LTPP Seasonal Monitoring Program

Site Installation and Initial Data Collection
Section 481060, Victoria, Texas

Prepared by

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Prepared for

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

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Technical Report Documentation Page

1. Report No.	2. Government Accession No.	3. Recipient's Catalog No.
4. Title and Subtitle LTPP Seasonal Monitoring Program Site Installation and Initial Data Collection Section 481060, Victoria, Texas		5. Report Date March 1995 6. Performing Organization Code
7. Author(s) Laurence L. Peirce and Richard Zamora		8. Performing Organization Report No.
9. Performing Organization Name and Address Brent Rauhut Engineering Inc. 8240 Mopac, Suite 220 Austin, Texas 78759		10. Work Unit No. (TRAIS) 11. Contract or Grant No. DTFH61-92-C-00008
12. Sponsoring Agency Name and Address Federal Highway Administration LTPP Division, HNR-40 Turner-Fairbanks Highway Research Center 6300 Georgetown Pike McLean, Virginia 22101		13. Type of Report and Period Covered Final Report November 1993 14. Sponsoring Agency Code
15. Supplementary Notes		

16. Abstract

This report contains a description of the instrumentation installation activities and initial data collection for test section 481060, which is a part of the LTPP Core Seasonal Monitoring Program. This asphalt concrete surfaced pavement test section, which is located on US-77 in the northbound lanes, approximately 1.1 km south of SH-239, was instrumented on November 30 and December 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 December 1, 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 Pavement, Highway, Instrumentation, Monitoring, Time Domain Reflectometry, Thermistor, Observation Well, Test Equipment, Field Tests.		18. Distribution Statement	
19. Security Classif. (of this report)	20. Security Classif. (of this page)	21. No. of Pages	22. Price

Form DOT F 1700.7 (8-72) Facsimile

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SEASONAL INSTRUMENTATION STUDY
INSTRUMENTATION INSTALLATION
TEXAS SECTION 481060/48SF

I. Introduction

The seasonal instrumentation installation of Section 481060 was performed on November 30 and December 1, 1993, and was the sixth one completed in the Southern Region.

The GPS-1 test section resides in Seasonal Cell 9 and is located in a wet-no freeze zone. The site (see Figure A-1) is in the northbound lanes on US-77, approximately 1.1 km south of SH-239. 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 33.6°C and the average minimum daily temperature for the months of December through February is 8.2°C. The average annual precipitation is 838 mm.

The pavement is a flexible structure consisting of approximately 191 mm of asphalt concrete over 292 mm of granular aggregate base. The subgrade is classified as a silty sand. 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	191	- - -
Base	292	1954
Subbase	152	- - -
Subgrade	- - -	1663

The annual average daily traffic (AADT) in the GPS lane is almost 2700, of which 20% is truck traffic. The estimated annual ESALs on the GPS lane were 141,671. 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 (Texas DOT), Federal Highway Administration (FHWA) Southern Region Coordination Office (SRCO) 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
Jerry Daleiden	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 DOT 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 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 March 31, 1993 by Jerry Daleiden (SRCO). Deflection testing was conducted on March 5, 1993, and on December 1, 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. 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 DOT. 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	229 (48 FT)
TDR Sensors	10	48F01-48F10
Equipment Cabinet		
CR10 Data Logger	1	16518
Battery Package	1	5673
Weather Station		
Tipping-Bucket Rain Gauge	1	12091-693
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 Nº.	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	17	This unit was installed in the base and subgrade.
	5	94	
	6	169	
	7	245	
	8	321	
	9	477	
	10	625	
	11	778	
	12	931	
	13	1083	
	14	1234	
	15	1388	
	16	1541	
	17	1693	
	18	1843	

Location of Instrumentation

The instrumentation was installed at station 0-19 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, 2.09 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 7.7 m from the lane edge.

The observation well was installed at Station 1+00 of the test section approximately 3.4 m from the lane edge. A permanent benchmark was also set at Station 2+00 approximately 3.7 m from the lane edge.

Installation

Installation of the monitoring equipment was completed on November 30, 1993. Verification that the instrumentation was working was made the following day. The Texas DOT provided the pavement sawing, pavement repair materials and a permanent benchmark. Texas 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. 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 asphalt concrete surface was patched. 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 Nº	Sensor Depth (mm)	TDR Moisture Content (%, by wt)	Measured Moisture Content (%, by wt)
48F01	320	6.88	3.96
48F02	495	12.57	22.54
48F03	650	11.81	16.28
48F04	803	13.41	14.90
48F05	960	12.51	19.96
48F06	1110	15.66	25.16
48F07	1257	8.95	34.13
48F08	1412	12.06	32.37
48F09	1732	10.27	32.44
48F10	2019	8.08	35.37

Table 5. Thermistor Sensor Locations

Unit	Channel Nº.	Depth from Pavement Surface (mm)	Remarks
1	1	25	This unit was installed in the AC layer.
	2	99	
	3	173	
2	4	249	This unit was installed in the base and subgrade.
	5	326	
	6	401	
	7	477	
	8	553	
	9	709	
	10	857	
	11	1010	
	12	1163	
	13	1315	
	14	1466	
	15	1620	
	16	1773	
	17	1925	
	18	2075	

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 30, 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 was 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. It should be noted that the measured moisture content was much higher than that obtained by the TDRs during the initial data collection for depth greater than 1200 mm. This is likely due to disruption and partial drying due to excavation.

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 481060 was completed on November 30, 1993 and initial data collection was completed on December 1, 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.

After the initial installation, the alkaline battery pack was replaced with a gel-cell sealed battery.

One problem has been noted with the data being collected on this site. Thermistor #1, located in a metal probe at a depth of 25 mm from the pavement surface, began giving erratic readings between June 24 and August 1. The cause of the problem has yet to be identified. Efforts are underway to find a solution.

APPENDIX A

Test Section Background Information

Appendix A contains the following information:

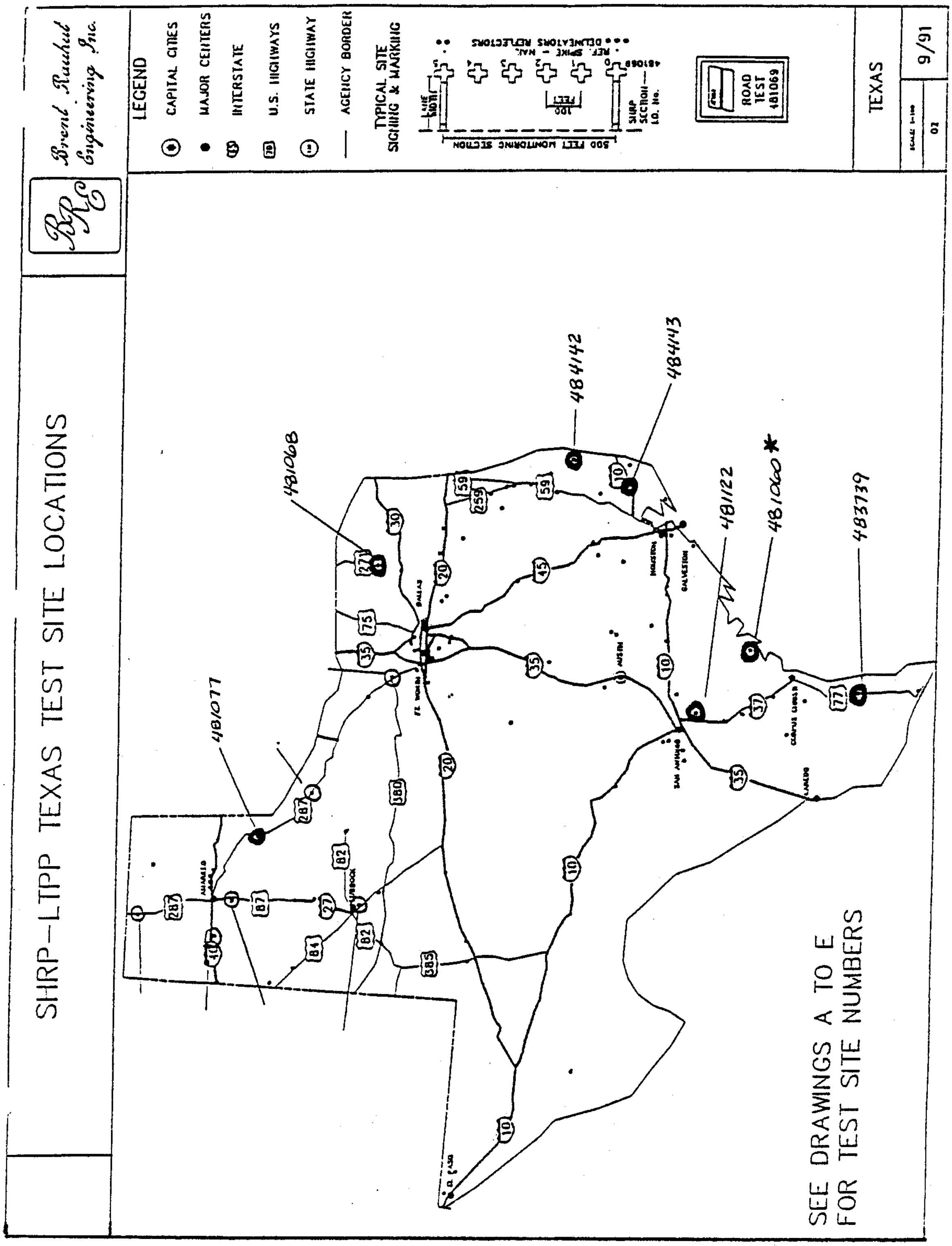
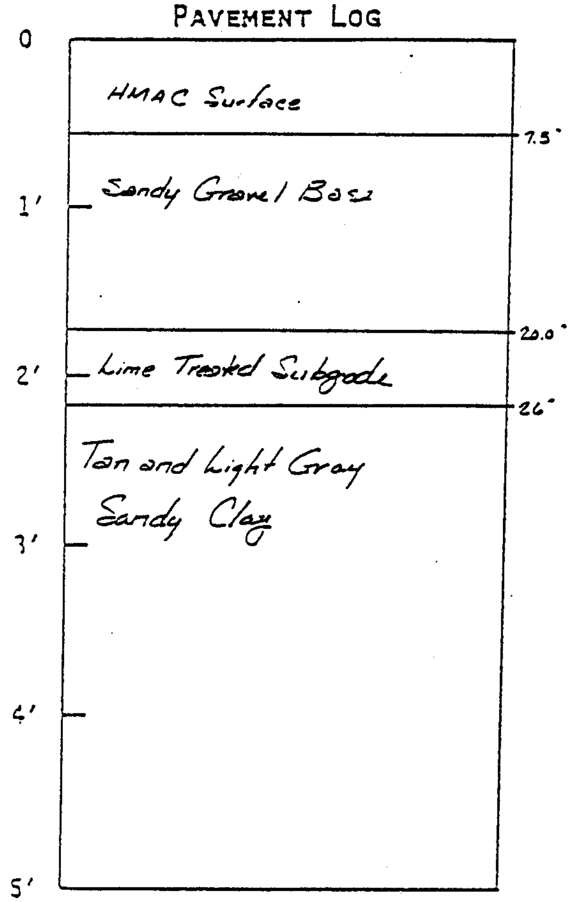


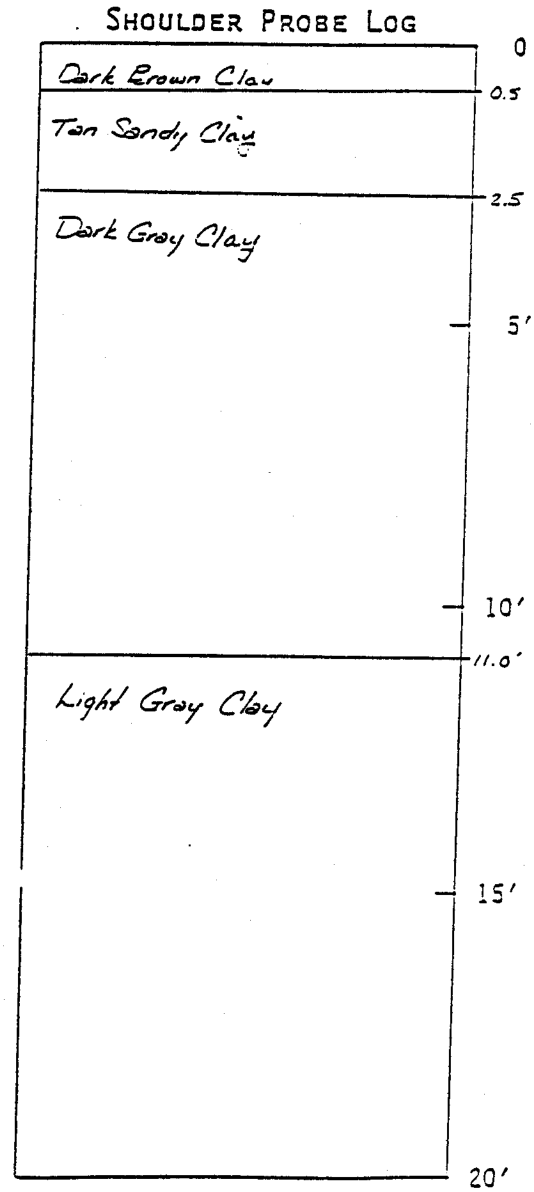
Figure A-1. Location of Test Site, GPS Test Section 481060

