U.S. Department of Transportation
Federal Highway Administration

LTPP Seasonal Monitoring Program

Site Installation and Initial Data Collection

Section 040113

Kingman, Arizona

Report No. FHWA-04-0113

May 1997

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LTPP Seasonal Monitoring Program

Site Installation and Initial Data Collection
Section 040113, Kingman, Arizona

Report No. FHWA-04-0114

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16. Abstract

This report contains a description of the instrumentation installation activities and initial data collection for test section 040113 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 15, 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 16, 1995. This included FWD and precipitation data, elevation , air and subsurface temperature and TDR moisture 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.

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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 040113

INTRODUCTION

This report describes the equipment installation activities and initial data collection for test section 040113 near Kingman, Arizona. The equipment installation activities were carried out on August 15, 1995 and initial data was collected on August 16, 1995.

Section Location

Section 040113 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 51.3, 25 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 5 requirements. Figure A1 in appendix A contains a map showing the location of the section.

Section Details

The pavement section consists of 117mm of Asphalt Concrete (AC) with 203mm aggregate base (AB) over medium sand subgrade. The test section has a 3.70m travel lane with a 4.20m wide asphalt shoulder. Additional details are summarized in table 1.

Table 1. Details of section 040113 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 #5

Pre-installation FWD testing was carried out on the test section on February 21, 1995. In addition, several notes and pictures were taken to assist in selecting the end to instrument. FWD data was analyzed using the FWDCheck program. The deflection profile of the section indicates some non-uniformity of the section at both ends. The results are presented in figures A2 through A6 in appendix A. The material properties of individual pavement layers are presented in table 2. Figures A7 and A8 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	Medium Sand
Thickness (mm)	117*	203*	N/A
Proctor Dry Density (kg/m^3)	----	----	1930**
Proctor Moisture Content (%)	----	----	6**
Field Measured Density	----	----	2118@5.8% MC***
Laboratory Maximum Dry Density (kg/m^3)	----	2253@5% MC	2016@9.8% MC
Liquid Limit	----	NP	NP
Plastic Limit	----	NP	NP
Plastic Index	----	NP	NP
Percent Passing #200	----	8.9%	8.8%

* 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 15, 1995 and initial data collection was performed on August 16, 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	J.J. Lieu	:	ADOT
William Nichols	:	NCE	J. Potter	:	ADOT traffic control
Mark A. Potter	:	NCE	A. Mannarel	:	ADOT traffic control
Michael E. Esposito	:	NCE	R. Gross	:	ADOT traffic control
Philip Friedman	:	NCE	Roger	:	Drilling crew

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 carried out all the SMP equipment installation. The site was visited and inspected by Douglas Frith and Mark Potter on February 21, 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	04A#2
TDR Sensors	10	04A01-04A10
Equipment Cabinet		
Campbell Scientific CR10 Datalogger	1	16562
Battery Pack	1	None
Weather Station		
TE 525 Tipping Bucket Rain Gauge	1	12050-693
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, which is within the recommended limits. 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 specified limits, and the sensors produced the expected traces and were functioning properly. Serial numbers of equipment to be installed were noted with the exception of radiation shield and air temperature sensors. The bench mark did not have a serial number and the batter pack serial number was not noted because the battery packs get changed frequently. Individual TDR probe traces obtained during calibration are presented in figures B1 through B10 in appendix B.

Instrument Installation

Analysis of pre-installation FWD data indicated non-uniform deflection response at both ends of the section. Since both ends were non-uniform, construction data, drainage conditions at both ends, and other site information were carefully considered before the selection of the leave end for instrumentation. The equipment installation generally followed the schedule given below.

0730	:	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.

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	

1000-1030	:	Excavation of instrumentation cable trench.
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 157.32m (station 5.00+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 2.0m 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 figure C2 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 9.90m away, to the right of lane edge on almost level ground. Extension cables were used for 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 obtained at a depth of 0.811m 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.

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

It is seen from the data in table 6 that field measured moisture contents were generally close to the moisture contents determined from the TDR traces obtained during installation. Variability observed in moisture contents at some sensor depths can be attributed to the field conditions, soil type, and the moisture determination method used in the field..

Table 5. Installed depths of TDR sensors.

TDR Sensor No.	Depth from Pavement Surface (m)	Layer
04A01	0.202	Base
04A02	0.355	Subgrade
04A03	0.508	
04A04	0.660	
04A05	0.811	
04A06	0.968	
04A07	1.116	
04A08	1.250	
04A09	1.510	
04A10	1.920	

Table 6. Measured moisture contents during installation.

Sensor No.	Sensor Depth (m)	Layer	Moisture Content (% by wt)	
			Field Measured[1]	TDR Installation[2]
04A01	0.202	Base	4.91	3.5
04A02	0.355		4.22	4.2
04A03	0.508		3.51	4.9
04A04	0.660		4.27	2.2
04A05	0.811		1.81	3.5
04A06	0.068		2.21	3.5
04A07	1.116		1.30	2.8
04A08	1.250		2.39	4.2
04A09	1.510		2.42	3.5
04A10	1.920		2.64	4.9

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.

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	0.015	AC
	2	0.050	
	3	0.080	
2	4	0.172	Base
	5	0.243	
	6	0.319	Subgrade
	7	0.396	
	8	0.472	
	9	0.626	
	10	0.775	
	11	0.930	
	12	1.082	
	13	1.235	
	14	1.386	
	15	1.540	
	16	1.690	
	17	1.845	
	18	1.993	

A 152mm diameter flight auger was used to bore the observation piezometer/benchmark at the edge of pavement shoulder at a distance of 121.95m (section station 4+00), and 4.1m to the right of lane edge. The piezometer was installed in accordance with the guidelines. 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 and the wires leading to the equipment cabinet. Subsequent tests confirmed that all installed equipment was functioning properly. The repair patch put on the instrument hole performed quite well throughout the monitoring period.

INITIAL DATA COLLECTION

The second day (August 16, 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. Post installation FWD testing of the section was also carried out.

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 for the ten TDR sensors during initial data collection. TDR traces obtained by the mobile data acquisition 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 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 and 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 040113 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 51.3, 25 miles north of the City of Kingman. This is a SPS-1 section in the "Dry, No Freeze" climatic zone in SMP cell #5.

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 15 and 16, respectively, in accordance with the LTPP SMP guidelines. 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 as it is located in the "No Freeze" environmental zone. The equipment installation hole is located at the leave end of the section at a distance of 157.32m from the section beginning. The equipment cabinet is located 9.9m 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 acquisition system during initial data collection indicated loose contact within the box. This resulted in some blank and flat traces. TDR trace data collected at the site during subsequent visits confirmed that the TDR sensors were functioning properly. There were no unusual conditions at this site.

APPENDIX A

Test Section Background Information

Appendix A includes the following supporting information:

Figure A1. Site location map.
Figure A2. Normalized deflection profile from FWDCHECK.
Figure A3. Corrected normalized deflection profile from FWDCHECK.
Figure A4. Elastic modulus of subgrade from FWDCHECK.
Figure A5. Composite modulus at Station 5+00 from FWDCHECK.
Figure A6. Equivalent structural number from FWDCHECK.
Figure A7. Sampling log of section during construction.
Figure A8. Boring log of instrument hole.

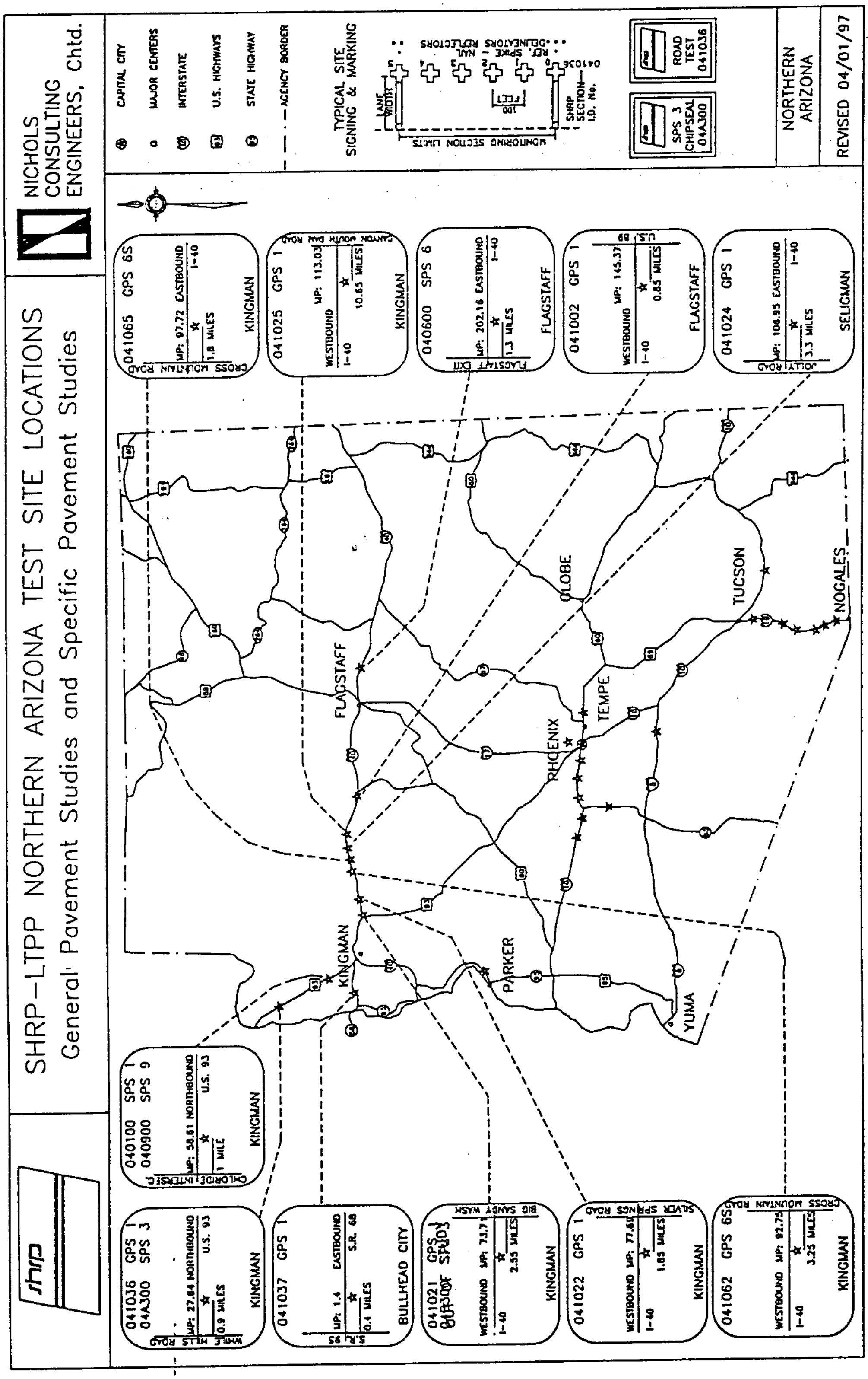


Figure A1. Site location map.

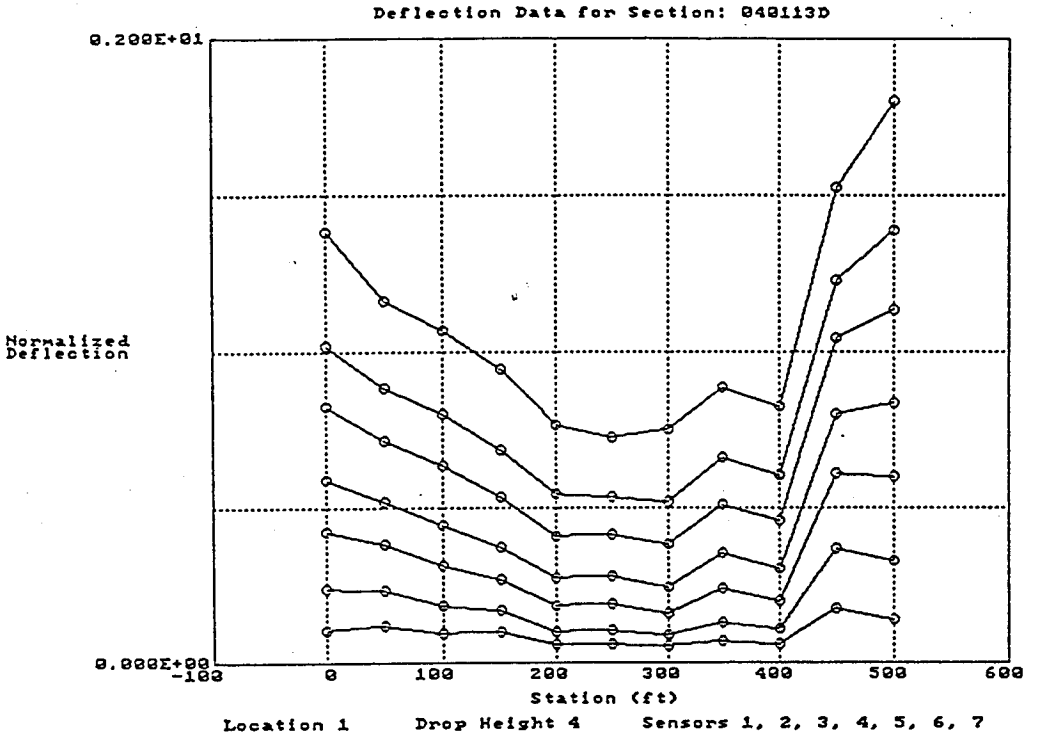


Figure A2. Normalized deflection profile from FWDCHECK.

