LTPP Seasonal Monitoring Program

Site Installation and Initial Data Collection
Section 484143, Beaumont, Texas

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16. Abstract

This report contains a description of the instrumentation installation activities and initial data collection for test section 484143, which is a part of the LTPP Core Seasonal Monitoring Program. This asphalt concrete surfaced pavement test section, which is located on US-90 in the eastbound lanes, approximately 3.5 km east of FM-365, near the city of Beaumont, Texas, was instrumented on November 17-18, 1993. The instrumentation installed included time domain reflectometry probes for moisture content, thermistor probes for temperature, tipping-bucket rain gauge, an observation well to monitor the ground water table, and an on-site data logger. Initial data collection was performed on November 18, 1993, which consisted of deflection measurements with a Falling Weight Deflectometer (FWD), elevation measurements, temperature measurements, and TDR measurements. The report contains a description of the test site and its location, the instruments installed at the site and their locations, characteristics of the installed instruments and probes, problems encountered during installation, specific site circumstances and deviations from the standard guidelines, and a summary of the initial data collection.

17. Key Words	18. Distribution Statement
Pavement, Highway, Instrumentation, Monitoring, Time Domain Reflectometry, Thermistor, Observation Well, Test Equipment, Field Tests.	

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INSTRUMENTATION INSTALLATION
TEXAS SECTION 484143/48SD

I. Introduction

The seasonal instrumentation installation of Section 484143 was performed on November 17-18, 1993, and was the first one completed in the Southern Region.

The GPS-1 test section resides in Seasonal Cell 26 and is located in a wet-no freeze zone. The site (see Figure A-1) is in the eastbound lanes on US-90, approximately 3.5 km east of FM-365, near the city of Beaumont, Texas. The divided highway consists of two 3.7 m wide travel lanes in each direction. The outside shoulder is 3.0 m wide.

The average maximum daily temperature for the months of June through August is 33.1°C and the average minimum daily temperature for the months of December through February is 5.4°C. The average annual precipitation is 1466 mm.

The pavement is a jointed reinforced concrete structure consisting of approximately 264.2 mm of portland cement concrete over 109.2 mm of cement-treated base. The subbase is lime-treated soil and is approximately 139.7 mm in thickness. The subgrade is classified as a clay. The typical soil profile under the pavement is illustrated in Figure A-2. This information was obtained from bore holes drilled during the GPS material sampling and testing. The dry densities of the unbound layers are given in Table 1.

Table 1. Layer Thicknesses and Dry Densities of the Unbound Layers

Material	Layer Thickness (mm)	In Situ Dry Density (kg/m^3)
Portland Cement Concrete (PCC)	264.2	- - -
Base	109.2	- - -
Subbase	139.7	- - -
Subgrade	- - -	1,718

The annual average daily traffic (AADT) in the GPS lane is almost 1800, of which 8% is truck traffic. The estimated annual ESALs on the GPS lane were 62,600. This information is based on traffic data collected on site.

Installation of the instrumentation was completed through the cooperative efforts of the Texas Department of Transportation and FHWA Southern Region Coordination Office staff from Brent Rauhut Engineering Inc. (BRE). The following is a list of the personnel who participated in the installation:

Larry Peirce	SRCO, Brent Rauhut Engineering
Jon Peacock	SRCO, Brent Rauhut Engineering
Steve Davis	SRCO, Brent Rauhut Engineering
Richard Zamora	Federal Highway Administration

II. Instrumentation Installation

Pre-Installation Activities

A pre-installation meeting was held at the BRE offices on October 18, 1993. The meeting agenda appears in Appendix B. The Texas Department of Transportation elected to contract out both traffic control services and drilling and augering services to private firms for all seven sites in the state. Therefore, the participants at the meeting were personnel from the Southern Region Coordination Office (SRCO), the Texas Department of Transportation (TX-DOT), Campbell Industries (traffic control services) and Jones & Neuse, Inc. (drilling and augering services). No support was required from the Districts where the seasonal sites reside. At the planning meeting, roles and responsibilities for all the various tasks to be performed during installation were assigned. A slide presentation was given, highlighting the order of operations for the installations in Delta, Colorado and Grand Rapids, Minnesota.

A site inspection and a manual distress survey were performed on April 29, 1993 by Jerry Daleiden (SRCO). Deflection testing was conducted on November 2, 1992, and on November 16, 1993. The 5+00 end of the test section was selected for instrumentation, based on the amount of distress present and uniformity of the deflection profile. Both the deflection plots and distress survey data can be found in Appendix A.

Equipment Installed

The equipment installed at the test site included instrumentation for measuring air and subsurface temperature, rainfall, and subsurface moisture contents. An equipment cabinet was installed to house the cable leads from the instrumentation, the data logger and the battery pack. In addition, an observation well was set to measure the depth to the water table. A benchmark was also set by the Texas Department of Transportation. A list of the equipment installed, with the respective serial numbers, is in Table 2.

Table 2. Equipment Installed

Equipment	Quantity	Serial Nº.
Instrument Hole		
MRC Thermistor Probe	1	198 (48DT)
TDR Sensors	10	48D01-48D10
Equipment Cabinet		
CR10 Data Logger	1	16522
Battery Package	1	5667
Weather Station		
Tipping-Bucket Rain Gauge	1	12077-693
Air Temperature Probe	1	421316
Observation Well	1	None

Equipment Check/Calibration

Prior to installation, all instrumentation was checked or calibrated. The CR10 Data Logger was wired according to the Guidelines and the air temperature probe and thermistor probe were connected and monitored over a period of several hours to ensure that the sensors were working. The tipping-bucket was also connected to the data logger and the calibration was checked according to the method recommended by the manufacturer. These tests indicated that the air temperature probe and thermistor probe were working properly and that the tipping-bucket measurement was within the manufacturer's specifications.

In addition to the above tests, the distances between sensors in the thermistor probe were measured and are presented in Table 3.

Table 3. Sensor Spacing in MRC Thermistor Probe

Unit	Channel №.	Distance from Top of Unit (mm)	Remarks
1	1	Not Measured	This unit was installed in the PCC layer.
	2	Not Measured	
	3	Not Measured	
2	4	19	This unit was installed in the base and subgrade.
	5	99	
	6	172	
	7	248	
	8	324	
	9	475	
	10	629	
	11	783	
	12	934	
	13	1086	
	14	1237	
	15	1393	
	16	1544	
	17	1696	
	18	1844	

Location of Instrumentation

The instrumentation was installed at Station 5+08 of the test section. Approximately 762 mm from the lane edge, in the outside wheel path, a 457 mm square was removed from the pavement and a 254 mm diameter hole, 2.3 m deep, was drilled to install the thermistor

probe and TDR sensors. Cables from the instrumentation were placed in a 51 mm diameter flexible conduit and buried in a 102 mm wide trench leading to the equipment cabinet located approximately 8.1 m from the lane edge.

The observation well was installed at Station 4+00 of the test section approximately 3.0 m from the lane edge. A permanent benchmark was also set at Station 2+50 approximately 3.4 m from the lane edge.

Installation

Installation of the monitoring equipment was completed on November 17, 1993. Verification that the instrumentation was working was made the following day. The Texas Department of Transportation (TX-DOT) provided the pavement sawing, pavement repair materials and a permanent benchmark. TX-DOT elected to contract the traffic control to Campbell Industries and the augering operations to Jones and Neuse, Inc.. The observation well was also drilled by Jones and Neuse due to licensing and construction requirements mandated by the Texas Water Commission. The monitoring equipment and cabinet installation was performed by the SRCO staff.

The first day of operations included traffic control; site layout and marking; installation of the thermistor probe, TDR probes, air temperature probe, and rain gauge; and wiring of the cabinet. The installation of all equipment was performed according to the procedures outlined in the "LTPP Seasonal Monitoring Program: Instrumentation and Data Collection Guidelines."

To ensure functioning of the TDR sensors during installation, the 1502B cable tester was connected to each sensor as backfilling of the instrumentation hole was performed. If a reasonable trace was displayed, it was assumed the sensor was functioning properly. The trace was printed for each TDR and the moisture content was determined using Topp's equation. The field moisture content was also measured by drying the soil on a propane stove. The TDR moisture contents, position of the TDR sensors and field moisture contents appear in Table 4. The field printed traces appear in Appendix C. It should be noted that the TDR sensor 48D10 was apparently damaged during installation, but this was not evident during the backfilling process. Table 5 shows the distance from the top of the pavement to each individual thermistor sensor.

When backfilling of the instrumentation hole was completed, the concrete surface was patched using Set 45. The overcuts from the pavement sawing operation (including the groove for the temperature probe) were also sealed with Dow-Corning 888 crack sealant.

Upon completion of the installation, the ONSITE program was downloaded to the onsite CR10 Data Logger and data from the air temperature probe, rain gauge and thermistor probe were collected overnight and evaluated the second day.

The second day activities included traffic control setup, evaluation of the data collected the previous night, monitoring of the TDR sensors, deflection testing and elevation surveys. The following sections describe these operations.

Table 4. Location of TDR Sensors and Measured Moisture Contents

Sensor №.	Sensor Depth (mm)	TDR Moisture Content (%, by wt)	Measured Moisture Content (%, by wt)
48D01	457	28.6	32.3
48D02	622	30.3	25.5
48D03	762	28.0	26.4
48D04	914	28.0	20.3
48D05	1080	26.4	21.8
48D06	1219	25.6	23.4
48D07	1372	26.6	22.5
48D08	1511	27.5	23.8
48D09	1842	28.4	30.5
48D10	2134	29.3	32.7

Table 5. Thermistor Sensor Locations

Unit	Channel №.	Depth from Pavement Surface (mm)	Remarks
1	1	25	This unit was installed in the PCC layer.
	2	132	
	3	239	
2		426	This unit was installed in the base and subgrade.
	5	506	
	6	579	
	7	655	
	8	731	
	9	882	
	10	1036	
	11	1190	
	12	1341	
	13	1493	
	14	1644	
	15	1800	
	16	1951	
	17	2103	
	18	2251	

III. Initial Data Collection

Onsite Data Logger

The air temperature, subsurface temperatures and rainfall data were collected by the onsite CR10 Data Logger. The version of the ONSITE program used reads the thermistor probe (18 sensors) every minute. The average temperatures for the first five sensors are recorded hourly and the average temperature for every sensor is saved daily. The maximum and minimum temperature for all sensors are also saved on a daily basis.

The air temperature is read every minute by the ONSITE program and the average temperature is saved both daily and hourly. The maximum and minimum temperatures are saved daily. The precipitation is recorded on both an hourly and daily basis.

Figure D-1 shows the average hourly ambient air temperatures which were collected the night of November 16, 1993. Figure D-2 shows hourly average subsurface temperatures for the first five sensors for the same data collection period. Figure D-3 shows the measured average subsurface temperatures for all 18 sensors during the initial data collection.

Moisture Content Measurement by TDR Sensors

TDR data was collected using the mobile data logging system provided by the FHWA. The mobile system consists of a CR10 Data Logger, battery pack and two multiplexors for TDR data collection.

To begin data collection using the mobile system the TDR cable leads and 1502B cable reader were connected to the proper channels and the MOBILE program was downloaded from the notebook computer to the CR10 Data Logger. After approximately five minutes, the cable reader was triggered by the MOBILE program and the TDR traces were displayed. The data collection process was completed in approximately five minutes and was automatically repeated four hours later. The data were then uploaded to the notebook computer. Traces displayed on the cable reader indicated that the sensors were working properly. Figures D-4 through D-13 show the plots of the TDR traces obtained approximately 24 hours after installation.

Deflection Measurements

Deflection measurements were made according to the procedures outlined in the "LTPP Seasonal Monitoring Program: Instrumentation Installation and Data Collection Guidelines." At this time no analysis has been performed on this data.

Elevation Surveys

The elevation of the benchmark was assumed to be 0.000 meters and surface elevations were measured following the guidelines. These elevations were measured using a Spectra-Physics Laser Plane 350 level and Lenker rod, and were converted to the SI system using soft conversion factors. The elevations are contained in Appendix D.

IV. Summary

The instrumentation installation on Section 484143 was completed on November 17, 1993 and initial data collection was completed on November 18, 1993. Instrumentation and equipment currently at the site includes time domain reflectometry probes for moisture content measurements; a thermistor probe for monitoring temperature gradient changes in the pavement, base and subgrade layers; a tipping-bucket rain gauge; an air temperature probe; an observation well to monitor ground water table movement; a permanent swell and frost-free benchmark; and an on-site data logger and battery pack.

The instrumentation hole had water seeping into it throughout the entire TDR installation process. After installation and during equipment checks on November 18, 1993, some of the TDR sensors exhibited a small spike just before the initial inflection point on the trace display. This is likely due to a small crack in the silicone sealant that bonds the ceramic plug head to the TDR's PCB that allowed moisture to affect the readings for these sensors. All other instrumentation was functioning properly.

At the time of this report, all of the equipment installed on-site appears to be functioning properly. After the initial installation, the alkaline battery pack was replaced with a gel-cell sealed battery.

APPENDIX A

Test Section Background Information

Appendix A contains the following information:

Figure A-1. Site Location Map

Figure A-2. Profile of Test Section Layers

Figure A-3 thru Figure A-8. Plots from FWDCHECK

Figure A-9. Manual Distress Survey Data

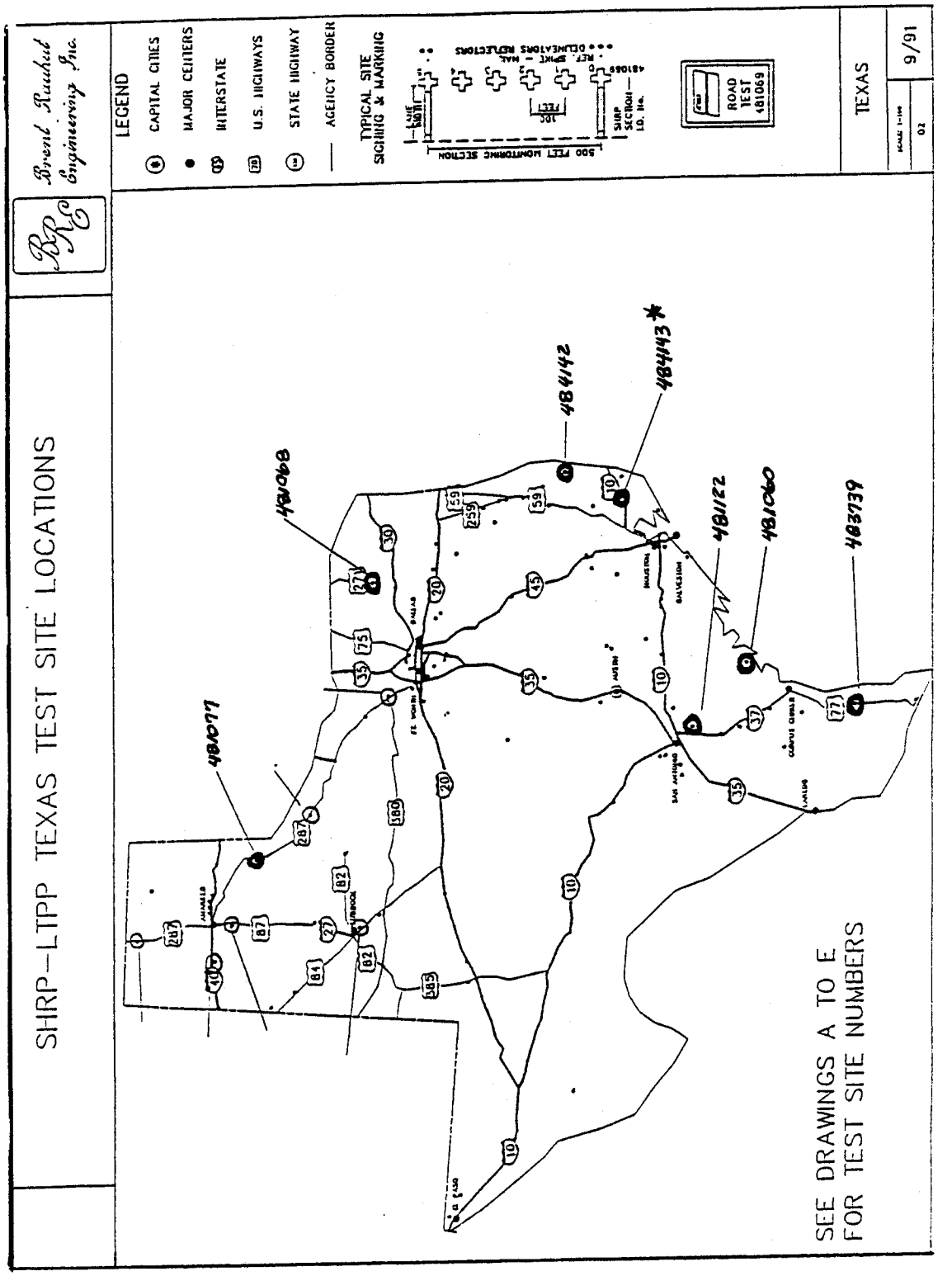


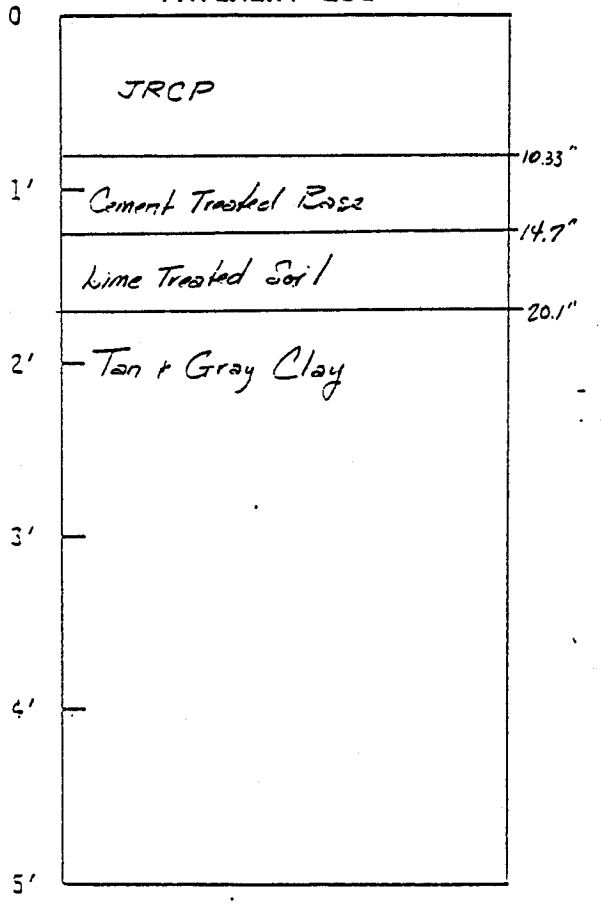
Figure A-1. Location of Test Site, GPS Test Section 484143

APPROXIMATE
SUMMARY OF FIELD LOGS
GPS TEST SECTIONS

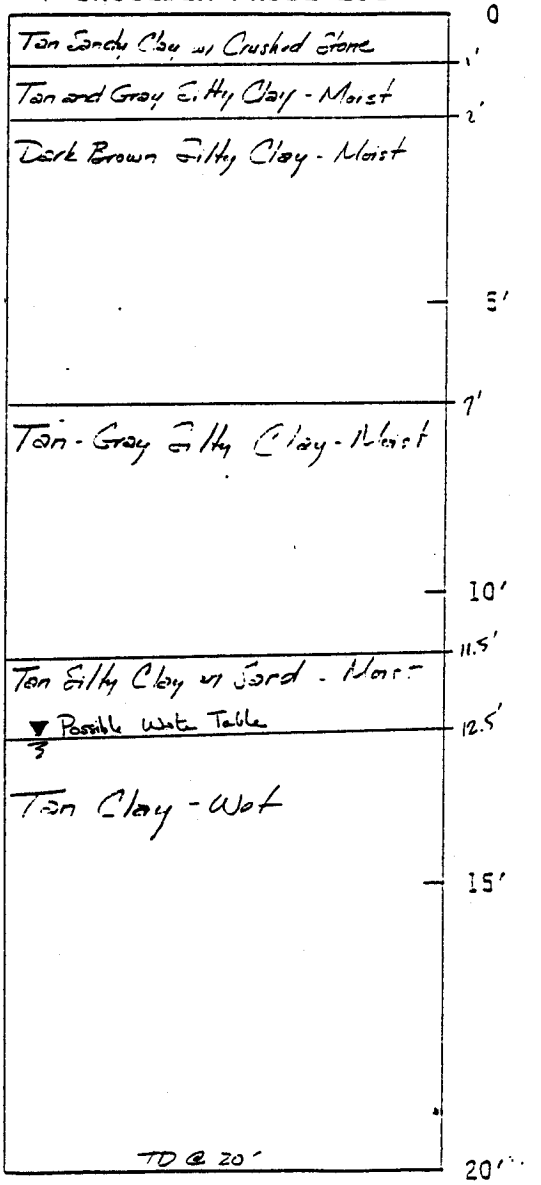
TEST SECTION I.D. No. 484143
STATE TEXAS

EXPERIMENT No. GPS-4
DATE SAMPLED 7/24/90

PAVEMENT LOG



SHOULDER PROBE LOG



Instructions for Pavement Log:

1. Review logs of bore holes, cores, and test pit to establish approximate depths of layer changes.

2. Draw lines across log above to indicate approximate average layer depths and label to identify the materials.

Instructions for Shoulder Probe Log:
Same as for "Pavement Log," except depths are taken directly from field log.

Depth to Rigid Layer, > 20 Ft.
(If Rigid Layer Not Encountered, Enter ">20.")

USE THIS FORM FOR ENTERING ONLY DEPTH TO RIGID LAYER INTO THE DATA BASE!