APPROXIMATE
SUMMARY OF FIELD LOGS
GPS TEST SECTIONS

TEST SECTION I.D. No. 481060 EXPERIMENT No. GPS-1

STATE Texas DATE SAMPLED 3-5-90





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

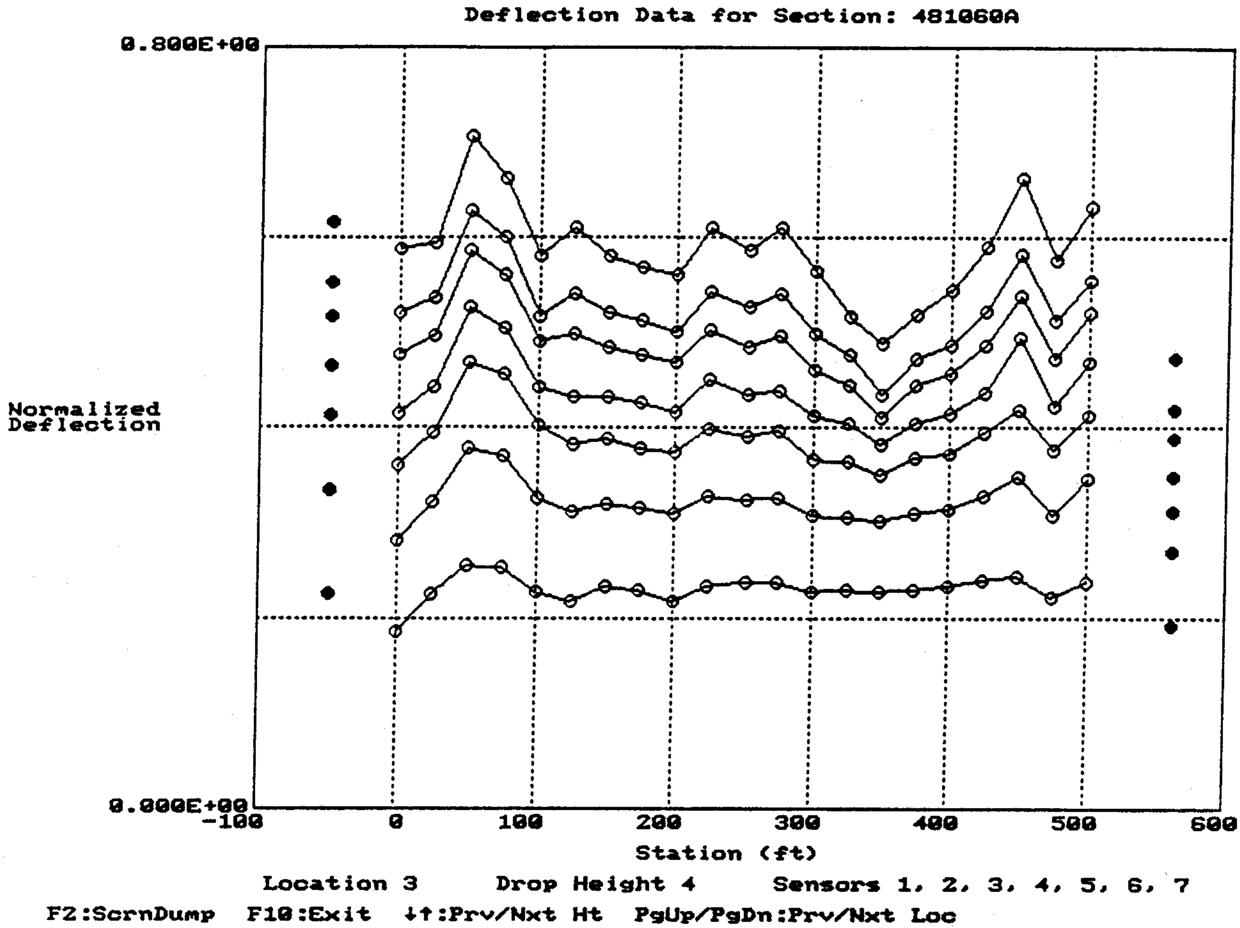


Figure A-3. Deflection Profiles from FWDCHECK

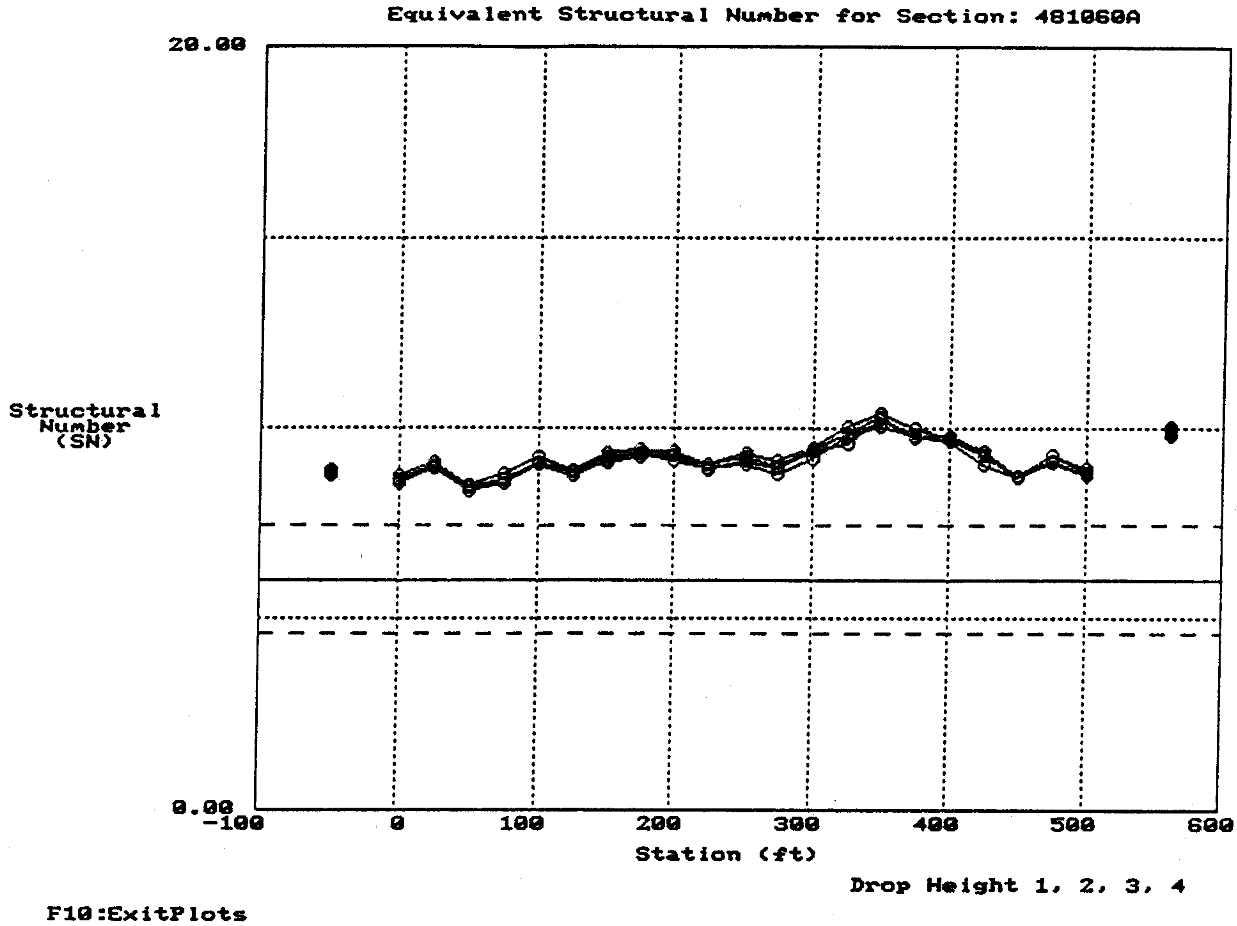


Figure A-4. Structural Number Profiles from FWDCHECK

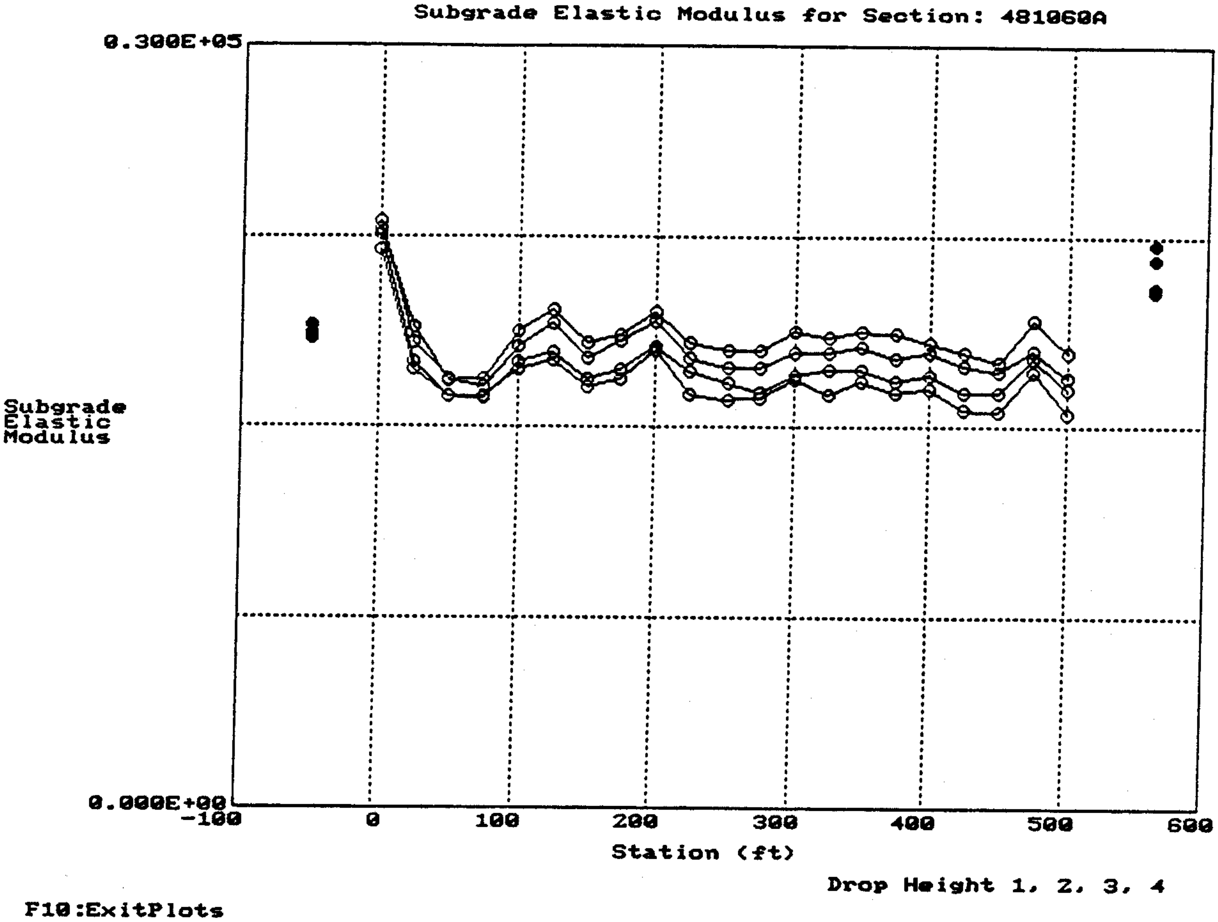


Figure A-5. Subgrade Modulus Profiles from FWDCHECK

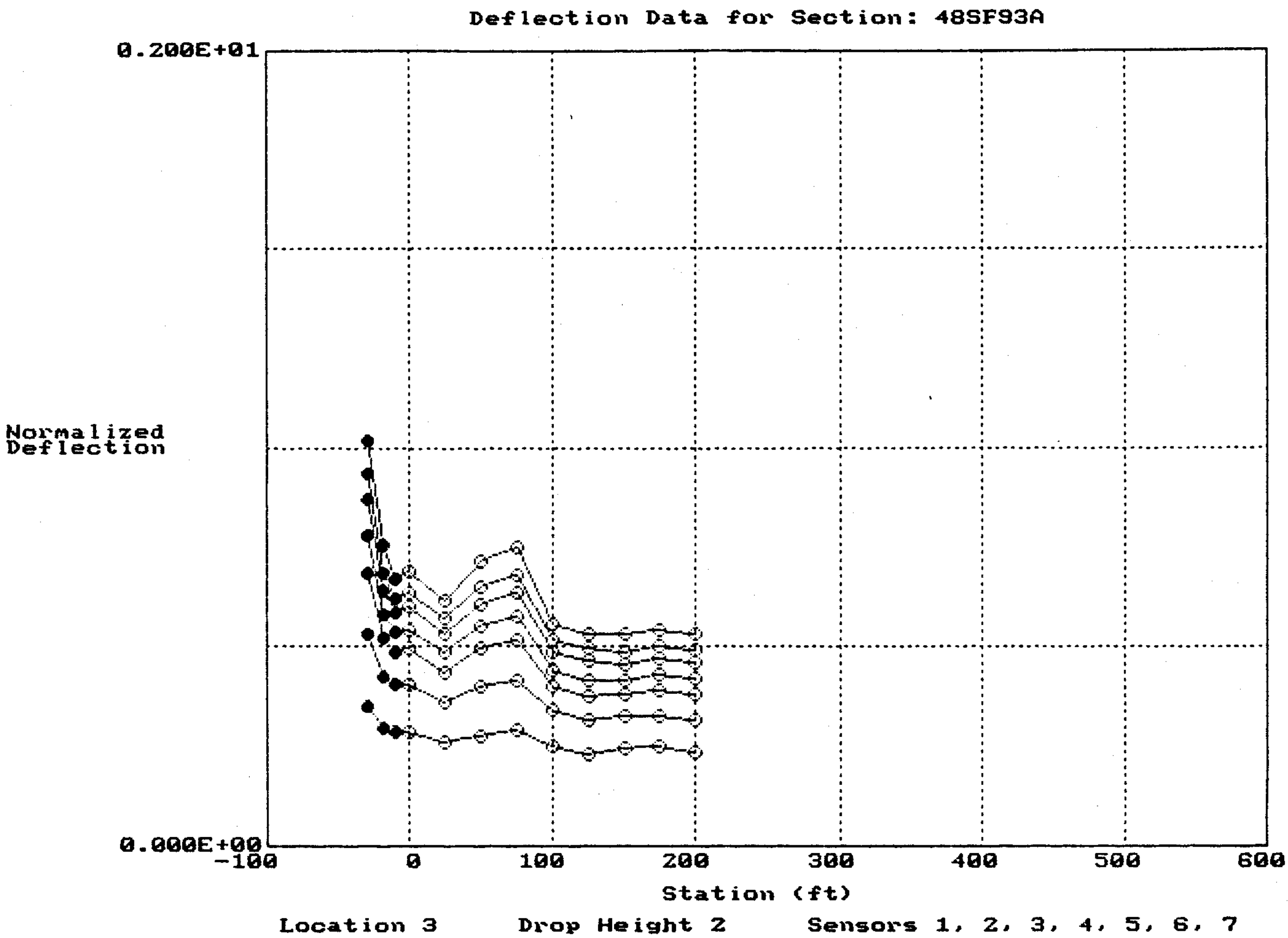


Figure A-6. Deflection Profiles from FWDCHECK on Installation Day

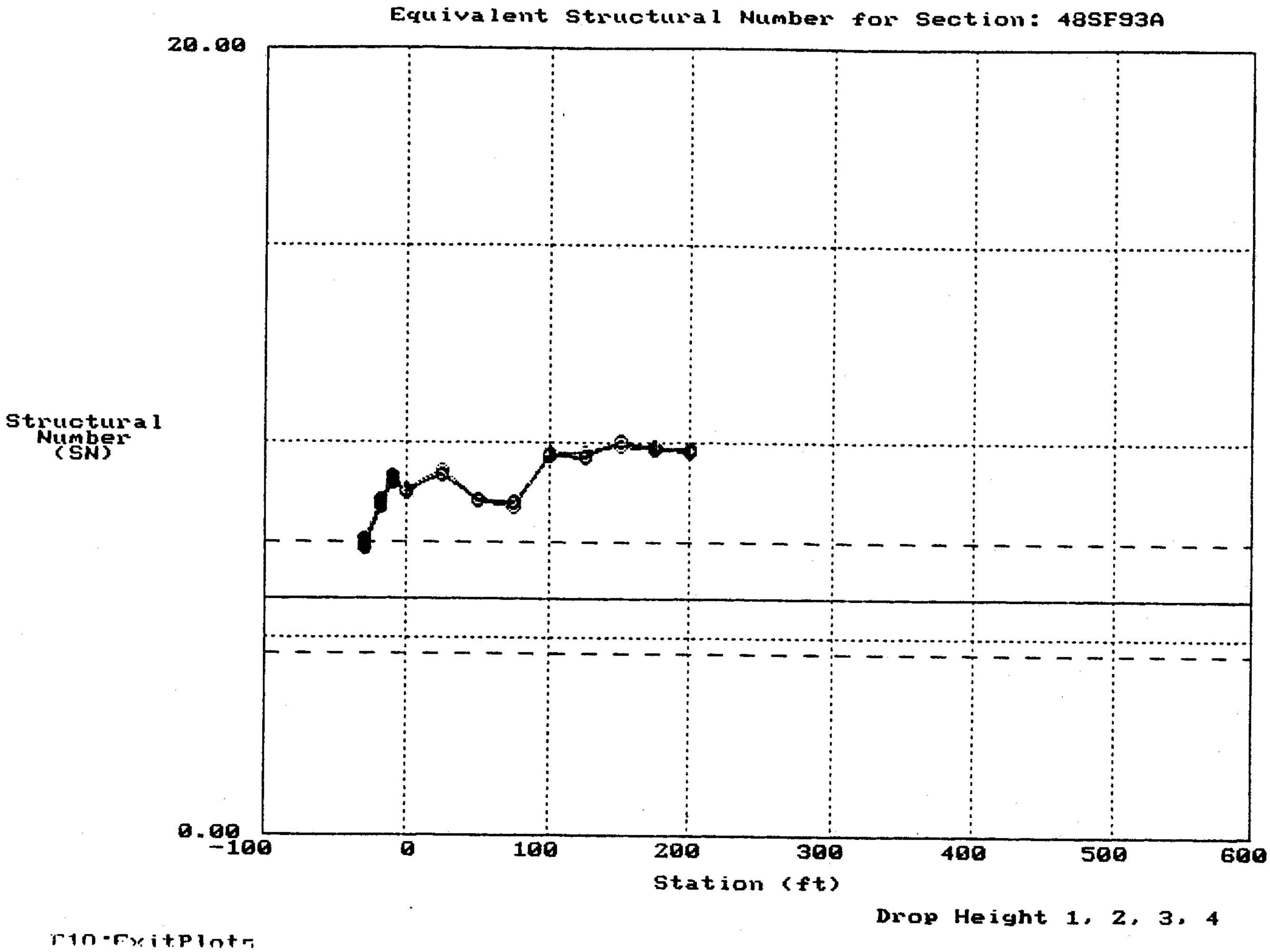


Figure A-7. Structural Number Profiles from FWDCHECK on Installation Day

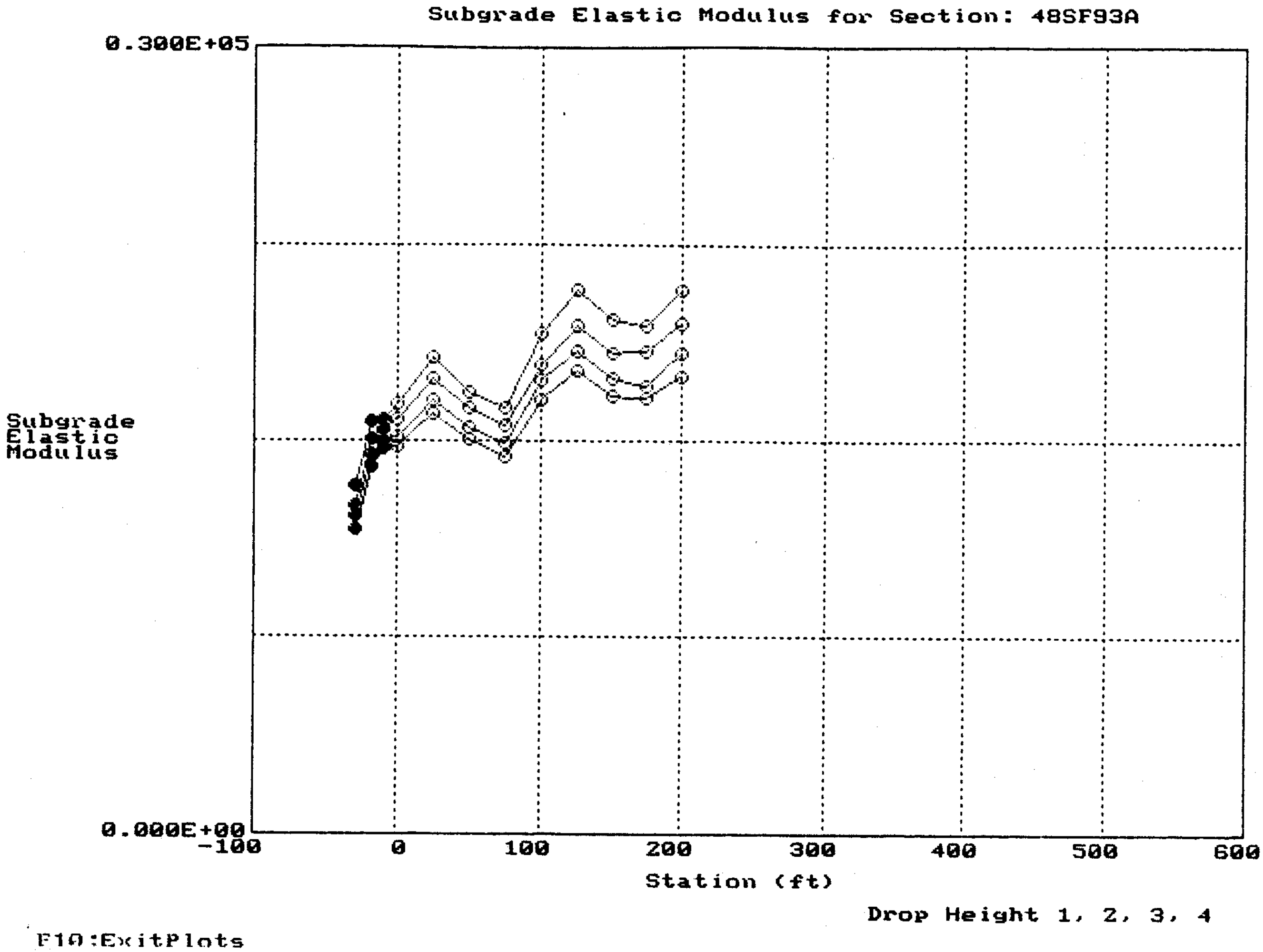


Figure A-8. Subgrade Modulus Profiles from FWDCHECK on Installation Day

Revised December 1, 1992

SHEET 1

DISTRESS SURVEY

LTPP PROGRAM

STATE ASSIGNED ID _ _ _ _

STATE CODE 48

SHRP SECTION ID 1060

DISTRESS SURVEY FOR PAVEMENTS WITH ASPHALT CONCRETE SURFACES

DATE OF DISTRESS SURVEY (MONTH/DAY/YEAR) 03/31/93

SURVEYORS: JFD, _ _ _ PHOTOS, VIDEO, OR BOTH WITH SURVEY (P, V, B) B

PAVEMENT SURFACE TEMP - BEFORE 35 °C; AFTER 35 °C

DISTRESS TYPE	SEVERITY LEVEL LOW	MODERATE	HIGH
CRACKING			
1. FATIGUE CRACKING (Square Meters)	0.	0.	0.
2. BLOCK CRACKING (Square Meters)	0.	0.	0.
3. EDGE CRACKING (Meters)	0.	0.	0.
4. LONGITUDINAL CRACKING (Meters)			
4a. Wheel Path	7.0	0.	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	1	0	0
Length (Meters)	2.6	0.	0.
Length Sealed (Meters)	2.6	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.