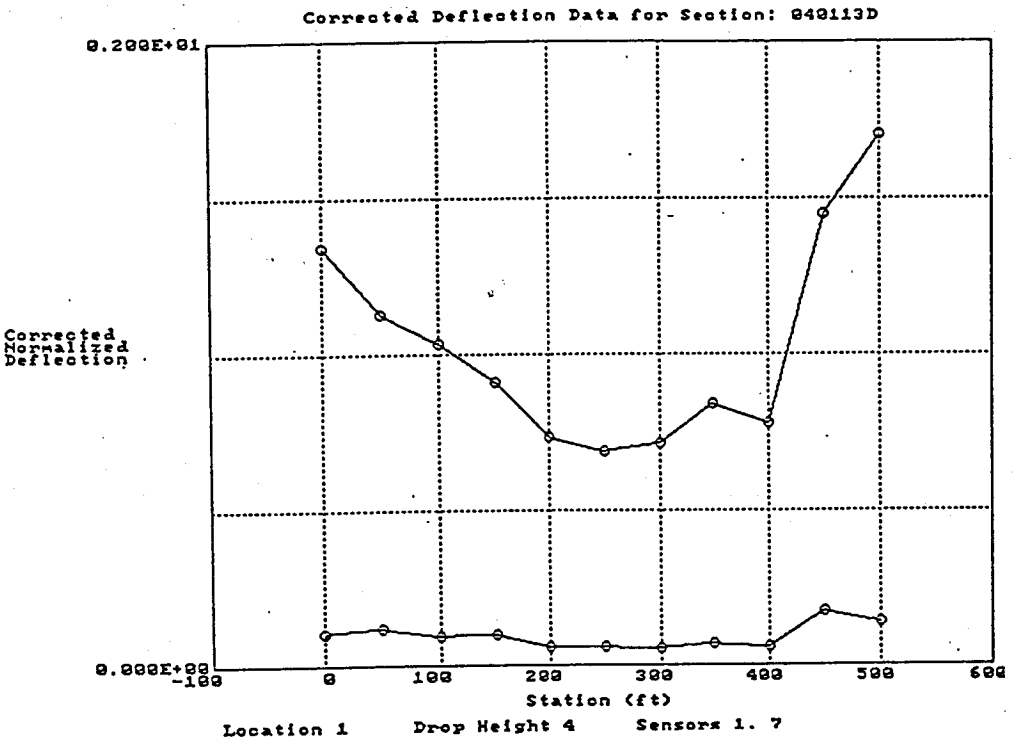


Figure A3. Corrected normalized deflection profile from FWDCHECK.

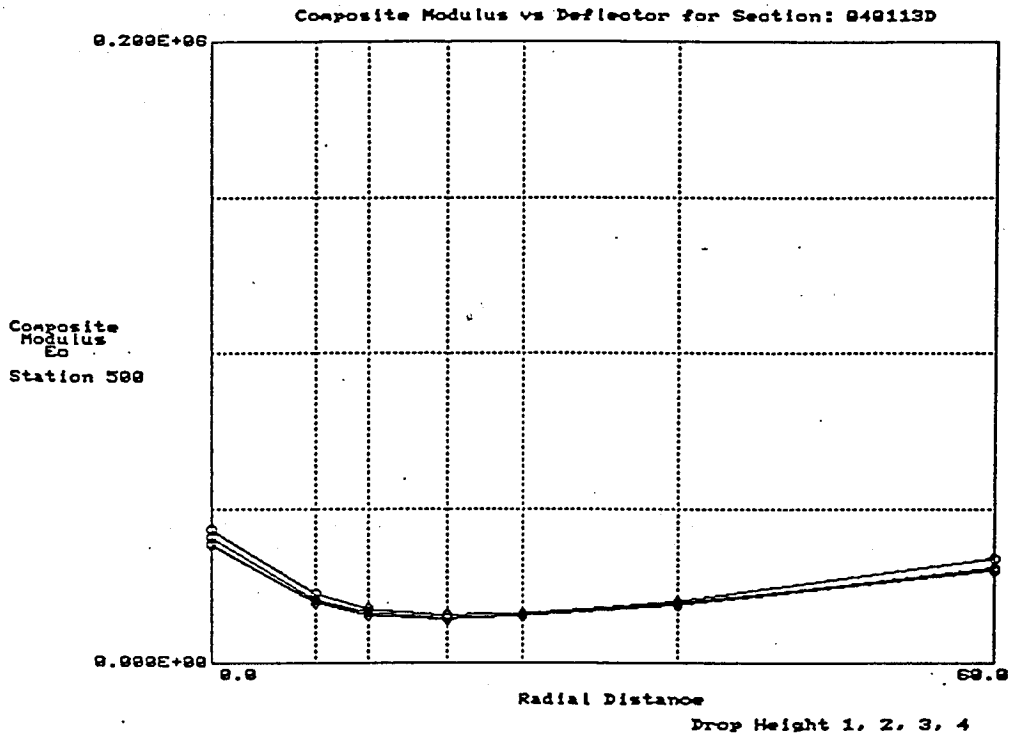


Figure A4. Elastic modulus of subgrade from FWDCHECK.

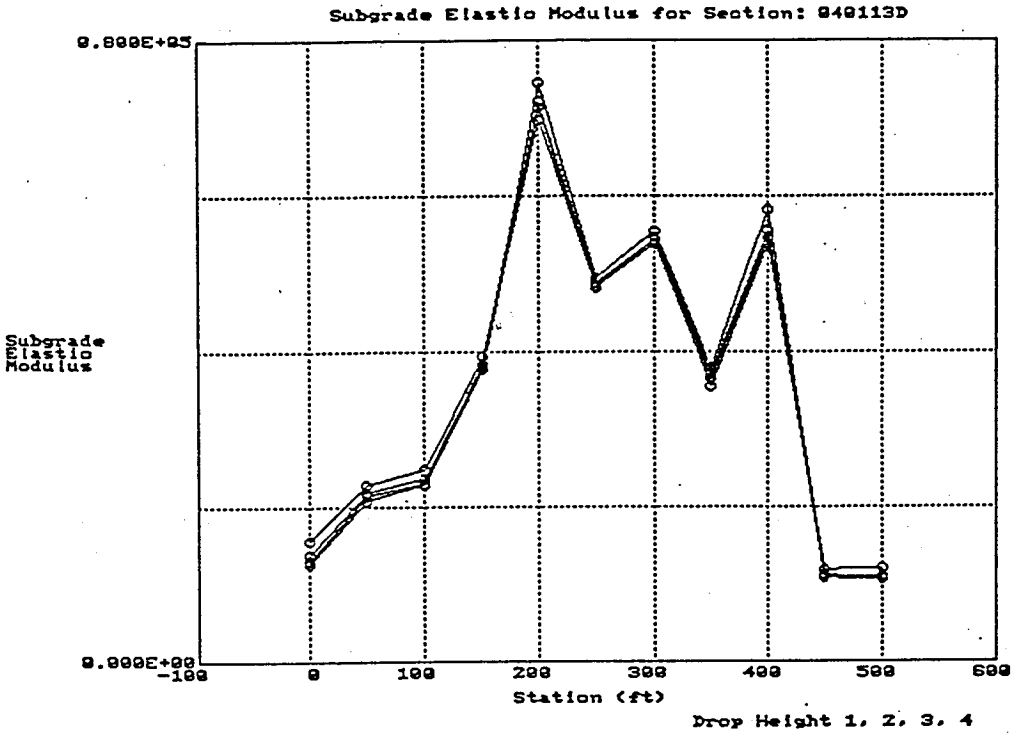


Figure A5. Composite modulus at Station 5+00 from FWDCHECK.

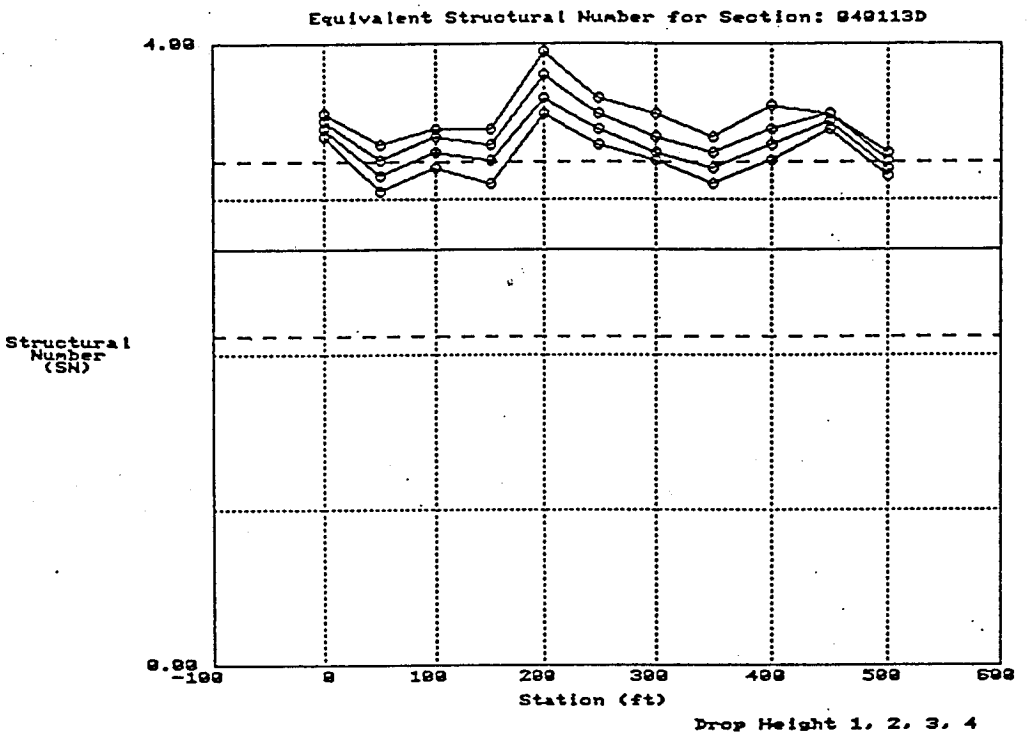


Figure A6. Equivalent structural number from FWDCHECK.

DRILLING & SAMPLING LOG

STATE: Arizona SHRP I.D. 040113

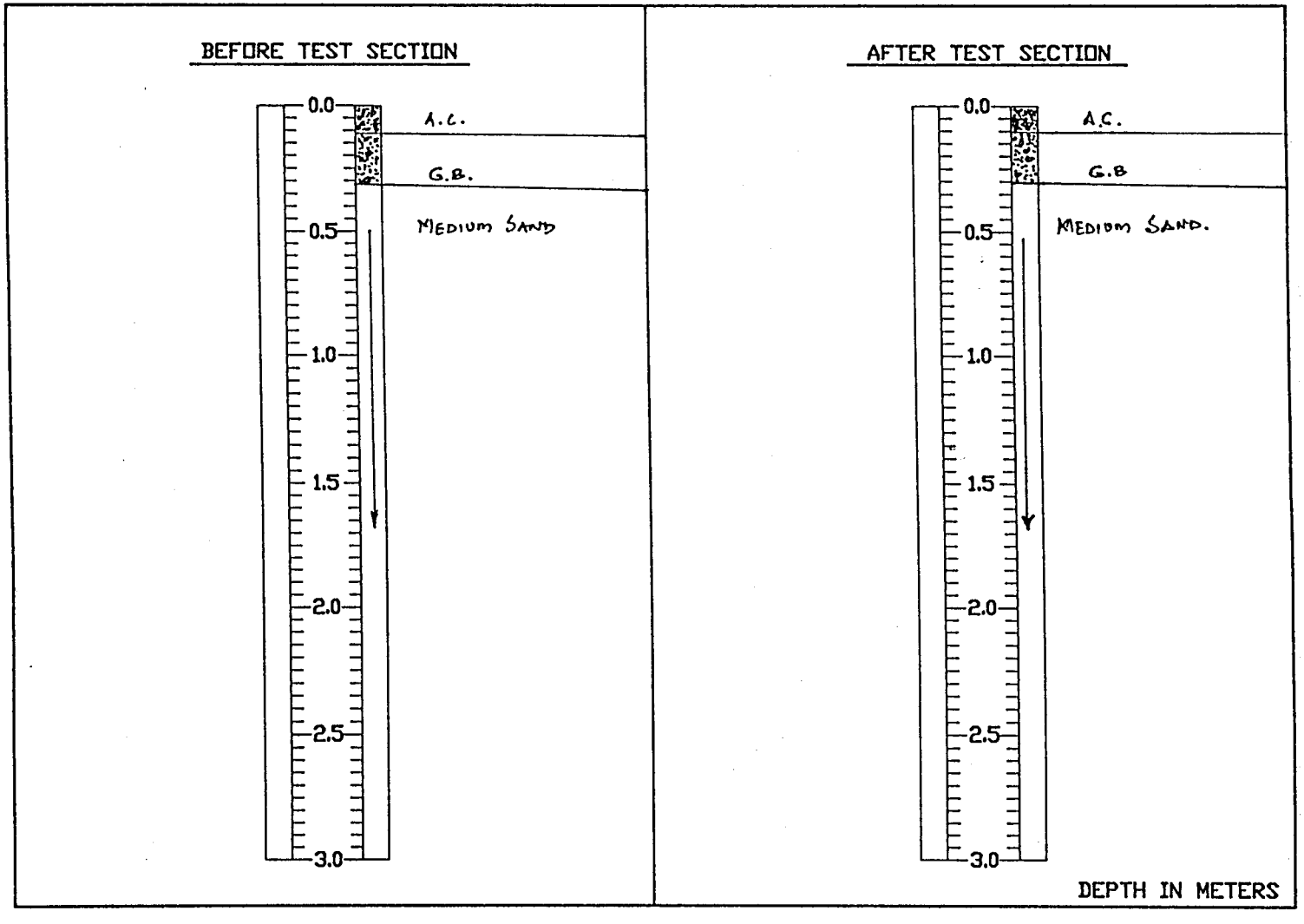
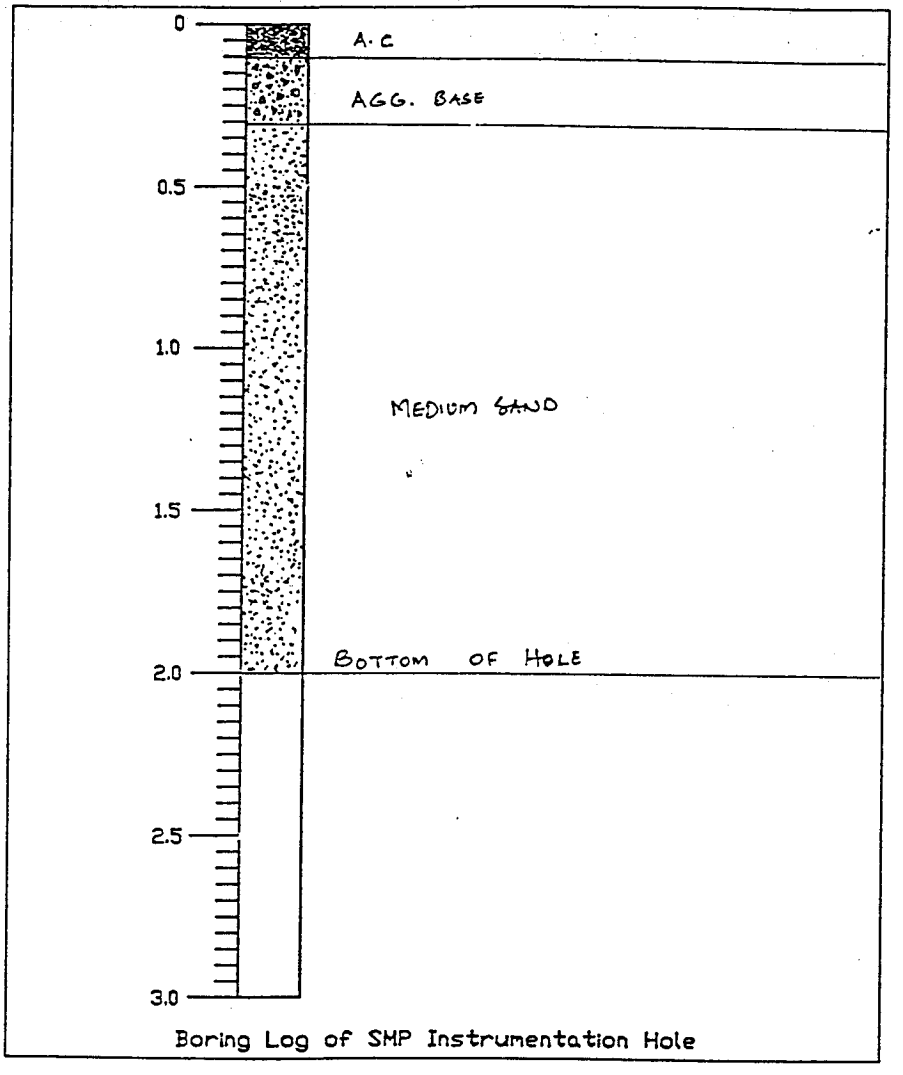


Figure A7. Sampling log of section during construction.