Figure A-2. Profile of Test Section Layers

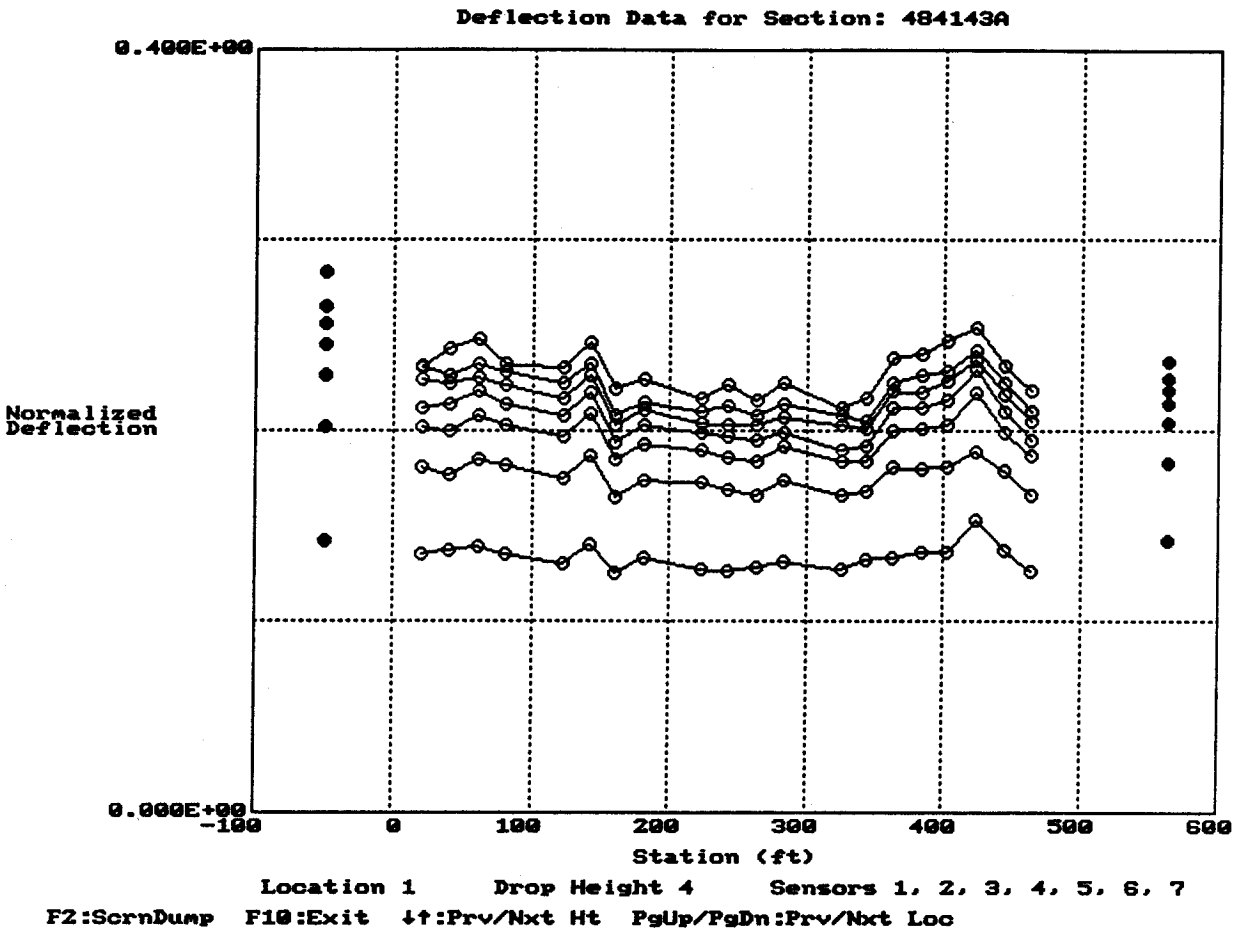


Figure A-3. Deflection Profiles from FWDCHECK

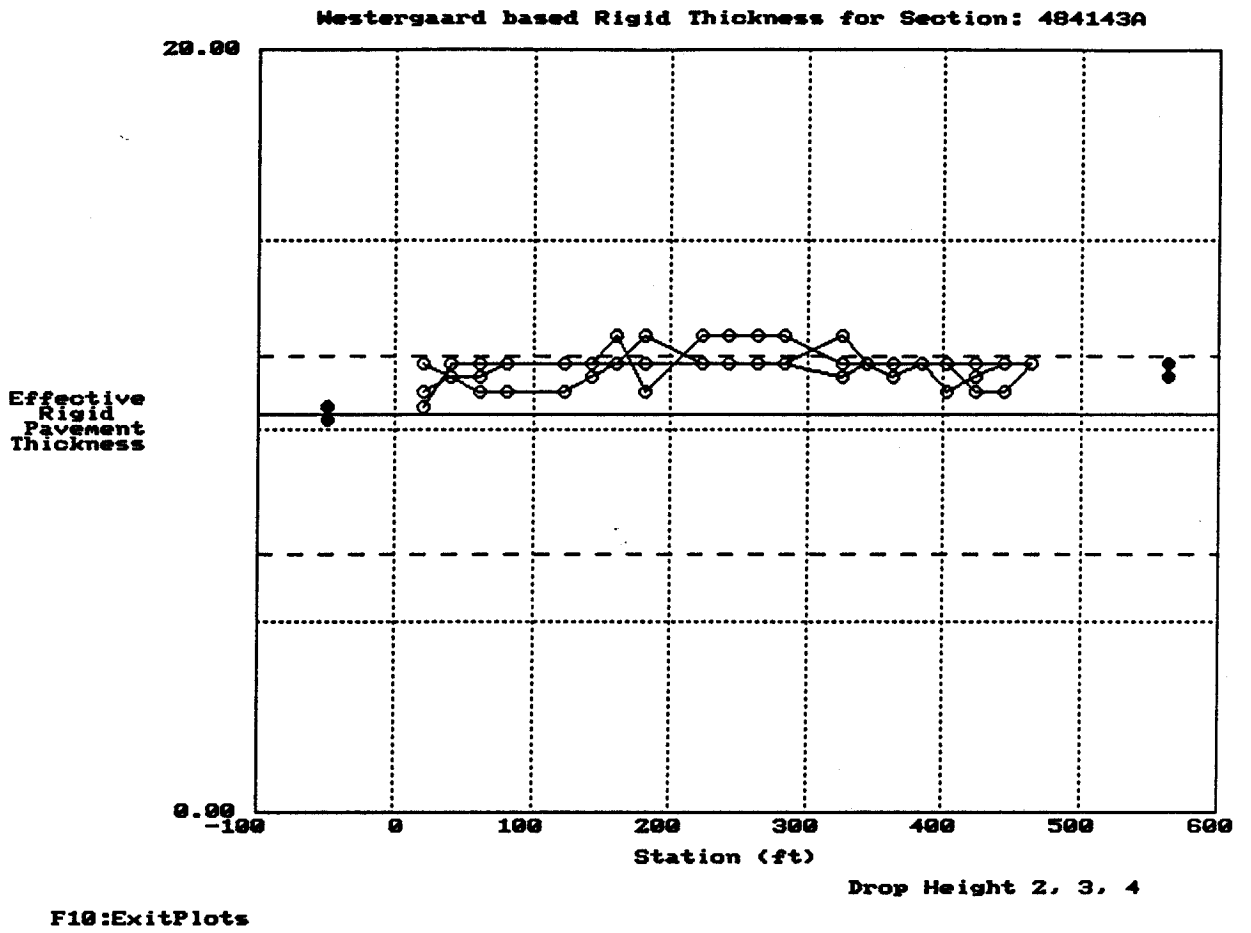


Figure A-4. Westergaard-Based Rigid Thickness

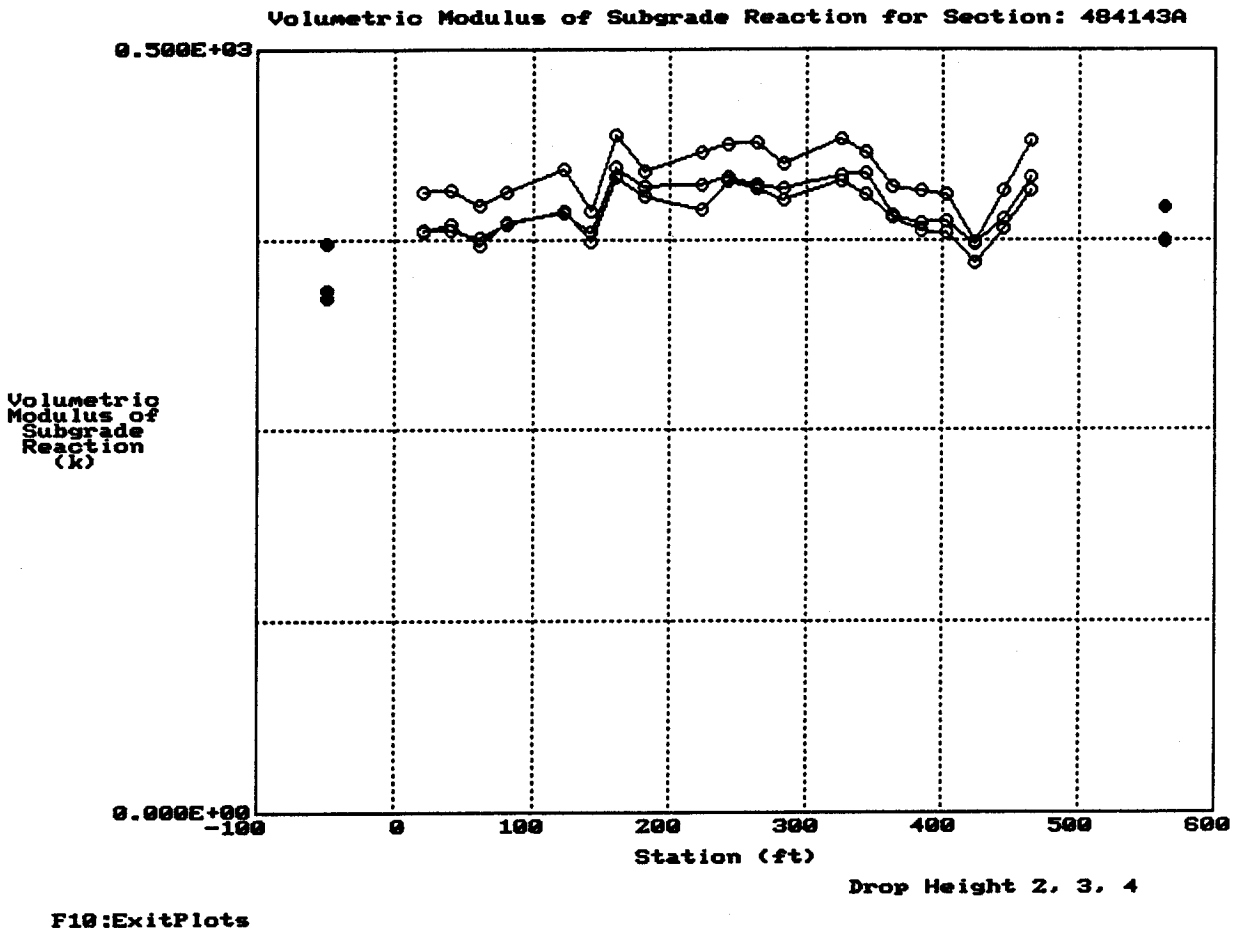


Figure A-5. Volumetric Modulus of Subgrade Reaction

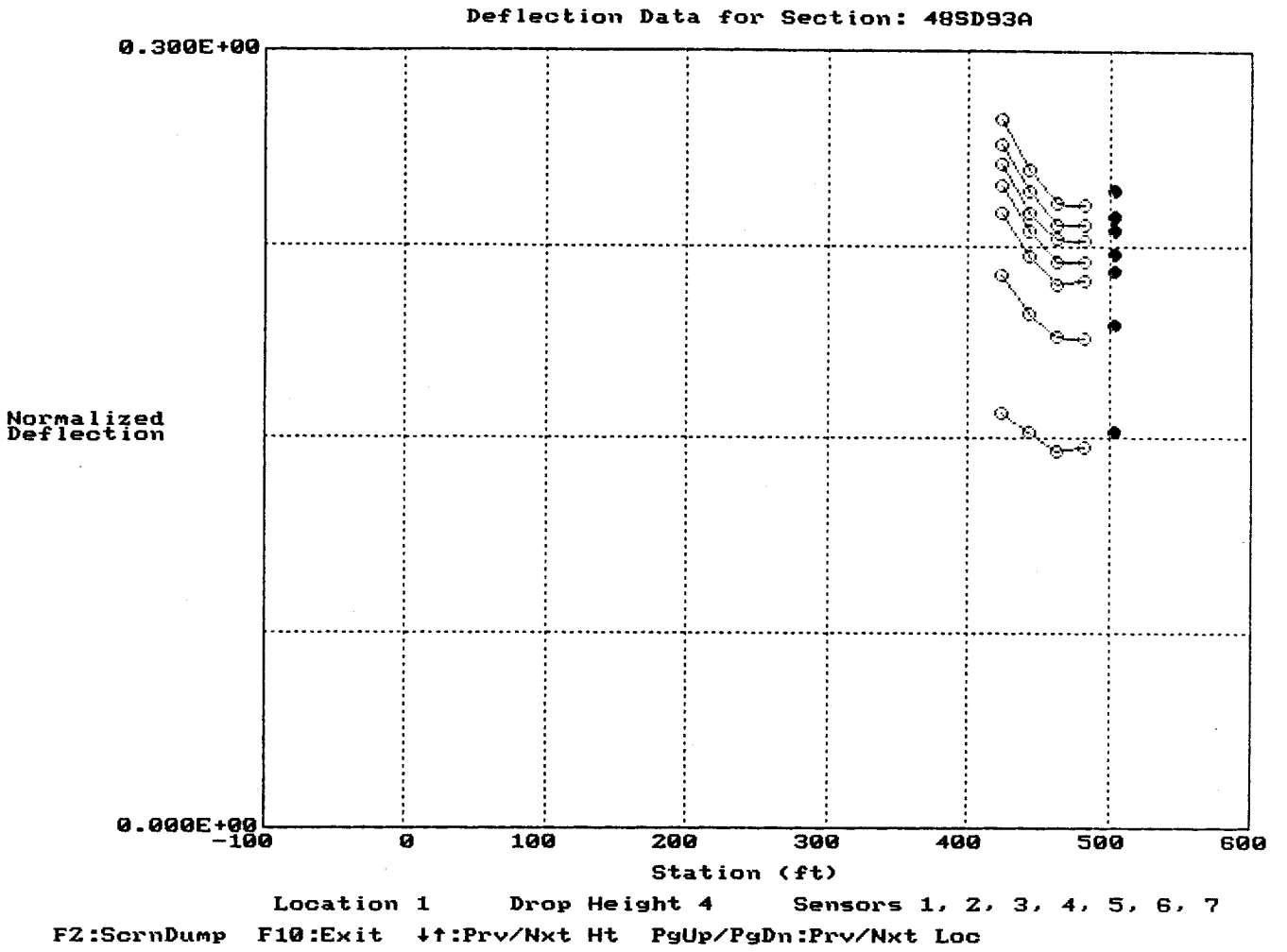


Figure A-6. Deflection Profiles from FWDCHECK on Installation Day

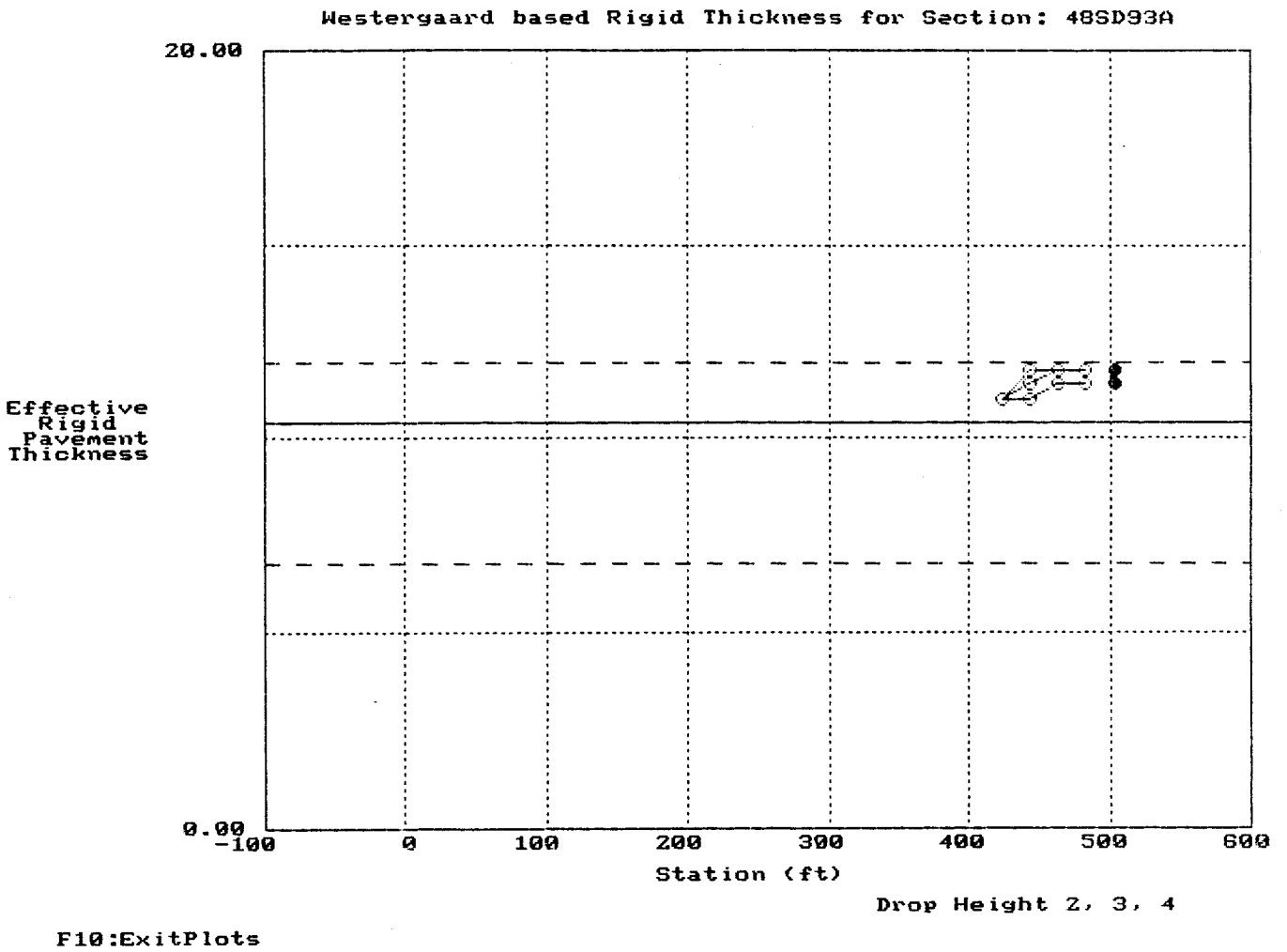


Figure A-7. Westergaard-Based Rigid Thickness FWDCHECK on Installation Day

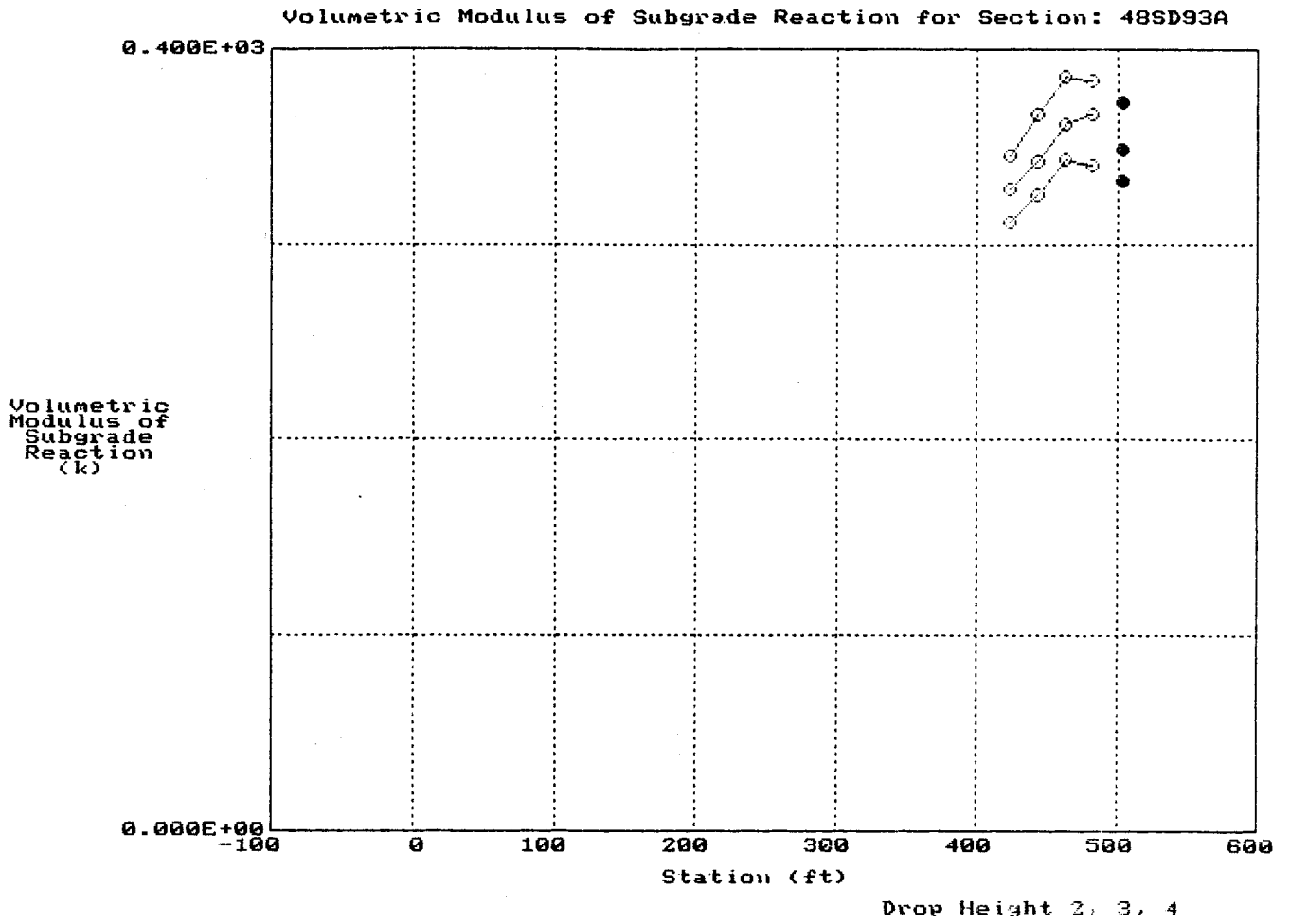


Figure A-8. Volumetric Modulus of Subgrade Reaction from FWDCHECK on Installation Day

Revised May 29, 1992

SHEET 4

DISTRESS SURVEY

LTPP PROGRAM

STATE ASSIGNED ID ____

STATE CODE 48

SHRP SECTION ID 4143

DISTRESS SURVEY FOR PAVEMENTS WITH JOINTED PORTLAND CEMENT CONCRETE SURFACES

DATE OF DISTRESS SURVEY (MONTH/DAY/YEAR) 04/29/93

SURVEYORS: JED, ____, ____

PAVEMENT SURFACE TEMP - BEFORE __ __ 22°C; AFTER __ __ 22°C

PHOTOS, VIDEO, OR BOTH WITH SURVEY (~~P, V, B~~) ~~B~~ NOT DONE DUE TO RAIN

DISTRESS TYPE	SEVERITY LEVEL LOW	MODERATE	HIGH
CRACKING			
1. CORNER BREAKS (Number)	00	00	00
2. DURABILITY "D" CRACKING (Number of Affected Slabs)	00	00	00
AREA AFFECTED (Square Meters)	00.0	00.0	00.0
3. LONGITUDINAL CRACKING (Meters)	00.0	00.0	00.0
Length Sealed (Meters)	00.0	00.0	00.0
4. TRANSVERSE CRACKING (Number of Cracks)	00	00	00
(Meters)	00.0	00.0	00.0
Length Sealed (Meters)	00.0	00.0	00.0
JOINT DEFICIENCIES			
5a. TRANSVERSE JOINT SEAL DAMAGE Sealed? (Y, N)			
If "Y" Number of Joints	00	00	25 (4) ✓
5b. LONGITUDINAL JOINT SEAL DAMAGE Number of Longitudinal Joints that have been sealed (0, 1, or 2)			1
Length of Damaged Sealant (Meters)			00.0
6. SPALLING OF LONGITUDINAL JOINTS (Meters)	00.0	00.0	00.0
7. SPALLING OF TRANSVERSE JOINTS Number of Affected Joints	15 ✓	00	00
Length Spalled (Meters)	11.3 ✓	00.0	00.0

Figure A-9. Distress Survey Data

SHEET 5

DISTRESS SURVEY

LTPP PROGRAM

STATE ASSIGNED ID _ _ _ _

STATE CODE 48

SHRP SECTION ID 4143

DISTRESS SURVEY FOR PAVEMENTS WITH JOINTED PORTLAND CEMENT CONCRETE SURFACES (CONTINUED)

DISTRESS TYPE	SEVERITY LEVEL LOW	MODERATE	HIGH
SURFACE DEFORMATION			
8a. MAP CRACKING (Number)			00
(Square Meters)			00.0
8b. SCALING (Number)			00
(Square Meters)			00.0
9. POLISHED AGGREGATE (Square Meters)			00.0
10. POPOUTS (Number)			000
MISCELLANEOUS DISTRESSES			
11. BLOWUPS (Number)			00
12. FAULTING OF TRANSVERSE JOINTS AND CRACKS - REFER TO SHEET 6			
13. LANE-TO-SHOULDER DROPOFF - REFER TO SHEET 7			
14. LANE-TO-SHOULDER SEPARATION - REFER TO SHEET 7			
15. PATCH/PATCH DETERIORATION			
Flexible (Number)	00	00	00
(Square Meters)	00.0	00.0	00.0
Rigid (Number)	00	00	00
(Square Meters)	00.0	00.0	00.0
16. WATER BLEEDING AND PUMPING (Number of Occurrences)			00
Length Affected (Meters)			00.0
17. OTHER (Describe) _____			

Figure A-9 (Continued). Distress Survey Data

SHEET 6

DISTRESS SURVEY

LTPP PROGRAM

STATE ASSIGNED ID _ _ _ _

STATE CODE 48

SHRP SECTION ID 4143

4/23/93

DISTRESS SURVEY FOR PAVEMENTS WITH JOINTED PORTLAND CEMENT CONCRETE SURFACES (CONTINUED)

12. FAULTING OF TRANSVERSE JOINTS AND CRACKS

Point[1] Distance (Meters)	Joint or Crack (J/C)	Crack Length (Meters)	Well Sealed (Y/N)	Length of Spalling, m L	M	H	Faulting (mm)[2] 0.3m	0.75m
2.9	J	-	Y	0.	0.	0.	1	0
9.1	J	-	Y	0.5	0.	0.	0	-1
15.2	J	-	Y	1.5	0.	0.	0	-1
21.3	J	-	Y	0.	0.	0.	0	1
27.6	J	-	Y	0.	0.	0.	0	2
33.6	J	-	Y	1.	0.	0.	0	2
39.7	J	-	Y	0.4	0.	0.	0	0
46.1	J	-	Y	0.	0.	0.	1	1
52.1	J	-	Y	0.	0.	0.	0	2
58.3	J	-	Y	0.6	0.	0.	3	0
64.4	J	-	Y	1.	0.	0.	2	1
70.5	J	-	Y	0.3	0.	0.	2	1
76.6	J	-	Y	0.3	0.	0.	1	2
82.8	J	-	Y	0.7	0.	0.	2	0
88.9	J	-	Y	0.3	0.	0.	0	0
95.0	J	-	Y	0.	0.	0.	0	2
101.3	J	-	Y	1.5	0.	0.	1	0
107.4	J	-	Y	1.3	0.	0.	0	1
113.6	J	-	Y	0.5	0.	0.	3	1
119.8	J	-	Y	1.	0.	0.	1	0
125.9	J	-	Y	0.4	0.	0.	0	1
132.0	J	-	Y	0.	0.	0.	1	1
138.2	J	-	Y	0.	0.	0.	0	0
144.3	J	-	Y	0.	0.	0.	0	1
150.4	J	-	Y	0.	0.	0.	0	1
- - -	-	-	-	- - -	- - -	- - -	- - -	- - -
- - -	-	-	-	- - -	- - -	- - -	- - -	- - -

Note 1. Point Distance is from the start of the test section to the measurement location.

