	430.0	304.6	x	x	x	x	x	x
6:21 PM	407.5	293.6	5962	6099	5917	5921	6413	6525
6:22 PM	445.0	314.6	x	x	x	x	x	x
6:26 PM	425.0	305.4	5931	6075	5896	5892	6393	6497
6:48 PM	350.0	293.6	x	x	x	x	x	x
6:52 PM	350.0	293.0	5958	6098	5916	5903	6396	6498
6:53 PM	260.0	226.8	x	x	x	x	x	x
6:57 PM	260.0	227.8	6097	6185	5985	5972	6423	6513
6:58 PM	175.0	161.4	x	x	x	x	x	x
7:02 PM	175.0	162.6	6249	6292	6078	6070	6463	6534
7:03 PM	85.2	91.2	x	x	x	x	x	x
7:07 PM	85.2	91.6	6438	6447	6233	6239	6545	6598
7:08 PM	0.0	0.0	x	x	x	x	x	x
7:12 PM	0.0	0.0	6635	6591	6365	6431	6615	6647

APPENDIX J

TENSION LOAD TEST SETUP AND TEST RESULTS

Table J-1. Load – displacement measurements during axial tension loading test of pile T-1

PILE DIAMETER: 18 IN
PILE LENGTH: 60 FT
LOAD TEST TYPE: Tension
BERKEL REP: Tanner Swafford