N/A - NOT AVAILABLE

REVISED 4/14/94 JFD

Figure A-9. Distress Survey Data

Revised December 1, 1992

SHEET 2	STATE ASSIGNED ID _ _ _ _
DISTRESS SURVEY	STATE CODE 48
LTPP PROGRAM	SHRP SECTION ID 1060

DATE OF DISTRESS SURVEY (MONTH/DAY/YEAR) 03/31/93

SURVEYORS: JED, _ _ _

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) (Square Meters)			0 _ _ 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) Length of Affected Pavement (Meters)			_ _ 0 _ _ 0. _
16. OTHER (Describe) ________			

Figure A-9 (Continued). Distress Survey Data

SHEET 3

DISTRESS SURVEY

LTPP PROGRAM

STATE ASSIGNED ID _ _ _ _

STATE CODE 48

SHRP SECTION ID 1060

DISTRESS SURVEY FOR PAVEMENTS WITH ASPHALT CONCRETE SURFACES (CONTINUED)

9. RUTTING (FOR SPS-3 SITE SURVEYS)

INNER WHEEL PATH

Point No.	Distance[1] (Meters)	Point Rut Depth (mm)
1	0.	_ _ _.
2	15.25	_ _ _.
3	30.5	_ _ _.
4	45.75	_ _ _.
5	61.	_ _ _.
6	76.25	_ _ _.
7	91.5	_ _ _.
8	106.75	_ _ _.
9	122.	_ _ _.
10	137.25	_ _ _.
11	152.5	_ _ _.

OUTER WHEEL PATH

(NOT MEASURED)

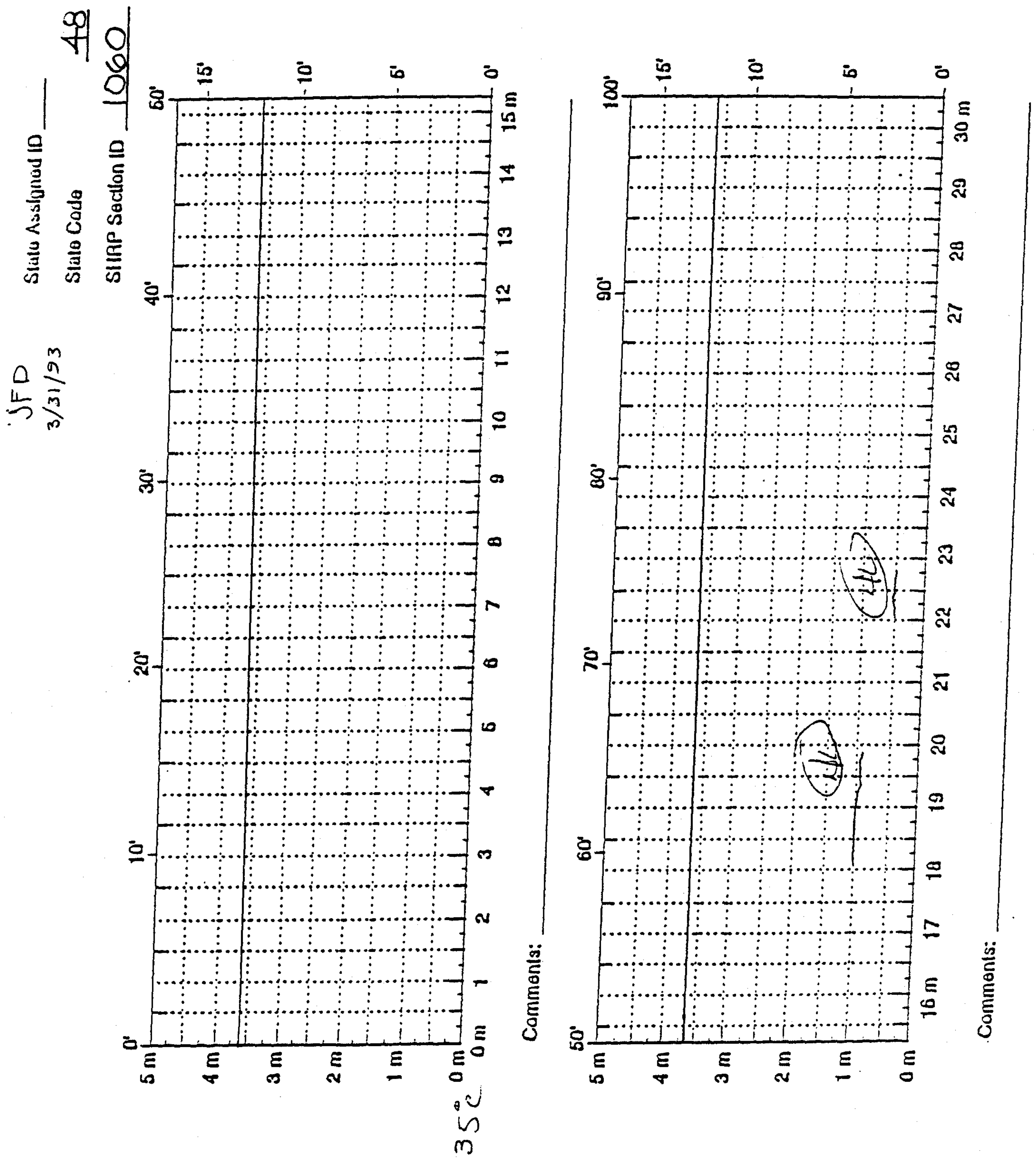
Point No.	Distance[1] (Meters)	Point Rut Depth (mm)
1	0.	_ _ _.
2	15.25	_ _ _.
3	30.5	_ _ _.
4	45.75	_ _ _.
5	61.	_ _ _.
6	76.25	_ _ _.
7	91.5	_ _ _.
8	106.75	_ _ _.
9	122.	_ _ _.
10	137.25	_ _ _.
11	152.5	_ _ _.

14. LANE-TO-SHOULDER DROPOFF

Point No.	Point Distance[1] Meters	Lane-to-Shoulder Dropoff (mm)
1	0.	_ _ 0.
2	15.25	_ _ 0.
3	30.5	_ _ 0.
4	45.75	_ _ 0.
5	61.	_ _ 0.
6	76.25	_ _ 0.
7	91.5	_ _ 0.
8	106.75	_ _ 0.
9	122.	_ _ 0.
10	137.25	_ _ 0.
11	152.25	_ _ 0.

Note 1: "Point Distance" is the distance in meters from the start of the test section to the point where the measurement was made. The values shown are SI equivalents of the 50 feet spacing used in previous surveys.

Figure A-9 (Continued). Distress Survey Data



4L- 2.75m

Figure A-9 (Continued). Distress Survey Data

State Assigned ID ______

State Code 48

SHRP Section ID 1060

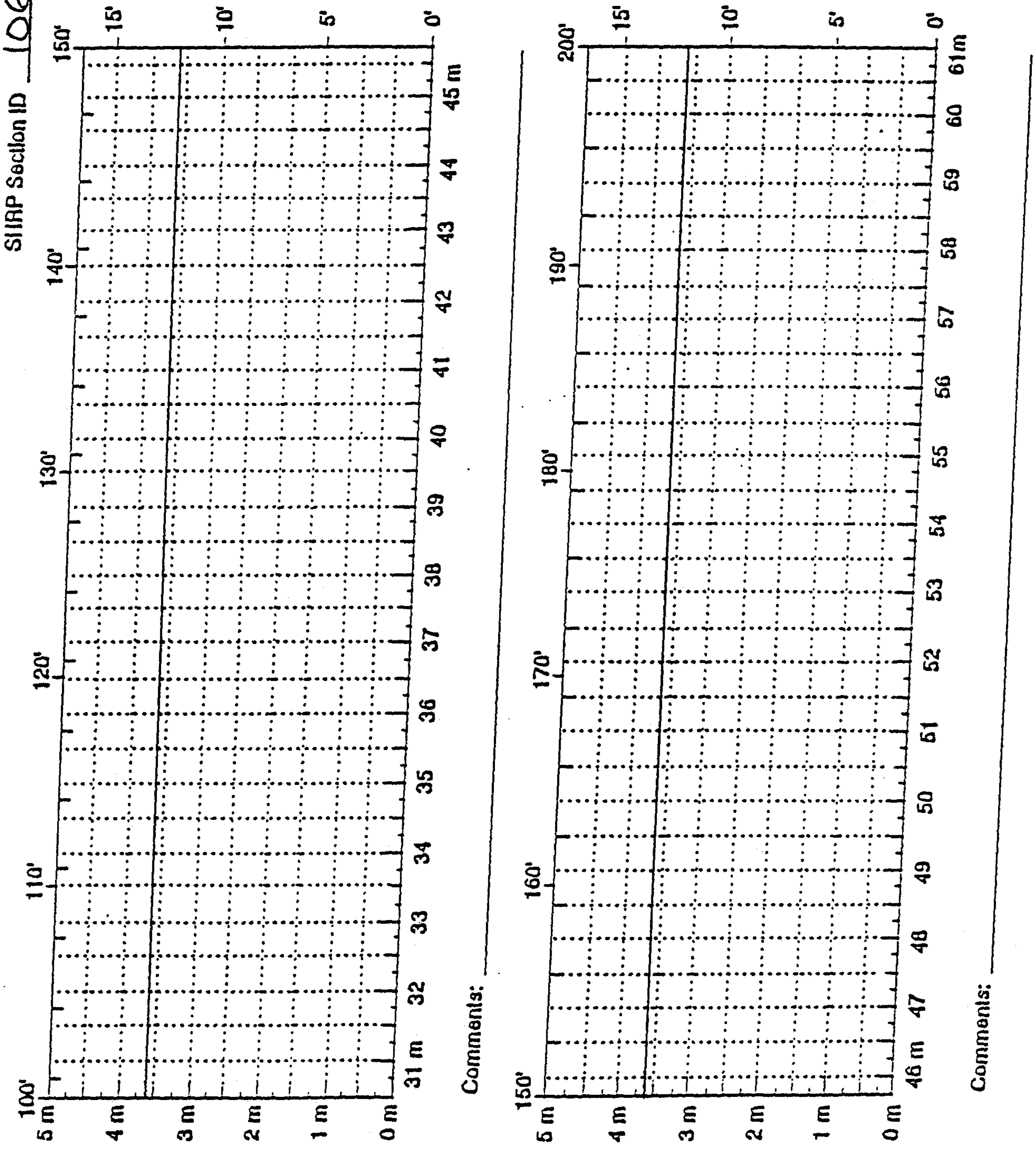
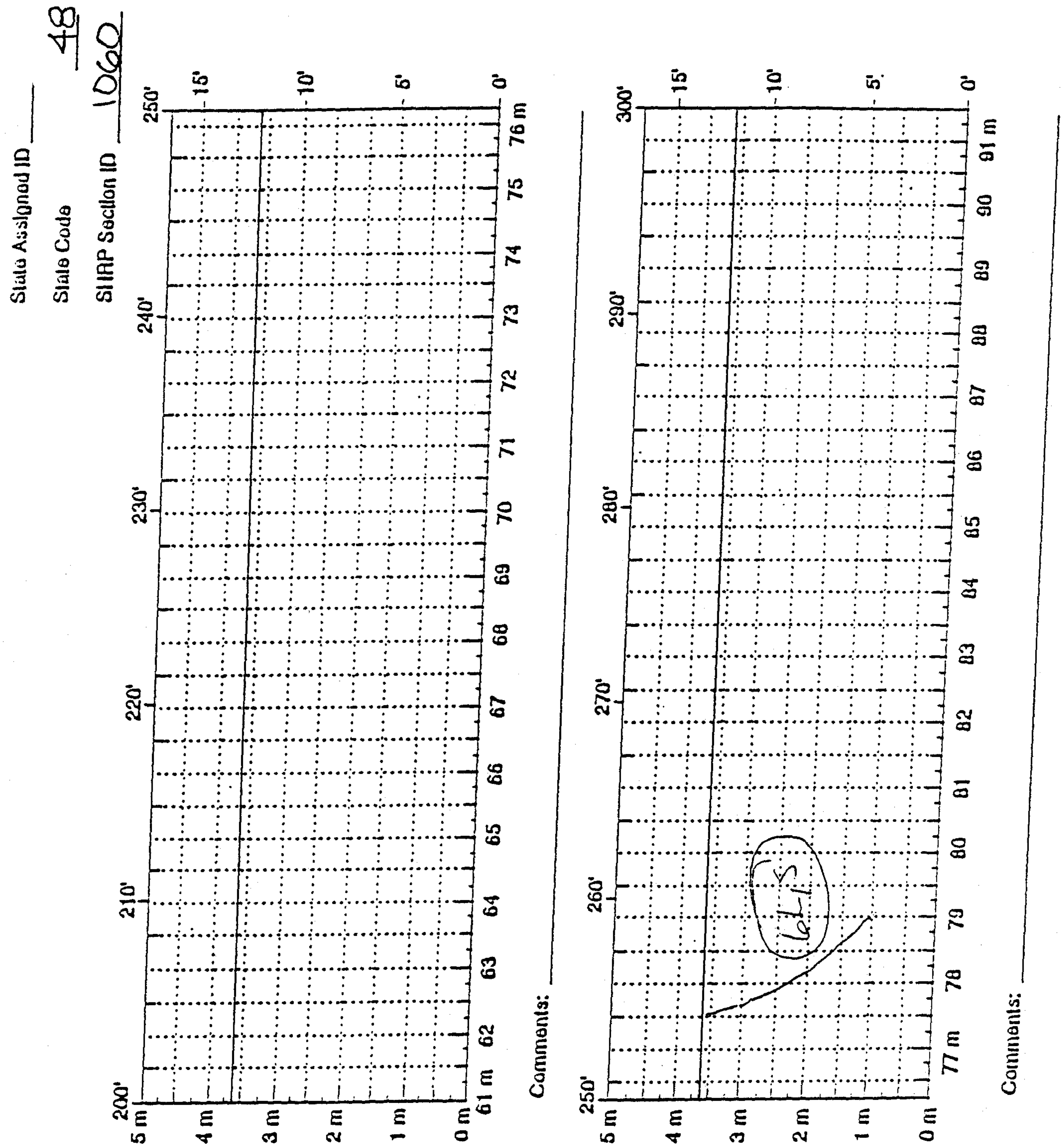
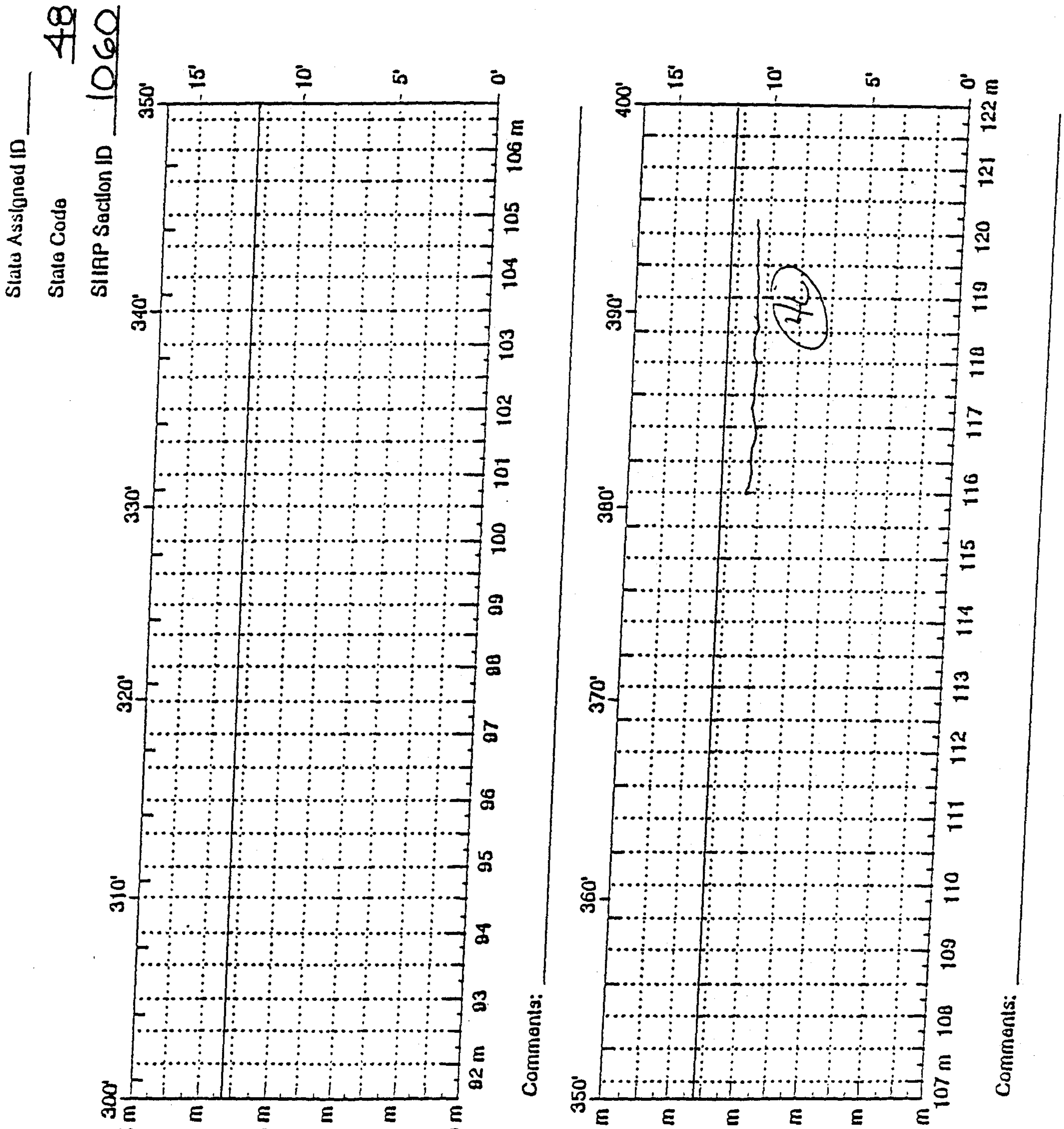