Note 2. If the "approach" slab is higher than the "departure" slab, faulting is recorded as positive (+ or 0); if the "approach" slab is lower, record faulting as negative (-) and the minus sign must be used.

Figure A-9 (Continued). Distress Survey Data

SHEET 7

DISTRESS SURVEY

LTPP PROGRAM

STATE ASSIGNED ID _ _ _ _

STATE CODE 48

SHRP SECTION ID 4143

DISTRESS SURVEY FOR PAVEMENTS WITH JOINTED PORTLAND CEMENT CONCRETE SURFACES (CONTINUED)

13. LANE-TO-SHOULDER DROPOFF

14. LANE-TO-SHOULDER SEPARATION

Point No.	Point[1] Distance (meters)	Lane-to-shoulder[2] Dropoff (mm)	Lane-to-shoulder Separation (mm)	Well Sealed (Y/N)
1.	0.	6.	8.	Y
2.	15.25	12.	12.	Y
3.	30.5	11.	6.	Y
4.	45.75	5.	9.	Y
5.	61.	7.	5.	Y
6.	76.25	14.	7.	Y
7.	91.5	8.	5.	Y
8.	106.75	0.	7.	Y
9.	122.	6.	8.	Y
10.	137.25	13.	9.	Y
11.	152.5	12.	7.	Y

Note 1. Point Distance is from the start of the test section to the measurement location. The values shown are SI equivalents of the 50 feet spacing used in previous surveys.

Note 2. If heave of the shoulder occurs (upward movement), record as a negative (-) value. Do not record (+) signs, positive values are assumed.

Figure A-9 (Continued). Distress Survey Data

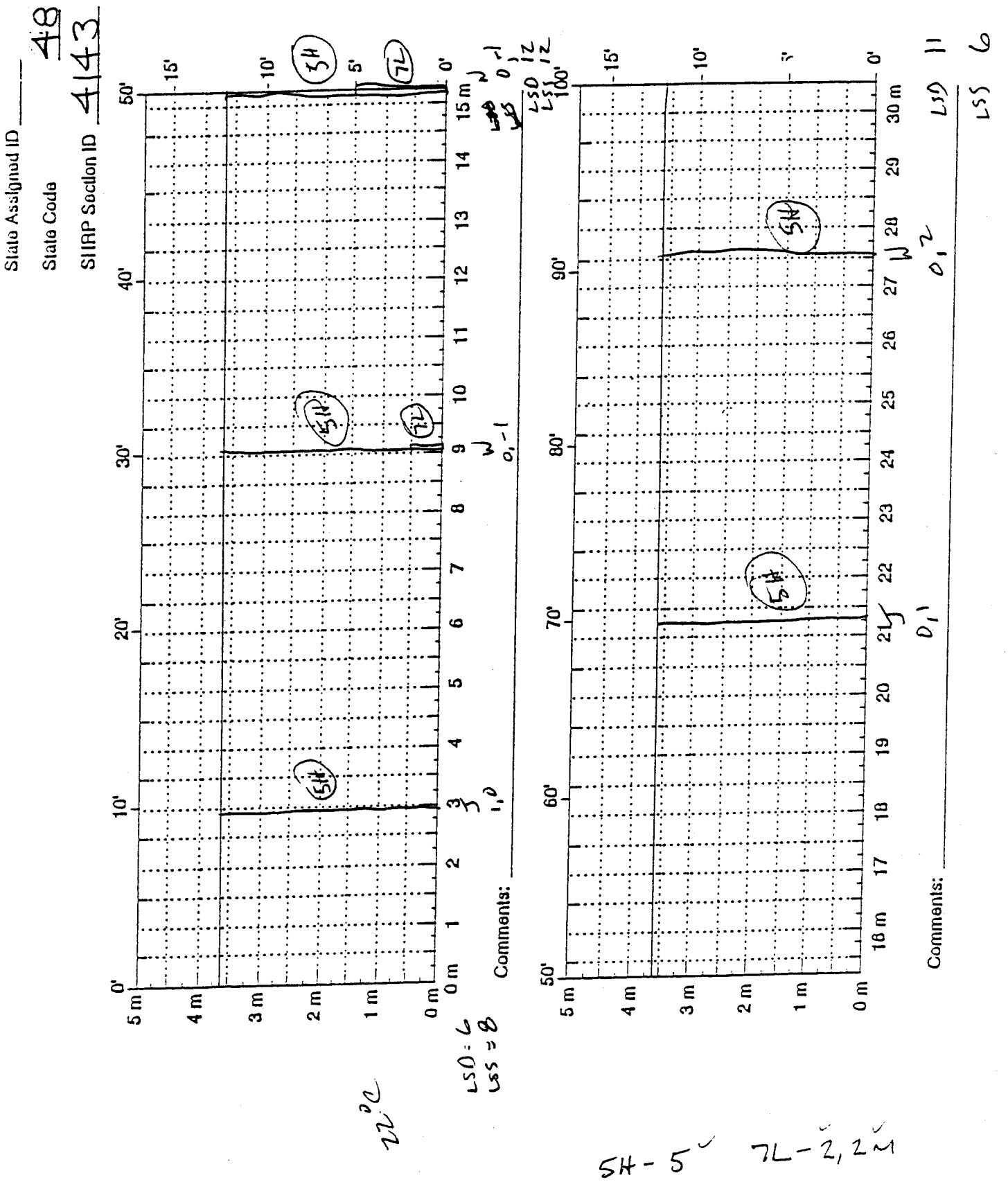


Figure A-9 (Continued). Distress Survey Data

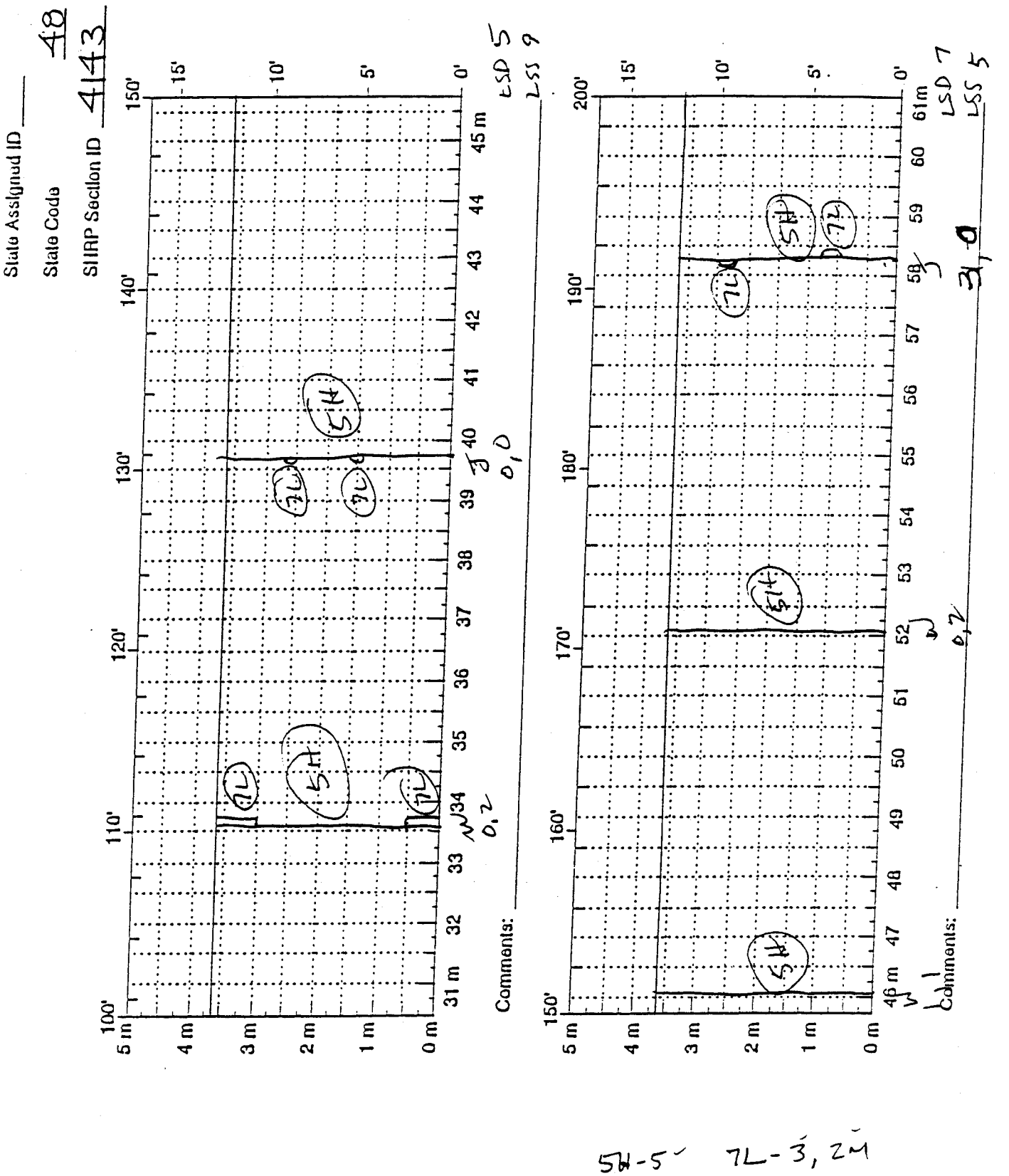


Figure A-9 (Continued). Distress Survey Data

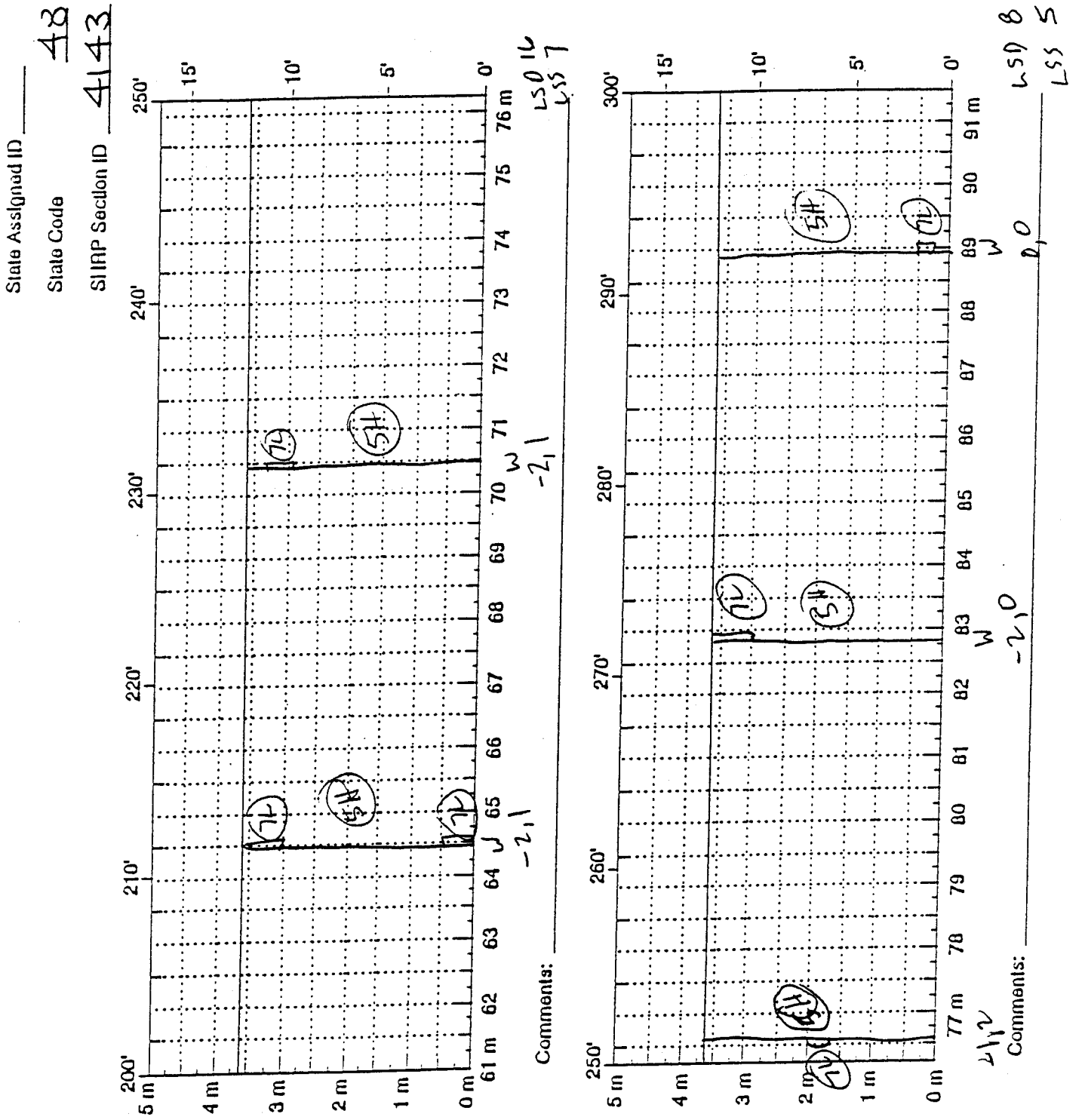


Figure A-9 (Continued). Distress Survey Data

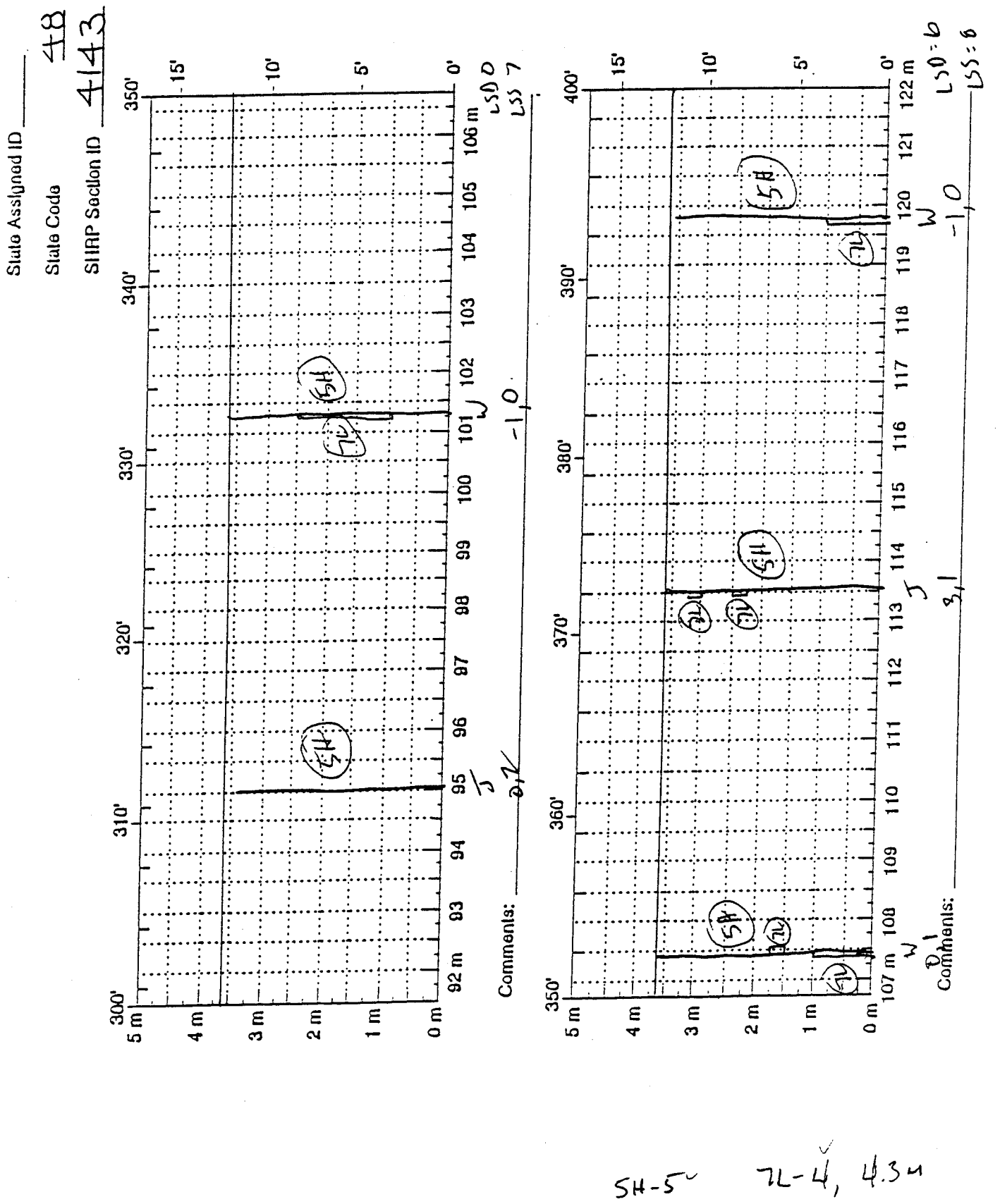


Figure A-9 (Continued). Distress Survey Data

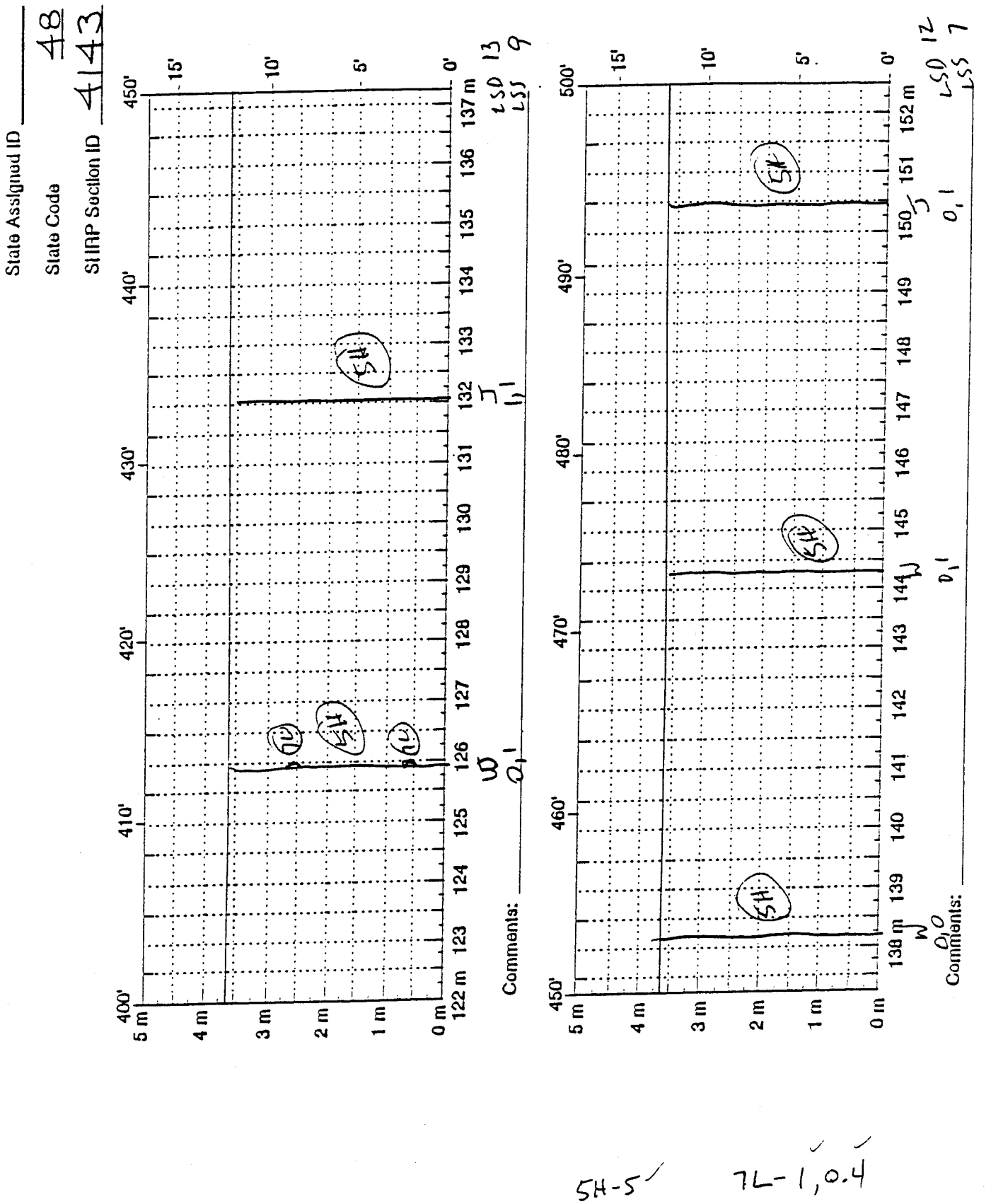


Figure A-9 (Continued). Distress Survey Data

APPENDIX B

Pre-installation Activities

Appendix B contains the following information:

Seasonal Monitoring Meeting Agenda

Seasonal Site Information

Figure B-1. TDR Traces Obtained During Calibration

AGENDA
Seasonal Monitoring Meeting
October 18, 1993

I. Introductions

II. Brief Overview of the Seasonal Program

III. Roles & Responsibilities

IV. Activities on Site - Day 1

- A. Arrival
- B. Traffic Control
- C. Marking Section
- D. FWD Testing
- E. Sawing/Coring
- F. Observation Well
- G. Instrumentation Hole
- H. Weather Station
- I. Hook-up all Electronics
- J. Patching/Clean-up

V. Activities on Site - Day 2

- A. Instrumentation Check
- B. Data Collection
  1. FWD Testing
  2. Rod/Level Elevations
  3. Download Instrumentation Data

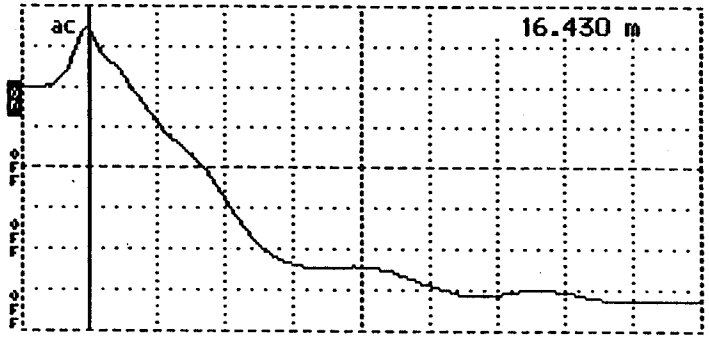
VI. Questions/Discussion

TEXAS SEASONAL SITE INFORMATION

Type	SHRP ID	Hwy. Nº.	Location of Test Section
AC over Granular Base	481060	US-77, Refugio Co., Northbound	0.7 mi. S. of SH-289, 2 mi. S. of the Refugio/Victoria Co. line.
AC over Granular Base	481068	SH-19, Lamar Co., Northbound	2.1 mi. N. of the North Sulfur River, 1.3 mi. S. of FM-1184.
AC over Granular Base	481077	US-287, Hall Co., Southbound	2.1 mi. S. of the Red River, 1100' N. of FM-658.
AC over Granular Base	481122	US-181, Wilson Co., Northbound	4.9 mi. N. of Loop 181, 2.5 mi. S. of the Bexar/Wilson Co. line.
AC over Granular Base	483739	US-77, Kenedy Co., Northbound	Milepost 20.05-19.95. 26.6 mi. N. of the Kenedy/Willacy Co. line, 20.1 mi. S. of the Kenedy/Kleberg Co. line.
JRCP	484142	US-96, Jasper Co., Northbound	7.6 mi. N. of US-190, 1.9 mi. S. of Recreation Rd. 255.
JRCP	484143	US-90, Jefferson Co., Eastbound	2.2 mi. E. of FM-365/SH-326, 11.0 mi. W. of FM-364.

LTPP Seasonal Monitoring Program Data Sheet SMP-C01 (Page 1) TDR Probe Check	Agency Code [48] LTPP Section ID [4143]

Cursor ..... 16.430 m
Distance/Div..... .25 m/div
Vertical Scale.... 158 mρ/div
VP 0.99
Noise Filter..... 1 avg
Power..... ac

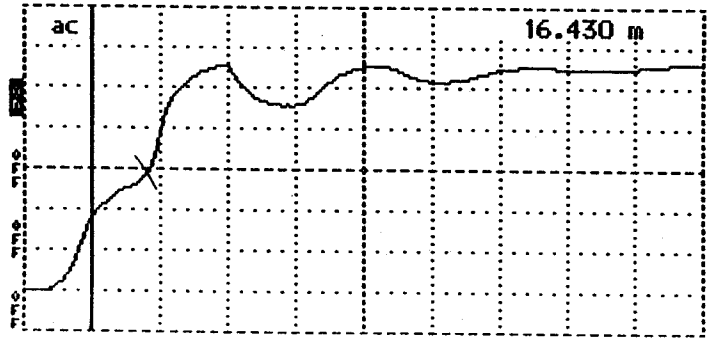


Tektronix 1502B TDR
Date 10/29/93
Cable 48001
Notes SHORTED
N.D.
Input Trace
Stored Trace
Difference Trace

TDR Trace	Apparent Length, (m)	Dielectric Constant
"Shorted at Start"	__.__	__ __.__ __

Figure B-1. TDR Traces Obtained During Calibration

Cursor ..... 16.430 m
Distance/Div..... .25 m/div
Vertical Scale.... 158 mρ/div
VP 0.99
Noise Filter..... 1 avg
Power..... ac

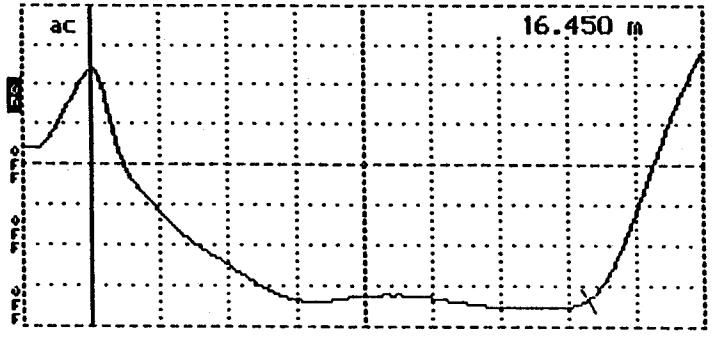


Tektronix 1502B TDR
Date 10/29/93
Cable 48001
Notes IN AIR
N.D.
Input Trace
Stored Trace
Difference Trace

TDR Trace	Apparent Length, (m)	Dielectric Constant[1]
"In Air"	0.24	1.43

LTPP Seasonal Monitoring Program Data Sheet SMP-C01 (Page 2) TDR Probe Check	Agency Code [48] LTPP Section ID [4143]

Cursor ..... 16.450 m
Distance/Div..... .25 m/div
Vertical Scale.... 74.8 mρ/div
VP 0.99
Noise Filter..... 1 avg
Power..... ac



Tektronix 1502B TDR
Date 10/28/93
Cable 48001
Notes IN WATER
WATER TEMP. 20.4
Input Trace
Stored Trace
Difference Trace

TDR Trace	Apparent Length, (m)	Dielectric Constant[2]
"In Water"	1.76	76.67

[1] If dielectric constant not between 0.75 and 2.0, contact FHWA LTPP Division
[2] If dielectric constant not between 76 and 84, contact FHWA LTPP Division

Note: Dielectric constant is determined as follows:

$$\varepsilon = \left[\frac{(L_a)}{(L)(V_p)}\right]^2 = \left[\frac{(D_2 - D_1)}{(L)(V_p)}\right]^2$$

where ε = dielectric constant; L_a = apparent length of probe, m; L = actual length of probe units (= 0.203 m (8 in) for FHWA probes); V_p = phase velocity setting (= 0.99).

TDR Probe Assigned Serial Number: 48D01 Measured Length of Coax Cable: 12.3 m

Comments: _____

Prepared by: Matt Cole Employer: BRE

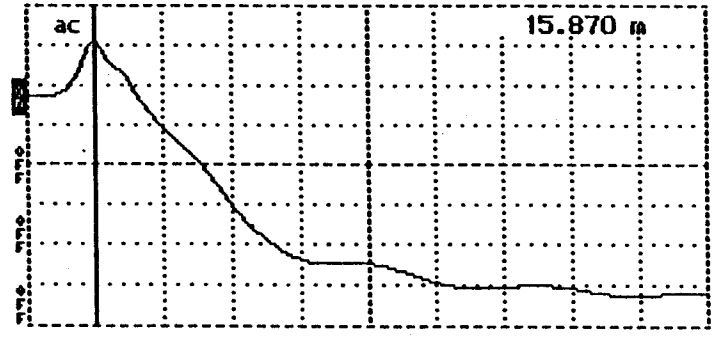
Date (dd/mm/yy): 31/08/94

Data Sheet SMP-C01: TDR Probe Check (Continued)

Figure B-1 (Continued). TDR Traces Obtained During Calibration

LTPP Seasonal Monitoring Program Data Sheet SMP-C01 (Page 1) TDR Probe Check	Agency Code [48] LTPP Section ID [4143]

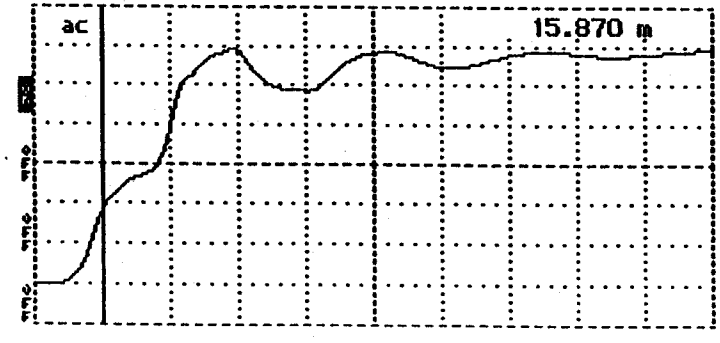
Cursor ..... 15.870 m
Distance/Div..... .25 m/div
Vertical Scale.... 167 mρ/div
VP 0.99
Noise Filter..... 1 avg
Power..... ac



Tektronix 1502B TDR
Date 10/29/93
Cable 48002
Notes SHORTED
I.D.
Input Trace
Stored Trace
Difference Trace

TDR Trace	Apparent Length, (m)	Dielectric Constant
"Shorted at Start"	__.__	__.__

Cursor ..... 15.870 m
Distance/Div..... .25 m/div
Vertical Scale.... 149 mρ/div
VP 0.99
Noise Filter..... 1 avg
Power..... ac



Tektronix 1502B TDR
Date 10/29/93
Cable 48002
Notes IN AIR
I.D.
Input Trace
Stored Trace
Difference Trace

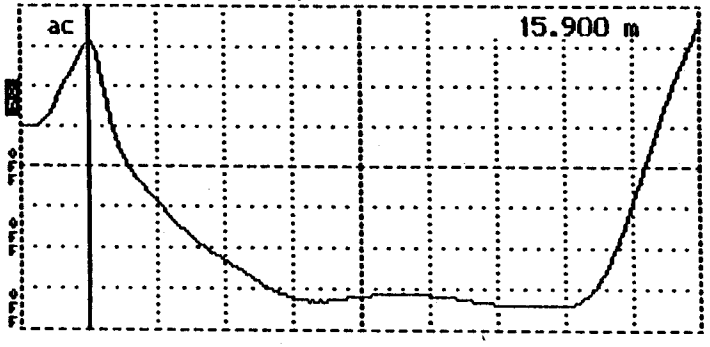
TDR Trace	Apparent Length, (m)	Dielectric Constant
"In Air"	0.24	1.43

Data Sheet SMP-C . TDR Probe Check

Figure B-1 (Continued). TDR Traces Obtained During Calibration

LTPP Seasonal Monitoring Program Data Sheet SMP-C01 (Page 2) TDR Probe Check	Agency Code [48] LTPP Section ID [41 43]

Cursor ..... 15.900 m
Distance/Div..... .25 m/div
Vertical Scale.... 68.6 mρ/div
Vp 0.99
Noise Filter..... 1 avg
Power..... ac



Tektronix 1502B TDR
Date 10/29/93
Cable 48D02
Notes IN WATER
WATER TEMP. 20.6
A.D.
Input Trace
Stored Trace
Difference Trace

TDR Trace	Apparent Length, (m)	Dielectric Constant[2]
"In Water"	1.76	76.67

[1] If dielectric constant not between 0.75 and 2.0, contact FHWA LTPP Division
[2] If dielectric constant not between 76 and 84, contact FHWA LTPP Division

Note: Dielectric constant is determined as follows:

$$\varepsilon = \left[\frac{(L_a)}{(L)(V_p)}\right]^2 = \left[\frac{(D_2 - D_1)}{(L)(V_p)}\right]^2$$

where ε = dielectric constant; L_a = apparent length of probe, m; L = actual length of probe units (= 0.203 m (8 in) for FHWA probes); V_p = phase velocity setting (= 0.99).

TDR Probe Assigned Serial Number: 48D02 Measured Length of Coax Cable: 12.3 m

Comments: _____

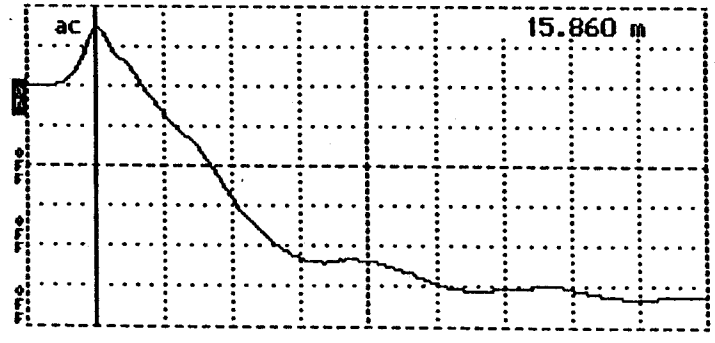
Prepared by: Matt Cole Employer: BRE

Date (dd/mm/yy): 31/08/94

Figure B-1 (Continued). TDR Traces Obtained During Calibration

LTPP Seasonal Monitoring Program Data Sheet SMP-C01 (Page 1) TDR Probe Check	Agency Code [48] LTPP Section ID [4143]

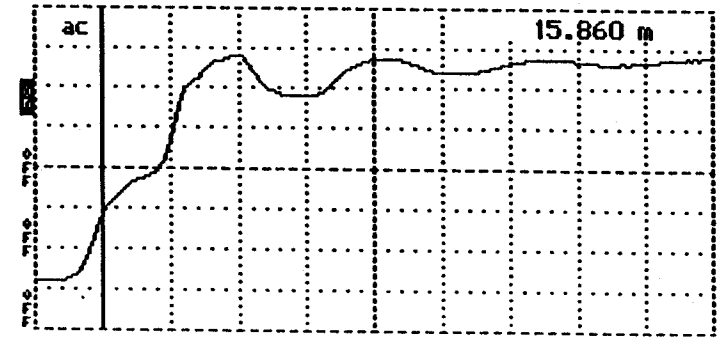
Cursor ..... 15.860 m
Distance/Div..... .25 m/div
Vertical Scale.... 158 mρ/div
VP 0.99
Noise Filter..... 1 avg
Power..... ac



Tektronix 1502B TDR
Date 10/29/93
Cable 48003
Notes SHORTED
N.D.
Input Trace
Stored Trace
Difference Trace

TDR Trace	Apparent Length, (m)	Dielectric Constant
"Shorted at Start"	__.__	__.__

Cursor ..... 15.860 m
Distance/Div..... .25 m/div
Vertical Scale.... 158 mρ/div
VP 0.99
Noise Filter..... 1 avg
Power..... ac



Tektronix 1502B TDR
Date 10/29/93
Cable 48003
Notes IN AIR
N.D.
Input Trace
Stored Trace
Difference Trace

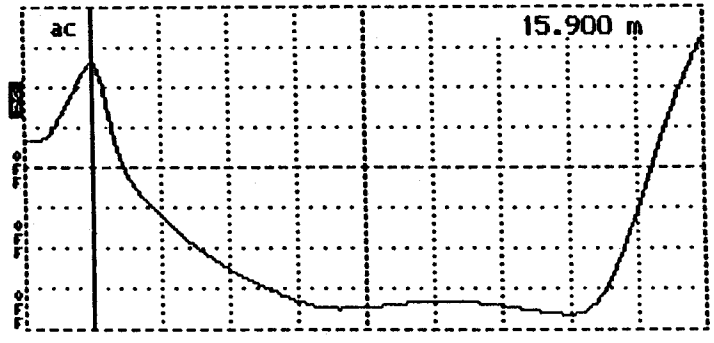
TDR Trace	Apparent Length, (m)	Dielectric Constant[1]
"In Air"	0.24	1.43

Data Sheet SMP-C . TDR Probe Check

Figure B-1 (Continued). TDR Traces Obtained During Calibration

LTPP Seasonal Monitoring Program Data Sheet SMP-C01 (Page 2) TDR Probe Check	Agency Code [48] LTPP Section ID [4143]

Cursor ..... 15.900 m
Distance/Div..... .25 m/div
Vertical Scale.... 72.7 mρ/div
VP 0.99
Noise Filter..... 1 avg
Power..... ac



Tektronix 1502B TDR
Date 10/29/93
Cable 48003
Notes IN WATER
WATER TEMP 20.6 C.
Input Trace
Stored Trace
Difference Trace

TDR Trace	Apparent Length, (m)	Dielectric Constant[2]
"In Water"	1.77	77.55

[1] If dielectric constant not between 0.75 and 2.0, contact FHWA LTPP Division
[2] If dielectric constant not between 76 and 84, contact FHWA LTPP Division

Note: Dielectric constant is determined as follows:

$$\varepsilon = \left[\frac{(L_a)}{(L)(V_p)}\right]^2 = \left[\frac{(D_2 - D_1)}{(L)(V_p)}\right]^2$$

where ε = dielectric constant; L_a = apparent length of probe, m; L = actual length of probe units (= 0.203 m (8 in) for FHWA probes); V_p = phase velocity setting (= 0.99).

TDR Probe Assigned Serial Number: 48D03 Measured Length of Coax Cable: 12.3 m

Comments: _____

Prepared by: Matt Cole Employer: BRE

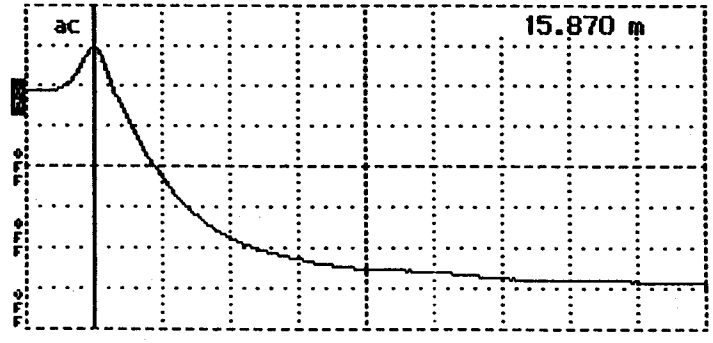
Date (dd/mm/yy): 31/08/94

Data Sheet SMP-C01, TDR Probe Check (Continued)

Figure B-1 (Continued). TDR Traces Obtained During Calibration

LTPP Seasonal Monitoring Program Data Sheet SMP-C01 (Page 1) TDR Probe Check	Agency Code [48] LTPP Section ID [41 43]

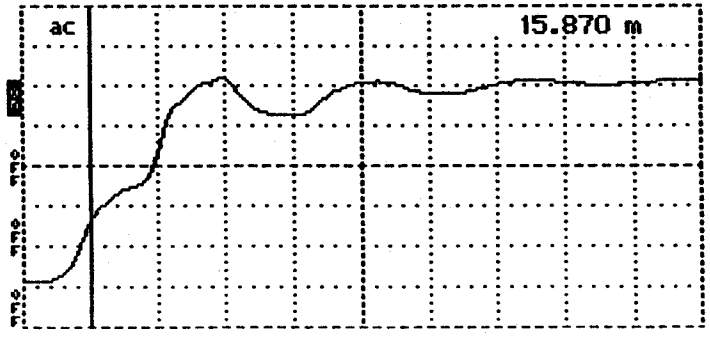
Cursor ..... 15.870 m
Distance/Div..... .25 m/div
Vertical Scale.... 177 mρ/div
Vp 0.99
Noise Filter..... 1 avg
Power..... ac



Tektronix 1502B TDR
Date 10/29/93
Cable 48D04
Notes Shorted
Input Trace JA
Stored Trace .....
Difference Trace .....

TDR Trace	Apparent Length, (m)	Dielectric Constant
"Shorted at Start"	__.__	___.__

Cursor ..... 15.870 m
Distance/Div..... .25 m/div
Vertical Scale.... 177 mρ/div
Vp 0.99
Noise Filter..... 1 avg
Power..... ac



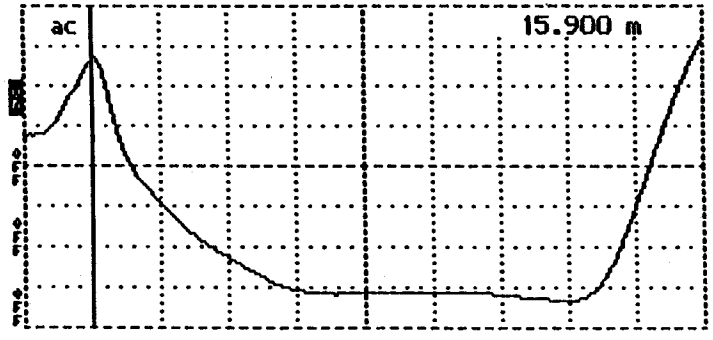
Tektronix 1502B TDR
Date 10/29/93
Cable 48004
Notes IN AIR N.D.
Input Trace .....
Stored Trace .....
Difference Trace .....

TDR Trace	Apparent Length, (m)	Dielectric Constant[1]
"In Air"	0.24	1.43

Figure B-1 (Continued). TDR Traces Obtained During Calibration

LTPP Seasonal Monitoring Program Data Sheet SMP-C01 (Page 2) TDR Probe Check	Agency Code [48] LTPP Section ID [4143]

Cursor ..... 15.900 m
Distance/Div..... .25 m/div
Vertical Scale.... 74.8 mρ/div
Vp 0.99
Noise Filter..... 1 avg
Power..... ac



Tektronix 1502B TDR
Date 10/29/93
Cable 48104
Notes IN WATER
WATER TEMP. 20.6
A.D.
Input Trace
Stored Trace
Difference Trace

TDR Trace	Apparent Length, (m)	Dielectric Constant[2]
"In Water"	1.77	77.55

[1] If dielectric constant not between 0.75 and 2.0, contact FHWA LTPP Division
[2] If dielectric constant not between 76 and 84, contact FHWA LTPP Division

Note: Dielectric constant is determined as follows:

$$\varepsilon = \left[\frac{(L_a)}{(L)(V_p)}\right]^2 = \left[\frac{(D_2 - D_1)}{(L)(V_p)}\right]^2$$

where ε = dielectric constant; L_a = apparent length of probe, m; L = actual length of probe units (= 0.203 m (8 in) for FHWA probes); V_p = phase velocity setting (= 0.99).