CONTRACTOR: BERKEL
PILE TYPE : ACIP
WEATHER: WINDY/SUNNY

PILE ID: T-1
JACK S/N: BM8838
GAUGE S/N: 1101UXL2
LOAD CELL S/N: 09-22592
BEGIN DATE: 12/5/2016
END DATE: 12/5/2016

TIME	JACK		LOAD CELL		PILE HEAD MOVEMENT					Reaction Movement		
	PRESSURE (psi)	LOAD (tons)	(dgs)	Load (tons)	Dial 1 (in)	Dial 2 (in)	Dial 3 (in)	Dial 4 (in)	Dial Average	R1	R5	CB reading(in)
11:20	0 / 0	0.0	-538 / -540	0.0	0.000	0.000	0.000	0.000	0.000			0.75
11:20	186 / 275	14.7	-437 / -417	12.0	0.002	0.000	0.000	0.002	0.002			
11:24	186 / 275	14.7	-437 / -422	11.5	0.002	0.001	0.002	0.003	0.003			
11:25	373 / 375	20.1	-336 / -364	17.2	0.005	0.004	0.005	0.006	0.006			
11:29	373 / 375	20.1	-336 / -369	16.7	0.006	0.007	0.009	0.007	0.007			0.78
11:30	559 / 550	29.5	-235 / -255	28.0	0.011	0.010	0.014	0.013	0.012			
11:34	559 / 500	26.8	-235 / -260	27.5	0.013	0.012	0.013	0.014	0.014			
11:35	746 / 750	40.2	-134 / -121	41.3	0.019	0.019	0.021	0.020	0.020			
11:39	746 / 725	38.9	-134 / -136	39.8	0.020	0.020	0.021	0.020	0.020			0.81
11:40	933 / 950	51.0	-33 / 16	54.9	0.026	0.025	0.027	0.030	0.028	0.012	0.010	
11:44	933 / 900	48.2	-33 / 4	53.7	0.031	0.029	0.033	0.038	0.035			
11:45	1100 / 1125	61.5	67 / 95	62.7	0.075	0.095	0.096	0.090	0.083			
11:49	1100 / 1050	57.0	67 / 76	60.8	0.079	0.089	0.101	0.091	0.085			
11:50	1266 / 1250	69.0	168 / 205	73.7	0.112	0.122	0.138	0.126	0.119			0.94
11:54	1266 / 1200	66.0	168 / 171	70.3	0.119	0.129	0.140	0.130	0.125			
11:55	1433 / 1500	84.0	269 / 358	88.9	0.185	0.195	0.210	0.200	0.193			
11:59	1433 / 1425	79.5	269 / 329	86.0	0.190	0.200	0.214	0.204	0.197			
12:00	1600 / 1700	96.0	369 / 401	93.1	0.240	0.250	0.266	0.260	0.250			1.06
12:04	1600 / 1600	90.0	369 / 446	97.6	0.249	0.252	0.270	0.264	0.257			
12:05	1767 / 1800	102.0	470 / 552	108.3	0.280	0.286	0.305	0.300	0.290	0.028	0.023	
12:09	1767 / 1750	99.0	470 / 537	106.8	0.282	0.288	0.308	0.301	0.292			1.13
12:10	1933 / 2000	114.0	568 / 696	123.0	0.340	0.341	0.366	0.364	0.352			
12:14	1933 / 1950	111.0	568 / 671	120.4	0.348	0.351	0.375	0.368	0.358			
12:15	2100 / 2250	129.0	666 / 846	138.2	0.423	0.428	0.456	0.450	0.437			
12:19	2100 / 2150	123.0	666 / 824	136.0	0.430	0.431	0.461	0.452	0.441			
12:20	2266 / 2325	133.5	765 / 917	145.4	0.468	0.470	0.498	0.493	0.481			
12:24	2266 / 2250	129.0	765 / 883	142.0	0.470	0.473	0.500	0.492	0.481			
12:25	2433 / 2500	144.0	863 / 1047	158.4	0.537	0.538	0.566	0.562	0.550			
12:29	2433 / 2450	141.0	863 / 1009	154.7	0.540	0.538	0.568	0.563	0.552			1.66
12:30	2600 / 2700	155.9	962 / 1154	169.1	0.593	0.593	0.627	0.625	0.609	0.035	0.039	
12:34	2600 / 2600	150.0	962 / 1108	164.5	0.602	0.602	0.633	0.629	0.616			
12:35	2770 / 2850	164.7	1062 / 1249	178.5	0.662	0.659	0.693	0.693	0.678			
12:39	2770 / 2725	157.4	1062 / 1204	174.1	0.664	0.664	0.696	0.695	0.680			
12:40	2940 / 3050	176.5	1163 / 1377	191.3	0.754	0.748	0.781	0.783	0.769			
12:44	2940 / 2950	170.6	1163 / 1329	186.5	0.758	0.754	0.788	0.787	0.773			1.78
12:45	3110 / 3200	185.3	1263 / 1495	203.0	0.862	0.854	0.892	0.892	0.877			
12:49	3110 / 3125	180.9	1263 / 1453	198.8	0.925	0.918	0.950	0.951	0.921			