Figure A-9 (Continued). Distress Survey Data



62.5-1, 2.6M

Figure A-9 (Continued). Distress Survey Data



4L - 4.25 m ✓

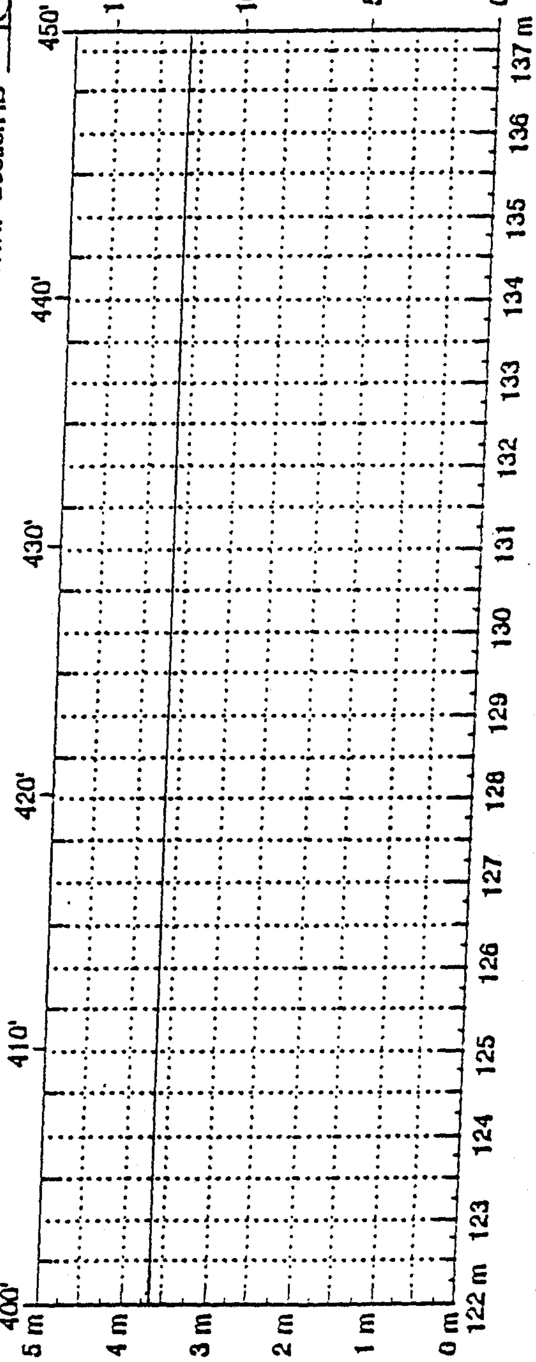
Figure A-9 (Continued). Distress Survey Data

State Assigned ID ____

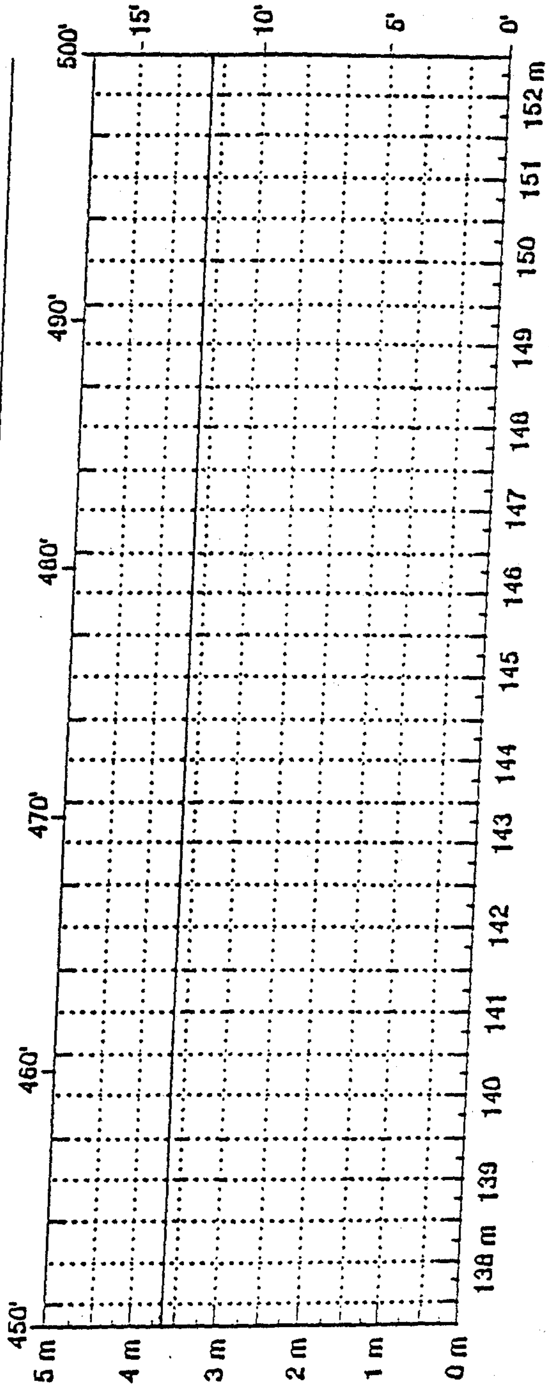
State Code 48

SHRP Section ID 1060

35



Comments: ____



Comments: ____

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

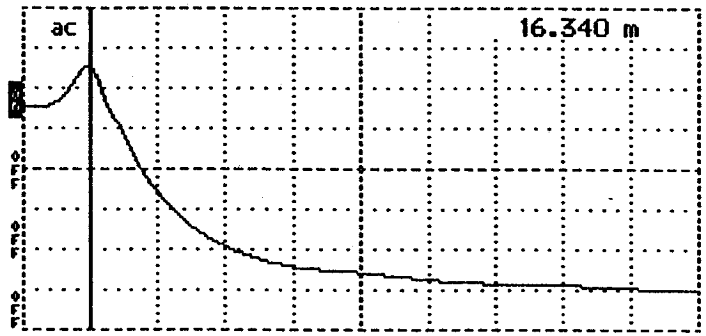
VI. Questions/Discussion

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 [__]
	LTPP Section ID [____]

Cursor .... 16.340 m
Distance/Div ..... .25 m/div
Vertical Scale.... 182 mρ/div
VP 0.99
Noise Filter...... 1 avg
Power...........ac

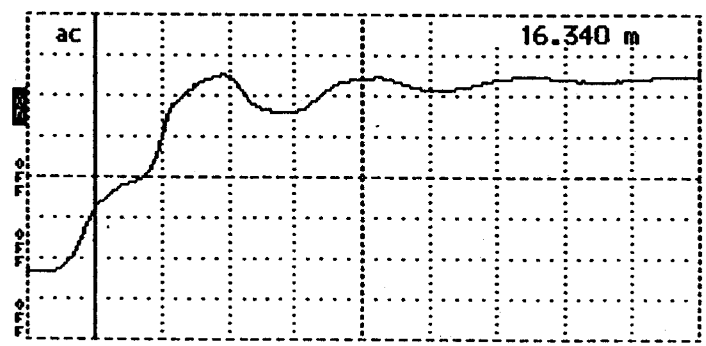


Tektronix 1502B TDR
Date 11/03/93
Cable 48F10
Notes Shorted

Input Trace J.P.
Stored Trace
Difference Trace

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

Cursor .... 16.340 m
Distnce/Div ..... .25 m/div
Vertical Scale.... 182 mρ/div
VP 0.99
Noise Filter...... 1 avg
Powr........... ac



Tektronix 1502B TDR
Date 11/03/93
Cable 48F10
Notes AIR

Input Trace J.P.
Stored Trace
Difference Trace

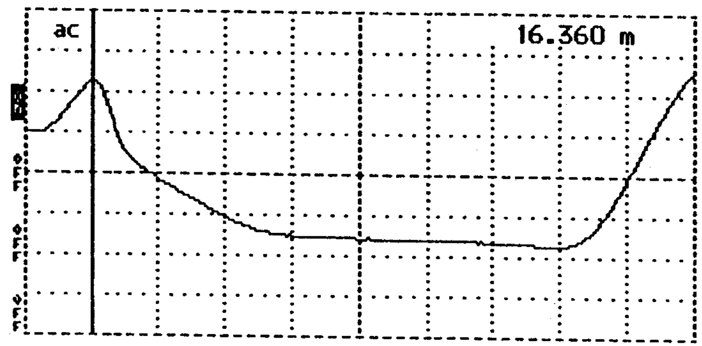
TDR Trace	Apparent Length, (m)	Dielectric Constant[1]
"In Air"	0.24	1.42

Data Sheet SMP-C . TDR Probe Check

Figure B-1. 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 0]

Cursor .... 16.360 m
Distance/Div..... .25 m/div
Vertical Scale.... 112 mρ/div
Vp 0.99
Noise Filter...... 1 avg
Power .... ac



Tektronix 1502B TDR
Date 11/03/93
Cable 48F10
Notes WATER
21.2°C

Input Trace J.P.
Stored Trace
Difference Trace

TDR Trace	Apparent Length, (m)[1]	Dielectric Constant[2]
"In Water"	1.76	76.89

[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 F 1 0 Measured Length of Coax Cable: 1 2 . 3 m

Comments:

Prepared by: Matt Cole Employer: BRE

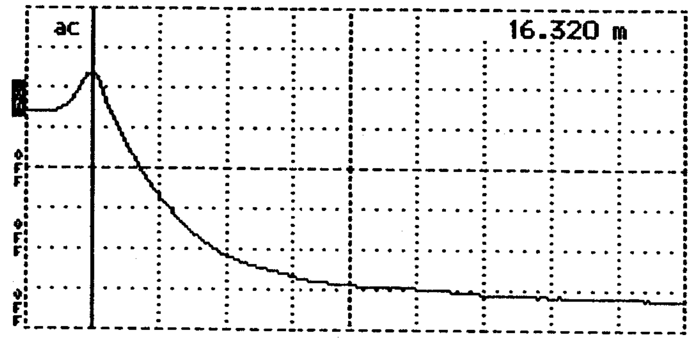
Date (dd/mm/yy): 31 / 03 / 94

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

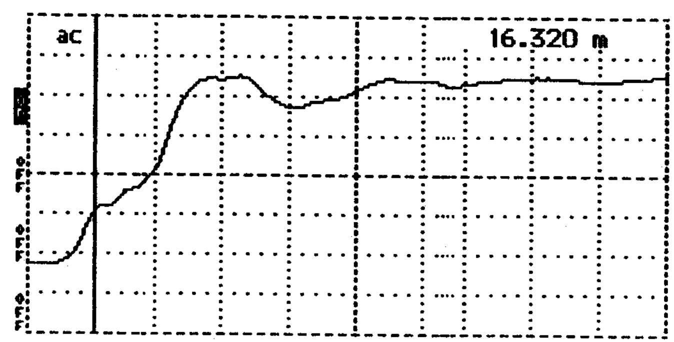
Cursor .... 16.320 m
Distance/Div ..... .25 m/div
Vertical Scale.... 182 mρ/div
Vp 0.99
Noise Filter...... 1 avg
Power .... ac



Tektronix 1502B TDR
Date 11/03/93
Cable 48F09
Notes SHORTED
Input Trace J.P.
Stored Trace
Difference Trace

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

Cursor .... 16.320 m
Distance/Div ..... .25 m/div
Vertical Scale.... 182 mρ/div
Vp 0.99
Noise Filter...... 1 avg
Power .... ac



Tektronix 1502B TDR
Date 11/03/93
Cable 48F09
Notes AIR
Input Trace J.P.
Stored Trace
Difference Trace

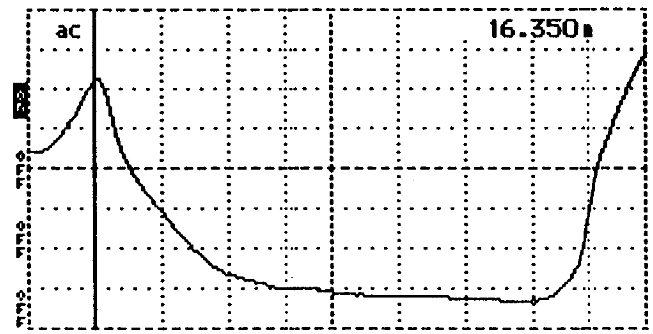
TDR Trace	Apparent Length, (m)	Dielectric Constant[1]
"In Air"	0.24	1.42

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 [1060]

Cursor.......... 16.350 m
Distance/Div..... .25 m/div
Vertical Scale.... 81.6 mρ/div
VP 0.99
Noise filter...... 1 avg
Power........... ac



Tektronix 1502B TDR
Date 11/03/93
Cable 48F09
Notes WATER 21.2°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: 48F09 Measured Length of Coax Cable: 12.3 m

Comments: ______________________

Prepared by: Matt Cole Employer: BRE

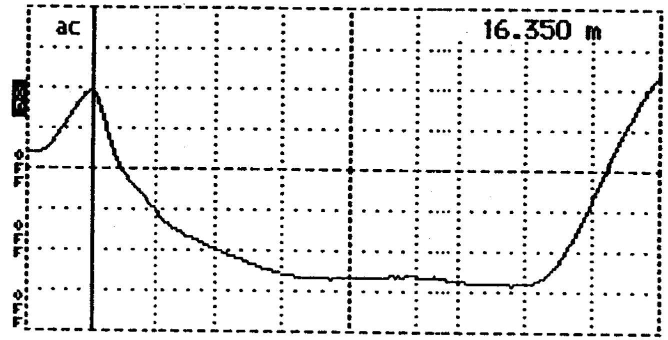
Date (dd/mm/yy): 31/08/94

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 2) TDR Probe Check	Agency Code [4 8] LTPP Section ID [1 0 6 0]

Cursor .... 16.350 m
Distance/Div 5m/div
Vertical Scale.... 94mρ/div
VP 0.99
Noise Filter...... 1 avg
Power .... ac



Tektronix 1502B TDR
Date 11/03/93
Cable 48 F08
Notes WATER
21.2°C

Input Trace J.P.
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: 4 8 F 0 8   Measured Length of Coax Cable: 1 2 . 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 [1060]

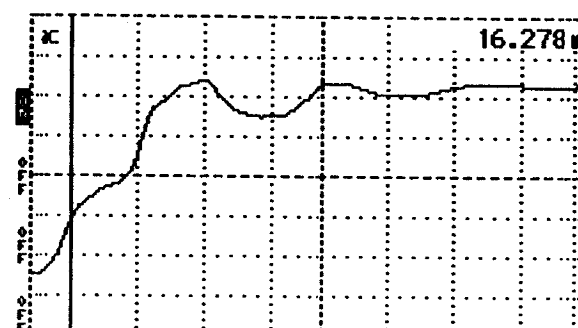
Cursor .... 16.278 m
Distance/Div ..... .25 m/div
Vertical Scale.... 182 mρ/div
Vp............ 0.99
Noise Filter...... 1 avg
Power........... ac

Tektronix 1502B TDR
Date 11/03/93
Cable 48F07
Notes SHORTED

Input Trace J.P
Stored Trace
Difference Trace

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

Cursor .... 16.278 m
Distance/Div... .25 m/div
Vertical Scale... 182 mρ/div
Vp 0.99
Noise Filter.... 1 avg
Power....... ac



Tektronix 1502B TDR
Date 11/03/93
Cable 48F07
Notes AIR

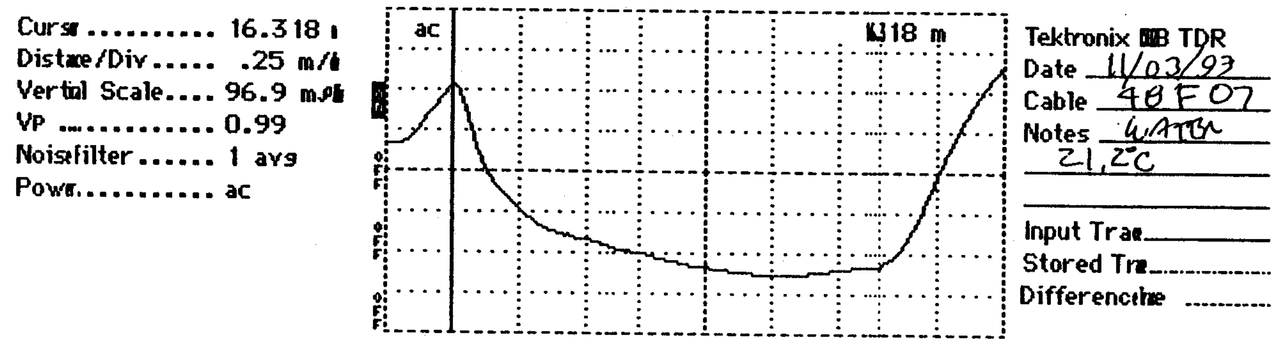
Input Trace J.P
Stored Trace
Difference Trace

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

Data Sheet SMP-C . TDR Probe Check

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 [1060]



TDR Trace	Apparent Length, (m)	Dielectric Constant[2]
"In Water"	1.75	75.80 *

[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: 48F07 Measured Length of Coax Cable: 12.3 m

Comments: * Check in water was questionable due to thermal paper feeder malfunction.

