LTPP Seasonal Monitoring Program

Site Installation and Initial Data Collection
Section 481068, Paris, Texas

Prepared by

Brent Rauhut Engineering Inc.
8240 Mopac, Suite 220
Austin, Texas 78759

Prepared for

Federal Highway Administration
LTPP Division, HNR-40
Turner-Fairbanks Highway Research Center
6300 Georgetown Pike
McLean, Virginia 22101

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16. Abstract

This report contains a description of the instrumentation installation activities and initial data collection for test section 481068, which is a part of the LTPP Core Seasonal Monitoring Program. This asphalt concrete surfaced pavement test section, which is located on SH-19 in the northbound lanes, approximately 2.1 km south of FM-1184, near Paris, Texas, was instrumented on November 1, 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 2, 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.			
19. Security Classif. (of this report)	20. Security Classif. (of this page)	21. No. of Pages	22. Price

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SEASONAL INSTRUMENTATION STUDY
INSTRUMENTATION INSTALLATION
TEXAS SECTION 481068/48SB

I. Introduction

The seasonal instrumentation installation of Section 481068 was performed on November 1, 1993, and was the second one completed in the Southern Region.

The GPS-1 test section resides in Seasonal Cell 10 and is located in a wet-no freeze zone. The site (see Figure A-1) is in the northbound lanes on SH-19, approximately 2.1 km south of FM-1184 near Paris, Texas. The divided highway consists of 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 33.5°C and the average minimum daily temperature for the months of December through February is 0.6°C. The average annual precipitation is 1,275 mm.

The pavement is a flexible structure consisting of approximately 254 mm of asphalt concrete over 152.4 mm of granular aggregate base. The subbase is a lime-treated fine-grained soil and is approximately 203.2 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)
Asphalt Concrete	254	---
Base	152	2000
Subbase	203	2000
Subgrade	---	1551

In 1994, the estimated Annual Average Daily Traffic (AADT) in the GPS lane was 2600, of which 18% was truck traffic. The estimated annual ESALs on the GPS lane were 130,000.

Installation of the instrumentation was completed through the cooperative efforts of the Texas Department of Transportation (TX-DOT), Federal Highway Administration (FHWA) Southern Region Coordination Office (SRCO) staff from Brent Rauhut Engineering Inc. (BRE), and FHWA staff from the Long Term Pavement Performance (LTPP) Division. 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
John Klemunes	Federal Highway Administration, LTPP Division
John Earle	Texas Department of Transportation

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, the Texas Department of Transportation, 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 August 13, 1993 by Amy Simpson (SRCO). Deflection testing was conducted on May 26 and December 20, 1993. The 0+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. Instrumentation was not installed to measure frost depth because this site is located in a no-freeze zone. 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 drilled 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 №.
Instrument Hole		
MRC Thermistor Probe	1	179 (48BT)
TDR Sensors	10	48B01-48B10
Equipment Cabinet		
CR10 Data Logger	1	16520
Battery Package	1	5665
Weather Station		
TE525 MM Rain Gauge	1	12073-693
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 AC layer.
	2	Not Measured	
	3	Not Measured	
2	4	21	This unit was installed in the base and subgrade.
	5	97	
	6	173	
	7	249	
	8	324	
	9	478	
	10	631	
	11	782	
	12	934	
	13	1087	
	14	1238	
	15	1391	
	16	1544	
	17	1695	
	18	1846	

Location of Instrumentation

The instrumentation was installed at station 0-20 of the test section. Approximately 914 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, 2.18 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 7.8 m from the lane edge.

The observation well was installed at Station 1+00 of the test section approximately 3.7 m from the lane edge. A permanent benchmark was also set at Station 0+00 approximately 3.5 m from the lane edge.

Installation

Installation of the monitoring equipment was completed on November 1, 1993. Verification that the instrumentation was working was made the following day. The Texas Department of Transportation 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, 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. Table 5 shows the distance from the top of the pavement to each of the thermistor sensors.

When backfilling of the instrumentation hole was completed, the pavement was patched using a cold mix asphalt patching material. 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)
48B01	348	6.36	7.42
48B02	500	12.28	22.03
48B03	650	25.61	23.19
48B04	808	20.53	26.91
48B05	960	27.12	23.65
48B06	1107	27.00	18.30
48B07	1257	24.00	17.51
48B08	1402	17.75	16.36
48B09	1720	22.31	22.12
48B10	2007	11.02	20.66

Table 5. Thermistor Sensor Locations

Unit	Channel №.	Depth from Pavement Surface (mm)	Remarks
1	1	25	This unit was installed in the AC layer.
	2	137	
	3	249	
2	4	321	This unit was installed in the base and subgrade.
	5	397	
	6	473	
	7	549	
	8	624	
	9	778	
	10	931	
	11	1082	
	12	1234	
	13	1387	
	14	1538	
	15	1691	
	16	1844	
	17	1995	
	18	2146	

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 2, 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 datalogging 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 was then uploaded to the notebook computer. Traces displayed on the cable reader indicated that the sensors were working properly. Figure D-4 shows 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." Due to rain and safety considerations, only two rounds of deflection testing were performed. At this time no analysis has been performed on this data.

Elevation Surveys

Elevation surveys were not made during the initial data collection phase due to rain and safety considerations. This data will be collected during the first monitoring round.

IV. Summary

The instrumentation installation on Section 481068 was completed on November 2, 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.

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.

The installation of the instrumentation at this site went fairly smoothly and all of the equipment appears to be functioning properly.

APPENDIX A

Test Section Background Information

Appendix A contains the following information:

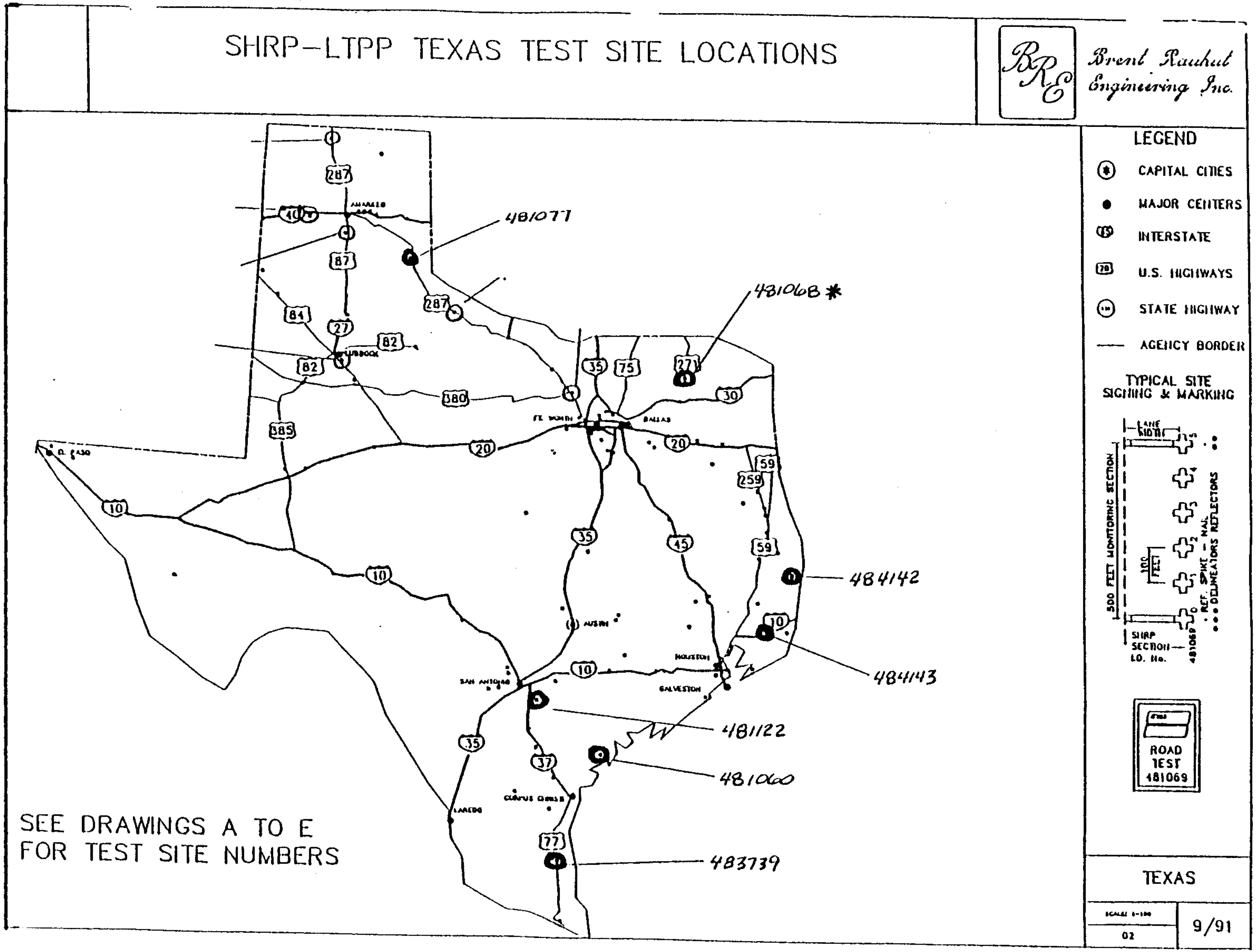


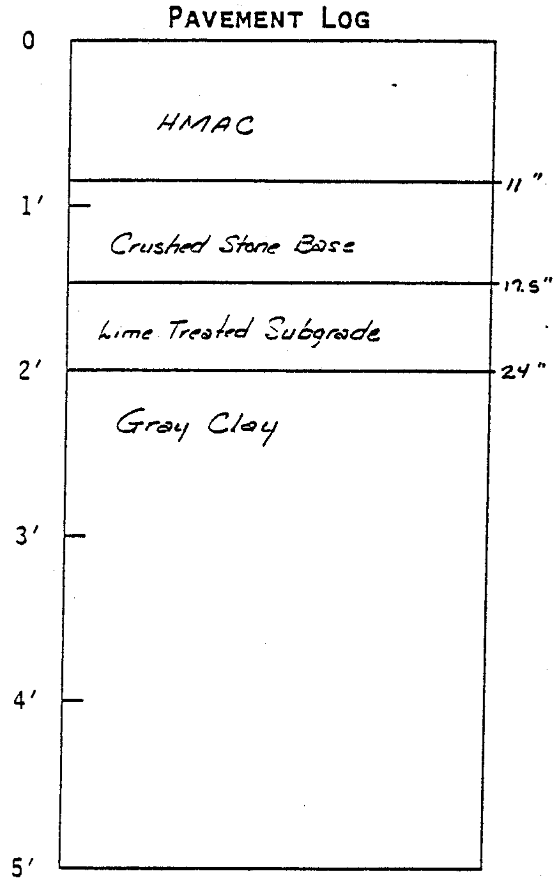
Figure A-1. Location of Test Site, GPS Test Section 481068

APPROXIMATE
SUMMARY OF FIELD LOGS
GPS TEST SECTIONS

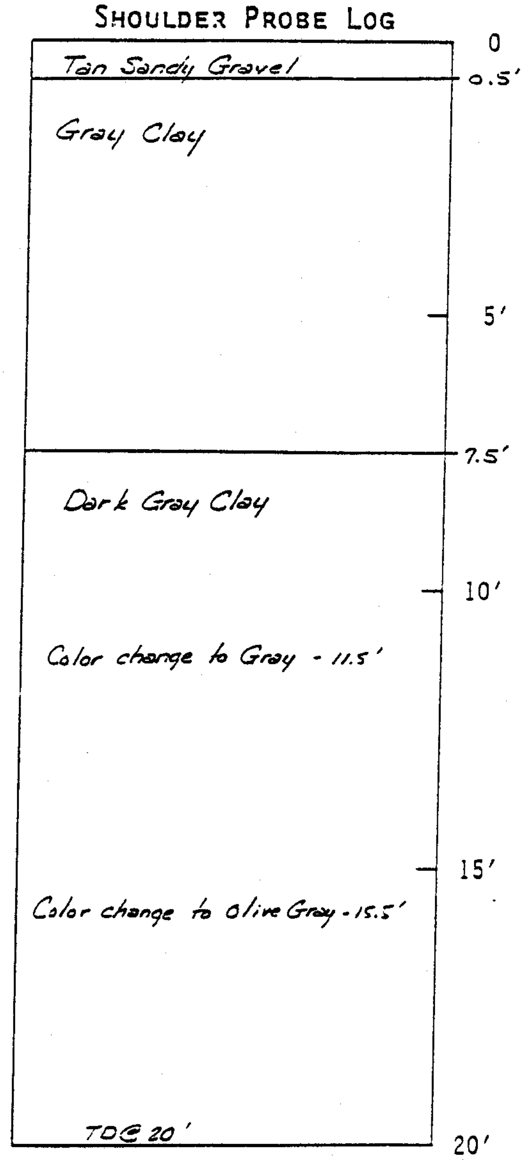
TEST SECTION I.D. NO. 481068 EXPERIMENT NO. GPS-1