State ID. 04 SHRP ID. 0113

Station 157.32 m Date(dd/mm/yy) 15-08-96



Start Time _____ End Time _____

Prepared By HAIPING ZHOU Employed By N.C.E

Figure A8. Boring log of instrument hole.

SHEET 2

DISTRESS SURVEY

LTPP PROGRAM

STATE ASSIGNED ID ____

STATE CODE 64

SHRP SECTION ID 0113

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

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16. OTHER (Describe) _____

Revised December 1, 1992

SHEET 1

STATE ASSIGNED ID _ _ _ _

DISTRESS SURVEY

STATE CODE 0 4

LTPP PROGRAM

SHRP SECTION ID 0 1 1 3

DISTRESS SURVEY FOR PAVEMENTS WITH ASPHALT CONCRETE SURFACES

DATE OF DISTRESS SURVEY (MONTH/DAY/YEAR) 0 8/1 7/9 5

SURVEYORS: M E __, _ _ _ _ PHOTOS, VIDEO, OR BOTH WITH SURVEY (P, V, B) _
PAVEMENT SURFACE TEMP - BEFORE _ 3 2.5°C; AFTER _ 3 2.7°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	_ _ _.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	_ _ 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 RS

APPENDIX B

Installed Instrument Information

Appendix B includes the following supporting information:

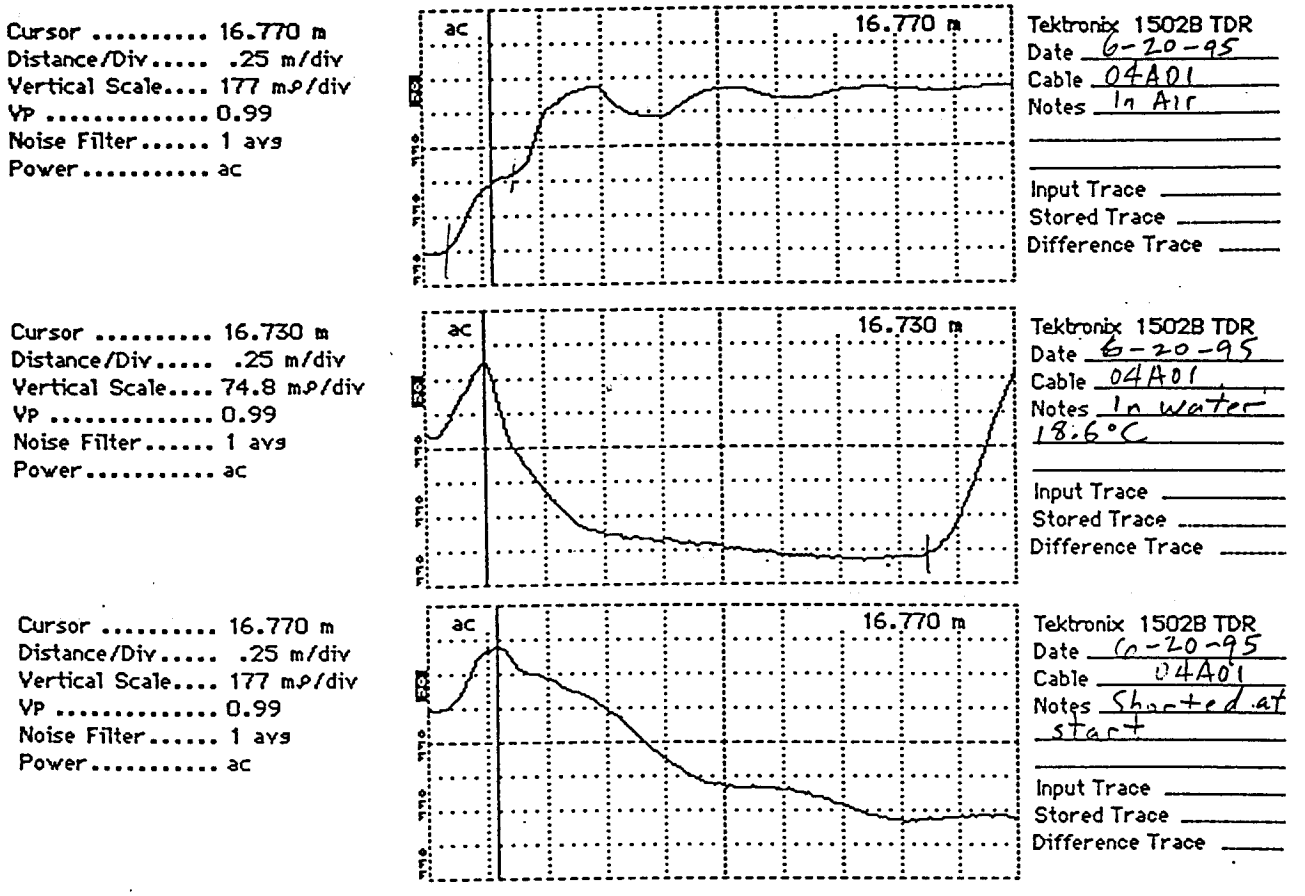


Figure B1. TDR trace obtained during calibration for sensor 04A01.

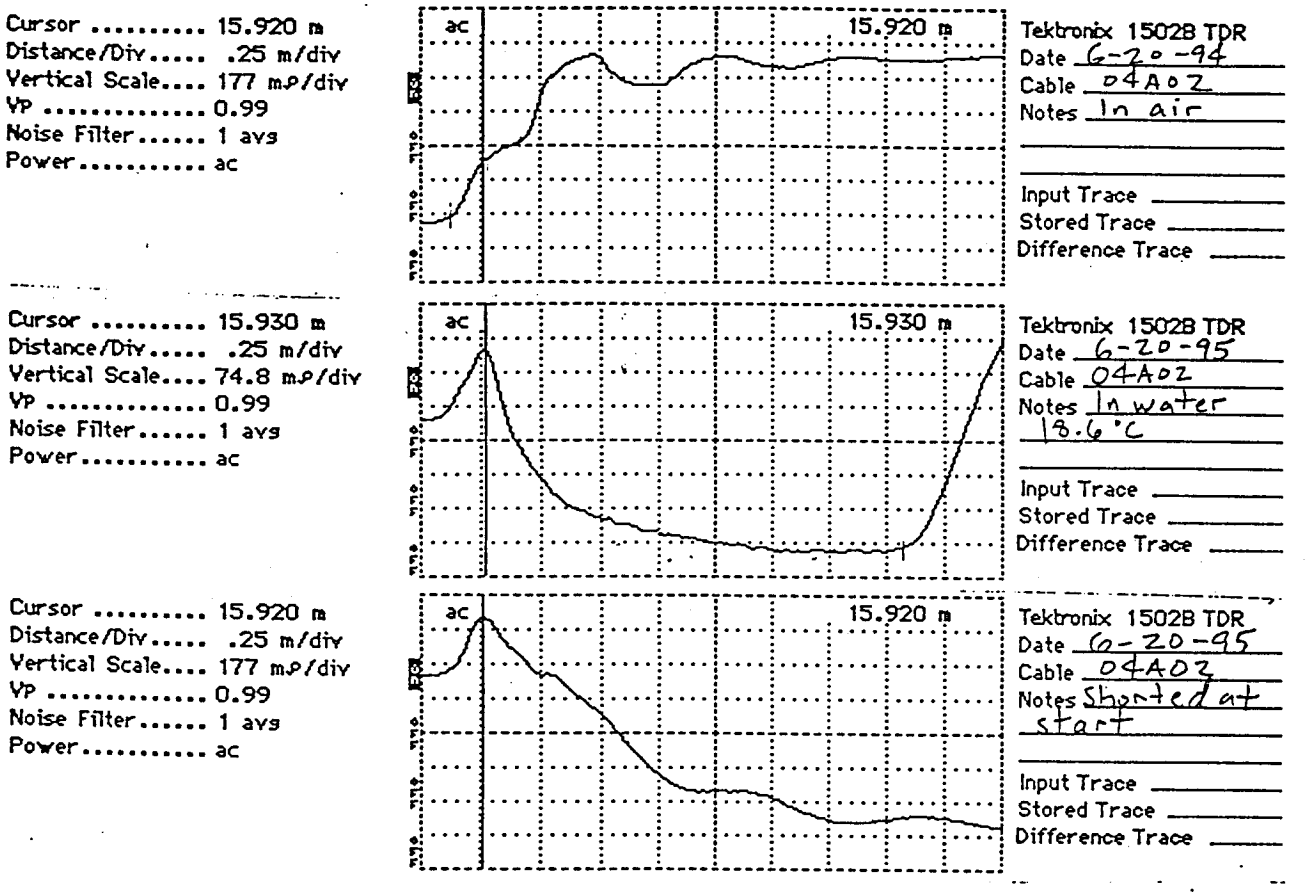


Figure B2. TDR trace obtained during calibration for sensor 04A02.

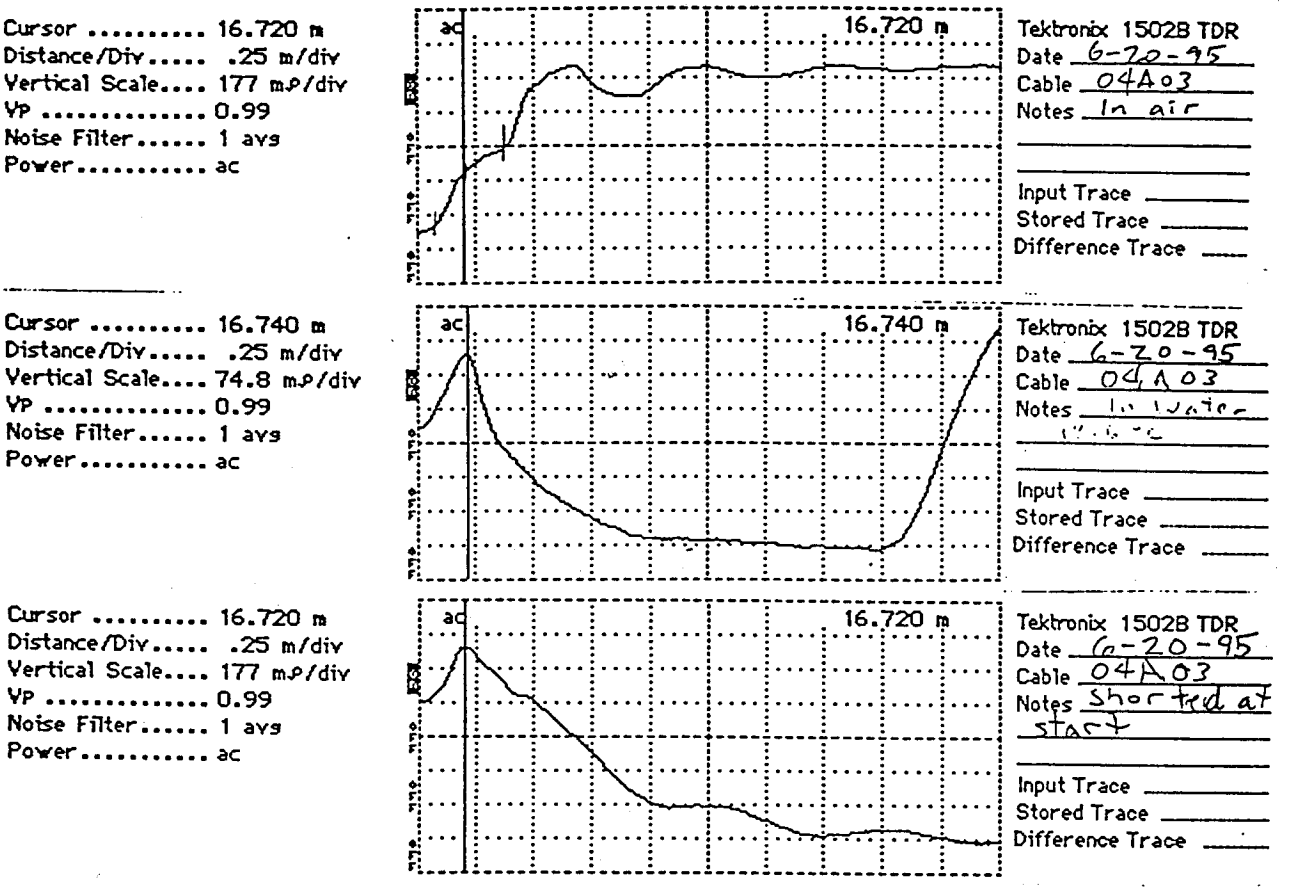


Figure B3. TDR trace obtained during calibration for sensor 04A03.