Prepared by: Matt Cole Employer: BRE

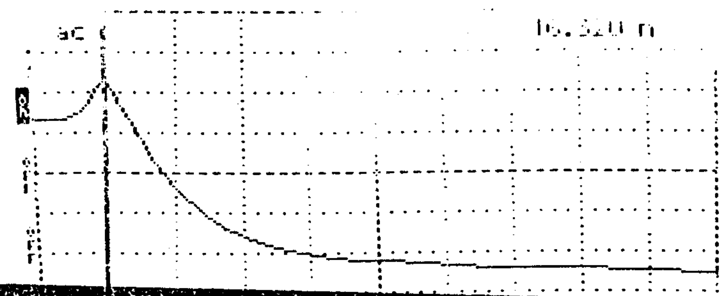
Date (dd/mm/yy): 31/08/94

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 [1060]

Cursor .... 16.3?6 m
Distance/Div ..... .25 m/div
Vertical Scale.... 223 mρ/div
VP 0.99
Noise Filter...... 1 avg
Power........... ac

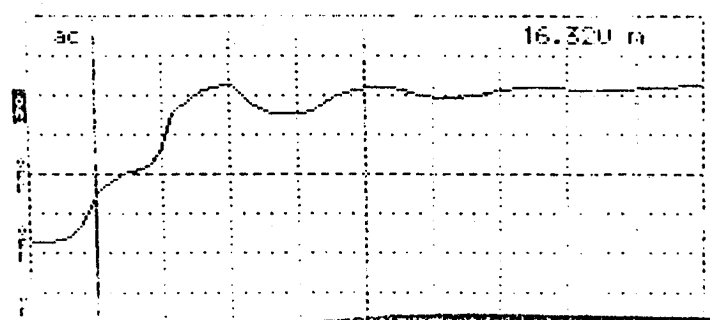


Tektronix 1502B TDR
Date 11/04/93
Cable 48F06
Notes SHORTED

Input Trace J.P.
Stored Trace
Difference Trace

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

Cursor .... 16.320 m
Distance/Div ..... .25 m/div
Vertical Scale.... 223 mρ/div
VP 0.99
Noise Filter...... 1 avg
Power........... ac



Tektronix 1502B TDR
Date 11/04/93
Cable 48F06
Notes AIR

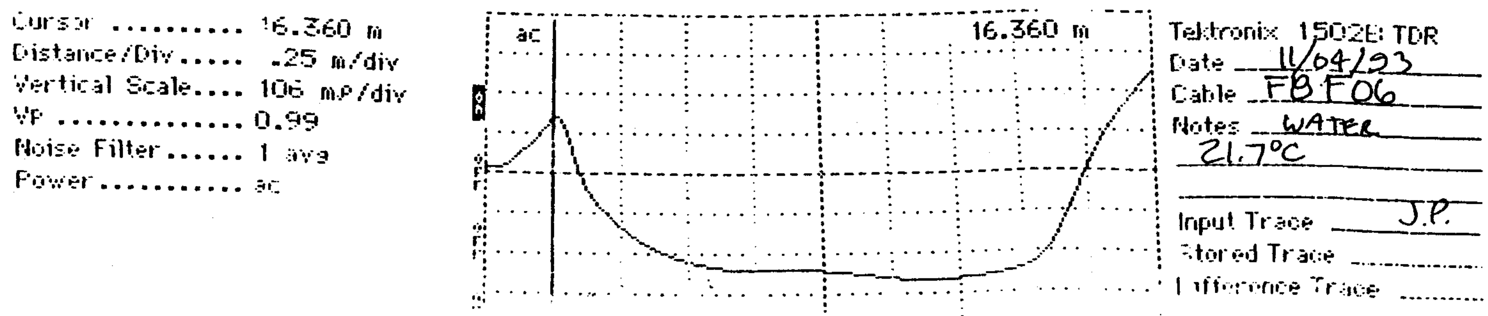
Input Trace J.P.
Stored Trace
Difference Trace

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

Data Sheet SMP-C . TDR Probe Check

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 0]



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

[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 F 0 6 Measured Length of Coax Cable: 1 2 . 3 m

Comments: __________

Prepared by: Matt Cole Employer: BRE

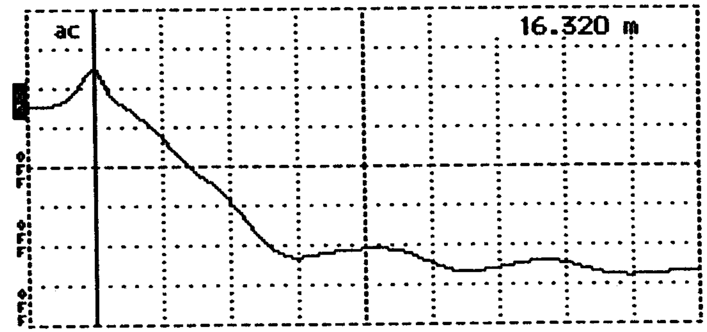
Date (dd/mm/yy): 31 / 08 / 94

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 [1060]

Cursor .... 16.320 m
Distance/Div..... .25 m/div
Vertical Scale.... 200 mρ/div
Vp 0.99
Noise Filter...... 1 avg
Power........... ac

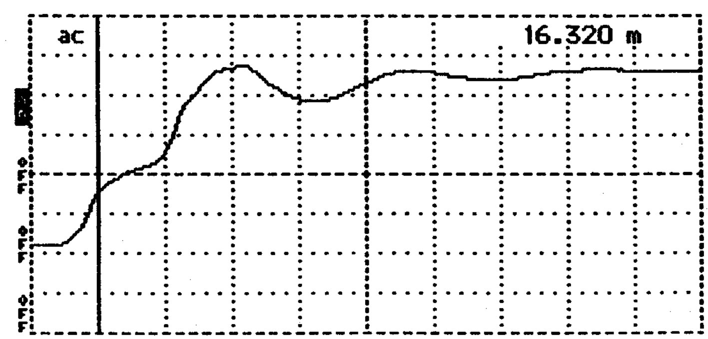


Tektronix 1502B TDR
Date 11/04/93
Cable 48F05
Notes SHORTED

Input Trace J.P.
Stored Trace ....
Difference Trace ....

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

Cursor .... 16.320 m
Distance/Div..... .25 m/div
Vertical Scale.... 200 mρ/div
Vp 0.99
Noise Filter...... 1 avg
Power........... ac



Tektronix 1502B TDR
Date 11/04/93
Cable 48F05
Notes AIR

Input Trace J.P.
Stored Trace ....
Difference Trace ....

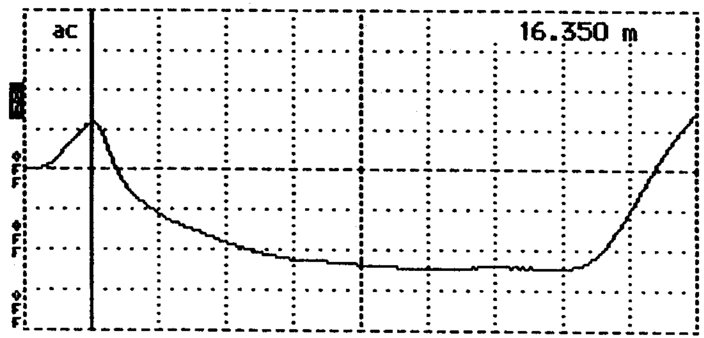
TDR Trace	Apparent Length, (m)	Dielectric Constant[1]
"In Air"	_ .24	_1.43

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 [48] LTPP Section ID [1060]

Cursor .... 16.350 m
Distance/Div ..... .25 m/div
Vertical Scale.... 122 mρ/div
VP 0.99
Noise Filter ...... 1 avg
Power .... ac



Tektronix 1502B TDR
Date 1/04/93
Cable 40F05
Notes WATER 73°F

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: 48F05 Measured Length of Coax Cable: 12.3 m

Comments:

Prepared by: Matt Cole Employer: BRE

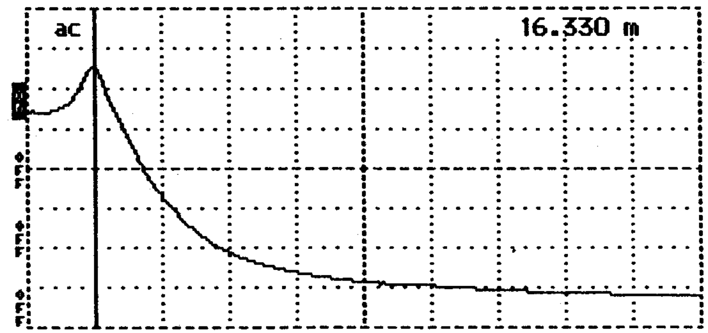
Date (dd/mm/yy): 31/08/94

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

Cursor .... 16.330 m
Distance/Div..... .25 m/div
Vertical Scale.... 182 mρ/div
VP 0.99
Noise Filter...... 1 avg
Power.......... ac

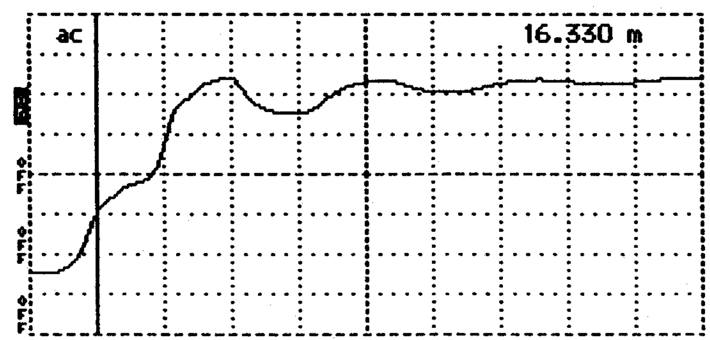


Tektronix 1502B TDR
Date 11/04/93
Cable 48F04
Notes Shorted

Input Trace S.P.
Stored Trace
Difference Trace

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

Cursor .... 16.330 m
Distance/Div..... .25 m/div
Vertical Scale.... 182 mρ/div
VP 0.99
Noise Filter...... 1 avg
Power.......... ac



Tektronix 1502B TDR
Date 11/04/93
Cable 48F04
Notes AIR

Input Trace S.P.
Stored Trace
Difference Trace

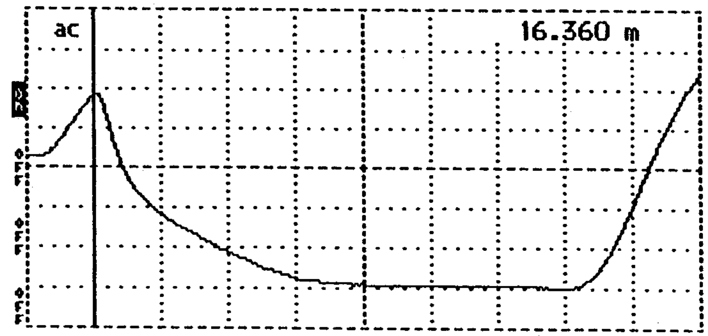
TDR Trace	Apparent Length, (m)	Dielectric Constant[1]
"In Air"	_ . 24	_ 1 . 43

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 [48] LTPP Section ID [1060]

Cursor .... 16.360 m
Distance/Div ..... .25 m/div
Vertical Scale.... 91.5 mρ/div
VP 0.99
Noise Filter ...... 1 avg
Power .... ac



Tektronix 1502B TDR
Date ______
Cable 48F04
Notes WATER
74°F

Input Trace J.P.
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: 48F04 Measured Length of Coax Cable: 12.3 m

Comments: ______

Prepared by: Matt Cole Employer: DRE

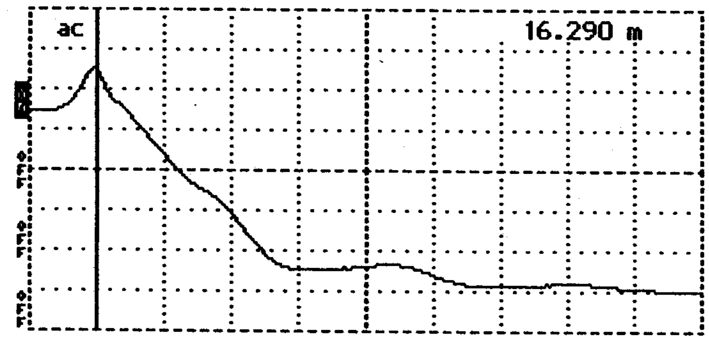
Date (dd/mm/yy): 31/08/94

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

Cursor .... 16.290 m
Distance/Div..... .25 m/div
Vertical Scale.... 193 mρ/div
VP 0.99
Noise Filter...... 1 avg
Power........... ac

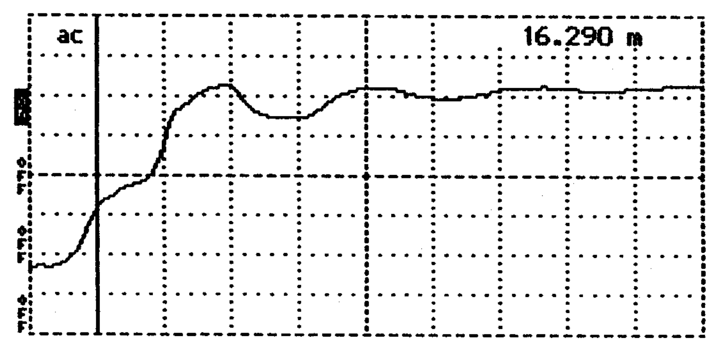


Tektronix 1502B TDR
Date 11/04/93
Cable 4BF03
Notes SHORTED

Input Trace J.P.
Stored Trace
Difference Trace

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

Cursor .... 16.290 m
Distance/Div..... .25 m/div
Vertical Scale.... 193 mρ/div
VP 0.99
Noise Filter...... 1 avg
Power........... ac



Tektronix 1502B TDR
Date 11/04/93
Cable 4BF03
Notes AIR

Input Trace J.P.
Stored Trace
Difference Trace

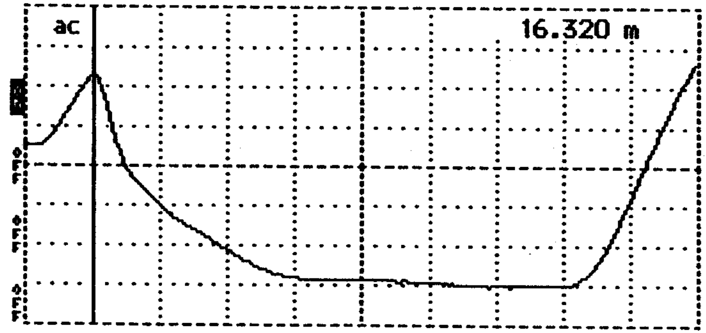
TDR Trace	Apparent Length, (m)	Dielectric Constant[1]
"In Air"	_ . 2 4	_ 1 . 4 3

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

Cursor .... 16.320 m
Distance/Div ..... .25 m/div
Vertical Scale.... 83.9 mρ/div
Vp 0.99
Noise Filter ...... 1 avg
Power .... ac



Tektronix 1502B TDR
Date 11/04/93
Cable 48F03
Notes WATER
74°F

Input Trace JP
Stored Trace
Difference Trace

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: 48F03 Measured Length of Coax Cable: 12.3 m

Comments:

Prepared by: Matt Cole Employer: BRE

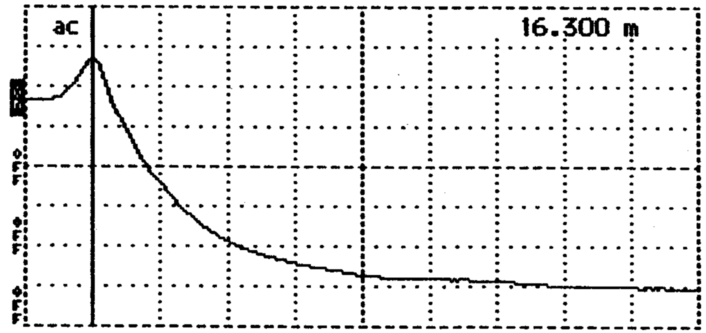
Date (dd/mm/yy): 31/08/94

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

Cursor .... 16.300 m
Distance/Div..... .25 m/div
Vertical Scale.... 182 mρ/div
VP 0.99
Noise Filter...... 1 avg
Power........... ac

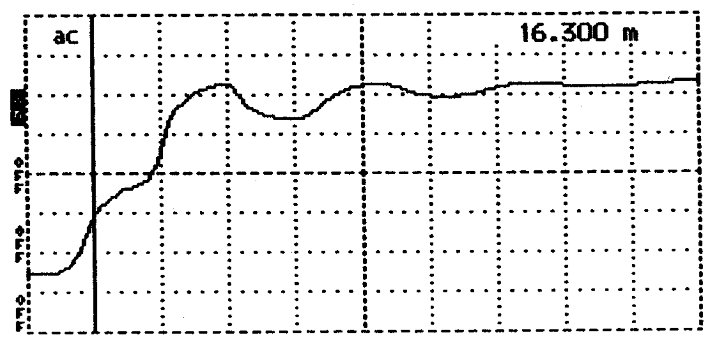


Tektronix 1502B TDR
Date 11/04/93
Cable 48F02
Notes SHORTED

Input Trace J.P.
Stored Trace
Difference Trace

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

Cursor .... 16.300 m
Distance/Div..... .25 m/div
Vertical Scale.... 182 mρ/div
VP 0.99
Noise Filter...... 1 avg
Power........... ac



Tektronix 1502B TDR
Date 11/04/93
Cable 48F02
Notes AIR

Input Trace J.P.
Stored Trace
Difference Trace

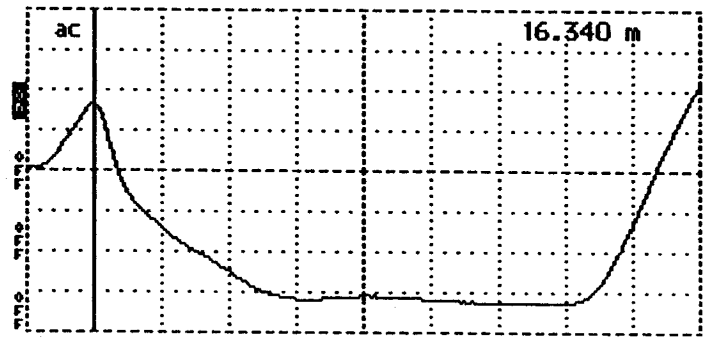
TDR Trace	Apparent Length, (m)	Dielectric Constant[1]
"In Air"	_ . 24	_ 1 . 43

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 [48] LTPP Section ID [1060]

Cursor .... 16.340 m
Distance/Div..... .25 m/div
Vertical Scale.... 91.5 mρ/div
Vp 0.99
Noise Filter...... 1 avg
Power........... ac



Tektronix 1502B TDR
Date 11/08/93
Cable 48F02
Notes WATER 79°F

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: 48F02 Measured Length of Coax Cable: 12.3 m

Comments: ______

Prepared by: Matt Cole Employer: BRE

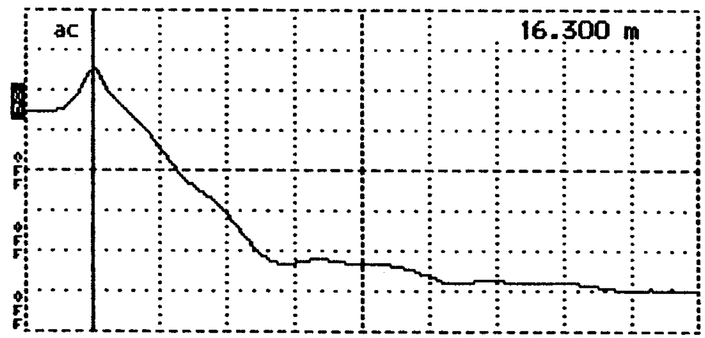
Date (dd/mm/yy): 31/08/94

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

Cursor .... 16.300 m
Distance/Div..... .25 m/div
Vertical Scale.... 193 mρ/div
Vp 0.99
Noise Filter...... 1 avg
Power........... ac