STATE Texas DATE SAMPLED 8-23-89

PAVEMENT LOG



SHOULDER PROBE LOG



Instuctions 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

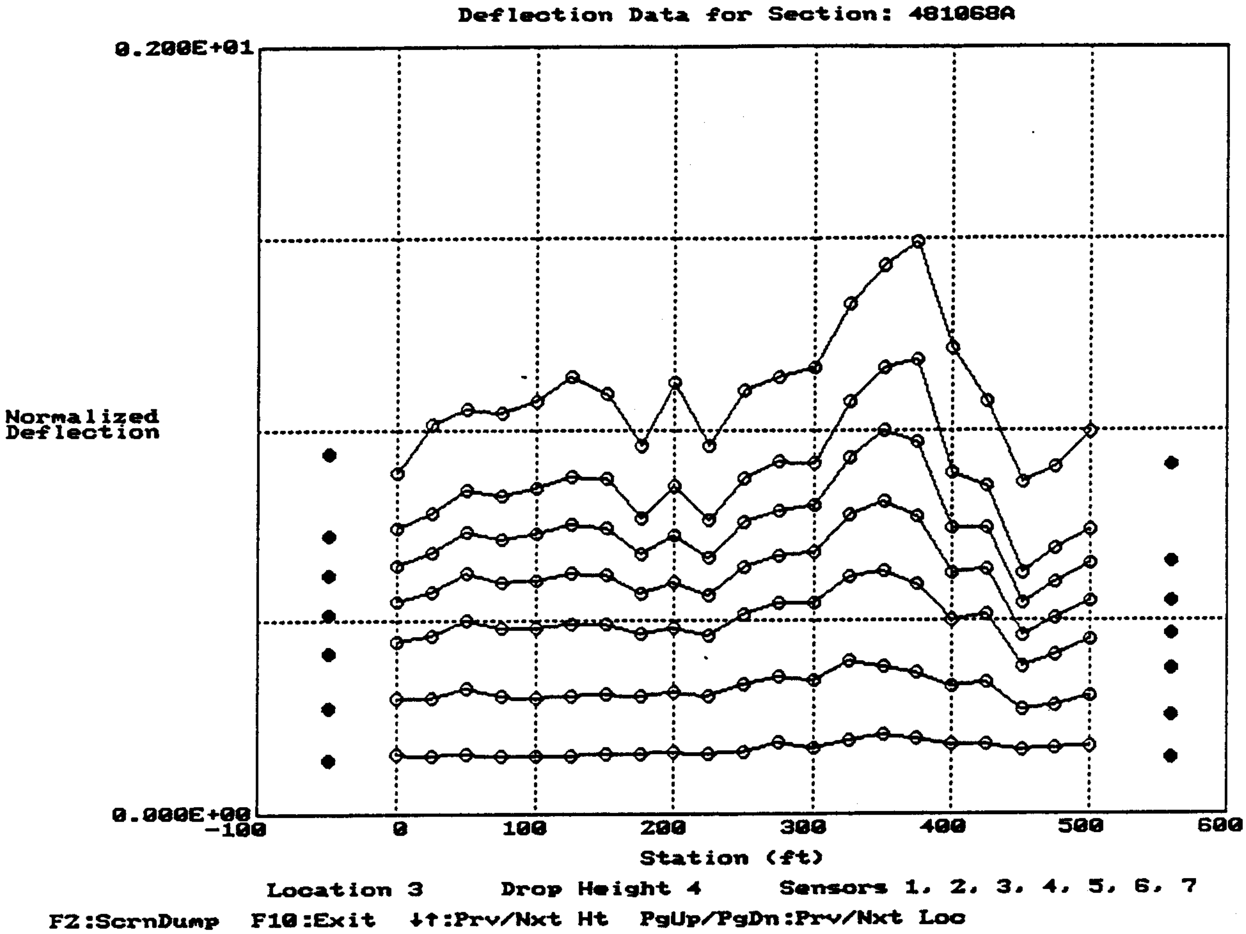


Figure A-3. Deflection Profiles from FWDCHECK

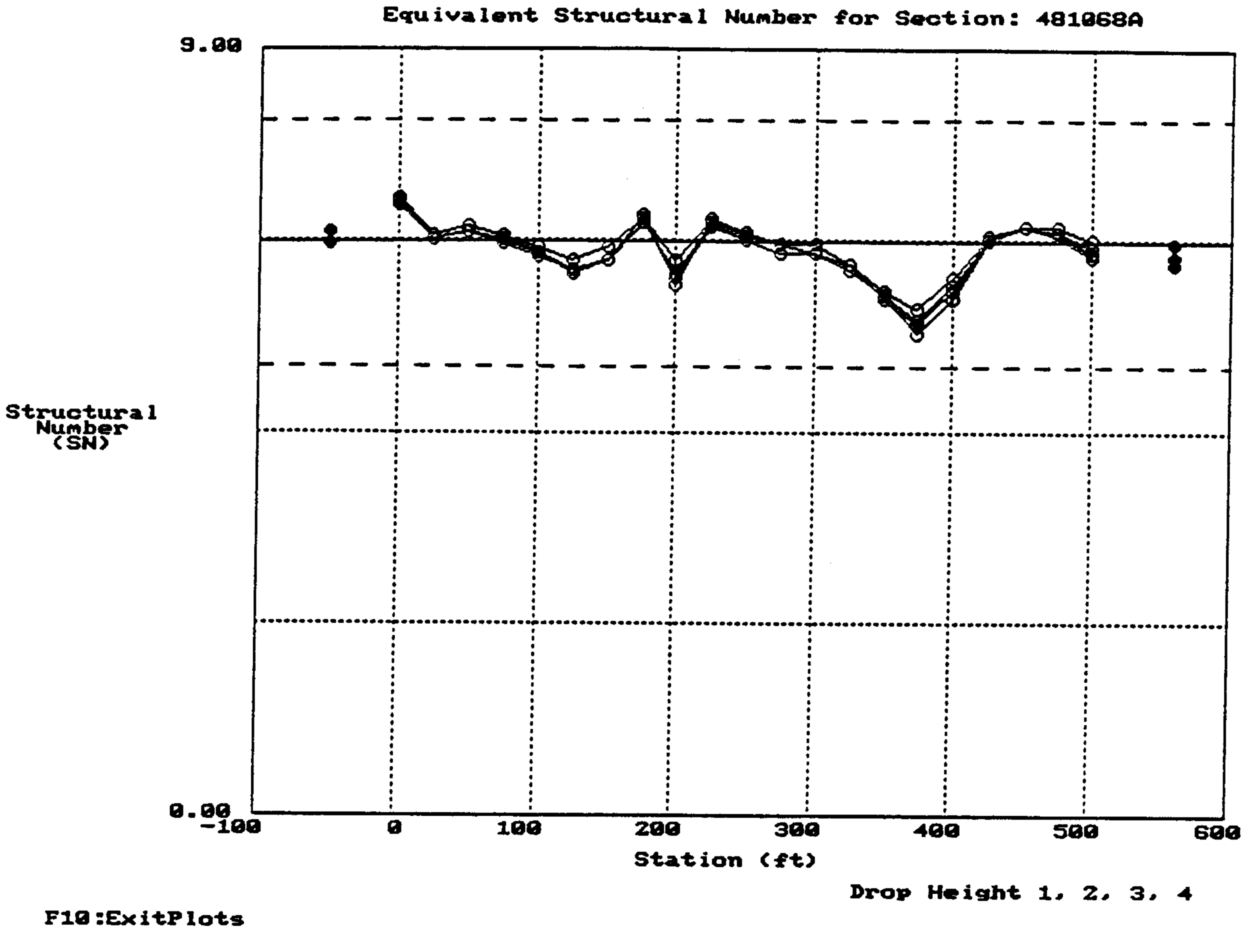


Figure A-4. Structural Number Profiles from FWDCHECK

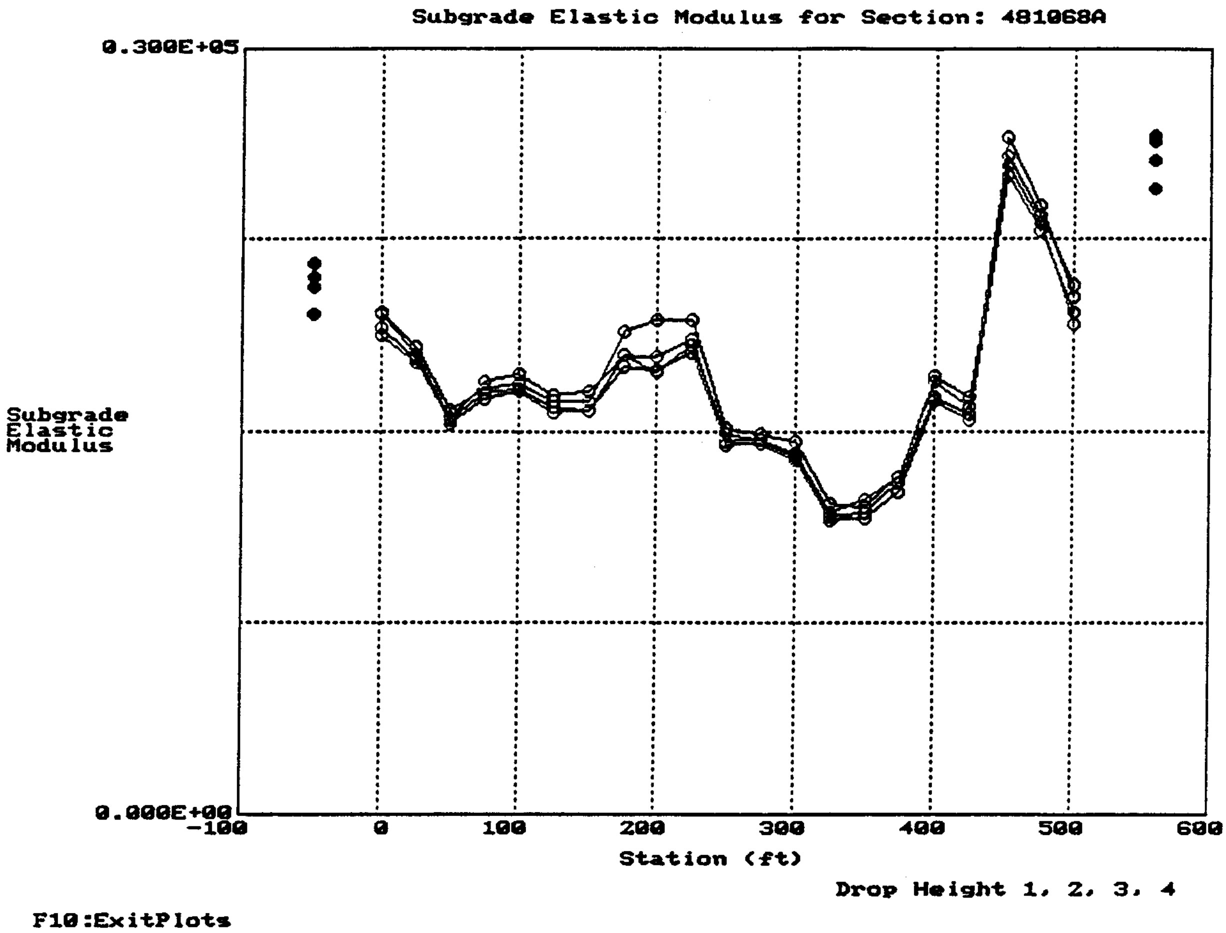


Figure A-5. Subgrade Modulus Profiles from FWDCHECK

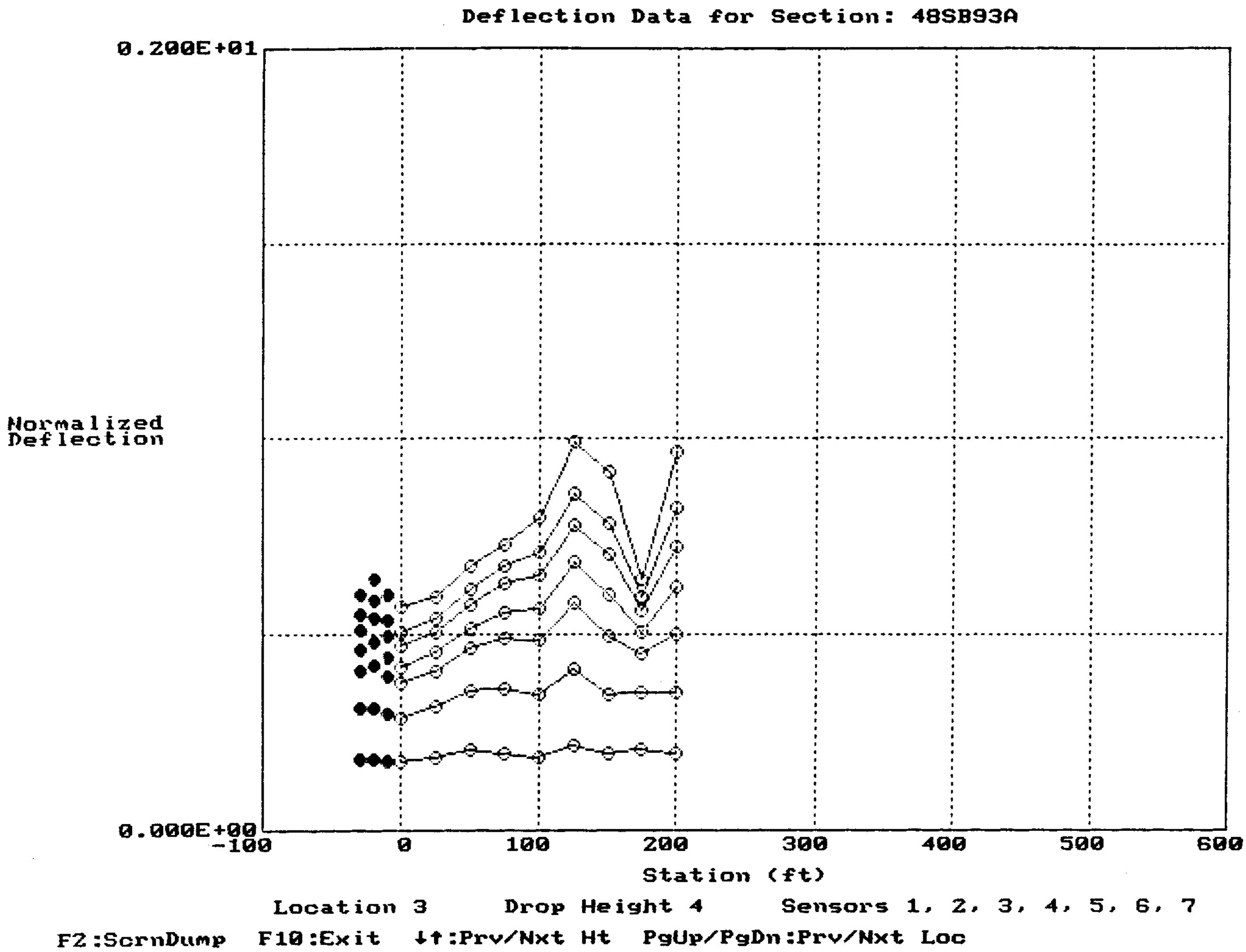


Figure A-6. Deflection Profiles from FWDCHECK on Installation Day

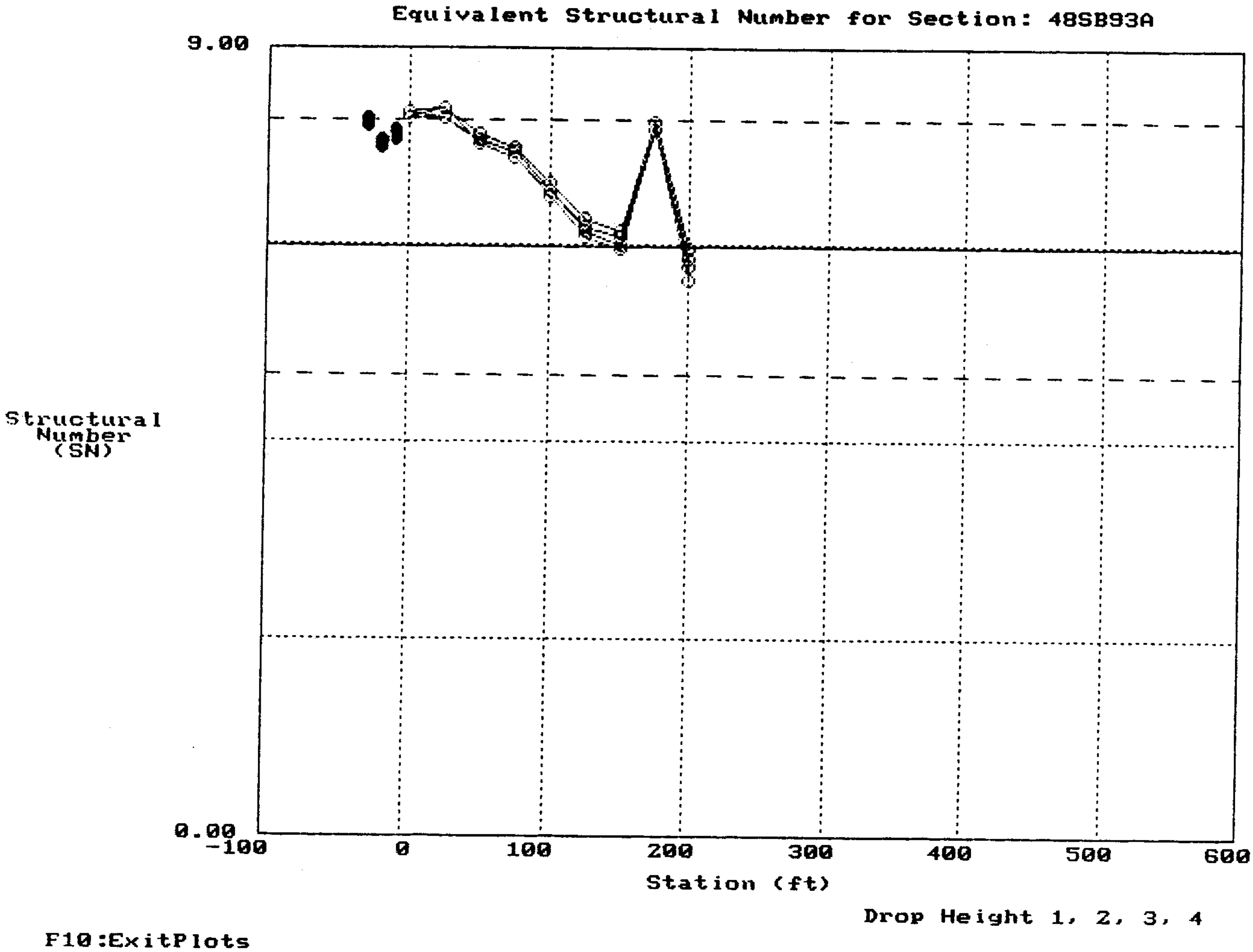


Figure A-7. Structural Number Profiles from FWDCHECK on Installation Day

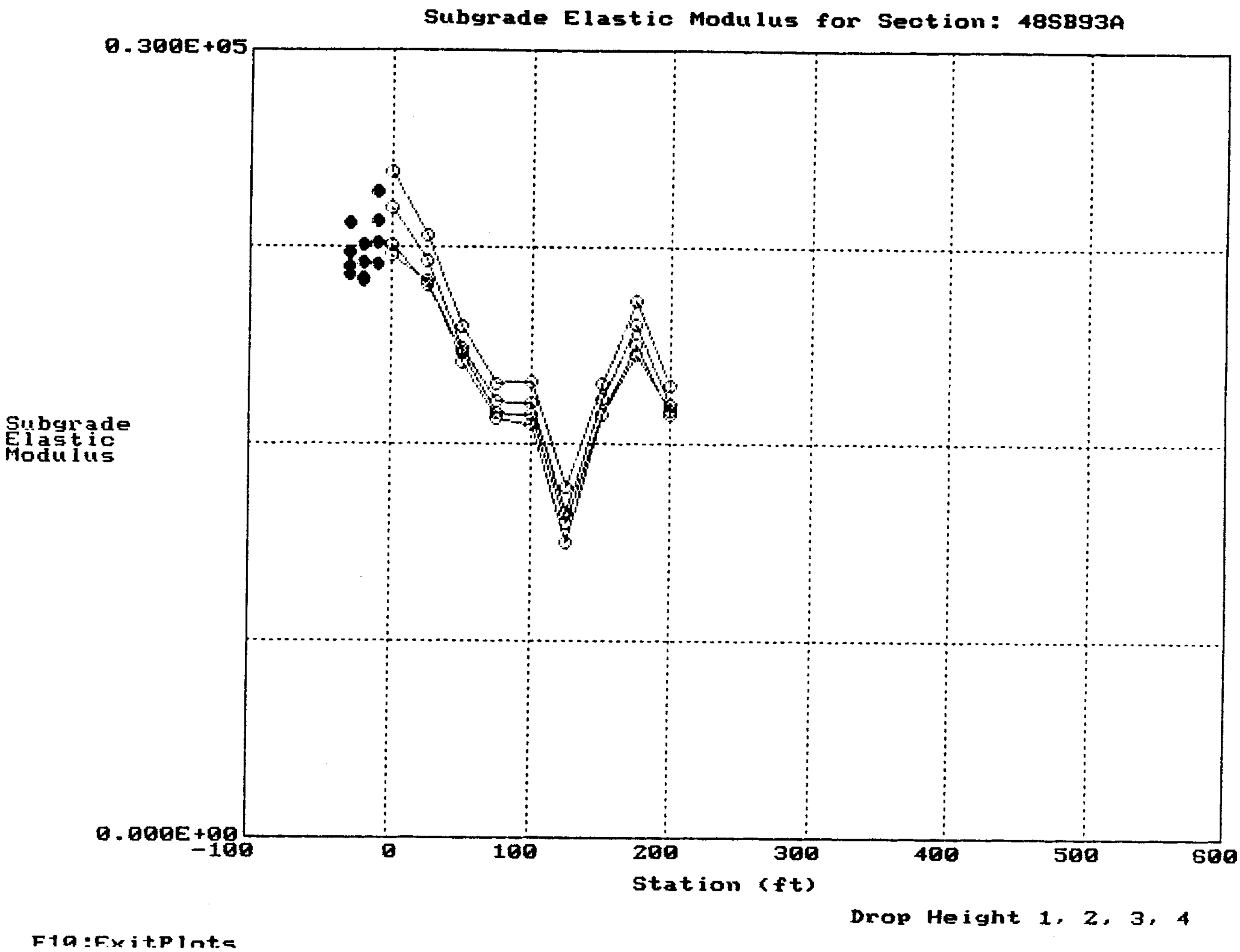


Figure A-8. Subgrade Modulus Profiles from FWDCHECK on Installation Day

Revised December 1, 1992

SHEET 1

DISTRESS SURVEY

LTPP PROGRAM

STATE ASSIGNED ID _ _ _ _

STATE CODE 48

SHRP SECTION ID 1068

Bl 8-31

DISTRESS SURVEY FOR PAVEMENTS WITH ASPHALT CONCRETE SURFACES

DATE OF DISTRESS SURVEY (MONTH/DAY/YEAR) 08/13/93

SURVEYORS: A L S, _ _ _ PHOTOS, VIDEO, OR BOTH WITH SURVEY (P, V, B) _
PAVEMENT SURFACE TEMP - BEFORE _ _ _ _°C; AFTER _ _ _ _°C

DISTRESS TYPE	SEVERITY LEVEL LOW	MODERATE	HIGH
CRACKING			
1. FATIGUE CRACKING (Square Meters)	11.4	0	0.
2. BLOCK CRACKING (Square Meters)	0.	0.	0.
3. EDGE CRACKING (Meters)	0.	0.	0.
4. LONGITUDINAL CRACKING (Meters)			
4a. Wheel Path	28.8	35.1	0.
Length Sealed (Meters)	0.	0.	0.
4b. Non-Wheel Path	0.	0.	0.
Length Sealed (Meters)	0.	0.	0.
5. REFLECTION CRACKING AT JOINTS Number of Transverse Cracks	0	0	0
Transverse Cracking (Meters)	0.	0.	0.
Length Sealed (Meters)	0.	0.	0.
Longitudinal Cracking (Meters)	0.	0.	0.
Length Sealed (Meters)	0.	0.	0.
6. TRANSVERSE CRACKING Number of Cracks	0	0	0
Length (Meters)	0.	0.	0.
Length Sealed (Meters)	0.	0.	0.
PATCHING AND POTHOLES			
7. PATCH/PATCH DETERIORATION (Number)	0	0	0
(Square Meters)	0.	0	0.
8. Potholes (Number)	0	0	0
(Square Meters)	0.	0.	0.