TDR Probe Assigned Serial Number: 48D04 Measured Length of Coax Cable: 12.3 m

Comments: _____

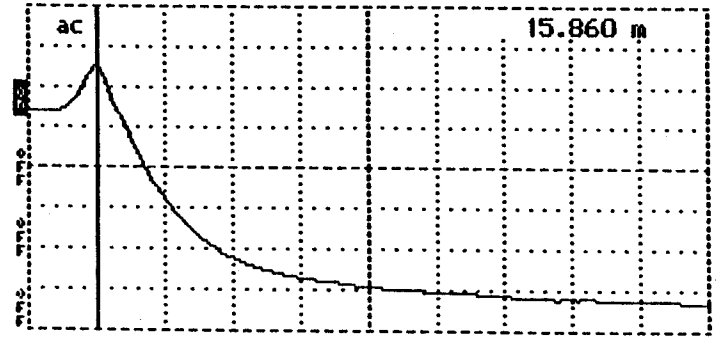
Prepared by: Matt Cole Employer: BRE

Date (dd/mm/yy): 31/08/94

Figure B-1 (Continued). TDR Traces Obtained During Calibration

LTPP Seasonal Monitoring Program Data Sheet SMP-C01 (Page 1) TDR Probe Check	Agency Code [48]
	LTPP Section ID [4143]

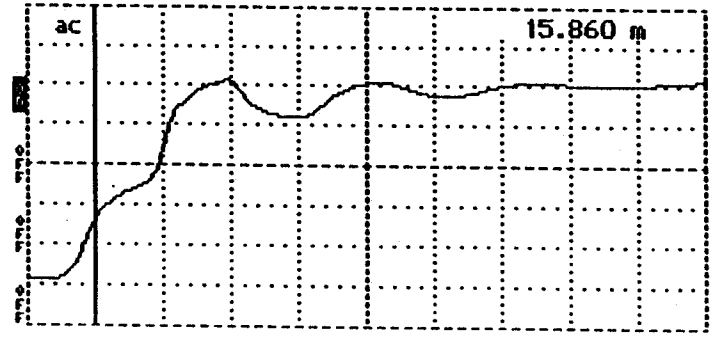
Cursor ..... 15.860 m
Distance/Div..... .25 m/div
Vertical Scale.... 177 mρ/div
VP 0.99
Noise Filter..... 1 avg
Power..... ac



Tektronix 1502B TDR
Date 10/29/93
Cable 4BD05
Notes SHORTED
Input Trace J.P.
Stored Trace .....
Difference Trace .....

TDR Trace	Apparent Length, (m)	Dielectric Constant
"Shorted at Start"	__.__	__.__

Cursor ..... 15.860 m
Distance/Div..... .25 m/div
Vertical Scale.... 177 mρ/div
VP 0.99
Noise Filter..... 1 avg
Power..... ac



Tektronix 1502B TDR
Date 10/29/93
Cable 4BD05
Notes AIR
Input Trace JP
Stored Trace .....
Difference Trace .....

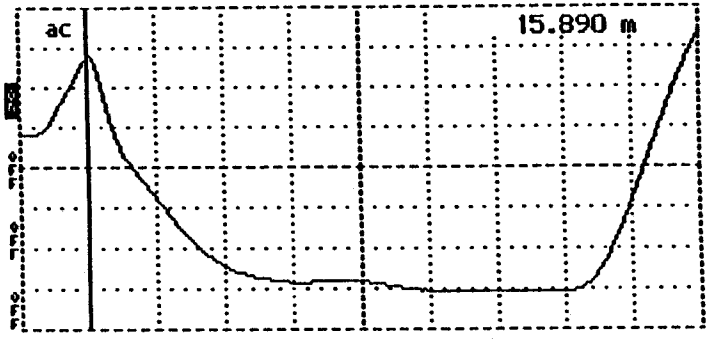
TDR Trace	Apparent Length, (m)	Dielectric Constant[1]
"In Air"	0.24	1.43

Data Sheet SMP-C . TDR Probe Check

Figure B-1 (Continued). TDR Traces Obtained During Calibration

LTPP Seasonal Monitoring Program Data Sheet SMP-C01 (Page 2) TDR Probe Check	Agency Code [48] LTPP Section ID [4143]

Cursor ..... 15.890 m
Distance/Div..... .25 m/div
Vertical Scale.... 77.0 mρ/div
Vp 0.99
Noise Filter..... 1 avg
Power..... ac



Tektronix 1502B TDR
Date 10/27/93
Cable 48D05
Notes WATER
20.6°C
Input Trace S.P.
Stored Trace .....
Difference Trace .....

TDR Trace	Apparent Length, (m)	Dielectric Constant[2]
"In Water"	1.77	77.55

[1] If dielectric constant not between 0.75 and 2.0, contact FHWA LTPP Division
[2] If dielectric constant not between 76 and 84, contact FHWA LTPP Division

Note: Dielectric constant is determined as follows:

$$\varepsilon = \left[\frac{(L_a)}{(L)(V_p)}\right]^2 = \left[\frac{(D_2 - D_1)}{(L)(V_p)}\right]^2$$

where ε = dielectric constant; L_a = apparent length of probe, m; L = actual length of probe units (= 0.203 m (8 in) for FHWA probes); V_p = phase velocity setting (= 0.99).

TDR Probe Assigned Serial Number: 48D05 Measured Length of Coax Cable: 12.3 m

Comments: _____

Prepared by: Matt Cole Employer: BRE

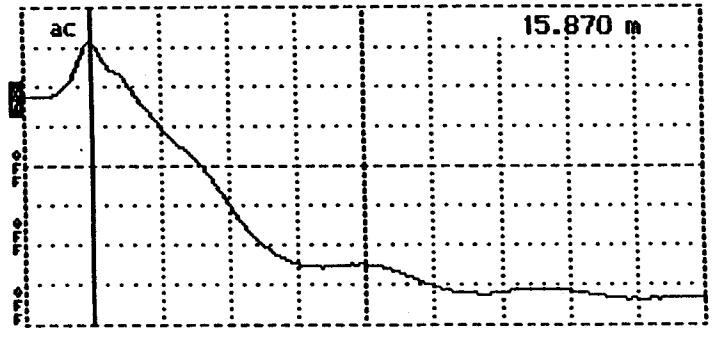
Date (dd/mm/yy): 31/08/94

Data Sheet SMP-C01 TDR Probe Check (Continued)

Figure B-1 (Continued). TDR Traces Obtained During Calibration

LTPP Seasonal Monitoring Program Data Sheet SMP-C01 (Page 1) TDR Probe Check	Agency Code [48] LTPP Section ID [4143]

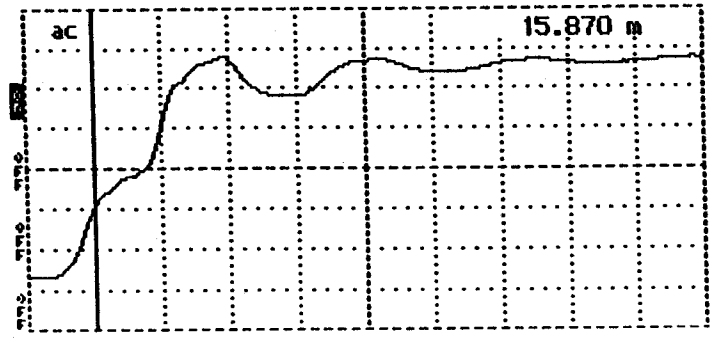
Cursor ..... 15.870 m
Distance/Div..... .25 m/div
Vertical Scale.... 163 mρ/div
Vp 0.99
Noise Filter..... 1 avg
Power..... ac



Tektronix 1502B TDR
Date 10/29/93
Cable 48006
Notes SHORTED
X.D.
Input Trace
Stored Trace
Difference Trace

TDR Trace	Apparent Length, (m)	Dielectric Constant
"Shorted at Start"	__.__	___.__

Cursor ..... 15.870 m
Distance/Div..... .25 m/div
Vertical Scale.... 163 mρ/div
Vp 0.99
Noise Filter..... 1 avg
Power..... ac



Tektronix 1502B TDR
Date 10/29/93
Cable 48006
Notes IN AIR
X.D.
Input Trace
Stored Trace
Difference Trace

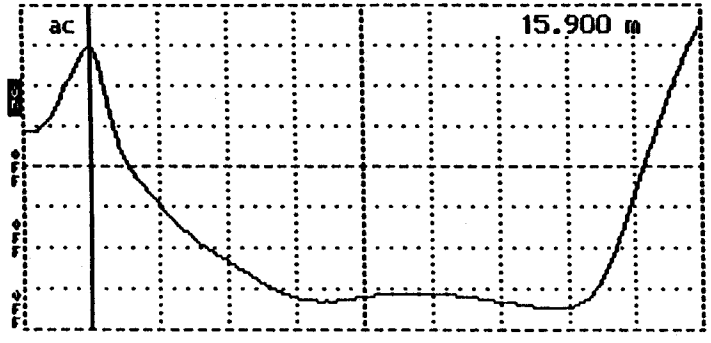
TDR Trace	Apparent Length, (m)	Dielectric Constant[1]
"In Air"	0.24	1.43

Data Sheet SMP-C . TDR Probe Check

Figure B-1 (Continued). TDR Traces Obtained During Calibration

LTPP Seasonal Monitoring Program Data Sheet SMP-C01 (Page 2) TDR Probe Check	Agency Code [48] LTPP Section ID [4143]

Cursor ..... 15.900 m
Distance/Div..... .25 m/div
Vertical Scale.... 70.6 mρ/div
VP 0.99
Noise Filter..... 1 avg
Power..... ac



Tektronix 1502B TDR
Date 10/29/93
Cable 48006
Notes IN WATER
WATER TEMP. 20.6
C.D.
Input Trace
Stored Trace
Difference Trace

TDR Trace	Apparent Length, (m)	Dielectric Constant[2]
"In Water"	1.76	76.67

[1] If dielectric constant not between 0.75 and 2.0, contact FHWA LTPP Division
[2] If dielectric constant not between 76 and 84, contact FHWA LTPP Division

Note: Dielectric constant is determined as follows:

$$\varepsilon = \left[\frac{(L_a)}{(L)(V_p)}\right]^2 = \left[\frac{(D_2 - D_1)}{(L)(V_p)}\right]^2$$

where ε = dielectric constant; L_a = apparent length of probe, m; L = actual length of probe units (= 0.203 m (8 in) for FHWA probes); V_p = phase velocity setting (= 0.99).

TDR Probe Assigned Serial Number: 48D06 Measured Length of Coax Cable: 12.3 m

Comments: _____

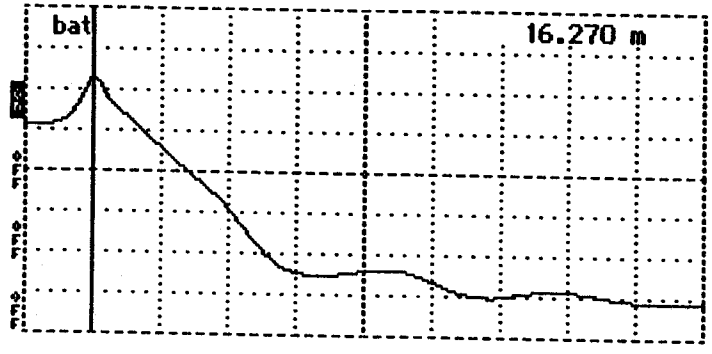
Prepared by: Matt Cole Employer: BRE

Date (dd/mm/yy): 31/08/94

Figure B-1 (Continued). TDR Traces Obtained During Calibration

LTPP Seasonal Monitoring Program Data Sheet SMP-C01 (Page 1) TDR Probe Check	Agency Code [48] LTPP Section ID [4143]

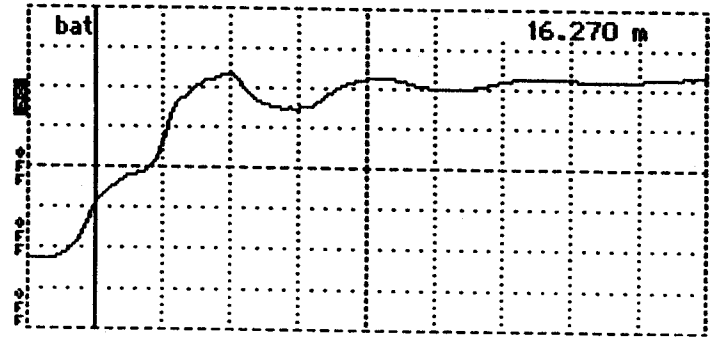
Cursor ..... 16.270 m
Distance/Div..... .25 m/div
Vertical Scale.... 200 mρ/div
Vp 0.99
Noise Filter..... 1 avg
Power..... bat



Tektronix 1502B TDR
Date 10/29/93
Cable 48D07
Notes SHORTED
JP
Input Trace
Stored Trace
Difference Trace

TDR Trace	Apparent Length, (m)	Dielectric Constant
"Shorted at Start"	_ . _ _	_ _ . _ _

Cursor ..... 16.270 m
Distance/Div..... .25 m/div
Vertical Scale.... 193 mρ/div
Vp 0.99
Noise Filter..... 1 avg
Power..... bat



Tektronix 1502B TDR
Date 10/29/93
Cable 48D07
Notes AIR
Input Trace JP
Stored Trace
Difference Trace

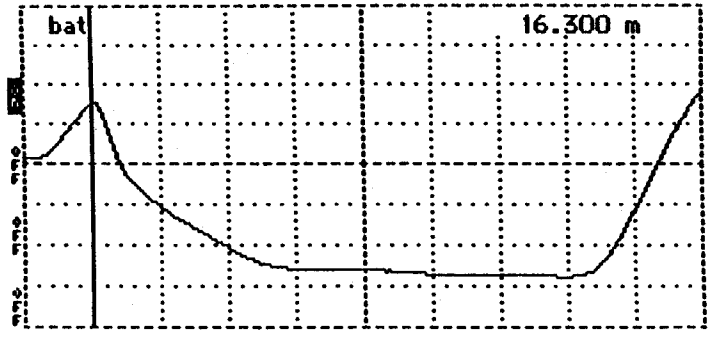
TDR Trace	Apparent Length, (m)	Dielectric Constant[1]
"In Air"	0.24	1.43

Data Sheet SMP-C . TDR Probe Check

Figure B-1 (Continued). TDR Traces Obtained During Calibration

LTPP Seasonal Monitoring Program Data Sheet SMP-C01 (Page 2) TDR Probe Check	Agency Code [48] LTPP Section ID [41 43]

Cursor ..... 16.300 m
Distance/Div..... .25 m/div
Vertical Scale.... 103 mρ/div
VP 0.99
Noise Filter..... 1 avg
Power..... bat



Tektronix 1502B TDR
Date 10/29/93
Cable 48D07
Notes WATER
20.6°C
Input Trace
Stored Trace
Difference Trace

TDR Trace	Apparent Length, (m)	Dielectric Constant[2]
"In Water"	1.77	77.55

[1] If dielectric constant not between 0.75 and 2.0, contact FHWA LTPP Division
[2] If dielectric constant not between 76 and 84, contact FHWA LTPP Division

Note: Dielectric constant is determined as follows:

$$\varepsilon = \left[\frac{(L_a)}{(L)(V_p)}\right]^2 = \left[\frac{(D_2 - D_1)}{(L)(V_p)}\right]^2$$

where ε = dielectric constant; L_a = apparent length of probe, m; L = actual length of probe units (= 0.203 m (8 in) for FHWA probes); V_p = phase velocity setting (= 0.99).

TDR Probe Assigned Serial Number: 48D07 Measured Length of Coax Cable: 12.3 m

Comments: _____

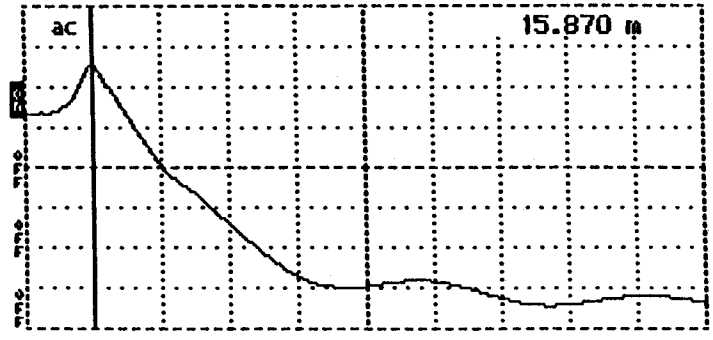
Prepared by: Matt Cole Employer: BRE

Date (dd/mm/yy): 31/08/94

Figure B-1 (Continued). TDR Traces Obtained During Calibration

LTPP Seasonal Monitoring Program Data Sheet SMP-C01 (Page 1) TDR Probe Check	Agency Code [48] LTPP Section ID [4143]

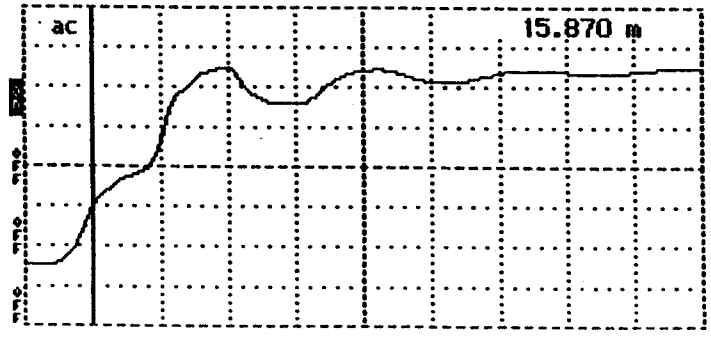
Cursor ..... 15.870 m
Distance/Div..... .25 m/div
Vertical Scale.... 177 mρ/div
VP 0.99
Noise Filter..... 1 avg
Power..... ac



Tektronix 1502B TDR
Date 10/29/93
Cable 4000B
Notes SHORTED
Input Trace SP
Stored Trace .....
Difference Trace .....

TDR Trace	Apparent Length, (m)	Dielectric Constant
"Shorted at Start"	__.__	__.__

Cursor ..... 15.870 m
Distance/Div..... .25 m/div
Vertical Scale.... 177 mρ/div
VP 0.99
Noise Filter..... 1 avg
Power..... ac



Tektronix 1502B TDR
Date 10/29/93
Cable 4000B
Notes AIR
Input Trace SP.
Stored Trace .....
Difference Trace .....

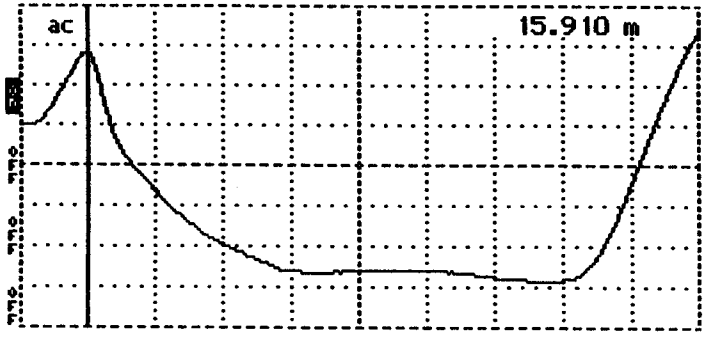
TDR Trace	Apparent Length, (m)	Dielectric Constant[1]
"In Air"	0.24	1.43

Data Sheet SMP-C , TDR Probe Check

Figure B-1 (Continued). TDR Traces Obtained During Calibration

LTPP Seasonal Monitoring Program Data Sheet SMP-C01 (Page 2) TDR Probe Check	Agency Code [48] LTPP Section ID [4143]

Cursor ..... 15.910 m
Distance/Div..... .25 m/div
Vertical Scale.... 79.2 mρ/div
Vp 0.99
Noise Filter..... 1 avg
Power..... ac



Tektronix 1502B TDR
Date 10/29/93
Cable 48D08
Notes WATER
20.6°C
Input Trace SP.
Stored Trace .....
Difference Trace .....

Figure B-1 (Continued). TDR Traces Obtained During Calibration

TDR Trace	Apparent Length, (m)[1]	Dielectric Constant[2]
"In Water"	1.76	76.67

[1] If dielectric constant not between 0.75 and 2.0, contact FHWA LTPP Division
[2] If dielectric constant not between 76 and 84, contact FHWA LTPP Division

Note: Dielectric constant is determined as follows:

$$\varepsilon = \left[\frac{(L_a)}{(L)(V_p)}\right]^2 = \left[\frac{(D_2 - D_1)}{(L)(V_p)}\right]^2$$

where ε = dielectric constant; L_a = apparent length of probe, m; L = actual length of probe units (= 0.203 m (8 in) for FHWA probes); V_p = phase velocity setting (= 0.99).

TDR Probe Assigned Serial Number: 48D08 Measured Length of Coax Cable: 12.3 m

Comments: _____

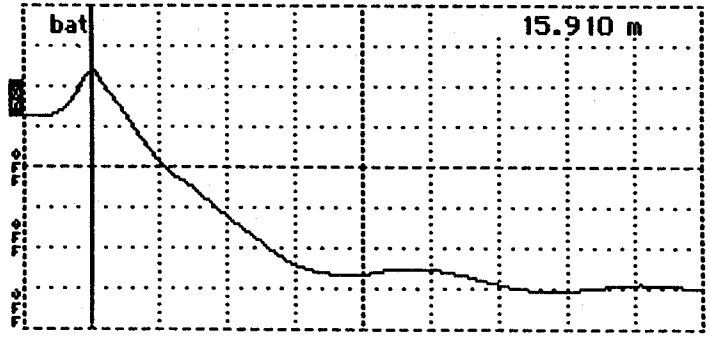
Prepared by: Matt Cole Employer: BRE

Date (dd/mm/yy): 31/08/94

Data Sheet SMP-C01, TDR Probe Check (Continued)

LTPP Seasonal Monitoring Program Data Sheet SMP-C01 (Page 1) TDR Probe Check	Agency Code [48] LTPP Section ID [4143]

Cursor ..... 15.910 m
Distance/Div..... .25 m/div
Vertical Scale.... 193 mρ/div
VP 0.99
Noise Filter..... 1 avg
Power..... bat

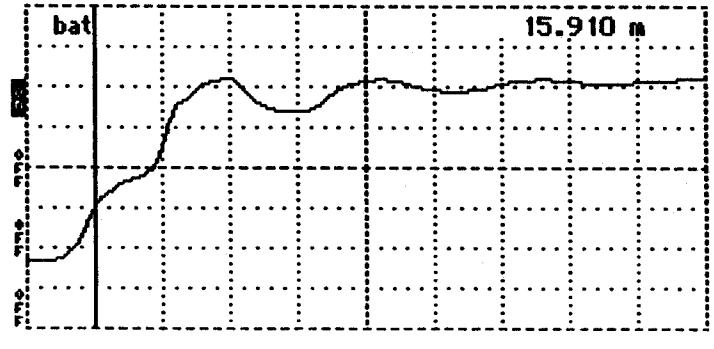


Tektronix 1502B TDR
Date 10/29/93
Cable 48D09
Notes SHORTED
Input Trace J.P.
Stored Trace .....
Difference Trace .....

TDR Trace	Apparent Length, (m)	Dielectric Constant
"Shorted at Start"	__.__	__.__

Figure B-1 (Continued). TDR Traces Obtained During Calibration

Cursor ..... 15.910 m
Distance/Div..... .25 m/div
Vertical Scale.... 193 mρ/div
VP 0.99
Noise Filter..... 1 avg
Power..... bat



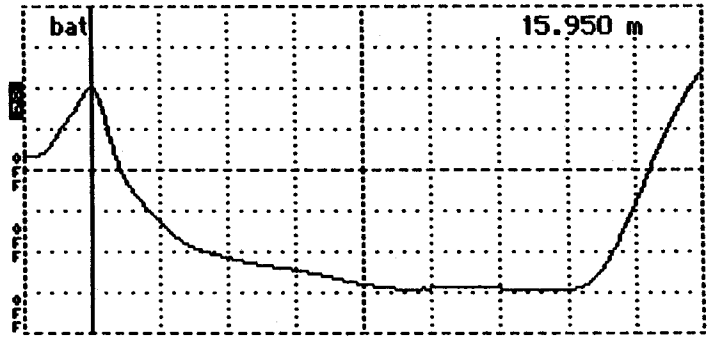
Tektronix 1502B TDR
Date 10/29/93
Cable 48D09
Notes AIR
Input Trace J.P.
Stored Trace .....
Difference Trace .....

