LTPP Seasonal Monitoring Program

Site Installation and Initial Data Collection
Section 040114, Kingman, Arizona

Report No. FHWA-04-0114

Prepared by

Nichols Consulting Engineers, Chtd.
1885 S. Arlington Ave., Suite 111
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Prepared for

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

May 1997

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Technical Report Documentation Page

1. Report No.	2. Government Accession No.	3. Recipient's Catalog No.
FHWA-04-0114	N/A	N/A

4. Title and Subtitle	5. Report Date
LTPP Seasonal Monitoring Program Site Installation and Initial Data Collection Section 040114, Kingman Arizona.	November, 1996.
	6. Performing Organization Code

7. Author(s)	8. Performing organization Report No.
Srikanth S. Holikatti, Sirous H. Alavi, Douglas J. Frith, Mark A. Potter.	

9. Performing Agency Name and Address	10. Work Unit No. (TRAIS)
Nichols Consulting Engineers, Chtd. 1885 S. Arlington Avenue, Suite 111 Reno, Nevada 89503.	N/A
	11. Contract or Grant No.
	DTFH61-96-C-00010

12. Sponsoring Agency Name and Address	13. Type of Report and Period Covered.
Federal Highway Administration LTPP-Division, HNR-40 Turner Fairbanks Highway Research Center 6300 Georgetown Pike McLean, Virginia 22101	Final Report, August 1995.
	14. Sponsoring Agency Code.

15. Supplementary Notes

Contracting Officer's Technical Representative (COTR) - Monte Symons, HNR-30

16. Abstract

This report contains a description of the instrumentation installation activities and initial data collection for test section 040114 which is a part of the LTPP Core Seasonal Monitoring Program. This is a asphalt concrete surfaced pavement test section, located on northbound outside lane of US Highway 93, north of Kingman, Arizona. This section was instrumented on August 16, 1995. The instruments installed included TDR probes for moisture content, thermistor probes for subsurface temperature, tipping bucket rain gauge for precipitation, piezometer to monitor ground water table, and an on-site datalogger. Initial data was collected on August 17, 1995. This included FWD and precipitation data, elevation , air and subsurface temperature and TDR measurements. This report also contains description of site location, characteristics of installed equipment and the location of installed equipment within the test section and a summary of initial data collection.

17. Key Words: Seasonal Monitoring, TDR Probes, Thermistor Probes, CR10 Datalogger, Temperature Gauge, Initial Data.		18. Distribution Statement No restrictions	
19. Security Classification. (of this report) Unclassified	20. Security Classification. (Of this page) Unclassified	21. No. Of Pages	22. Price

Form DOT F 1700.7(8-72)

SI* (MODERN METRIC) CONVERSION FACTORS

APPROXIMATE CONVERSIONS TO SI UNITS

Symbol	When You Know	Multiply By	To Find	Symbol
	LENGTH			
in	inches	25.4	millimeters	mm
ft	feet	0.305	meters	m
yd	yards	0.914	meters	m
mi	miles	1.61	kilometers	km
	AREA			
in^2	square inches	645.2	square millimeters	mm^2
ft^2	square feet	0.093	square meters	m^2
yd^2	square yards	0.836	square meters	m^2
ac	acres	0.405	hectares	ha
mi^2	square miles	2.59	square kilometers	km^2
	VOLUME			
fl oz	fluid ounces	29.57	milliliters	mL
gal	gallons	3.785	liters	L
ft^3	cubic feet	0.028	cubic meters	m^3
yd^3	cubic yards	0.765	cubic meters	m^3

NOTE: Volumes greater than 1000 l shall be shown in m^3.

	MASS			
oz	ounces	28.35	grams	g
lb	pounds	0.454	kilograms	kg
T	short tons (2000 lb)	0.907	megagrams (or "metric ton")	Mg (or "t")
	TEMPERATURE (exact)			
°F	Fahrenheit temperature	5(F-32)/9 or (F-32)/1.8	Celcius temperature	°C
	ILLUMINATION			
fc	foot-candles	10.76	lux	lx
fl	foot-Lamberts	3.426	candela/m^2	cd/m^2
	FORCE and PRESSURE or STRESS			
lbf	poundforce	4.45	newtons	N
lbf/in^2	poundforce per square inch	6.89	kilopascals	kPa

APPROXIMATE CONVERSIONS FROM SI UNITS

Symbol	When You Know	Multiply By	To Find	Symbol
	LENGTH			
mm	millimeters	0.039	inches	in
m	meters	3.28	feet	ft
m	meters	1.09	yards	yd
km	kilometers	0.621	miles	mi
	AREA			
mm^2	square millimeters	0.0016	square inches	in^2
m^2	square meters	10.764	square feet	ft^2
m^2	square meters	1.195	square yards	yd^2
ha	hectares	2.47	acres	ac
km^2	square kilometers	0.386	square miles	mi^2
	VOLUME			
mL	milliliters	0.034	fluid ounces	fl oz
L	liters	0.264	gallons	gal
m^3	cubic meters	35.71	cubic feet	ft^3
m^3	cubic meters	1.307	cubic yards	yd^3
	MASS			
g	grams	0.035	ounces	oz
kg	kilograms	2.202	pounds	lb
Mg (or "t")	megagrams (or "metric ton")	1.103	short tons (2000 lb)	T
	TEMPERATURE (exact)			
°C	Celcius temperature	1.8C + 32	Fahrenheit temperature	°F
	ILLUMINATION			
lx	lux	0.0929	foot-candles	fc
cd/m^2	candela/m^2	0.2919	foot-Lamberts	fl
	FORCE and PRESSURE or STRESS			
N	newtons	0.225	poundforce	lbf
kPa	kilopascals	0.145	poundforce per square inch	lbf/in^2

* SI is the symbol for the International System of Units. Appropriate rounding should be made to comply with Section 4 of ASTM E380.

(Revised September 1993)

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SITE INSTALLATION AND INITIAL DATA COLLECTION ARIZONA SECTION 040114

INTRODUCTION

This report describes the equipment installation activities and initial data collection for test section 040114 near Kingman, Arizona. The equipment installation activities were carried out on August 16, 1995 and initial data was collected on August 17, 1995.

Section Location

Section 040114 is a Specific Pavement Studies (SPS) section selected for SMP. This section is located on the outside lane of northbound U.S. Route 93, a multi-lane highway facility in the State of Arizona. The closest city to the section is Kingman, Arizona. The beginning of the section is at milepost 50.3, 24 miles north of the City of Kingman. This section is also a SPS-1, "Strategic Study of Structural Factors for Flexible Pavements" section, meeting the seasonal monitoring program core experimental design cell number 13 requirements. Figure A1 in appendix A contains a map showing the location of the section.

Section Details

The pavement section consists of 178mm of asphalt concrete (AC) with 305mm aggregate base (AB) over silty clayey sand with gravel subgrade. The test section has a 3.70m travel lane with a 3.40m wide asphalt shoulder. Additional details are summarized in table 1.

Table 1. Details of section 040114 in Arizona.

Functional Classification of Roadway	United States Highway, Rural Principal Arterial
Number of Lanes/Direction	Two
Pavement Type	Asphalt Concrete
Estimated Annual ESAL Applications on Test Lane	208.5 KESALs
Climatic Classification	Dry, No-Freeze, SMP Cell #13

Pre-installation FWD testing was carried out on the test section on February 17, 1995. FWD data was analyzed using the FWDCheck program. The results are presented in figures A2 through A5 in appendix A. The material properties of individual pavement layers are presented in table 2. Figures A6 and A7 in appendix A present the construction sampling and boring log of the instrumentation hole, respectively. Appendix A also contains the distress survey summary of the section.

Table 2. Material properties.

Description	Surface Layer	Base Layer	Subgrade
Material	AC	AB	Silty Clayey Sand w/Gravel
Thickness (mm)	178*	305*	N/A
Proctor Dry Density (kg/m^3)	----	----	1800**
Proctor Moisture Content (%)	----	----	6**
Field Measured Density	----	----	2173@3.8%MC***
Laboratory Maximum Dry Density (kg/m^3)	----	2269@5%MC	2125@9.8%MC
Liquid Limit	----	21	24
Plastic Limit	----	NP	17
Plastic Index	----	NP	7
Percent Passing #200	----	12.2%	18.3%

* Layer thickness from construction records
** Proctor dry density and moisture content as on the day of instrument installation
*** Density in the field was measured using Nuclear gauge
MC Moisture Content
AC Asphalt Concrete
AB Aggregate Base
NP Non Plastic

According to LTPP weather database information, the following climatic conditions exist in the region:

Freezing Index	:	15	No. of Days Below 0° C	:	42
Precipitation	:	254mm	No. of Wet Days	:	42
No. of Days Above 32° C	:	86	No. of Freeze/Thaw Cycles	:	50

Installation of instrumentation was carried out on August 16, 1995 and initial data collection was performed on August 17, 1995. Instrument installation was a cooperative effort between Arizona Department of Transportation (ADOT) and Nichols Consulting Engineers (NCE) LTPP Western Region Coordination Office staff. The following personnel participated in the installation:

Haiping Zhou	:	NCE	Mark A. Potter	:	NCE
William Nichols	:	NCE	Michael E. Esposito	:	NCE
Philip Friedman	:	NCE	J. Potter	:	Traffic control
J.J. Lieu	:	ADOT	A. Mannarel	:	Traffic control
Roger	:	Drilling crew	R. Gross	:	Traffic control

INSTRUMENT INSTALLATION

Meeting With Highway Agency

A planning meeting between NCE and ADOT was held in Phoenix, Arizona on July 21, 1995 to discuss the SMP instrumentation, required equipment, the installation schedule, and installation team responsibilities. ADOT agreed to provide traffic control, equipment, and personnel to achieve instrument and piezometer hole auguring and also to carry out post installation patching of the instrumentation hole and conduit trench. NCE staff completed all the SMP equipment installation. The site was inspected by Douglas Frith and Mark Potter on February 17, 1995.

SMP Equipment Installed

Type and quantity of instruments installed at the section are listed in table 3. These included instrumentation to measure air and subsurface temperature, subsurface moisture content, rainfall, ground water table depth, and an equipment cabinet to house the cable ends and the CR10 data logger. The rain gauge and the air temperature probe were mounted on a 51mm diameter steel pole near the equipment cabinet. The resistivity probe for frost depth was not installed as the section was in the "No Freeze" region.

Table 3. Equipment installed.

Equipment	Quantity	Serial No.
Instrument Hole		
MRC Thermistor Probe	1	04B#2
TDR Sensors	10	04B01 - 04B10
Equipment Cabinet		
Campbell Scientific CR10 Data Logger	1	16582
Battery Pack	1	None
Weather Station		
TE 525 Tipping Bucket Rain Gauge	1	12098
Air Temperature Probe	1	None
Radiation Shield	1	None
Observation Well/Bench Mark	1	None

Pre-Installation Equipment Check and Calibration

Prior to installation, all equipment used in the installation were checked for functionality, accuracy, and calibrated whenever necessary. The air temperature probe, thermistor probe, and the rain gauge were connected to the CR10 data logger to verify that they were functioning properly. The rain gauge was calibrated by recording the number of tips to drain out 473ml of water from the container in at least 45 minutes. For the first trial, it took 50 minutes and 88 tips to drain 473ml of water. The two screws at the bottom of the rain gauge were adjusted by two turns (each turn causes a 2-3% increase in tips), this resulted in increased number of tips to 100 ± 3. This is within the limits recommended. The air temperature probe and the thermistor probe were checked for proper functioning by placing them in an ice bath and in direct sunlight and comparing the measured temperatures. The results indicated that both were functioning properly. The spacing of thermistor sensors within the clear plastic tube were measured and recorded. Descriptions of MRC thermistor probe and sensor spacing are presented in table 4. The CR10 data logger and battery unit was also checked. They were found to be in working order.

Calibration of TDR probes was completed by performing two measurements in air, one with the prongs shorted at the beginning of the sensor and the other not shorted. An additional measurement was made with the TDR sensor submerged in water. The TDR measured dielectric constants were within the specified limits, and the sensors produced the expected traces and were functioning properly. Individual TDR probe traces obtained during calibration are presented in figures B1 through B10 in appendix B. Serial numbers of equipment to be installed were noted, with the exception of radiation shield and air temperature sensor. The bench mark did not have a serial number and the battery pack serial number was not recorded because the batteries get frequently changed.

Instrument Installation

Analysis of pre-installation FWD data indicated a uniform section. There were no exceptional conditions that warranted any change in the selection of end to be instrumented, therefore, the leave end of the section was instrumented. The equipment installation followed the schedule given below.

0715	:	Depart from Kingman.
0800	:	Arrive at site, start unpacking equipment in preparation for installation.
0815	:	Traffic control in place, instrumentation hole and piezometer located and marked, FWD testing of instrumentation hole.
0815-0845	:	Drill piezometer, saw cutting of thermistor unit 1 slot, conduit trench and instrument hole.
0845- 0930	:	Installation of piezometer, drill weather station pole hole, place pole and concrete the base.
0930-1000	:	Install equipment cabinet.
1000-1030	:	Excavation of instrumentation cable trench.

Table 4. Description of MRC thermistor probe and sensor spacing.

Unit No.	Channel No.	Distance from Top of Unit (m)	Remarks
1	1	0.000	Unit installed in AC layer
	2	0.152	
	3	0.305	
2	4	0.022	Unit installed in base & subgrade
	5	0.093	
	6	0.169	
	7	0.246	
	8	0.322	
	9	0.476	
	10	0.625	
	11	0.780	
	12	0.932	
	13	1.085	
	14	1.236	
	15	1.390	
	16	1.540	
	17	1.695	
	18	1.843	

1030-1200	:	Layout the cables, run the cables through the conduit, drill instrument hole.
1200-1500	:	Installation of thermistor unit #2, TDR probes, collection of moisture samples from each TDR location, proctor test, testing of each TDR probe, etc.
1515-1545	:	Installation of thermistor probe unit #1, into the groove previously cut in the pavement, check all equipment for proper functioning.
1545-1630	:	Patch and repair instrumentation hole and conduit trench, seal all saw cuts with silicone sealant.
1630-1730	:	Clean up site, pack all equipment, place instrument cabinet cover, and lock.
1730-1745	:	Depart from site.

Pavement and subsurface instrumentation was installed at the leave end of the section at a distance of 157.04m (station 5+16) from the section beginning, in a 0.30m diameter hole bored using a 252mm diameter flight auger. The pavement temperature sensors (thermistors, unit #1) were installed in the AC layer as per LTPP guidelines. TDR moisture probes and subsurface temperature sensors (thermistors, unit #2) were installed in the base course and subgrade layers. The instrumentation hole was 2.07m deep. Figure C1 in appendix C presents the site layout and site location. The TDR probes were placed in an offset fan pattern such that the lead wires were on the side closest to the pavement edge. All the TDR probes were placed with an "S" shaped stress relief loop in their cables. Each TDR probe was connected to the 1502B cable tester while the soil around it was being compacted. Manual traces were generated to ensure that none of the TDR sensors were damaged during backfilling and compaction of instrumentation hole. TDR traces monitored during installation are presented in figures C2 and C3 in appendix C. TDR and thermistor probe lead wires were bundled and pulled through a 51mm diameter flexible electrical conduit buried in a 76mm wide trench, leading to the equipment cabinet. The equipment cabinet was located 9.00m away to the right of lane edge on almost level ground. Extension cables were used in all the sensors placed in the pavement. The installed depths of the TDR sensors are presented in table 5.