Figure A-9. Distress Survey Data

SHEET 2

DISTRESS SURVEY

LTPP PROGRAM

STATE ASSIGNED ID _ _ _ _

STATE CODE 48

SHRP SECTION ID 1068

DATE OF DISTRESS SURVEY (MONTH/DAY/YEAR) 08/13/93

SURVEYORS: ALS, _ _ _

DISTRESS SURVEY FOR PAVEMENTS WITH ASPHALT CONCRETE SURFACES (CONTINUED)

DISTRESS TYPE	SEVERITY LEVEL LOW	MODERATE	HIGH
SURFACE DEFORMATION			
9. RUTTING - REFER TO SHEET 3 FOR SPS-3 OR Form S1 from Dipstick Manual			
10. SHOVING (Number)			0
(Square Meters)			0.
SURFACE DEFECTS			
11. BLEEDING (Square Meters)	0.	0.	0.
12. POLISHED AGGREGATE (Square Meters)			0.
13. RAVELING (Square Meters)	0.	0.	0.
MISCELLANEOUS DISTRESSES			
14. LANE-TO-SHOULDER DROPOFF - REFER TO SHEET 3			
15. WATER BLEEDING AND PUMPING (Number)			0
Length of Affected Pavement (Meters)			0
16. OTHER (Describe) ______			