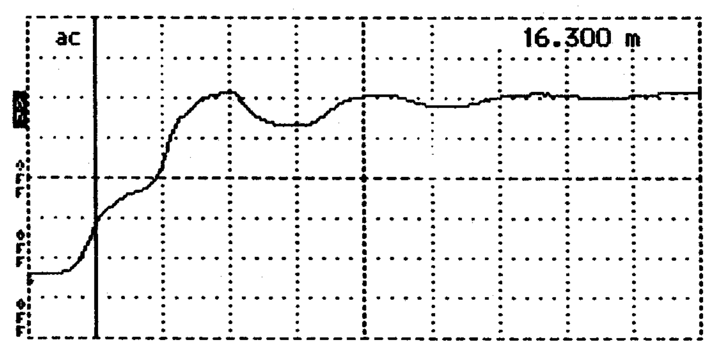


Tektronix 1502B TDR
Date 11/04/93
Cable 48F01
Notes SHORTED

Input Trace J.P.
Stored Trace
Difference Trace

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

Cursor .... 16.300 m
Distance/Div..... .25 m/div
Vertical Scale.... 193 mρ/div
Vp 0.99
Noise Filter...... 1 avg
Power........... ac



Tektronix 1502B TDR
Date 11/03/93
Cable 48F01
Notes AIR

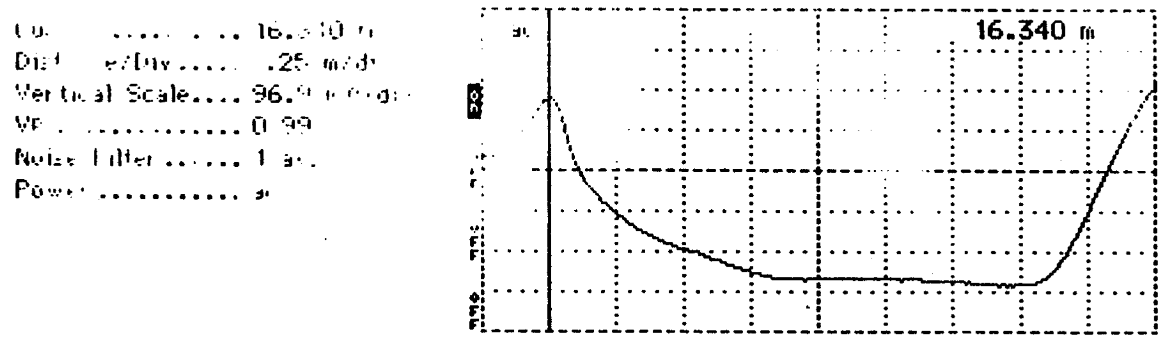
Input Trace J.P.
Stored Trace
Difference Trace

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

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 [1060]



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: 48F01 Measured Length of Coax Cable: 12.3 m

Comments: ______

Prepared by: Matt Cole Employer: BRE

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

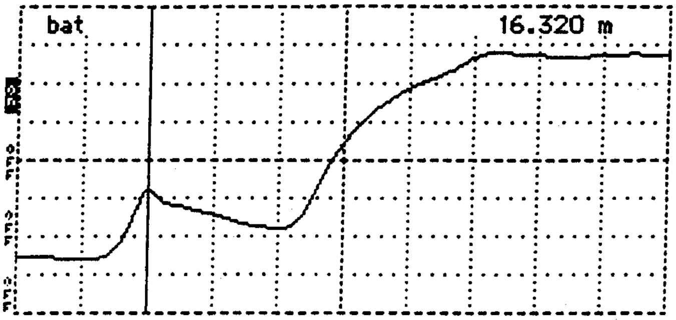
Figure B-1 (Continued). TDR Traces Obtained During Calibration

APPENDIX C

Instrumentation Installation Information

Appendix C contains the following information:

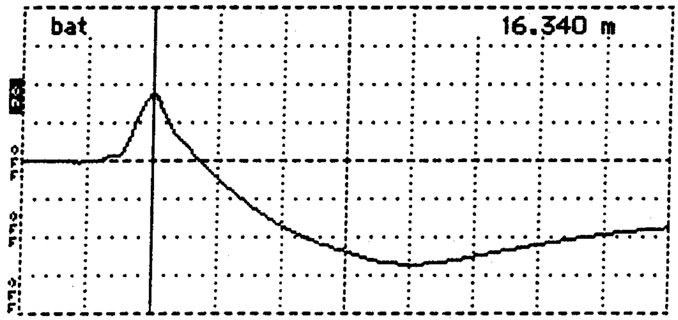
Cursor .... 16.320 m
Distance/Div ..... .25 m/div
Vertical Scale.... 122 mρ/div
Vp 0.99
Noise Filter...... 1 avg
Power........... bat/low



Tektronix 1502B TDR
Date 11/30/93
Cable 48F01
Notes DEPTH
12.5"

Input Trace J.P.
Stored Trace ....
Difference Trace ....

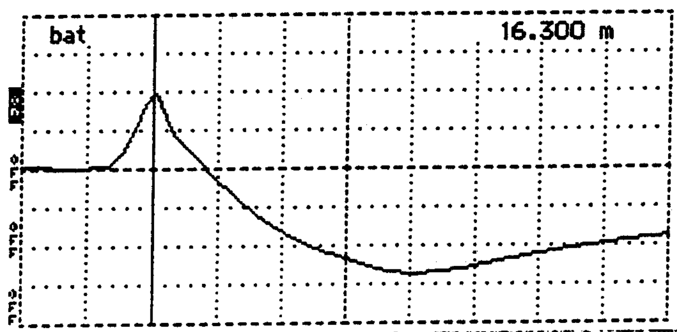
Cursor .... 16.340 m
Distance/Div ..... .25 m/div
Vertical Scale.... 103 mρ/div
Vp 0.99
Noise Filter...... 1 avg
Power........... bat/low



Tektronix 1502B TDR
Date 11/30/93
Cable 48F02
Notes DEPTH
19.5"

Input Trace J.P.
Stored Trace ....
Difference Trace ....

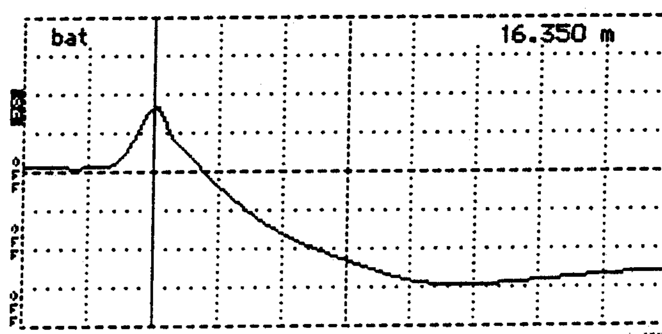
Cursor .... 16.300 m
Distance/Div ..... .25 m/div
Vertical Scale.... 103 mρ/div
Vp 0.99
Noise Filter...... 1 avg
Power........... bat/low



Tektronix 1502B TDR
Date 11/30/93
Cable 48F03
Notes DEPTH
25.5"

Input Trace J.P.
Stored Trace ....
Difference Trace ....

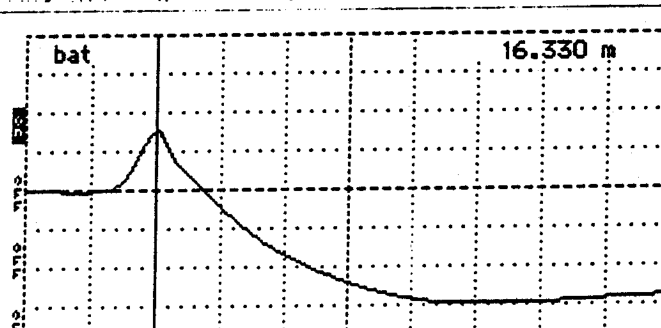
Cursor .... 16.350 m
Distance/Div ..... .25 m/div
Vertical Scale.... 122 mρ/div
Vp 0.99
Noise Filter...... 1 avg
Power........... bat/low



Tektronix 1502B TDR
Date 11-30-93
Cable 48F04
Notes DEPTH
31.7"
J.P.

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

Cursor .... 16.330 m
Distance/Div ..... .25 m/div
Vertical Scale.... 122 mρ/div
Vp 0.99
Noise Filter...... 1 avg
Power........... bat



Tektronix 1502B TDR
Date 11/30/93
Cable 48F05
Notes DEPTH
37.8"

Input Trace J.P.
Stored Trace ....
Difference Trace ....

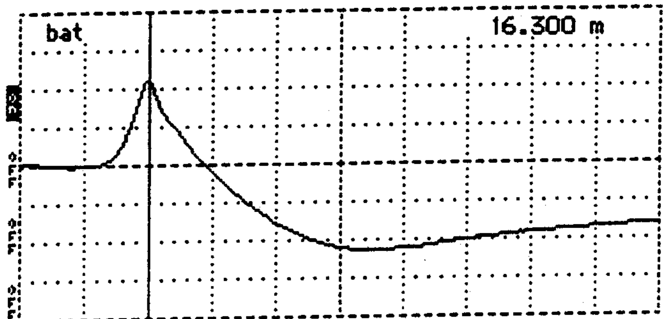
Figure C-1. TDR Traces During Installation

Cursor .... 16.320 m
Distance/Div..... .25 m/div
Vertical Scale.... 86.4 mρ/div
VP 0.99
Noise Filter...... 1 avg
Power........... bat

Tektronix 1502B TDR
Date 11/30/93
Cable 4806
Notes DEPTH 43.7"

Input Trace J.P.
Stored Trace
Difference Trace

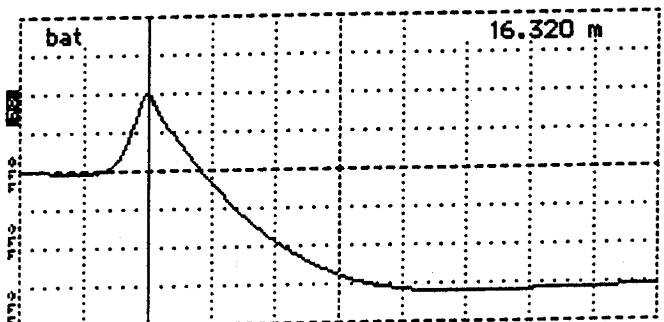
Cursor .... 16.300 m
Distance/Div..... .25 m/div
Vertical Scale.... 103 mρ/div
VP 0.99
Noise Filter...... 1 avg
Power........... bat



Tektronix 1502B TDR
Date 11/30/93
Cable 48F07
Notes DEPTH 49.6"

Input Trace J.P.
Stored Trace
Difference Trace

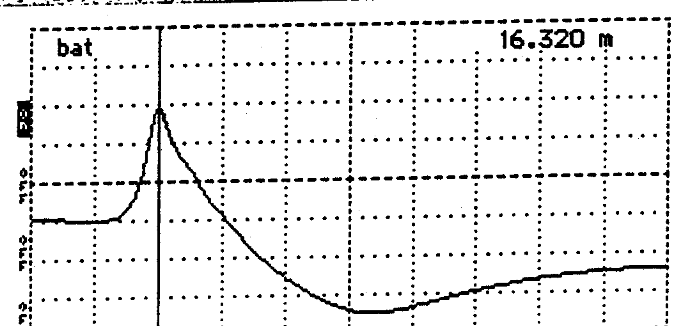
Cursor .... 16.320 m
Distance/Div..... .25 m/div
Vertical Scale.... 109 mρ/div
VP 0.99
Noise Filter...... 1 avg
Power........... bat



Tektronix 1502B TDR
Date 11/30/93
Cable 48F08
Notes DEPTH 55.6"

Input Trace J.P.
Stored Trace
Difference Trace

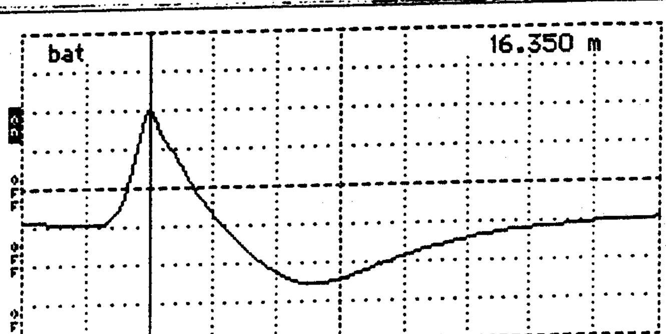
Cursor .... 16.320 m
Distance/Div..... .25 m/div
Vertical Scale.... 79.2 mρ/div
VP 0.99
Noise Filter...... 1 avg
Power........... bat



Tektronix 1502B TDR
Date 11/30/93
Cable 48F09
Notes Depth 68.2"

Input Trace J.P.
Stored Trace
Difference Trace

Cursor .... 16.350 m
Distance/Div..... .25 m/div
Vertical Scale.... 81.6 mρ/div
VP 0.99
Noise Filter...... 1 avg
Power........... bat



Tektronix 1502B TDR
Date 11/30/93
Cable 48F10
Notes DEPTH 79.5"

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. 481060 12/01/93

MOISTURE CONTENTS FOR TDR

TDR #	WT. OF PAN(g)	(WET) PAN & SOIL(g)	(DRY) PAN & SOIL(g)	M.C. (%)
48F10	152.6	376.5	318.0	35.37%
48F09	171.5	359.7	313.6	32.44%
48F08	179.1	343.9	303.6	32.37%
48F07	149.2	341.0	292.2	34.13%
48F06	203.8	378.9	343.7	25.16%
48F05	152.4	344.7	312.7	19.96%
48F04	171.4	425.9	392.9	14.90%
48F03	178.9	366.7	340.4	16.28%
48F02	149.1	353.0	315.5	22.54%
48F01	203.6	440.0	431.0	3.96%

APPENDIX D

Initial Data Collection

Appendix D contains the following support information:

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

5,1993,334,1600,12.29,22.72,.2
6,1993,334,1600,23.11,21.5,20.59,20.69,20.21
5,1993,334,1700,12.31,21.91,0
6,1993,334,1700,21.94,21.39,20.66,20.19,19.73
5,1993,334,1800,12.31,19.13,0
6,1993,334,1800,19.68,20.47,20.37,19.9,19.36
5,1993,334,1900,12.3,16.64,0
6,1993,334,1900,17.74,19.18,19.71,19.76,19.19
5,1993,334,2000,12.3,15.43,0
6,1993,334,2000,16.72,18.18,18.97,19.6,19.1
5,1993,334,2100,12.3,15.14,0
6,1993,334,2100,15.87,17.4,18.34,19.39,19
5,1993,334,2200,12.3,15.08,0
6,1993,334,2200,15.37,16.81,17.8,19.15,18.88
5,1993,334,2300,12.29,14.46,0
6,1993,334,2300,14.89,16.34,17.36,18.89,18.75
1,1993,334,2400,12.3,12.32,1648,12.11,1536,16.76,22.92,1537,13.53,2355,.2
2,1993,334,2400,17.38,18.37,18.86,19.5,19.13,18.85,18.78,18.83,19.22,19.69,20.53,21.56,22.3,22.95,23.43,24.21,24.62,24.91
3,1993,334,2400,24,1536,21.6,1606,20.69,1613,20.94,1536,20.4,1536,20.02,1537,19.81,1536,19.92,1536,20.36,1537,20.78,1536,21.37,1536,22.26,1540,22.64,1536,23.13,1544,23.47,1807,24.26,15
40,24.71,2240,25.02,2343
4,1993,334,2400,14.26,0,15.71,0,16.76,2356,18.53,2351,18.53,2354,18.43,2348,18.39,2341,18.39,2332,18.71,2348,19.16,2354,20.01,0,21.14,2350,22.07,2330,22.83,2310,23.33,1544,24.19,1829,24
.45,1539,24.68,1536
5,1993,334,2400,12.29,13.82,0
6,1993,334,2400,14.44,15.91,16.96,18.63,18.61
5,1993,335,100,12.29,14.08,0
6,1993,335,100,14.14,15.56,16.59,18.38,18.44
5,1993,335,200,12.29,14.58,0
6,1993,335,200,13.88,15.25,16.29,18.13,18.29
5,1993,335,300,12.29,14.59,0
6,1993,335,300,13.79,15.05,16.02,17.91,18.12
5,1993,335,400,12.28,13.99,0
6,1993,335,400,13.71,14.88,15.81,17.69,17.97
5,1993,335,500,12.28,14.1,0
6,1993,335,500,13.98,14.86,15.67,17.49,17.81
5,1993,335,600,12.28,14.46,0
6,1993,335,600,14.46,15.02,15.65,17.31,17.66
5,1993,335,700,12.28,14.99,0
6,1993,335,700,14.78,15.25,15.71,17.15,17.52
5,1993,335,800,12.28,16.35,0
6,1993,335,800,15.24,15.44,15.79,17.04,17.41
5,1993,335,900,12.28,17.12,0
6,1993,335,900,16.54,15.99,16,16.95,17.3
5,1993,335,1000,12.28,19.52,0
6,1993,335,1000,18.9,17.1,16.48,16.89,17.22
5,1993,335,1100,12.28,23.48,0
6,1993,335,1100,23.03,19.17,17.48,16.88,17.16
5,1993,335,1200,12.28,25.23,0
6,1993,335,1200,26.9,21.78,19.02,16.98,17.16