Moisture samples were collected at each TDR probe location. A representative Proctor sample was taken at a depth of 1.07m from pavement surface. TDR traces obtained during installation were later used to determine in-situ moisture content at each TDR probe depth. From the individual trace, apparent probe length was determined and used in the moisture determination equations provided in the FHWA LTPP SMP Guidelines, April 1994.

Table 5. Installed depths of TDR sensors.

TDR Sensor No.	Depth from Pavement Surface (m)	Layer
04B01	0.202	Base
04B02	0.355	Subgrade
04B03	0.508	
04B04	0.660	
04B05	0.811	
04B06	0.968	
04B07	1.116	
04B08	1.250	
04B09	1.510	
04B10	1.920	

A comparison of moisture contents determined from TDR traces obtained during installation with field measured moisture contents are presented in table 6.

Table 6. Measured moisture contents during installation.

Sensor No.	Sensor Depth (m)	Layer	Moisture Content (% by wt)	
			Field Measured[1]	TDR Installation[2]
04B01	0.202	Base	5.4	6.0
04B02	0.355	Subgrade	5.4	6.0
04B03	0.508		6.0	5.6
04B04	0.660		6.6	4.5
04B05	0.811		6.0	3.7
04B06	0.968		3.1	3.7
04B07	1.116		2.7	2.9
04B08	1.250		2.6	4.5
04B09	1.510		1.9	3.7
04B10	1.920		3.8	3.0

[1]Moisture contents determined in field from the material sampled at each TDR probe depth.

[2]The moisture contents were determined from TDR traces obtained during TDR probe installation. From the individual trace, apparent length was determined and used in the moisture determination equations given in FHWA LTPP SMP Guidelines, April 1994.

It can be seen from the data in table 6, field measured moisture contents were generally close to the moisture contents determined from the TDR traces obtained during installation. Some difference in moisture contents at some sensor depths can be attributed to the field conditions and limitations of the moisture determination method used.

Thermistor unit #2 was installed in the unbound base and subgrade layers as per the SMP instrument installation guidelines. Table 7 presents the installed locations of thermistor sensors with reference to the pavement surface.

Table 7. Installed locations of MRC thermistor sensors.

Unit No.	Channel No.	Depth from Pavement Surface (m)	Remarks
1	1	0.012	AC
	2	0.080	
	3	0.149	
2	4	0.225	Base
	5	0.317	
	6	0.394	Subgrade
	7	0.469	
	8	0.545	
	9	0.698	
	10	0.849	
	11	1.002	
	12	1.184	
	13	1.307	
	14	1.461	
	15	1.612	
	16	1.763	
	17	1.916	
	18	2.066	

A 152mm diameter flight auger was used to bore the observation piezometer/benchmark at the edge of the pavement shoulder at a distance of 121.95m (section station 4+00), and 4.9m to the right of the lane edge. Upon completion of instrumentation installation, all wiring connections to the equipment cabinet were checked carefully for continuity and proper contacts. The "ONSITE" computer program was downloaded to the CR10 data logger located

in the equipment cabinet. The data logger was left "ON" overnight to collect data so that the results could be evaluated the next day.

Site Repair

The instrumentation hole and the conduit trench were patched by ADOT personnel with cold-mix asphalt concrete. Care was exercised to prevent damage to all of the equipment installed or the wires leading to the equipment cabinet. Subsequent tests confirmed that all the installed equipment was functioning properly. The repair patch of the instrument hole performed quite well throughout the monitoring period.

INITIAL DATA COLLECTION

The second day (August 17, 1995) was spent checking the functionality of installed equipment, this included collection of initial data, elevation surveys of the section, examination of the overnight data collected by the onsite data logger, and TDR data collection using the mobile data acquisition system. Air temperature, rainfall, pavement and subsurface temperature data monitored and stored by the onsite data logger were examined. The equipment and data logger were functioning correctly. The battery voltage was checked and found acceptable.

TDR data was collected using the mobile data acquisition system. The mobile system contains a CR10 data logger, a battery pack, two multiplexers, and a resistance multiplexer circuit board. Figures D1 through D10 in appendix D show the TDR waveform traces obtained with the mobile data acquisition system. TDR traces obtained by the mobile data aquisition system indicated some malfunctioning of the contact points. This explains flat traces recorded for some of the TDR sensors. This was noted for closer examination. Every single point of contact in the wiring was checked and the mobile box was thoroughly inspected. TDR trace data collected at the site during subsequent visits confirmed that the TDR sensors were functioning properly.

Post-installation FWD testing of the section could not be carried out because of a mechanical breakdown of the FWD van. Due to the tight installation schedule and the numerous agencies which would be affected, FWD testing was skipped for this timeframe. One set of elevation surveys were carried out following the LTPP guidelines. The elevation of the observation well top was assumed as 1.0 meter. The elevation survey results are presented in table D2 in appendix D.

SUMMARY

This report describes the SMP equipment installation activities on section 040114 located in the State of Arizona. The section is located on the northbound outside lane of U.S. Route 93 near the City of Kingman. The beginning of the section is at milepost 50.3, 24 miles north of the City of Kingman. This is a SPS-1 section in the "Dry, No Freeze" climatic zone in SMP cell #13.

The site was inspected on February 21, 1995. A planning meeting with ADOT representatives was held in Phoenix on July 21, 1995 to discuss SMP equipment installation and work responsibilities. Successful installation of SMP equipment and initial data collection were carried out on August 16 and 17, 1995, respectively, in accordance with the LTPP SMP guidelines. One exception was that the post installation FWD testing was not performed due to a mechanical breakdown of the FWD van. Equipment to measure and record the following data was installed at the site:

- Ambient temperature and daily rainfall
- Pavement surface and subsurface depth-temperature profile
- Subsurface depth-moisture profile
- Ground water measurements

A resistivity probe was not installed at this site. The equipment installation hole is located at the leave end of the section at a distance of 157.04m from the section beginning. The equipment cabinet is located 9.0m to the right of the lane edge on almost level ground. Post-installation checks indicated proper functioning of all installed equipment. TDR traces recorded by the mobile data aquisition system during initial data collection indicated loose contact within the box. This resulted in some blank and flat traces. TDR trace data collecteted at the site during subsequent visits confirmed that the TDR sensors were functioning properly. A breakdown of the FWD van and a tight installation schedule prevented post-installation FWD testing of the section.

APPENDIX A

Test Section Background Information

Appendix A includes the following supporting information.

Figure A1. Site location map.
Figure A2. Corrected normalized deflection profile from FWDCheck.
Figure A3. Elastic modulus of subgrade from FWDCheck.
Figure A4. Composite modulus at station 5+00 from FWDCheck.
Figure A5. Equivalent structural number from FWDCheck.
Figure A6. Sampling log of section during construction.
Figure A7. Boring log of instrument hole.

Figure A1. Site location map.

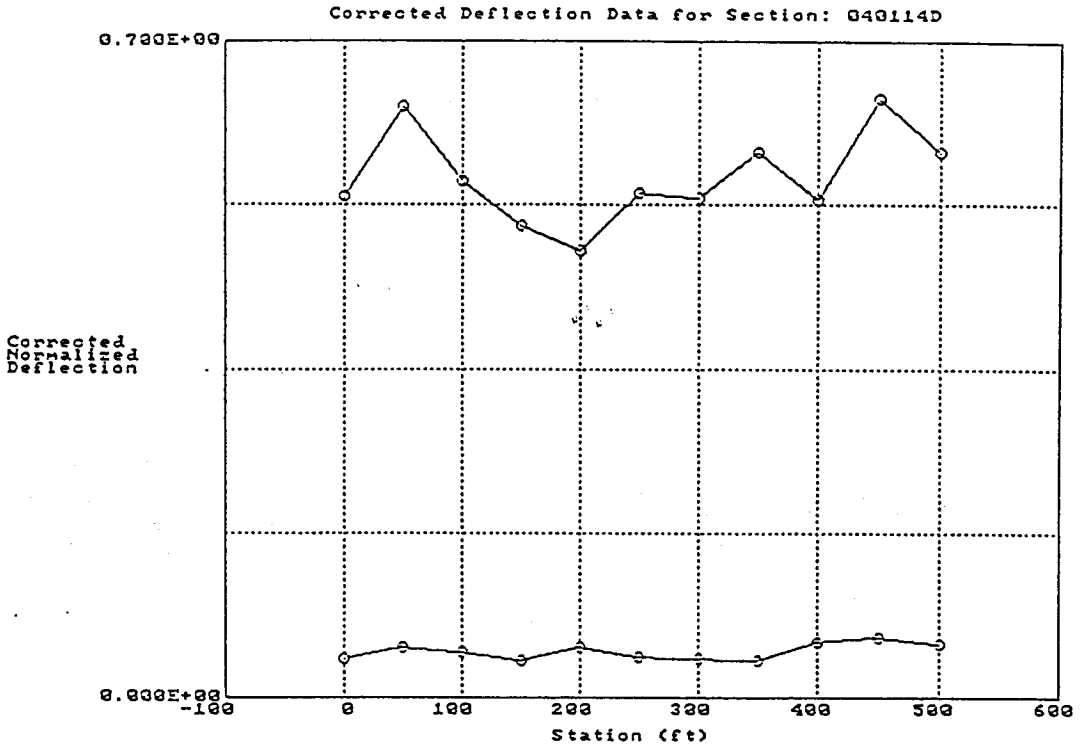


Figure A2. Corrected normalized deflection profile from FWDCheck.

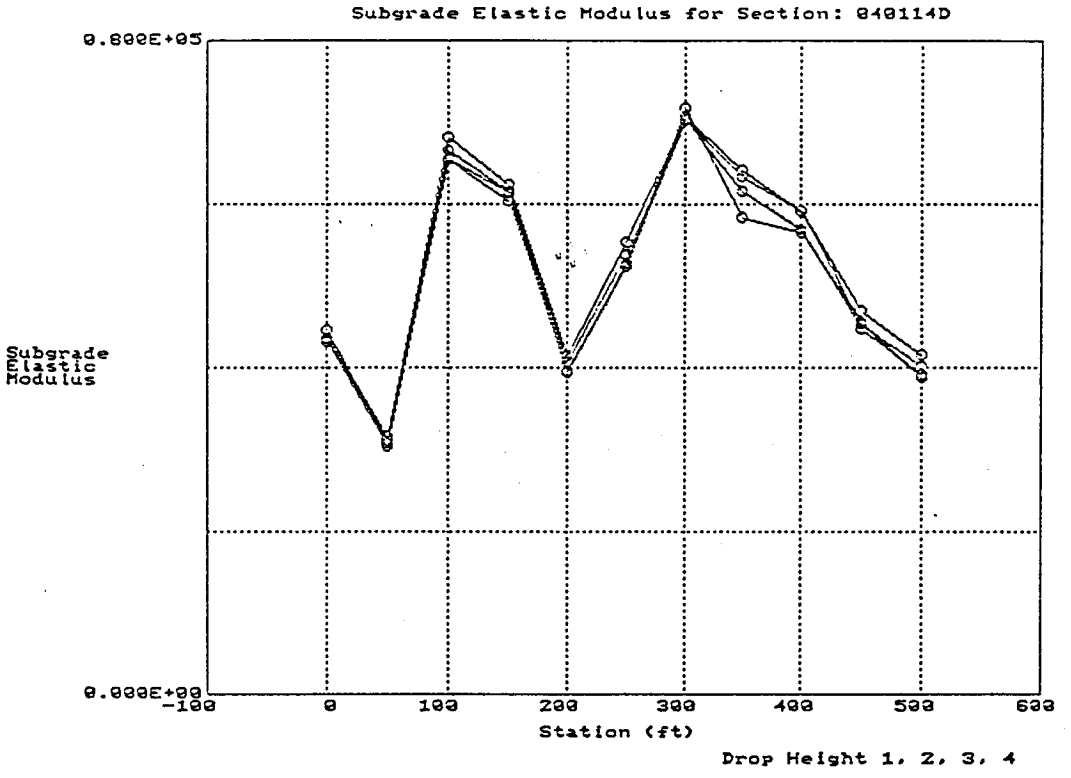


Figure A3. Elastic modulus of subgrade from FWDCheck.

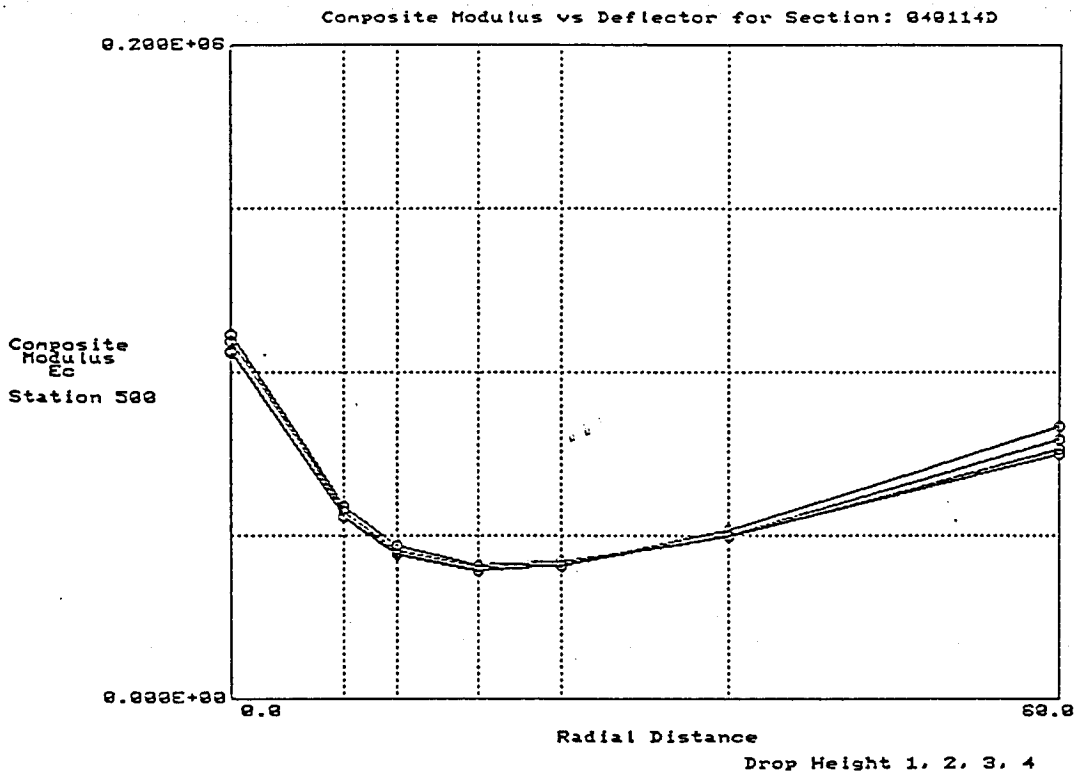


Figure A4. Composite modulus at station 5+00 from FWDCheck.