Figure A-9 (Continued). Distress Survey Data

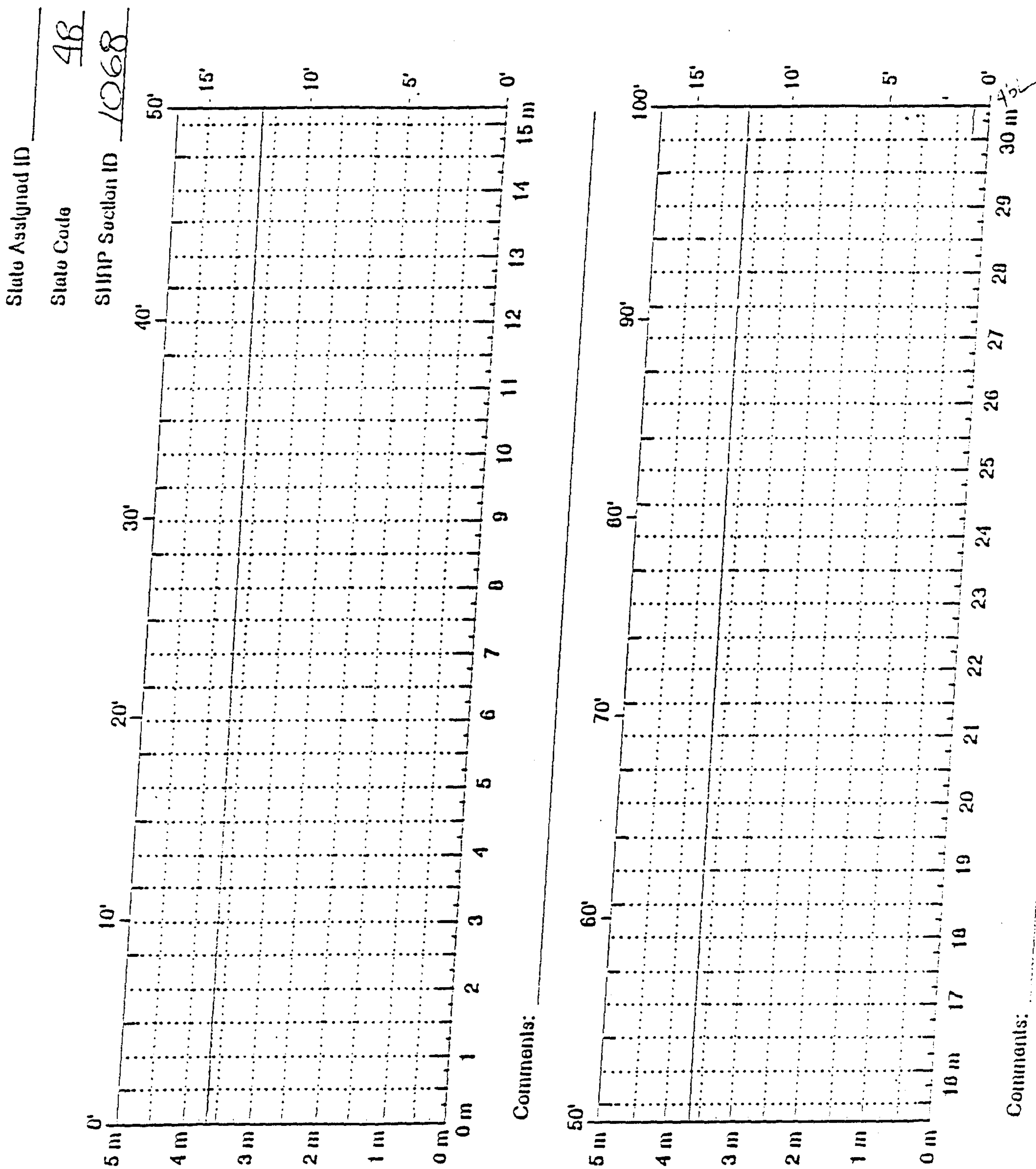


Figure A-9 (Continued). Distress Survey Data

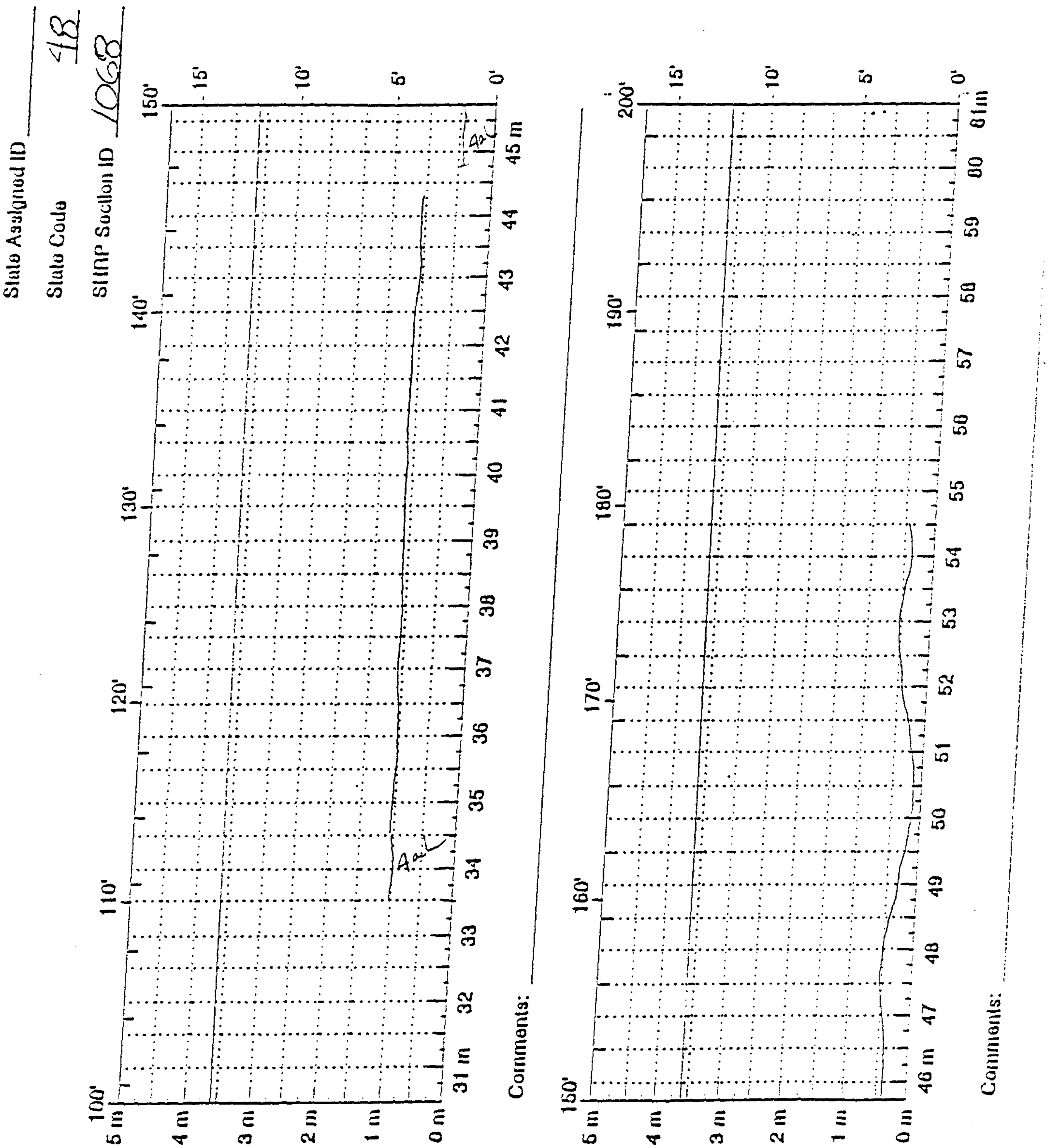


Figure A-9 (Continued). Distress Survey Data

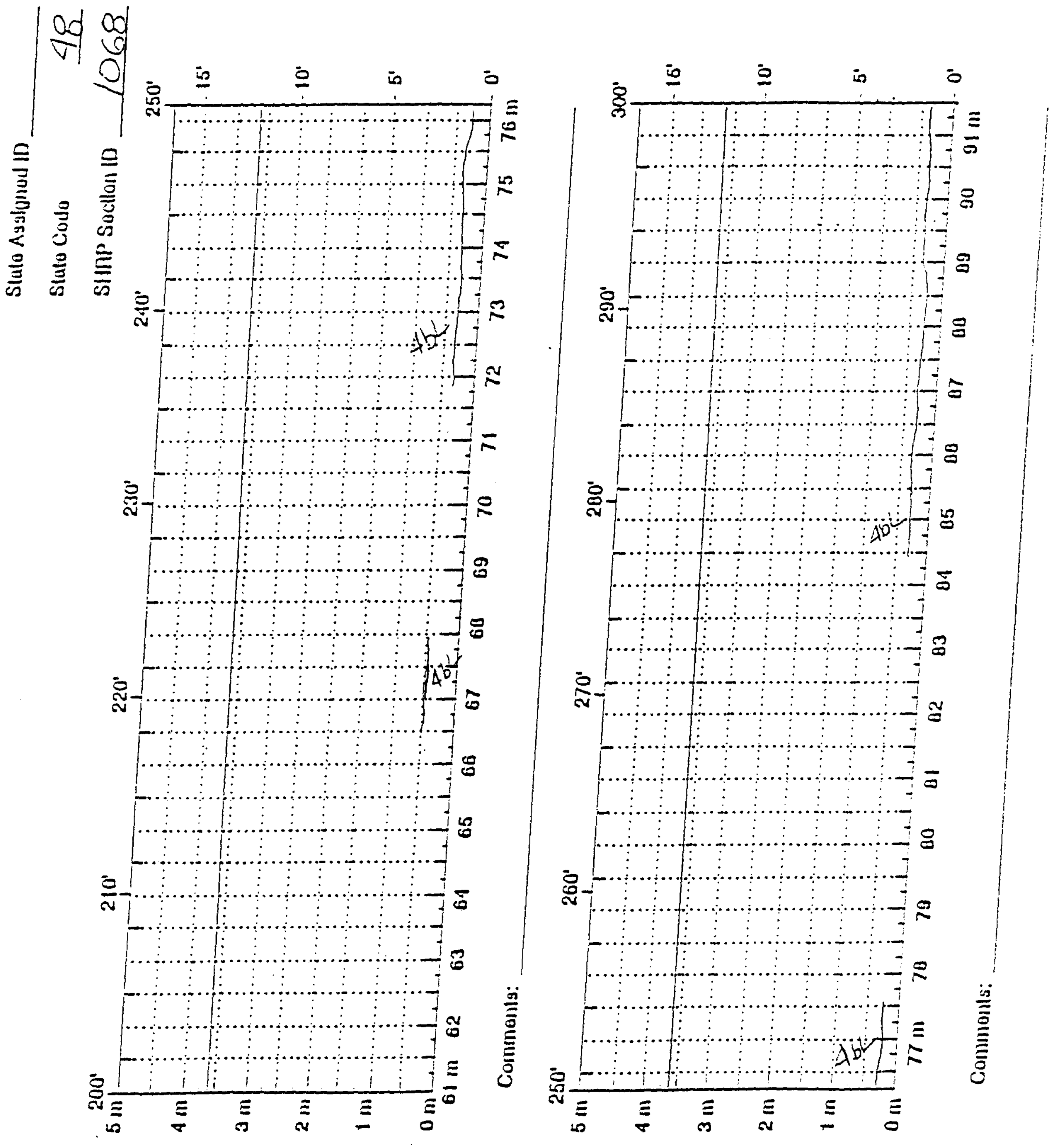


Figure A-9 (Continued). Distress Survey Data

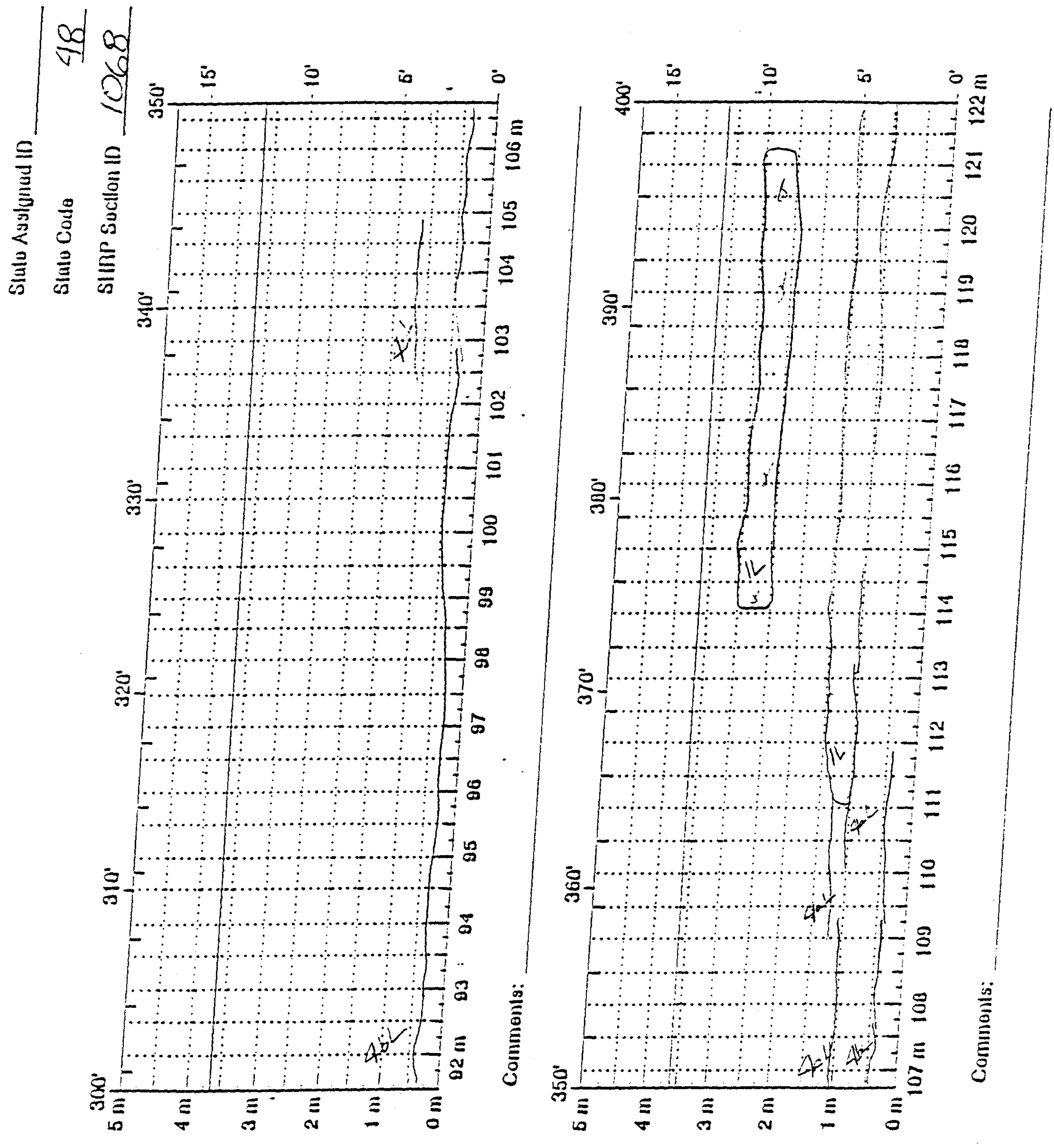


Figure A-9 (Continued). Distress Survey Data

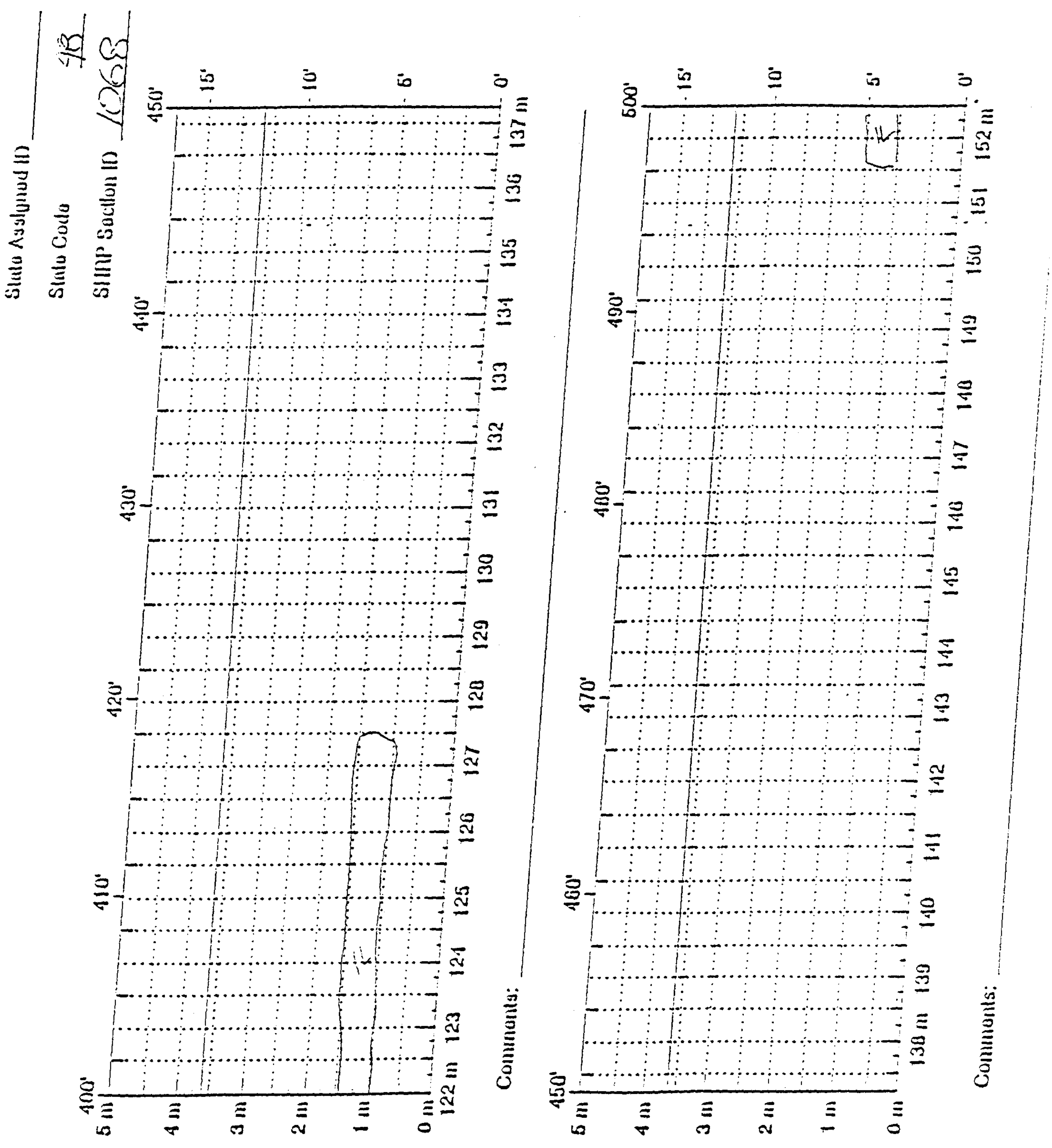


Figure A-9 (Continued). Distress Survey Data

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

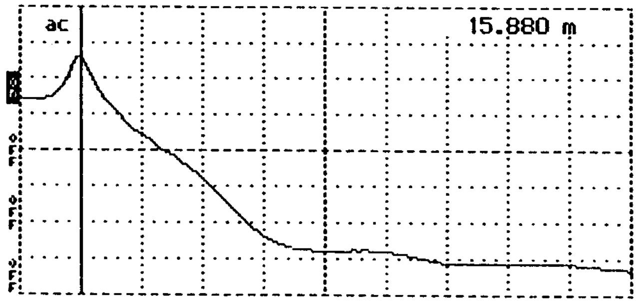
VI. Questions/Discussion

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 [1068]

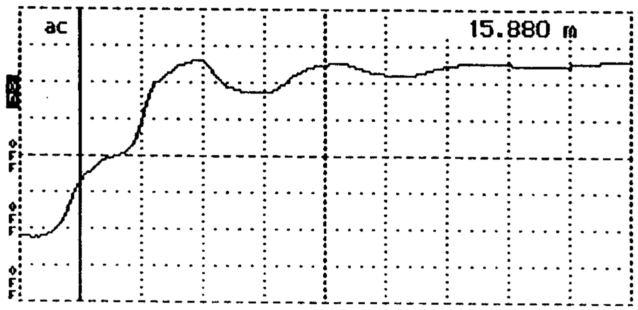
Cursor .... 15.880 m
Distance/Div..... .25 m/div
Vertical Scale.... 182 mρ/div
VP 0.99
Noise Filter...... 1 avg
Power.......... ac



Tektronix 1502B TDR
Date 10/22/93
Cable 48B01
Notes Shorted
LP.
Input Trace
Stored Trace
Difference Trace

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

Cursor .... 15.880 m
Distance/Div..... .25 m/div
Vertical Scale.... 182 mρ/div
VP 0.99
Noise Filter...... 1 avg
Power.......... ac



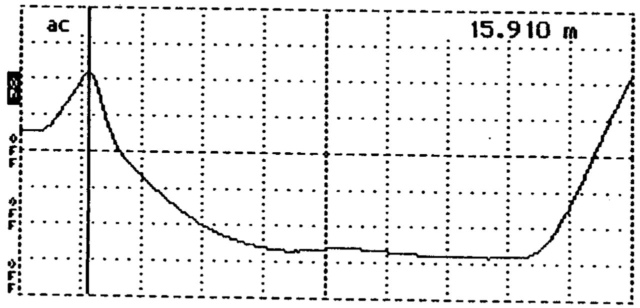
Tektronix 1502B TDR
Date 10/22/93
Cable 48B01
Notes IN AIR
LP.
Input Trace
Stored Trace
Difference Trace

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

Figure B-1. TDR Traces Obtained During Calibration

LTPP Seasonal Monitoring Program Data Sheet SMP-C01 (Page 2) TDR Probe Check	Agency Code [48] LTPP Section ID [1068]

Cursor .... 15.910 m
Distance/Div..... .25 m/div
Vertical Scale.... 88.9 mρ/div
VP 0.99
Noise Filter...... 1 avg
Power........... ac



Tektronix 1502B TDR
Date 10/22/93
Cable 48B01
Notes 10" WATER
18.1 °C water Temp

Input Trace LP
Stored Trace ________
Difference Trace ________

TDR Trace	Apparent Length, (m)	Dielectric Constant[2]
"In Water"	1.78	78.42

[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: 48B01 Measured Length of Coax Cable: __ __ . __ m

Comments: ____________________

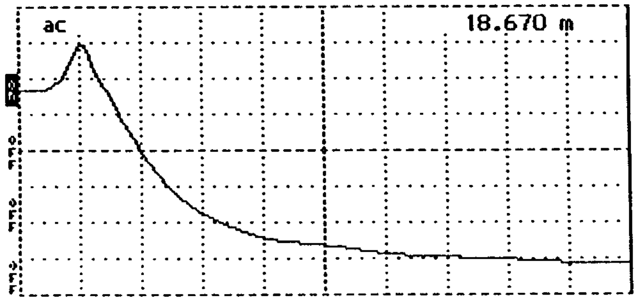
Prepared by: MaH Cole Employer: BRE

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 [4 8] LTPP Section ID [1 0 6 8]

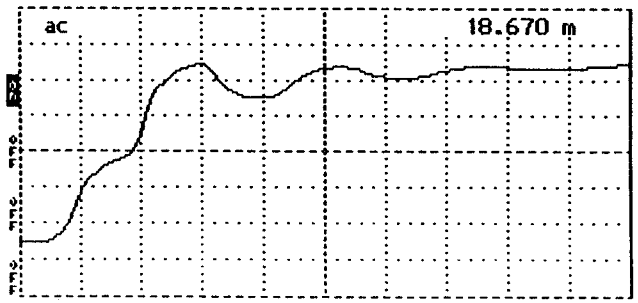
Cursor .... 18.670 m
Distance/Div..... .25 m/div
Vertical Scale.... 177 mρ/div
Vp 0.99
Noise Filter...... 1 avg
Power........... ac



Tektronix 1502B TDR
Date 10/22/93
Cable 48B07
Notes Shorted
LP.
Input Trace
Stored Trace
Difference Trace

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

Cursor .... 18.670 m
Distance/Div..... .25 m/div
Vertical Scale.... 177 mρ/div
Vp 0.99
Noise Filter...... 1 avg
Power........... ac



Tektronix 1502B TDR
Date 10/22/93
Cable 48B07
Notes IN AIR
LP.
Input Trace
Stored Trace
Difference Trace

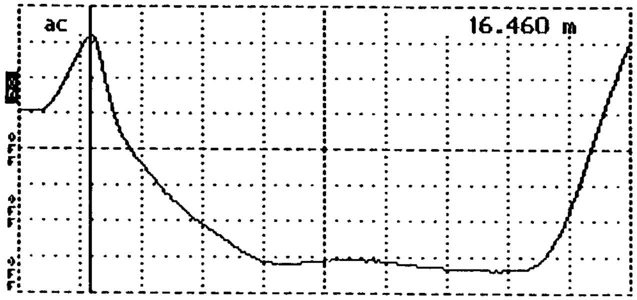
TDR Trace	Apparent Length, (m)	Dielectric Constant[1]
"In Air"	_ . 24	_ 1 . 43

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 [_ _] LTPP Section ID [_ _ _ _]

Cursor .... 16.460 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 10/22/93
Cable 48B02
Notes IN WATER
18.2 °C water temp

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: 4 8 B 0 2 Measured Length of Coax Cable: __ __ . __ m

Comments: ______

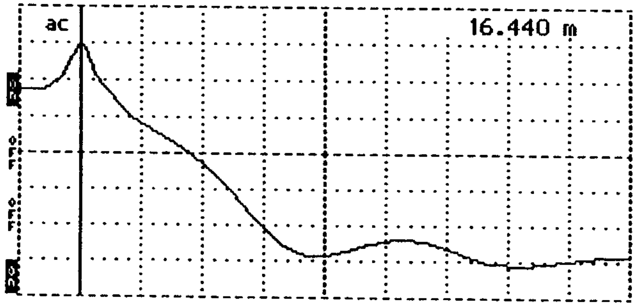
Prepared by: Matt Cole Employer: BRE

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 [1068]

Cursor .... 16.440 m
Distance/Div..... .25 m/div
Vertical Scale.... 177 mρ/div
VP 0.99
Noise Filter...... 1 avg
Power........... ac

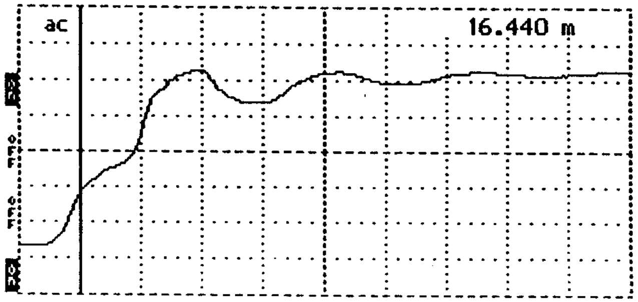


Tektronix 1502B TDR
Date 10/22/93
Cable 48B03
Notes Shorted

Input Trace
Stored Trace
Difference Trace

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

Cursor .... 16.440 m
Distance/Div..... .25 m/div
Vertical Scale.... 177 mρ/div
VP 0.99
Noise Filter...... 1 avg
Power........... ac



Tektronix 1502B TDR
Date 10/22/93
Cable 48B03
Notes IN AIR

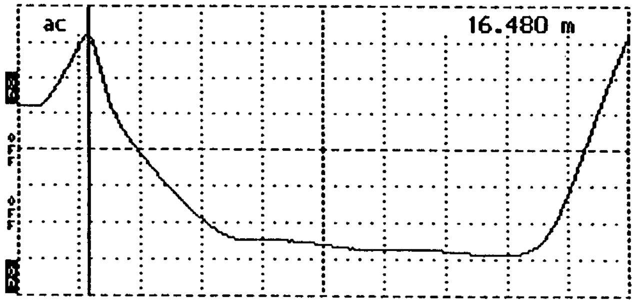
Input Trace
Stored Trace
Difference Trace

TDR Trace	Apparent Length, (m)	Dielectric Constant[1]
"In Air"	.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 [1068]

Cursor .... 16.480 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 10/22/93
Cable 48B03
Notes IN WATER
18.4 °C in water
LP
Input Trace ________
Stored Trace ....
Difference Trace ....

TDR Trace	Apparent Length, (m)[1]	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: 48B03 Measured Length of Coax Cable: __ __ . __ m

Comments: ____________________

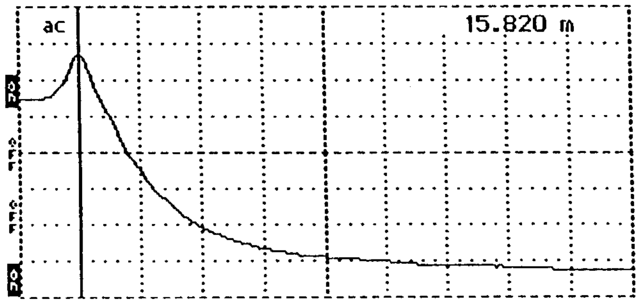
Prepared by: Matt Cole Employer: BRE

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 [4 8] LTPP Section ID [1 0 6 8]

Cursor .... 15.820 m
Distance/Div..... .25 m/div
Vertical Scale.... 177 mρ/div
Vp 0.99
Noise Filter...... 1 avg
Power........... ac

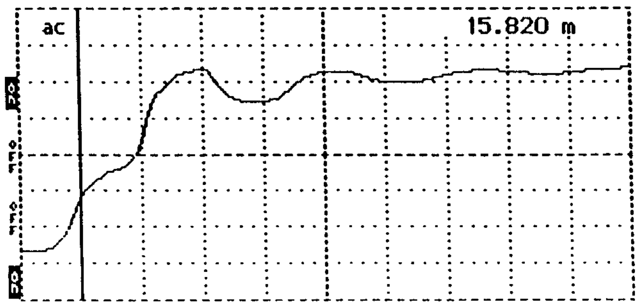


Tektronix 1502B TDR
Date 10/22/93
Cable 48B04
Notes Shorted
LC.

Input Trace
Stored Trace
Difference Trace

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

Cursor .... 15.820 m
Distance/Div..... .25 m/div
Vertical Scale.... 177 mρ/div
Vp 0.99
Noise Filter...... 1 avg
Power........... ac



Tektronix 1502B TDR
Date 10/22/93
Cable 48B04
Notes 1" AIR
LC.

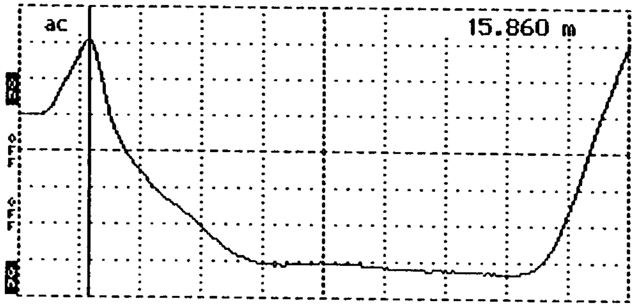
Input Trace
Stored Trace
Difference Trace

TDR Trace	Apparent Length, (m)	Dielectric Constant[1]
"In Air"	_ . 2 4	_ 1 . 4 3

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 [1068]

Cursor .... 15.860 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 10/22/93
Cable 48B04
Notes IN WATER
18.4 water Temp

Input Trace
Stored Trace
Difference Trace

TDR Trace	Apparent Length, (m)[1]	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: 48B04 Measured Length of Coax Cable: __._ m

Comments: ____________________

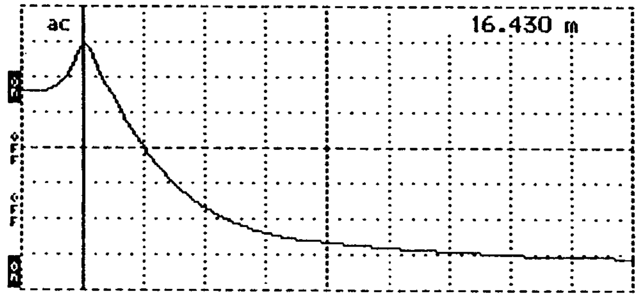
Prepared by: Matt Cole Employer: BRE

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 [1068]

Cursor .... 16.430 m
Distance/Div..... .25 m/div
Vertical Scale.... 177 mρ/div
Vp 0.99
Noise Filter...... 1 avg
Power........... ac

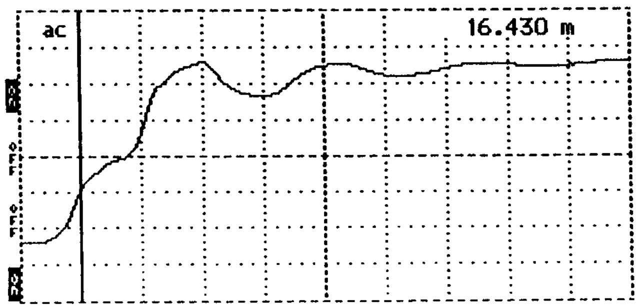


Tektronix 1502B TDR
Date 10/22/93
Cable 48B05
Notes Shorted

Input Trace ____
Stored Trace ....
Difference Trace ....