TDR Trace	Apparent Length, (m)	Dielectric Constant[1]
"In Air"	0.24	1.43

Data Sheet SMP-C . TDR Probe Check

LTPP Seasonal Monitoring Program Data Sheet SMP-C01 (Page 2) TDR Probe Check	Agency Code [48] LTPP Section ID [4 1 4 3]

Cursor ..... 15.950 m
Distance/Div..... .25 m/div
Vertical Scale.... 88.9 mρ/div
VP 0.99
Noise Filter..... 1 avg
Power..... bat



Tektronix 1502B TDR
Date 12/29/93
Cable 48D09
Notes WATER
20.6°C
Input Trace JP
Stored Trace .....
Difference Trace .....

TDR Trace	Apparent Length, (m)	Dielectric Constant[2]
"In Water"	1.77	77.55

[1] If dielectric constant not between 0.75 and 2.0, contact FHWA LTPP Division
[2] If dielectric constant not between 76 and 84, contact FHWA LTPP Division

Note: Dielectric constant is determined as follows:

$$\varepsilon = \left[\frac{(L_a)}{(L)(V_p)}\right]^2 = \left[\frac{(D_2 - D_1)}{(L)(V_p)}\right]^2$$

where ε = dielectric constant; L_a = apparent length of probe, m; L = actual length of probe units (= 0.203 m (8 in) for FHWA probes); V_p = phase velocity setting (= 0.99).

TDR Probe Assigned Serial Number: 48D09 Measured Length of Coax Cable: 12.3 m

Comments: _____

Prepared by: Matt Cole Employer: BRE

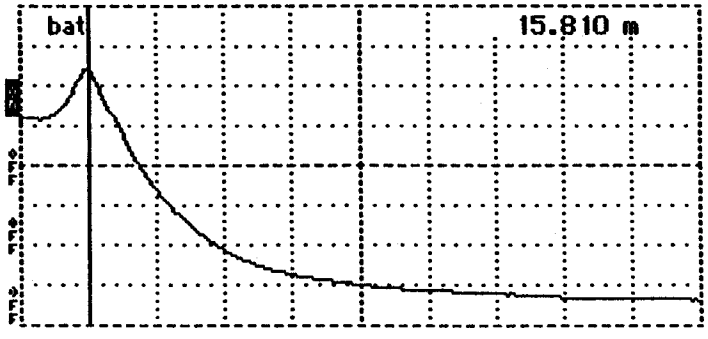
Date (dd/mm/yy): 31/08/94

Data Sheet SMP-C01 TDR Probe Check (Continued)

Figure B-1 (Continued). TDR Traces Obtained During Calibration

LTPP Seasonal Monitoring Program Data Sheet SMP-C01 (Page 1) TDR Probe Check	Agency Code [48] LTPP Section ID [4143]

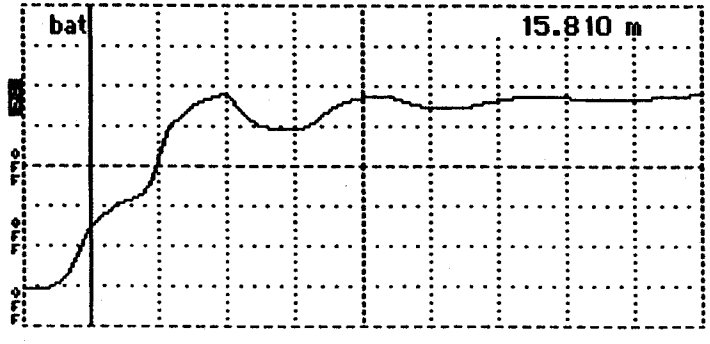
Cursor ..... 15.810 m
Distance/Div..... .25 m/div
Vertical Scale.... 182 mρ/div
VP 0.99
Noise Filter..... 1 avg
Power..... bat



Tektronix 1502B TDR
Date 10/29/93
Cable 48D10
Notes SHORTED
Input Trace JP
Stored Trace
Difference Trace

TDR Trace	Apparent Length, (m)	Dielectric Constant
"Shorted at Start"	__.__	__.__

Cursor ..... 15.810 m
Distance/Div..... .25 m/div
Vertical Scale.... 182 mρ/div
VP 0.99
Noise Filter..... 1 avg
Power..... bat



Tektronix 1502B TDR
Date 10/29/93
Cable 48D10
Notes AIR
J.P.
Input Trace
Stored Trace
Difference Trace

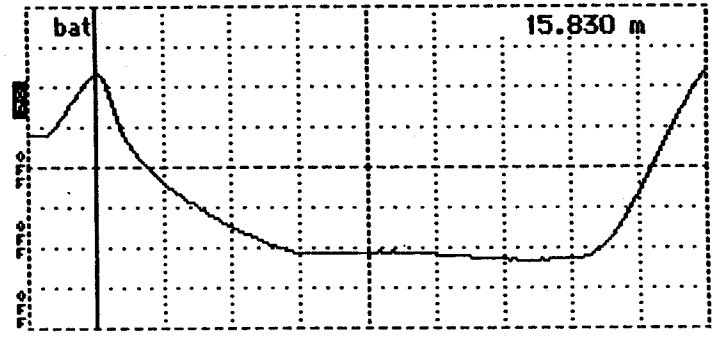
TDR Trace	Apparent Length, (m)	Dielectric Constant[1]
"In Air"	0.24	1.43

Data Sheet SMP-C . TDR Probe Check

Figure B-1 (Continued). TDR Traces Obtained During Calibration

LTPP Seasonal Monitoring Program Data Sheet SMP-C01 (Page 2) TDR Probe Check	Agency Code [48] LTPP Section ID [4143]

Cursor ..... 15.830 m
Distance/Div..... .25 m/div
Vertical Scale.... 96.9 mρ/div
Vp 0.99
Noise Filter..... 1 avg
Power..... bat



Tektronix 1502B TDR
Date 10/29/93
Cable 4D10
Notes WATER
20.5°C
Input Trace J.P.
Stored Trace .....
Difference Trace .....

TDR Trace	Apparent Length, (m)	Dielectric Constant[2]
"In Water"	1.77	77.55

[1] If dielectric constant not between 0.75 and 2.0, contact FHWA LTPP Division
[2] If dielectric constant not between 76 and 84, contact FHWA LTPP Division

Note: Dielectric constant is determined as follows:

$$\varepsilon = \left[\frac{(L_a)}{(L)(V_p)}\right]^2 = \left[\frac{(D_2 - D_1)}{(L)(V_p)}\right]^2$$

where ε = dielectric constant; L_a = apparent length of probe, m; L = actual length of probe units (= 0.203 m (8 in) for FHWA probes); V_p = phase velocity setting (= 0.99).

TDR Probe Assigned Serial Number: 48D10 Measured Length of Coax Cable: 12.3 m

Comments: _____

Prepared by: Matt Cole Employer: BRE

Date (dd/mm/yy): 31/08/94

Figure B-1 (Continued). TDR Traces Obtained During Calibration

APPENDIX C

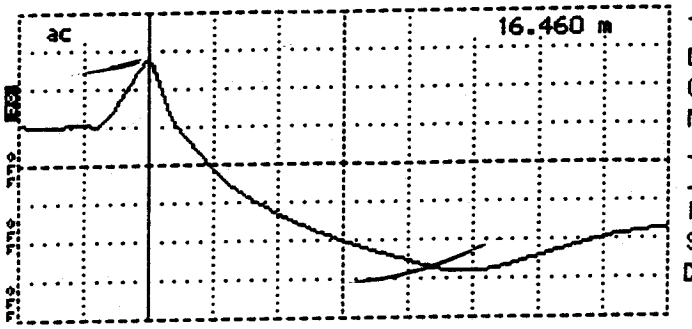
Instrumentation Installation Information

Appendix C contains the following information:

Figure C-1. TDR Traces During Installation

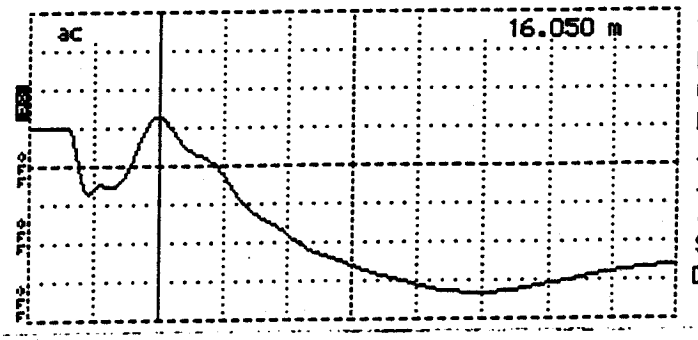
Table C-1. Field Measured Moisture Contents

Cursor ..... 16.460 m
Distance/Div..... .25 m/div
Vertical Scale.... 96.9 mΩ/div
VP 0.99
Noise Filter..... 1 avg
Power..... ac



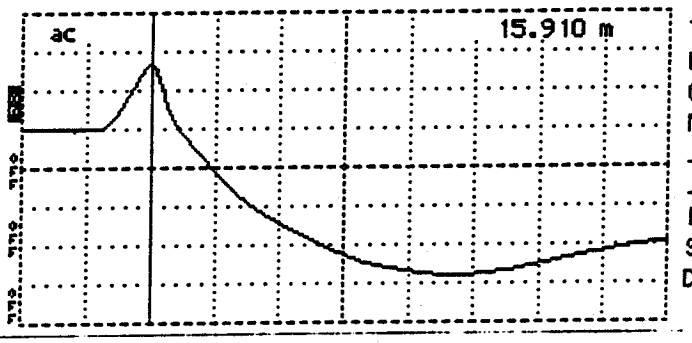
Tektronix 1502B TDR
Date 11/17/93
Cable 40001
Notes DEPTH 19"
Input Trace J.P.
Stored Trace
Difference Trace

Cursor ..... 16.050 m
Distance/Div..... .25 m/div
Vertical Scale.... 96.9 mΩ/div
VP 0.99
Noise Filter..... 1 avg
Power..... ac



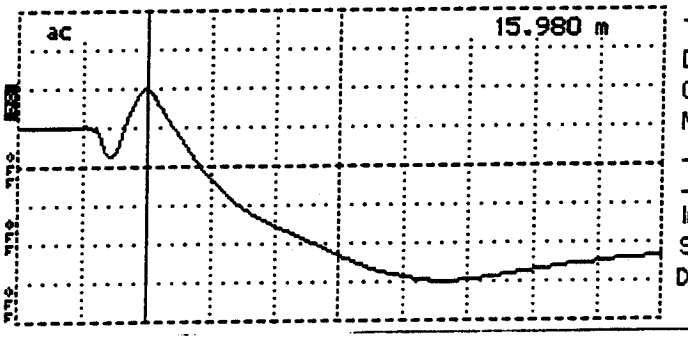
Tektronix 1502B TDR
Date 11/17/93
Cable 40002
Notes DEPTH 24.5"
Input Trace
Stored Trace
Difference Trace

Cursor ..... 15.910 m
Distance/Div..... .25 m/div
Vertical Scale.... 96.9 mΩ/div
VP 0.99
Noise Filter..... 1 avg
Power..... ac



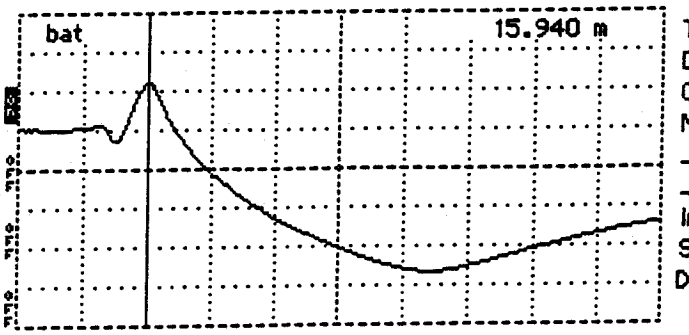
Tektronix 1502B TDR
Date 11/17/93
Cable 40003
Notes DEPTH 30"
Input Trace J.D
Stored Trace
Difference Trace

Cursor ..... 15.980 m
Distance/Div..... .25 m/div
Vertical Scale.... 96.9 mΩ/div
VP 0.99
Noise Filter..... 1 avg
Power..... ac



Tektronix 1502B TDR
Date 11/17/93
Cable 40004
Notes LENGTH 36.0"
Input Trace J.P.
Stored Trace
Difference Trace

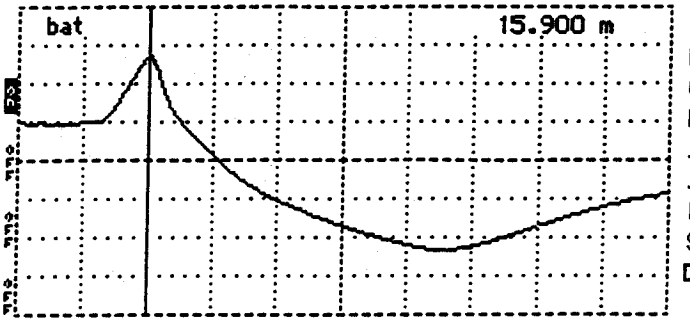
Cursor ..... 15.940 m
Distance/Div..... .25 m/div
Vertical Scale.... 96.9 mΩ/div
VP 0.99
Noise Filter..... 1 avg
Power..... bat/low



Tektronix 1502B TDR
Date 11/17/93
Cable 40005
Notes DEPTH 42.0"
Input Trace J.P
Stored Trace
Difference Trace

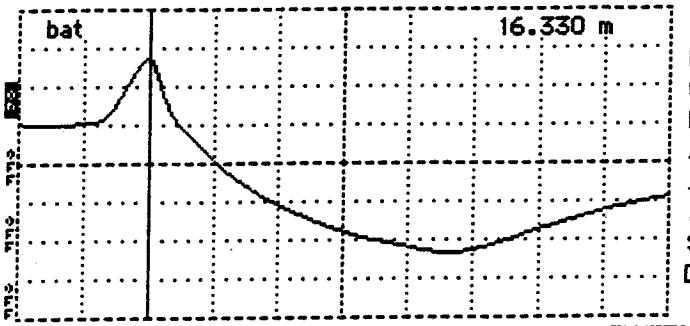
Figure C-1. TDR Traces During Installation

Cursor ..... 15.900 m
Distance/Div..... .25 m/div
Vertical Scale.... 96.9 mΩ/div
VP 0.99
Noise Filter..... 1 avg
Power..... bat/low



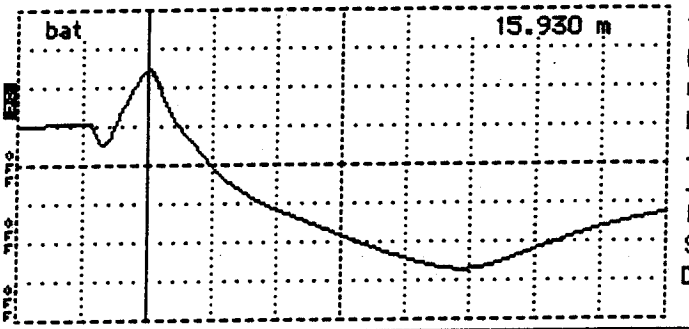
Tektronix 1502B TDR
Date 11/17/93
Cable 48D06
Notes DEPTH 48.0"
Input Trace J.P
Stored Trace
Difference Trace

Cursor ..... 16.330 m
Distance/Div..... .25 m/div
Vertical Scale.... 96.9 mΩ/div
VP 0.99
Noise Filter..... 1 avg
Power..... bat/low



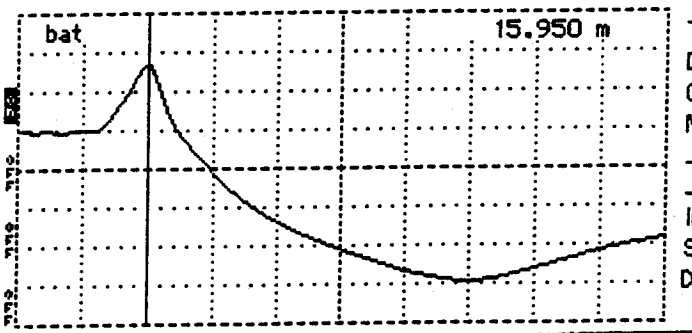
Tektronix 1502B TDR
Date 11/17/93
Cable 48D07
Notes DEPTH 54.0"
Input Trace J.P.
Stored Trace
Difference Trace

Cursor ..... 15.930 m
Distance/Div..... .25 m/div
Vertical Scale.... 96.9 mΩ/div
VP 0.99
Noise Filter..... 1 avg
Power..... bat



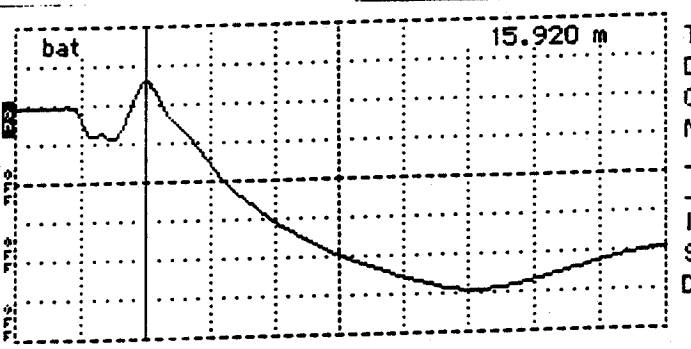
Tektronix 1502B TDR
Date 11/17/93
Cable 48D08
Notes DEPTH 59.0"
Input Trace J.P
Stored Trace
Difference Trace

Cursor ..... 15.950 m
Distance/Div..... .25 m/div
Vertical Scale.... 96.9 mΩ/div
VP 0.99
Noise Filter..... 1 avg
Power..... bat



Tektronix 1502B TDR
Date 11/17/93
Cable 48D09
Notes DEPTH 72.5"
Input Trace J.P.
Stored Trace
Difference Trace

Cursor ..... 15.920 m
Distance/Div..... .25 m/div
Vertical Scale.... 83.9 mΩ/div
VP 0.99
Noise Filter..... 1 avg
Power..... bat



Tektronix 1502B TDR
Date 11/17/93
Cable 48D10
Notes DEPTH 84.5"
Input Trace J.P.
Stored Trace
Difference Trace

Figure C-1 (Continued). TDR Traces During Installation

Table C-1. Field Measured Moisture Contents

SITE NO. 484143 11/16/93

MOISTURE CONTENTS FOR TDR

TDR #	WT. OF PAN(g)	(WET) PAN & SOIL(g)	(DRY) PAN & SOIL(g)	M.C. (%)
48D10*	160.6	438.9	370.3	32.71%
48D09	203.5	449.8	392.3	30.46%
48D08	179.0	414.3	369.1	23.78%
48D07	177.5	379.1	342.1	22.48%
48D06	198.6	411.4	371.0	23.43%
48D05	177.5	391.9	353.5	21.82%
48D04	178.9	410.1	371.1	20.29%
48D03	178.9	426.3	374.6	26.42%
48D02	198.7	424.8	378.9	25.47%
48D01	177.6	370.6	323.5	32.28%

* 48D10 BROKEN, LEFT IN GROUND

APPENDIX D

Initial Data Collection

Appendix D contains the following support information:

Table D-1.	Raw Data from the On-site Data Logger
Figure D-1.	Measured Air Temperature During Initial Data Collection
Figure D-2.	Measured Average Subsurface Temperature for the First 5 Sensors During Initial Data Collection
Figure D-3.	Measured Average Subsurface Temperature for all 18 Sensors During Initial Data Collection
Figure D-4. thru Figure D-13.	Traces from TDR Sensor
Table D-2.	Elevation Measurements from Installation

5,1993,321,1800,12.34,15,0
5,1993,321,1900,12.34,13.56,0
5,1993,321,2000,12.34,12.9,0
6,1993,321,2000,18.15,20.29,24.12,19.65,19.43
7,1993,321,2001,-684.9,-1165,-1628,-2005,-2233,-2346,-2396,-2417,-2425,-2428,-2429,-2430,-2431,-2431,-2432,-2432,-2432,-2431,-2430,-2431,-2399,-2417,-2425,-2428,-2428,-2428,-2428,-2430,-2428,-2427,-2426,-2427,-2428,-2428,-2430
5,1993,321,2100,12.33,11.67,0
5,1993,321,2200,12.32,10.83,0
5,1993,321,2300,12.31,10.36,0
1,1993,321,2400,12.33,12.35,1825,12.17,1724,11.86,15.81,1724,9.5,2342,0
2,1993,321,2400,17.55,20.13,23.31,21.43,20.28,20.06,20.28,20.61,21.26,21.86,22.45,22.91,23.29,23.59,23.94,24.28,24.69,25
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6,1993,322,1200,16.35,16.07,17.09,21.37,21.52
7,1993,322,1201,-480.1,-885,-1277,-1638,-1908,-2069,-2153,-2195,-2214,-2223,-2227,-2229,-2229,-2229,-2230,-2230,-2230,-2229,-2229,-2229,-2229,-2229,-2229,-2229,-2227,-2227,-2228,-2227,-2228,-2229,-2228,-2228,-2227,-2229
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5,1993,322,1400,12.24,18.44,0

Table D-1. Raw Data from the On-Site Data Logger During Initial Data Collection

Site 484143

November 16, 1993

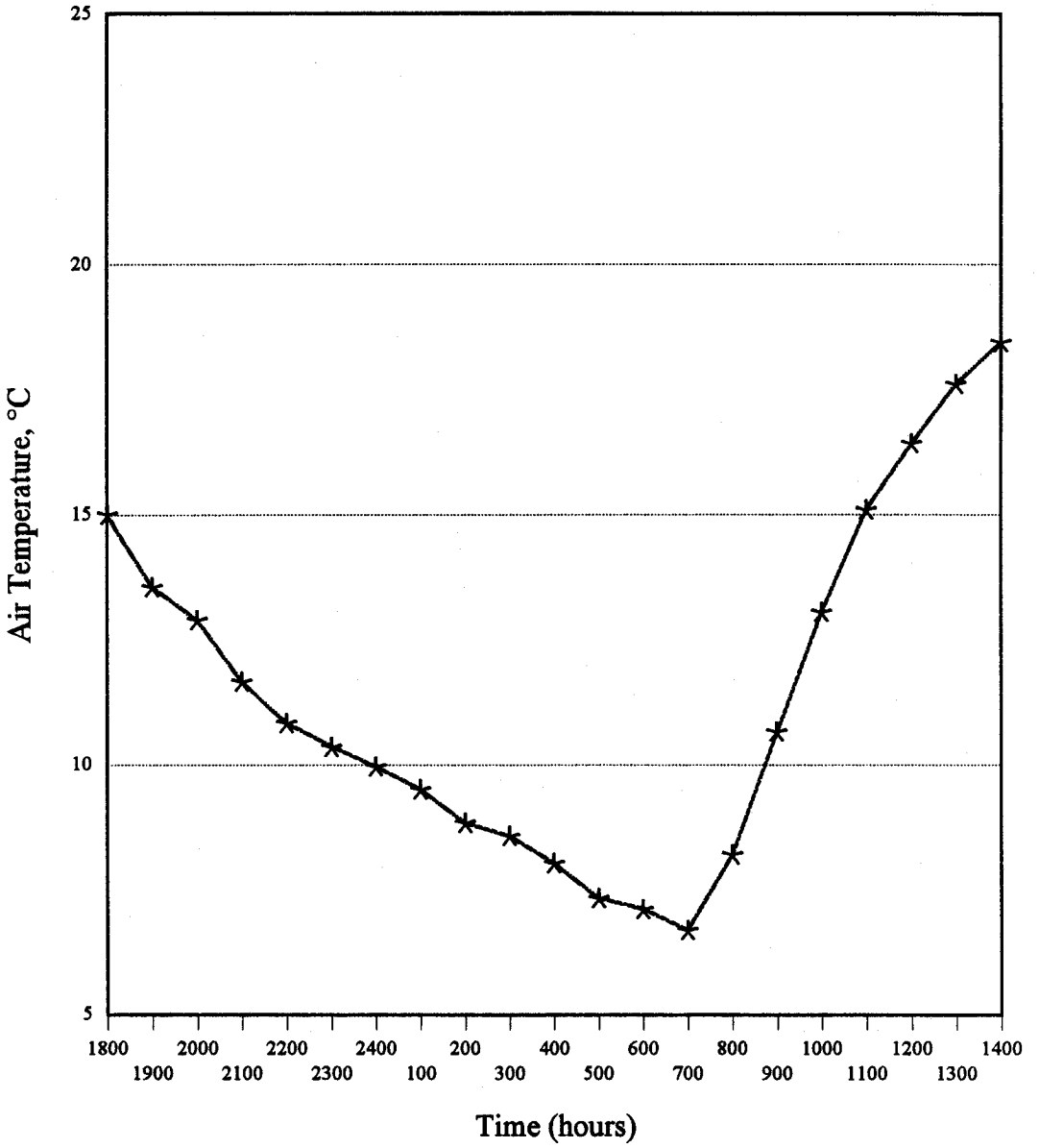

Figure D-1. Measured Air Temperature During Initial Data Collection.