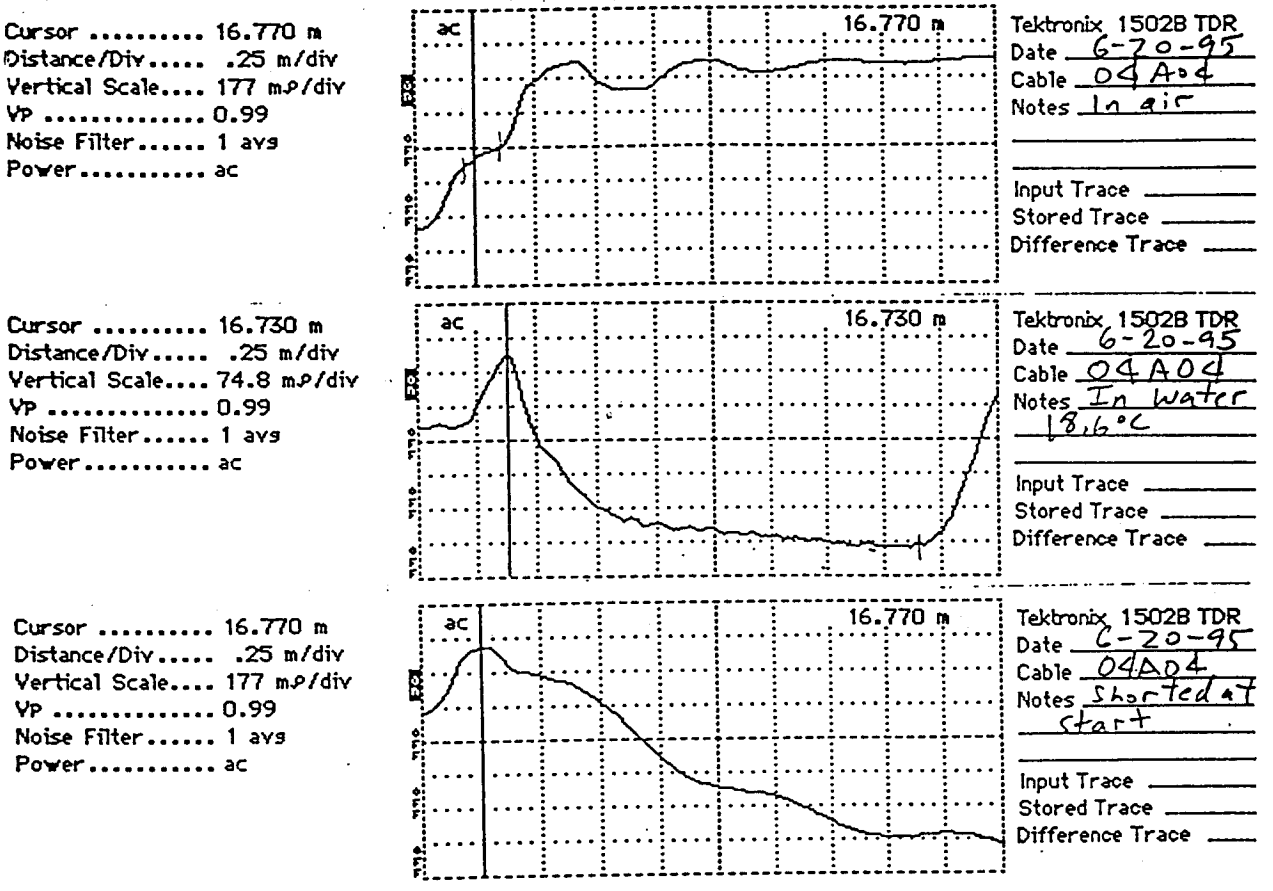


Figure B4. TDR trace obtained during calibration for sensor 04A04.

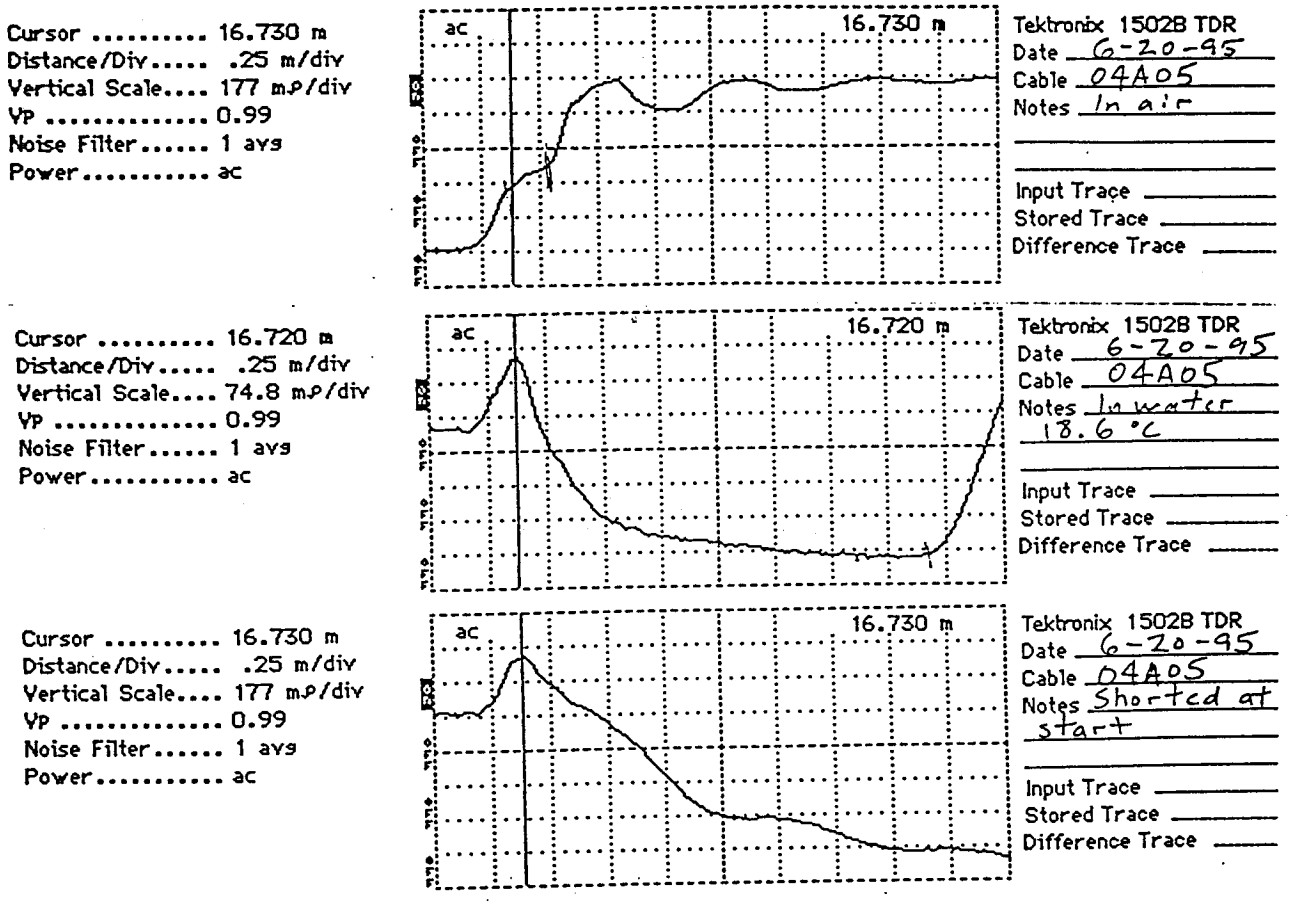


Figure B5. TDR trace obtained during calibration for sensor 04A05.

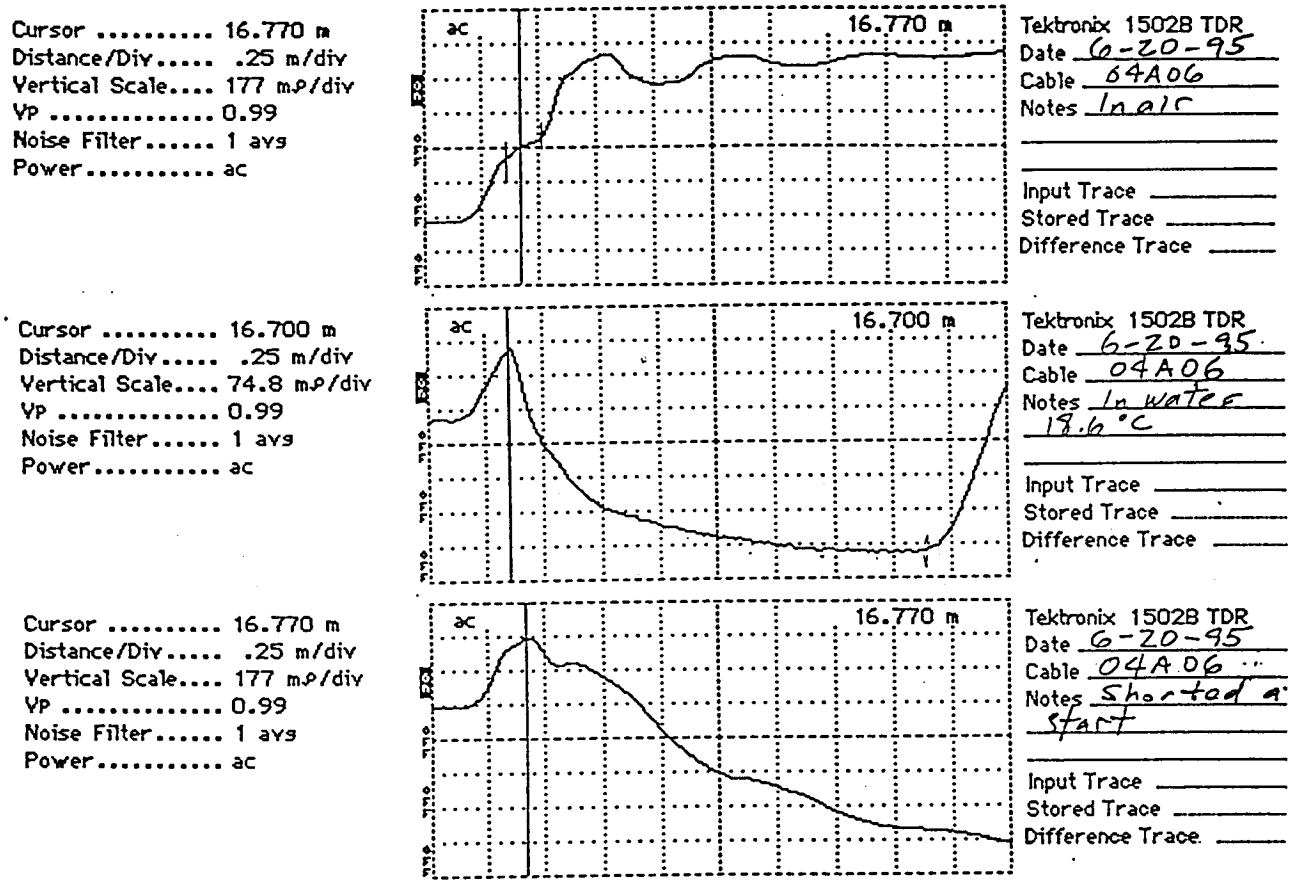


Figure B6. TDR trace obtained during calibration for sensor 04A06.

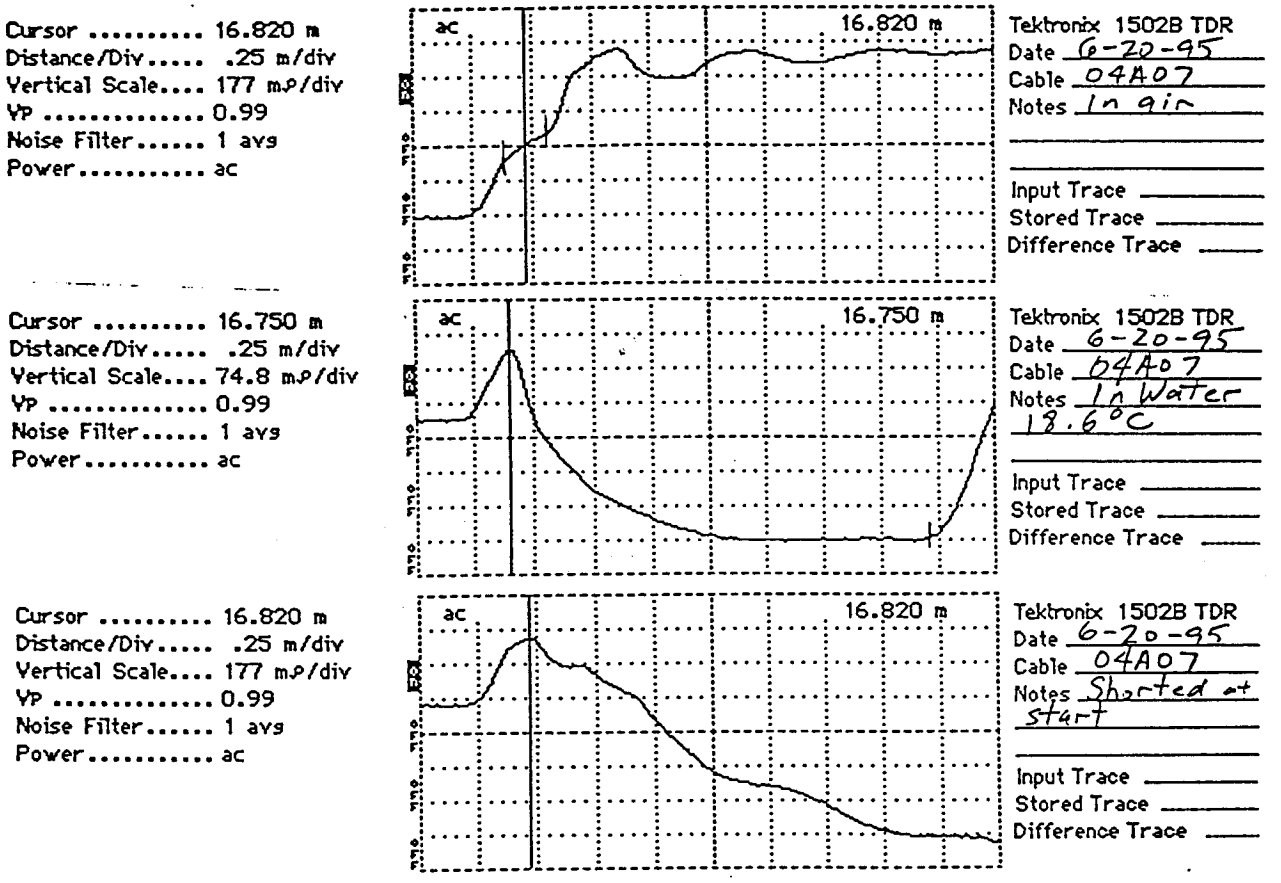


Figure B7. TDR trace obtained during calibration for sensor 04A07.