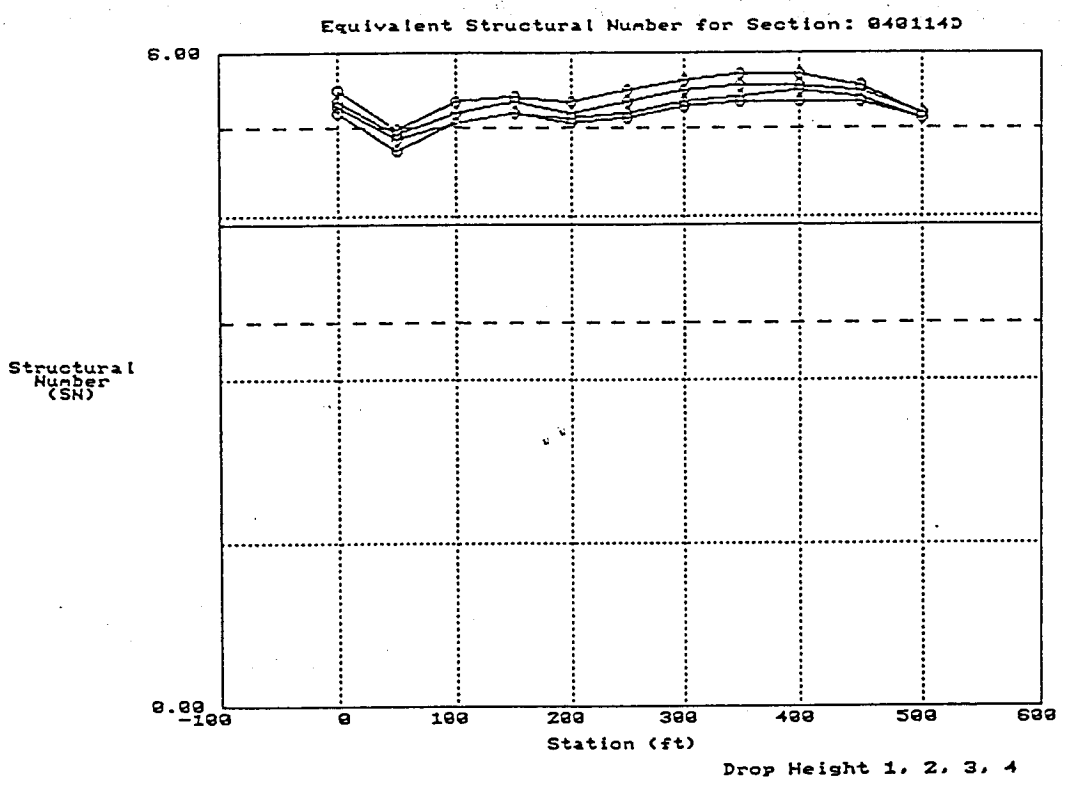


Figure A5. Equivalent structural number from FWDCheck.

DRILLING & SAMPLING LOG

STATE: ARIZONA SHRP I.D. 040114

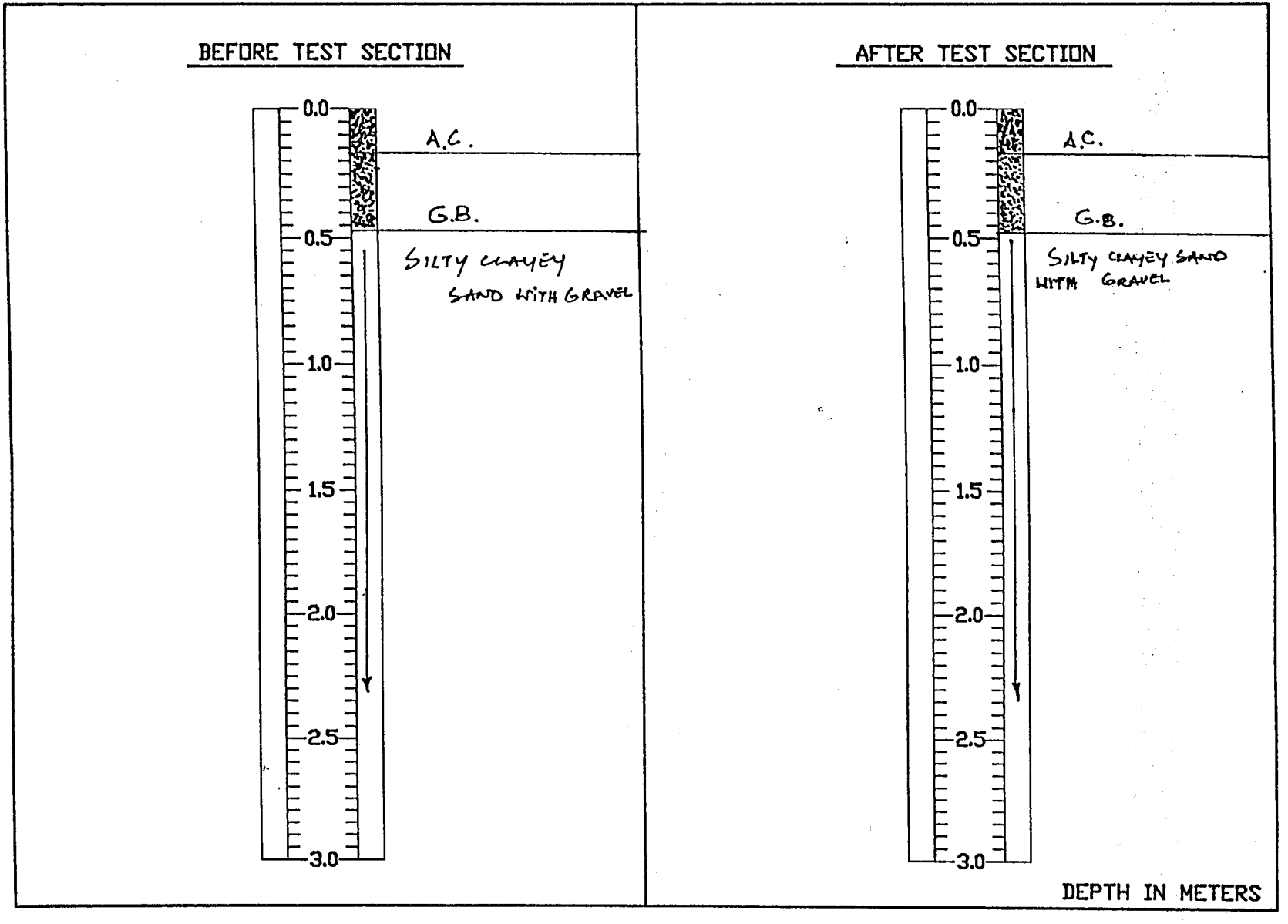
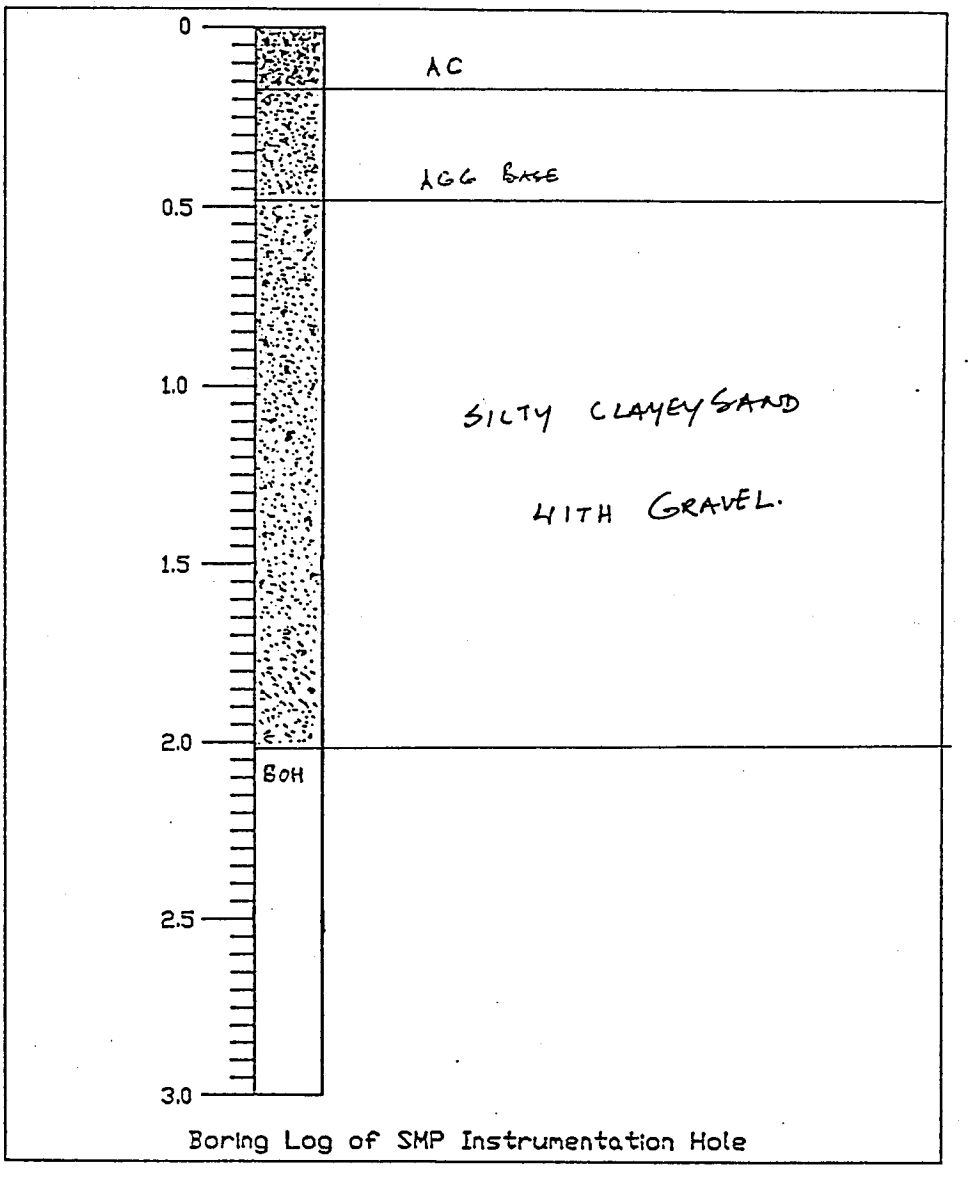


Figure A6. Sampling log of section during construction.

State ID. 04 SHRP ID. 0114

Station 157.04m (500+15'i) Date(dd/mm/yy) 16/08/95



Boring Log of SMP Instrumentation Hole

Start Time NA End Time NA

Prepared By HAIPING ZHOU Employed By NCE

Figure A7. Boring log of instrument hole.

Revised December 1, 1992

SHEET 1

STATE ASSIGNED ID ____

DISTRESS SURVEY

STATE CODE 04

LTPP PROGRAM

SHRP SECTION ID 0114

DISTRESS SURVEY FOR PAVEMENTS WITH ASPHALT CONCRETE SURFACES

DATE OF DISTRESS SURVEY (MONTH/DAY/YEAR) 08/17/95

SURVEYORS: ME __, ____ PHOTOS, VIDEO, OR BOTH WITH SURVEY (P, V, B) __
PAVEMENT SURFACE TEMP - BEFORE 32.5°C; AFTER 32.5°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 Length	____.0	____.0	____.0
Sealed (Meters)	____.0	____.0	____.0
4b. Non-Wheel Path Length	____.0	____.0	____.0
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

ENTERED JAN 08 1996 BY KS

SHEET 2

DISTRESS SURVEY

LTPP PROGRAM

STATE ASSIGNED ID ____

STATE CODE 04

SHRP SECTION ID 0117

DATE OF DISTRESS SURVEY (MONTH/DAY/YEAR) 08/17/95

SURVEYORS: ME ; ____

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 TRNPROF1 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 AND WEATHERING (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) ____			

ENTERED
JAN 08 1996
BY RS

APPENDIX B

Installed Instrument Information

Appendix B includes the following supporting information.

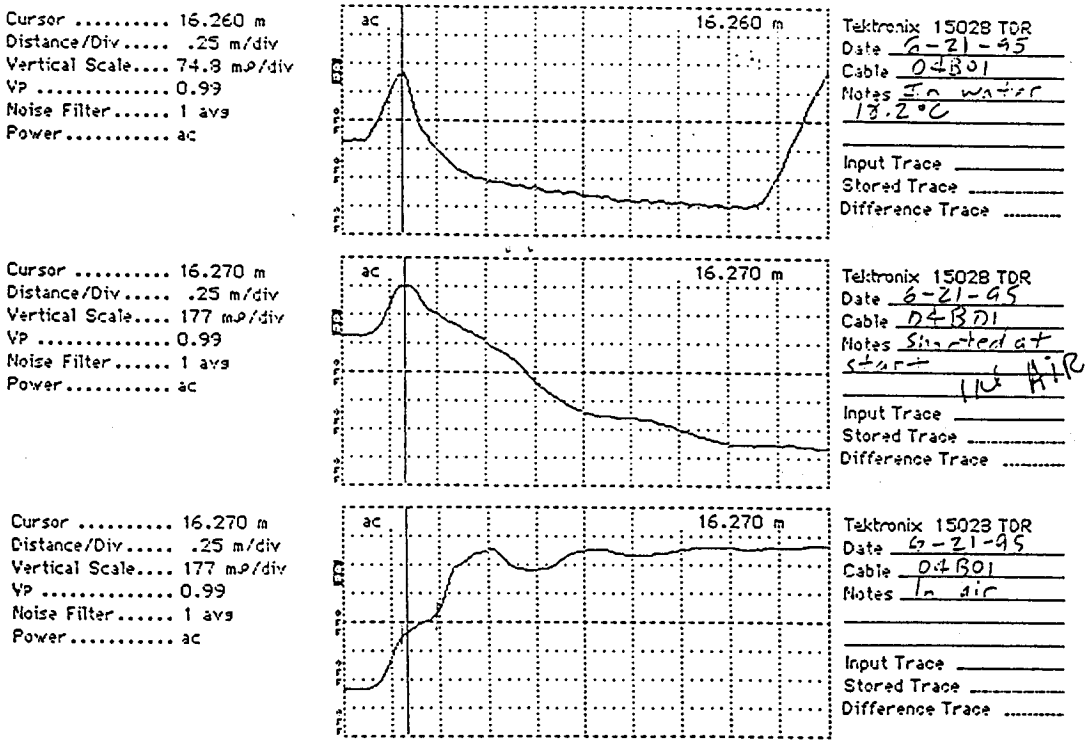


Figure B1. TDR trace obtained during calibration for sensor 04B01.