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

Cursor .... 16.430 m
Distance/Div..... .25 m/div
Vertical Scale.... 177 mρ/div
Vp 0.99
Noise Filter...... 1 avg
Power........... ac



Tektronix 1502B TDR
Date 10/22/93
Cable 48B05
Notes IN AIR

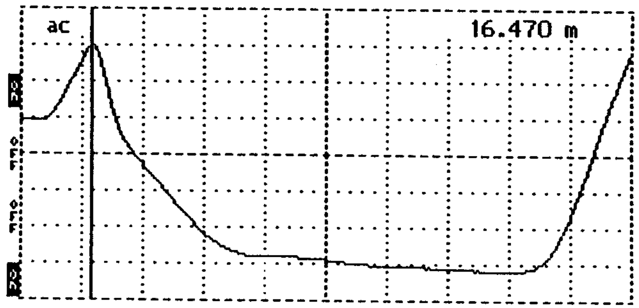
Input Trace ____
Stored Trace ....
Difference Trace ....

TDR Trace	Apparent Length, (m)	Dielectric Constant[1]
"In Air"	_ . 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 [4 8] LTPP Section ID [1 0 6 8]

Cursor .... 16.470 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 10/22/93
Cable 48B05
Notes Water
18.3 Water Temp

Input Trace
Stored Trace
Difference Trace

TDR Trace	Apparent Length, (m)[1]	Dielectric Constant[2]
"In Water"	1.78	78.42

[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: 4 8 B 0 5 Measured Length of Coax Cable: __ __ . __ m

Comments: ______________________________

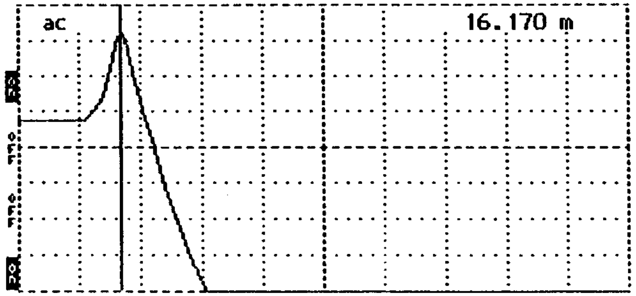
Prepared by: Matt Cole Employer: BRE

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 [1068]

Cursor .... 16.170 m
Distance/Div ..... .25 m/div
Vertical Scale.... 96.9 mρ/div
VP 0.99
Noise Filter ...... 1 avg
Power .... ac

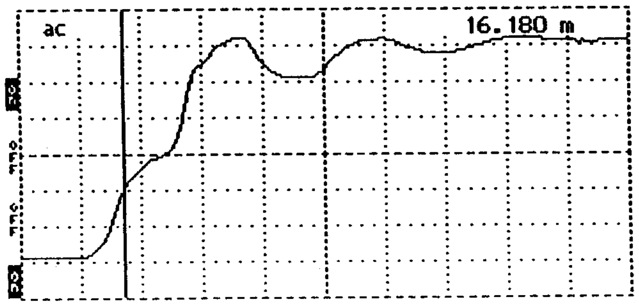


Tektronix 1502B TDR
Date 10-22-93
Cable #6
Notes Shorted

Input Trace
Stored Trace
Difference Trace

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

Cursor .... 16.180 m
Distance/Div ..... .25 m/div
Vertical Scale.... 145 mρ/div
VP 0.99
Noise Filter ...... 1 avg
Power .... ac



Tektronix 1502B TDR
Date 10-22-93
Cable #6
Notes Air

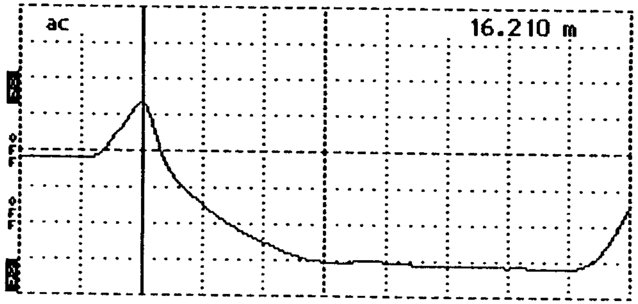
Input Trace
Stored Trace
Difference Trace

TDR Trace	Apparent Length, (m)	Dielectric Constant[1]
"In Air"	_ . 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 [4 8] LTPP Section ID [1 0 6 8]

Cursor .... 16.210 m
Distance/Div..... .25 m/div
Vertical Scale.... 100 mρ/div
VP 0.99
Noise Filter...... 1 avg
Power........... ac



Tektronix 1502B TDR
Date 10-22-93
Cable #6
Notes Water

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: 4 8 B 0 6 Measured Length of Coax Cable: __ __ . __ m

Comments: ____________________

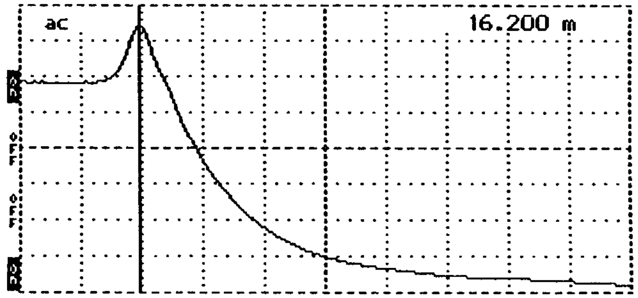
Prepared by: Matt Cole Employer: BRE

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 [1068]

Cursor .... 16.200 m
Distance/Div..... .25 m/div
Vertical Scale.... 149 mρ/div
VP 0.99
Noise Filter...... 1 avg
Power........... ac

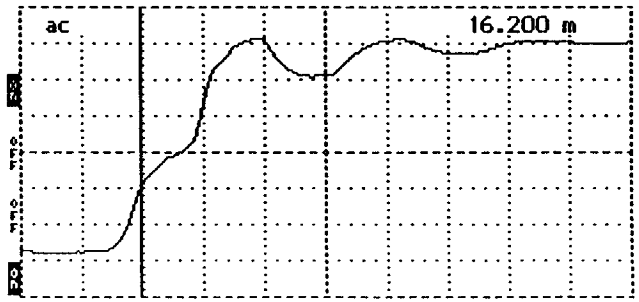


Tektronix 1502B TDR
Date 10-22-93
Cable #7
Notes Shorted

Input Trace
Stored Trace
Difference Trace

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

Cursor .... 16.200 m
Distance/Div..... .25 m/div
Vertical Scale.... 149 mρ/div
VP 0.99
Noise Filter...... 1 avg
Power........... ac



Tektronix 1502B TDR
Date 10-22-93
Cable #7
Notes Air

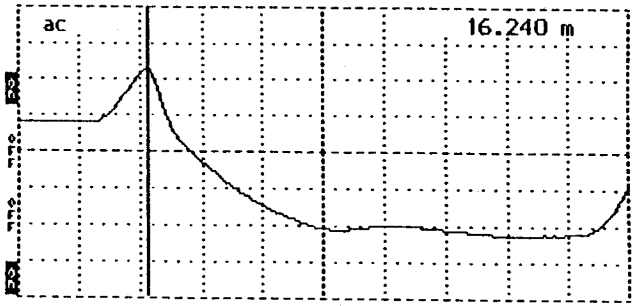
Input Trace
Stored Trace
Difference Trace

TDR Trace	Apparent Length, (m)	Dielectric Constant[1]
"In Air"	_ . 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 [1068]

Cursor .... 16.240 m
Distance/Div..... .25 m/div
Vertical Scale.... 100 mρ/div
Vp 0.99
Noise Filter...... 1 avg
Power........... ac



Tektronix 1502B TDR
Date 10-22-93
Cable #2
Notes WATER

Input Trace
Stored Trace
Difference Trace

TDR Trace	Apparent Length, (m)[1]	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: 48B07 Measured Length of Coax Cable: __ __ . __ m

Comments: ______

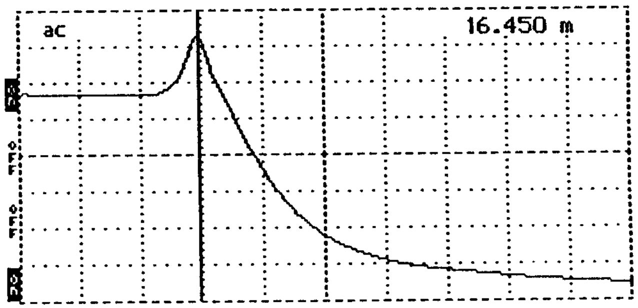
Prepared by: Matt Cole Employer: BRE

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 [1068]

Cursor .... 16.450 m
Distance/Div..... .25 m/div
Vertical Scale.... 149 mρ/div
Vp 0.99
Noise Filter...... 1 avg
Power........... ac

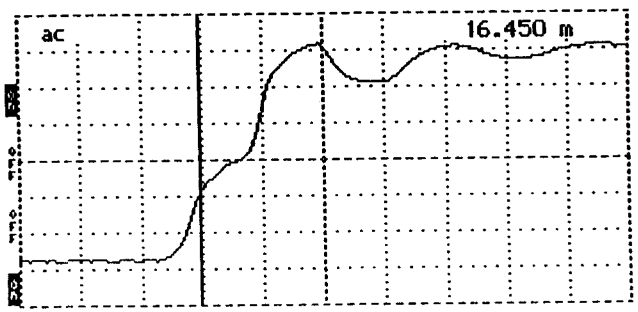


Tektronix 1502B TDR
Date 10-22-93
Cable #8
Notes Shorted.

Input Trace
Stored Trace
Difference Trace

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

Cursor .... 16.450 m
Distance/Div..... .25 m/div
Vertical Scale.... 149 mρ/div
Vp 0.99
Noise Filter...... 1 avg
Power........... ac



Tektronix 1502B TDR
Date 10-22-93
Cable #8
Notes AiR

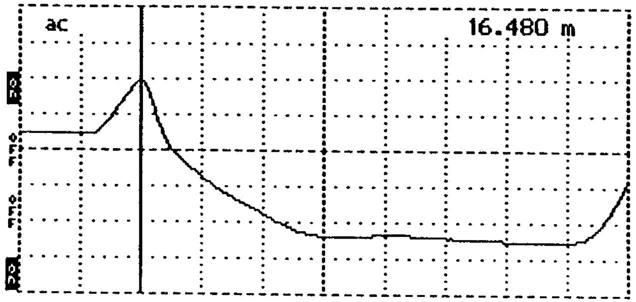
Input Trace
Stored Trace
Difference Trace

TDR Trace	Apparent Length, (m)	Dielectric Constant[1]
"In Air"	_ . 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 [1068]

Cursor .... 16.480 m
Distance/Div..... .25 m/div
Vertical Scale.... 100 mρ/div
VP 0.99
Noise Filter...... 1 avg
Power........... ac



Tektronix 1502B TDR
Date 10-22-93
Cable #8
Notes Water
18.3° 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: 48B08 Measured Length of Coax Cable: __ __ . __ m

Comments: ______________________

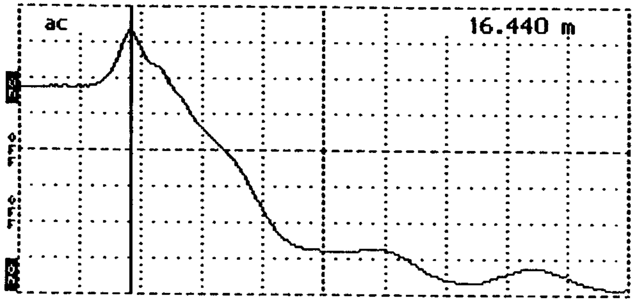
Prepared by: Matt Cole Employer: ______________

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 [1068]

Cursor .... 16.440 m
Distance/Div..... .25 m/div
Vertical Scale.... 149 mρ/div
VP 0.99
Noise Filter...... 1 avg
Power........... ac

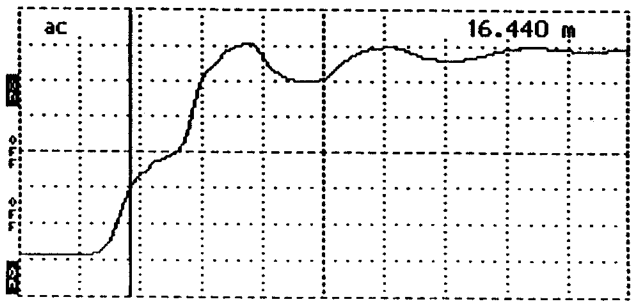


Tektronix 1502B TDR
Date 10-22-93
Cable #9
Notes shorted.

Input Trace
Stored Trace
Difference Trace

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

Cursor .... 16.440 m
Distance/Div..... .25 m/div
Vertical Scale.... 149 mρ/div
VP 0.99
Noise Filter...... 1 avg
Power........... ac



Tektronix 1502B TDR
Date 10-22-93
Cable #9
Notes AiR

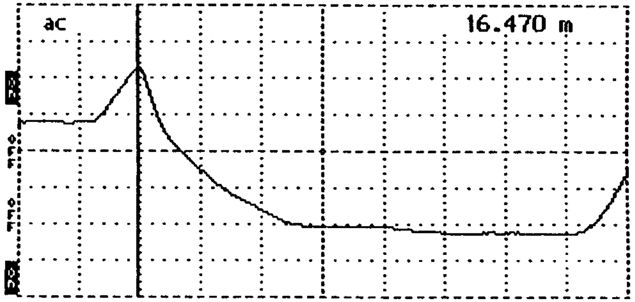
Input Trace
Stored Trace
Difference Trace

TDR Trace	Apparent Length, (m)	Dielectric Constant[1]
"In Air"	.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 [1068]

Cursor .... 16.470 m
Distance/Div..... .25 m/div
Vertical Scale.... 100 mρ/div
VP 0.99
Noise Filter...... 1 avg
Power........... ac



Tektronix 1502B TDR
Date 10-22-93
Cable #9
Notes WATER

Input Trace
Stored Trace
Difference Trace

TDR Trace	Apparent Length, (m)[1]	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: 4 8 B 0 9 Measured Length of Coax Cable: __ __ . __ 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 [1068]

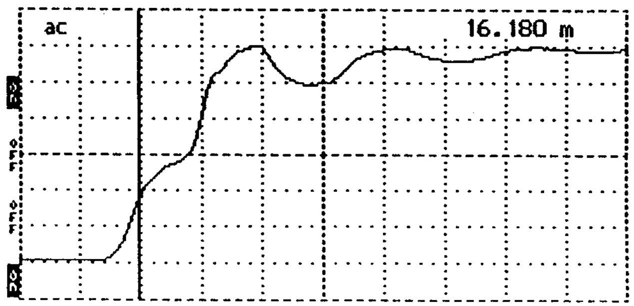
Cursor .... 16.180 m
Distance/Div..... .25 m/div
Vertical Scale.... 149 mρ/div
VP 0.99
Noise Filter...... 1 avg
Power........... ac

Tektronix 1502B TDR
Date 10-22-93
Cable #10
Notes Shorted -

Input Trace
Stored Trace
Difference Trace

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

Cursor .... 16.180 m
Distance/Div..... .25 m/div
Vertical Scale.... 149 mρ/div
VP 0.99
Noise Filter...... 1 avg
Power........... ac



Tektronix 1502B TDR
Date #10-22-93
Cable #10
Notes AIR

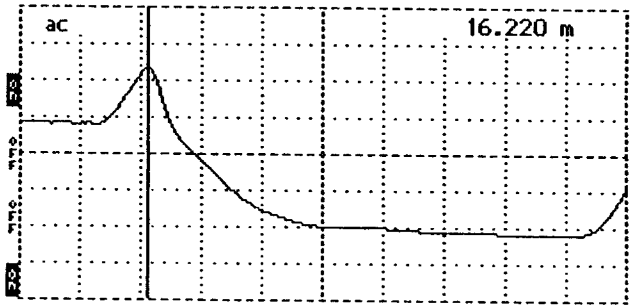
Input Trace
Stored Trace
Difference Trace

TDR Trace	Apparent Length, (m)	Dielectric Constant[1]
"In Air"	_.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 [1068]

Cursor .... 16.220 m
Distance/Div..... .25 m/div
Vertical Scale.... 100 mρ/div
VP 0.99
Noise Filter...... 1 avg
Power........... ac



Tektronix 1502B TDR
Date 10-22-93
Cable #10
Notes WATER
18.2°C
Input Trace
Stored Trace
Difference Trace

TDR Trace	Apparent Length, (m)[1]	Dielectric Constant[2]
"In Water"	1.78	78.42

[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: 48B10 Measured Length of Coax Cable: __ __ . __ m

Comments: ____________________

Prepared by: Matt Cole Employer: BRE

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

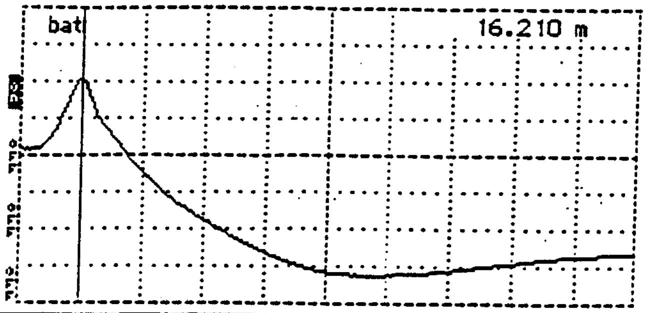
Figure B-1 (Continued). TDR Traces Obtained During Calibration

APPENDIX C

Instrumentation Installation Information

Appendix C contains the following information:

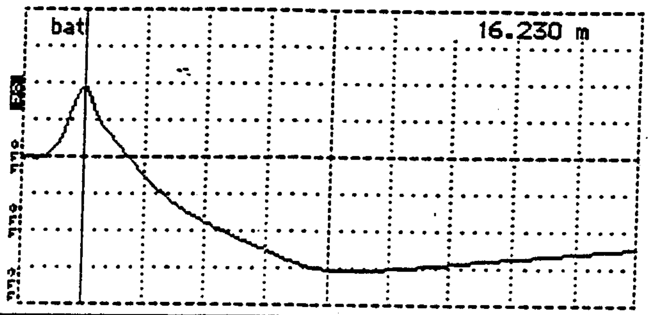
.... 16.210 m
Div..... .25 m/div
Scale.... 103 mρ/div
.... 0.99
er...... 1 avg
.... bat/low



Tektronix 1502B TDR
Date 11/01/93
Cable 48806
Notes Dep-14
43.6"