12:50	3280 / 3350	194.1	1364 / 1592	212.8	0.925	0.918	0.950	0.951	0.938			
12:54	3280 / 3250	188.2	1364 / 1551	208.7	0.930	0.918	0.953	0.957	0.944			
12:55	3450 / 3550	205.9	1465 / 1726	226.4	1.010	0.995	1.030	1.040	1.025	0.054	0.039	2.00
12:59	3450 / 3450	200.0	1465 / 1678	221.5	1.015	1.006	1.038	1.045	1.030			
1:00	3620 / 3750	217.6	1564 / 1841	238.0	1.103	1.090	1.125	1.130	1.117			
1:04	3620 / 3600	208.8	1564 / 1790	232.8	1.109	1.095	1.129	1.137	1.123			2.25
1:05	3790 / 3850	223.5	1663 / 1922	246.2	1.170	1.163	1.198	1.200	1.185			
1:09	3790 / 3750	217.6	1663 / 1871	241.0	1.176	1.163	1.199	1.204	1.190			
1:10	3960 / 4150	241.2	1762 / 2114	265.6	1.304	1.293	1.325	1.335	1.320			
1:14	3960 / 4000	232.4	1762 / 2051	259.2	1.318	1.304	1.334	1.341	1.330			
1:15	4130 / 4250	247.1	1861 / 2191	273.4	1.392	1.375	1.405	1.417	1.405			
1:19	4130 / 4150	241.2	1861 / 2132	267.4	1.400	1.382	1.412	1.420	1.410			
1:20	4300 / 4425	257.6	1960 / 2305	285.0	1.490	1.470	1.500	1.515	1.503	0.073	0.039	
1:24	4300 / 4300	250.0	1960 / 2243	278.7	1.500	1.478	1.510	1.520	1.510			
1:25	4463 / 4550	265.3	2058 / 2394	294.0	1.582	1.560	1.595	1.606	1.594			
1:29	4463 / 4450	259.2	2058 / 2330	287.5	1.587	1.565	1.599	1.610	1.599			2.88
1:30	4626 / 4775	279.1	2157 / 2535	308.3	1.715	1.694	1.726	1.740	1.728			
1:34	4626 / 4650	271.4	2157 / 2461	300.8	1.726	1.708	1.735	1.750	1.738			
1:35	4790 / 4925	288.2	2255 / 2627	317.6	1.830	1.800	1.838	1.850	1.840			
1:39	4790 / 4750	277.5	2255 / 2543	309.1	1.838	1.813	1.843	1.858	1.848			
1:40	4953 / 5100	299.0	2354 / 2760	331.0	1.975	1.949	1.983	2.000	1.988	*Reset Gages*		2.94
1:44	4953 / 4925	288.2	2354 / 2637	318.6	1.983	1.956	1.990	2.005	1.994			
1:45	5117 / 5250	308.0	2453 / 2840	339.1	2.116	2.085	2.123	2.145	2.131			
1:49	5117 / 5050	295.9	2453 / 2744	329.4	2.128	2.099	2.136	2.155	2.142	0.088	0.039	
1:50	5283 / 5400	317.0	2552 / 2929	348.1	2.305	2.274	2.315	2.338	2.322			3.25
1:54	5283 / 5175	303.5	2552 / 2812	336.3	2.323	2.291	2.323	2.345	2.334			
1:55	5450 / 5600	329.0	2651 / 3041	359.4	2.585	2.544	2.591	2.618	2.602			
1:59	5450 / 5300	311.0	2651 / 2903	345.5	2.600	2.564	2.608	2.630	2.615			
2:00	5616 / 5800	341.0	2750 / 3159	371.3	3.073	3.149	3.081	3.110	3.092			
2:04	5616 / 5400	317.0	2750 / 2976	352.8	3.115	3.079	3.121	3.142	3.129	0.098	0.039	4.00
2:05	4528 / 4525	263.8	2098 / 2468	301.5	3.091	3.051	3.099	3.118	3.105			
2:09	4528 / 4550	265.3	2098 / 2474	302.1	3.089	3.044	3.093	3.110	3.100			
2:10	3416 / 3400	197.1	1444 / 1730	226.8	2.927	2.877	2.931	2.950	2.939			
2:14	3416 / 3450	200.0	1444 / 1738	227.6	2.933	2.887	2.931	2.955	2.944			
2:15	2300 / 2300	132.0	784 / 964	150.2	2.583	2.534	2.568	2.600	2.592			
2:19	2300 / 2300	132.0	784 / 984	152.2	2.584	2.534	2.569	2.600	2.592			
2:20	1200 / 1200	66.0	127 / 207	73.9	2.403	2.361	2.388	2.415	2.409			
2:24	1200 / 1250	69.0	127 / 230	76.1	2.403	2.361	2.388	2.415	2.409			
2:25	0 / 0	0.0	-538 / -539	0.0	2.083	2.043	2.057	2.085	2.084	0.030	0.039	2.78
2:29	0 / 0	0.0	-538 / -542	0.0	2.057	2.011	2.028	2.065	2.061			
	Target/Actual		Target/Actual		NOTE: Dial Gages Reset at 290 tons. Shown are calculated displacements corrected for reset							