Site 484143

November 16, 1993

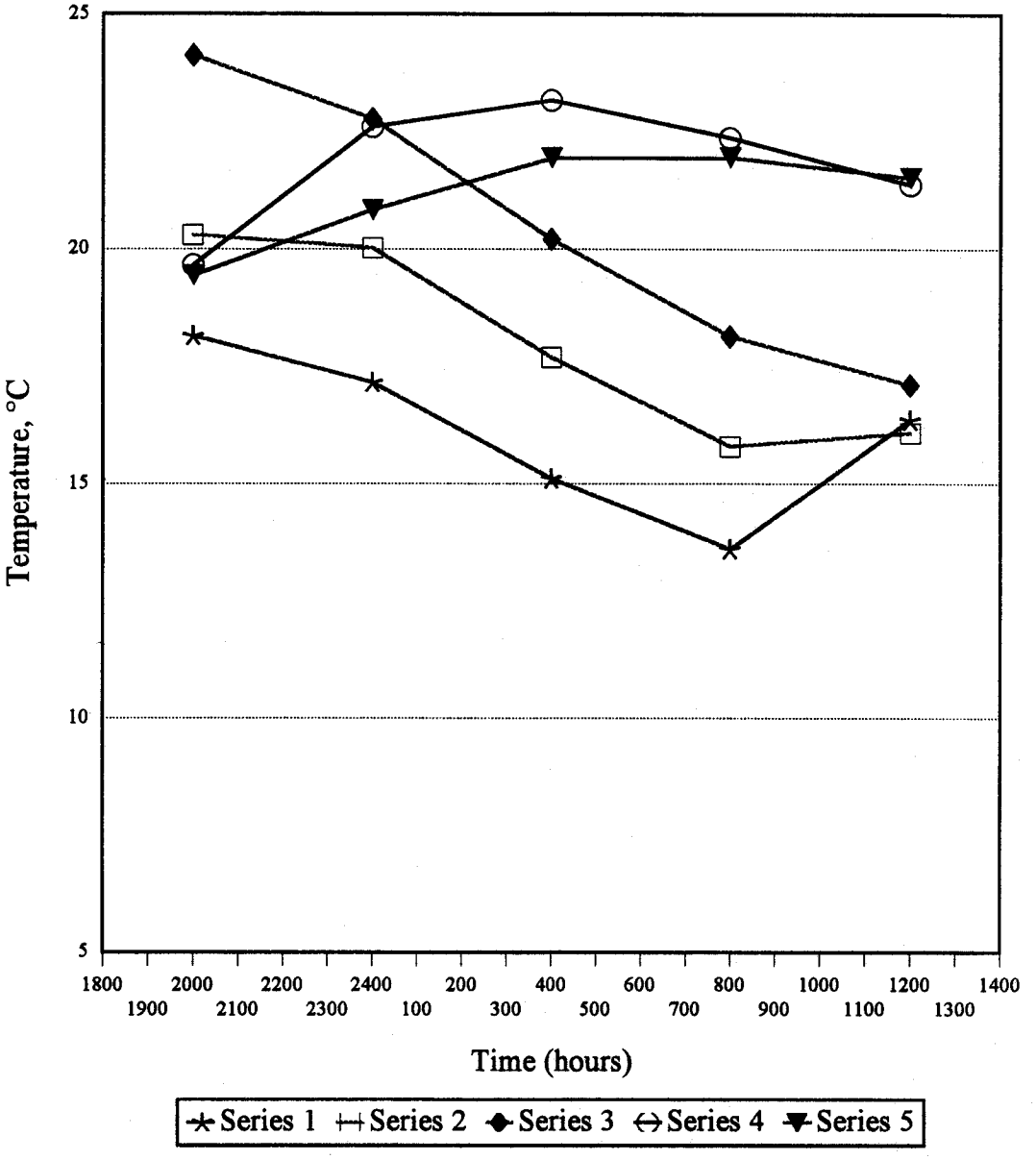

Figure D-2. Measured Average Subsurface Temperature for the First 5 Sensors During Initial Data Collection.

Site 484143

November 16, 1993

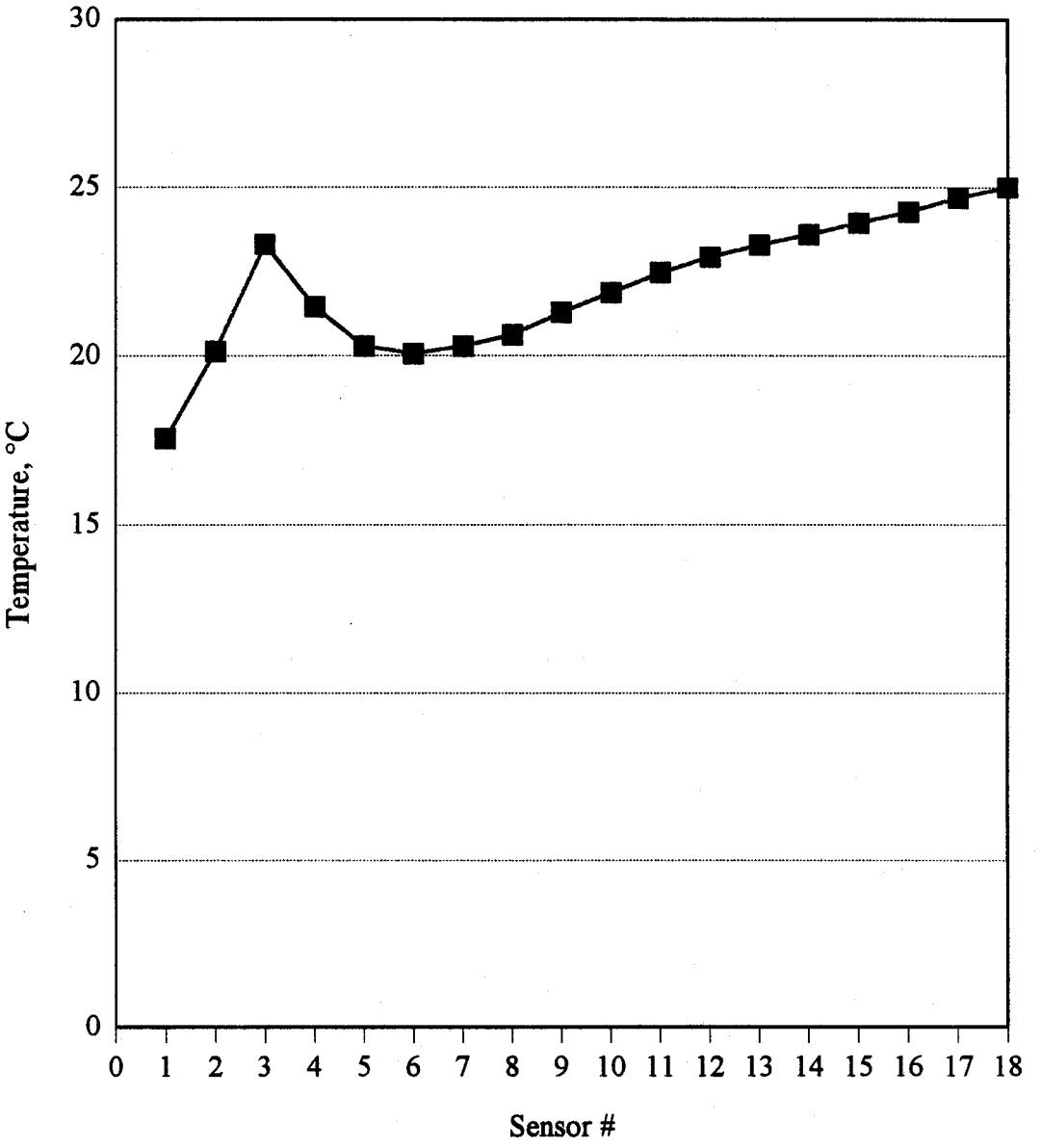

Figure D-3. Measured Average Subsurface Temperature for All 18 Sensors During Initial Data Collection.