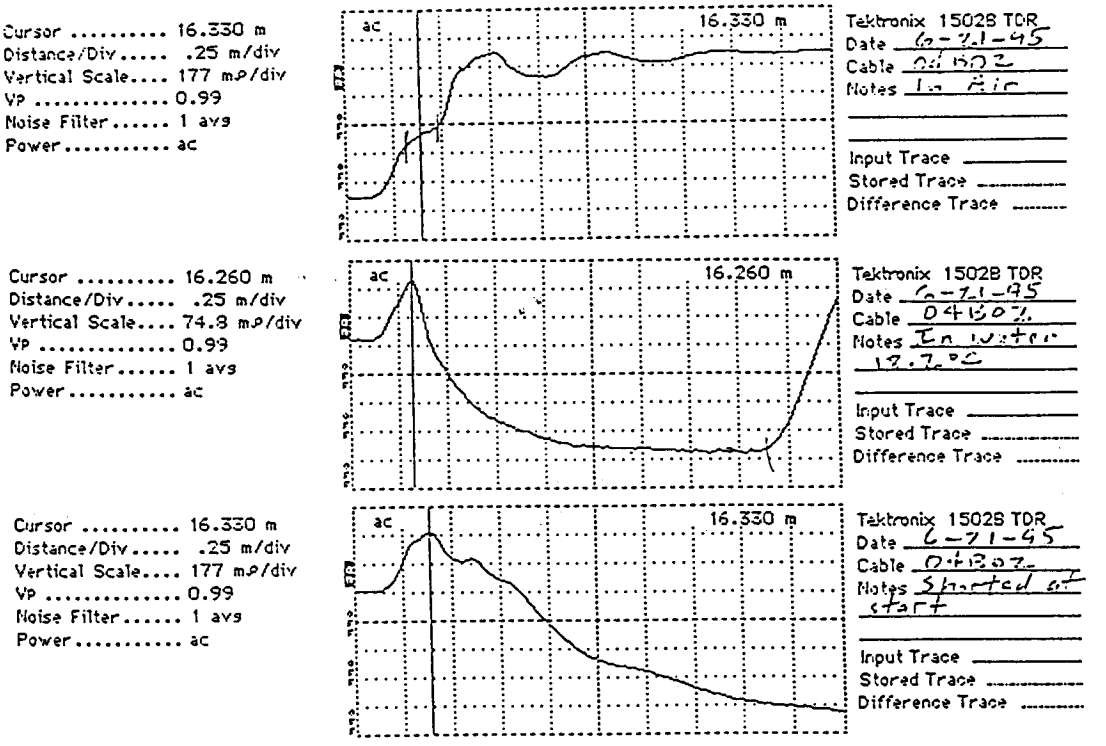


Figure B2. TDR trace obtained during calibration for sensor 04B02.

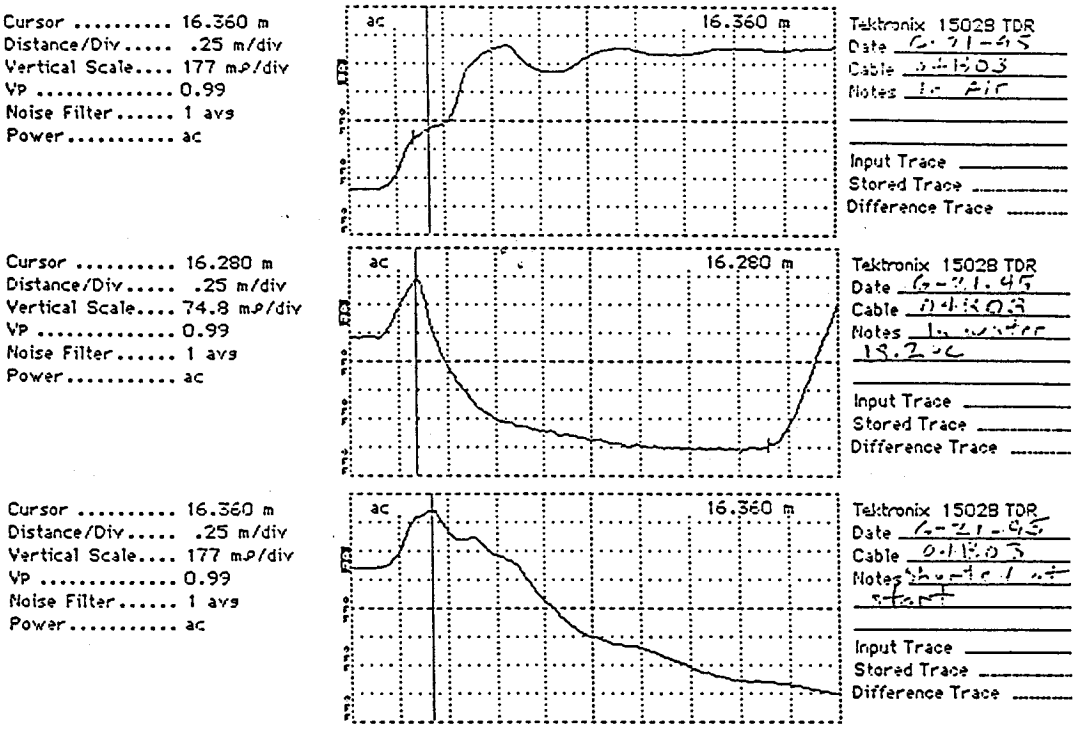


Figure B3. TDR trace obtained during calibration for sensor 04B03.

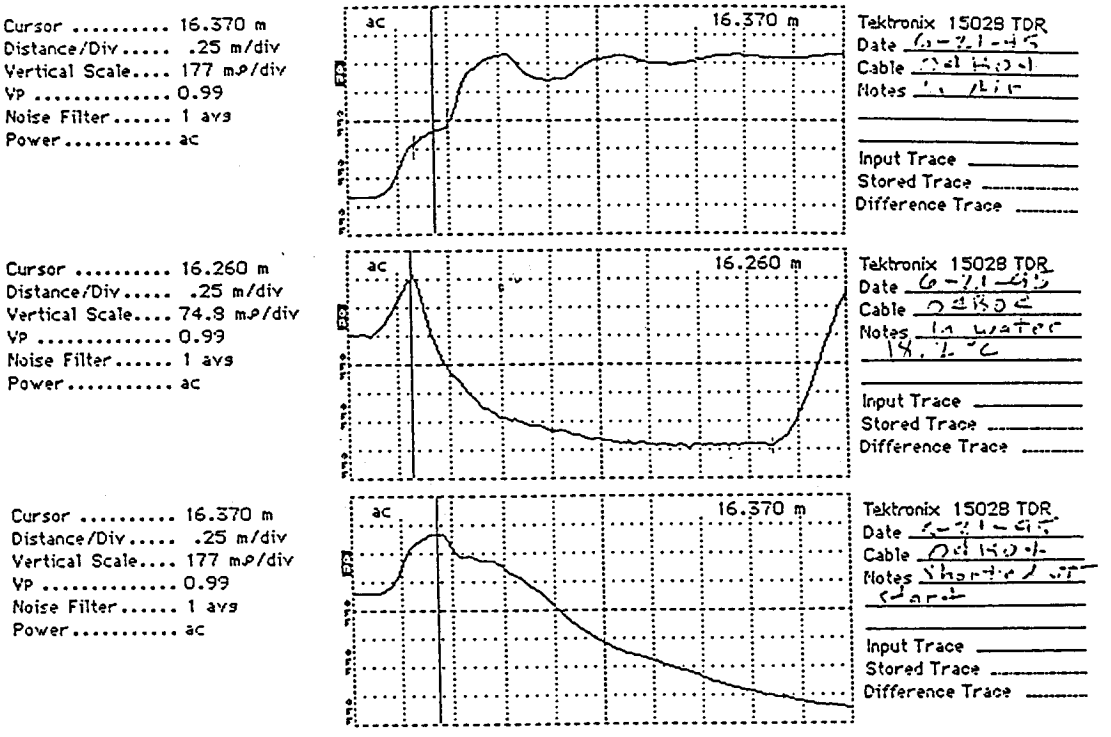


Figure B4. TDR trace obtained during calibration for sensor 04B04.

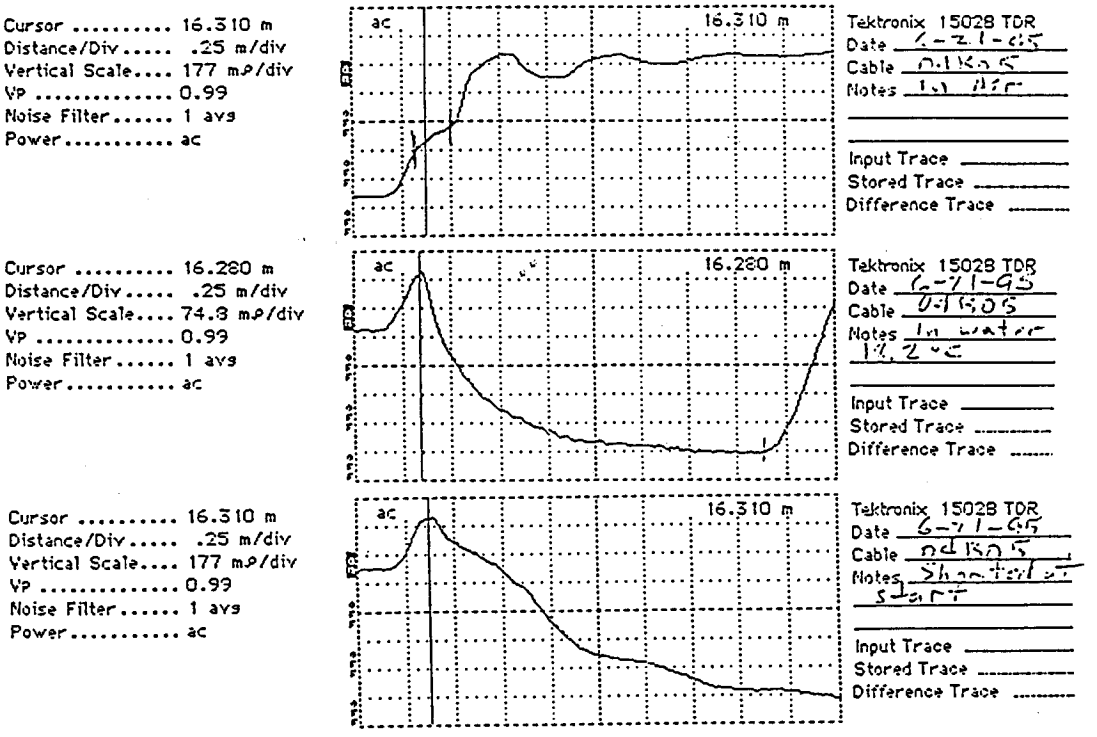


Figure B5. TDR trace obtained during calibration for sensor 04B05.

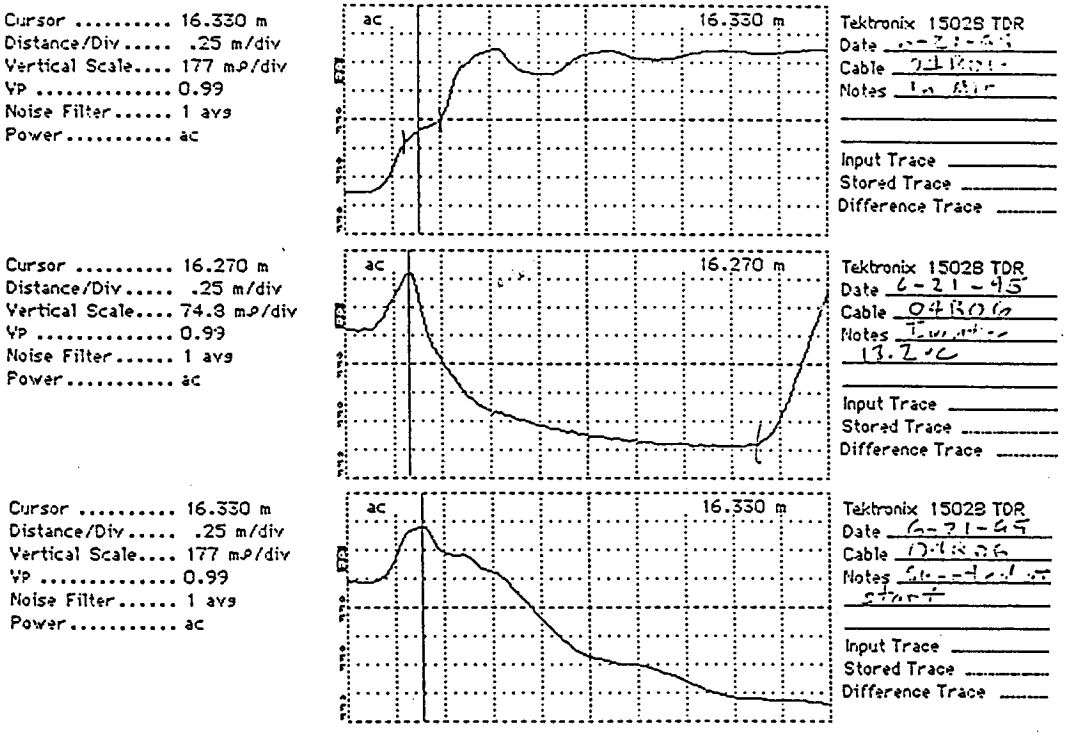


Figure B6. TDR trace obtained during calibration for sensor 04B06.

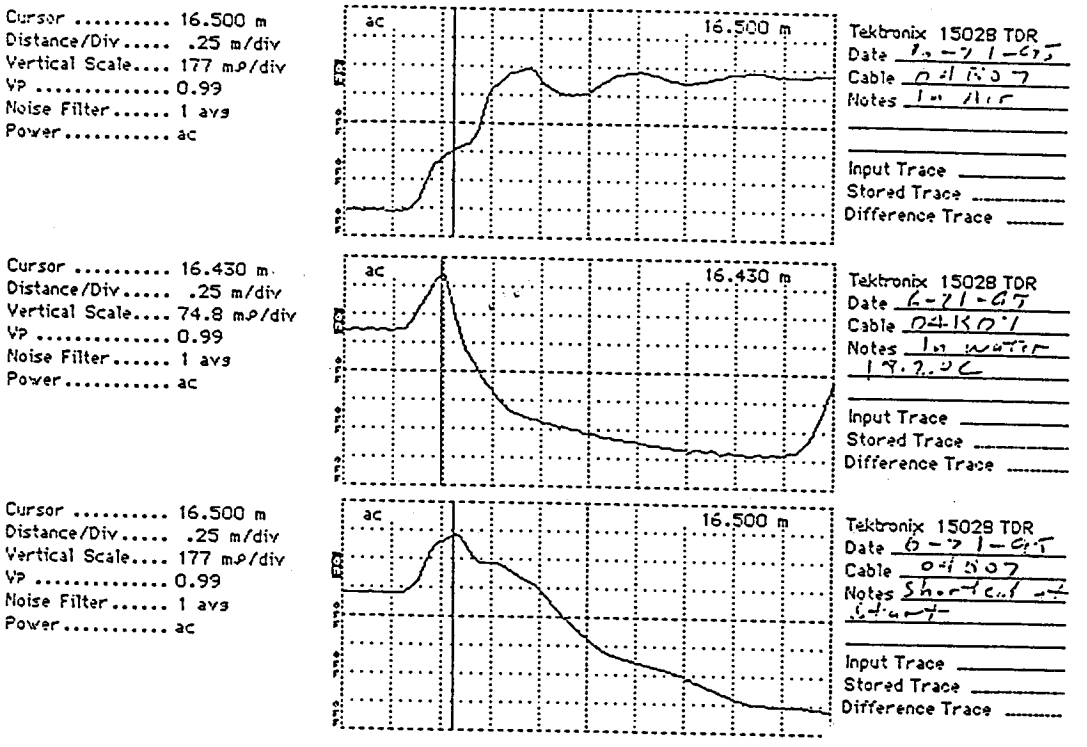


Figure B7. TDR trace obtained during calibration for sensor 04B07.