Table J-2. Load – displacement measurements during axial tension loading test of pile T-2

PILE DIAMETER:	24	CONTRACTOR:	BERKEL	PILE ID:	T-2
PILE LENGTH:	60 FT	PILE TYPE :	ACIP	JACK S/N:	BM8838
LOAD TEST TYPE:	Tension	WEATHER:	WINDY/SUNNY	GAUGE S/N:	1101UXL2
BERKEL REP:	Tanner Swafford			LOAD CELL S/N:	08-22592
				BEGIN DATE:	12/2/2016
				END DATE:	12/2/2016

TIME	JACK		LOAD CELL		PILE HEAD MOVEMENT					
	PRESSURE (psi)	LOAD (tons)	(dgs)	Load (tons)	DIAL 1 (in)	Dial 2 (in)	Dial 3 (in)	Dial 4 (in)	Dial Average (in)	
12:15	0 / 0	0.00	-538 / -540	0.00	0.000	0.000	0.000	0.000	0.000	
12:15	280 / 300	16.07	-386 / -420	11.68	0.001	0.001	0.003	0.003	0.002	
12:19	280 / 300	16.07	-386 / -420	11.68	0.001	0.001	0.004	0.003	0.002	
12:20	560 / 600	32.22	-235 / -224	31.09	0.001	0.002	0.007	0.006	0.004	
12:24	560 / 600	32.22	-235 / -232	30.30	0.001	0.002	0.007	0.006	0.004	
12:25	840 / 850	46.11	-83 / -80	45.40	0.005	0.005	0.012	0.011	0.008	
12:29	840 / 850	46.11	-83 / -80	45.40	0.006	0.005	0.012	0.011	0.009	
12:30	1100 / 1100	60.00	67 / 64	59.70	0.013	0.014	0.019	0.018	0.016	
12:34	1100 / 1050	57.22	67 / 62	59.50	0.016	0.017	0.017	0.017	0.017	
12:35	1350 / 1300	72.00	218 / 219	75.05	0.094	0.074	0.055	0.075	0.075	**popping
12:39	1350 / 1250	69.00	218 / 181	71.29	0.100	0.075	0.061	0.080	0.079	
12:40	1600 / 1600	90.00	370 / 400	93.03	0.176	0.150	0.130	0.152	0.152	
12:44	1600 / 1500	84.00	370 / 343	87.33	0.181	0.156	0.135	0.157	0.157	
12:45	1850 / 1950	111.00	519 / 639	117.17	0.328	0.289	0.268	0.301	0.297	**popping
12:49	1850 / 1800	102.00	519 / 550	108.18	0.330	0.290	0.268	0.303	0.298	
12:50	2100 / 2200	126.00	667 / 806	134.14	0.525	0.477	0.452	0.488	0.486	
12:54	2100 / 2200	126.00	667 / 759	129.36	0.525	0.477	0.452	0.488	0.486	
12:55	2350 / 2350	135.00	814 / 908	144.51	0.605	0.558	0.532	0.571	0.567	
12:59	2350 / 2300	132.00	814 / 888	142.47	0.610	0.559	0.534	0.572	0.569	
1:00	2600 / 2600	150.00	962 / 1086	162.36	0.704	0.650	0.627	0.670	0.663	
1:04	2600 / 2500	144.00	962 / 1053	159.07	0.711	0.657	0.629	0.672	0.667	
1:05	2855 / 3000	173.53	1113 / 1341	187.77	0.865	0.810	0.786	0.834	0.824	
1:09	2855 / 2900	167.65	1113 / 1300	183.69	0.872	0.813	0.790	0.837	0.828	
1:10	3110 / 3250	188.24	1263 / 1514	205.02	0.971	0.914	0.901	0.948	0.934	
1:14	3110 / 3100	179.41	1263 / 1470	200.63	0.973	0.916	0.905	0.951	0.936	
1:15	3365 / 3500	202.94	1414 / 1677	221.41	0.993	0.938	1.020	1.066	1.004	