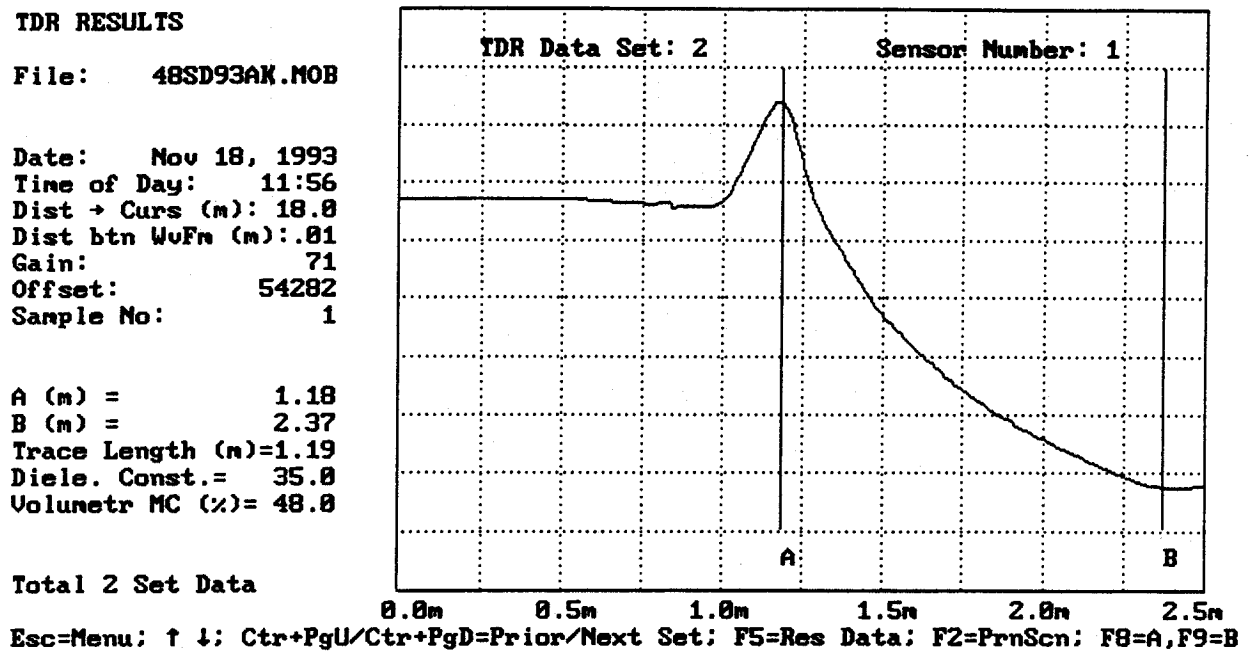

Figure D-4. Trace from TDR Sensor 1

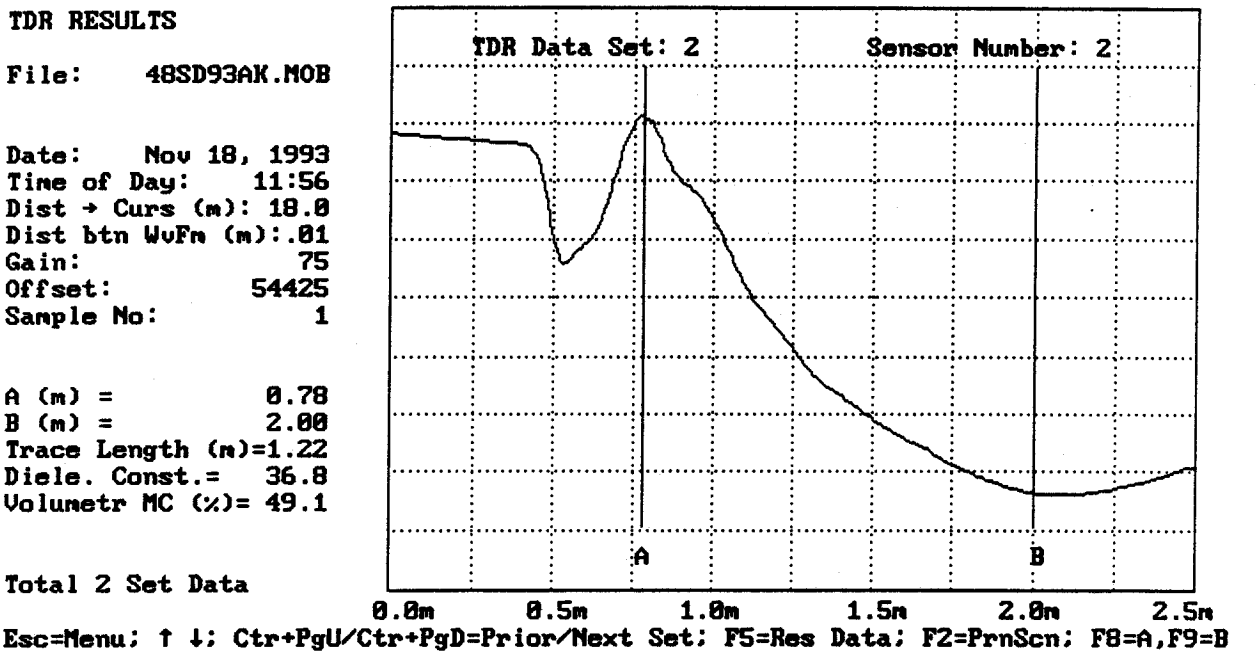

Figure D-5. Trace from TDR Sensor 2

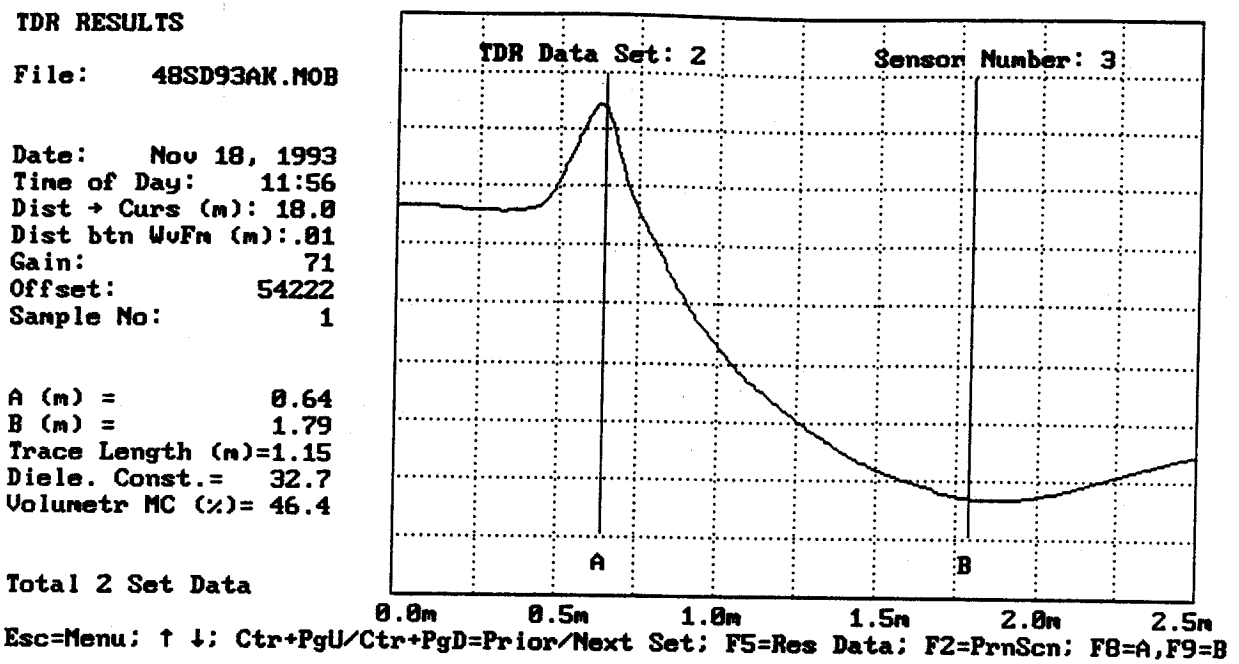

Figure D-6. Trace from TDR Sensor 3

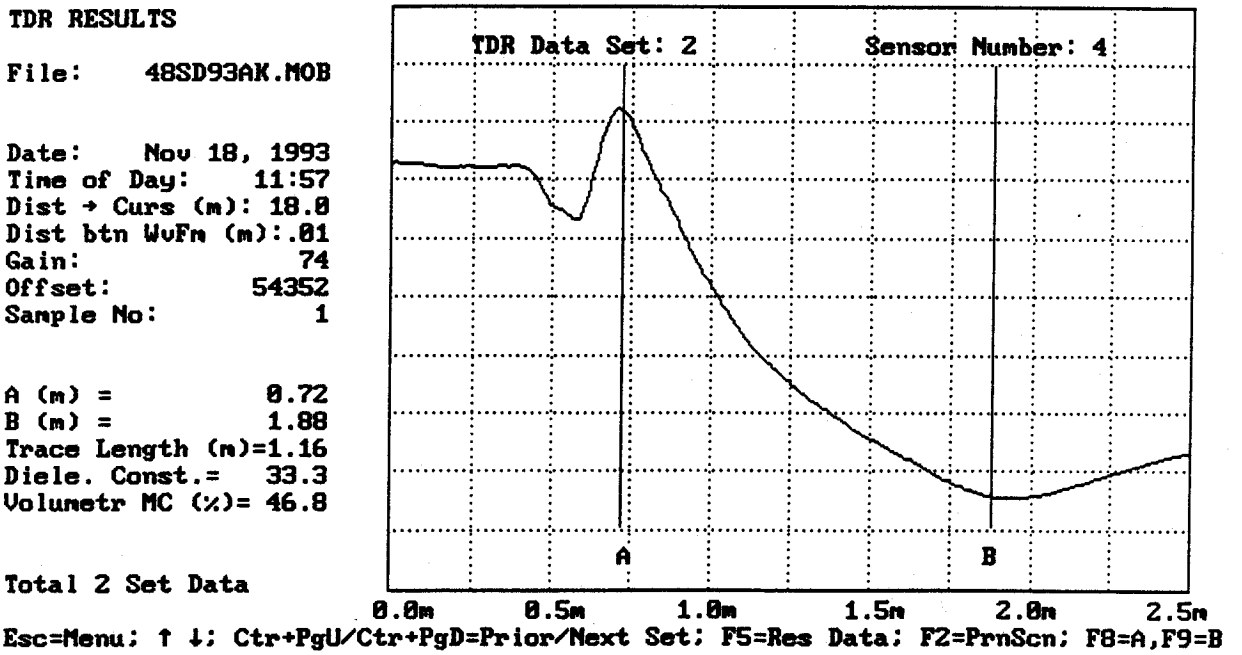

Figure D-7. Trace from TDR Sensor 4

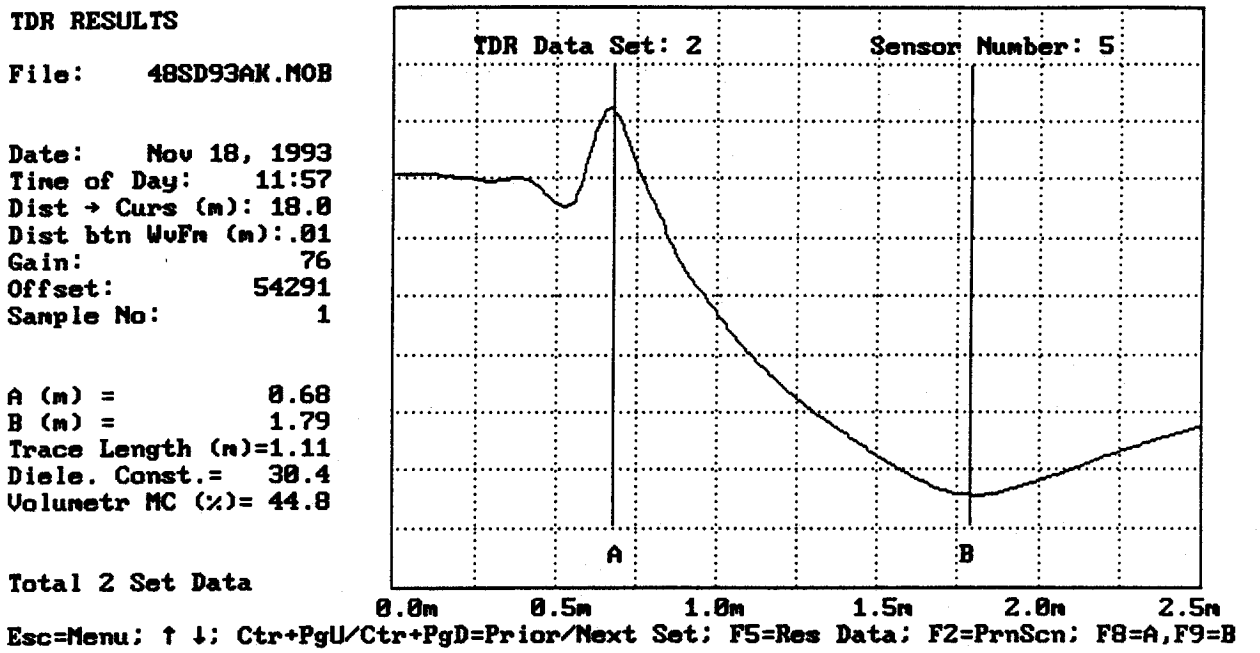

Figure D-8. Trace from TDR Sensor 5

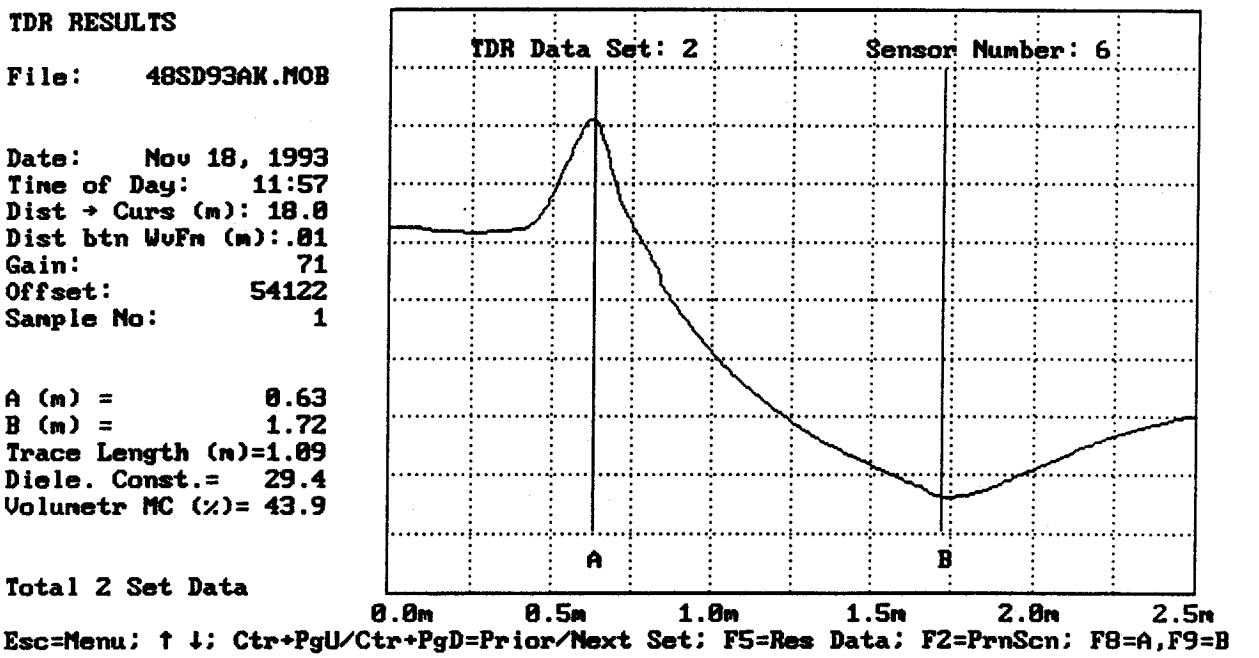

Figure D-9. Trace from TDR Sensor 6

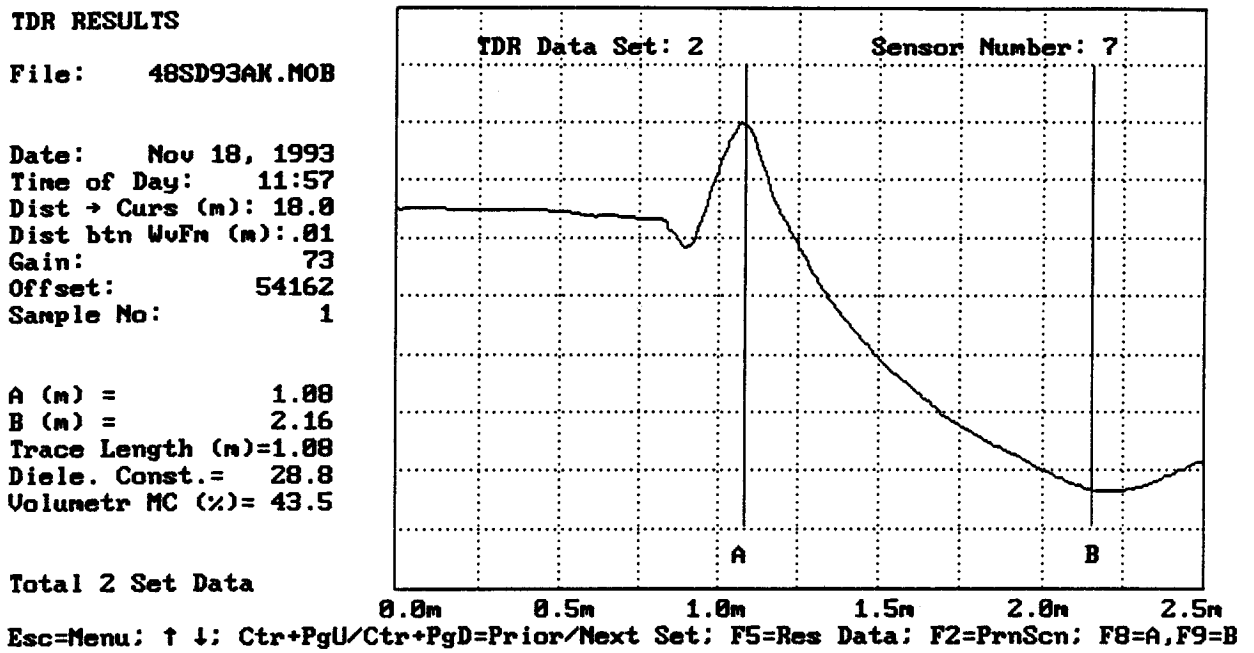

Figure D-10. Trace from TDR Sensor 7

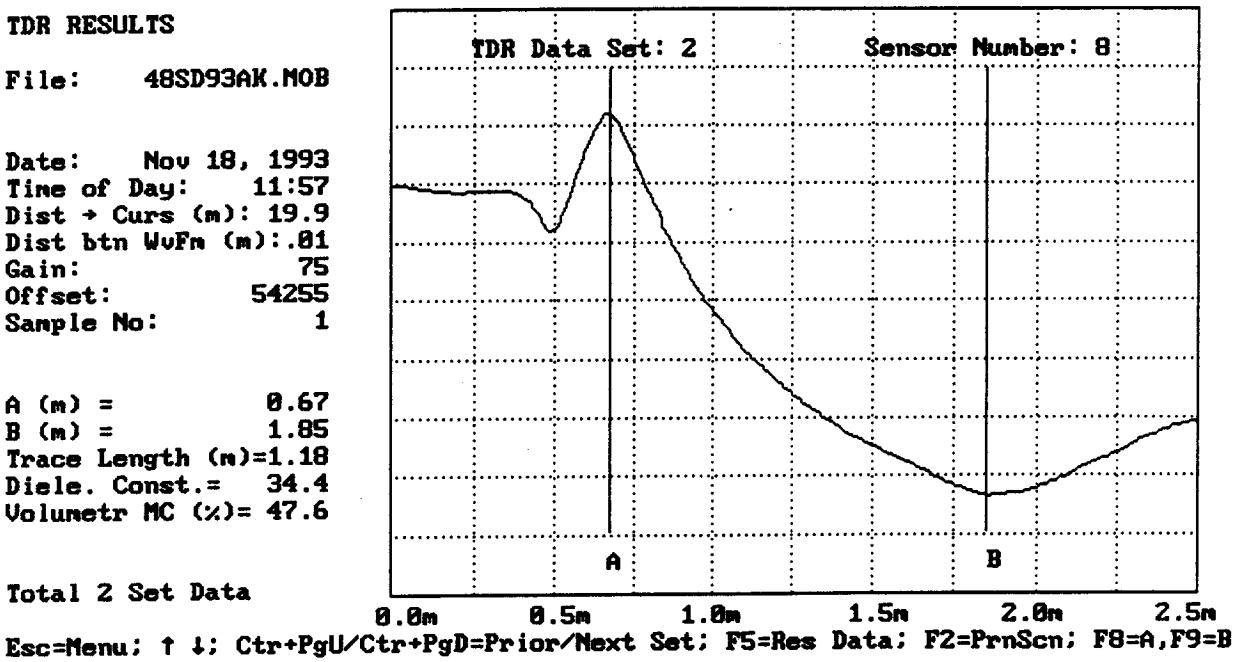

Figure D-11. Trace from TDR Sensor 8

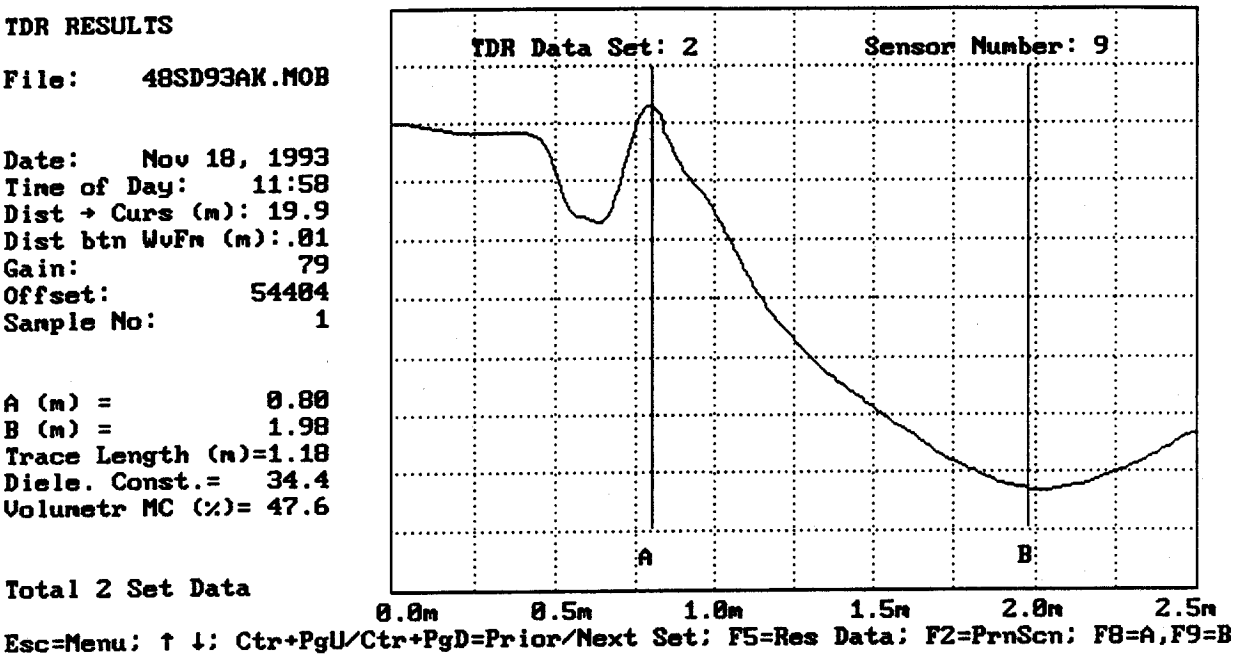

Figure D-12. Trace from TDR Sensor 9

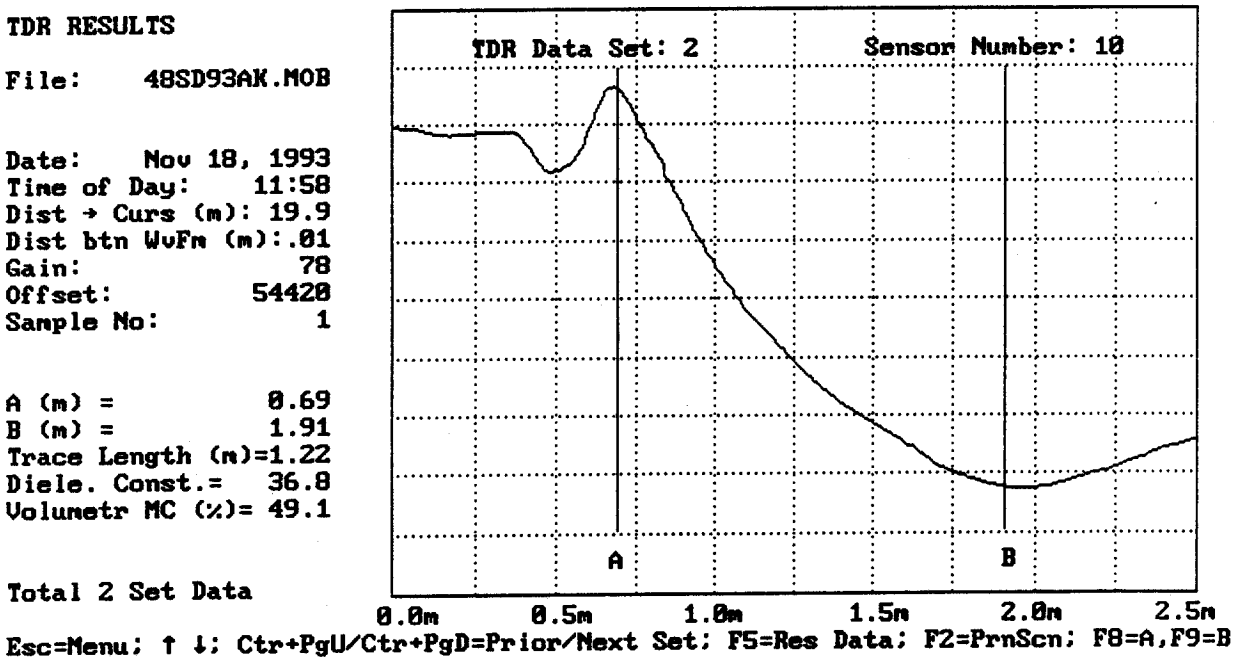

Figure D-13. Trace from TDR Sensor 10

Table D-2. Elevation Measurements from Installation

SEASONAL MONITORING
"RIGID" TRANSVERSE ELEVATION MEASUREMENTS[1]

Station		Outside Edge		ML		Inside Edge	
		O/S	Elev.	O/S	Elev.	O/S	Elev.
4+12.72	L	Edge Slab	2.645	1.83m	2.705	3.66m	2.748
4+22.90	M	"	2.648	1.825m	2.702	3.644m	2.742
4+32.57	A	"	2.647	1.82m	2.702	3.64m	2.742
"	L	"	2.643	"	2.699	"	2.742
4+42.92	M	"	2.643	1.815m	2.700	3.63m	2.740
4+53.10	A	"	2.648	1.817m	2.703	3.63m	2.743
"	L	"	2.646	"	2.703	"	2.744
4+62.93	M	"	2.638	1.82m	2.702	3.64m	2.744
4+72.96	A	"	2.653	1.815m	2.708	3.636m	2.749
"	L	"	2.652	"	2.706	"	2.751
4+82.93	M	"	2.650	1.81m	2.704	3.62m	2.747
4+93.06	A	"	2.656	1.82m	2.718	3.63m	2.757
"	L	"	2.655	"	2.718	"	2.758
5+03.25	M	"	2.663	1.82m	2.718	3.64m	2.758
5+13.65	A	"	2.672	1.82m	2.724	3.64m	2.768

Bench Mark : ALLOY CAP IN TOP OF 6" CONCRETE CYLINDER 20' DEEP 23.5' SOUTH OF ℄ EAST BOUND LANE, U.S. 90 JEFFERSON Co.; STATION 2+50, OFF SHOULDER EDGE ELEV. 41.153 FEET
12.543 METERS TIE IN: ✓

Comments: INST. @ ± 3+75 SHOULDER EDGE, SLAB ± 144" TO 142.5" WIDE THROUGHOUT (± 3.64m WIDE)

Test Section No. 484143 **Date** 11/18/93
Time 9:25 **Device Used** 10:04
Recorded By J.P, R.Z. **Employer** LASER PLANE LEVEL

[1] ML readings to be taken at FWD test locations, A = Approach Joint, L = Leave Joint, M = Mid Lane. Stations are at slab joint. 10/29/93

APPENDIX E

Photographs

Appendix E contains the following photographs:

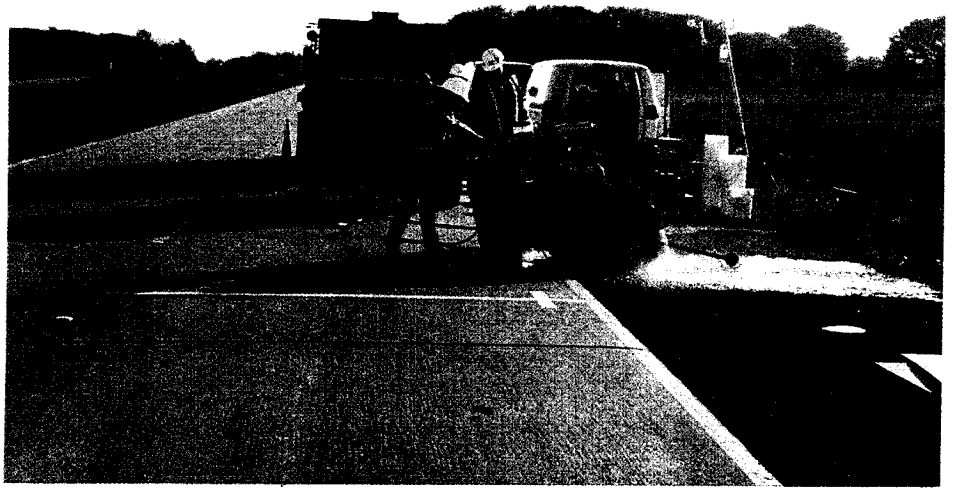

Photo E-1. Location of Instrumentation Area

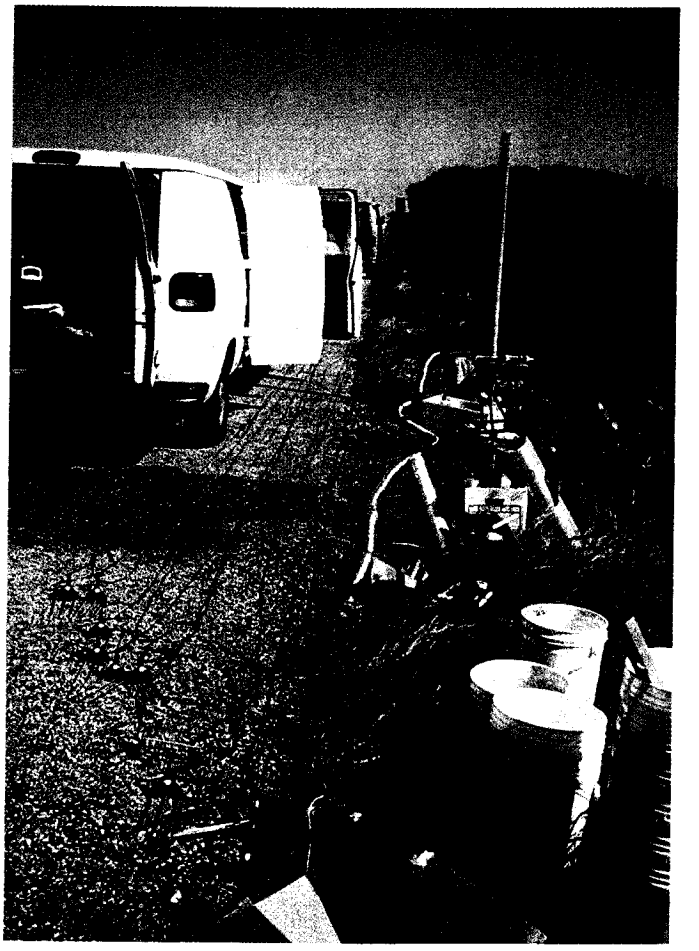

Photo E-2. Preparing for Instrumentation Installation

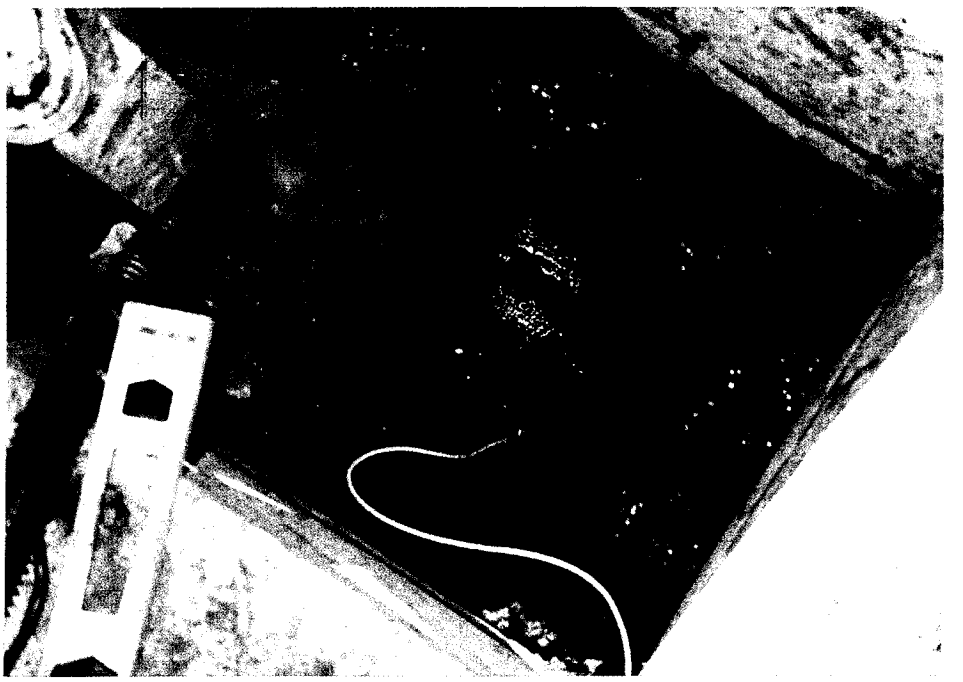

Photo E-3. Placement of Instrumentation Probes

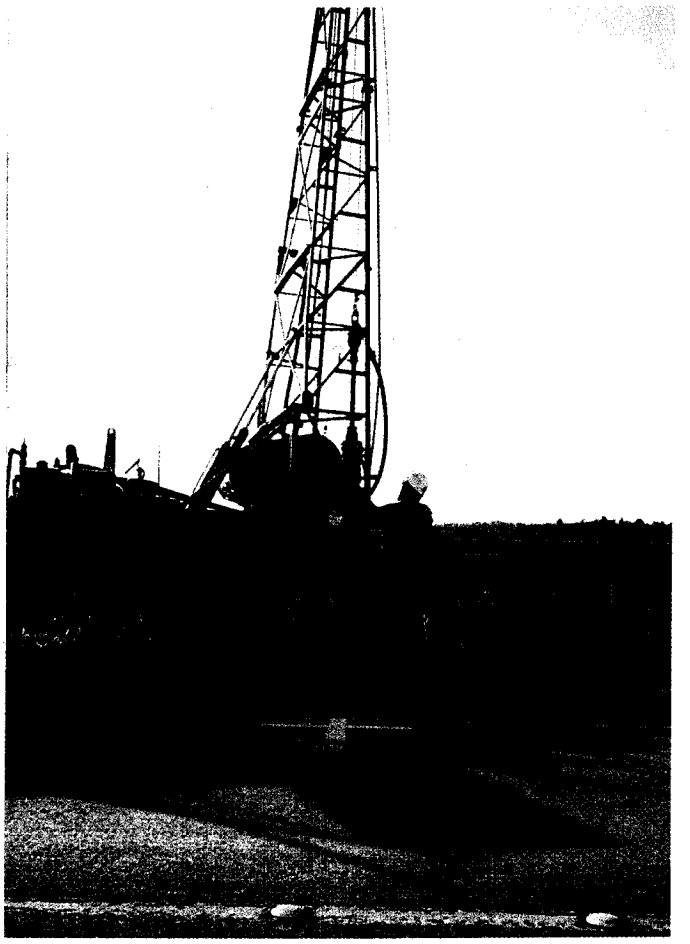

Photo E-4. Setting Observation Well

Photo E-5. Preparing Weather Station for Installation

Photo E-6. Observation Well