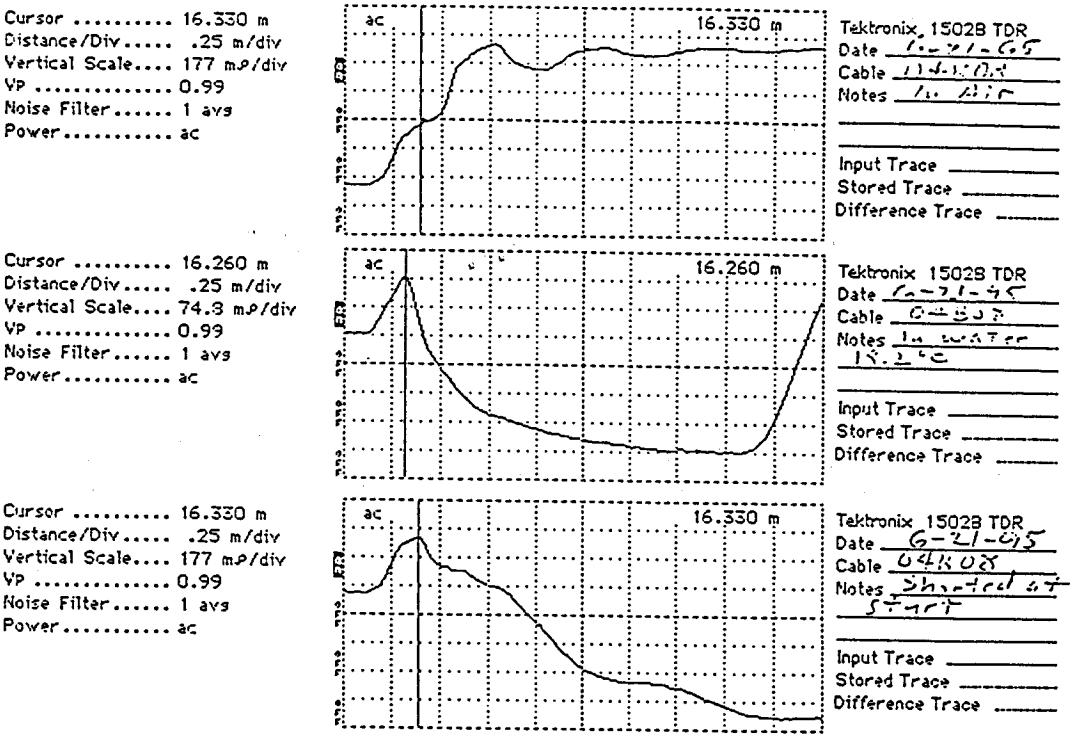


Figure B8. TDR trace obtained during calibration for sensor 04B08.

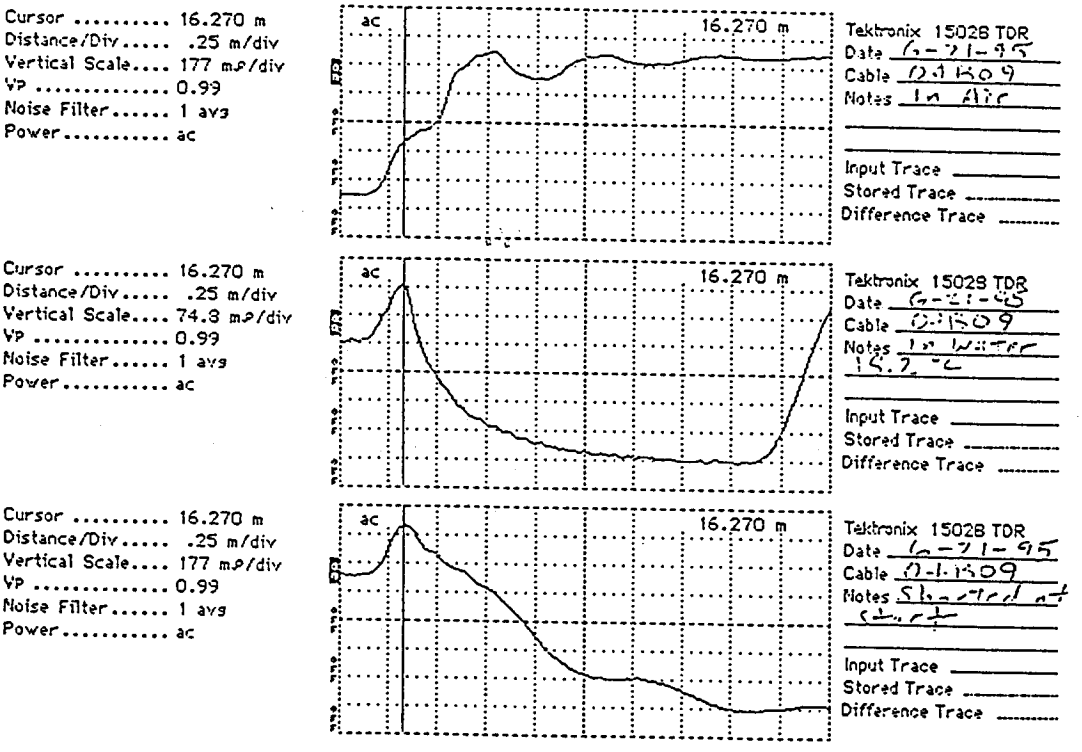


Figure B9. TDR trace obtained during calibration for sensor 04B09.

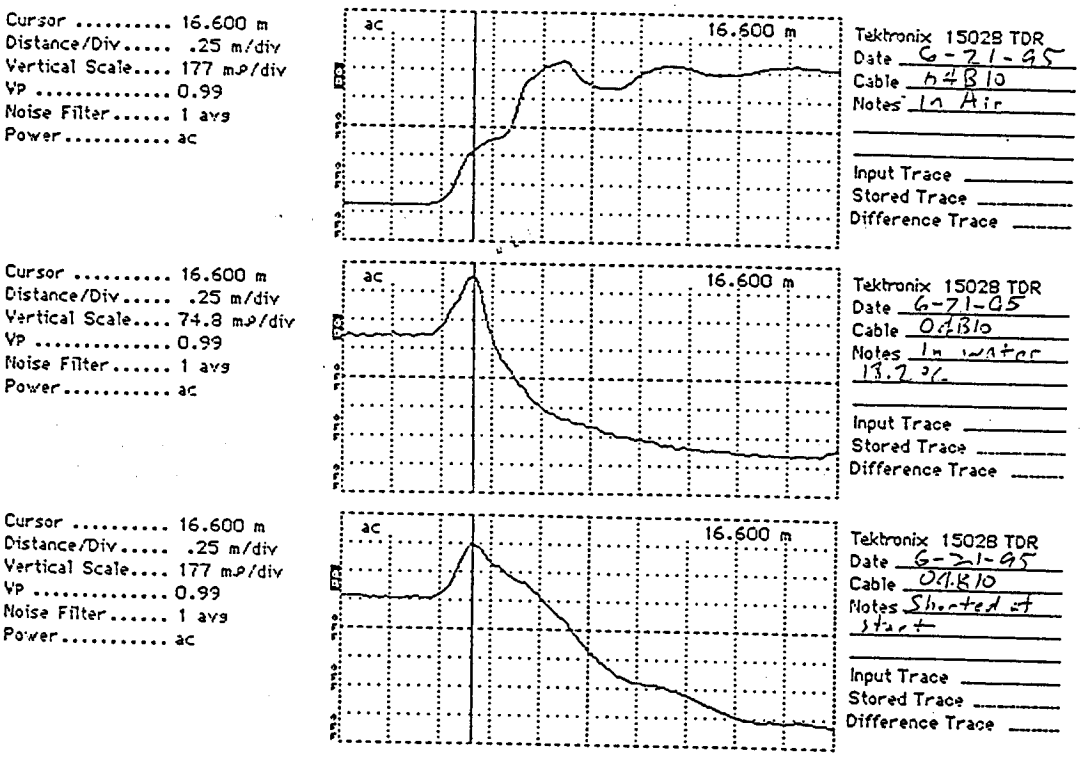


Figure B10. TDR trace obtained during calibration for sensor 04B010.

APPENDIX C

Installation Information

Appendix C has the following supporting information.

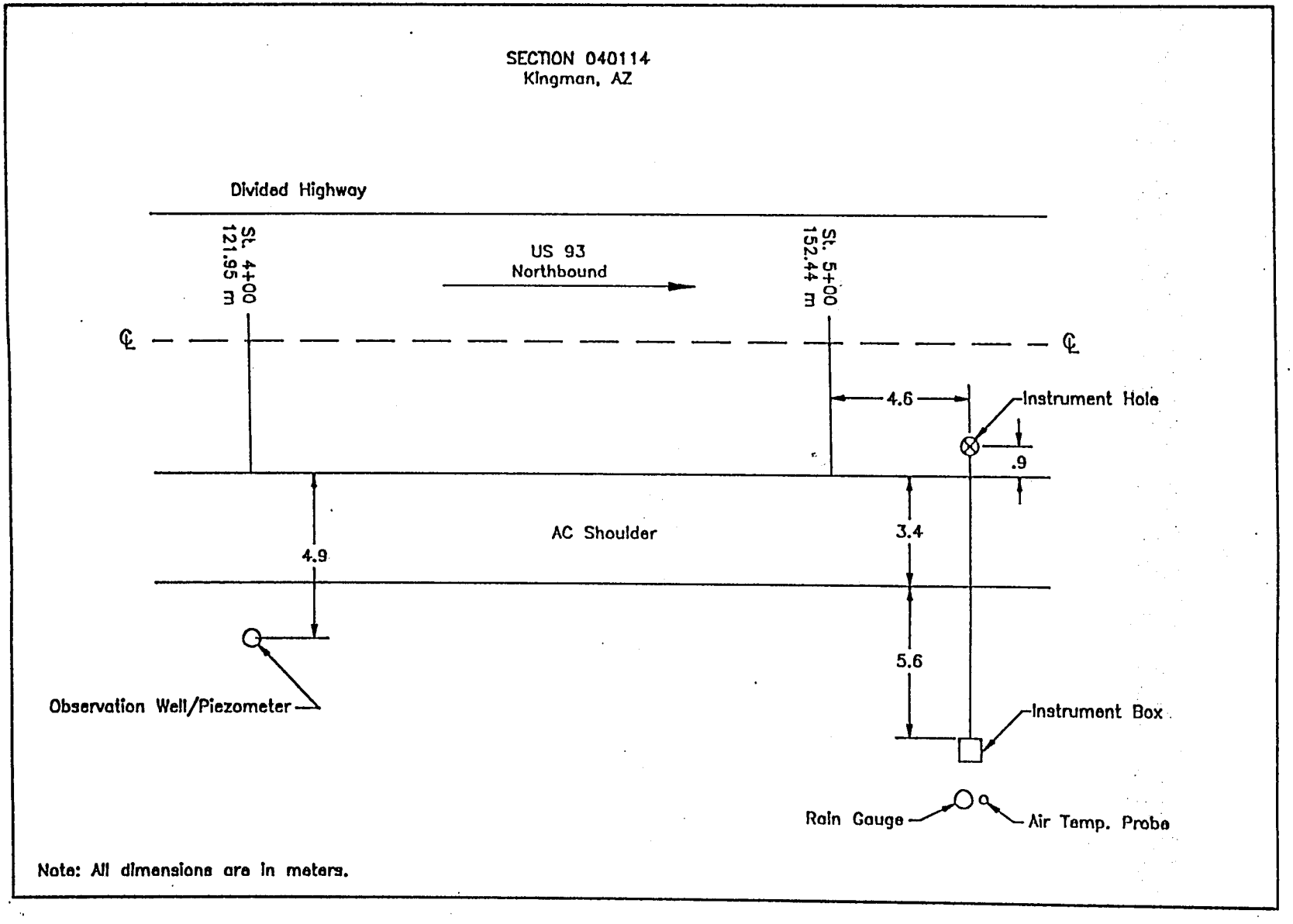
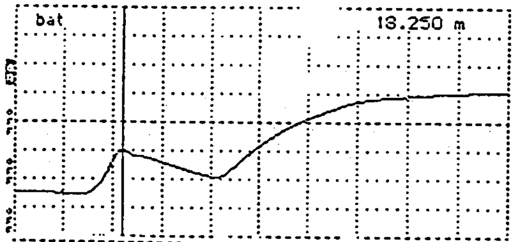


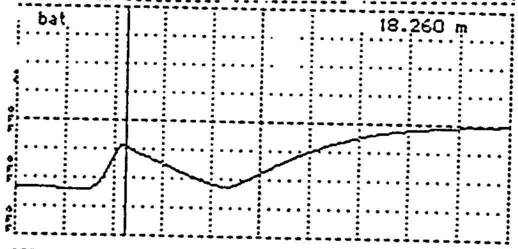
Figure C1. Instrumentation location within the section.