1:19	3365 / 3300	191.18	1414 / 1631	216.77	0.993	0.940	1.021	1.068	1.006	
1:20	3620 / 3700	214.71	1564 / 1837	237.58	1.010	0.958	1.137	1.184	1.072	
1:24	3620 / 3600	208.82	1564 / 1783	232.12	1.024	0.971	1.141	1.186	1.081	
1:25	3875 / 4000	232.35	1712 / 2024	256.52	1.041	0.996	1.272	1.320	1.157	
1:29	3875 / 3900	226.47	1712 / 1973	251.35	1.043	0.998	1.276	1.324	1.160	
1:30	4130 / 4250	247.26	1861 / 2181	272.43	1.060	1.020	1.390	1.438	1.227	
1:34	4130 / 4100	238.24	1861 / 2109	265.14	1.064	1.023	1.397	1.445	1.232	
1:35	4381 / 4500	262.38	2009 / 2353	289.86	1.090	1.053	1.526	1.570	1.310	
1:44	4381 / 4300	250.28	2009 / 2242	278.61	1.095	1.056	1.538	1.583	1.318	
1:45	4626 / 4800	280.63	2157 / 2540	308.79	1.134	1.103	1.700	1.748	1.421	
1:49	4626 / 4600	268.43	2157 / 2461	300.81	1.143	1.109	1.705	1.752	1.427	
1:50	4871 / 5000	292.85	2305 / 2683	323.23	1.190	1.152	1.827	1.879	1.512	
1:54	4871 / 4850	283.69	2305 / 2603	315.15	1.196	1.157	1.883	1.940	1.544	**Reset gages
2:00	5117 / 5300	310.99	2453 / 2866	341.72	1.265	1.232	2.061	2.121	1.670	
2:04	5117 / 5150	301.98	2453 / 2773	332.32	1.283	1.245	2.066	2.126	1.680	
2:05	5366 / 5500	323.01	2601 / 3010	356.26	1.355	1.320	2.166	2.227	1.767	
2:09	5366 / 5350	314.00	2601 / 2893	344.44	1.367	1.329	2.186	2.249	1.783	
2:10	5616 / 5800	341.03	2750 / 3135	368.92	1.475	1.440	2.433	2.496	1.961	
2:14	5616 / 5575	327.52	2750 / 3021	357.37	1.494	1.455	2.463	2.508	1.980	
2:15	5866 / 6000	352.89	2900 / 3357	391.42	1.995	1.970	2.991	3.042	2.500	
2:19	5866 / 5850	344.04	2900 / 3219	377.43	2.087	2.057	3.121	3.178	2.611	
2:33	4722 / 4700	274.52	2216 / 2472	301.92	2.076	2.062	3.131	3.182	2.613	
2:37	4722 / 4750	277.58	2216 / 2499	304.65	2.076	2.062	3.131	3.182	2.613	
2:38	3569 / 3550	205.88	1532 / 1801	233.94	2.020	1.994	3.047	3.104	2.541	
2:42	3569 / 3550	205.88	1532 / 1812	235.05	2.020	1.994	3.047	3.104	2.541	
2:43	2403 / 2400	138.00	845 / 987	152.49	1.903	1.870	2.898	2.966	2.409	
2:47	2403 / 2400	138.00	845 / 989	152.69	1.903	1.870	2.898	2.966	2.409	
2:48	1250 / 1250	69.00	157 / 167	69.90	1.742	1.710	2.615	2.685	2.188	
2:52	1250 / 1250	69.00	157 / 164	69.60	1.742	1.710	2.615	2.684	2.188	
2:53	0 / 0	0.00	-538 / -541	0.00	1.592	1.582	2.347	2.391	1.978	
2:57	0 / 0	0.00	-538 / -541	0.00	1.592	1.581	2.347	2.391	1.978	
	Target/Actual		Target/Actual		NOTE: Dial Gages Reset at 285 tons. Shown are calculated displacements correcte					