Site 481060

December 1, 1993

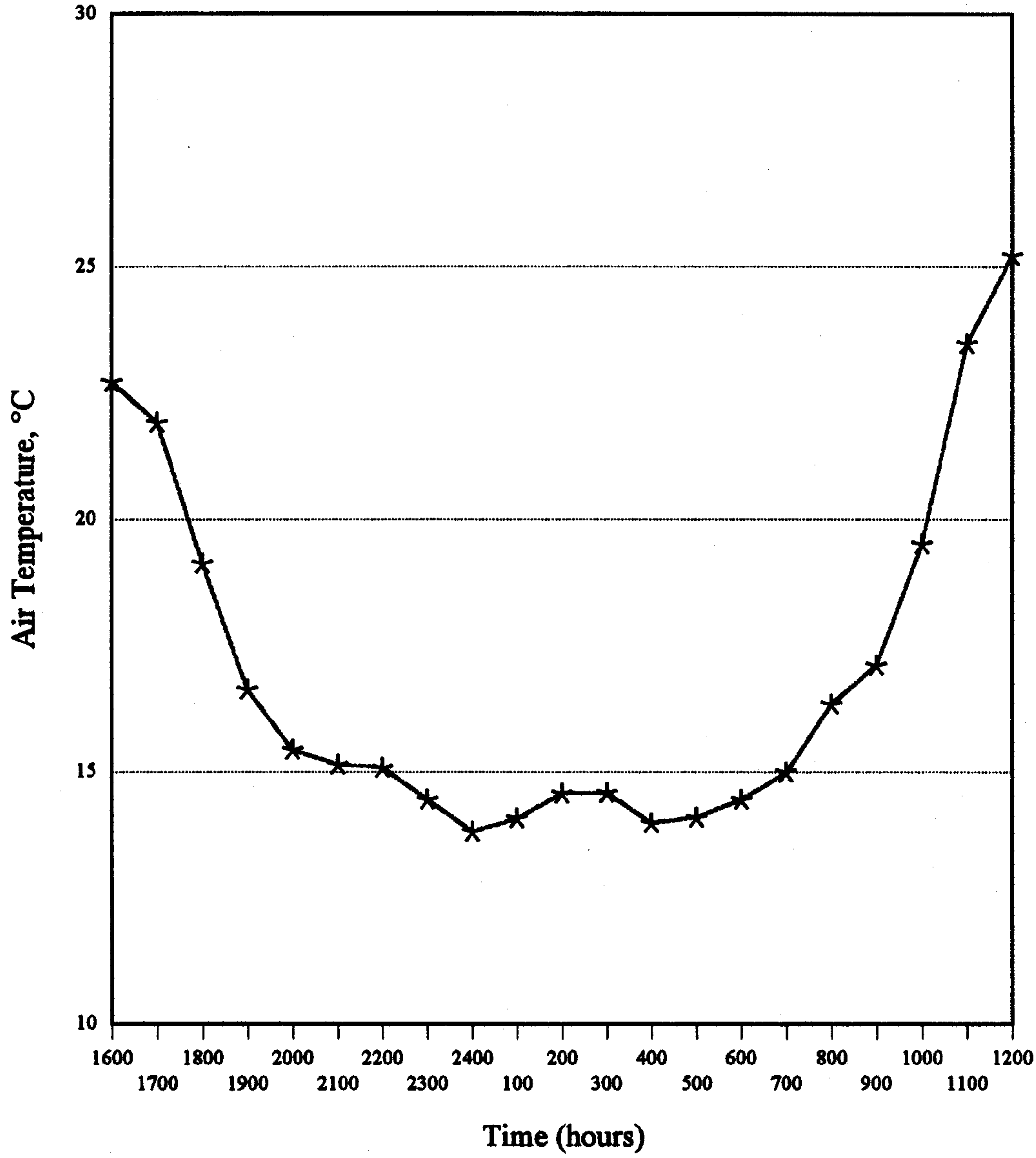


Figure D-1. Measured Air Temperature During Initial Data Collection

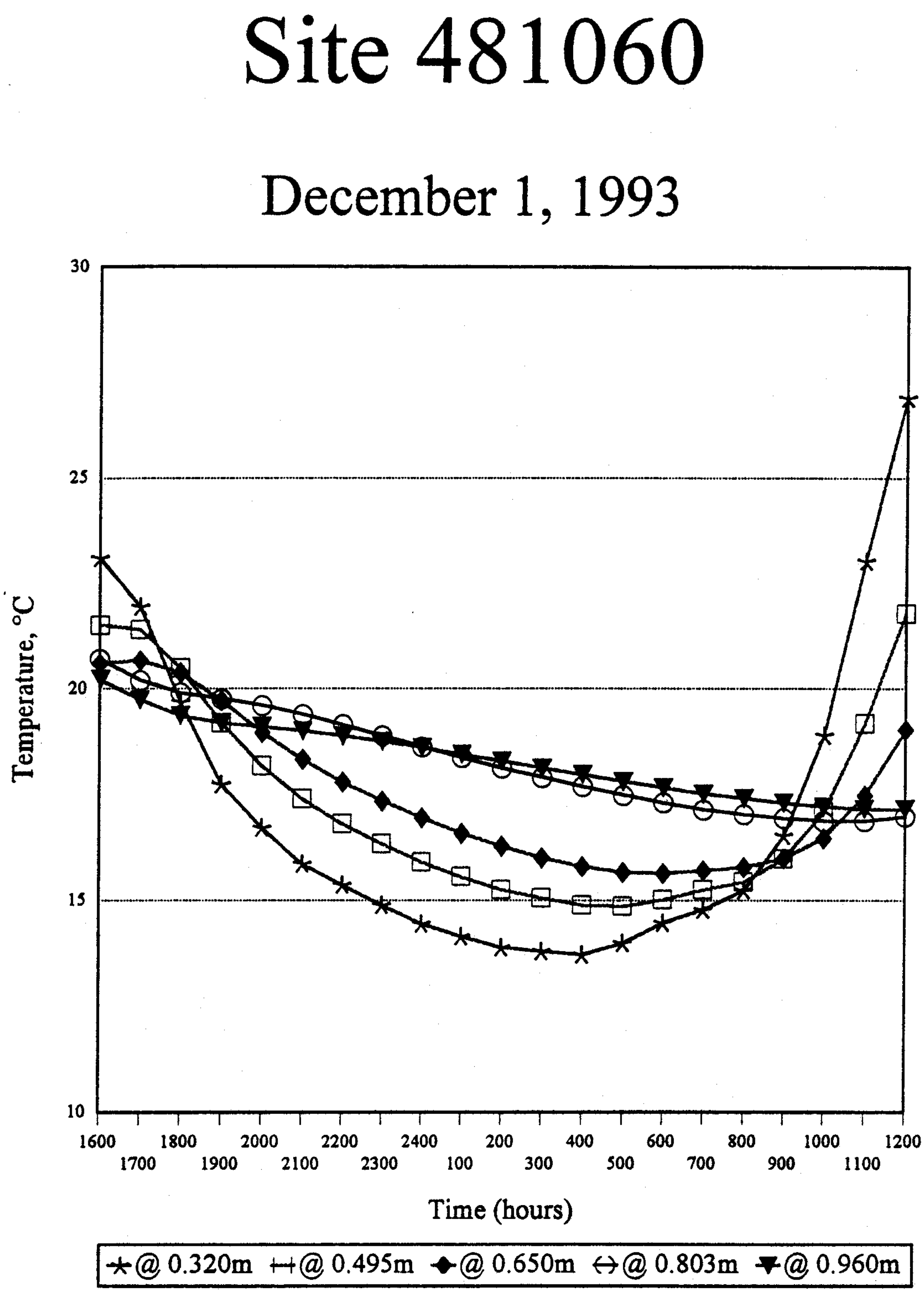


Figure D-2. Measured Average Subsurface Temperature for the First 5 Sensors During Initial Data Collection

Site 481060

December 1, 1993

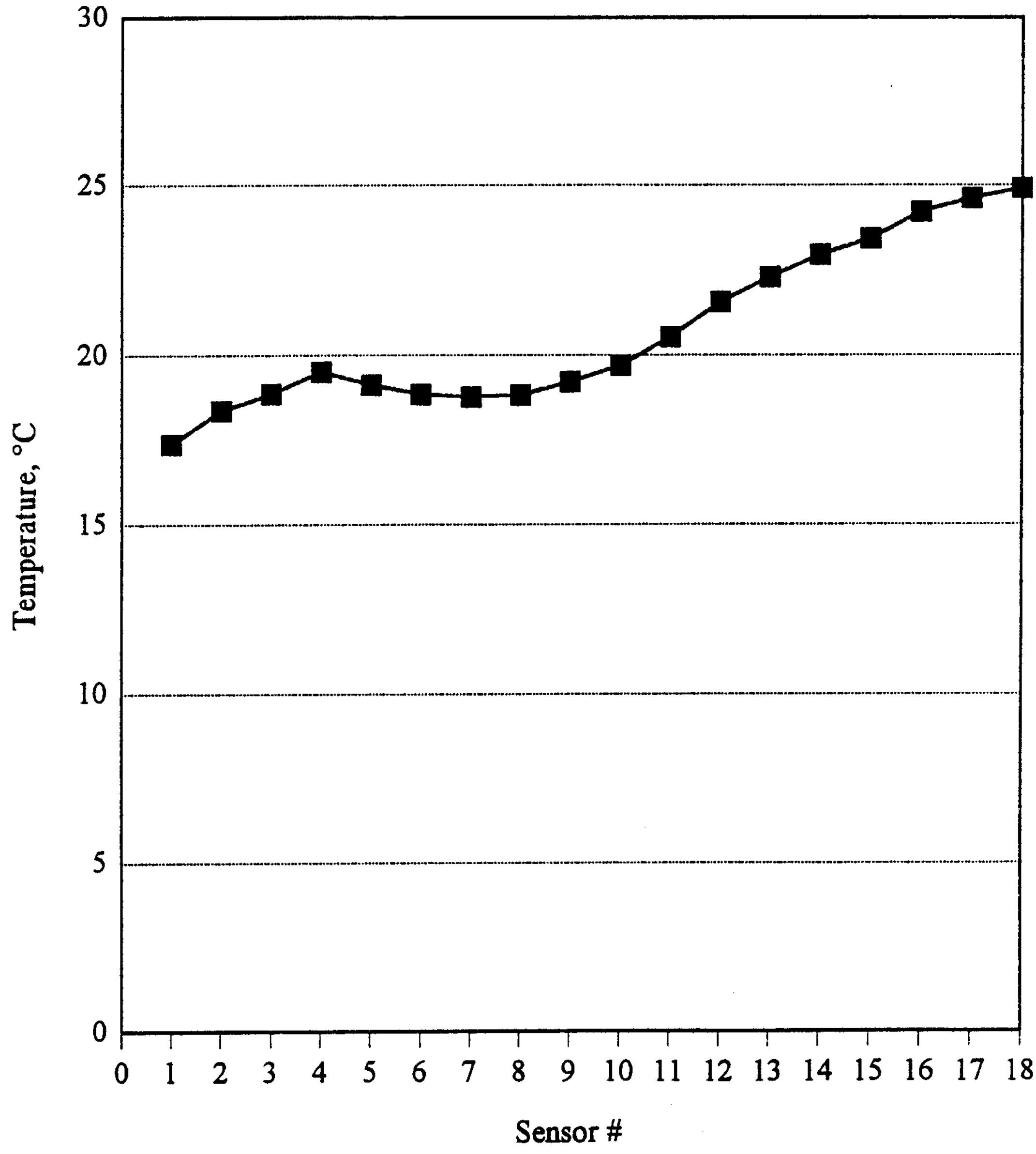


Figure D-3. Measured Average Subsurface Temperature for All 18 Sensors During Initial Data Collection