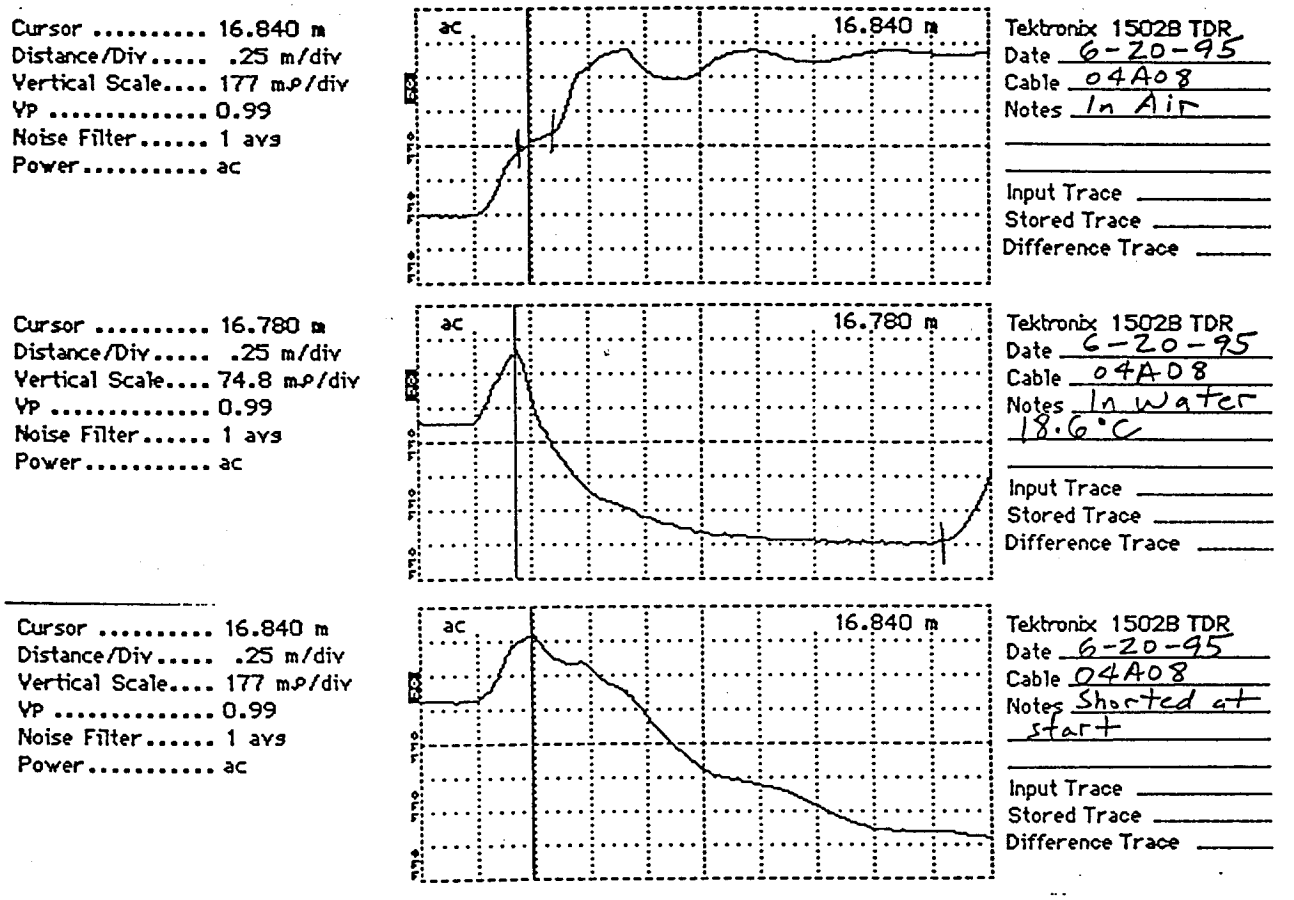


Figure B8. TDR trace obtained during calibration for sensor 04A08.

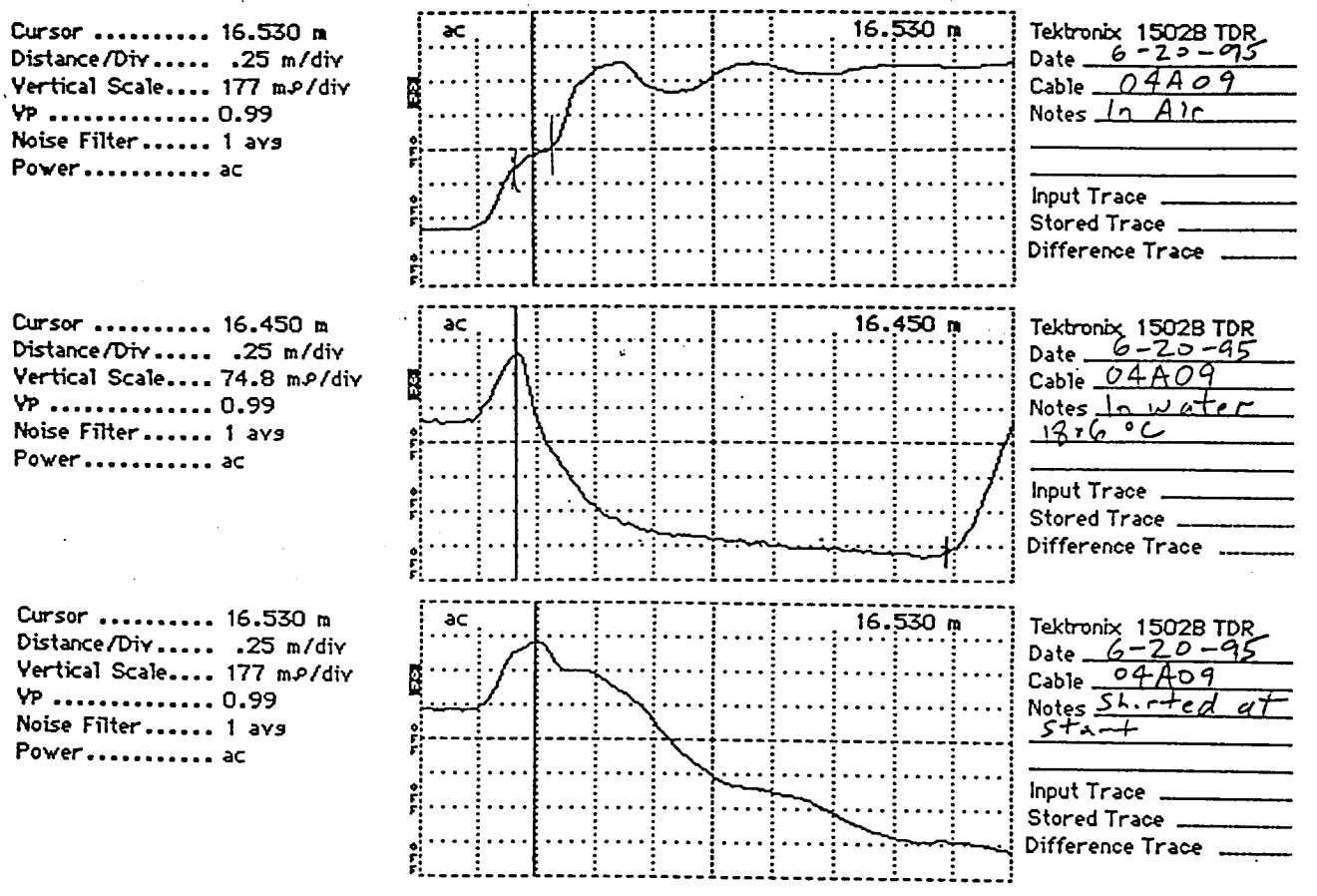
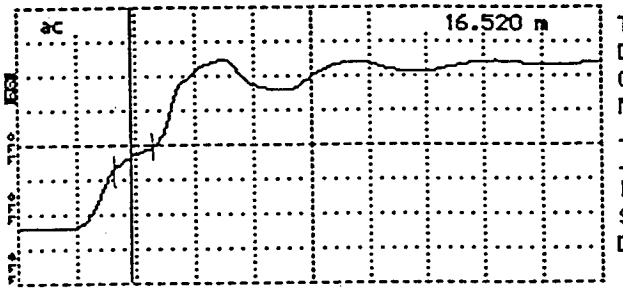


Figure B9. TDR trace obtained during calibration for sensor 04A09.

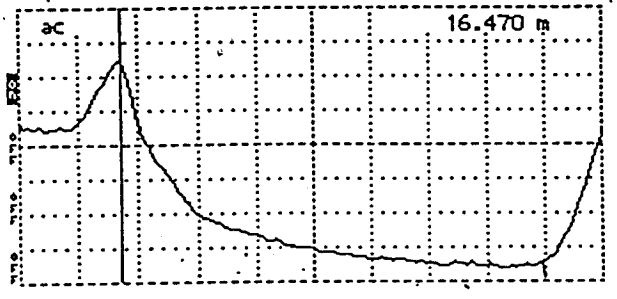
Cursor ..... 16.520 m
Distance/Div..... .25 m/div
Vertical Scale.... 177 mρ/div
Vp 0.99
Noise Filter..... 1 avs
Power..... ac



Tektronix 1502B TDR
Date 6-20-95
Cable 04A10
Notes In Air

Input Trace
Stored Trace
Difference Trace

Cursor ..... 16.470 m
Distance/Div..... .25 m/div
Vertical Scale.... 74.8 mρ/div
Vp 0.99
Noise Filter..... 1 avs
Power..... ac



Tektronix 1502B TDR
Date 6-20-95
Cable 04A10
Notes In water
13.6 °C

Input Trace
Stored Trace
Difference Trace

Cursor ..... 16.520 m
Distance/Div..... .25 m/div
Vertical Scale.... 177 mρ/div
Vp 0.99
Noise Filter..... 1 avs
Power..... ac

Tektronix 1502B TDR
Date 6-20-95
Cable 04A10
Notes Shorted at start

Input Trace
Stored Trace
Difference Trace

B10. TDR trace obtained during calibration for sensor 04A10.

APPENDIX C

Installation Information

Appendix C contains the following supporting information:

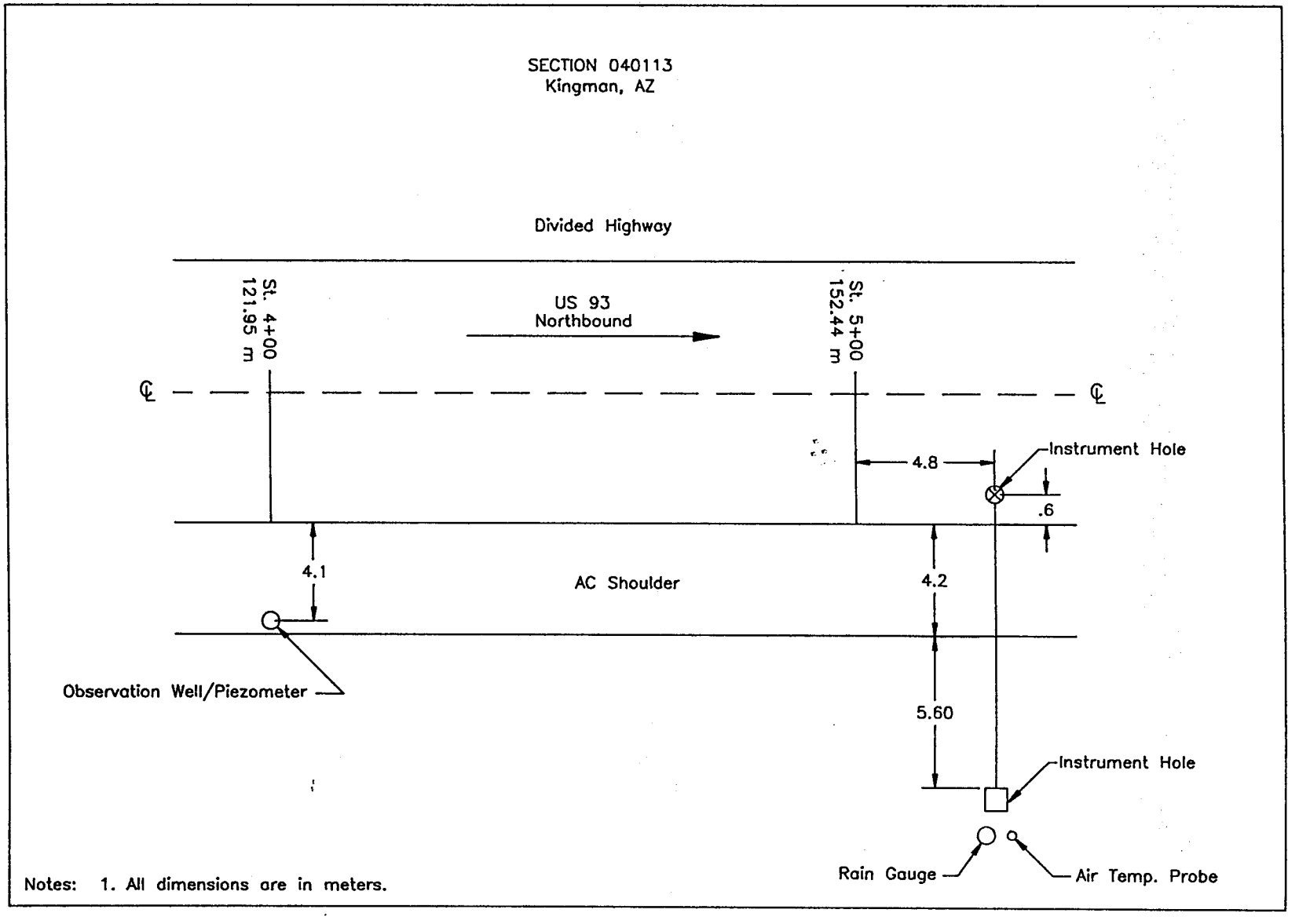


Figure C1. Instrumentation location within the section.