Curs ...... 18.250 m
Dis ....v .... .25 m/div
Ve.. ...cale.... 133 mρ/div
Vp 0.99
Noise Filter .... 1 avg
Power .... bat



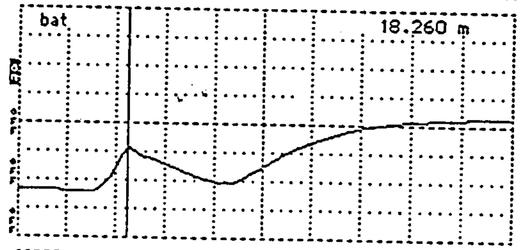
Tektronix 1502B TDR
Date 8/4/95
Cable 04A01
Notes ____
Input Trace ____
Stored Trace ____
Difference Trace ____

Cursr .. .8.260 m
Dist.../Div..... .25 m/div
Vertical Scale.... 133 mρ/div
Vp 0.99
Noise Filter...... 1 avg
Power........... bat



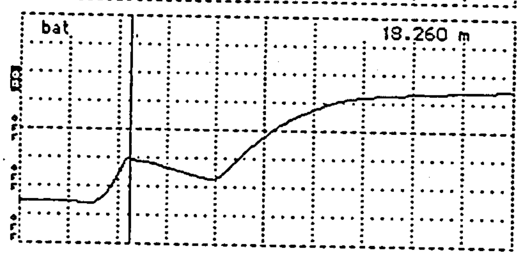
Tektronix 1502B TDR
Date 8/4/95
Cable 04A02
Notes ____
Input Trace ____
Stored Trace ____
Difference Trace ____

Cursor .... 18.260 m
Distance/Div..... .25 m/div
Vertical Scale.... 133 mρ/div
Vp 0.99
Noise Filter...... 1 avg
Power........... bat



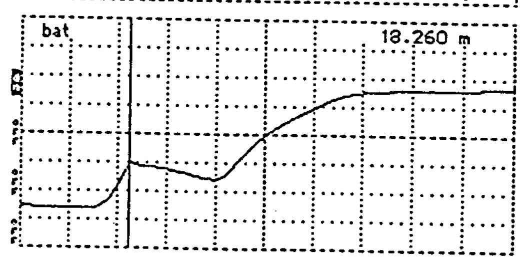
Tektronix 1502B TDR
Date 8/4/95
Cable 04A03
Notes ____
Input Trace ____
Stored Trace ____
Difference Trace ____

Cursor .... 18.260 m
Distance/Div..... .25 m/div
Vertical Scale.... 133 mρ/div
Vp 0.99
Noise Filter...... 1 avg
Power........... bat



Tektronix 1502B TDR
Date 8/4/95
Cable 04A04
Notes ____
Input Trace ____
Stored Trace ____
Difference Trace ____

Cursor .... 18.260 m
Distance/Div..... .25 m/div
Vertical Scale.... 133 mρ/div
Vp 0.99
Noise Filter...... 1 avg
Power........... bat



Tektronix 1502B TDR
Date 8/4/95
Cable 04A05
Notes ____
Input Trace ____
Stored Trace ____
Difference Trace ____

Figure C2. TDR traces measured during installation for sensors 04A01 thru 04A05.

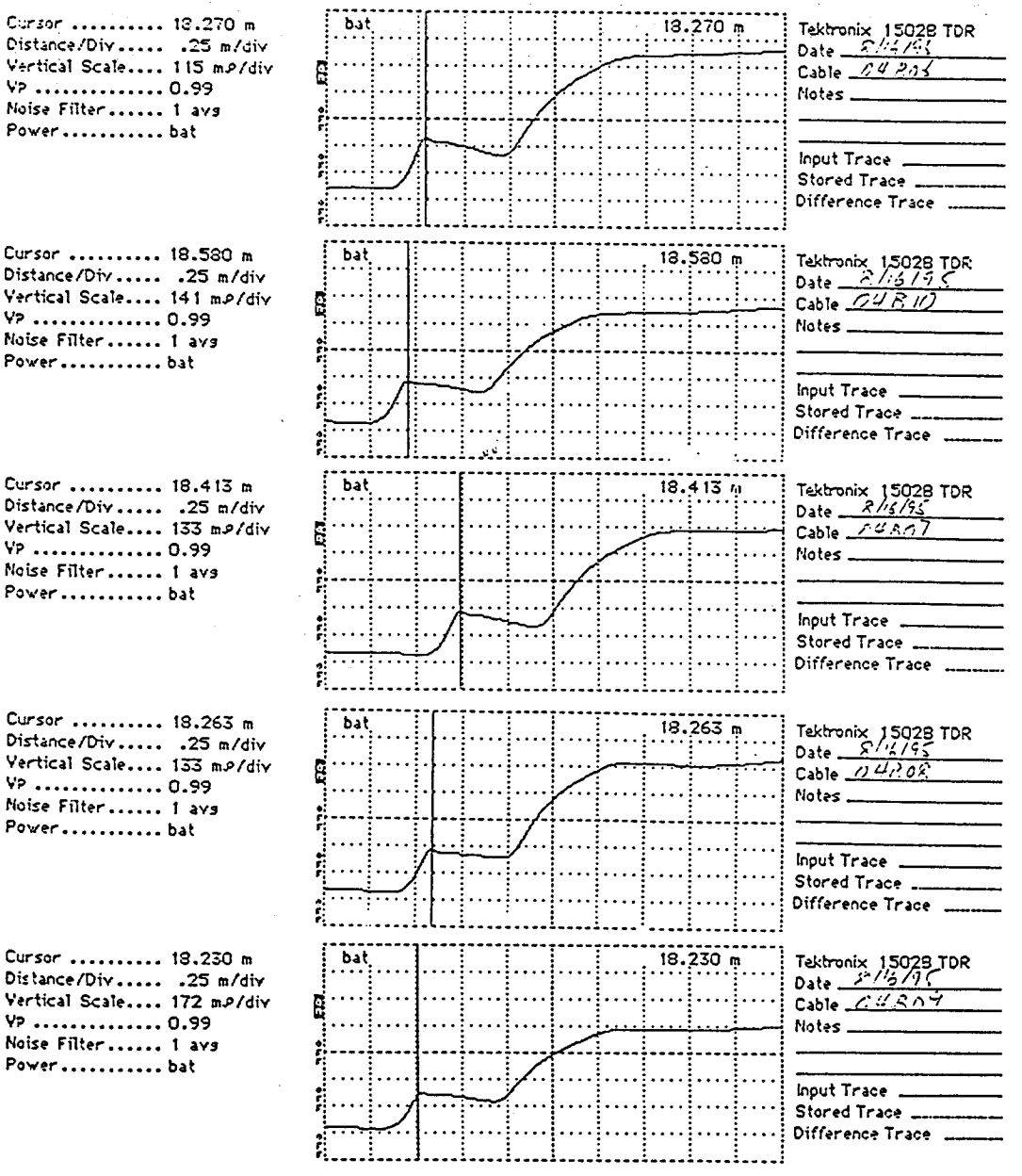


Figure C3. TDR traces measured during installation for sensors 04A06 thru 04A010.

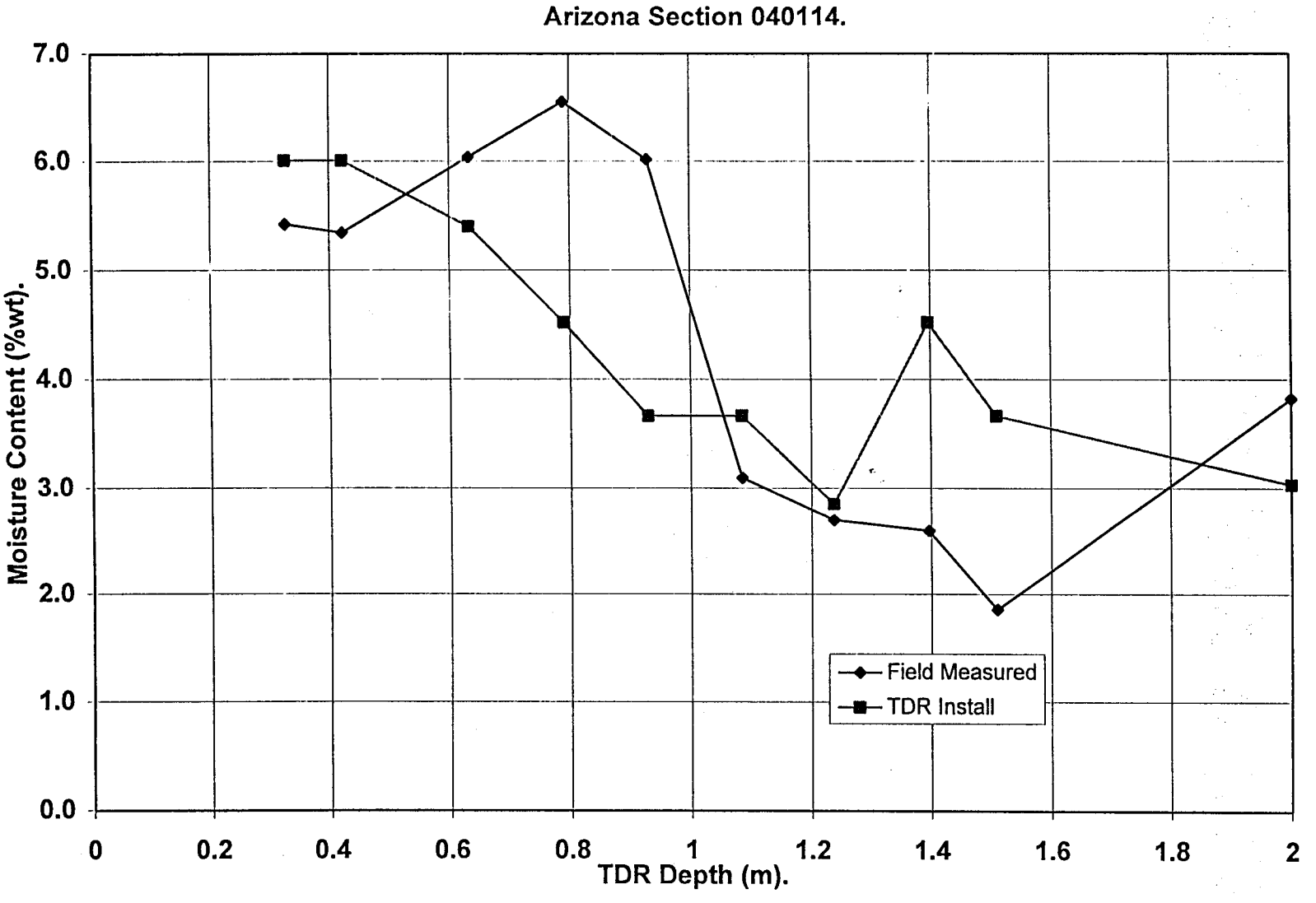


Figure C4. Measured field moisture contents and TDR moisture contents during installation.

Figure C5. Instrument installation in progress.

Figure C6. Weather station and instrument cabinet.

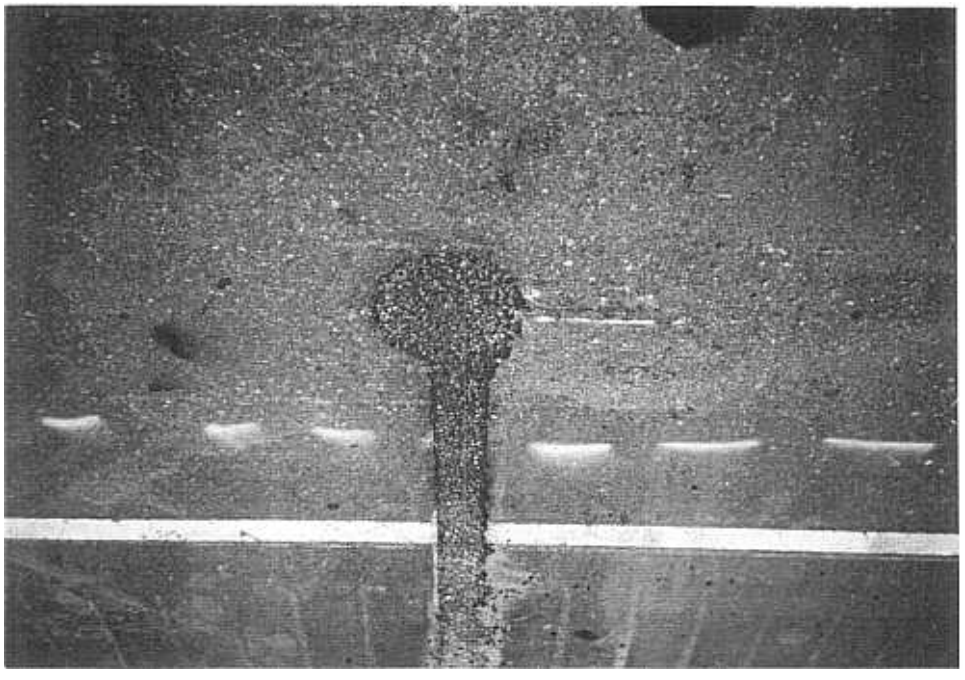


Figure C7. Instrument hole after repair.

Figure C8. Observation well/piezometer.

Table C1. Measured field moisture contents during installaton.

LTPP Seasonal Monitoring Study Field Measured Moisture Contents	*State Code [04] *Test Section Number [0114]

Personnel : Phil Friedman
Date : 8/15/95
Start Time : N/A
Finish Time : N/A
Surface Type : Asphalt Concrete
Weather Conditions : Clear, Sunny
Unusual Conditions : None

TDR Sensor Number	Field Measured Moisture Content %
10	5.4
9	5.4
8	6.0
7	6.6
6	6.0
5	3.1
4	2.7
3	2.6
2	1.9
1	3.8

APPENDIX D

Initial Data Collection

Appendix D includes the following support information.

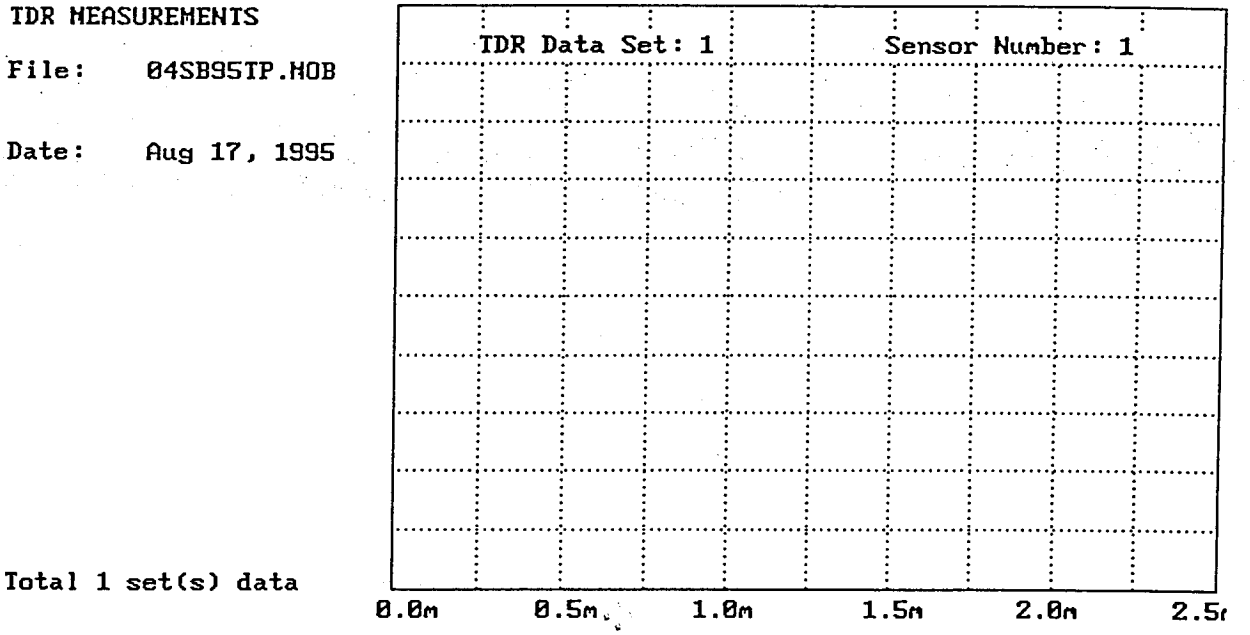


Figure D1. TDR trace recorded by the mobile system during initial data collection, sensor 04A01.