APPENDIX K

LATERAL LOAD TEST SETUP AND TEST RESULTS

Table K-1. Load – displacement measurements during lateral loading test of pile L-1

PILE DIAMETER:	18 IN	CONTRACTOR:	BERKEL	PILE ID:	L-1
PILE LENGTH:	40 FT	PILE TYPE :	ACIP	JACK S/N:	61129
LOAD TEST TYPE:	Lateral	WEATHER:	WINDY/SUNNY	GAUGE S/N:	1102QF1
BERKEL REP:	Tanner Swafford			LOAD CELL S/N:	n/a
				BEGIN DATE:	12/6/2016
				END DATE:	12/6/2016

HOLD TIME/TIME	JACK		LOAD CELL		PILE HEAD MOVEMENT			Secondary
	PRESSURE (psi)	LOAD (tons)	(dgs)	Load (tons)	Top - DIAL 1 (in)	Bottom - DIAL 2 (in)	Average (in)	(in)
2:58	0 / 0	0.0	X	0.0	0.000	0.000	0.000	2.00
2:59	197 / 225	2.3	X	2.0	0.024	0.019	0.022	2.03
3:08	197 / 200	2.0	X	2.0	0.025	0.019	0.022	2.03
3:09	393 / 450	4.6	X	4.0	0.056	0.049	0.053	2.06
3:18	393 / 375	3.8	X	4.0	0.053	0.044	0.049	2.06
3:19	590 / 650	6.6	X	6.0	0.094	0.081	0.088	2.13
3:33	590 / 600	6.1	X	6.0	0.099	0.085	0.092	2.13
3:34	786 / 850	8.6	X	8.0	0.166	0.145	0.156	2.19
3:53	786 / 725	7.4	X	8.0	0.162	0.141	0.152	2.19
3:54	983 / 1050	10.6	X	10.0	0.284	0.247	0.266	2.34
4:13	983 / 950	9.7	X	10.0	0.282	0.246	0.264	2.34
4:14	1196 / 1275	12.7	X	12.0	0.454	0.397	0.426	2.53
4:33	1196 / 1150	11.6	X	12.0	0.455	0.398	0.427	2.53
4:34	1410 / 1500	14.8	X	14.0	0.668	0.583	0.626	2.78
4:53	1410 / 1300	13.0	X	14.0	0.668	0.585	0.627	2.78
4:54	1517 / 1650	16.3	X	15.0	0.798	0.699	0.749	2.94
5:13	1517 / 1450	14.4	X	15.0	0.795	0.698	0.747	2.94
5:14	1623 / 1750	17.2	X	16.0	0.918	0.805	0.862	3.06
5:33	1623 / 1625	16.0	X	16.0	0.918	0.808	0.863	3.06
5:34	1730 / 1850	18.1	X	17.0	1.041	0.912	0.977	3.22
5:53	1730 / 1725	17.0	X	17.0	1.041	0.914	0.978	3.19
5:54	1837 / 1950	19.1	X	18.0	1.130	0.995	1.063	3.31
6:13	1837 / 1800	17.7	X	18.0	1.130	0.996	1.063	3.31
6:14	1943 / 2050	20.0	X	19.0	1.308	1.155	1.232	3.50
6:33	1943 / 1900	18.6	X	19.0	1.308	1.156	1.232	3.50
6:34	1436 / 1425	14.1	X	14.25	1.297	1.148	1.223	3.50
6:38	1436 / 1425	14.1	X	14.25	1.297	1.148	1.223	3.50
6:39	933 / 900	9.2	X	9.5	1.278	1.047	1.163	3.34
6:43	933 / 900	9.2	X	9.5	1.277	1.047	1.162	3.34
6:44	466 / 450	4.6	X	4.75	0.940	0.841	0.891	3.06
6:48	466 / 500	5.1	X	4.75	0.940	0.841	0.891	3.06
6:49	0 / 0	0.0	X	0.0	0.286	0.257	0.272	2.31
6:53	0 / 0	0.0	X	0.0	0.286	0.257	0.272	2.31
	Target/Actual							

Table K-2. Load – displacement measurements during lateral loading test of pile L-2

PILE DIAMETER: 24 IN	CONTRACTOR: BERKEL	PILE ID: L-2
PILE LENGTH: 40 FT	PILE TYPE : ACIP	JACK S/N: 61129
LOAD TEST TYPE: Lateral	WEATHER: WINDY/SUNNY	GAUGE S/N: 1102QF1
BERKEL REP: Tanner Swafford		LOAD CELL S/N: n/a
		BEGIN DATE: 12/6/2016
		END DATE: 12/6/2016

TIME	JACK		LOAD CELL		PILE HEAD MOVEMENT			Secondary
	PRESSURE (psi)	LOAD (tons)	(dgs)	Load (tons)	Top - DIAL 1 (in)	Bottom - DIAL 2 (in)	Average (in)	(in)
9:08	0 / 0	0.00	X	0	0.000	0.000	0.000	3.00
9:08	393 / 425	4.33	X	4	0.030	0.025	0.028	3.03
9:17	393 / 400	4.07	X	4	0.032	0.026	0.029	3.03
9:18	786 / 850	8.62	X	8	0.091	0.078	0.085	3.09
9:27	786 / 800	8.14	X	8	0.091	0.080	0.086	3.09
9:28	1196 / 1200	12.04	X	12	0.298	0.271	0.285	3.31
9:41	1196 / 1175	11.80	X	12	0.303	0.278	0.291	3.34
9:42	1623 / 1650	16.25	X	16	0.491	0.444	0.468	3.47
10:01	1623 / 1600	15.78	X	16	0.494	0.448	0.471	3.50
10:02	2050 / 2000	19.53	X	20	0.712	0.646	0.679	3.59
10:21	2050 / 1925	18.83	X	20	0.720	0.652	0.686	3.59
10:22	2423 / 2400	23.75	X	24	1.020	0.924	0.972	4.03
10:41	2423 / 2350	23.22	X	24	1.022	0.928	0.975	4.03
10:42	2610 / 2600	25.89	X	26	1.255	1.136	1.196	4.59
11:01	2610 / 2500	24.82	X	26	1.258	1.145	1.202	4.59
11:02	1996 / 2000	19.53	X	19.5	1.258	1.144	1.201	4.59
11:06	1996 / 2025	19.77	X	19.5	1.243	1.128	1.186	4.59
11:07	1302 / 1300	12.97	X	13	1.163	1.062	1.113	4.38
11:11	1302 / 1300	12.97	X	13	1.169	1.064	1.117	4.38
11:12	638 / 650	6.62	X	6.5	0.993	0.817	0.905	3.91
11:16	638 / 650	6.62	X	6.5	0.996	0.820	0.908	3.88
11:17	0 / 0	0.00	X	0	0.412	0.385	0.399	3.38
11:21	0 / 0	0.00	X	0	0.411	0.385	0.398	3.38
	Target/Actual							