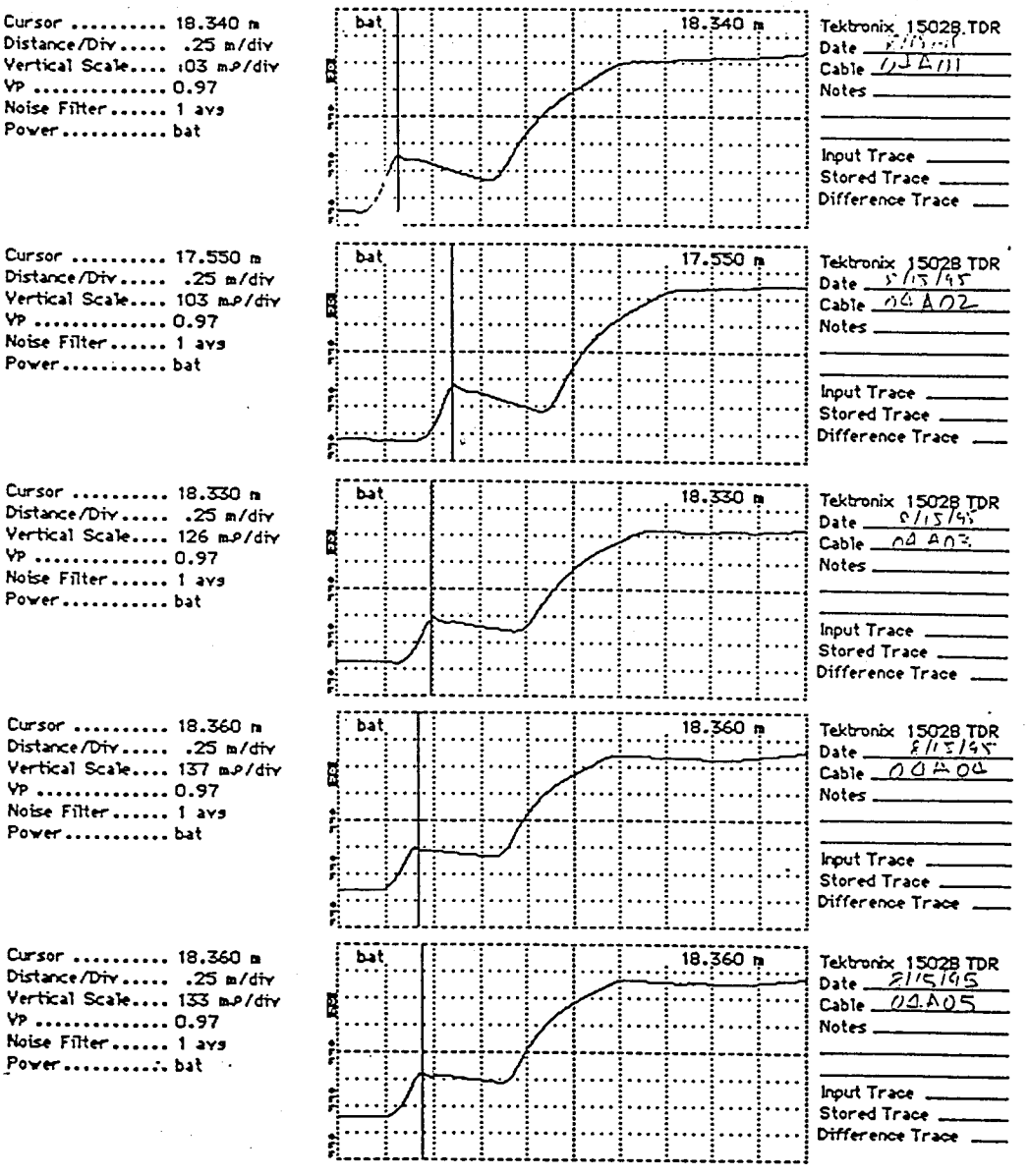


Figure C2. TDR traces measured during installation for sensors 04A01 through 04A05.

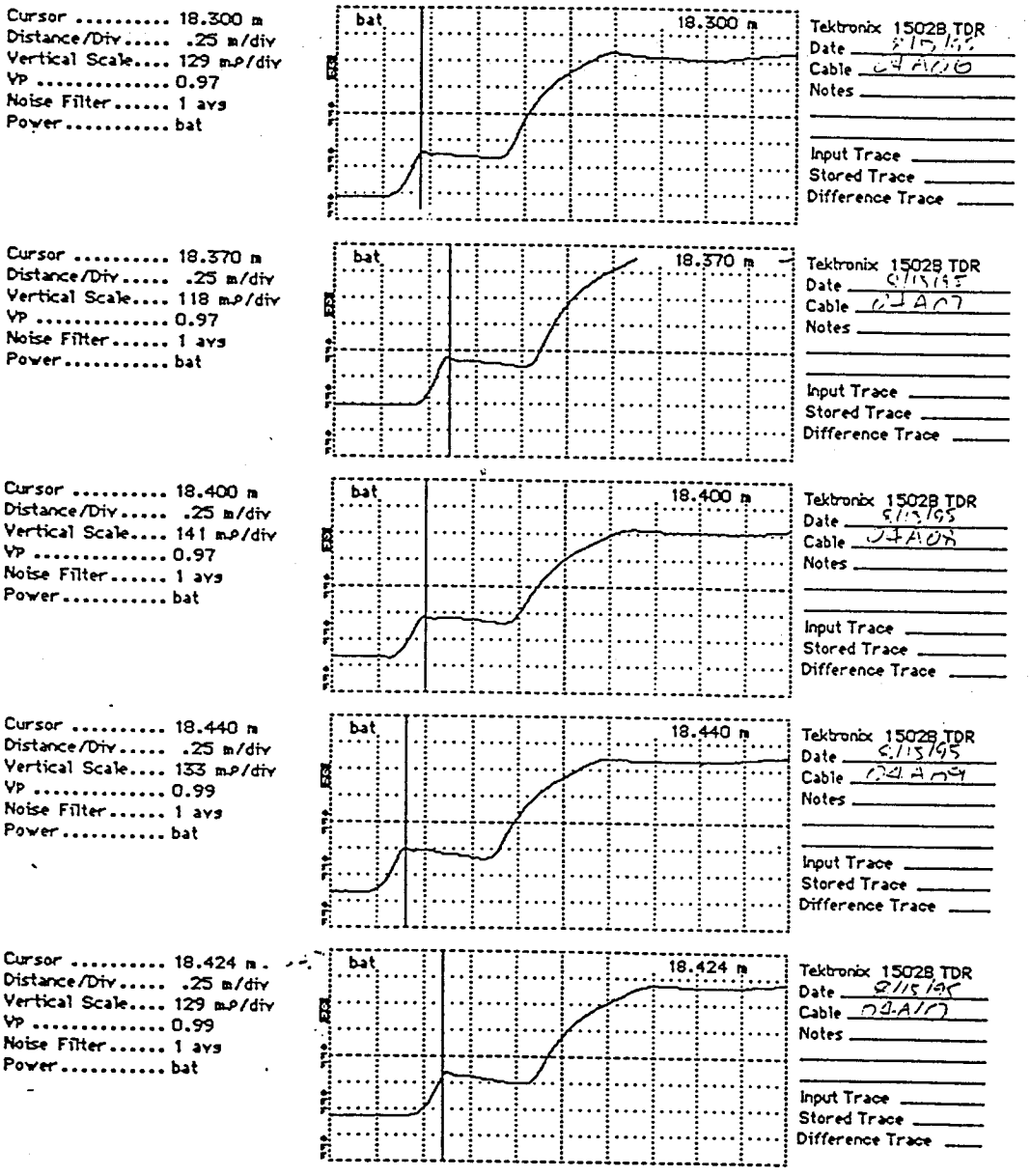


Figure C3. TDR traces measured during installation for sensors 04A06 through 04A10.

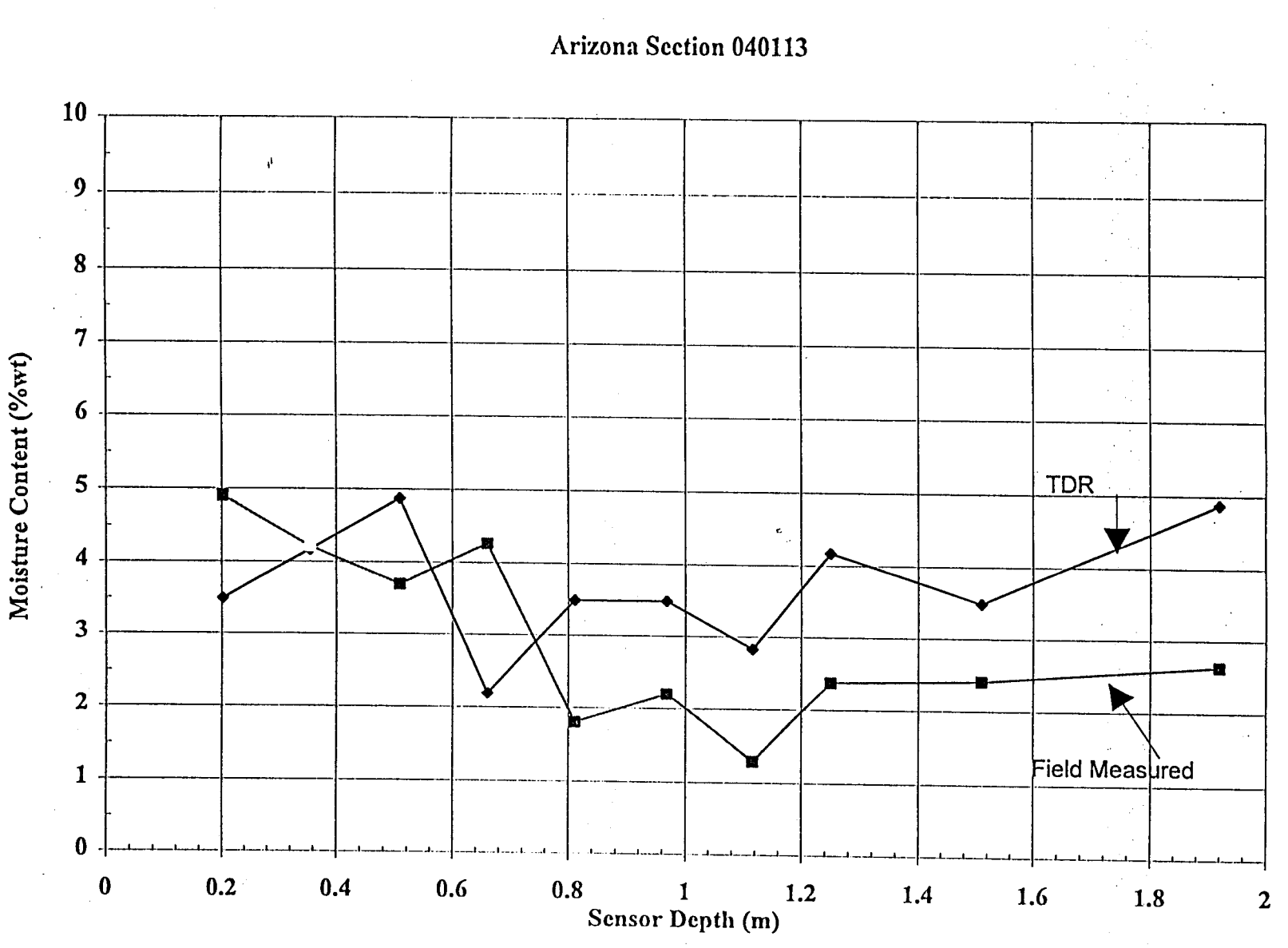


Figure C4. Measured field moisture contents and TDR moisture contents during installation.

Table C1. Measured field moisture contents during installation.

LTPP Seasonal Monitoring Study Field Measured Moisture Contents	* State Code [04] * Test Section Number [0113]

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	4.91
9	4.22
8	3.51
7	4.27
6	1.81
5	2.21
4	1.30
3	2.39
2	2.42
1	2.64

Figure C5. Instrument installation in progress.

Figure C6. Weather station and instrument cabinet.

Figure C7. Instrumentation hole after repair.

Figure C8. Observation well/piezometer.

APPENDIX D

Initial Data Collection

Appendix D includes the following supporting information:

Figure D1. TDR trace recorded by the mobile system during initial data collection, sensor 04A01.
Figure D2. TDR trace measured 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 measured 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 measured by the mobile system during initial data collection, sensor 04A06.
Figure D7. TDR trace recorded by the mobile system during initial data collection, sensor 04A07.
Figure D8. TDR trace measured by the mobile system during initial data collection, sensor 04A08.
Figure D9. TDR trace measured by the mobile system during initial data collection, sensor 04A09.
Figure D10. TDR trace measured by the mobile system during initial data collection, sensor 04A010.

Table D2. Pavement elevations at the time of installation.

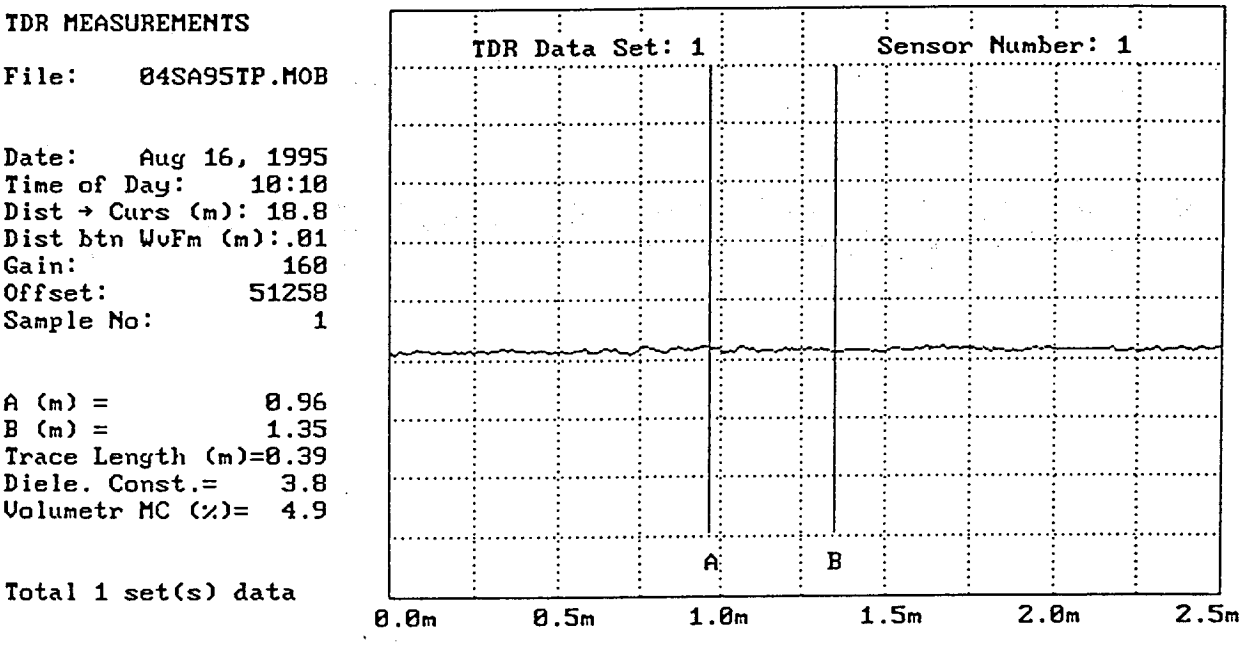


Figure D1. TDR trace recorded by the mobile system during initial data collection, sensor 04A01.