Input Trace JO
Stored Trace
Difference Trace

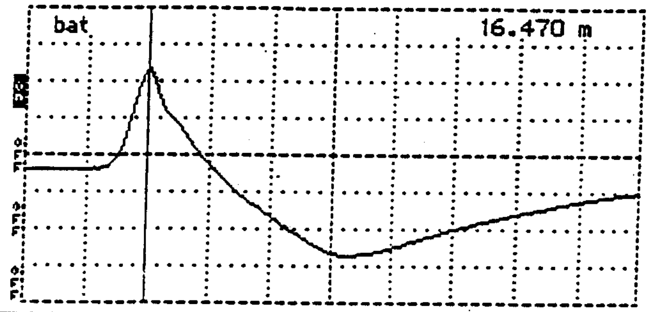
.... 16.230 m
Div..... .25 m/div
Scale.... 106 mρ/div
.... 0.99
er...... 1 avg
.... bat/low



Tektronix 1502B TDR
Date 11/01/93
Cable 48807
Notes
49.5'

Input Trace JP
Stored Trace
Difference Trace

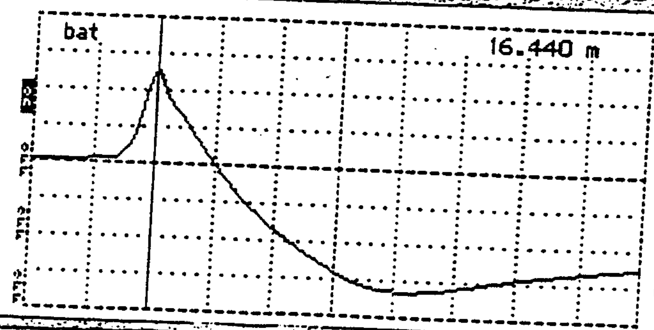
.... 16.470 m
Div..... .25 m/div
Scale.... 79.2 mρ/div
.... 0.99
er...... 1 avg
.... bat



Tektronix 1502B TDR
Date 11/01/93
Cable 48808
Notes Dep-14
55"
JP

Input Trace
Stored Trace
Difference Trace

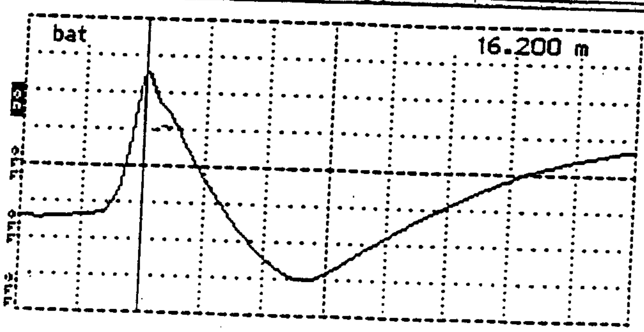
.... 16.440 m
Div..... .25 m/div
Scale.... 91.5 mρ/div
.... 0.99
er...... 1 avg
.... bat/low



Tektronix 1502B TDR
Date 11/01/93
Cable 48809
Notes Dep-14
67.7"

Input Trace JP
Stored Trace
Difference Trace

.... 16.200 m
iv..... .25 m/div
ale.... 59.4 mρ/div
.... 0.99
...... 1 avg
.... bat

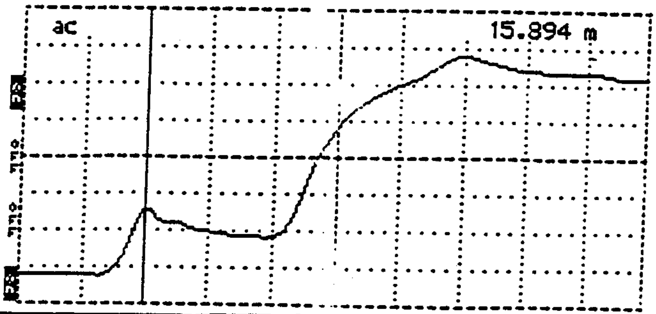


Tektronix 1502B TDR
Date 11/01/93
Cable 48810
Notes Dep-14
79"

Input Trace
Stored Trace J.P.
Difference Trace

Figure C-1. TDR Traces During Installation

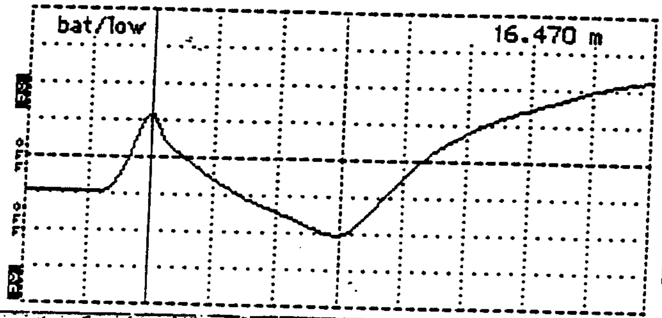
.... 15.894 m
iv...... .25 m/div
:ale.... 129 mρ/div
.... 0.99
r...... 1 avg
.... ac



Tektronix 1502B TDR
Date 11/01/93
Cable 48B01
Notes
Depth 13.7"

Input Trace JP
Stored Trace
Difference Trace

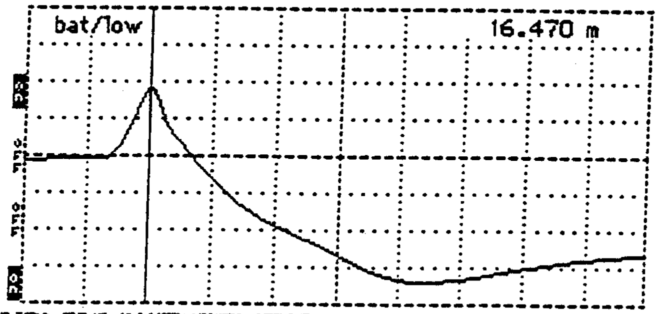
.... 16.470 m
iv...... .25 m/div
:ale.... 96.9 mρ/div
.... 0.99
.... 1 avg
.... bat/low



Tektronix 1502B TDR
Date 11/01/93
Cable 48B02
Notes
DEPTH 19.7

Input Trace JP
Stored Trace
Difference Trace

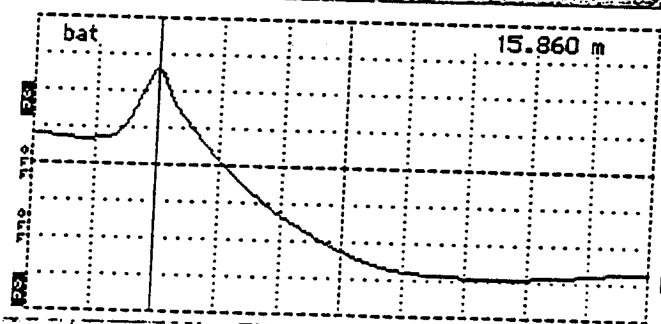
.... 16.470 m
iv...... .25 m/div
:ale.... 103 mρ/div
.... 0.99
r...... 1 avg
.... bat/low



Tektronix 1502B TDR
Date 11/01/93
Cable 48B03
Notes
Depth 25.6

Input Trace J.P.
Stored Trace
Difference Trace

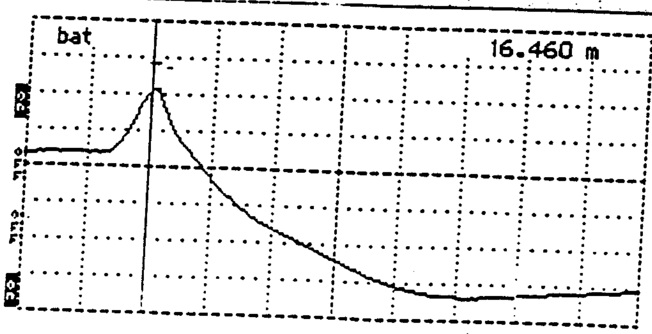
.... 15.860 m
/Div...... .25 m/div
Scale.... 106 mρ/div
.... 0.99
ter...... 1 avg
.... bat/low



Tektronix 1502B TDR
Date 11/01/93
Cable 48B'04
Notes
31.8 DEPTH

Input Trace JP
Stored Trace
Difference Trace

.... 16.460 m
Div...... .25 m/div
cale.... 106 mρ/div
.... 0.99
r...... 1 avg
.... bat/low



Tektronix 1502B TDR
Date 11/01/93
Cable 48B05
Notes Depth
37.8"

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. 481068 11/02/93

MOISTURE CONTENTS FOR TDR

TDR #	WT. OF PAN(g)	(WET) PAN & SOIL(g)	(DRY) PAN & SOIL(g)	M.C. (%)
48B10	179.2	433.8	390.2	20.66%
48B09	178.9	414.6	371.9	22.12%
48B08	203.9	405.9	337.5	16.36%
48B07	177.5	381.5	351.1	17.51%
48B06	199.0	383.2	354.7	18.30%
48B05	179.1	394.0	352.9	23.65%
48B04	178.4	401.5	354.2	26.91%
48B03	203.5	395.8	359.6	23.19%
48B02	177.2	399.3	359.2	22.03%
48B01	198.3	519.6	497.4	7.42%*

* PEBBLES

APPENDIX D

Initial Data Collection

Appendix D contains the following support information:

5,1993,306,1000,12.04,7.48,.5
5,1993,306,1100,12.04,7.66,.2
5,1993,306,1200,12.04,8.05,0
6,1993,306,1200,11.3,11.91,12.55,13.38,13.97
7,1993,306,1201,-374.5,-441.6,-480.9,-508.1,-524.1,-534.1,-540.7,-502.8,-528.8,-540.7,-546.7,-550.7,-553.4,-554,-556,-557.4,-515.5,-539.4,-548.7,-554,-556,-558.7,-516.1,-538.1,-547.4,-552,-555.4,-556.7,-558,-558.7,-559.4,-
517.5,-540.7,-550.7,-555.4
5,1993,306,1300,12.03,8.33,.6
5,1993,306,1400,12.02,8.52,0
5,1993,306,1500,12.02,8.89,.1
5,1993,306,1600,12.02,9.17,.9
6,1993,306,1600,11.65,12.26,12.82,13.53,14.02
7,1993,306,1601,-300.6,-349.9,-380.4,-401.7,-417,-428.3,-436.3,-443,-447.6,-450.3,-452.9,-455.6,-457.6,-458.3,-459.6,-460.3,-460.9,-460.9,-461.6,-461.6,-462.9,-462.9,-462.9,-435,-452.3,-457.6,-460.9,-462.3,-462.9,-463.6,-
463.6,-463.6,-464.3,-464.9,-464.9
5,1993,306,1700,12.01,8.98,1.3
5,1993,306,1800,12.01,8.92,.7
5,1993,306,1900,12,8.92,.1
5,1993,306,2000,12,8.93,.1
6,1993,306,2000,11.16,12.05,12.8,13.59,14.08
7,1993,306,2001,-294.6,-335.2,-360.5,-379.1,-391.1,-400.4,-407.7,-413.7,-418.4,-422.3,-425.7,-428.3,-430.3,-431.7,-433.7,-435,-436.3,-436.3,-437,-437,-437.6,-438.3,-438.3,-437.6,-436.3,-436.3,-437,-436.3,-413.7,-426.3,-431.7,-
433.7,-436.3,-437.6,-439
5,1993,306,2100,11.99,8.95,0
5,1993,306,2200,11.99,8.92,0
5,1993,306,2300,11.98,8.96,0
1,1993,306,2400,12.01,12.06,946,11.91,2001,8.67,9.3,1516,7.42,951,4.5
2,1993,306,2400,11.29,12.04,12.72,13.52,14.03,15.12,16.4,17.49,19.29,20.86,22.18,23.26,24.23,24.87,25.43,25.85,26.17,26.45
3,1993,306,2400,11.81,1211,12.3,1414,12.88,1447,13.6,1513,14.11,1605,15.17,922,16.47,922,17.56,922,19.37,933,20.9,932,22.22,1013,23.28,1212,24.24,1201,24.89,1430,25.46,1641,25.9,1934,26.2,1638,26.49,2055
4,1993,306,2400,10.9,922,11.66,922,12.45,922,13.34,1010,13.94,1057,15.09,1324,16.34,2245,17.4,2340,19.21,2320,20.77,2320,22.11,2324,23.21,2332,24.19,922,24.81,922,25.33,922,25.77,922,26.08,922,26.38,922
5,1993,306,2400,11.98,9.02,0
6,1993,306,2400,11.06,11.9,12.66,13.53,14.04
7,1993,307,1,-292.7,-325.9,-346.5,-362.5,-373.1,-381.8,-369.8,-385.8,-393.7,-380.4,-393.7,-401.1,-405.1,-407.7,-409.7,-392.4,-404.4,-410.4,-413,-415,-416.4,-417,-417.7,-419,-419.7,-399.7,-410.4,-415,-417,-418.4,-419,-401.1,-
411.7,-415,-417.7
5,1993,307,100,11.98,8.87,.1
5,1993,307,200,11.97,8.81,0
5,1993,307,300,11.97,8.49,0
5,1993,307,400,11.96,8.3,0
6,1993,307,400,10.99,11.84,12.6,13.46,13.99
7,1993,307,401,-274.7,-304.6,-323.3,-337.2,-348.5,-357.2,-363.8,-370.5,-375.1,-378.5,-363.8,-375.8,-380.5,-385.1,-387.1,-389.1,-391.8,-393.8,-394.4,-395.7,-396.4,-397.1,-397.7,-397.7,-398.4,-399.1,-399.7,-399.7,-382.4,-391.1,-
395.1,-397.1,-397.7,-399.1,-399.7
5,1993,307,500,11.96,8.03,0
5,1993,307,600,11.95,7.83,0
5,1993,307,700,11.95,7.69,0
5,1993,307,800,11.94,7.51,0
6,1993,307,800,10.85,11.72,12.5,13.39,13.93
7,1993,307,801,-278.1,-304.7,-321.3,-333.9,-343.9,-351.2,-357.9,-363.2,-367.9,-371.2,-374.5,-360.6,-370.5,-375.9,-379.8,-381.2,-383.2,-385.2,-385.8,-387.2,-370.5,-379.8,-383.2,-385.2,-386.5,-387.8,-388.5,-389.2,-389.8,-390.5,-
390.5,-391.2,-391.2,-374.5,-383.2
5,1993,307,900,11.94,7.42,0
5,1993,307,1000,11.94,7.65,0
5,1993,307,1100,11.93,8.13,0
5,1993,307,1200,11.93,8.51,0
6,1993,307,1200,12.33,12.32,12.64,13.34,13.87

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

Site 481068

November 2, 1993

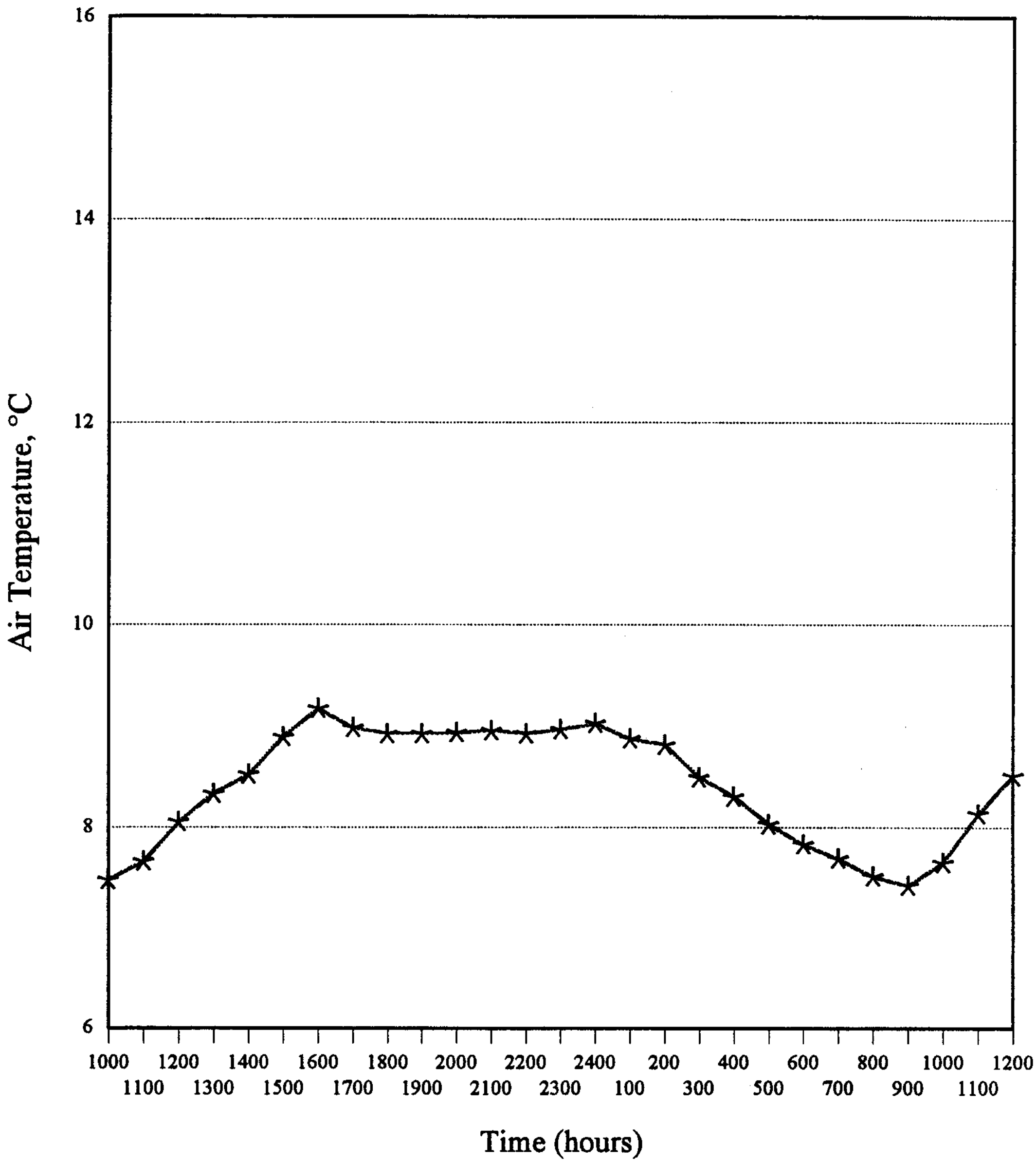


Figure D-1. Measured Air Temperature During Initial Data Collection.