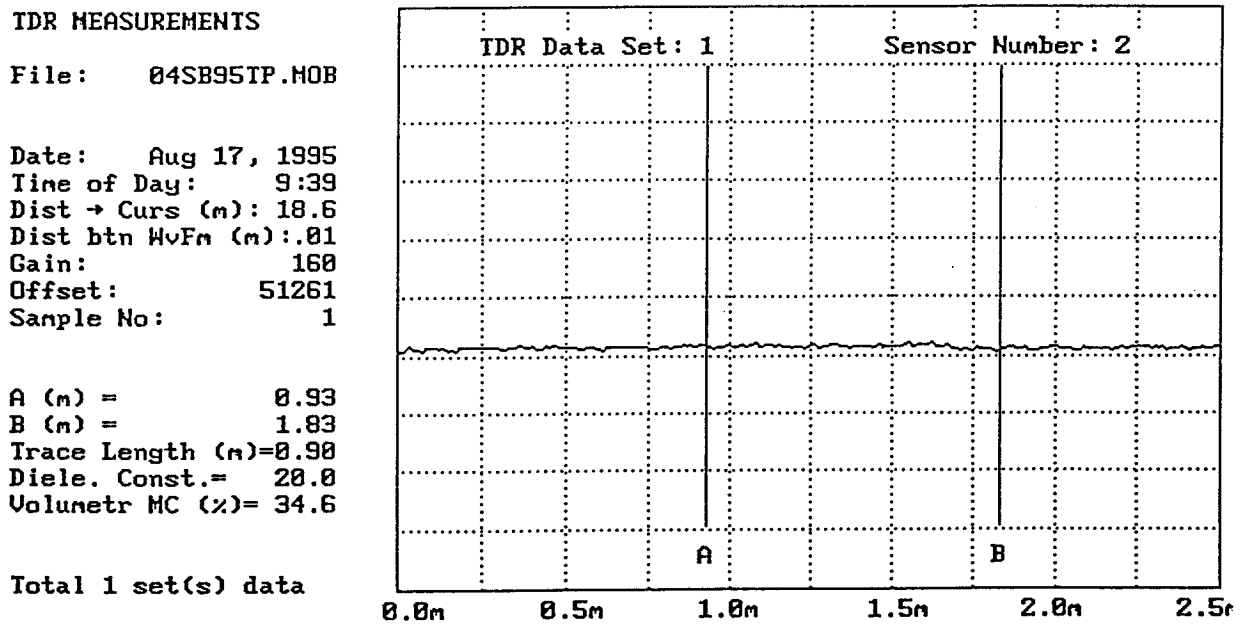


Figure D2. TDR trace recorded by the mobile system during initial data collection, sensor 04A02.

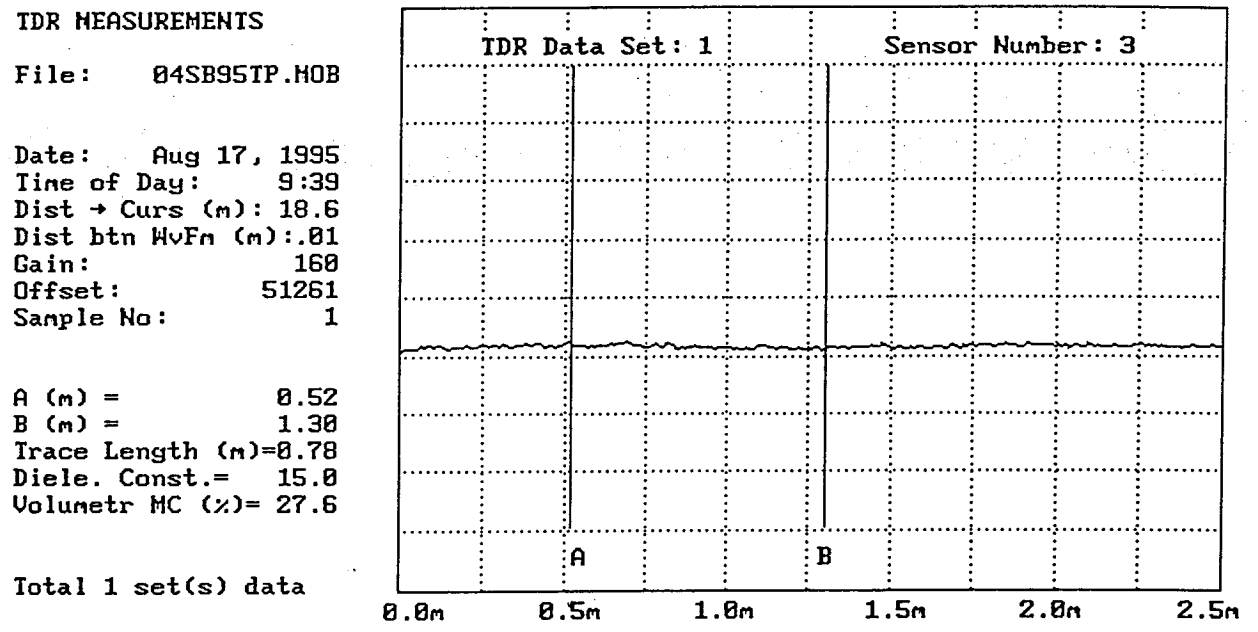


Figure D3. TDR trace recorded by the mobile system during initial data collection, sensor 04A03.

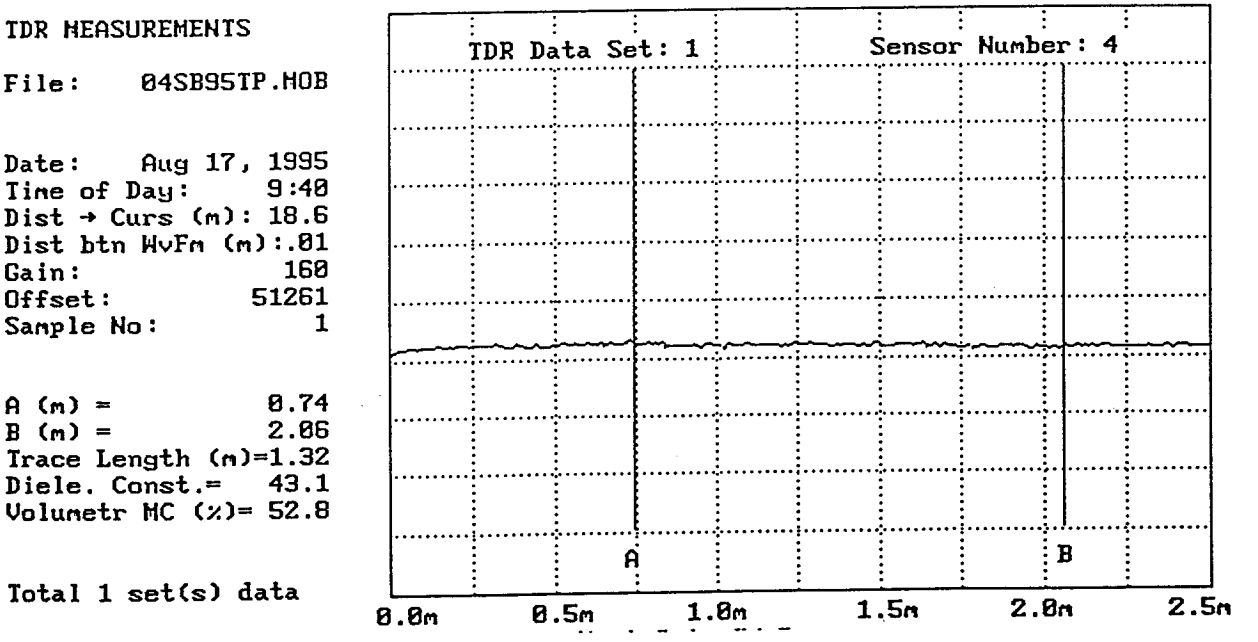


Figure D4. TDR trace recorded by the mobile system during initial data collection, sensor 04A04.

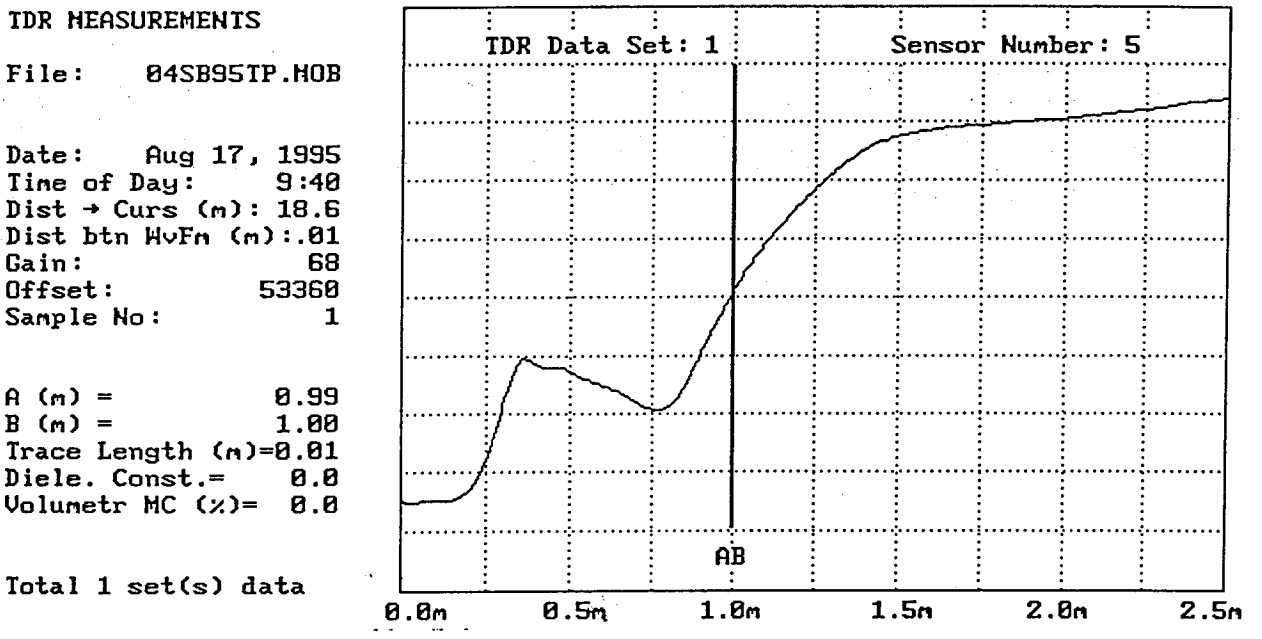


Figure D5. TDR trace recorded by the mobile system during initial data collection, sensor 04A05.

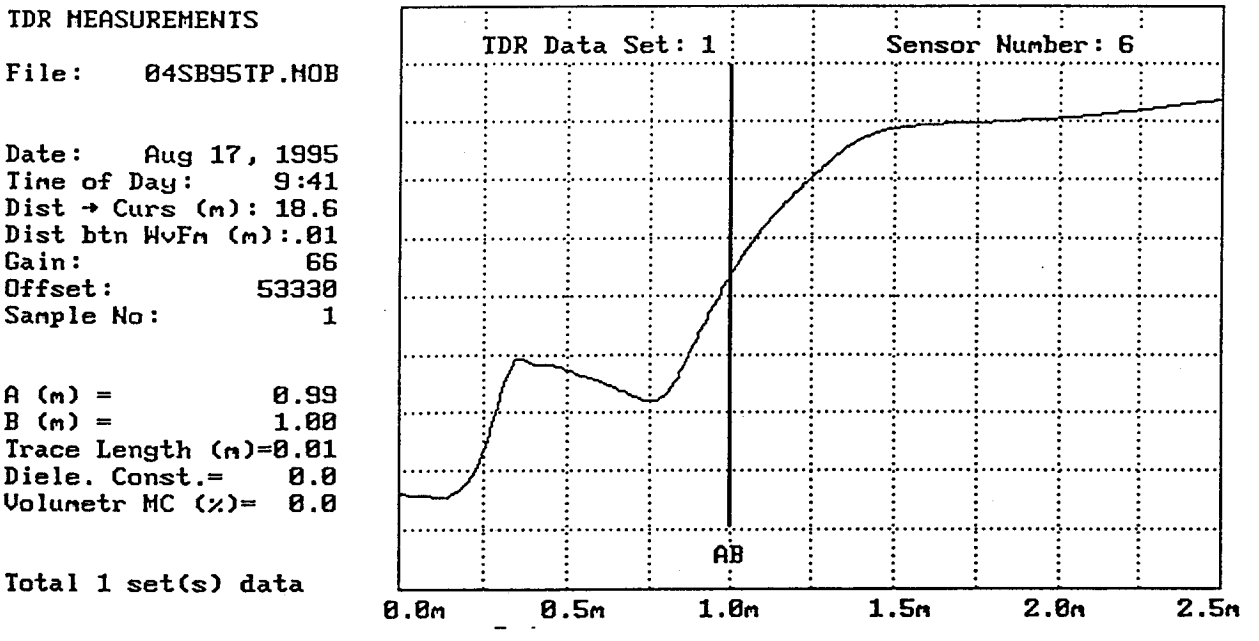


Figure D6. TDR trace recorded by the mobile system during initial data collection, sensor 04A06.

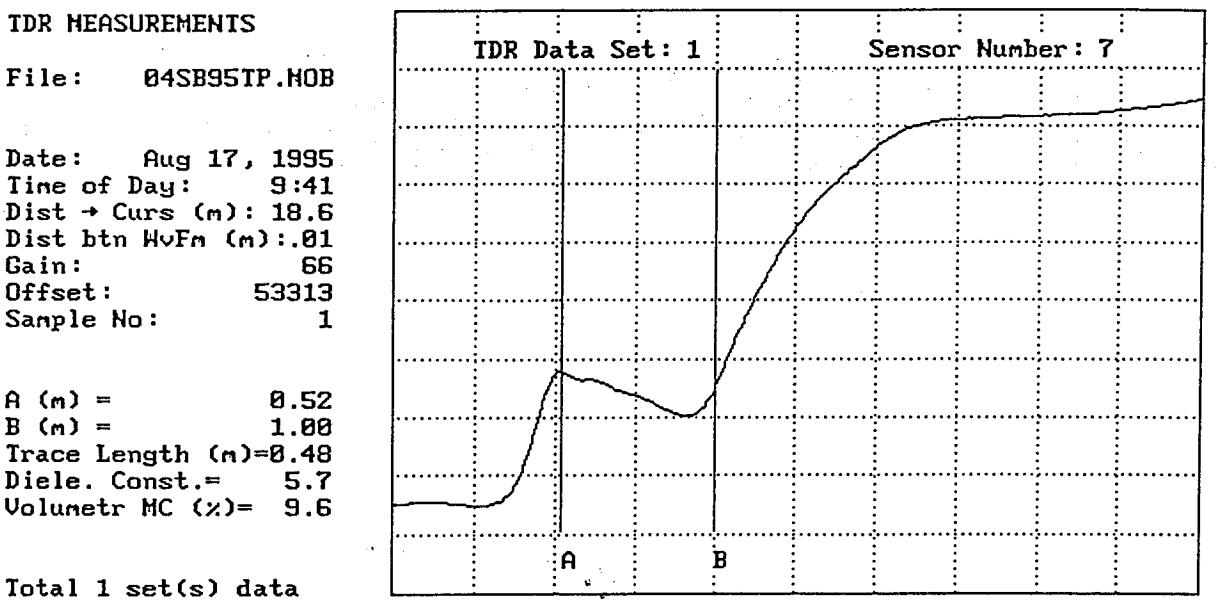


Figure D7. TDR trace recorded by the mobile system during initial data collection, sensor 04A071.