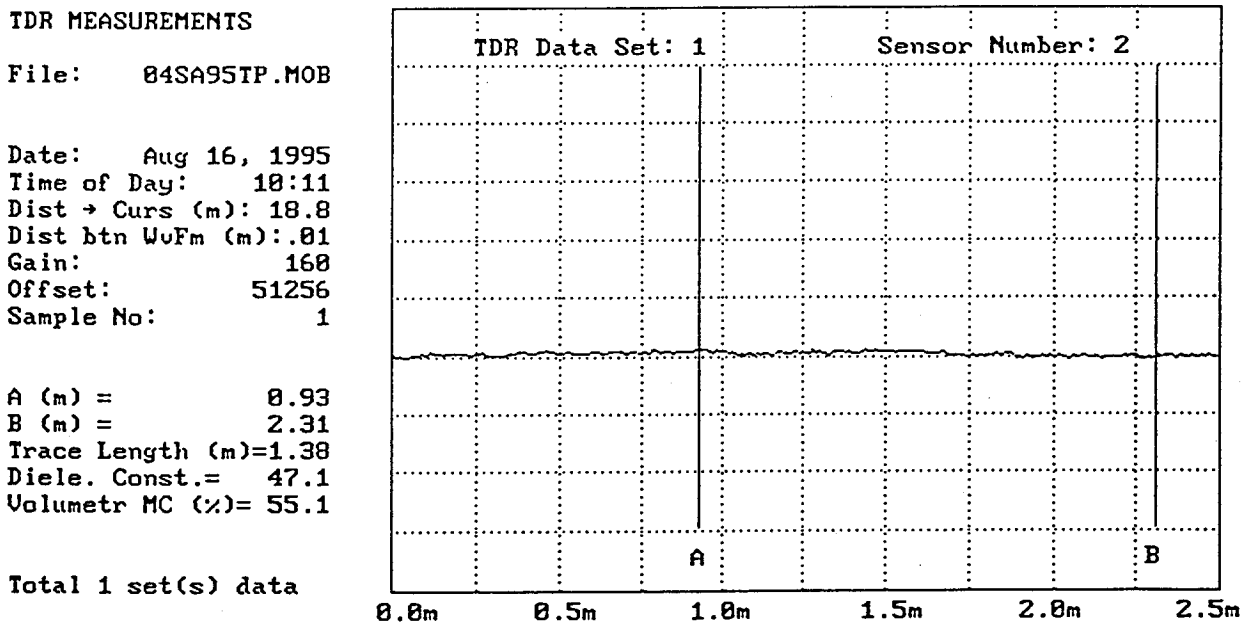


Figure D2. TDR trace measured by the mobile system during initial data collection, sensor 04A02.

TDR MEASUREMENTS

File: 04SA95TP.MOB

Date: Aug 16, 1995
Time of Day: 10:11
Dist → Curs (m): 18.8
Dist btn WvFm (m):.01
Gain: 160
Offset: 51257
Sample No: 1

A (m) = 0.67
B (m) = 2.34
Trace Length (m)=1.67
Diele. Const.= 68.9
Volumetr MC (%)= 75.5

Total 1 set(s) data

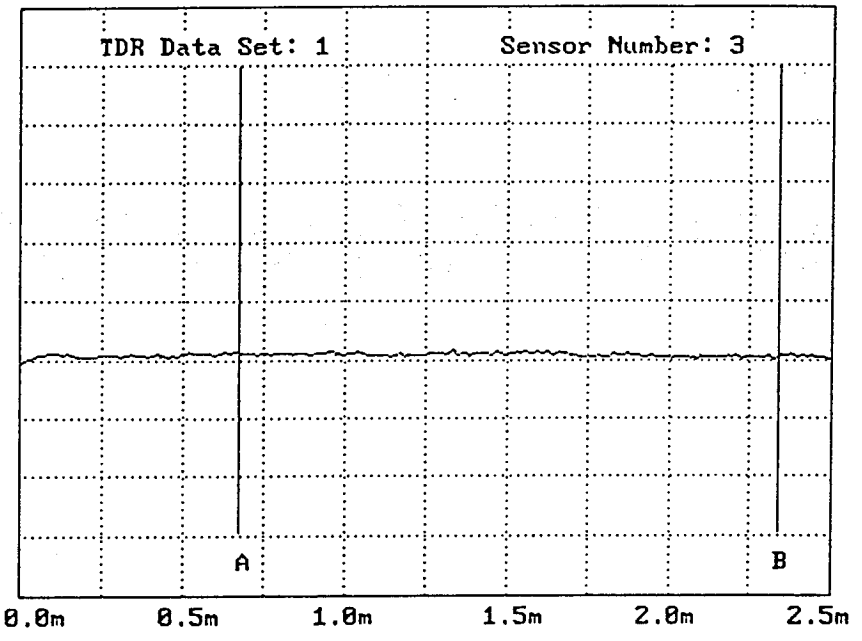


Figure D3. TDR trace recorded by the mobile system during initial data collection, sensor 04A03.

TDR MEASUREMENTS

File: 04SA95TP.MOB

Date: Aug 16, 1995
Time of Day: 10:12
Dist → Curs (m): 18.8
Dist btn WvFm (m):.01
Gain: 160
Offset: 51256
Sample No: 1

A (m) = 0.82
B (m) = 1.15
Trace Length (m)=0.33
Diele. Const.= 2.7
Volumetr MC (%)= 2.2

Total 1 set(s) data

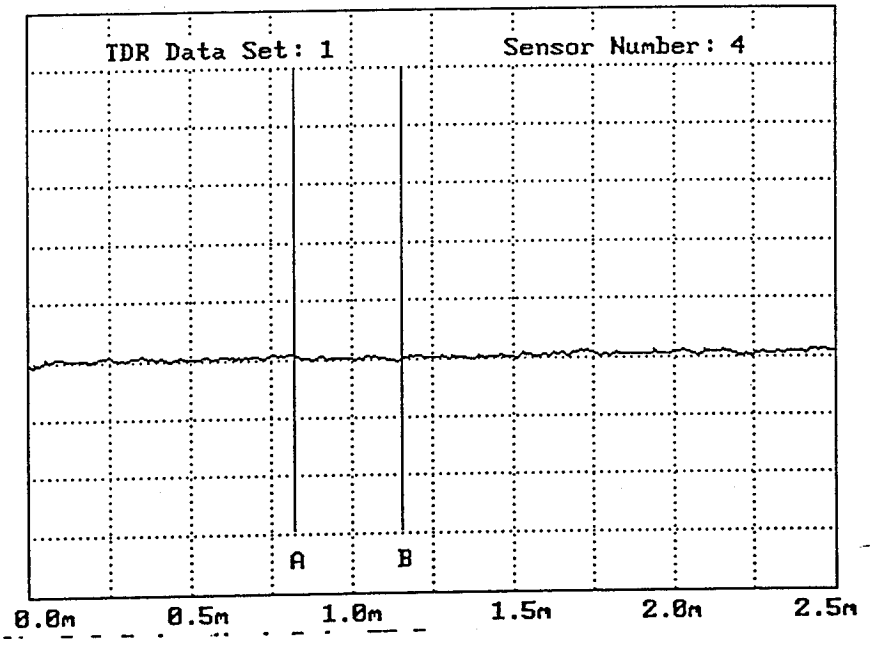


Figure D4. TDR trace measured by the mobile system during initial data collection, sensor 04A04.

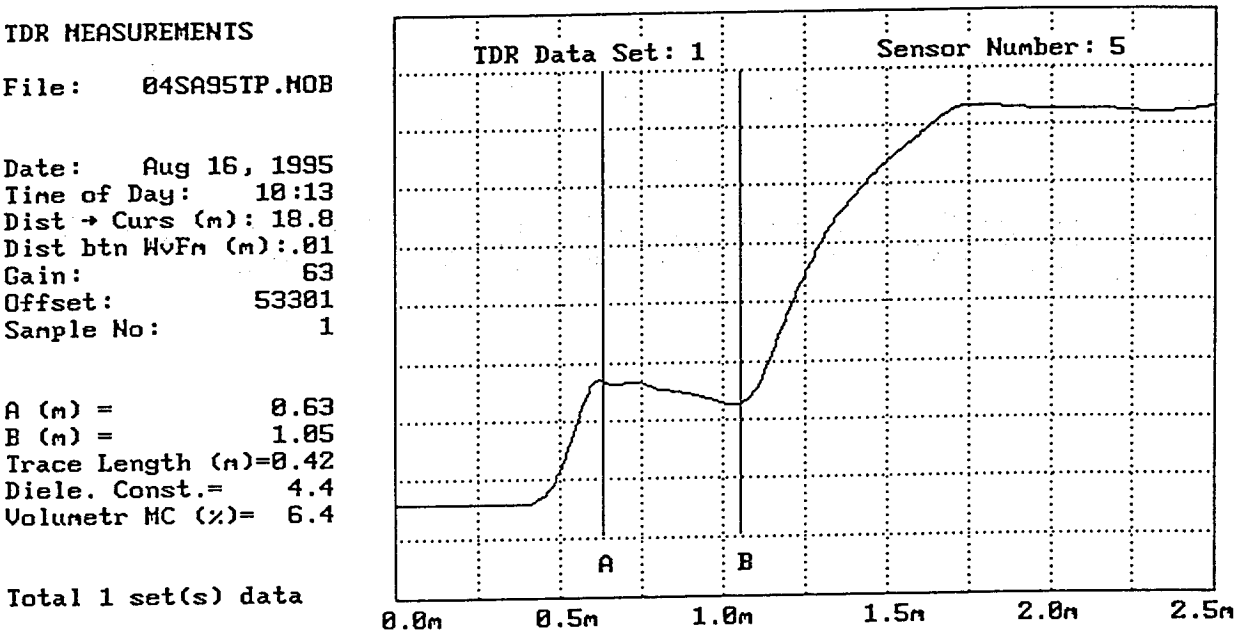


Figure D5. TDR trace recorded by the mobile system during initial data collection, sensor 04A05.

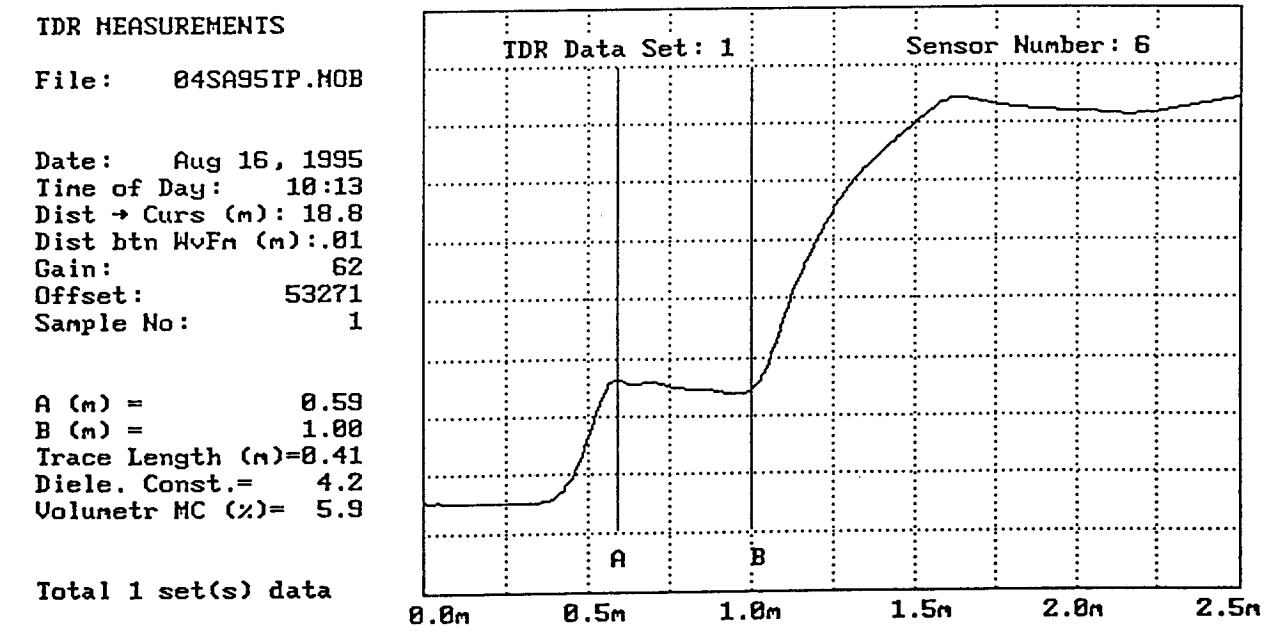


Figure D6. TDR trace measured by the mobile system during initial data collection, sensor 04A06.

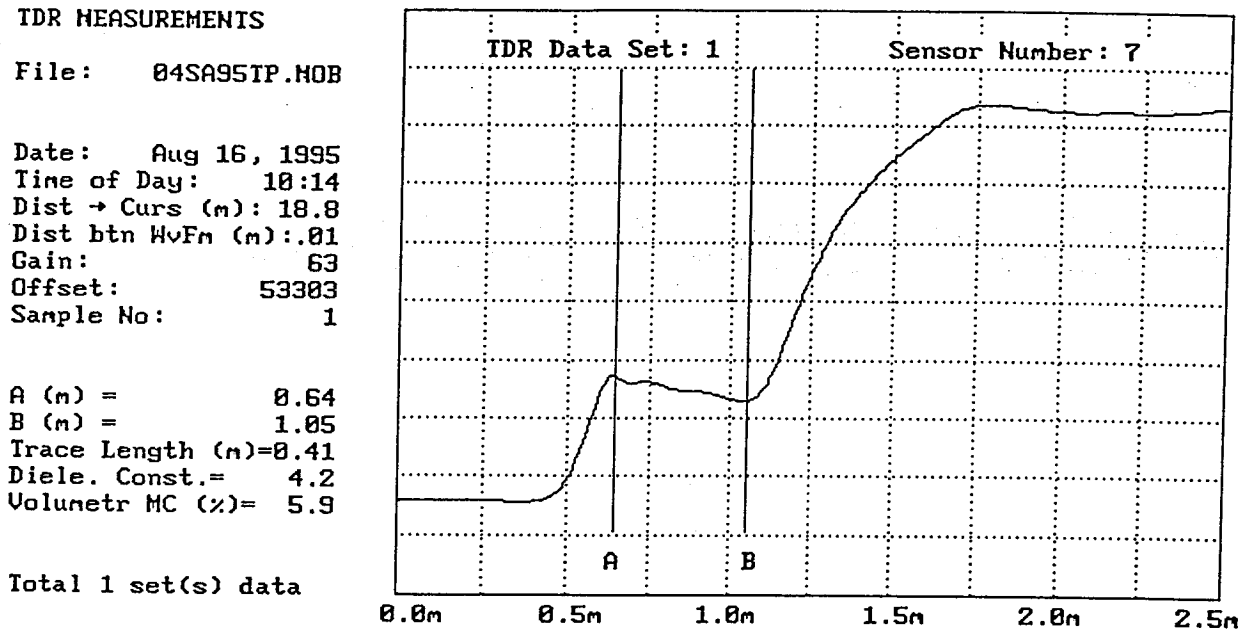


Figure D7. TDR trace recorded by the mobile system during initial data collection, sensor 04A07.