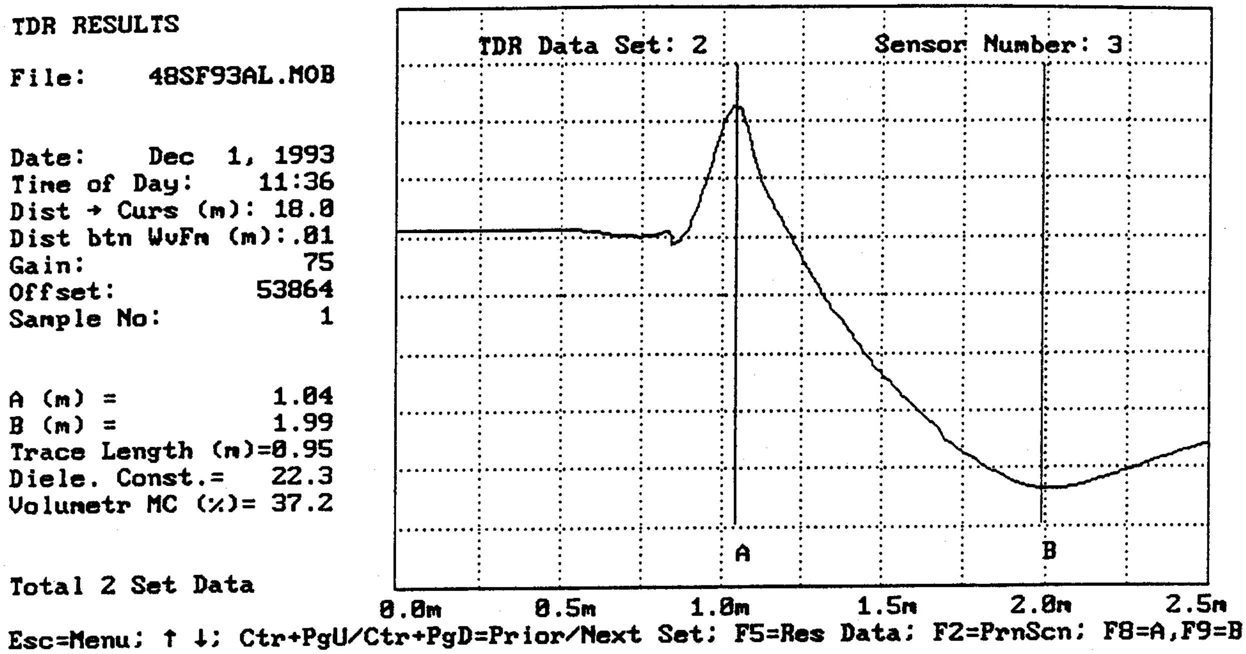


Figure D-6. Trace from TDR Sensor 3

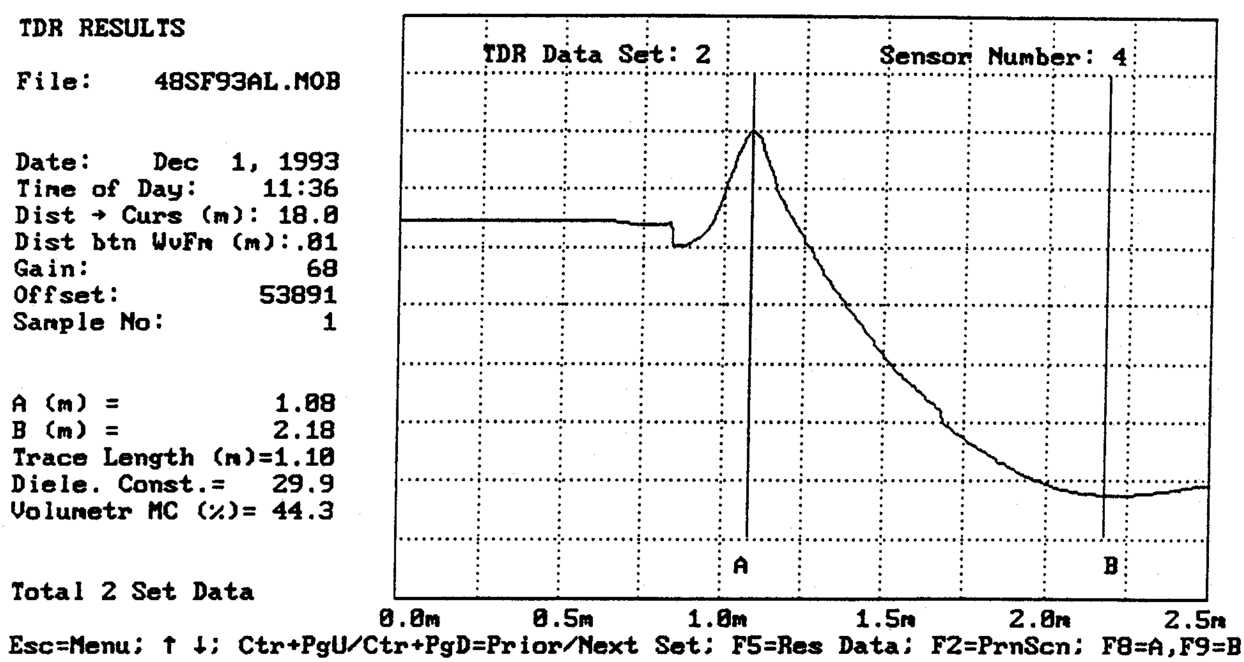


Figure D-7. Trace from TDR Sensor 4

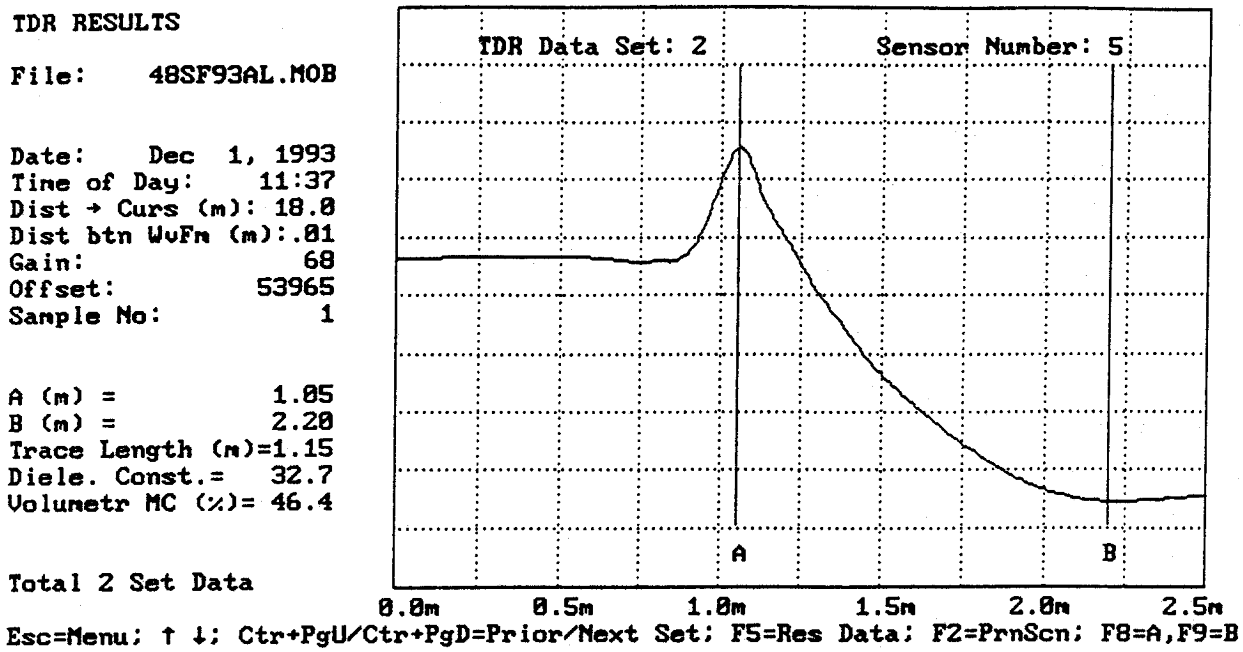


Figure D-8. Trace from TDR Sensor 5

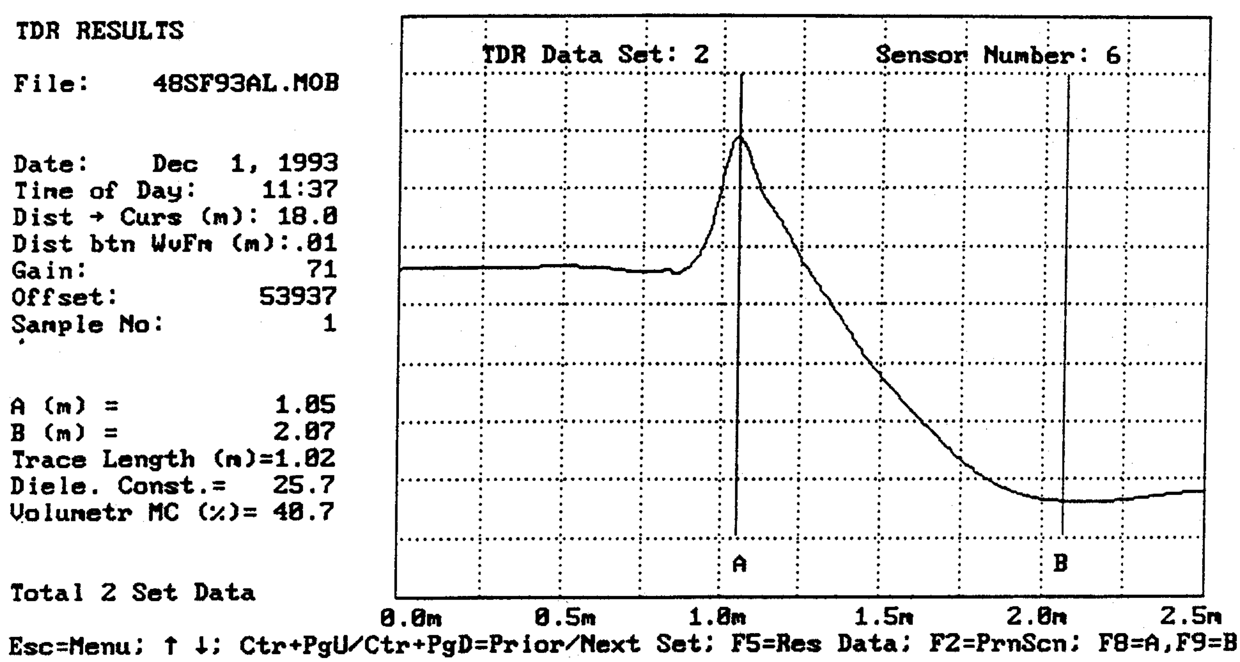


Figure D-9. Trace from TDR Sensor 6

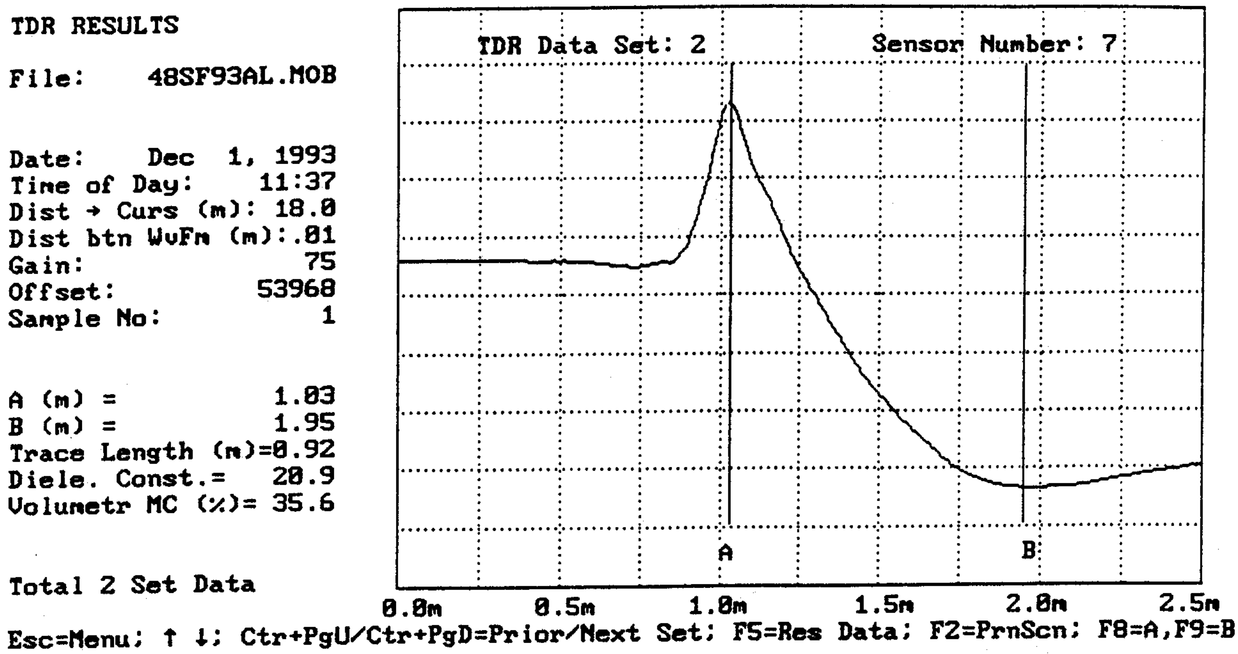


Figure D-10. Trace from TDR Sensor 7

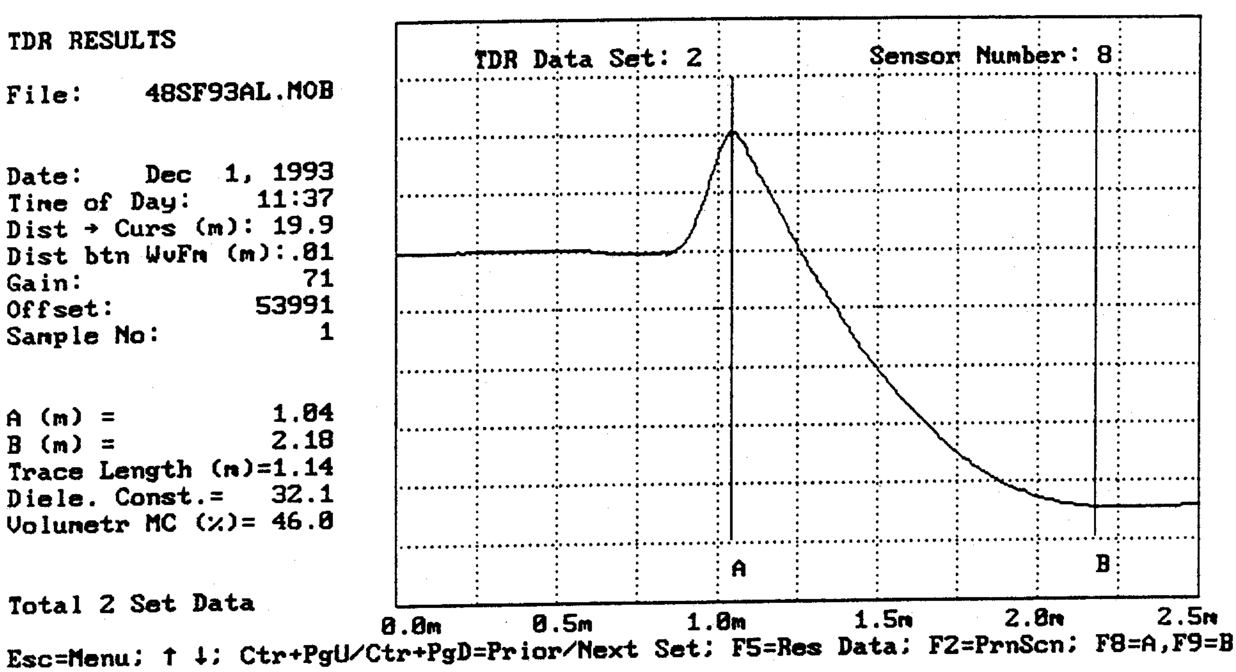


Figure D-11. Trace from TDR Sensor 8

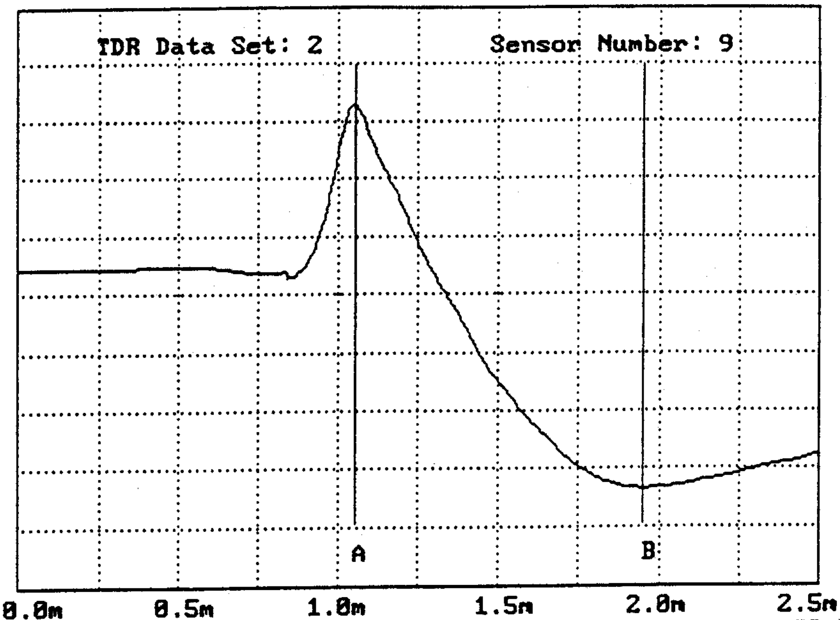
TDR RESULTS

File: 48SF93AL.MOB

Date: Dec 1, 1993
Time of Day: 11:38
Dist → Curs (m): 19.9
Dist btn WvFm (m):.01
Gain: 82
Offset: 53900
Sample No: 1

A (m) = 1.05
B (m) = 1.95
Trace Length (m)=0.90
Diele. Const.= 20.0
Volumetr MC (%)= 34.6

Total 2 Set Data



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

Figure D-12. Trace from TDR Sensor 9

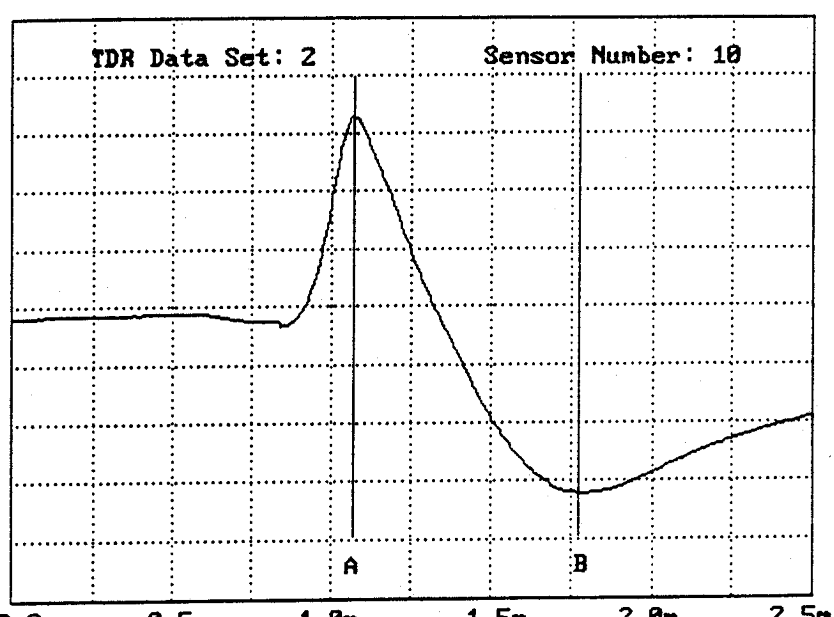
TDR RESULTS

File: 48SF93AL.MOB

Date: Dec 1, 1993
Time of Day: 11:38
Dist → Curs (m): 19.9
Dist btn WvFm (m):.01
Gain: 86
Offset: 53850
Sample No: 1

A (m) = 1.07
B (m) = 1.77
Trace Length (m)=0.70
Diele. Const.= 12.1
Volumetr MC (%)= 22.8

Total 2 Set Data



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

Figure D-13. Trace from TDR Sensor 10

Table D-2. Elevation Measurements from Installation

SEASONAL MONITORING
"FLEX" TRANSVERSE ELEVATION MEASUREMENTS[1] 48SF

Station	Outside Edge		OWP		ML		IWP		Inside Edge	
	O/S	Elev.	O/S	Elev.	O/S	Elev.	O/S	Elev.	O/S	Elev.
0-30	M		M .80	10.084	M		M		M	
0-20					1.85	10.083				
0-10			.80	10.045						
0+00	.10	10.037	.80	10.035	1.85	10.045	2.60	10.049	3.70	10.075
0+25	"	10.000	"	10.006	"	10.025	"	10.036	"	10.070
0+50	"	10.034	"	10.036	"	10.048	"	10.052	"	10.078
0+75	"	10.033	"	10.029	"	10.036	"	10.033	"	10.060
1+00	"	10.010	"	10.008	"	10.021	"	10.027	"	10.055
1+25	"	9.995	"	9.999	"	10.017	"	10.025	"	10.063
1+50	"	9.997	"	10.000	"	10.020	"	10.029	"	10.063
1+75	"	10.009	"	10.012	"	10.033	"	10.041	"	10.077
2+00	"	10.003	"	10.008	"	10.029	"	10.037	"	10.072

Bench Mark: T.B.M. Cotton Spindle In Shoulder @ Sta 0+00 ; 2.755 M Rt. Of 0+00 P.K. (91)
Assumed Elevation 10.000 Meters

Comments: Baseline Is P.K. Nails Set @ Outside Edge Of Outside Shoulder Stripe ; P.K. Nails Set @ 3.80 Meters Lt. O/S For ₵

B.M. Drilled 25' ... Edge Shoulder — TIE IN (+ 0.001)

Test Section No.	481060	Date	12/01/93
Start Time	920 Am	Finish Time	10:05 Am
Recorded By	J.R. / R.Z	Device Used	Large Rang Level

[1] OWP and ML readings to be taken at FWD test locations

10/29/93

APPENDIX E

Photographs

Appendix E contains the following photographs:

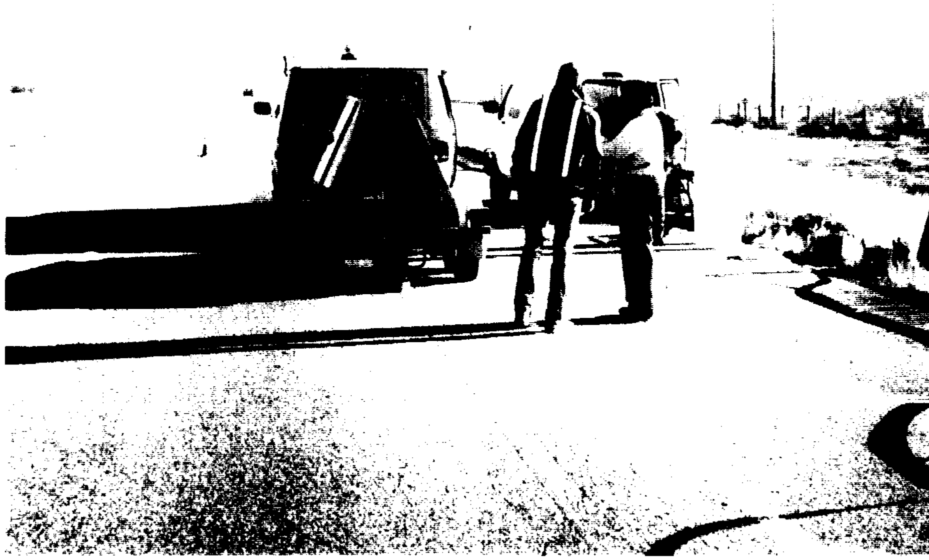


Photo E-1. General View of Site Prior to Installation

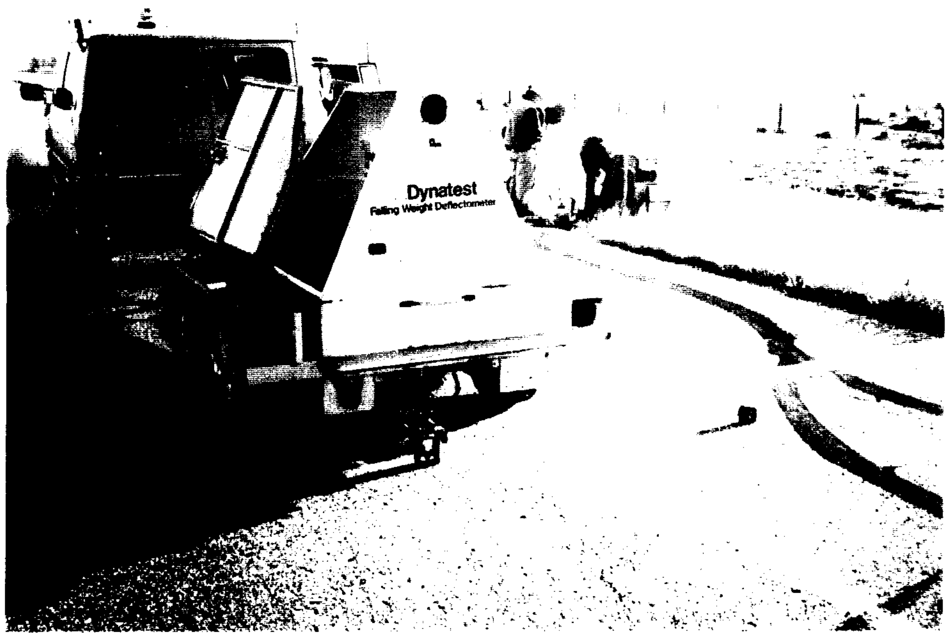


Photo E-2. FWD Testing Instrumentation Area Prior to Installation