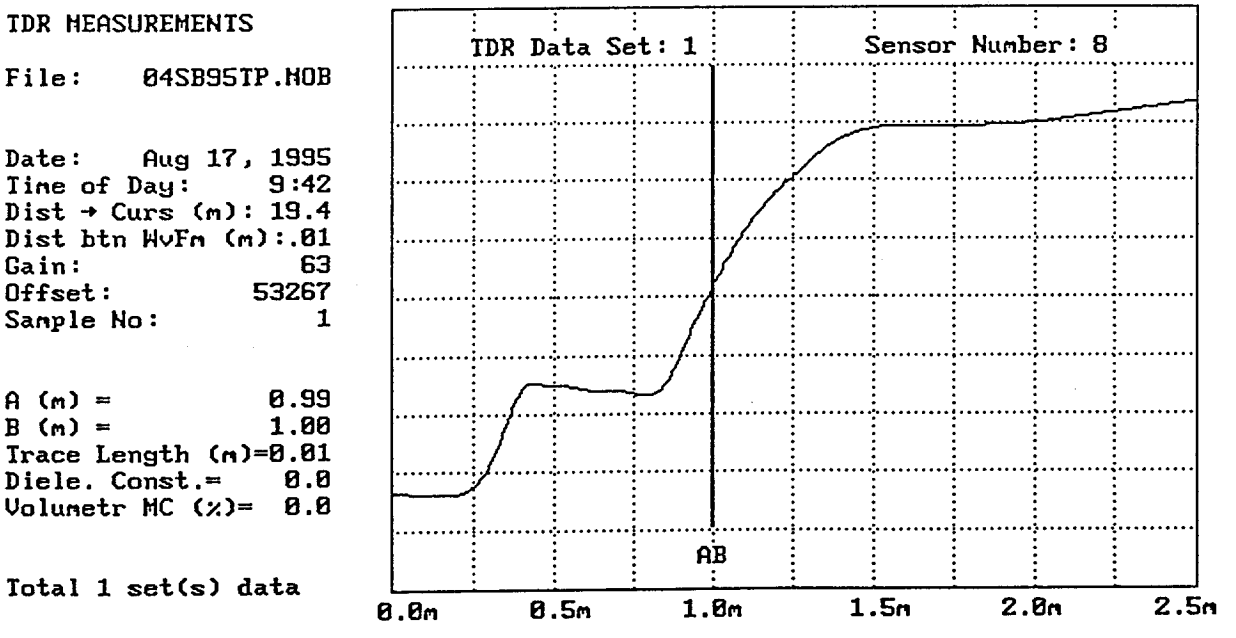


Figure D8. TDR trace recorded by the mobile system during initial data collection, sensor 04A08.

TDR MEASUREMENTS

File: 04SB95TP.MOB

Date: Aug 17, 1995
Time of Day: 9:43
Dist → Curs (m): 19.4
Dist btn WvFm (m):.01
Gain: 63
Offset: 52973
Sample No: 1

A (m) = 0.99
B (m) = 1.00
Trace Length (m)=0.01
Diele. Const.= 0.0
Volumetr MC (%)= 0.0

Total 1 set(s) data

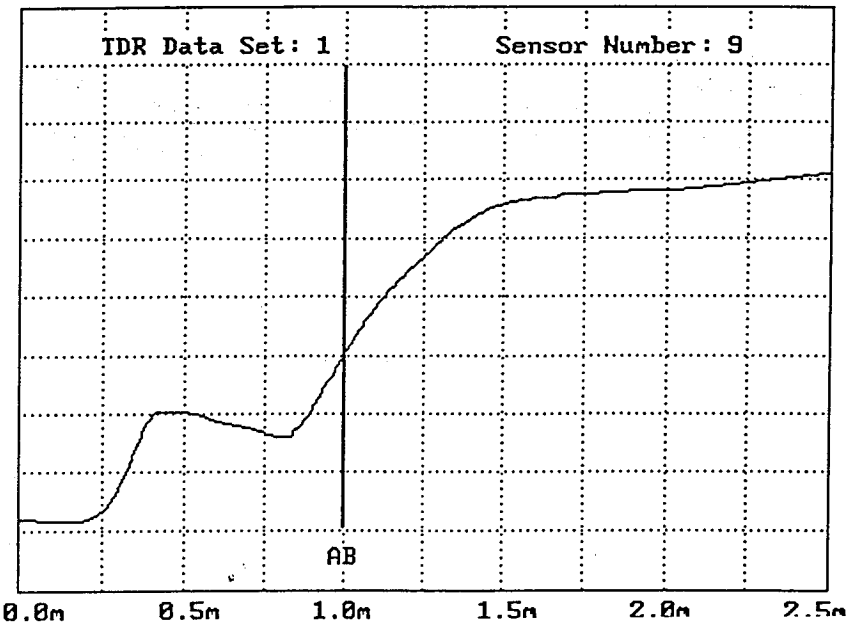


Figure D9. TDR trace recorded by the mobile system during initial data collection, sensor 04A09.

TDR MEASUREMENTS

File: 04SB95TP.MOB

Date: Aug 17, 1995
Time of Day: 9:43
Dist → Curs (m): 19.4
Dist btn WvFm (m):.01
Gain: 160
Offset: 51259
Sample No: 1

A (m) = 0.65
B (m) = 2.06
Trace Length (m)=1.41
Diele. Const.= 49.1
Volumetr MC (%)= 56.4

Total 1 set(s) data

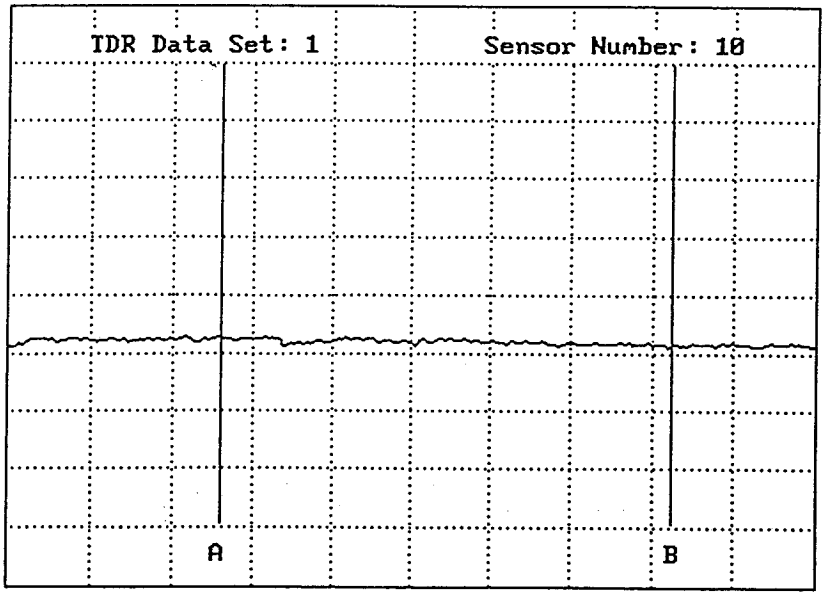


Figure D10. TDR trace recorded by the mobile system during initial data collection, sensor 04A010.

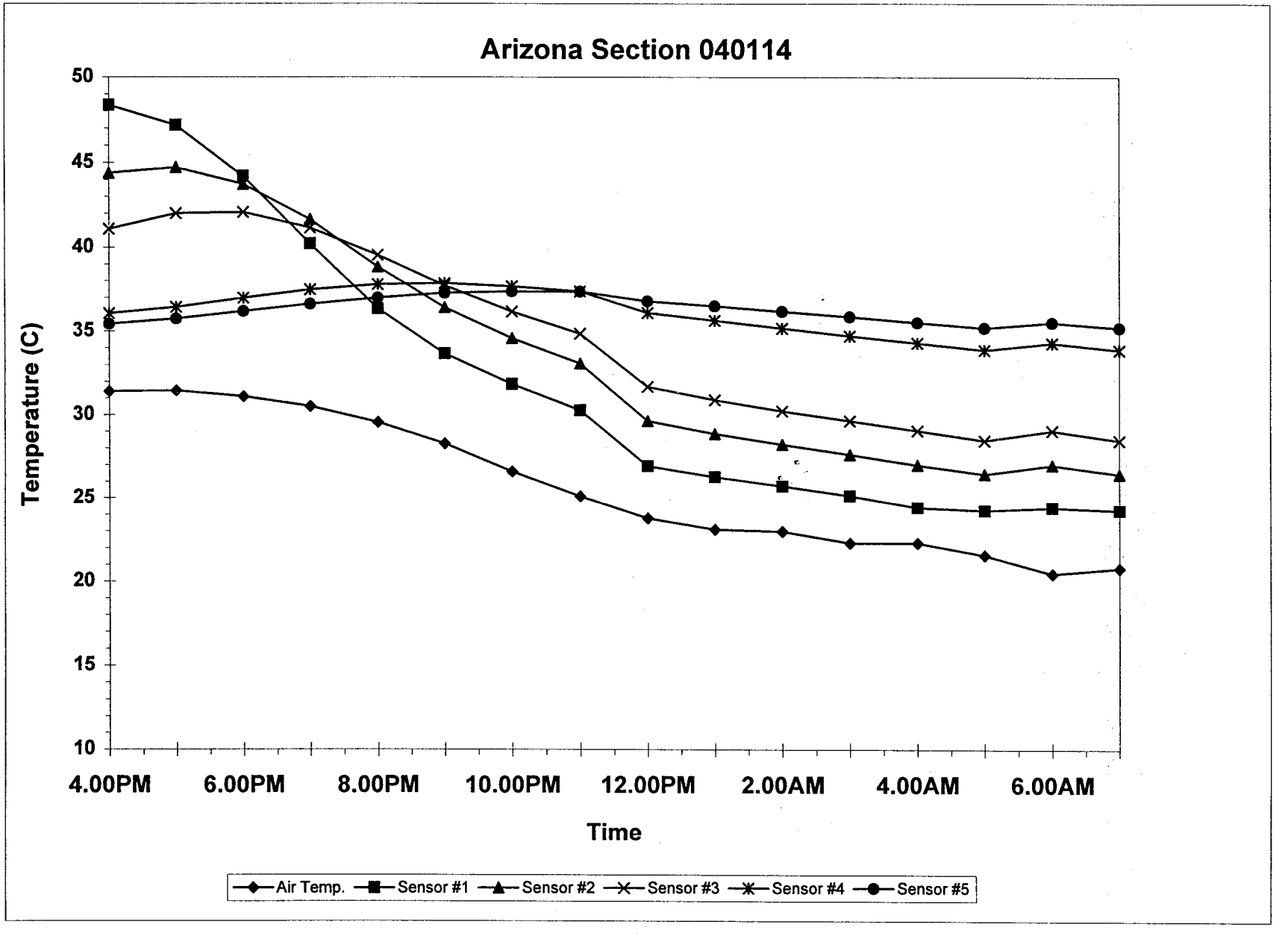


Figure D11. Hourly average air and top 5 sensor temperature recorded during initial data collection.

Table D1. Onsite raw data collected by the datalogger.

5	1995	228	1600	12.05	31.41	0																
6	1995	228	1600	48.35	44.38	41.08	36.05	35.42														
5	1995	228	1700	12.05	31.45	0																
6	1995	228	1700	47.17	44.71	41.99	36.42	35.74														
5	1995	228	1800	12.05	31.09	0																
6	1995	228	1800	44.2	43.73	42.07	36.96	36.18														
5	1995	228	1900	12.05	30.51	0																
6	1995	228	1900	40.23	41.66	41.16	37.46	36.61														
5	1995	228	2000	12.05	29.55	0																
6	1995	228	2000	36.34	38.84	39.54	37.78	36.98														
5	1995	228	2100	12.05	28.28	0																
6	1995	228	2100	33.67	36.41	37.73	37.85	37.26														
5	1995	228	2200	12.04	26.6	0																
6	1995	228	2200	31.85	34.58	36.17	37.67	37.37														
5	1995	228	2300	12.04	25.11	0																
6	1995	228	2300	30.28	33.08	34.85	37.37	37.35														
1	1995	228	2400	12.05	12.06	1902	12.03	2320	28.53	32.67	1601	22.99	2348	0	4067							
2	1995	228	2400	37.47	38.57	38.6	37.22	36.73	36.4	36.46	36.73	37.01	36.67	36.34	35.81	35.29	34.87	34.58	34.38	33.99		
3	1995	228	2400	48.58	1527	44.95	1609	42.42	1708	38.03	2021	37.4	2024	37.12	2335	36.99	2351	36.99	0	37.27		
4	1995	228	2400	28.29	0	31.15	0	33.13	2359	35.96	1522	35.31	1528	35.35	1526	36	1530	36.51	1740	36.89		
5	1995	228	2400	12.03	23.78	0																
6	1995	228	2400	28.94	31.77	33.67	36.98	37.23														
5	1995	229	100	12.03	23.1	0																
6	1995	229	100	27.8	30.6	32.61	36.55	37.03														
5	1995	229	200	12.03	22.99	0																
6	1995	229	200	26.93	29.64	31.69	36.1	36.78														
5	1995	229	300	12.02	22.3	0																
6	1995	229	300	26.28	28.87	30.9	35.64	36.49														
5	1995	229	400	12.02	22.31	0																
6	1995	229	400	25.74	28.23	30.24	35.18	36.18														
5	1995	229	500	12.02	21.57	0																
6	1995	229	500	25.15	27.64	29.65	34.73	35.86														
5	1995	229	600	12.02	20.48	0																
6	1995	229	600	24.43	27	29.06	34.31	35.53														
5	1995	229	700	12.02	20.8	0																

Table D2. Pavement elevations at the time of installation.

Station*	Offsets in m.					Comments
	PE[1]	OWP[2]	ML[3]	IWP[4]	ILE[5]	
3+00	2.60	2.56	2.50	2.45	2.38	Observation Well/Piezometer top assumed as 1.0 meter
3+25	3.21	3.19	3.10	3.02	2.96	
3+50	3.87	3.86	3.76	3.68	3.61	
3+75	4.54	4.52	4.44	4.37	4.31	
4+00	5.21	5.18	5.14	5.06	5.00	
4+25	5.87	5.84	5.78	5.73	5.65	
4+50	6.57	6.52	6.47	6.41	6.33	
4+75	7.24	7.21	7.18	7.08	7.02	
5+00	7.92	7.89	7.82	7.76	7.68	
5+08		8.19				
5+15		8.36	8.30			
5+22		8.51				

*. Customary units.
1. Pavement Edge
2. Outer Wheel Path
3. Middle of Lane
4. Inner Wheel Path
5. Inner Left Edge