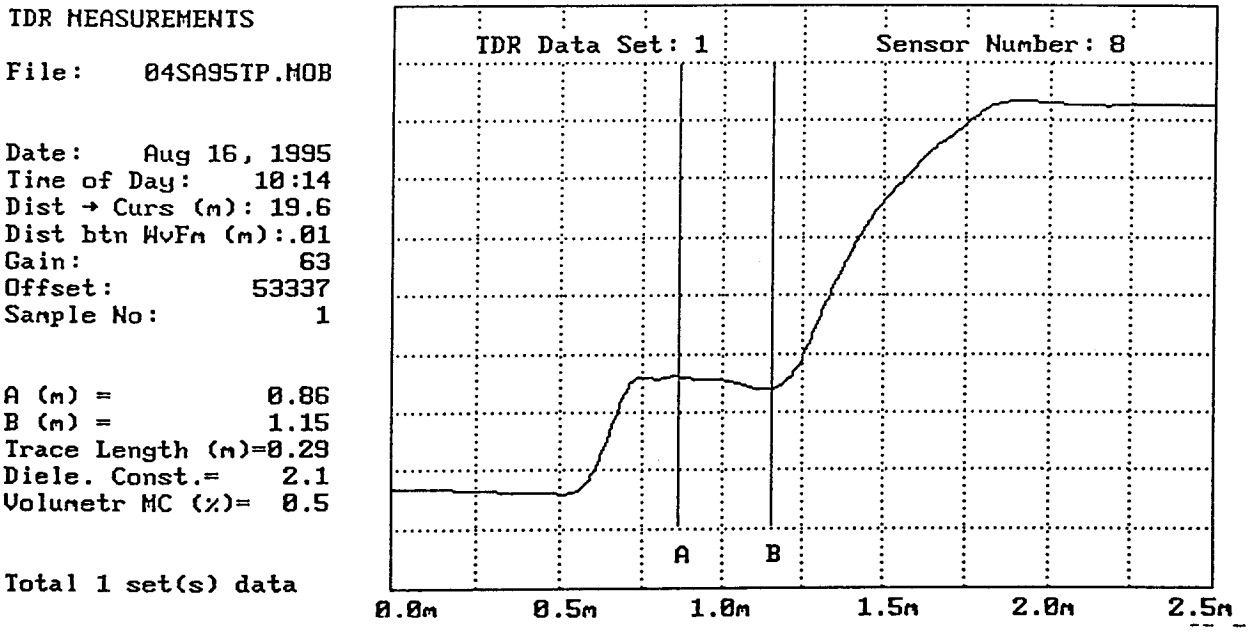


Figure D8. TDR trace measured by the mobile system during initial data collection, sensor 04A08.

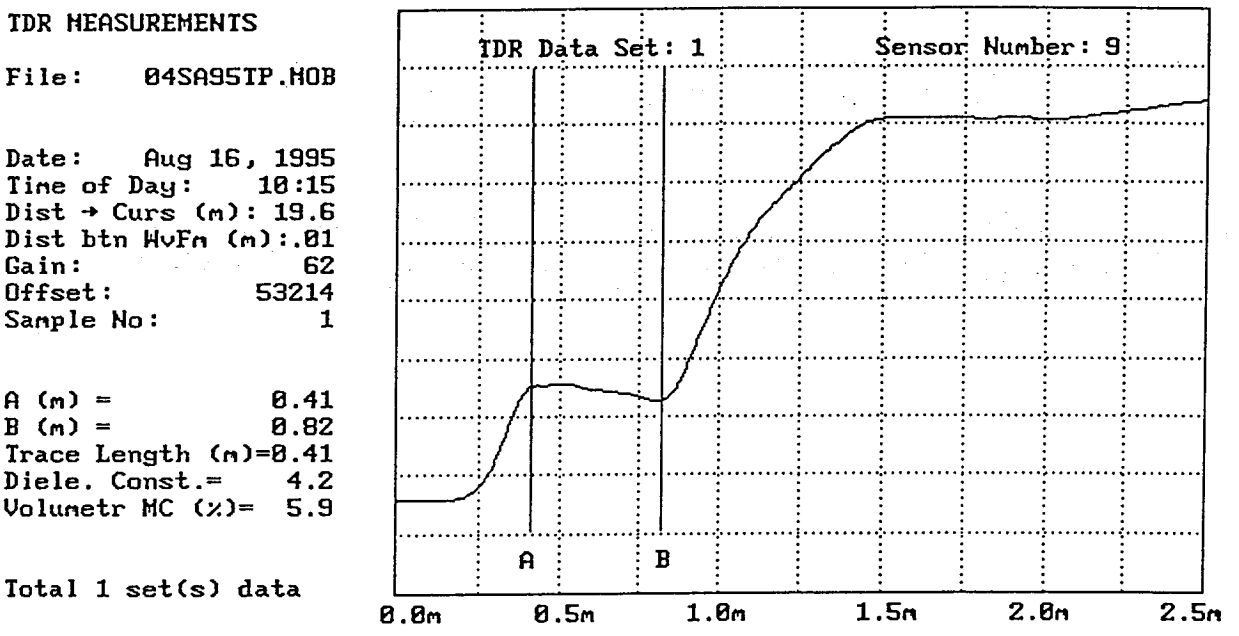


Figure D9. TDR trace recorded by the mobile system during initial data collection, sensor 04A09.

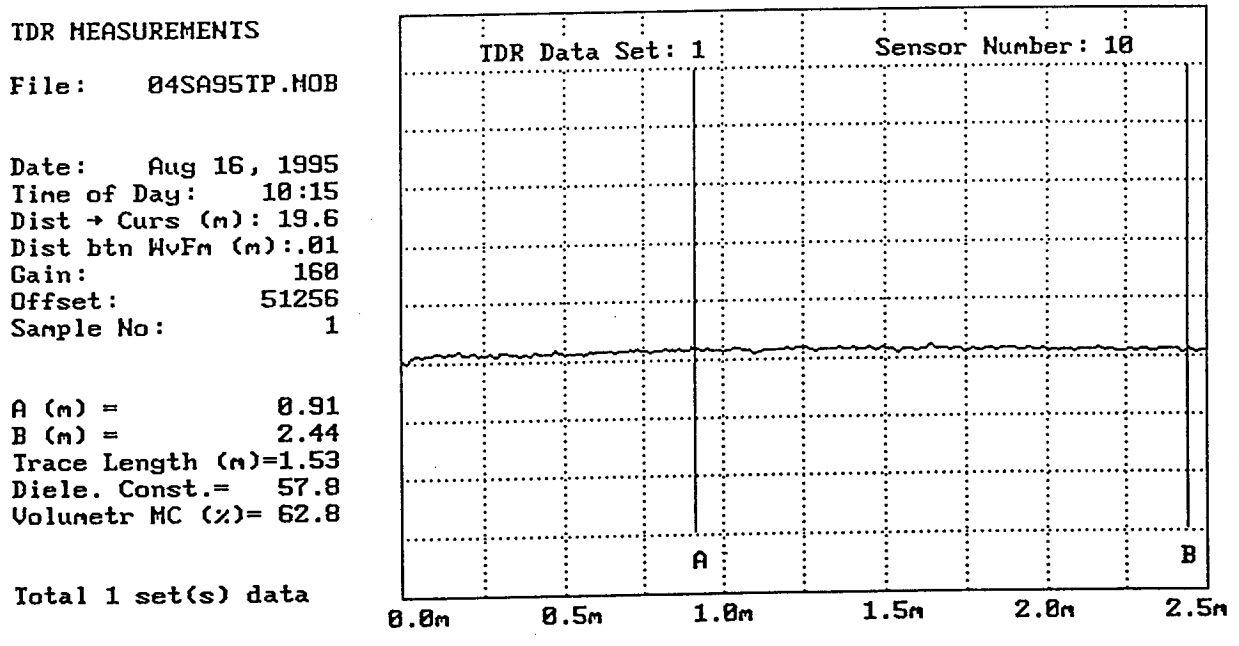


Figure D10. TDR trace measured by the mobile system during initial data collection, sensor 04A010.

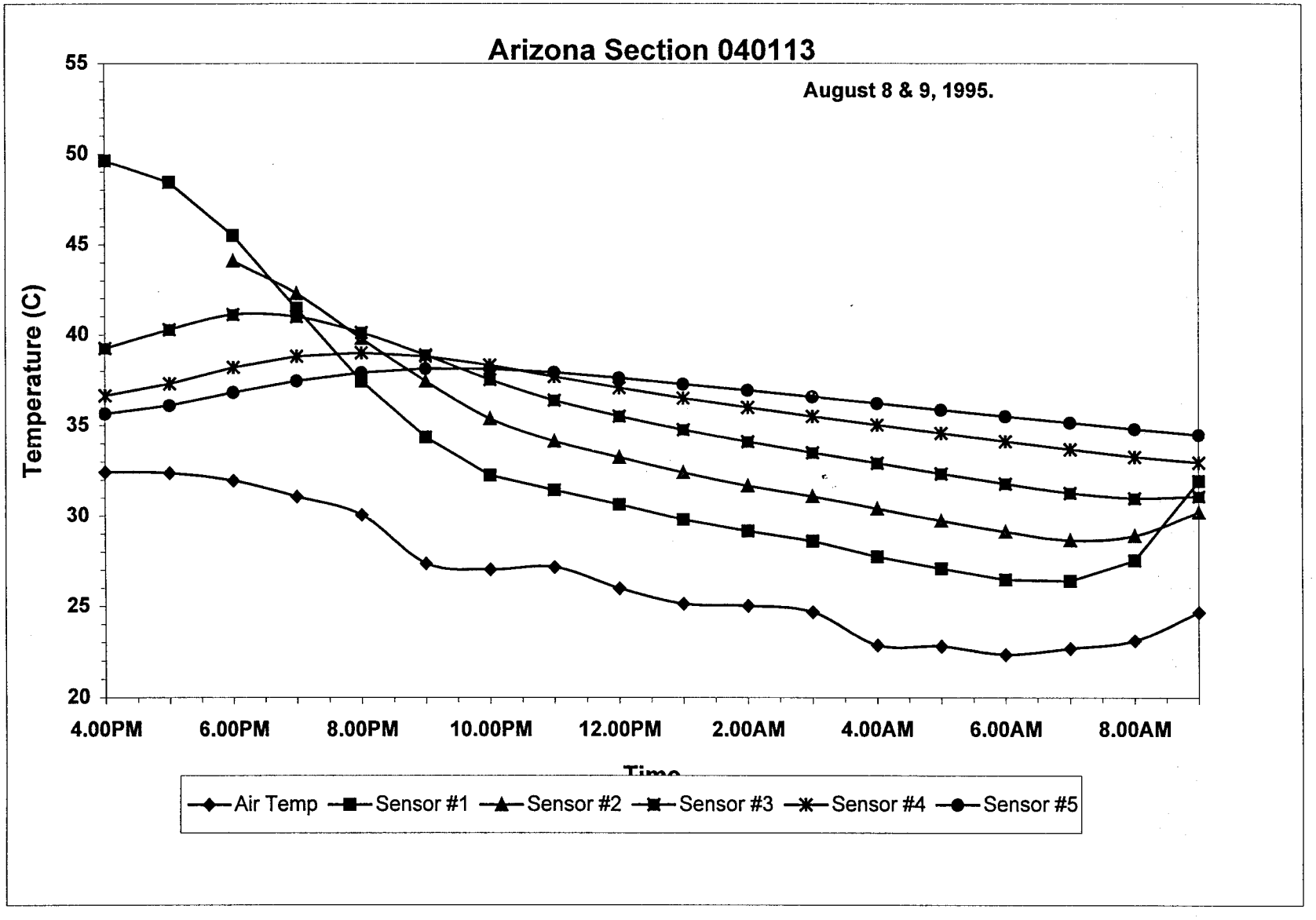


Figure D11. Hourly average air and top 5 sensor temperature recorded during initial data collection.

Table D1. Onsite Raw Data Collected by the Datalogger.

5	1995	227	1600	12.62	32.44	0																			
6	1995	227	1600	49.63	206.1	39.26	36.66	35.66																	
5	1995	227	1700	12.62	32.39	0																			
6	1995	227	1700	48.43	58.13	40.28	37.3	36.12																	
5	1995	227	1800	12.62	31.97	0																			
6	1995	227	1800	45.51	44.1	41.11	38.2	36.83																	
5	1995	227	1900	12.62	31.09	0																			
6	1995	227	1900	41.46	42.28	40.99	38.81	37.46																	
5	1995	227	2000	12.61	30.06	0																			
6	1995	227	2000	37.44	39.8	40.12	39.01	37.92																	
5	1995	227	2100	12.6	27.37	0																			
6	1995	227	2100	34.36	37.44	38.88	38.81	38.14																	
5	1995	227	2200	12.6	27.04	0																			
6	1995	227	2200	32.26	35.38	37.53	38.33	38.13																	
5	1995	227	2300	12.59	27.16	0																			
6	1995	227	2300	31.44	34.13	36.39	37.7	37.93																	
1	1995	227	2400	12.61	12.63	1556	12.59	2153	29.26	33.09	1630	25.61	2345	0	4067										
2	1995	227	2400	38.15	46.87	38.87	38.1	37.45	36.84	36.52	36.36	36.42	36.39	36.31	35.93	35.55	35.05	34.7	34.19	33.75	33.23				
3	1995	227	2400	49.77	1550	207.6	1543	41.2	1741	39.04	1918	38.18	2036	37.65	2228	37.36	2337	37.1	2359	36.84	2345	36.66	2304	36.4	
4	1995	227	2400	30.22	2359	32.81	0	35.15	2359	36.51	1542	35.56	1542	35.25	1544	35.27	1542	35.33	1543	35.62	1544	35.75	1542	36.06	
5	1995	227	2400	12.59	25.99	0																			
6	1995	227	2400	30.64	33.24	35.52	37.08	37.63																	
5	1995	228	100	12.59	25.14	0																			
6	1995	228	100	29.79	32.41	34.77	36.52	37.28																	
5	1995	228	200	12.59	25.03	0																			
6	1995	228	200	29.16	31.68	34.1	36	36.94																	
5	1995	228	300	12.59	24.68	0																			
6	1995	228	300	28.6	31.08	33.5	35.51	36.58																	
5	1995	228	400	12.58	22.86	0																			
6	1995	228	400	27.73	30.4	32.93	35.04	36.22																	
5	1995	228	500	12.58	22.8	0																			
6	1995	228	500	27.08	29.73	32.35	34.58	35.87																	
5	1995	228	600	12.58	22.34	0																			
6	1995	228	600	26.46	29.12	31.79	34.12	35.51																	
5	1995	228	700	12.58	22.68	0																			
6	1995	228	700	26.39	28.64	31.28	33.67	35.16																	
5	1995	228	800	12.58	23.11	0																			
6	1995	228	800	27.52	28.89	30.99	33.26	34.8																	

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