APPENDIX L

AS-BUILT MEASUREMENTS OF EXTRACTED PILE (E-1)

Table L-1. Measurements of circumference of the extracted pile E-1

Increment	Distance along Pile		Measured Circumference		Calculated Diameter		Difference from Theoretical Diameter		
	(ft)	(m)	(in)	(mm)	(in)	(mm)	(in)	(mm)	(%)
1	1	0.3	57	1448	18.1	461	0.1	4	0.8%
2	2	0.6	57	1448	18.1	461	0.1	4	0.8%
3	3	0.9	62	1575	19.7	501	1.7	44	9.6%
4	4	1.2	62	1575	19.7	501	1.7	44	9.6%
5	5	1.5	61	1549	19.4	493	1.4	36	7.9%
6	6	1.8	60	1524	19.1	485	1.1	28	6.1%
7	7	2.1	59	1499	18.8	477	0.8	20	4.3%
8	8	2.4	59	1499	18.8	477	0.8	20	4.3%
9	9	2.7	61	1549	19.4	493	1.4	36	7.9%
10	10	3.0	61	1549	19.4	493	1.4	36	7.9%
11	11	3.4	60	1524	19.1	485	1.1	28	6.1%
12	12	3.7	60	1524	19.1	485	1.1	28	6.1%
13	13	4.0	60	1524	19.1	485	1.1	28	6.1%
14	14	4.3	60	1524	19.1	485	1.1	28	6.1%
15	15	4.6	60	1524	19.1	485	1.1	28	6.1%
16	16	4.9	60	1524	19.1	485	1.1	28	6.1%
17	17	5.2	60	1524	19.1	485	1.1	28	6.1%
18	18	5.5	61	1549	19.4	493	1.4	36	7.9%
19	19	5.8	60	1524	19.1	485	1.1	28	6.1%
20	20	6.1	60	1524	19.1	485	1.1	28	6.1%
21	21	6.4	60	1524	19.1	485	1.1	28	6.1%
22	22	6.7	60	1524	19.1	485	1.1	28	6.1%
23	23	7.0	60	1524	19.1	485	1.1	28	6.1%
24	24	7.3	60	1524	19.1	485	1.1	28	6.1%
25	25	7.6	62	1575	19.7	501	1.7	44	9.6%
26	26	7.9	62	1575	19.7	501	1.7	44	9.6%
27	27	8.2	63	1600	20.1	509	2.1	52	11.4%
28	28	8.5	65	1651	20.7	526	2.7	69	15.0%
29	29	8.8	65	1651	20.7	526	2.7	69	15.0%
30	30	9.1	65	1651	20.7	526	2.7	69	15.0%
31	31	9.5	65	1651	20.7	526	2.7	69	15.0%
32	32	9.7	63	1600	20.1	509	2.1	52	11.4%
33	33	10.1	64	1626	20.4	517	2.4	60	13.2%
34	34	10.4	63	1600	20.1	509	2.1	52	11.4%
35	35	10.7	63	1600	20.1	509	2.1	52	11.4%
36	36	11.0	64	1626	20.4	517	2.4	60	13.2%
37	37	11.3	61	1549	19.4	493	1.4	36	7.9%
38	38	11.6	59	1499	18.8	477	0.8	20	4.3%
39	39	11.9	59	1499	18.8	477	0.8	20	4.3%
40	40	12.2	59	1499	18.8	477	0.8	20	4.3%