Site 481068

November 2, 1993

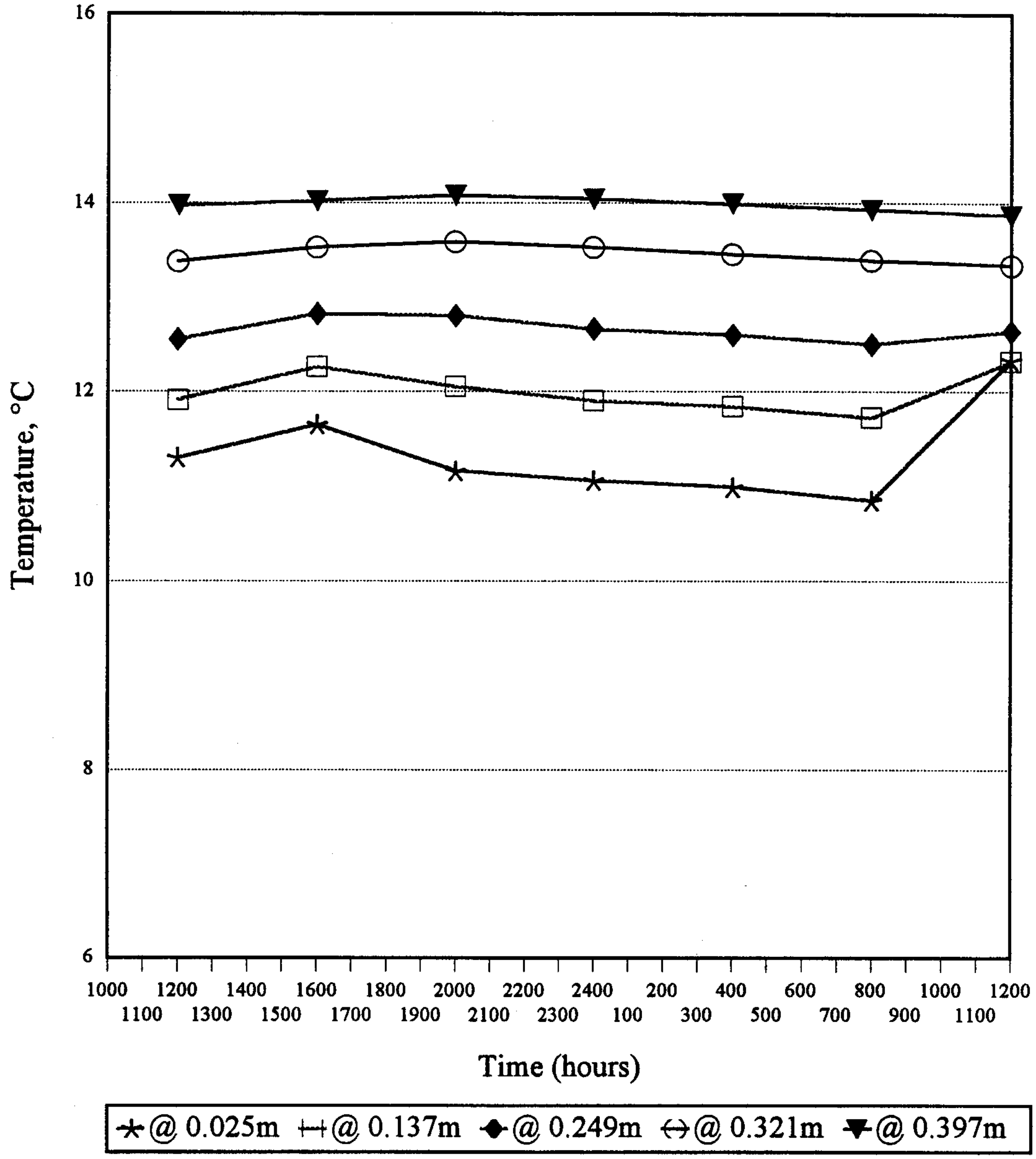


Figure D-2. Measured Average Subsurface Temperature for the First 5 Sensors During Initial Data Collection.

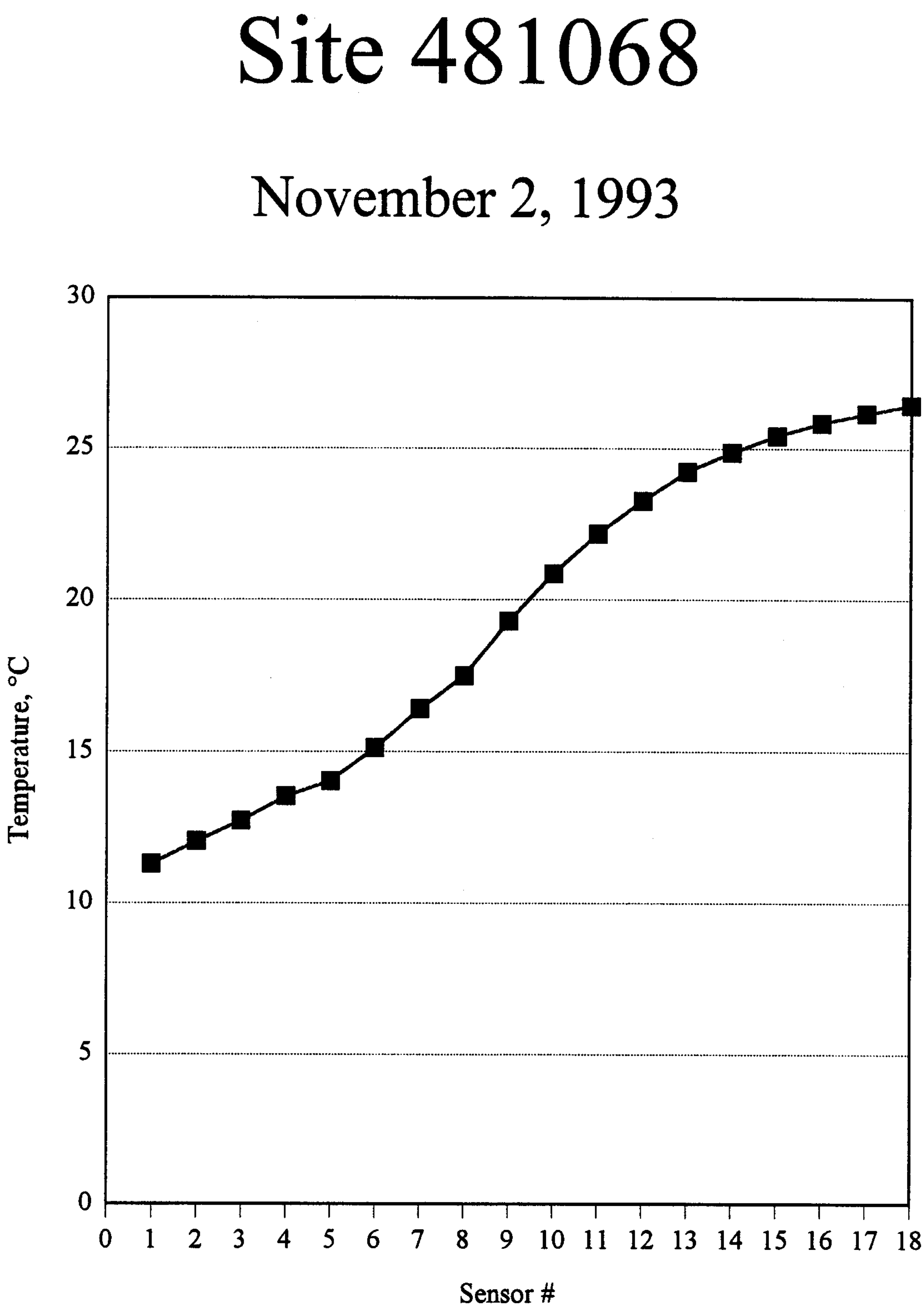


Figure D-3. Measured Average Subsurface Temperature for all 18 Sensors Dduring Initial Data Collection.

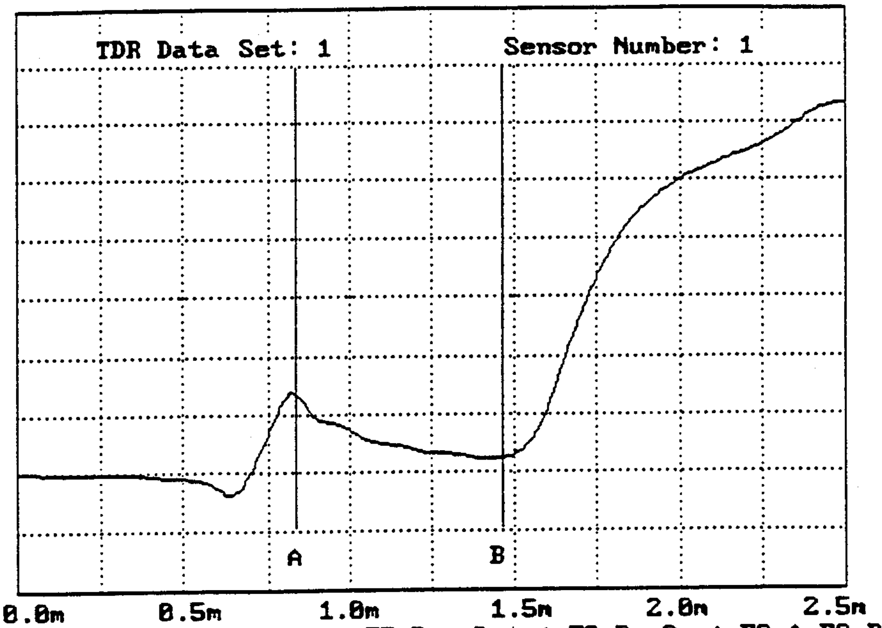
TDR RESULTS

File: 48SB93BL.MOB

Date: Dec 16, 1993
Time of Day: 6:57
Dist → Curs (m): 18.0
Dist btn WvFm (m):.01
Gain: 61
Offset: 53325
Sample No: 1

A (m) = 0.83
B (m) = 1.46
Trace Length (m)=0.63
Diele. Const.= 9.8
Volumetr MC (%)= 18.5

Total 3 Set Data



Esc=Menu; ↑ ↓; Ctr+PgU/Ctr+PgD=Prior/Next Set; F5=Res Data; F2=PrnScn; F8=A,F9=B

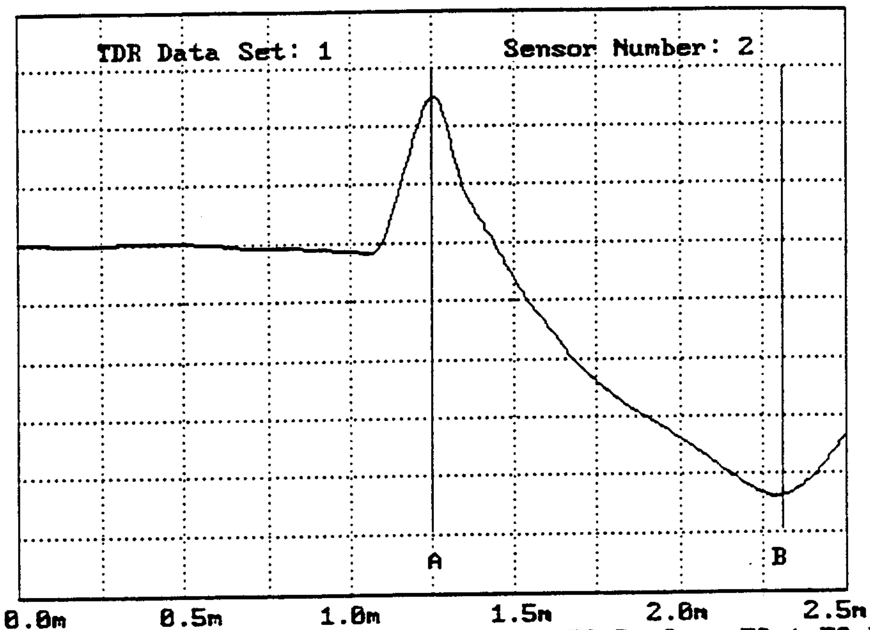
TDR RESULTS

File: 48SB93BL.MOB

Date: Dec 16, 1993
Time of Day: 6:58
Dist → Curs (m): 18.0
Dist btn WvFm (m):.01
Gain: 81
Offset: 54292
Sample No: 1

A (m) = 1.25
B (m) = 2.31
Trace Length (m)=1.06
Diele. Const.= 27.8
Volumetr MC (%)= 42.6

Total 3 Set Data



Esc=Menu; ↑ ↓; Ctr+PgU/Ctr+PgD=Prior/Next Set; F5=Res Data; F2=PrnScn; F8=A,F9=B

Figure D-4. Traces from TDR Sensors

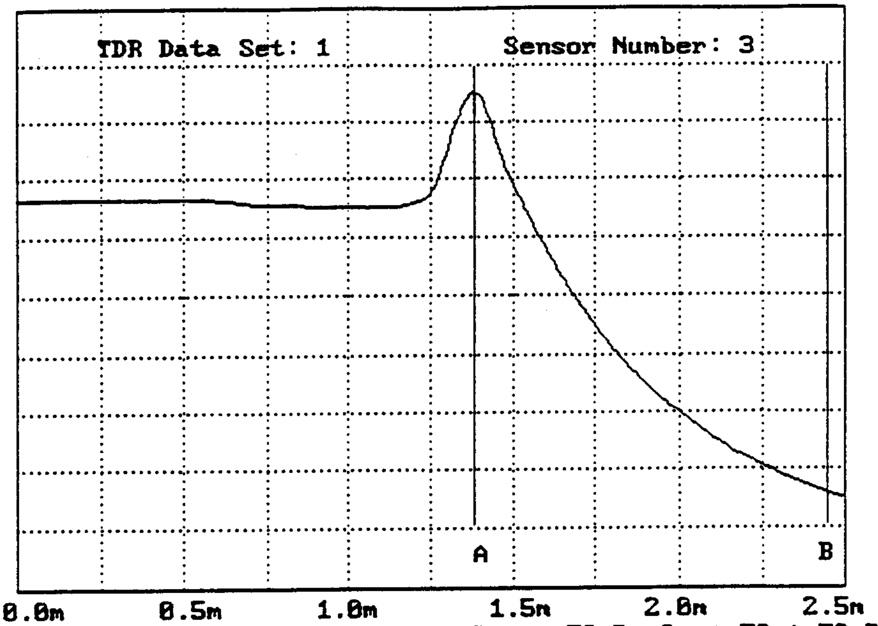
TDR RESULTS

File: 48SB93BL.MOB

Date: Dec 16, 1993
Time of Day: 6:58
Dist → Curs (m): 18.0
Dist btn WvFm (m):.01
Gain: 75
Offset: 54309
Sample No: 1

A (m) = 1.38
B (m) = 2.45
Trace Length (m)=1.07
Diele. Const.= 28.3
Volumetr MC (%)= 43.0

Total 3 Set Data



Esc=Menu; ↑ ↓; Ctr+PgU/Ctr+PgD=Prior/Next Set; F5=Res Data; F2=PrnScn; F8=A,F9=B

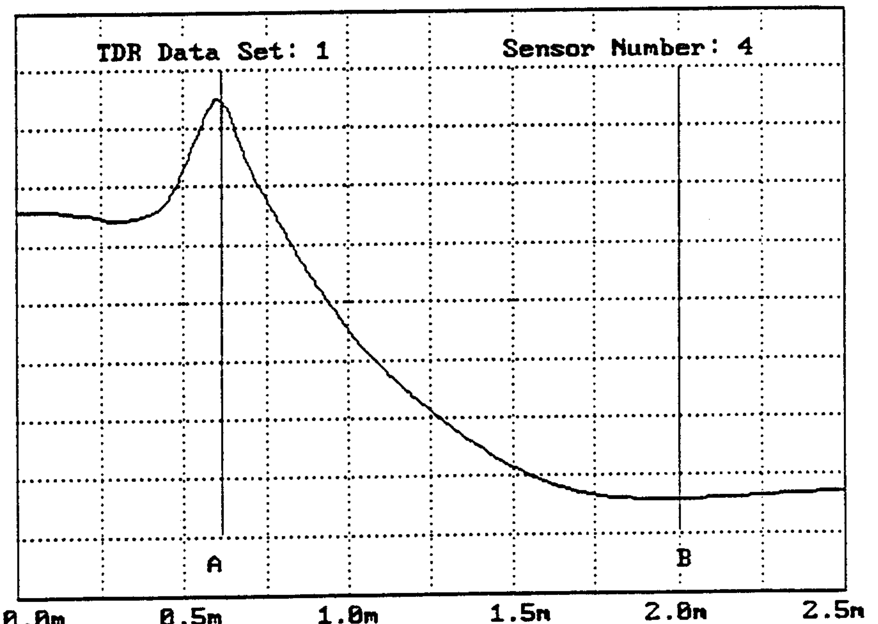
TDR RESULTS

File: 48SB93BL.MOB

Date: Dec 16, 1993
Time of Day: 6:59
Dist → Curs (m): 18.0
Dist btn WvFm (m):.01
Gain: 68
Offset: 54282
Sample No: 1

A (m) = 0.61
B (m) = 2.00
Trace Length (m)=1.39
Diele. Const.= 47.7
Volumetr MC (%)= 55.5

Total 3 Set Data



Esc=Menu; ↑ ↓; Ctr+PgU/Ctr+PgD=Prior/Next Set; F5=Res Data; F2=PrnScn; F8=A,F9=B

Figure D-4 (Continued). Traces from TDR Sensors

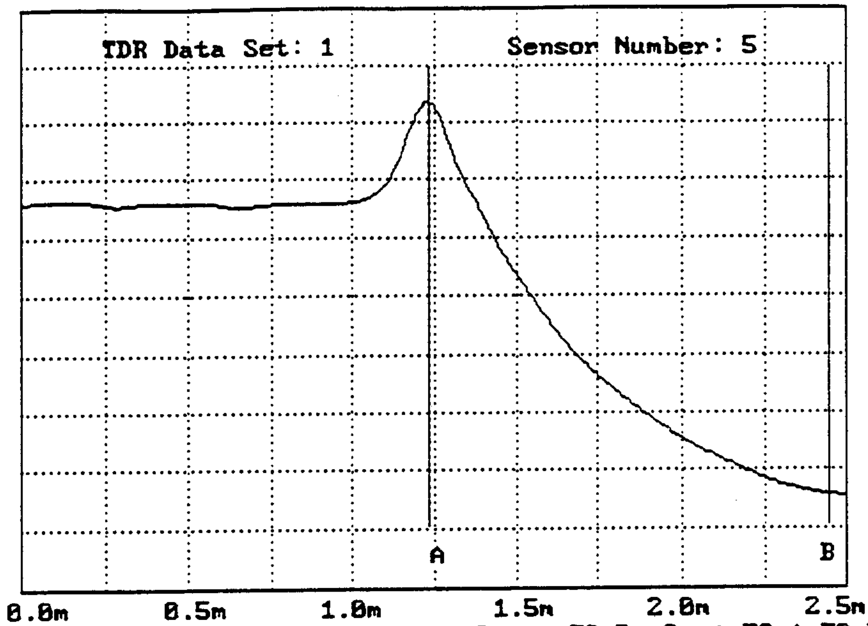
TDR RESULTS

File: 48SB93BL.MOB

Date: Dec 16, 1993
Time of Day: 6:59
Dist → Curs (m): 18.0
Dist btn WvFm (m):.01
Gain: 68
Offset: 54299
Sample No: 1

A (m) = 1.23
B (m) = 2.45
Trace Length (m)=1.22
Diele. Const.= 36.8
Volumetr MC (%)= 49.1

Total 3 Set Data



Esc=Menu; ↑ ↓; Ctr+PgU/Ctr+PgD=Prior/Next Set; F5=Res Data; F2=PrnScn; F8=A,F9=B

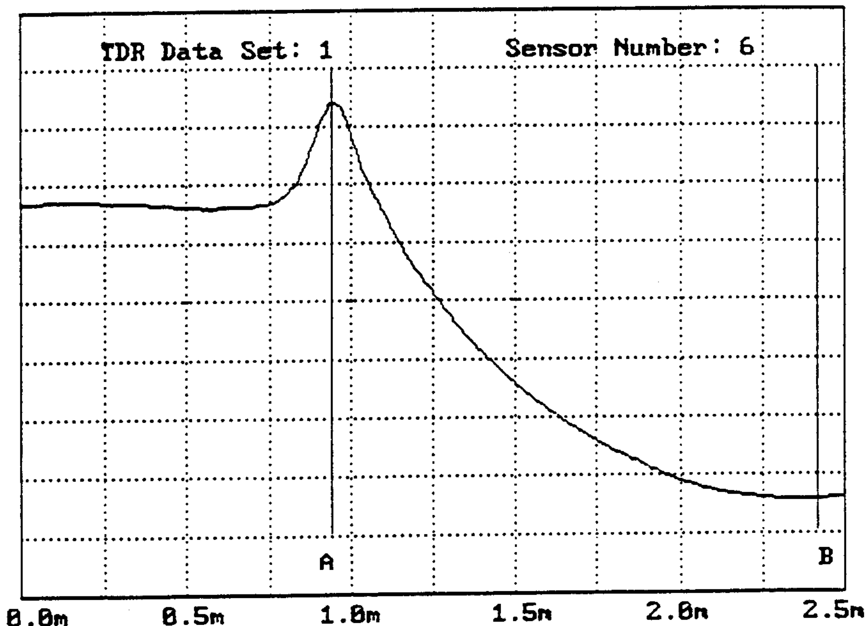
TDR RESULTS

File: 48SB93BL.MOB

Date: Dec 16, 1993
Time of Day: 7:00
Dist → Curs (m): 18.0
Dist btn WvFm (m):.01
Gain: 67
Offset: 54325
Sample No: 1

A (m) = 0.94
B (m) = 2.42
Trace Length (m)=1.48
Diele. Const.= 54.1
Volumetr MC (%)= 59.8

Total 3 Set Data



Esc=Menu; ↑ ↓; Ctr+PgU/Ctr+PgD=Prior/Next Set; F5=Res Data; F2=PrnScn; F8=A,F9=B

Figure D-4 (Continued). Traces from TDR Sensors

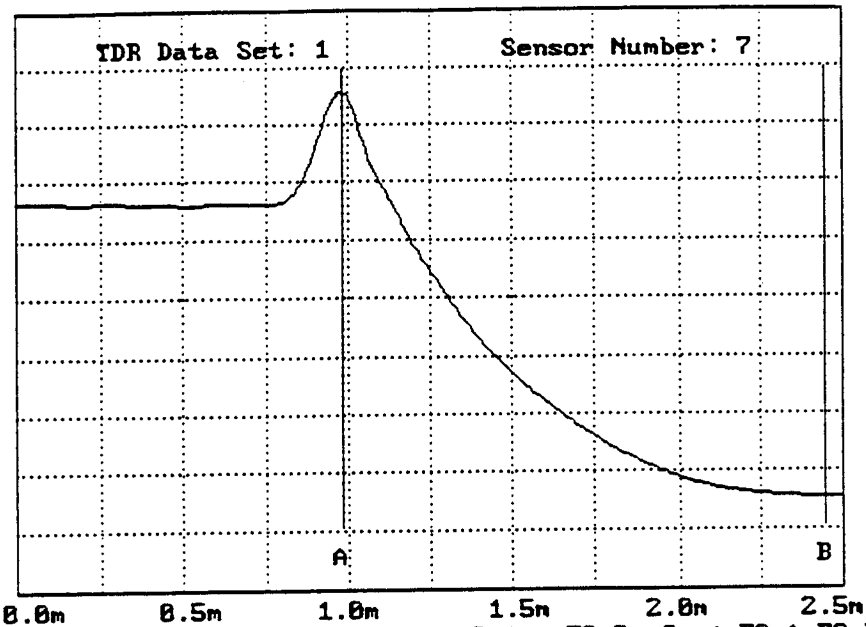
TDR RESULTS

File: 48SB93BL.MOB

Date: Dec 16, 1993
Time of Day: 7:01
Dist → Curs (m): 18.0
Dist btn WvFm (m): .01
Gain: 69
Offset: 54302
Sample No: 1

A (m) = 0.98
B (m) = 2.45
Trace Length (m)=1.47
Diele. Const.= 53.4
Volumetr MC (%)= 59.3

Total 3 Set Data



Esc=Menu; ↑ ↓; Ctr+PgU/Ctr+PgD=Prior/Next Set; F5=Res Data; F2=PrnScn; F8=A,F9=B

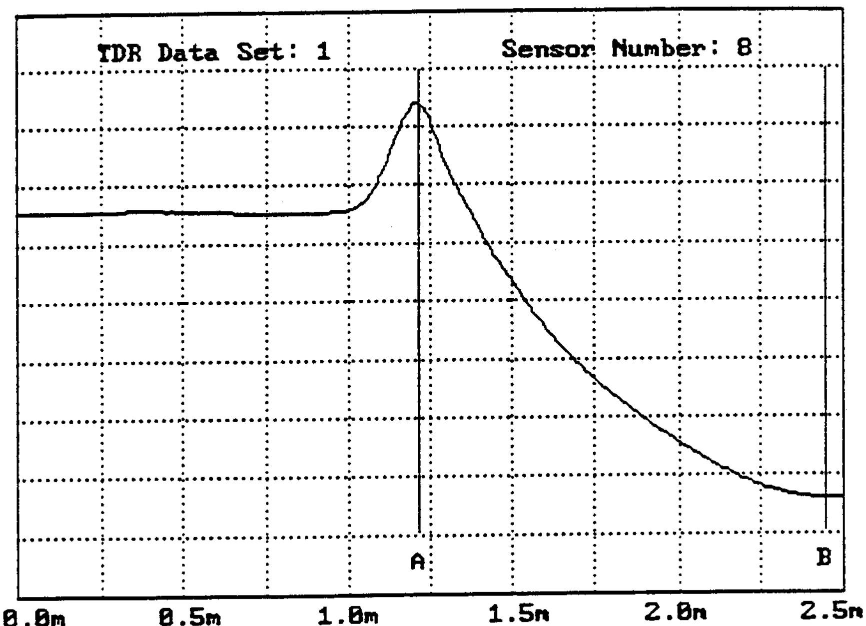
TDR RESULTS

File: 48SB93BL.MOB

Date: Dec 16, 1993
Time of Day: 7:01
Dist → Curs (m): 19.9
Dist btn WvFm (m): .01
Gain: 72
Offset: 54211
Sample No: 1

A (m) = 1.21
B (m) = 2.45
Trace Length (m)=1.24
Diele. Const.= 38.0
Volumetr MC (%)= 49.8

Total 3 Set Data



Esc=Menu; ↑ ↓; Ctr+PgU/Ctr+PgD=Prior/Next Set; F5=Res Data; F2=PrnScn; F8=A,F9=B

Figure D-4 (Continued). Traces from TDR Sensors

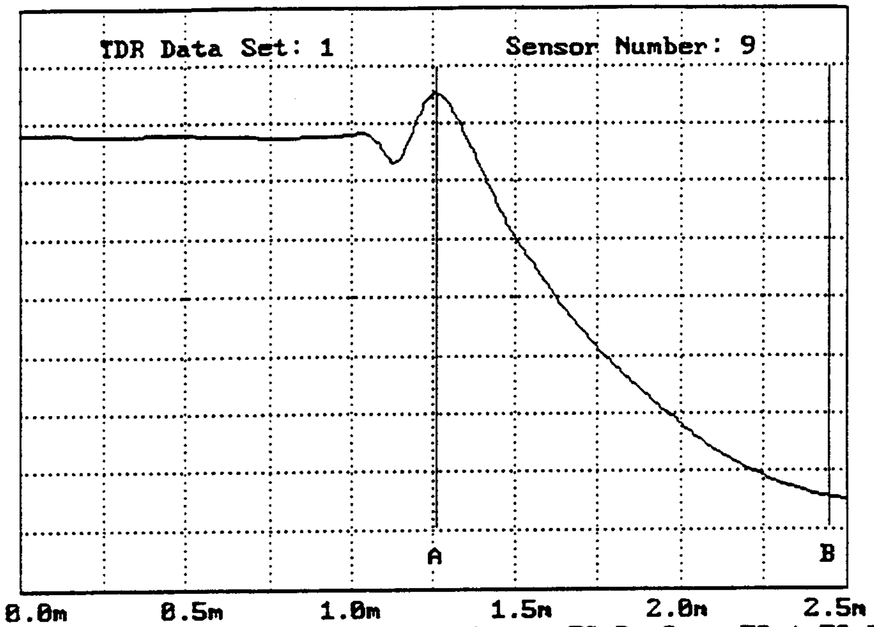
TDR RESULTS

File: 48SB93BL.MOB

Date: Dec 16, 1993
Time of Day: 7:02
Dist → Curs (m): 19.9
Dist btn WvFm (m): .01
Gain: 77
Offset: 54418
Sample No: 1

A (m) = 1.26
B (m) = 2.45
Trace Length (m)=1.19
Diele. Const.= 35.0
Volumetr MC (%)= 48.0

Total 3 Set Data



Esc=Menu; ↑ ↓; Ctr+PgU/Ctr+PgD=Prior/Next Set; F5=Res Data; F2=PrnScn; F8=A,F9=B

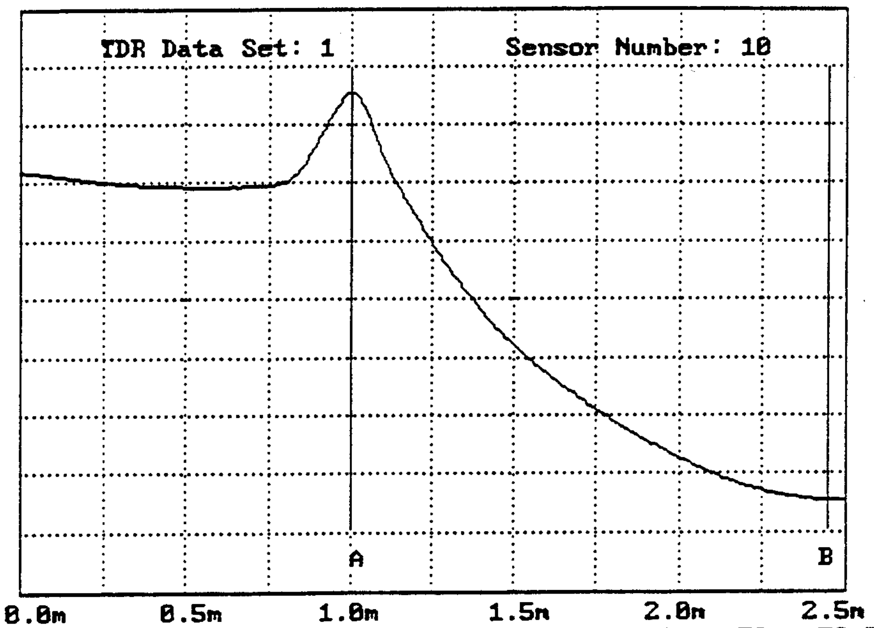
TDR RESULTS

File: 48SB93BL.MOB

Date: Dec 16, 1993
Time of Day: 7:02
Dist → Curs (m): 19.9
Dist btn WvFm (m): .01
Gain: 69
Offset: 54423
Sample No: 1

A (m) = 1.00
B (m) = 2.45
Trace Length (m)=1.45
Diele. Const.= 52.0
Volumetr MC (%)= 58.2

Total 3 Set Data



Esc=Menu; ↑ ↓; Ctr+PgU/Ctr+PgD=Prior/Next Set; F5=Res Data; F2=PrnScn; F8=A,F9=B

Figure D-4 (Continued). Traces from TDR Sensors

APPENDIX E

Photographs

Appendix E contains the following photographs:

Photo E1 - General Photo of Site

Photo E2 - Preparing Site for Installation

Photo E3 - Sawing Instrumentation Hole and Trench

Photo E4 - Completion of Observation Well

Photo E5 - Placing TDR Probes in Instrumentation Hole

Photo E6 - Checking TDR Probe Traces and Preparing Equipment Cabinet

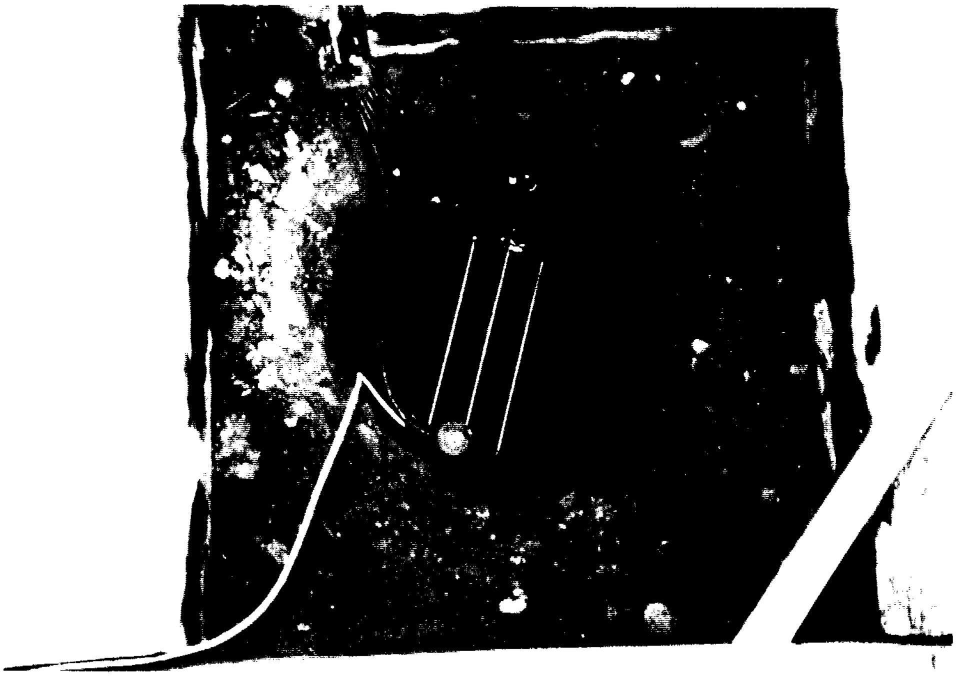


Photo E7 - Instrumentation Hole Just Prior to Completion

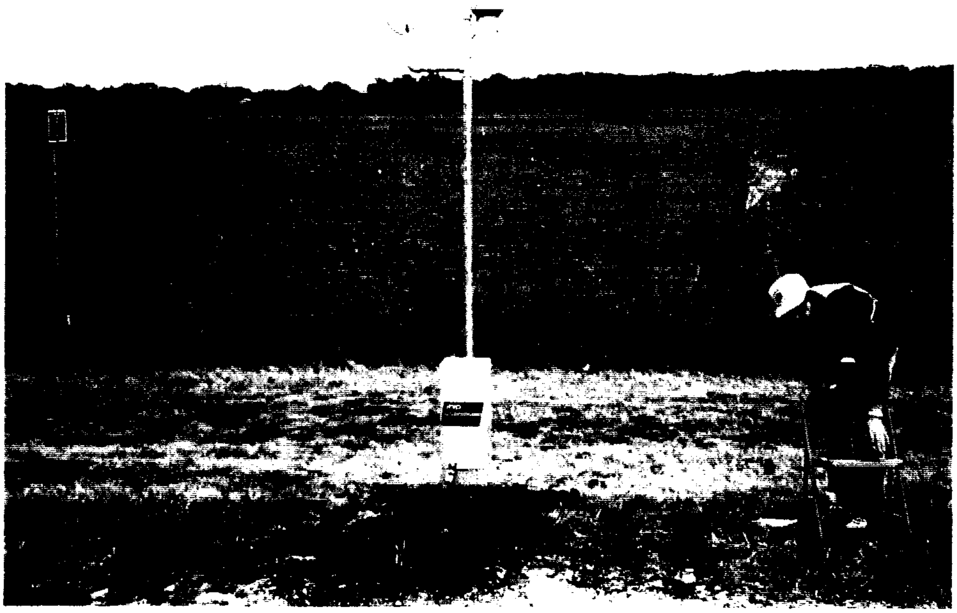


Photo E8 - Equipment Cabinet and Weather Station After Completion